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THE VERMONT AGENCY OF TRANSPORTATION "POLICIES AND PROCEDURES FOR PREQUALIFICATION, BIDDING, AND AWARD OF CONTRACTS", LATEST EDITION, IS HEREBY INCORPORATED IN THESE SPECIFICATIONS AND THE CONTRACT BY REFERENCE.

DIVISION 100

GENERAL PROVISIONS

SECTION 101 - DEFINITIONS AND TERMS

101.01 ABBREVIATIONS. Wherever the following abbreviations are used in these Specifications or on the Plans, they are to be construed the same as the respective expressions represented:

A	Ampere(s)
A	Arch (Section 601)
ABS	Acrylonitrile-Butadiene-Styrene
ADA	Americans with Disabilities Act
AAN	Americans Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
Amp(s)	Ampere(s)
AMRL	AASHTO Materials and Reference Laboratory
ANR	Agency of Natural Resources
ANSI	American National Standards Institute
AREA	American Railway Engineering Association
AREMA	American Railway Engineering and Maintenance–of–Way Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASR	Alkali-Silica Reactivity
ASTM	American International Standards Worldwide
AWPA	American Wood-Preservers' Association
AWS	American Welding Society

AWWA	American Water Works Association
BTU	British Thermal Unit
ºC	Degrees Celsius
CAAP	Corrugated Aluminum Alloy Pipe
CCRL	Cement and Concrete Reference Laboratory
CF, FT^3, ft^3	Cubic Foot (Feet)
CFR	Code of Federal Regulations
CIP	Cast Iron Pipe
CM, M^3or m^3	Cubic Meter(s)
CPEP	Corrugated Polyethylene Pipe
CPM	Critical Path Method
CRSI	Concrete Reinforcing Steel Institute
CSP	Corrugated Steel Pipe
CWT	Hundredweight
CY, YD^3, yd^3	Cubic Yard(s)
DIP	Ductile Iron Pipe
DN	Diameter nominal for metric pipes
DTA	District Transportation Administrator
EA	Each
EPA	Environmental Protection Agency
ES	End Section (Section 601)
ºF	Degrees Fahrenheit
FAA	Federal Aviation Administration, US Department of Transportation
FHWA	Federal Highway Administration, US Department of Transportation
FRA	Federal Railroad Administration, US Department of Transportation
FSS	Federal Specifications and Standards (General Services Administration)
FTA	Federal Transit Administration, US Department of Transportation
G or g	Gram(s)
Gal or gal	Gallon(s)
HA or ha	Hectare(s)
HDPE	High Density Polyethylene
Hz	Hertz
in^2	Square Inch(es)
ISEA	International Safety Equipment Association
ISO	International Standards Organization
ITE	Institute of Transportation Engineers
J	Joule(s)
KG or kg	Kilogram(s)
kips	Thousand pounds
KM or km	Kilometer(s)

kN	Kilonewton(s)
kPa	Kilopascal(s)
Kw	Kilowatt(s)
lbf	Pounds of Force
L	Liter(s)
Lb(s) or lb(s)	Pound(s)
LF	Linear Foot (Feet)
LRFD	Load and Resistance Factor Design
LS	Lump Sum
LU	Lump Unit
M or m	Meter(s)
mm	Millimeter(s)
MC	Medium Curing
MS	Medium Set
MFBM	Thousand Feet Board Measure
MGAL	Thousand Gallons
MNL	Manual
MPa	Megapascal(s)
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
NBFU	National Board of Fire Underwriters
NCHRP	National Cooperative Highway Research Program
NDS	National Design Specification
NDT	Nondestructive Testing
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NETC	New England Transportation Consortium
NHS	National Highway System
NIST	National Institute of Standards and Technology
NPS	Nominal Pipe Size
NSBA	National Steel Bridge Alliance
NSPE	National Society of Professional Engineers
OSHA	Occupational Safety and Health Administration
Pa	Pascal(s)
PCA	Portland Cement Association
PCC	Portland Cement Concrete
PCCSP	Polymeric Coated Corrugated Steel Pipe
PCI	Precast/Prestressed Concrete Institute
PI	Paved Invert
PSI or psi	Pounds Per Square Inch
PVC	Polyvinyl Chloride
QA	Quality Acceptance

QC	Quality Control
RAP	Recycled Asphalt Pavement
RCP	Reinforced Concrete Pipe
RC	Rapid Curing
RS	Rapid Set
ROW or R.O.W	Right-Of-Way
RT	Refined Tar
SAE	Society of Automotive Engineers
SF, FT^2, ft^2	Square Foot (Feet)
SM, M^2 or m^2	Square Meter(s)
SI	The International System of Units. The version of the metric system used in these Specifications.
SL	Smooth Lined
SSPC	Steel Structures Painting Council
SY, YD^2, yd^2	Square Yard(s)
T	Metric Ton
TL	Test Level (NCHRP 350)
UL	Underwriters' Laboratories, Inc.
µm	Micrometer
µW	Microwatt
USC or U.S.C.	United States Code
UTO	Uniformed Traffic Officer(s)
V	Volt(s)
VAOT, AOT or VTrans	Vermont Agency of Transportation
VCP	Vitrified Clay Pipe
VOSHA	Vermont Occupational Safety and Health Act
VSA or V.S.A.	Vermont Statutes Annotated
W	Watt
YD or yd	Yard(s)

All standard recognized abbreviations may be used in connection with the Contract.

101.02 DEFINITIONS. Wherever in these Specifications or in other Contract Documents the following terms or pronouns in place of them are used, the intent and meaning shall be interpreted as follows:

ACCEPTANCE DATE - Date noted in the Completion and Acceptance memorandum on which designated responsible Agency personnel have accepted the completeness and quality of all material incorporated in and work performed to complete the project(s).

ACTUAL COMPLETION DATE – Date noted in the Completion and Acceptance memorandum on which designated responsible Agency personnel have reviewed the project(s) and determined that all Contract work is complete and all Contract requirements have been met, generally considered to be the last day the Contractor performed physical work on any Contract item.

ACT OF GOD - An "Act of God" means an earthquake, flood, cyclone, or other cataclysmic phenomena of nature beyond the ability of a prudent Contractor to foresee and make preparation to defend against damage.

AGENCY - Agency of Transportation, State of Vermont (VAOT or VTrans).

AGGREGATE - Inert material such as sand, gravel, crushed gravel, broken stone, or crushed stone, or a combination thereof.

APPROVED PRODUCTS LIST (APL) – A listing of products and materials that have been tested and/or evaluated by the Materials and Research Section and have been deemed satisfactory for use on Agency projects without additional certification requirements.

AUTHORIZED REPRESENTATIVE

> Contractor's – An individual registered with the Office of Contract Administration having the legal authority to sign Contract documents on behalf of the Contractor.
>
> Agency's – The Director of Program Development's Duly Authorized Representative(s) who are responsible for engineering supervision of the construction project.

BASE COURSE - The layer or layers of specified or selected material of designed thickness on a subbase to support a surface course.

BOARD - Transportation Board of the State of Vermont or its successor.

BRIDGE - A structure, including supports, erected over a depression or an obstruction such as water, a highway, or a railway, having a track or passageway for carrying traffic or other moving loads and having a clear span of more than 6.1 m (20 feet) [1.8 m (6 feet) on Non-Federal-Aid projects] measured along the center of the roadway between abutments, spring lines of arches, extreme ends of openings for multiple boxes, or multiple pipes where the clear distance between openings is less than 50 percent of the smaller contiguous opening.

Bridge Length - The dimension of a structure measured along the center of the roadway between backs of abutment backwalls or between the ends of a bridge floor, whichever is greater.

Bridge Width - The clear dimension of structure measured at right angles to the center of the roadway between the inner faces of parapet or railing.

CALENDAR DAY - Any day shown on the calendar, beginning and ending at midnight.

CHANGE ORDER/SUPPLEMENTAL AGREEMENT - A written agreement made and entered into by and between the Contractor and the Agency covering work not otherwise provided for in the Contract, revisions in or amendments to the terms of the Contract, an increase to the original quantities as set forth in the original Contract proposal, or conditions specifically described in these Specifications as requiring a change order or Supplemental Agreement. Change Orders/Supplemental Agreements constitute amendments to the original Contract once properly signed and executed.

CHANNEL - A natural or artificial water course.

CHIEF ENGINEER - See DIRECTOR OF PROGRAM DEVELOPMENT.

CHIEF OF UTILITIES AND PERMITS – The Agency's authorized representative to perform all liaison and negotiation between utility companies and the Agency to ensure conflicting utility facilities are relocated as part of transportation projects.

CLAIM

Contractor's Claim - A claim by the Contractor for adjustment or dispute under Subsection 105.20.

Damage Claim - A claim by an individual or entity for damage to property or for personal injury.

Labor and Materials Claim - A claim by a subcontractor, supplier, or other entity covered by 19 V.S.A. Section 10(9) for monies claimed to be due and payable.

CLEAR ZONE - The roadside border area starting at the edge of the traveled way available for use by errant vehicles. Specified clear zones are as shown in the Plans.

COLLUSION - A secret agreement among two or more persons for a deceitful or fraudulent purpose.

CONDUIT - A tube used for carrying, holding, and protecting electrical or other utilities.

CONSTRUCTION AREA - The entire portion of a project site within the right-of-way and easement limits during construction.

CONSTRUCTION EASEMENT - See EASEMENT

CONSTRUCTION ENGINEER - The duly authorized representative of the Agency responsible for engineering supervision of a specific project after the Contract has been signed and until project completion and final acceptance.

CONSTRUCTION ENVIRONMENTAL ENGINEER – The Agency's authorized representative of the Construction Section to provide guidance and technical assistance to Resident Engineers and Contractors in order to maintain compliance with environmental regulations. This representative is responsible for reviewing, approving and, as necessary, submitting information related to erosion prevention and sediment control to the Agency of Natural Resources Water Quality Division for authorization.

CONSTRUCTION SERVICES ENGINEER – The duly authorized representative of the Construction Engineer for the purposes of providing expertise in matters of claims, specifications, policy, procedures, and Contract finals.

CONTRACT - The written agreement between the Agency and the Contractor setting forth the obligations of the parties relative to the performance of the work.

The Contract includes the invitation for bids, proposal, Contract agreement, Contract bonds, Project Permits, Special Provisions, Contract Plans, General Special Provisions, Standard Drawings, Supplemental Specifications, *the Standard Specifications for Construction*, Notice to Proceed, and any supplemental agreements that are required to complete the work in an acceptable manner.

CONTRACT BONDS - The approved forms of security, signed and furnished by the Contractor and the Contractor's surety or sureties, guaranteeing complete performance of the Contract, compliance with the Contract, and the payment of all legal debts pertaining to the construction of the project or work.

CONTRACT COMPLETION DATE - The calendar date by which the work shall be completed. If the Contract is a duration type Contract, the Notice to Proceed shall also indicate the Contract Completion Date.

CONTRACT DOCUMENTS - See CONTRACT.

CONTRACT DURATION - The number of working days or calendar days allowed for completion of the Contract.

CONTRACT ITEM - A specific unit of work for which a price is provided in the Contract.

CONTRACTOR - The individual, partnership, firm, corporation, any acceptable combination thereof, or a joint venture which is a party to the Contract with the Agency which is undertaking the performance of the work under the terms of the Contract and acting directly or through its agent(s) or employee(s). The term "Contractor" means the prime Contractor as differentiated from a subcontractor. All Contractors must be registered with the Secretary of State. The Contractor will act in an independent capacity and not as officers or employees of the State.

CONTRACT PLANS - The Contract drawings that show the location, character, and dimensions of the work, including layouts, profiles, cross-sections, and other details. See also PLANS.

CPM (CRITICAL PATH METHOD) – A Schedule that must depict work activities in a time-based, logic diagram format showing the relationship with preceding and succeeding activities with the critical path clearly indicated.

DETOUR - A temporary route to carry traffic.

DIAMETER NOMINAL (DN) — The metric version of nominal pipe size (NPS), applying to all plumbing, gas, oil, drainage, and other piping used in the project.

DIRECTOR or DIRECTOR OF PROGRAM DEVELOPMENT – Director of the Program Development Division of the Agency.

Wherever the terms "Director," "Chief Engineer," "Director of Engineering and Construction," "Director of Construction and Maintenance," or "Director of Project Development" appear in the Contract Document, they shall be read as, and shall mean, "Director of Program Development."

DISTRICT TRANSPORTATION ADMINISTRATOR (DTA) - The duly authorized representative of the Agency for a maintenance district subdivision of the State who is responsible for maintenance of State transportation facilities.

DRAINAGE - The system of pipes, drainage ways, ditches, and structures by which surface or subsurface waters are collected and conducted from the project area or a transportation facility.

EARTH – See SOIL.

EASEMENT (RIGHT-OF-WAY) - A right acquired to use or control property outside of the established right-of-way limits for a designated purpose.

EMBANKMENT - That portion of a filled area situated between the previously existing ground level and the subgrade (roadbed).

ENCROACHMENT - Use of highway right-of-way or easement unlawfully and/or without authority or permission.

ENGINEER – See RESIDENT ENGINEER.

ENGLISH – Other than when referring to the English language, the U.S. Customary Units of Measurement.

EQUIPMENT - All machinery, instruments, tools, vehicles, and apparatus together with the necessary supplies for upkeep and maintenance, for the proper construction and acceptable completion of the work.

EXTRA WORK - An item of work not provided for in the Contract as awarded but determined by the Engineer to be essential to the satisfactory completion of the Contract. Extra Work shall be performed at agreed upon prices or on a force account basis as provided in the Contract.

EXTRA WORK ORDER - A form used to provide for the performance of work or furnishing of materials involving Extra Work.

FEDERAL AVIATION ADMINISTRATION - The agency within the US Department of Transportation, Washington, D.C., with authority concerning airports and aviation.

FEDERAL HIGHWAY ADMINISTRATION - The agency within the US Department of Transportation, Washington, D.C., with authority concerning highways.

FEDERAL RAILROAD ADMINISTRATION - The agency within the US Department of Transportation, Washington, D.C., with authority concerning railroads.

FEDERAL TRANSIT ADMINISTRATION - The agency within the US Department of Transportation, Washington, D.C., with authority concerning public transit.

FINAL ESTIMATE - A compilation of item quantities prepared upon completion of the Contract stating the whole amount of work done by the Contractor and the final amount to be paid under the Contract.

FINALS ENGINEER – The duly authorized representative of the Construction Engineer responsible for handling all issues related to finalizing a Contract.

FORCE ACCOUNT - Prescribed work paid for on the basis of actual costs, including appropriate extra work, as defined in Subsection 109.06.

GENERAL SPECIAL PROVISIONS - Additions and revisions to the *Standard Specifications for Construction* approved pursuant to the Specification approval process.

GRADE SEPARATION - A crossing of two or more transportation facilities at different elevations.

HAZARDOUS MATERIALS AND WASTE COORDINATOR – The Agency's duly authorized Hazardous Materials and Waste Coordinator.

HOLIDAYS - In the State of Vermont, "Holidays" occur on:

New Years Day	January 1
M.L. King's Birthday	Third Monday in January
President's Day	Third Monday in February
Town Meeting Day	First Tuesday in March
Memorial Day	Last Monday in May
Independence Day	July 4

Bennington Battle Day	August 16
Labor Day	First Monday in September
Columbus Day	Second Monday in October
Veteran's Day	November 11
Thanksgiving Day	Fourth Thursday in November
Christmas Day	December 25

If a Holiday falls on a Sunday, the following Monday shall be considered the Holiday; if a Holiday falls on a Saturday, the Friday immediately preceding shall be considered the Holiday.

INSPECTOR - An authorized representative of the Engineer assigned to make detailed inspections of Contract performance.

LABORATORY - The Agency's Materials and Research Section Central Laboratory or any other testing laboratory which may be designated by the Engineer.

LIQUIDATED DAMAGES - The charge assessed to the Contractor pursuant to the Contract because the Contractor did not complete the Contract within the Contract time or by the Contract Completion Date, not as a penalty but as an assessment of damages that are impossible or difficult to determine with accuracy.

LOAD TICKET - A ticket accompanying a load of material and indicating the gross weight of the load less the tare weight of the delivery vehicle, and other information as specified and/or as required by the Engineer.

MASS - The words "mass" and "weight" are used interchangeably. Mass must be converted to force (by multiplying by gravity) before computing structural reactions, shears, moments, or internal stresses.

MATERIALS - Any substance(s) specified for use in the construction of the project and its appurtenances.

MATERIALS AND RESEARCH ENGINEER - The duly authorized representative of the Agency responsible for the supervision, research, and approval of materials specified in contracts or to be added to the Approved Products List.

MEDIAN - Unless different in context, the portion of a divided highway separating opposing traveled ways.

METRIC TON - A unit of measure equivalent to 1000 kg, denoted in the Contract Documents as “Metric Ton” or “T.” See also TON.

NON-PARTICIPATING - Designates work in which the cost is not shared by the Federal and/or State Government.

NOTICE TO PROCEED - Written notice to the Contractor stipulating the date on which the Contractor can begin on-project construction and from which date Contract duration can be charged.

PAY ITEM - See CONTRACT ITEM.

PAVEMENT STRUCTURE - The combination of subbase, base course, and surface course (wearing course or travel course) placed on a subgrade to support the traffic load and distribute it to the roadbed.

PLANS - The plans and drawings that show the location, character, sequence, and dimensions of the work, including layouts, profiles, cross-sections, and other details.

Contract Plans - See CONTRACT PLANS.

Standard Drawings – See STANDARD DRAWINGS.

PLANT INSPECTOR - An authorized representative of the Agency assigned to perform detailed inspections of methods and materials at plants, including bituminous, concrete, and structural steel assembly plants.

PROFESSIONAL ENGINEER - A qualified registered Professional Engineer licensed in the State of Vermont or eligible to practice engineering in the State of Vermont under the transient practice provisions of Title 26 VSA Section 1181a.

PROFILE GRADE - The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline. Depending on the context, “profile grade” means either the elevation at one or more points or the gradient of such trace.

PROJECT - The specific portion(s) of transportation facility infrastructure on which work is to be performed under one or more contracts.

PROJECT MANAGER – The duly authorized representative of the Director of Program Development responsible for the development of project design and management of project costs.

QUALIFIED PRODUCTS LIST (QPL) – A listing of protective coatings for new and 100% bare existing steel for bridges that have been tested and/or evaluated by the Northeast Protective Coating Committee (NEPCOAT) and have been deemed satisfactory for use on Agency projects without additional certification requirements.

REGIONAL CONSTRUCTION ENGINEER - The duly authorized representative of the Agency for a Construction regional subdivision of the State who is responsible for administering and overseeing construction contracts.

RESIDENT ENGINEER or ENGINEER - The duly authorized representative of the Agency and Director of Program Development who is responsible for engineering supervision of one or more specific projects.

RIGHT-OF-WAY - The land or property, or interests therein, devoted to transportation purposes.

ROADBED - The graded surface prepared as a foundation for the pavement structure and shoulders of a transportation facility. See also SUBGRADE.

ROADSIDE - The area adjoining the outer edge of the traveled way or shoulder of a highway. Extensive median areas between the roadways of a divided highway may also be considered roadside.

ROADWAY - The portion of a highway within limits of construction.

ROADWAY, TRAFFIC, AND SAFETY ENGINEER – The Agency's duly authorized representative responsible for the design aspects of roadway, traffic, and safety projects. (Sometimes referred to as the "Roadway Program Manager" or "Highway Safety & Design Engineer").

SAFETY OFFICER

> Contractor's - An individual designated by the Contractor charged to assure that all construction operations under the Contract are performed safely and according to all VOSHA regulations.

Agency's - The Agency's duly authorized Occupational Safety Coordinator whose job duties include safety inspection of Agency construction projects.

SCHEDULE OF WORK - The approved CPM chart or other work schedule prepared and submitted by the Contractor.

SECRETARY - The appointed head of the Agency of Transportation of the State of Vermont.

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

SIDEWALK - That portion of the roadway primarily constructed for the use of pedestrians.

SLOPES - The inclined areas extending from the shoulders to the previously existing surface of the ground.

SOIL (EARTH) - Sediments or other unconsolidated accumulations of solid particles produced by the chemical and physical disintegration of rocks and which may or may not contain organic matter.

SPECIAL PROVISIONS - Additions and revisions to the *Standard Specifications for Construction*, Supplemental Specifications, and General Special Provisions applicable to the Contract, as well as other provisions specific to the Contract.

SPECIALTY ITEM - Work that requires highly specialized knowledge, ability, or equipment not ordinarily available in contracting organizations qualified to bid on the Contract as a whole; in general specialty items are limited to minor components of the overall Contract.

SPECIFICATIONS - The compilation of provisions and requirements for the performance of prescribed work including the *Standard Specifications for Construction*, Supplemental Specifications, General Special Provisions, Special Provisions, and other requirements included in the Contract.

STANDARD DRAWINGS - Agency approved drawings used for typical repetitive use, showing details to be used where appropriate.

STANDARD SPECIFICATIONS or STANDARD SPECIFICATIONS FOR CONSTRUCTION - The book entitled *Standard Specifications for Construction,* as approved for general application and repetitive use in Agency construction contracts.

STATE - Unless different in context, the State of Vermont acting through its Agency of Transportation and authorized representative(s).

STRUCTURAL CONCRETE ENGINEER – The Agency's duly authorized representative of the Materials and Research Section responsible for the supervision of plant inspectors utilized at concrete plants and for the evaluation of portland cement concrete mix designs.

STRUCTURAL EMBANKMENT AREA - The cross-sectional area of an embankment situated between the lines projected downward from the outer edges of the subgrade on a 1:1.5 (vertical:horizontal) slope to the intersection with the previously existing ground.

STRUCTURES ENGINEER - The Agency's duly authorized representative responsible for structural engineering supervision of the project. (Sometimes called the "Structures Program Manager.")

SUBBASE - The layer or layers of specified or selected material of designated thickness placed to support a base and/or surface course.

SUBCONTRACTOR - An individual or legal entity to whom or which the Contractor sublets part of the work.

SUBGRADE - The graded surface prepared as a foundation for the pavement structure and shoulders of a transportation facility. See also ROADBED.

SUBSTANTIAL COMPLETION DATE - The date when, in the opinion of the Engineer, all Contract items have been sufficiently completed.

SUBSTRUCTURE - All of that part of a structure below the bearings of simple and continuous spans, skewbacks of arches, and tops of footings of rigid frames; included are backwalls, wingwalls, and wing protection railings.

SUPERINTENDENT - The Contractor's authorized representative in responsible charge of the work.

SUPERSTRUCTURE - All that part of a structure supported by the substructure, excluding the approach slabs.

SUPPLEMENTAL AGREEMENT- See CHANGE ORDER/ SUPPLEMENTAL AGREEMENT.

SUPPLEMENTAL SPECIFICATIONS - Specifications so designated that are not included in the Standard Specifications, General Special Provisions, or Special Provisions.

SURETY - The individual, partnership, firm, or corporation, or any acceptable combination thereof, other than the Contractor, executing the bond or bonds furnished by the Contractor. Surety Companies must be authorized to do business in the state of Vermont [See 19 VSA Section 10 (8)].

SURFACE COURSE - The uppermost component of a pavement structure, also called the wearing course or travel surface.

TON - The word "ton" by itself is a unit of measure equivalent to 2000 pounds. See also METRIC TON.

TRAFFIC ENGINEER – See ROADWAY, TRAFFIC, AND SAFETY ENGINEER.

TRAVELED WAY - The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

UNIT PRICE - The Contract price for one unit of work, as defined by the Contract.

UTILITY - The privately, publicly, or cooperatively owned lines, facilities, and systems for producing, transmitting, or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, stormwater not connected with highway drainage, and other similar commodities, including publicly owned fire and police signal systems and street lighting systems, which directly or indirectly serve the public or any part thereof. The term "utility" shall also mean the utility company, inclusive of any wholly owned or controlled subsidiary.

WEIGHT - In these Specifications, the words "weight" and "mass" are used interchangeably.

WEIGHTS AND MEASURES – The Vermont Department of Agriculture, Division of Weights and Measures.

WORK - The furnishing of all labor, materials, equipment, and incidentals necessary or convenient to the successful completion of the project and carrying out of the duties and obligations imposed by the Contract.

WORKING DAY - A calendar day on which construction operations could proceed as determined by the Engineer; unless excepted, "Working Day" excludes Saturdays, Sundays, Holidays, and the period from December 1st to April 15th, exclusive.

WORKING DRAWINGS - Supplemental design sheets or similar data which the Contractor is required to submit to the Engineer such as stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, and bending diagrams for reinforcing steel.

WRITTEN ORDER - A statement in writing from the Resident Engineer to the Contractor that:

(a) Authorizes or directs work to be done that is not part of the Contract, including method of payment.

(b) Informs the Contractor of work that is not being accomplished according to the Plans and these Specifications, and directs corrective action.

(c) Documents quantities to be paid for designated Contract items.

(d) Directs that safety, environmental, or other requirements or measures be followed.

(e) Directs that certain work or all work be stopped or discontinued.

(f) Brings to the Contractor's attention any other information or concerns that the Engineer may wish to emphasize.

101.03 INTENTION OF TERMS.

(a) By/To the Engineer. In order to avoid cumbersome and confusing repetition of expressions in these Specifications, whenever anything is, or is to be, done if, as, when, or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned," it shall be read

and understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

(b) As Ordered/Directed by the Engineer. When the phrases "as ordered by the Engineer," "as directed by the Engineer," or similar phrases are used in the Contract, they shall be understood to provide the Engineer latitude to meet field conditions, but in no case shall these phrases be construed to permit changing the intent of the Contract Documents.

(c) Furnish and Provide. "Furnish," "provide," and words of similar meaning, when used in relation to the "Contractor," shall mean at the Contractor's expense unless otherwise specifically provided in a Contract item.

(d) Headings and Caption of Sections, Subsections, and Paragraphs. All headings and captions are inserted for convenience and identification only and are in no way intended to define, limit, or expand the scope and intent of the Contract.

(e) Approval of/Ordered by/Consent of Engineer. As they appear in these specifications, phrases like "approval of the Engineer," "as ordered by the Engineer," "with the consent of the Engineer," and any similar phrase indicating the acceptance or direction by the Engineer shall not supersede any requirement of the Contract that the Contractor meet all contractual obligations, including but not limited to, compliance with permit conditions and applicable laws, rules, regulations, ordinances, and bylaws.

(f) Construction/Interpretation of Contract Documents. The Contract and its provisions shall not be construed or interpreted for or against the Agency because the Agency drafted or caused its representative(s) to draft its provisions.

SECTION 102
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SECTION 103 – TAXES AND INSURANCE

103.01 CONSTRUCTION EQUIPMENT TAX. The Contractor shall pay all construction equipment tax assessed under Title 32 VSA Section 3603 for machinery and other personal estate; the provisions of Title 32 VSA Section 3603 are made a part hereof by reference.

103.02 WITHHOLDING OF TAXES. The Contractor shall comply with the requirements of subchapter 4 of Chapter 151 of Title 32 VSA relating to the withholding of taxes from employees, and all taxes withheld pursuant to subchapter 4 shall be reported and paid to the Commissioner of Taxes.

103.03 STATE SALES TAX. Contractors are not required to pay the Vermont sales tax for materials incorporated into a state funded project completed on property owned or held in trust for the benefit of any governmental body or agency and used exclusively for public purposes or owned or held in trust for the benefit of any organization holding a valid Exemption Certificate [see Vermont Sales and Use Tax Regulations No. 226-2 and 226-7 and 32 V.S.A. Section 9743(4)] and used exclusively in the conduct of its business or purpose, or for materials incorporated in a rail line in connection with the construction, maintenance, repair, improvement, or reconstruction of the rail line [see 32 V.S.A. Section 9741(44)].

Therefore, no sales tax shall be included in the cost of these materials.

Contractors are responsible for maintaining records sufficient to justify eligibility for sales tax exemption. Forms for maintaining these records are available from the Vermont Department of Taxes.

103.04 INSURANCE REQUIREMENTS. Insurance obtained by the Contractor to cover the below-listed requirements shall be procured from an insurance company registered and licensed to do business in the State of Vermont. All insurance coverage for property damage shall provide coverage for "Replacement" cost. Before the Contract is signed and becomes effective, the Contractor shall file with the Agency a certificate of insurance, in duplicate, executed by an insurance company or its licensed agent(s), on a form satisfactory to the Agency, stating that with respect to the Contract awarded, the Contractor carries insurance in accordance with the following requirements. Renewal certificates for keeping the required insurance in force for the duration of the Contract shall also be filed as specified above.

No warranty is made that the coverages and limits listed herein are adequate to cover and protect the interests of the Contractor and any subcontractor for the Contractor's and any subcontractor's operations. These are solely minimums that have been established to protect the interests of the State.

(a) Workers Compensation Insurance. With respect to all operations performed the Contractor shall carry Workers Compensation

Insurance in accordance with the laws of the State of Vermont, 21 V.S.A. Chapter 9. The Contractor shall also ensure that all subcontractors carry Workers Compensation Insurance in accordance with 21 V.S.A. Chapter 9 for all work performed by them.

(b) Commercial General Liability Insurance. With respect to all operations performed by the Contractor and subcontractors, the Contractor shall carry Commercial General Liability Insurance on an occurrence form providing all major divisions of coverage, including but not limited to:

Premises - Operations
Independent Contractor's Protective
Products and Completed Operations
Personal Injury Liability
Contractual Liability applying to the Contractor's obligations under Subsection 107.16, Broad Form Property Damage
Collapse and Underground (CU) Coverage
Explosion (X) Coverage, unless this requirement is waived in writing by the Agency of Transportation

Limits of Coverage shall be not less than:

$1,500,000	Each Occurrence
$2,000,000	General Aggregate applying, in total, to this project only
$2,000,000	Products/Completed Operations Aggregate
$ 250,000	Fire Damage Legal Liability

(c) Automobile Liability Insurance. The Contractor shall carry Automobile Liability Insurance covering all motor vehicles, including owned, hired, borrowed, and non-owned vehicles, used in connection with the project. Limits of Coverage shall be not less than:

Bodily Injury:	$1,000,000 Each Person, $1,000,000 Each Occurrence
Property Damage:	$ 500,000 Each Occurrence

OR

Combined Single Limit: $1,500,000 Each Occurrence

(d) Railroad Protective Liability Insurance. When the Contract involves work on, over, or under the right-of-way of any railroad, the Contractor shall carry, with respect to operations performed by the Contractor and/or by the Contractor's subcontractors, Railroad Protective Liability Insurance in a form and amount as required by the railroad company and as specified in the Special Provisions and/or Supplemental Specifications for the project. If not available from insurance companies registered and licensed to do business in the State of Vermont, this insurance may be procured from Eligible Surplus Lines Companies approved by the Vermont Department of Banking, Insurance, Securities, & Health Care Administration (BISHCA).

The Contractor shall file the original Railroad Protective Policy and one duplicate policy with the Agency. The Agency will transmit the original Railroad Protective Policy to the railroad concerned.

The Contractor shall cooperate with and allow the railroad company or its agents free and full access to the project during construction along with all materials and equipment necessary in order that their duly authorized employees or agents may do any and all railroad construction, inspection, flagging, and watching.

The Contractor shall defend, indemnify, and save harmless the railroad and all of its officers, employees, and agents against any claim or liability arising from or based on any delay to the Contractor as a result of railroad construction or maintenance, whether by the railroad company, its employees, or agents.

(e) General Insurance Conditions. The insurance specified under parts (a), (b), and (c) above shall be maintained in force until acceptance of the project by the Agency.

Under part (b) above, Products and Completed Operations Coverage shall be maintained in force for at least one year from the date of acceptance of the project.

Under part (d) above, the Railroad Protective Policy shall remain in force until all work required to be performed on railroad property is completed to the satisfaction of the Railroad and of the Director of Program Development of the Agency.

The contractual liability insurance requirements detailed in the Contract Documents, including Subsection 107.16, are to indemnify, defend, and hold harmless the Municpality(ies), the State, the Agency, and railroad(s), as applicable, and their officers, agents, representatives, and employees, with respect to any and all claims, causes of actions, losses, expenses, or damages that arise out of, relate to, or are in any manner connected with the Contractor's work or the supervision of the Contractor's work on this project.

Each policy, except the Workers Compensation Policy, shall name the Municipality(ies), the State, the Agency, and railroad(s), as additional insureds for actions, losses, expenses, or damages that arise out of, relate to, or are in any manner connected with the Contractor's work or the supervision of the Contractor's work on this project.

Umbrella Excess Liability Policies may be used in conjunction with primary policies to comply with any of the limit requirements specified above.
"Claims-made" coverage forms are not acceptable without the prior written consent of the agency.

The Contractor shall investigate and the Contractor and/or insurance company shall either adjust or defend all claims against the insured for damages covered, even if groundless.

Each policy furnished shall contain a rider or non-cancellation clause reading in substance as follows:

> *Anything herein to the contrary notwithstanding, no cancellation, termination, or alteration of this policy by the company or the assured shall become effective unless and until notice of cancellation, termination, or alteration has been given by registered mail to the Director of Program Development of the Vermont Agency of Transportation, National Life Building, Montpelier, Vermont 05633-5001, at least 30 calendar days before the effective cancellation, termination, or alteration date unless all work required to be performed under the terms of the Contract is satisfactorily completed as evidenced by the formal, final acceptance of the project by the Agency.*

There shall be no directed compensation allowed the Contractor on account of any premium or other charge necessary to take out and keep in effect such insurance or bond; the cost thereof shall be considered included in the general cost of the work.

SECTION 104 - SCOPE OF WORK

104.01 INTENT OF CONTRACT. The intent of the Contract is to provide for the construction and completion in every detail of the work described. The Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the Plans, Specifications, and other provisions of the Contract.

104.02 ALTERATION OF PLANS OR CHARACTER OF WORK. To suit conditions disclosed as the work progresses, the Engineer may, without notice to the Sureties on the Contractor's bonds, make alterations in the design, in type of materials, in the quantities or character of the work or materials required, in the cross-sections, in dimensions of structures, in length of project, in locations, and any other ways deemed appropriate. Alterations will not constitute a change in other parts of the Contract or a waiver of any condition of the Contract, and shall not invalidate any of the provisions of the Contract Documents.

Payment for work occasioned by changes or alterations will be made according to Subsections 109.04 and 109.05. If the altered or added work is of sufficient magnitude to require additional time in which to complete the project, a time adjustment will be made pursuant to Subsection 108.11.

104.03 EXTRA WORK. The Contractor shall perform extra or unforeseen work for which there is no quantity and price included in the Contract according to the Contract or as directed by the Engineer whenever it is deemed necessary or desirable by the Engineer in order to complete the work as contemplated; payment will be made pursuant to Subsection 109.06.

104.04 MAINTENANCE OF TRAFFIC.

(a) All Facilities Safe and Passable. All facilities to be used by the traveling public, including temporary highways, bridges, sidewalks, and approaches as necessary to accommodate the vehicular or pedestrian traffic diverted from the facility undergoing improvements, shall be provided and maintained in a safe and passable condition. All traffic control plans and devices shall conform to the latest edition of the MUTCD.

(b) Service Shall Be Maintained. During working hours, at a minimum, one-lane traffic will be maintained. Working hours will be limited to the period between sunrise and sunset. At a minimum, one-lane traffic highway facilities shall be open to the unrestricted two-way flow of traffic, unless otherwise shown on the Plans or directed by the Engineer. Wherever one-way traffic is being maintained by the Contractor, the traveling public shall not be delayed more than 10 minutes. However, two-way traffic shall be re-established during all holiday periods, temporary shutdowns, and any other periods designated by the Engineer.

(c) Traffic Control Plan; Alternate Plan. When the Plans contain an Agency designed traffic control plan that includes, but is not limited to, references to Standard Drawings, the Contractor may submit an alternate traffic control plan for the project. This alternate plan may be for the entire traffic control plan of the project or for one or more phases of the Agency's design in the Plans, including the specific location of the lanes where the traffic will be maintained. The submitted alternative must include complete construction details, including all facets of traffic control, to the same extent as provided in the Agency design. The Agency shall have 30 calendar days to review the proposed alternative and to make changes before it is implemented.

(d) Detours and Temporary Bridges. Detours necessary for public travel which are not contiguous to the work will be designated by the Agency unless otherwise provided. When contiguous to the work, detours shall be constructed and maintained by the Contractor and no compensation will be allowed to the Contractor except as provided in the Contract. If the Contractor elects to construct a temporary bridge on a detour contiguous to the work over which traffic is to be maintained while a culvert or bridge is being constructed, the temporary bridge shall be constructed according to Section 528. The expense of the construction, maintenance, and removal of a temporary bridge and its approaches, and all incidental work pertaining thereto, shall not be paid directly, but shall be incidental to all other Contract items. The Contractor shall be responsible to the public for the structural adequacy and safety of these structures and approaches. The Contractor shall provide, erect, and maintain all necessary barricades, lights, signs, signals, other traffic control devices, and flaggers required in accordance with Subsections 107.08 and 107.09.

(e) Winter Maintenance On Active Projects. If conditions on active projects (not closed down for the winter) require snowplowing, sanding, or salting of the highway, including temporary highways, temporary sidewalks, detours, and bridges, the Contractor shall perform such snowplowing, sanding, and salting. The costs for snowplowing and sanding will be paid for under the Contract item Roadway Patrol Maintenance, and salting will be paid for under the Contract item Dust and Ice Control with Calcium Chloride.

(f) Winter Maintenance On Closed Projects. When a project is closed down for the winter season, the Contractor shall leave the project in a satisfactory condition for the traveling public and in a condition suitable for normal and satisfactory winter maintenance. The full depth of subbase shall be placed over portions of the road under construction and used by the traveling public unless otherwise shown on the Plans or directed by the Engineer. During the period that the project is officially closed down for the winter season, the State, a political subdivision thereof, or other properly designated entity will assume responsibility for snowplowing, salting, and sanding. This shall not relieve the Contractor of any other responsibilities regarding public convenience and safety as specified in this Section, from the liabilities as specified in Section 107, or as specified elsewhere in the Contract. If unsatisfactory travel conditions or

ruts develop in the traveled way or other construction defects or conditions dangerous to the traveling public develop, whether arising from the execution or non-execution of the work, the Contractor may be directed to return to the construction site and carry out necessary measures to satisfactorily remedy the situation; the cost for said work will be included as part of the cost of the items in the Contract, with no additional payment. If the Contractor fails to carry out the measures to satisfactorily remedy the situation immediately, the Engineer may cause the work to be performed and deduct the cost from any monies due or to become due to the Contractor. If the closing of a project is due to the Contractor's inability to complete the Contract before the Contract completion date, the Contractor shall bear all costs associated with making the project acceptable to the Engineer for winter shut down.

(g) Closed Projects; Temporary Traffic Control Devices. When a project is closed down for the winter season or for any other reason, the Contractor shall erect and maintain temporary guardrail, guide posts, barricades, warning signs, and other traffic control devices throughout the length of the project as directed by the Engineer. These temporary installations shall conform to requirements for the permanent items except that approved, used material may be substituted; they shall be removed when the Engineer indicates they are no longer required. The installation, maintenance and removal of temporary guardrail, guide posts, barricades, warning signs, and other traffic control devices will not be paid for directly, but will be incidental to other items in the Contract.

(h) Closed Projects; Guardrail. When the Contract specifies that the base course or the binder course of pavement be placed prior to suspension of work for the winter season, permanent, rather than temporary, guardrail shall be installed in accordance with the Plans. No payments will be made for adjustments to these permanent installations in order to accomplish work when construction resumes in the spring.

(i) Suspension of Work; Contractor Responsibility. If, regardless of the cause, construction is suspended on the project before the completion, acceptance, and termination of the Contractor's responsibility as defined under Subsection 108.15, the Contractor shall take precautions against injury or damage to the work and shall reinstall any damaged work as specified under Subsection 107.18.

(j) Traffic Control Devices. All traffic control devices shall be presented to the Engineer for approval prior to placement on the project. At no time will traffic control devices that do not have the specified reflectivity sheeting or are dirty, damaged, or unacceptable to the Engineer be placed or remain on the project.

All traffic control devices, including but not limited to signs, pavement markings, pavement marking removals, temporary traffic barrier, barricades, reflectorized plastic drums, cones, flashing arrow boards, and detours shall conform to the latest edition of the MUTCD, shall be approved by the Engineer, shall be installed to the satisfaction of the Engineer, and shall be functioning prior to the beginning of work.

(k) Reflectorized Sheeting; Cleaning; Costs. All reflectorized sheeting on the project shall be cleaned on a bi-weekly basis unless more frequent cleaning is directed by the Engineer. The cost of this work will not be paid for directly, but will be incidental to all other Contract items.

(l) Traffic Control Devices During Construction; Costs. Costs involved in covering, uncovering, and otherwise adjusting the signing and traffic control devices during construction to conform to the changing requirements of traffic flow around and through various construction operations will not be paid for directly, but will be incidental to all other Contract items.

(m) Suspension of Work; Treatment of Signing; Costs. Costs involved in covering or removing signs at the beginning of a suspension of work, including winter shutdown, and in uncovering or re-installing the signs at the end of a suspension of work will not be paid for directly, but will be incidental to all other Contract items. Such signing adjustments shall be performed as directed by the Engineer.

104.05 REMOVAL AND DISPOSAL OF STRUCTURES AND OBSTRUCTIONS. The Contractor shall remove any existing structure, parts of structure, or other obstructions which interfere in any way with the new construction or which is shown on the Plans to be removed.

Unless otherwise provided, all salvageable material being removed shall become the property of the Contractor and shall be disposed of and/or recycled as authorized by the Engineer. Salvage generated by utility relocation shall remain the property of the applicable utility.

104.06 USE OF MATERIALS FOUND IN THE ROADWAY; AUTHORIZATION; PAYMENT.

(a) General. With the written approval of the Engineer the Contractor may use stone, gravel, sand, or other materials found in the excavation for other construction items for the project provided the materials meet the requirements of the Contract.

The Contractor will be paid for the removal of such materials used for the project at the proper Contract unit price for items of excavation.

The Contractor shall not excavate or remove any material that is not within the slope and grade lines of an excavation as shown on the Plans without written authorization from the Engineer. If the Engineer allows over-excavation for the use of the Contractor, the State will be compensated for the quantity of material removed, and the replacement of material, if necessary, shall be done at no additional cost to the Agency and shall conform to the requirements of embankment construction as specified in the Contract. The over-excavation, if allowed by the Engineer, shall only occur within the State's right of way.

(b) Quantities. Whenever any material, except granular borrow, is removed from excavation and used in the construction of other items in the Contract, the total quantity measured for payment of these items shall be multiplied by 1.15, and the resulting quantity deducted from the total quantity of the Contract item Earth Borrow. If the final quantity of Earth Borrow is zero, no deductions will be made for material used for other items.

Whenever material meeting the requirements for granular borrow is taken from excavation on the project and used for Contract item Granular Borrow, its removal and use shall be paid for by single payment under the appropriate excavation item in Section 203.

104.07 FINAL CLEANING UP FOLLOWING COMPLETION OF PROJECT.

(a) Cleanup of Project. Upon completion of the work, before acceptance, and before final payment will be made, the Contractor shall satisfactorily and completely clean and remove from the right-of-way and grounds occupied by the Contractor in connection with the work all equipment, falsework, surplus and discarded materials, rubbish, temporary structures, buildings, tools, lumber, refuse, and other unsightly material.

(b) Restoration of Property. The Contractor shall restore in an acceptable manner satisfactory to the Engineer all property, both public or private, which has been damaged during the prosecution of the work; replace or renew any fences damaged; leave the waterways unobstructed; and leave the construction area in a neat and presentable condition throughout the entire length of the work.

(c) Drainage Structures and Ditches. The removal and disposal of silt, debris, and other material from drainage structures and ditches, whether deposited prior to or during construction under the Contract, shall be accomplished prior to acceptance of the project as ordered by the Engineer.

(d) Closure of Material Supply and Disposal Areas. Material supply and disposal areas shall be closed in accordance with Subsection 105.28.

(e) Costs. Costs involved with final cleanup following completion of the project will either be paid for under specific pay items or be incidental to all other Contract items.

104.08 DIFFERING SITE CONDITIONS.

(a) During the progress of the work, if subsurface or latent physical conditions are encountered at the site differing materially from those specified 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.

(b) Upon written notification, the Engineer will investigate to determine if the conditions materially differ and will cause an increase or decrease in the cost or time required for the performance of any work under the Contract. The Contractor will be notified of the Engineer's determination, whether or not an adjustment of the Contract is warranted. If an adjustment is warranted, the Contract will be modified in writing accordingly. Any adjustment made will exclude loss of anticipated profits.

(c) No Contract adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

(d) No Contract adjustment will be allowed under this clause for any effects caused on unchanged work.

SECTION 105 - CONTROL OF THE WORK

105.01 AUTHORITY OF THE ENGINEER.

(a) General. The Engineer shall decide all questions which arise concerning the quality and acceptability of materials furnished, the manner of performance of the work, the rate of progress of the work, and compliance with the requirements of the Contract; the Engineer shall decide all questions concerning interpretation of the Contract.

(b) Quantities; Orders; Disputes; Rejection of Materials, Work; Suspension of Work. The Engineer shall determine the amount and quantity of the work performed and materials furnished that are to be paid for under the Contract. The Engineer shall have authority to enforce and make effective decisions and orders the Contractor fails to carry out promptly. In case of any dispute arising between the Contractor and the Engineer as to materials furnished or the manner of performing the work, the Engineer has the authority to reject the materials and/or to suspend the work until the dispute is decided by the Director of Program Development. The Engineer is not authorized to revoke, alter, enlarge, relax, or release any requirements of the Contract Documents. The Engineer has authority to suspend the work or withhold payment of all estimates due the Contractor when necessary to secure proper compliance with the Contract.

(c) Performance of Work by Engineer; Setoff. If the Contractor fails to perform work ordered by the Engineer, the Engineer may, upon written notice, proceed to perform the work as deemed necessary; the cost of the work will be deducted from any monies due or which may become due the Contractor under the Contract.

(d) Advice by Engineer. Advice given the Contractor by the Engineer shall not be construed as binding the Agency in any way, or releasing the Contractor from any obligations under the Contract.

105.02 DIRECTOR OF PROGRAM DEVELOPMENT TO BE REFEREE.

(a) General. The Director of Program Development shall act as referee in all questions of dispute arising under the terms of the Contract. If the Contractor is aggrieved by the decision of the Director, the Contractor may appeal the decision in writing to the Transportation Board via the Director. Included with the notice of appeal shall be a complete outline of the nature and extent of the question or questions appealed together with any supporting documentation.

(b) Limitation of Time to Appeal. Notwithstanding any other provision of law, case law, regulation, or the Contract, all appeals shall be made within 30 calendar days of the decision to which the Contractor is aggrieved, and not thereafter.

105.03 PLANS AND WORKING DRAWINGS. A complete description of the work requires both the Plans, which are furnished to the Contractor by the Agency, and Working Drawings, which are submitted to the Agency by the Contractor or the Contractor's suppliers. The Plans and Working Drawings will be provided as follows:

(a) Contract Plans. The Agency will furnish Plans, consisting of general drawings and details that are necessary to give a comprehensive description of the construction contemplated.

The Agency will furnish the Contractor one copy of a signed set of the Plans, two complete full size sets of the Plans, and four complete half scale sets of the Plans.

Additional full sets or partial sets requested by the Contractor or a subcontractor, Fabricator, or supplier will be furnished at the standard current rates charged by the Agency. The Contractor shall keep one set of complete Plans available on the project at all times.

(b) Working Drawings.

(1) General. Certain items and construction activities require plans, drawings, procedures, and other information to document the Contractor's proposed actions to conform with Contract requirements.

Drawings and procedures shall be submitted sufficiently in advance of the anticipated work to allow for review(s), comment(s), and correction(s).

The cost of furnishing Working Drawings, including obtaining any necessary design or field measurements, shall be included in the Contract unit price for the item involved.

When a Contract item requires calculations to be submitted, the calculations shall be included with the submittal of the Working Drawings. Manufacturer's engineering data for prefabricated materials, including that for falsework and forms, shall be submitted with each set of Working Drawings.

All submittals, unless approved otherwise by the receiving entity, shall be addressed to the Vermont Agency of Transportation, 1 National Life Drive, Montpelier, Vermont 05633-5001. Submittals may be transmitted electronically where prior approval has been granted.

(2) Required Submittals. Working Drawings submitted to detail work that has been designed and detailed in the Contract Plans shall be submitted to the Agency for approval. These Working Drawings shall ensure that the Contractor or Contractor's suppliers have correctly interpreted the intent of the Contract Plans and specifications.

Working Drawings submitted to detail work that has not been designed and detailed in the Contract Plans shall be designed and detailed by a Professional Engineer and submitted to the Agency to be Reviewed for Conformance with the Contract Plans and specifications.

Working Drawings and/or procedures detailing work that has not been designed and detailed in the Contract Plans shall still be submitted for Approval, and unless otherwise directed by the Agency, shall be submitted for Approval to the entity who designed the detail or component. Thus, if a detail or component was designed by a Consultant or Contractor, the drawings associated with that detail or component shall be reviewed for Approval by that Consultant or Contractor.

All Working Drawings, regardless of who performed the design, shall be submitted to the Agency. Those drawings reviewed by others for Approval shall be Reviewed for Conformance by the appropriate Agency personnel.

No work shall begin on any item associated with a Working Drawing(s) until all of the associated drawing(s) have been returned and marked as Approved or Conforming by the Agency. The Contractor or Fabricator shall assume all risk for materials ordered or work performed prior to written notification by the Agency.

a. Submittals for Approval. The Contractor or Fabricator shall not begin work without approval of the drawings and/or procedures. One set of “approved” or “approved as noted” drawings and/or procedures will be returned to the Contractor or Fabricator. Approval of drawings and/or procedures indicates concurrence with the information presented and does not relieve the Contractor or Fabricator of compliance with all specifications and code requirements. The Agency assumes no responsibility for error(s)

and/or omission(s) in the drawings and procedures.

Drawings and procedures identified “approved as noted” indicate that specific clarification or conditional changes have been identified and take precedence over submitted information. Withholding of approval by the reviewer for selected details or procedures shall not constitute a basis for delay of performance of a non-related item of work that has approval to proceed.

After approval of the drawings and/or procedures, no changes shall be made without the written approval of the designing entity. The Contractor or Fabricator shall assume all risk for materials ordered or work performed prior to approval by the designing entity.

b. Submittals to be Reviewed for Conformance. When the submittal is Reviewed for Conformance, the Agency will review the submittal for compliance with the requirements of the specification. The Contractor shall submit the required drawings and/or procedures in advance of the proposed work. Once a complete submittal has been received, the reviewer shall be allowed 21 days for the initial review period. The reviewer for each subsequent review period, for those submittals which have been returned as Nonconforming, shall be allowed 14 days. The Contractor is entirely responsible for the work associated with these submittals; the Agency will not be responsible for errors in dimensions, incorrect erection procedures, design requirements, or successful completion of the work.

If the drawings and/or procedures have misinterpreted the Contract Plans or specifications, the submittal will be returned as Nonconforming. The submittal shall not be marked as Conforming until all of the required information has been received and reviewed.

The Contractor shall follow the means and methods specified for Construction Drawings and/or procedures in subpart (b)(3)b of this Subsection. In the event that any condition requires a change to the Construction Drawings of record, the Contractor is required to submit updated Construction Drawings prior to performing the work.

After the drawings have been marked Conforming, no changes shall be made without the written approval of the Agency. The Contractor or Fabricator shall assume all risk for materials ordered or work performed prior to the changes being marked as Conforming by the Agency.

(3) Categories of Working Drawings.

a. Fabrication Drawings.

1. General. Fabrication Drawings are required for work performed by or in conjunction with materials furnished by a Fabricator or supplier. They shall consist of complete details developed from information in the Plans, Contract Documents, and field measurements to define dimensions, sizes, procedures, and materials necessary to complete fabrication and installation or erection of the work specified.

2. Number of Sets. Unless otherwise specified, two sets of drawings and procedures will be required for review. For projects of normal complexity, the Fabricator or supplier shall anticipate a review time of four weeks.

3. Size. Drawing and detail sheets shall be 34 inches horizontal by 22 inches vertical. A 1 1/2 inch margin shall be provided on the left and 1/2 inch margins on the remaining three sides. A title block shall be provided in the lower right hand corner and shall include the following:

Town(s) in which project is located

Project name and number

Route number and location information

Prime contractor or Fabricator's name and address

Sheet title or identification of details shown

Name of supervisor in charge
Detailer's and checker's name

Date

Sheet number____ of _____.

4. Ownership; Delivery; Procedures. Original Fabrication Drawings shall be the property of the Agency. Prior to processing the final estimate, all Fabrication Drawings shall be submitted to the Agency. Original drawings shall be submitted as a PDF file or black on white original computer plots on bright white engineering bond paper with a minimum thickness of 24 #. All "approved as noted" changes must be transferred to the originals prior to transmittal to the Agency.

b. Construction Drawings.

1. General. For an item or element of work that permits the Contractor optional details, procedures, and materials that affect structural capacity, safety, and/or the results of the work, the Contractor shall prepare and submit to be reviewed for conformance detailed drawings and procedures of how the Contractor proposes to perform and control the work. Construction Drawings and procedures shall be prepared, stamped, and signed by a qualified Licensed Professional Engineer. The Professional Engineer is responsible for the design, performance of the designed element, and preparation of the Construction Drawings and procedures.

2. Number of Sets. Unless otherwise specified, three sets of drawings and procedures will be required for review. For work of normal complexity, the Contractor shall anticipate a review time of two weeks.

3. Size. Drawings shall be either 8 1/2 × 11 inches or 34 × 22 inches, shall have appropriate scale and detail, and shall convey sufficient information to provide for successful prosecution and inspection of the proposed work. Each sheet shall include a title block with the same information as specified for Fabrication Drawings.

c. Design Drawings.

1. General. For an item or element of work to be permanently incorporated in the project which has not been designed and detailed in the Contract Plans, the Contractor shall prepare and submit to be reviewed for conformance detailed designs, procedures, and drawings for the item or element of work. Design Drawings and procedures shall be prepared, stamped, and signed by a qualified Licensed Professional Engineer.

2. Number of Sets. Unless otherwise specified, three sets of drawings and procedures will be required for review. For work of normal complexity, the Contractor shall anticipate a review time of two weeks.

3. Size. Drawings shall be either 8 1/2 × 11 inches or 34 × 22 inches, shall have appropriate scale and detail, and shall convey sufficient information to provide for successful prosecution and inspection of the proposed work. Each sheet shall include a title block with the same information as specified for Fabrication Drawings.

(4) List of Working Drawings

Section	Forward To
204 Excavation for Structures (structure excavation support)	Construction Engineer
208 Cofferdams	Construction Engineer
501 HPC Structural Concrete (false work and form work plans - when shown on the Plans or directed by the Engineer)	Construction Engineer
501 HPC Structural Concrete (stay-in-place corrugated metal forms (SIPCMF))	Project Manager
502 Shoring Superstructures	Project Manager
505 Piling (temporary sheet piling)	Construction Engineer
506 Structural Steel (details and field welding procedures)	Project Manager
506 Structural Steel (erection plan)	Construction Engineer
507 Reinforcing Steel (reinforcing steel schedule)	Project Manager
510 Prestressed Concrete (details)	Project Manager
510 Prestressed Concrete (erection plan)	Construction Engineer
516 Expansion Devices	Project Manager
522 Lumber and Timber (i.e. Glued Laminated Decking)	Project Manager
522 Lumber and Timber (erection plan)	Construction Engineer
525 Bridge Railings	Project Manager
528 Temporary Bridge	Project Manager

531 Bearing Devices	Project Manager
540 Precast Concrete (details and structural design)	Project Manager
540 Precast Concrete (erection plan)	Construction Engineer
621 Traffic Barriers (bridge approach railing)	Project Manager
629 Water Systems (pipe insulation)	Chief of Utilities and Permits
641 Traffic Control (Contractor designed traffic control plan)	Roadway, Traffic, and Safety Engineer
677 Overhead Traffic Sign Supports	Project Manager
678 Traffic Control Signals	Roadway, Traffic, and Safety Engineer
679 Street Lighting	Roadway, Traffic, and Safety Engineer

105.04 CONFORMITY WITH PLANS AND ALLOWABLE DEVIATIONS.

(a) General. The work shall be performed in reasonably close conformity with the lines, grades, cross-sections, dimensions, and material requirements, including tolerances, shown on the Plans or specified in the Contract Documents. Any deviation from the Contract as required will be determined by the Engineer and authorized in writing.

(b) Acceptance of Non-Conforming Materials/Work; Price Adjustment. If the materials or the finished product in which the materials are used do not conform to the Contract requirements, but reasonably acceptable work has been produced, the Engineer will determine if the work will be accepted and remain in place. If accepted, the Engineer will document the basis of acceptance, which may require a Contract modification and price adjustment.

(c) Rejection of Non-Conforming Materials/Work; Treatment of Rejected Materials/Work. If the materials or the finished product in which the materials are used do not conform to the Contract requirements, and the Engineer determines that the

product is unsatisfactory, the Engineer will direct the work or materials be removed, replaced or otherwise corrected by the Contractor at the Contractor's expense.

105.05 COORDINATION OF CONTRACT DOCUMENTS – PERMITS, SPECIAL PROVISIONS, CONTRACT PLANS, GENERAL SPECIAL PROVISIONS, STANDARD DRAWINGS, SUPPLEMENTAL SPECIFICATIONS, STANDARD SPECIFICATIONS, AND SPECIFICATIONS ADOPTED BY REFERENCE.

(a) General. The Project Permits, Special Provisions, Contract Plans, General Special Provisions, Standard Drawings, Supplemental Specifications, Standard Specifications, and all supplemental documents are essential parts of the Contract; a requirement occurring in one is as binding as though occurring in all. The Contract Documents are complementary and intended to describe and provide for a complete work. In case of discrepancy, precedence of the Contract Documents will be determined in the following order:

Contract Document Precedence

(1) Project Permits. In the event of a conflict between permit requirements, the more protective or stringent shall take precedence as determined by the Engineer.

(2) Special Provisions

(3) Contract Plans

a. Calculated Dimensions

b. Scaled Dimensions

(4) General Special Provisions

(5) Standard Drawings

a. Calculated Dimensions

b. Scaled Dimensions

(6) Supplemental Specifications

(7) Standard Specifications

(8) Any Other Specifications Adopted by Reference

(b) No Advantage from Errors or Omissions in Contract Documents. Neither the Contractor nor the Agency shall take advantage or be afforded any benefit as the result of apparent error(s) or omission(s) in the Contract Documents. If either party discovers error(s) or omission(s), it shall immediately notify the other.

(c) Corrections to Contract Documents. The Engineer will make corrections and interpretations deemed necessary and appropriate to fulfill the intent of the Contract Documents. When there is an apparent absence or mention of a detail or an apparent omission of a detailed description in the Contract Documents, the detail or description shall be interpreted/understood/determined using the best general engineering and construction practice.

(d) Effect of Other Specifications/Standards. Other specifications (e.g. ASTM, NDS, CRSI, ACI) cited by reference shall become effective only if the work or material covered by them is not included in the Contract Documents. Specifications so referenced shall be the latest revision in effect on the date of advertisement for bids.

105.06 COOPERATION BY CONTRACTOR.

The Contractor shall:

(a) Plans and Specifications. Have available on the project at all times during the prosecution of the work one copy each of the Plans and Specifications.

(b) Bid Documents. Promptly provide copies of all bid documents upon request by the Engineer, including but not limited to all information used to prepare the bid proposal. Failure to provide such documents may result in the waiver of any right to bring a claim for additional compensation under Subsection 105.20.

(c) Competent Contractor Superintendent. Have on the project at all times a competent and reliable English-speaking Superintendent authorized to receive orders and to act for the Contractor. The Contractor shall make every effort to provide continuity in the position of Superintendent. However, the Agency reserves the

right to refuse or terminate the assignment of any Superintendent on the project; this shall not be grounds for a claim under Subsection 105.20.

(d) Competent Safety Officer. Have available on the project at all times during the prosecution of the work a competent and reliable English-speaking employee designated as the safety officer; this person shall be authorized to receive orders and issue binding directions concerning safety to all persons associated with the project who are employed by the Contractor, subcontractors or material suppliers. This individual shall be well versed in OSHA and VOSHA regulations, shall be capable of implementing a plan to conform to these regulations, and shall have the authority to stop construction operations on the project.

The safety officer shall maintain a complete copy of the safety plan(s) for the project, which shall be available at all times during the prosecution of the work for inspection and/or copying by the Engineer.

(e) Emergency Contacts. Furnish to the Engineer a list of addresses and telephone numbers of the Contractor's personnel who can be reached in an emergency. The Contractor shall alert certain personnel to stand by and shall inform the Engineer of all arrangements therefore.

(f) Facilities; Information; Assistance; Samples; Control Points. Provide all reasonable facilities and furnish the information, assistance, and samples required by the Engineer or Inspector to properly inspect and test materials and quality of work; and cooperate in setting and preserving stakes, bench marks, and other control points used in laying out the work.

105.07 COOPERATION WITH UTILITIES.

(a) General. The Agency will notify all utility companies, pipeline owners, and other known parties affected and endeavor to have all necessary adjustments of the public or private utility fixtures, pipelines, and other appurtenances within or adjacent to the limits of construction made as soon as practical.

(b) Moving Utility Property; Owner's Expense. Water lines, gas lines, wire lines, service connections, water and gas meter boxes, water and gas valve boxes, light standards, cableways, signals, and all other utility appurtenances within the limits of the

proposed construction which are to be relocated or adjusted are to be moved by the owners at their expense, unless otherwise provided in the Contract.

(c) Utility Interference; No Claim for Delays. The Contractor acknowledges and understands that, at the time of bid submission, it has considered all of the permanent and temporary utility facilities or appurtenances in their present and/or relocated positions as shown on the Plans and evident at the site. Notwithstanding any other provision of law, case law, regulation, or the Contract, no additional compensation will be allowed for any delays, inconvenience or damage sustained by the Contractor due to any interference from utilities, utility companies, utility facilities, appurtenances, or the operation of moving them.

(d) Utility Relocation for Contractor's Convenience. Should the Contractor desire temporary changes of location of any utility facilities or appurtenances for convenience in performing the work, the Contractor shall satisfy the Agency that the proposed relocation does not interfere with its own or other contractors' operations or the requirements of the work and does not cause an obstruction or a hazard to traffic. The Contractor shall be responsible for requesting such relocation work of a utility and/or other affected parties . Such relocation work shall be made solely at the Contractor's expense.

105.08 COOPERATION BETWEEN CONTRACTORS.

(a) Agency Right to Contract. The Agency reserves the right to contract for and perform other or additional work on or near the work covered by the Contract at any time.

(b) No Interference of Other Contractors. When separate contracts are let within the limits of a project, each contractor shall conduct its own work so as not to interfere with or hinder the progress or completion of the work being performed by other contractors. Contractors working on the same project shall cooperate with each other as specified or ordered by the Engineer.

(c) Liability, Indemnification, Defense. Each contractor involved shall assume all liability, financial or otherwise, in connection with its own contract and shall defend, indemnify, protect and save harmless the Agency from any and all damages or claims

that may arise because of inconvenience, delay, or loss experienced by the Contractor because of the presence and operations of other contractors working within the limits of the same project.

105.09 CONSTRUCTION STAKES.

(a) Initial Layout. Unless other methods of placing stakes are provided in the Contract, the Engineer will be responsible for setting sufficient points to establish the initial alignment and elevation of the proposed work; this shall include centerline offset stakes marked with centerline finish grades, offsets for establishing working points for any structures on the project, critical horizontal control points, and an adequate number of benchmarks for establishing vertical control. The Contractor shall check the proposed grades; any mistakes or errors identified shall be brought immediately to the attention of the Engineer, and adjustments will be made by the Engineer.

(b) Layout of Subgrade. Prior to fine-grading the subgrade, the Engineer will rerun the centerline, from which the Contractor shall set working stakes. After the Contractor has set the working stakes at the outer limits of the subbase course, the Engineer will reestablish the finished centerline grades. The Contractor shall check the proposed grades; any mistakes or errors identified shall be brought immediately to the attention of the Engineer, and adjustments will be made by the Engineer.

(c) Permanent Marking Layout. Once the wearing course has been placed, the Engineer will establish the layout for the centerline permanent traffic markings, including passing zones, breaks for town highways and side roads, and any other items required for the centerline markings.

(d) Responsibility for Layout. The Contractor shall be responsible for the preservation of all stakes and markings, and shall replace any stakes or grades that are destroyed or disturbed. No claim shall be brought and no additional compensation will be paid on account of any alleged inaccuracies in the construction layout, including any additional layout that the Engineer may perform that is not covered in this Subsection, unless the Contractor notifies the Engineer of the inaccuracies in writing at least 24 hours prior to commencement of the work.

(e) Qualified Personnel. All other stakes, templates, and other materials, either in addition to or in replacement of the original set, which may be required for the construction operations, shall be furnished, set, and properly referenced by qualified personnel employed by the Contractor.

(f) Contractor Layout. The Contractor shall stake out the work and make known the immediate plan or procedure of the next work contemplated sufficiently in advance of construction to permit the Engineer to take the necessary measurements for the computation of quantities and to check the Contractor's layout. The Contractor shall lay out in a timely manner and maintain a sufficient number of grade stakes so the Engineer can monitor and regulate all portions of the Contract work.

(g) Cost. The cost of this work shall be considered as incidental to the project as a whole, and shall be included in the unit price bid for the Contract items involved.

105.10 AUTHORITY AND DUTIES OF RESIDENT ENGINEER (ENGINEER). As the direct representative of the Director of Program Development, the Resident Engineer on a project has immediate charge of the engineering details of the project; is responsible for the administration and satisfactory completion of the project(s); has the authority to reject defective material, to suspend any work that is being improperly performed, and to withhold payment until defective work has been corrected. The Resident Engineer, in the sole discretion of the Resident Engineer, also has the authority to suspend work, or specific aspects of the work, if necessary to address a concern for safety of the workers or traveling public, or a serious environmental concern or violation. Notwithstanding any other provision of law, case law, regulation, or the Contract, no additional compensation shall be provided for any work suspensions of this sort.

105.11 AUTHORITY AND DUTIES OF INSPECTORS. Inspectors employed by the Agency are authorized to inspect all work done and materials furnished and to perform other duties as directed by the Engineer. Inspections can extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials used. An Inspector is not authorized to alter or waive the provisions of the Contract, to issue instructions contrary to the Contract Documents, or to act for the Contractor.

105.12 INSPECTION OF WORK.

(a) General; Contractor To Help Engineer. The Engineer or designated representative shall be allowed access to all parts of the work at all times and shall be furnished by the Contractor all information and assistance to be able to make a complete and detailed inspection The Contractor shall furnish such help as the Engineer desires and/or needs to ascertain whether or not the work is performed in accordance with the requirements and the intent of the Contract.

(b) Examination of Completed Work. If, before the acceptance of the work, the Engineer requests, the Contractor shall remove or uncover portion(s) of the finished work as the Engineer may direct. After the examination, the Contractor shall restore the portion of the work to the standard required by the Contract. If the work thus exposed or examined proves acceptable, the expenses of uncovering or removing and replacing the parts removed shall be paid for as Extra Work as defined in Subsection 109.06; but if the work exposed or examined is unacceptable, the expenses of uncovering or removing and replacing the parts removed shall be borne by the Contractor.

(c) All Work Requires Supervision or Inspection. The Agency will not be required to pay for any work done or materials used without supervision or inspection by the Engineer or an Inspector. Supervision/inspection includes project, mill, plant, or shop inspection of any material furnished under the Contract.

(d) Inspection By Others. When any unit of government or of a public or private entity is to pay a portion of the cost of the work covered by the Contract, its respective representative(s) shall have the right to inspect the work. Such inspection shall not make any entity a party to this Contract and shall not interfere with the rights of either party hereunder.

105.13 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK.

(a) General. All work which does not conform to the requirements of the Contract will be considered unacceptable unless otherwise determined to be acceptable under the provisions of Subsection 105.04.

(b) Removal and Replacement of Unacceptable Work. Unacceptable work, whether the result of poor quality of work, use of defective materials, damage through carelessness or any other cause found to exist prior to the acceptance of the work, shall be removed immediately and replaced in an acceptable manner.

(c) All Work Must Be Authorized. Work shall be performed only with lines and grades having been provided by the Engineer. Work performed contrary to the instructions of the Engineer, beyond the lines shown on the Plans, or without authority will be considered unauthorized and no payment therefore will be made. Work so done may be ordered removed or replaced at the Contractor's expense.

(d) Failure To Comply With Order of Engineer. Upon failure by the Contractor to comply forthwith with any order of the Engineer communicated under the provisions of this Subsection, the Engineer will have authority to require unacceptable work to be remedied or removed and replaced and to require unauthorized work to be removed; in either case, the Engineer is authorized to deduct the costs from any monies due or to become due the Contractor.

(e) Responsibility for Agency Expense. Any expense incurred by the Agency in making removals, renewals, or repairs which the Contractor has failed or refused to make shall be paid for out of any monies due or which may become due the Contractor or may be charged against one or more Contract Bonds.

(f) No Compensation for Additional Time. No additional Contract time shall be warranted for any of the work described in this Subsection.

105.14 SUNDAY AND HOLIDAY WORK.

(a) Sundays. The Contractor shall not carry on construction operations on Sundays except as authorized by the Engineer.

(b) Holidays. If the Contractor's operations are of such a nature, the project is so located, or traffic is of such volume that the Engineer deems it expedient to do so, the Engineer may require the Contractor to cease construction operations on holidays, the day before if a holiday falls on Tuesday, and the day after if a holiday falls on Friday,

(c) Application. The limitations in this Subsection shall not apply for the purposes of maintenance, emergency repairs, and proper protection of the work, including but not limited to the curing of concrete and the repair and servicing of equipment.

(d) Other Provisions Not Affected. The above limitations shall not relieve the Contractor of any responsibility for the work involved as set forth in Subsections 105.06, 107.18, or elsewhere in the Contract.

105.15 CONVICT LABOR. No incarcerated convict labor shall be employed on the project.

105.16 LOAD RESTRICTIONS.

(a) General. The Contractor and all subcontractors and suppliers shall comply with all legal load restrictions specified in Title 23 VSA § 1392 in the hauling of equipment or material on public roads beyond the limits of the project. The application for and possession of a hauling permit will not relieve the Contractor of liability for any damage that results from use or the moving of equipment and vehicles.

(b) Limitations or Use of Equipment and Vehicles. The operation of equipment and vehicles of such mass (weight) or loaded so as to cause damage to structures, the roadway, or to any other type of construction shall not be allowed. Hauling materials over the base course, surface course, or structure during construction shall be limited and allowed only as directed. No loads will be permitted on a concrete pavement, cement treated base course, or concrete structure prior to expiration of the curing period and until the concrete reaches its specified 28-day compressive strength. No vehicle or equipment exceeding the load restrictions cited in Title 23 VSA § 1392 shall be allowed on a structure. The Contractor shall be responsible for all damage done by the Contractor's equipment and vehicles.

(c) Speed Prior to Wearing Surface; Expansion Joints On Structures. Prior to placement of the wearing surface, vehicle travel speed over any structure shall not exceed 15 km/h (10 miles per hour); an acceptable transition ramp shall be constructed at any expansion joint that projects above the travel surface.

(d) Penalty and Reduction for Overweight Operation. Each vehicle entering or leaving the project limits must be within the legal load limit or the load limit imposed by a current overload permit for the roadways and structures. Should any vehicle not meet these requirements, in addition to the appropriate penalty under Title 23 V.S.A. § 1391a, the difference in mass (weight) between the legal load limit and the gross vehicle mass (weight) shall be converted to the appropriate measurement quantity for the item involved and treble this amount shall be deducted from the quantity of the item to be paid the Contractor. The Contractor shall not deduct this amount from the payment to its trucking subcontractor(s)/supplier(s).

(e) Provision of Overweight Permit Copies. The Contractor shall provide copies of overweight permits to the Engineer prior to the commencement of hauling. Copies of permits provided after hauling has begun will not be considered to be in effect for the project prior to the time that the Engineer receives the copy.

(f) Provision of Tare Masses(Weight). The Contractor shall provide the Engineer with tare masses (weights) for all vehicles carrying or delivering materials to be used on a project. A tare mass (weight) shall be the mass (weight) of the unloaded vehicle with full fuel tank and water tank as applicable.

(g) Application to All Vehicles Used for Project. These requirements, including the overload reduction, shall apply to the Contractor's vehicles as well as all other vehicles used in conjunction with the construction of this project, including the vehicles of subcontractors and suppliers.

105.17 MAINTENANCE OF PROJECT DURING CONSTRUCTION.

(a) General. The Contractor shall maintain the work during construction and until the work is finally accepted. This maintenance shall constitute continuous and effective performance of the work day by day with adequate equipment and forces so that the roadway, structures, or other portions of the project are kept in satisfactory condition at all times.

(b) Costs. All cost of maintenance work during construction and before acceptance of the work shall be included in the Contract unit prices for the various pay items, and the Contractor will not be paid an additional amount for such work.

(c) Maintenance During Shutdown. In the event the work is ordered shut down for failure to comply with the provisions of the Contract or for any other reason, the Contractor shall maintain the project as provided herein and provide such ingress and egress for local residents as necessary during the period of shutdown.

105.18 FAILURE TO MAINTAIN PROJECT; COST. Failure on the part of the Contractor to properly maintain the work will result in the Engineer immediately notifying the Contractor to comply with the required maintenance provisions. If, after receipt of such notice, the Contractor fails to remedy the situation to the Engineer's satisfaction, the Engineer will proceed with adequate forces and equipment to maintain the project; the cost of this maintenance will be deducted from monies due or which may become due the Contractor under the Contract.

105.19 FINAL ACCEPTANCE AND FINAL INSPECTION.

(a) General. None of the work shall be accepted until all of the work required by the Contract has been satisfactorily completed.

(b) Procedure. Upon notice from the Contractor of presumptive completion of the project, the Engineer will arrange a date for inspection of the work. If all construction provided for and contemplated by the Contract is found to be completed, the Contractor will be informed in writing immediately following the inspection that the Acceptance Date is the date of the inspection of the project; should any of the work be found unsatisfactory or incomplete, instructions for corrective action will be issued in writing. As soon as the deficiencies have been corrected to the satisfaction of the Engineer, notification will be made in writing to the Contractor establishing the Acceptance Date.

105.20 CLAIMS FOR ADJUSTMENT.

(a) Notice Requirements. In order to bring a claim for additional compensation not clearly covered by the Contract for conditions substantially different than represented by the Contract and not ordered by the Engineer as Extra Work as defined herein, the Contractor must provide written notice ("the Notice of Intent to File a Claim" or the "Notice") to the Engineer before conducting any work or purchasing any materials subject to the claim (the "Claim"). The words "Notice of Intent to File a Claim" must appear in large print at the top of the document. The Notice

must specify the basis for the Claim, including the nature of the Claim, the reason why the Contractor believes that the Agency is responsible for payment of the Claim, and a description of the additional compensation, including reference to each activity associated with the work and/or materials, including reference to any impacts to the Contractor's Progress Schedule, as defined in Subsection 108.03 (the "Critical Path"). If the Contractor fails to provide the Notice as specified herein, the Contractor waives its right to bring the Claim under the Contract.

(b) Notice Documentation Requirements. Upon providing the Notice of Intent to File a Claim, the Project Superintendent must commence daily records for all labor hours, equipment hours (idle and operating), and materials involved with the work or materials at issue in the Notice. The Contractor must submit such records to the Engineer on a daily basis. Such records must include a written analysis of how the work and/or materials at issue in the Notice impact/s the Critical Path. If the Contractor fails to provide such records to the Engineer as required herein, the Contractor waives its right to bring the Claim.

(c) Claims Procedure. The Engineer's written acknowledgement of the Notice and receipt of the Contractor's daily reporting under this Subsection shall not be construed as an approval by the Agency of the merits of the Claim. Claims are evaluated by the Construction Engineer. If the Construction Engineer rules in favor of the Contractor, the Claim will be allowed, in whole or in part, and paid as provided in the Contract. If the Construction Engineer denies the Claim, in whole or in part, the Contractor may appeal to the Director of Program Development. Notwithstanding any other provision of law, case law, regulation, or the Contract, an appeal from the decision of the Construction Engineer shall be made within 30 calendar days of denial, and not thereafter.

(d) Claims Documentation Requirements. The Contractor must provide the Construction Engineer with the following documentation in support of the Claim:

(1) A detailed statement of the Claim, including all necessary dates, location, and work and material items at issue in the Claim;

(2) The date on which the Contractor first became aware of the actions or conditions giving rise to the Claim;

(3) A copy of the Notice of Intent to File a Claim;

(4) A list of the names of all Agency employees and agents, including consultants, the Contractor believes have knowledge or information concerning the facts giving rise to the Claim;

(5) A list of the names of all Contractor employees and agents, including subcontractors, whom the Contractor believes have knowledge or information concerning the facts giving rise to the Claim;

(6) A list of the specific provisions of the Contract that the Contractor believes support the Claim, and a description of why the Contractor believes those provisions support the Claim;

(7) A list of all documents and all oral statements that the Contractor believes support the Claim;

(8) A statement as to whether additional compensation and/or a time extension are being requested in the Claim;

(9) If a time extension is being requested in the Claim, a statement as to the specific number of days being requested, supported with reference to how the facts underlying the Claim affected the Contractor's performance schedule, including how such facts affected the Critical Path;

(10) A description of the amount of additional compensation being sought, itemized by category of work, including delays associated with performing the work, work items, materials costs, and any and all other costs at issue in the Claim. Such documentation includes, but is not limited to, invoices for rented equipment, a Blue Book analysis for owned equipment; and subcontractor agreements.

(11) If additional compensation for delays associated with performing the work is included in the Claim, the Contractor must provide a description of the operations that were delayed, the reasons for the delay, the impact of the delay on the operations, and how the delay

impacted the Contractor's progress schedule, including the Critical Path.

(12) For every claim seeking additional compensation in excess of $50,000, the Contractor must provide a separate document certifying that the documentation provided in support of the Claim and that the amount of additional compensation sought in the Claim is accurate and that the Contractor has a good faith basis for believing that the Agency is responsible for payment of the Claim (the "Claims Certification"). The Claims Certification shall be notarized and executed by a senior officer of the Contractor with legal authority to bind the Contractor, or if the Contractor is a sole proprietor, by the proprietor. The Claims Certification may be used in any proceeding under the False Claims Act, 18 U.S.C.A. §1020 C.F.R. §635.119.

(e) Appeal to the Director of Program Development. Appeals will be judged by the Director of Program Development. Should an appeal be judged in favor of the Contractor, it will be allowed and paid as provided in the Contract. Should a claim be denied by the Director of Program Development, the Contractor may appeal under Subsection 105.02.

(f) Time for Claims; Appeals. Notwithstanding any other provision of law, case law, regulation, or the Contract, all claims by the Contractor shall be submitted in writing within 90 calendar days after the Acceptance Date of the project or within 90 calendar days of the Notice of Intent to File a Claim, whichever occurs first, and not thereafter (the "Claim Filing Period"). Such claims must meet the requirements set forth above, including but not limited to complete documentation supporting the Claim. If the Contractor fails to meet these requirements, the Construction Engineer may grant the Contractor additional time to meet the requirements. Any additional time granted for such purpose shall not be the subject of any demand for interest payments or for attorneys' fees and/or other costs. If the Contractor fails to file the Claim within the Claim Filing Period, the Contractor waives its right to bring the Claim. If the disputed work continues to be performed beyond the Claim Filing Period, the Contractor must submit a written request to extend the Claim Filing Period prior to the expiration of the Claim Filing Period. The Contractor shall submit such requests for extension of the

Claims Filing Period every 90 calendar days until the disputed work is completed.

105.21 PAYROLLS.

(a) General. The Contractor shall maintain and make available payroll records as required in the Contract. This requirement shall also apply to the work of any subcontractor having a subcontract for any part of the work performed on the job. Any costs associated with this work will not be paid for directly, but will be considered incidental to the Contract pay items.

(b) Examination, Authority. The Contractor hereby authorizes the Engineer or the Engineer's authorized representative to examine the Contractor's orders for construction workers on file with the local employment office of the Vermont Department of Employment and Training.

105.22 ENVIRONMENTAL PROTECTION. The Contractor shall perform all project related operations so as to give adequate protection to the natural and cultural resources of the State.

The Contractor shall conduct the work in conformance with all regulations and permit conditions applicable to the project. If additional permits are required, or if the Contractor proposes to perform the work differently than the manner provided in the Contract, the Contractor shall obtain approval from the appropriate regulating entities prior to performing the work. The costs associated with obtaining and complying with permits required to perform the work will not be paid for directly, but will be considered incidental to the Contract pay items.

105.23 EROSION PREVENTION AND SEDIMENT CONTROL.

(a) Submission of Plans. At the preconstruction conference or prior to the start of applicable construction, the Contractor shall submit a plan in writing for the prevention of erosion and control of sedimentation and pollution on the project and on associated access roads, material waste and borrow areas, and staging areas. No work shall be started until the plan has been approved by the Engineer.

(b) Erosion Prevention and Sediment Control Measures. Erosion prevention and sediment control measures shall be installed and maintained in conformance with the Contract. Unless otherwise specified in the Contract, this work shall be performed as described in this Section.

(c) Engineer's Authority; General. The Engineer has authority to limit the surface area of erodible earth material exposed by excavation, borrow, and fill operations and to direct the Contractor to provide immediate permanent or temporary erosion prevention and sediment control measures to minimize adverse effects on resources. Such work may include the construction of berms, dikes, dams, sediment basins, slope drains and use of mulches, mats, seeding, or other control devices or methods as necessary to control or prevent erosion and siltation. As the earthwork proceeds, slopes shall be graded to finish grade whenever practical and all disturbed areas shall be stabilized by seeding and mulching or other acceptable methods within 48 hours of disturbance.

(d) Temporary and Permanent Erosion Prevention and Sediment Control. As shall be specified in the approved Erosion Prevention and Sediment Control Plan, the Contractor shall incorporate all temporary and permanent erosion prevention and sediment control measures into the project at the earliest reasonable time. Temporary erosion prevention and sediment control measures shall be used to prevent erosion and to correct conditions that develop during construction prior to installation of permanent measures; this may include work outside the right-of-way and/or defined project limits. When work outside the right-of-way or defined project limits is required, a property release form must be executed to allow access to the specific property and the area must be reviewed by the VAOT Environmental Section for adverse effects on cultural and natural resources.

(e) Erosion; Clearing and Grubbing. Where erosion is likely to occur and project conditions permit, clearing and grubbing shall be scheduled and performed so that grading operations and the installation of permanent erosion prevention and sediment control measures may be performed immediately thereafter; otherwise temporary erosion prevention and sediment control measures shall be required between successive construction stages.

(f) Limiting Operations. The Engineer may limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent erosion prevention and sediment control measures current in accordance with the approved Erosion Prevention and Sediment Control Plan. Without prior approval by the Engineer the amount of surface area of erodible earth material exposed at one time within the project limits shall not exceed 2 ha (5 acres).

(g) Conflicts. In the event of conflict between the requirements of this Subsection and those of Federal, State, or local agencies, the more restrictive provision(s) shall apply as determined by the Engineer.

(h) Suspension of Operations. If construction operations are suspended, the excavation and embankment areas shall be stabilized. If permanent stabilization is not possible, exposed areas shall be shaped and then covered with mulch or matting in order that water runoff will be intercepted and diverted to locations where the least amount of erosion will result. During a suspension of construction operations, the Contractor shall act immediately to correct any deficiencies that develop with the erosion prevention and sediment control measures and/or stabilized areas.

(i) Maintenance of Temporary Erosion Prevention and Sediment Control Measures. Temporary erosion prevention and sediment control measures shall be installed and acceptably maintained until both the permanent drainage facilities have been constructed and vegetation has been established throughout the project.

(j) Limits on Use of Mechanized Equipment. Unless otherwise approved in writing and permitted by the appropriate Federal or State regulating authority, mechanized equipment shall not be operated in flowing streams except as required and permitted to construct changes in the channel and permanent or temporary structures. Rivers, streams, and impoundments shall, as soon as construction will allow, be cleared of all falsework, piling, and debris caused by construction operations.

(k) Water Quality. Any construction activity in or adjacent to rivers, streams, brooks, creeks, lakes, ponds, reservoirs, wetlands, and any other regulated surface water shall not cause the average downstream water quality values to fall outside the classification limits specified in the Vermont Water Quality Standards. Should the Contractor desire a variance from the Vermont Water Quality Standards, the Contractor must obtain a 1272 Permit (Regulation of Activity Causing Discharge - Title 10 VSA § 1272) from the Agency of Natural Resources. When work in a river, stream, brook, creek, lake, pond, reservoir, wetland, or any other regulated surface water is prohibited, such work will be allowed only if the Contractor obtains a 1272 Permit for such work.

(l) Access Roads. Access roads will not be constructed without the approval of the Engineer. Access roads shall have proper erosion prevention and sediment control measures. All access roads shall be restored to their original condition unless a permit allows for a permanent change from that condition.

105.24 POLLUTION CONTROL.

(a) General. The Contractor shall exercise every reasonable precaution to prevent pollution of the waters of the State. Pollutants, including but not limited to chemicals, paints, fuels, lubricants, bitumens, raw sewage, sediment or sediment laden water, and other waste, shall not be discharged into or alongside the waters of the State or into natural or constructed channels leading thereto. The Contractor shall comply with applicable statutes and regulations relating to the prevention and abatement of pollution.

(b) Bridge Operations. When bridge painting, cleaning, cutting, welding, or grinding operations are in progress, the Contractor shall utilize containment devices to retain all materials which are generated. All waste materials generated that contain lead, zinc, or other hazardous materials shall be disposed of appropriately as hazardous waste.

(c) Coated/Treated Materials. The Contractor shall comply with all air, ground, and water pollution control, health, and transportation regulations when cleaning, handling, moving, repainting, cutting, welding, sanding, or grinding any coated or treated materials.

(d) Noise and Air Pollution. The Contractor shall employ standard methods to minimize noise and air pollution occurring in conjunction with and as a result of construction operations, including, but not limited to, clearing, grubbing, drilling, blasting, excavation, and hauling operations. The method(s) employed shall be acceptable to the Engineer and compatible with the location of the work. The burning of tires or other manufactured products is prohibited.

(e) Hazardous Materials and Waste. The Contractor shall provide documentation to the Engineer that any generated hazardous waste and any hazardous materials and waste found were disposed of in conformance with all applicable regulations governing the handling, transporting, and disposal of such materials and waste.

105.25 CONTROL OF WASTE, BORROW, AND STAGING AREAS.

(a) Definitions.

(1) Waste areas are those areas where excess material or materials unsuitable for construction are disposed.

(2) Borrow areas are all borrow pits, gravel pits, quarries, sand pits, and similar sources of materials used in the construction of the project.

(3) Staging areas are any areas that the Contractor uses for storage of materials and equipment or for general use for Contract operations.

(b) Permits and Clearances. Waste, borrow, and staging areas are necessary adjuncts to a VAOT construction project. The Contractor and/or the property owner shall be required to obtain all necessary permits and clearances, and specifically in accordance with Title 10 VSA Chapter 151 (Act 250), if applicable, prior to opening or using an area for an Agency project.

(c) Establishment of Waste, Borrow, and Staging Areas. To establish a waste, borrow, or staging area, the Contractor shall submit a completed Waste, Borrow, and Staging application package to the Engineer (application packages are available from the VAOT Environmental Section). The application must be completed and should be submitted at least twenty-one calendar

days prior to the planned utilization of the area. All proposed waste, borrow, and staging areas will be reviewed by the VAOT Environmental Section for effects on cultural and natural resources. If the proposal includes the initial disturbance of soil in an area or the wasting of erodible materials, the Construction Environmental Engineer must also approve a site specific Erosion Prevention and Sediment Control Plan prior to the use of such an area.

(d) Required Approval. The Contractor shall not perform any preparatory work or make use of a waste, borrow, or staging area until approval is obtained in writing from the Engineer.

(e) Unpermitted Areas. If a proposed waste, borrow, or staging area does not have a permit as provided in part (b) above, the application must state the length of time the area has been operating and the annual rates of disposal, extraction, or use for the last five years.

105.26 OPENING WASTE, BORROW, AND STAGING AREAS. Prior to issuing approval, the Engineer shall be satisfied that the area and its operation are approved in accordance with all project permits and:

(a) Will not seriously hurt or impair the rights of any adjacent property owner;

(b) Will not result in undue water or air pollution;

(c) The final shape, slope, and contour of the land in and about the area will not be undesirable aesthetically or as it relates to drainage;

(d) Will not cause unreasonable soil erosion or reduction in the capacity of the surrounding land to hold water in order that a dangerous or unhealthy condition may result;

(e) Will not have an undue, adverse effect on the scenic or natural beauty of the area's aesthetics, historic sites, or rare and irreplaceable natural areas;

(f) Is consistent with any duly adopted development plan, land use plan or land capability plan, whether site specific, local, or regional;.

(g) The entrance is at the most desirable angle or perspective from any nearby highways, residences, and other facilities;

(h) The Contractor will remove, stockpile, and preserve topsoil, sod, and other suitable material from the surface of the area prior to proceeding with other operations; and

(i) The Contractor has all erosion prevention and sediment control measures, as indicated in the approved Erosion Prevention and Sediment Control Plan, in place prior to use of the area.

105.27 MAINTAINING WASTE, BORROW, AND STAGING AREAS.

(a) General. The Contractor shall conduct waste, borrow, and staging area operations so as to maintain a minimum of air pollution. The Contractor shall keep in a condition acceptable to the Engineer the portions of an area where a pit or pits have been opened and shall maintain all access roads with sufficient dust control and proper drainage to prevent damage to adjacent properties. Area operations shall be restricted to normal working hours except with the express written approval of the Engineer and shall be in accordance with all permit conditions.

(b) Area Erosion Prevention and Sediment Control Measures. Installation and maintenance of erosion prevention and sediment control measures at waste, borrow, and staging areas shall be consistent with the approved Erosion Prevention and Sediment Control Plan for the specific area. The On Site Coordinator shall review these areas if and as required in the Contract.

105.28 CLOSING WASTE, BORROW, AND STAGING AREAS. With the exception of those areas which will remain open for commercial use, prior to abandoning or closing any area on which the Contractor has completed operations, the Contractor shall 1) shape the entire area to leave banks in a neat and presentable condition, properly and thoroughly graded and drained and 2) establish vegetation on all disturbed areas. All stones, boulders, stumps, and debris shall be removed or satisfactorily disposed of. Slopes shall not be left steeper than 1:1.5 (vertical:horizontal). The tops of slopes and toes of slopes shall be neatly rounded. After grading the slopes and surfaces of the area, the stockpiled sod, topsoil, and other stripped material shall be evenly spread over the surface of the area. The complete area shall be seeded and mulched in accordance with Section 651. The Contractor shall place screens of trees and/or other vegetation, berms, or

embankments where necessary to conceal the undesirable features of a waste, borrow, or staging area.

The Contractor shall have the written approval of the Engineer prior to completely abandoning or closing any waste, borrow, or staging area.

105.29 PAYMENT FOR EROSION PREVENTION AND SEDIMENT CONTROL.

(a) General. Unless otherwise indicated in the Contract, all materials, installation, monitoring, maintenance and, where necessary, removal for those erosion prevention and sediment control measures that are items in the Contract will be paid for at the appropriate Contract unit price bid.

Unless otherwise indicated in the Contract, all materials, installation, monitoring, maintenance and, where necessary, removal for those erosion prevention and sediment control measures required by the Plans and/or the Engineer that are not items in the Contract will not be paid for directly, but will be considered incidental to all other Contract items.

Environmental protection work in connection with erosion prevention and sediment control for the opening, maintaining, and closing of waste, borrow, and staging areas and pollution control measures will not be paid for directly, but will be considered incidental to all Contract items.

Costs for damages to waste, borrow, and staging areas, to the owners thereof, or to adjacent property owners shall be the responsibility of the Contractor.

(b) Temporary Erosion Prevention and Sediment Control Measures. Required temporary erosion prevention and sediment control work not attributable to the Contractor's negligence, carelessness, or failure to install permanent controls will be performed and paid for as specified in part (a) of this Subsection or as ordered by the Engineer.

Temporary erosion prevention and sediment control measures required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the scheduled work or as ordered by the Engineer shall be performed by the Contractor at the Contractor's expense.

(c) Failure to Control Erosion, Pollution, or Siltation. In case of repeated failures by the Contractor to control erosion, pollution, or siltation, the Engineer may employ outside assistance or use State forces to provide the necessary corrective measures. Such incurred direct costs, plus project engineering costs, will be charged to the Contract and appropriate deductions made from any money or monies due or to become due the Contractor.

105.30 VALUE ENGINEERING.

(a) General. The intent of value engineering (VE) is to provide an incentive to the Contractor to initiate, develop, and present to the Engineer for consideration cost reduction proposals 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 VE proposal.

The change in cost proposals contemplated are those that would require a Change Order/Supplemental Agreement (COSA) modifying the Contract and would produce an overall savings to the public by providing items or methods other than those specified in the Contract and/or reduce future maintenance costs without impairing essential functions and characteristics such as service life, safety, durability, reliability, economy of operation, ease of maintenance, and necessary standardized features. A VE proposal shall contain proven features that have been used under similar conditions, and is presented as such, and does not contain equivalent options already provided in the Contract.

(b) Procedure.

(1) General. Unless mutually agreed otherwise, the VE proposal approval process will occur in three steps:

a. A conceptual VE proposal submission and review.

b. A detailed VE proposal submission and evaluation, and if approved.

c. A COSA modifying the Contract, including the amount of payment due to the Contractor and credit due to the Agency.

(2) Conceptual Value Engineering Proposal (CVEP). To begin the VE proposal approval process, the Contractor shall submit a written Conceptual Value Engineering Proposal (CVEP) to the Engineer for consideration. The CVEP is not a formal and complete submittal based upon detailed technical analysis, but instead relays a conceptual idea based upon the Contractor's knowledge and expertise. The CVEP should include the following information based upon the Contractor's best knowledge and understanding:

a. General Description. A narrative that describes the proposed change in concept and includes the basic differences between the existing Contract and the proposed change.

b. Advantages and Disadvantages. A listing and brief description of the comparative advantages and disadvantages of the CVEP including effects on the service life, safety, durability, reliability, economy of operation, ease of maintenance, and any other factors significantly altered by the CVEP.

c. Impacts to Permits and/or Third-Party Agreements. A description of steps necessary to address existing permits, new permits, or third party agreements that may be impacted or required in order to initiate the proposed change(s). In addition, the Contractor shall describe its expectation of securing or modifying these documents, who is responsible for securing them, and required timeframe(s).

d. Identification of Prior Similar CVEPs. If the CVEP was submitted previously on another Agency project, the date, the project name and number, and the action taken by the Agency shall be indicated.

e. Known Use or Testing. A description of any previous use or testing of the concept(s) included in the CVEP that is known to the

Contractor, including the tester, the conditions, and the results.

f. Estimate of Net Savings. An estimate of the Net Savings as defined in part (c) below. This amount shall not include the cost to prepare and submit the CVEP)

g. Estimate of Development Costs. A scope of work and related cost estimate to develop and submit a Detailed Value Engineering Proposal (DVEP). This estimate should include a detailed estimate of both the engineering costs the Contractor will incur in preparing the DVEP (the "Internal DVEP Costs") and the cost the Contractor will incur to obtain specialty engineering services that the Contractor cannot perform and which are necessary to prepare the DVEP (the "External DVEP Costs") (collectively, the "DVEP Costs"). If the Contractor establishes, to the satisfaction of the Construction Engineer, that it does not have the financial resources to incur the DVEP Costs, the Agency may, in its sole discretion, decide to advance the Contactor up to 50% of the DVEP Costs. In no event will the Agency pay more than 50% of the DVEP Costs, nor will the DVEP Costs exceed 50% of the Net Savings amount, as defined in part (c) below.

h. Savings and Schedule Impacts. An estimate of the time necessary for the Contractor to submit a DVEP and the time-sensitivity of the savings identified. Such estimate shall specify the date by which the Agency must approve the DVEP to obtain the maximum cost reduction, and the latest date by which the Agency must approve the DVEP for the Contractor to avoid significant impacts on the estimated Net Savings or the Contractor's schedule of work. If the Agency determines that the time for response is insufficient for review, the Contractor will be promptly notified.

i. Agency Review. The Engineer will use best efforts to review a conforming CVEP and respond to the Contractor within 14 calendar days of receipt. The Agency may, at its sole discretion:

1. Invite the Contractor to submit a DVEP;

2. Reject the CVEP for reasons that will be described briefly; or

3. Request additional information.

(3) DVEP. If invited by the Agency as provided in subpart (b)(2)i.1., the Contractor may submit a DVEP. DVEPs will be processed in the same manner as prescribed for any other alterations of the Contract that require a COSA and shall contain, as a minimum, the following information:

a. Description. A description of what is being changed, altered, or deleted, and why, and what is being proposed to improve upon the originally designed feature.

b. Itemization. An itemization of the requirements of the Contract (plans, specifications, pay items, and unit prices) that must be changed and a recommendation of how to make each change, including a description of the advantages and disadvantages and where these items have been successfully used on other projects before or tested elsewhere.

c. Computation of Net Savings. A detailed computation of the estimated net savings to be generated as defined in part (c), actual DVEP development costs, and estimated savings and schedule impacts, including approval date(s) required. If the Agency determines that the time for response is insufficient for review, the Contractor will be promptly notified.

d. Prediction of Other Costs. A prediction of any effects the proposed changes would have on other costs to the Agency, including environmental effects, traffic impacts, and preventive action or treatment costs.

e. Plans and Specifications. A complete set of Plans and Specifications, prepared as Construction Drawings in accordance with Subsection 105.03, showing the proposed revisions relative to the original Contract features and requirements. All DVEPs that require engineering design, computations, or analysis shall be prepared under the responsible charge of and sealed by a Professional Engineer licensed in the State of Vermont.

f. Contract Completion. A statement as to the effect the proposal would have on the time for the completion of the Contract. Extension to the original Contract Completion Date will generally not be approved.

(4) Evaluation of DVEP. The Agency will evaluate the DVEP and consider the following:

a. The Agency may request any additional information that it determines is necessary to properly evaluate the DVEP. Where design changes are proposed, such additional information may include results of field investigations and surveys, design computations, specifications, and any field changes already incorporated into the project. The Contractor shall promptly provide any such requested information.

b. The Agency may require the Contractor to provide additional information to verify the Contractor's cost analysis.

c. When the Agency is acting as the contracting authority for a locally owned facility, the local governing body must also provide approval.

The Contractor shall present their proposal to the local governing body and allow sufficient time to present the proposal and receive comments.

(5) Evaluation Response. The Agency will use its best effort to evaluate a conforming DVEP and provide the Contractor with a written response within 30 calendar days of receipt of all of the information it has determined was necessary to properly evaluate the DVEP. Such response will include a brief description of the Agency's reason(s) for its decision. The Agency, at its sole discretion, will either accept the DVEP, accept it with conditions, or reject it.

(6) No Liability for Delay. The Agency shall not be liable for any delay in acting upon any VE proposal submitted. The Contractor may withdraw in whole or in part any VE proposal not accepted within the period specified in the proposal. The decision of the Engineer as to the acceptance or rejection of VE proposals will be final and will not be subject to the provisions of Subsections 105.02 or 105.20.

(7) Contingencies. The Agency may approve a DVEP with contingencies, which if not met by the Contractor, will prompt the Agency to reject the DVEP before the execution of a COSA. Contingencies may include but not be limited to the necessary approvals of permits, amendments, execution or amendments to third-party agreements, specific deadlines for completion of submittals, or execution of permits, agreements, and/or amendments thereof.

(8) Rejection/Termination. If the Agency rejects the DVEP, the DVEP process will terminate. The Agency, in its sole discretion, will determine whether to reimburse the Contractor for DVEP Costs, and if so, what percentage of those costs. In no event will the Agency pay more than 50% of the DVEP Costs. These costs will not include the cost to prepare the CVEP.

(c) Accepted Proposals; COSA. If a DVEP is accepted, or if it is accepted with conditions and the Contractor wants to proceed, the necessary Contract modifications will be effected by execution of a COSA which will provide for equitable price adjustments giving the Contractor and the Agency equal shares in the net savings. Unless and until a proposal is effected by such Contract modification, the Contractor shall remain obligated to perform in accordance with the terms of the existing Contract. In addition to the requirements of Subsections 109.04 and 109.05, the DVEP will set forth the credit due the Agency calculated as the difference between the cost of performing the work, as originally specified, and the amount payable to the Contractor for the revised work. The payment for this Contract modification will only include the following amounts:

(1) The cost of performing the work as revised by the DVEP at agreed upon unit or lump sum prices;

(2) The DVEP development costs that the Agency agreed to reimburse the Contractor as provided in subpart (b)(2)g., if any; and

(3) Fifty percent (50%) of the Net Savings (NS) generated by the DVEP as determined by the Agency, calculated as follows:

$$NS = EGS + CSP - CUDC - AVEC$$

Where:

NS = Net Savings generated by the DVEP.

EGS = Estimated Gross Savings is an agreed upon difference between the cost of performing the Work as originally specified in the Contract and the cost of performing the Work as revised by the DVEP.

CSP = Cost Savings to the Public are those funds not expended by the public, including but not limited to reduced maintenance costs and reduced road user costs. CSP shall not include any cost savings attributable to a time period exceeding ten (10) years from the Contract Completion Date.

CUDC = Contractor's Unreimbursed Development Costs related to the preparation of the DVEP, including costs of the Contractor's design subconsultants and subcontractors, but excluding all such costs already paid by the Agency under subpart (b)(2)g. above.

AVEC = Agency's VE Costs related to review, approval, and implementation of the DVEP including design costs, field inspection, and the value of any Agency-provided property.

The COSA effecting the necessary Contract modifications shall establish the net savings agreed upon and shall provide for such adjustment in the Contract price as will divide the net savings equally between the Contractor and the Agency. All reasonably incurred costs of developing the cost reduction proposal and implementing the changes, including any increased costs to the Agency resulting from its application, will be deducted from the total estimated decrease in the Contractor's costs of performance to arrive at the net savings.

(d) Subsequent Payment Adjustments. Upon completion of the portion of the work revised by the DVEP, the Agency, on its own initiative or upon request by the Contractor, may review the actual net savings realized by the DVEP. The Contractor will be afforded an opportunity to review and comment on such a review. If the actual net savings were greater than set forth in the COSA, the increased savings will be shared equally between the Agency and the Contractor. If the net savings were less than set forth in the COSA, the reduction in savings will be borne equally by the Agency and the Contractor by a reduction of amounts otherwise due the Contractor.

(e) General Conditions.

(1) DVEPs will remain the property of the Contractor, provided that the Agency will have the unrestricted right to use any approved DVEP, or any DVEP in which the Agency has reimbursed the Contractor for any portion of the development costs, on other Agency projects without notice, cost, or liability to the Contractor.

(2) Only the Contractor may submit DVEPs. The Contractor shall review, be responsible for, and submit all proposals initiated by the Contractor's subcontractors.

(3) The Contractor shall not anticipate Agency approval of a VE proposal when bidding or otherwise before approval of a DVEP. The Contractor is responsible for all delays caused by the VE proposal that were not negotiated in the COSA.

(4) If a VE proposal is rejected by the Agency, the Contractor shall perform the work in accordance with the Contract.

(5) Except as otherwise provided in this Subsection, the Contractor shall have no claim against the Agency for additional compensation or time resulting from the delayed review or rejection of a DVEP, including but not limited to development costs, loss of anticipated profits, and increased material or labor costs.

(6) Cost sharing applies only to the Contract for which the DVEP was submitted.

(7) Upon acceptance of a cost reduction proposal, any restrictions imposed by the Contractor on its use or on disclosure of the information submitted shall be void, and the Agency shall thereafter have the right to use, duplicate, and disclose in whole or in part any data necessary to the utilization of the proposal on this project or other projects.

(8) Any time savings realized by implementation of VE proposals may result in a corresponding adjustment in the Contract completion time. No incentive pay will be provided for early completion days resulting from time savings of any approved VE proposals.

(9) Because the Agency has no obligation to change the terms of the original Contract, all VE proposal decisions by the Agency are final and are not subject to the dispute resolution provisions provided in this Contract or otherwise available in law.

(10) The Contractor may withdraw any DVEP prior to the time the Contractor signs the COSA. If the Contractor elects to withdraw the DVEP in accordance with this provision, the Contractor waives its right under subpart (b)(2)(g) for reimbursement of DVEP costs, including any costs advanced to the Contractor. If such costs have been advanced, the Contractor shall reimburse the Agency for those costs within 30 calendar days of withdrawing its DVEP.

(11) Acceptance by the Agency of a DVEP does not indicate any assumption of liability by the Agency for any design errors and/or omissions associated with the implementation of the DVEP.

SECTION 106 - CONTROL OF MATERIAL

106.01 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS. The material used in the work shall meet quality requirements of the Contract. In order to expedite the inspection and testing of materials, the Contractor shall notify the Engineer of the proposed sources of materials at least 96 hours prior to delivery.

At the option of the Engineer, materials may be approved at the source of supply before delivery is started. If it is found during acceptance that supplied materials from previously approved sources do not meet specifications, the Contractor shall take action to supply materials that meet specifications.

106.02 LOCAL MATERIAL SOURCES. The Contractor shall determine potential sources of material and the amount of equipment and work required to produce material meeting the specifications. The Agency's Geologist maintains a list of material sources that have previously produced materials meeting specifications. Exploration for new material sources will be the responsibility of the Contractor. The ability to purchase from the owner(s) of the source(s) and the quality of the material are not guaranteed by the Agency. The Contractor acknowledges that it is not possible to ascertain from samples the limits of a deposit and that variations in quality in a material source are normal and to be expected. The Engineer may order procurement of material from any portion of a material source and may reject portions of the material sources as unacceptable.

It shall be the responsibility of the Contractor to acquire the right to take materials from any source together with the right to use such property as required for whatever purpose, including plant sites, stockpiles, and

hauling roads. The Contractor shall pay all costs related thereto together with any costs resulting from exploring and developing these sources.

106.03 SAMPLES AND TESTS. All materials will be inspected, sampled, tested or accepted by the Engineer as incorporated into the work. Under any applicable Quality Acceptance (QA) specifications, the Contractor shall perform all Process Quality Control testing with the Engineer performing all Quality Acceptance testing. Any work in which untested and/or unaccepted materials are used without the approval or written permission of the Engineer shall be performed at the Contractor's risk. Any work determined to be unacceptable and unauthorized will not be paid for. All testing will conform to the most recent cited standard methods of AASHTO or ASTM, including AASHTO Provisional Specifications or the ASTM Tentative Specifications that are current on the date of the advertisement for bids, unless otherwise specified. In the case of conflict between the ASTM and the AASHTO methods of sampling and testing, the AASHTO method shall govern. When modified AASHTO or ASTM test methods or Vermont Agency of Transportation test methods are designated, the test method will be available at the office of the Agency's Materials and Research Section. Tests for compliance with specification requirements will be made by and at the expense of the Agency.

Samples will be taken by authorized representatives of the Agency in accordance with the requirements of the latest edition of the Agency's Materials Sampling Manual. The Contractor shall provide such facilities, as specified in these Specifications, or as the Engineer may require, for collecting and/or forwarding samples. In all cases, the Contractor shall furnish the required samples without charge.

All materials used are subject to inspection, testing, and acceptance/rejection at any time during the Contract period. Materials contaminated by the Contractor's operations shall be removed. No work or materials shall be deemed approved until accepted by the Engineer. Copies of all test results will be furnished to the Contractor's representative upon request.

In lieu of testing, the Agency may approve the use of certain materials based upon the receipt of a certification from the manufacturer stating that such material is in compliance with these Specifications. The requirements for such certifications are specified in Subsection 700.02.

Bituminous materials designated for acceptance under QA provisions will be randomly sampled and tested in accordance with the recommended acceptance guidelines specified for the applicable Contract item. Samples may also be taken any time the material appears defective or when the

Engineer determines that a change in the process or product has occurred. Acceptance tests will govern in all cases for determination of pay factors without regard to quality control tests.

(a) The Contractor shall provide Process Quality Control adequate to produce work of acceptable quality. The Contractor shall perform Process Quality Control sampling, testing, and inspection during all phases of the work at a rate sufficient to assure that the work conforms to the Contract requirements and the minimum guidelines specified.

The Engineer will not sample or test for Process Quality Control or assist in controlling the Contractor's production operations. The Contractor shall provide personnel and testing equipment capable of providing a product which conforms to specified requirements. Continual production of non-conforming work at a reduced price, in lieu of adjustments to bring work into conformance, shall not be allowed.

(1) The Contractor shall provide and maintain a Process Quality Control Plan, hereinafter referred to as the "Plan", including all the personnel, equipment, supplies, and facilities necessary to obtain samples, perform tests, and otherwise control the quality of the product to meet specified requirements.

The Contractor shall be prepared to present and discuss, at the preconstruction conference, quality control responsibilities for the specific Contract items. The Contractor shall submit the Plan to the Materials and Research Engineer for approval/rejection, at least ten (10) working days prior to the start of related work. The Contractor shall not start work on the subject items without an approved Plan.

The approval process for the Contractor's Plan may include inspection of testing equipment and a sampling and testing demonstration by the Contractor's technician(s) to assure an acceptable level of performance.

(2) All Contractor Process Quality Control testing under the Plan shall be performed by qualified technicians in laboratories approved by the Materials and Research Engineer. Technician qualifications shall be as

described in the specifications for the Contract item being accepted.

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. Major pieces of equipment shall be calibrated and/or verified in accordance with the schedule provided by Subsection 106.03(b)(4). Records indicating equipment condition and calibration status shall be maintained in the laboratory. The Engineer shall be permitted unrestricted access to inspect and review the Contractor's laboratory facility. The Engineer will advise the Contractor of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. Deficiencies shall be grounds for the Engineer to order an immediate stop to incorporating materials into the work until deficiencies are corrected.

(3) The Plan shall be administered by a qualified individual. Administrator qualifications shall be as described in the specifications for the Contract item(s) being accepted.

The individual administering the Plan must be a full-time employee of, or a consultant engaged by, the Contractor. The individual shall have full authority to institute any and all actions necessary for the successful operation of the Plan.

(4) The Plan shall contain a system for sampling that assures all material being produced has an equal chance of being selected for testing. The Engineer shall be provided the opportunity to witness all sampling.

When directed by the Engineer, the Contractor shall sample and test any material which appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or the resulting deficiency otherwise corrected by the Contractor. All sampling and testing shall be in accordance with Agency, AASHTO, or ASTM procedures.

(5) All testing shall be performed in accordance with the acceptance test procedures applicable to the specified Contract items or other methods specified in the approved Plan. Should acceptance test procedures not be applicable to quality control tests, the Plan shall stipulate the test procedures to be utilized. Upon request, the Contractor shall provide copies of all test results on forms meeting the approval of the Engineer.

(6) The Contractor shall maintain complete records of all Process Quality Control tests and inspections. Quality control tests that are initiated but not run to completion shall be incorporated into the records with all available information that was derived. The records shall be available to the Engineer for review and copies furnished upon request. A complete set of all such documents shall be provided upon completion of the Contract.

Control Charts acceptable to the Engineer shall be maintained and kept current at a location satisfactory to the Engineer. At a minimum, the Control Charts shall identify the project number, the Contract item number, the test number(s), each test parameter, the upper and lower specification limit applicable to each test parameter and the Contractor's test results.

The Contractor shall include the Control Charts as part of a Process Quality Control System. The charts shall be used for identifying production and equipment problems and for identifying aspects which could result in pay factor reductions before they occur. Trigger mechanisms for corrective action and suspension of operations must be identified.

(7) The Engineer may suspend associated construction or production operations at any time that the Plan is not being followed by the Contractor.

(8) Under such conditions where two sub-lot test results indicate that the lot will result in a sub-par Percent Within Limits (PWL), the Contractor may request that a third test, herein termed a "lot termination test," be taken. After performing a lot termination test, all production operations shall immediately be terminated

for that day. The Contractor shall secure the Engineer's approval and concurrence prior to performing said test. This test shall not be cause for switching to "low production activities" as specified in Subsection 106.03(a)(9).

(9) Upon 24 hours advance request and subsequent approval by the Engineer, the Contractor may perform production activities outside of the requirements of the Plan in the instance those activities involve "low production activities". For the purpose of this Section, low production activities are defined as those not associated with mainline activities and up to a maximum daily production of 300 metric tons (tons) of bituminous mixture.

Materials being produced for low production activities will be tested under the "method spec" provisions of materials testing and control of mixtures and shall comply with all applicable specifications for the mix type being produced.

(b) Items specified to be sampled and tested for QA purposes will be evaluated for acceptance in accordance with the guidelines specified for those Contract items. All acceptance test results for a lot, as defined in the specification, will be analyzed collectively and statistically by the Quality Level Analysis – "Percent Within Limits" Method using the procedures listed to determine the total estimated percent of the lot that is within specification limits. Quality Level Analysis – "Percent Within Limits" is a statistical procedure for estimating the percent compliance with a specification and is affected by shifts in the arithmetic mean ($\bar{X}$) of the test results and by the sample standard deviation (s).

(1) If less than three samples have been obtained at the time a lot is terminated, the material in the shortened lot will be included as a part of an adjacent lot and a pay factor computed for the combined lots. Generally, this involves combining the shortened lot's results with a subsequent lot's test results.

However, if this occurs on the last lot of production, these results will be combined with the most recent lot's lot results for a revised determination.

(2) The Engineer may reject material which appears to be obviously defective based on visual inspection. Such rejected material shall not be used in the work.

(3) Quality Level Analysis – "Percent Within Limits" procedures are defined as follows:

a. Compute the upper quality index (Q_u):

$$Q_u = \frac{USL - \bar{x}}{s}$$

Where USL = upper specification limit

$\bar{x}$ = arithmetic mean of the test results
s = sample standard deviation

b. Compute the lower quality index (Q_L):

$$Q_L = \frac{\bar{x} - LSL}{s}$$

Where LSL = lower specification limit

c. Determine PWL_U (percent within the upper specification limit which corresponds to a given Q_U) from references available through the Engineer.

Note: If a USL is not specified, PWL_U will be 100.

d. Determine PWL_L (percent within the lower specification limit which corresponds to a given Q_L) from references available through the Engineer.

Note: If a LSL is not specified, PWL_L will be 100.

e. Determine the PWL (total percent within specification limits).

$$PWL = PWL_U + PWL_L - 100$$

f. Determine the Pay Factor (PF) for the lot from the process or equation applicable to the specific Contract item.

g. Results from the above calculations shall be carried to significant figures and rounded according to the following procedures:

1. Significant Figures:

-Report all standard deviation calculations to 0.01
-Report all pay factor calculations to 0.1%
-Use “precision as displayed” option when using “Excel” spreadsheets

2. Rounding: The use of AASHTO “rounding rule D” shall be discontinued and the following procedure used:

When Rounding: If the first number to the right of the number to be rounded is greater than or equal to 5, then the number is rounded up to the next highest number. If the number to be rounded is less than 5, then the number remains the same.

Example: Round to 1 decimal (1.0)

5.35 would round to 5.4
5.34 would round to 5.3

(4) Bituminous Concrete Lab Calibration / Verification Procedures:

This subpart provides a summary of procedures for both required internal laboratory calibration and verification and required external (independent) laboratory calibration services.

INTERNAL CALIBRATIONS / VERIFICATIONS PROCEDURES LISTING

VAOT Number	Calibration (C) / Verification (V) Item	Frequency (months)
4	General Purpose Drying Oven (V)	12
10	Temperature Measuring Devices (V)	6
10c	Temperature Measuring Devices - ASTM E 1, E 77, E 230 (C)	6
10f	Temperature Measuring Devices - Reference ASTM E 1, E 77, E 230 (C)	6
11	Sieves (V)	6
20	Marshall Compaction Molds – AASHTO T 245 (V)	12
21	Superpave Gyratory Compaction Molds and Gyratory Compactor – AASHTO T 312 (V)	6
22	Sand Equivalent Test – AASHTO T 176 (V)	12
23	Vacuum System – AASHTO T 209 (V)	12
32	Timers	6
45	Mechanical Sieve Shaker (C)	12
54m	Marshall Stability / Flow Apparatus – AASHTO T245 (C)	12
58	Marshall Molds, Manual Hammer, Breaking Heads, Pedestal – AASHTO T 245 (V)	12

EXTERNAL CALIBRATION REQUIREMENTS

VAOT Number	Verification (V)/ Calibration(C) Item	Frequency (months)
TBD	Scales, Balances	12

For the purposes of this Subsection, calibrations are performed on equipment that can be adjusted into compliance. Verifications are completed on fixed condition equipment or equipment that requires outside calibration (typically by a manufacturer or calibration service). Laboratory records that include the date, service person, equipment calibrated or verified, procedure used for calibration and/or verification, and equipment condition shall be maintained in the laboratory. Equipment determined unsuitable for use will be marked "out of service". Tests performed on equipment marginally meeting specifications shall include a note on the results sheet indicating such condition.

Example calibration/verification procedures noted above are available from the Agency's Materials and Research Section. Alternate procedures approved in advance by the Materials and Research Engineer are allowable and anticipated.

106.04 PLANT INSPECTION. The Engineer may undertake the inspection of materials at the source.

In the event plant inspection is undertaken the following conditions shall be met:

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

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

(c) When required by the Contract, the Contractor shall arrange for an approved building or trailer with the necessary equipment for testing for the use of the Inspector; such building or trailer shall be located conveniently near the plant.

(d) Adequate safety measures shall be provided and maintained.

The Agency reserves the right to retest all materials that have been tested and accepted at the source of supply prior to incorporation into the work after delivery and to reject all materials that do not meet the requirements of the Contract when retested.

106.05 STORAGE OF MATERIALS. Materials shall be stored so as to ensure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may be inspected prior to their use in the work; they shall meet the requirements of the Contract at the time of use. Stored materials shall be located so as to facilitate inspection. Upon approval, portions of the right-of-way not required for public travel may be used for storage purposes and for the placing of the Contractor's plant and equipment, but any additional space required therefore shall be at the Contractor's expense. Private property shall not be used for storage purposes without written permission of the owner and/or lessee. All storage sites shall be restored to their original condition at the Contractor's expense; this shall not apply to the stripping and storing of topsoil, or to other materials salvaged from the work or specifically prescribed in the Contract.

106.06 HANDLING MATERIALS. All materials shall be handled so as to preserve their quality and fitness for the work.

106.07 UNACCEPTABLE MATERIALS. At the discretion of the Engineer, all materials not in conformance with the requirements of the Contract shall be considered unacceptable and all such materials, whether in place or not, shall be rejected and removed immediately from the site of the work unless otherwise instructed by the Engineer. Rejected materials that have been subsequently corrected shall not be used unless and until approval has been given.

106.08 EXPLOSIVE AND FLAMMABLE MATERIALS. The Contractor's attention is directed to the provisions of the Vermont Statutes Annotated as amended which (1) authorize the State Fire Marshal to make, publish, enforce, and from time to time to alter, amend, or repeal rules and regulations pertaining to fire prevention and public safety concerning the safekeeping, storage, use, manufacture, sale, handling, transportation, or other disposition of blank cartridges, gun powder, dynamite, nitroglycerine, crude petroleum or any of its products including liquefied petroleum gas, explosives, flammable gases and flammable fluids, compounds or tablets, any other explosive, or any substance that may spontaneously or acting under the influence of any contiguous chemical or physical agent ignite, inflame, or generate inflammable or explosive vapors or gases to a dangerous extent, and (2) may prescribe the location, materials, and construction of buildings and other facilities to be used for storage of such products. Attention is further directed to the regulations applying to explosives while being transported by carriers in motor vehicles, railroad cars, or vessels in conformity with the regulations adopted by the US Department of Transportation, the US Coast Guard, or the Secretary of Transportation under the provisions of Title 5 VSA § 2001 and Subsection 107.11.

106.09 STOCKPILING OF MATERIALS.

(a) Ordering Materials; Stockpiling Authority. The Contractor is urged to place orders for materials with producers and suppliers as early as practical so that delays may be kept to a minimum.

The Contractor may submit a written request to the Agency to pay for stockpiled material.

The Engineer may authorize payment for the Contractor's cost of materials, including freight.

The Agency may deny any and all requests to stockpile materials and to make stockpile payments.

(b) Request and Procedure; Criteria. To request stockpiling, the Contractor shall submit the following for consideration by the Agency:

1. Listing of material(s) by specific Contract pay item and quantity to be stockpiled;

2. Invoice for all materials, or a receipt for delivery;

3. Drafts of documents that show that ownership of the material(s), without encumbrances, will be in the name of the Contractor and will be for the benefit of the Agency;

4. Appropriate certifications and/or passing samples as required for the specific material(s);

5. Statement that the material shall be clearly marked so as to easily identify the project in which the material will be incorporated and shall be available for inspection by the Agency; and

6. The location where and condition(s) under which the material will be stockpiled.

The storage location and security of the stockpiled material(s) shall be the responsibility of the Contractor.

(c) Raw Materials. In addition to the criteria set out above for other materials, raw material stockpiles shall be approved by the Director of Program Development and meet the following additional criteria:

1. The various components of the finished product shall include all of the appropriate certifications, passing samples, passing tests, and any other documentation that may be required to certify that the materials are acceptable; and

2. Any other criteria the Engineer deems necessary to allow for payment.

(d) Cap; Payment to Supplier; Charge Back; Minimum to Stockpile. Payment will be made for the invoiced amount, not to exceed 75% of the total Contract bid amount for each specific item for which stockpiling is allowed; the quantity of stockpiled material shall not exceed the Contract quantity for the specific item. The Contractor shall furnish the paid invoice within 28 calendar days after the cutoff date for the estimate in which the stockpile amount is paid. If the Contractor fails to furnish the paid invoice within this time limit, the amount of the stockpile payment will be deducted from one or more subsequent payments. Under no circumstances shall stockpiling be allowed for an item with a Contract bid amount totaling less than $25,000.

The stockpile credit amount shall be reduced once installation of the item begins, and the reduction shall correspond with the installation and payment of the specific stockpiled item.

The Contractor may request an exception to the 75% cap; any such request shall be included in the original request for stockpile and shall include all information to support the request.

(e) Finished Product. Payment for stockpiled materials shall not relieve the Contractor from providing an acceptable finished product or from its responsibility for the condition of the materials as specified elsewhere in the Contract. Any defects, flaws, or poor craftsmanship shall be the responsibility of the Contractor and shall be corrected to the Agency's satisfaction at the Contractor's expense.

(f) Material or Energy Shortage. In the event that unreasonable delays or changes in the work occur as a result of a material or energy shortage, the Contractor shall notify the Agency in writing. If, in the opinion of the Director of Program Development, the Contractor’s argument has merit, alternate methods of construction, substitution of materials, or an extension of time may be authorized.

SECTION 107 - LEGAL RELATIONS AND RESPONSIBILITY TO THE PUBLIC

107.01 LAWS TO BE OBSERVED.

(a) General; Defense and Indemnification. The Contractor shall observe and comply with all Federal and State laws and local bylaws, ordinances, and regulations in any manner affecting the conduct of the work and the action or operation of those engaged in the work, including all orders or decrees as exist at present and those which may be enacted later by bodies or tribunals having jurisdiction or authority over the work, and the Contractor shall defend, indemnify, and save harmless the State and all its officers, agents, and employees against any claim or liability arising from or based on the violation of any such law, bylaws, ordinances, regulations, order, or decree, whether by the Contractor in person, by the employees of the Contractor, or by a subcontractor or supplier.

(b) Contract Contrary. If the Contractor discovers any provisions in the Contract that are contrary to or inconsistent with any law, ordinance, regulation, order, or decree, the Contractor shall immediately report it to the Engineer in writing.

(c) U.S., VOSHA, and Environmental Protection Regulations. The Contractor's attention is directed to the various regulations promulgated and enforced by the United States and VOSHA and the environmental protection agencies.

(d) Fair Employee Practices Act. The Contractor shall comply with all of the requirements of Title 21 VSA Chapter 5, subchapter 6, relating to fair employment practices to the extent applicable. A similar provision shall be included in any and all subcontracts.

(e) Hazardous Wastes. The Contractor's attention is directed to regulations regarding the management of hazardous wastes such as waste crankcase and hydraulic oils, and waste paint generated by construction operations (ref: Agency of Natural Resources' Department of Environmental Conservation and Title 10 VSA Chapter 159).

(f) Americans with Disabilities Act. The Contractor shall comply with the Americans with Disabilities Act of 1990 and shall assure that individuals with disabilities have equal access to the services, programs and employment activities/opportunities offered by the Contractor under this Contract.

(g) Prompt Payment Act. The Contractor shall fully comply with the provisions of 9 V.S.A. Chapter 102, also referred to as Act No. 74 of 1991 or the Prompt Payment Act, as amended.

(h) Subcontractor Payments; Reporting; Violations; Inclusion In Subcontracts. On all federal-aid and state funded contracts, the Contractor, during the life of the Contract and on a monthly basis, shall submit electronically, a listing of payments to subcontractors on the form specified by the State and made available at: http://www.aot.state.vt.us/dbe/login.asp. Electronic reports shall be filed with the Agency Office of Civil Rights by an authorized representative and received in the Agency Office of Civil Rights on or before the tenth working day after month end. Contractors without access to the internet shall obtain and submit manual reports to the Agency Office of Civil Rights. Manual reports shall be signed by an authorized representative, sent to the Agency Office of Civil Rights, and postmarked on or before the tenth working day after month end. There shall be no direct compensation allowed the Contractor for this work, but the cost thereof shall be included in the general cost of the work.

In accordance with 9 V.S.A. Section 4003, notwithstanding any contrary agreement, payments made to subcontractors after seven days from receipt of a corresponding progress payment by the State to the Contractor, or seven days after receipt of a subcontractor's invoice, whichever is later, violate this agreement.

Violations shall be reported to the Agency Office of Civil Rights for review. Failure to resolve disputes in a timely manner may result in a complaint made to the Agency Pre-qualification Committee. In this Committee's judgment, appropriate penalties may be involved for failure to comply with this specification. Penalties may include suspension, reduction or revocation of the Contractor's pre-qualification rating.

This clause shall be included in the prime Contractor's Contract made with all if its subcontractors.

107.02 PERMITS, LICENSES, AND TAXES. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the lawful prosecution of the work.

107.03 PATENTED DEVICES, MATERIAL, AND PROCESSES. If any design, device, material, or process covered by letters of patent or copyright is used by the Contractor, whether required or not, the Contractor shall provide for such use by suitable legal agreement with the patentee or owner; a copy of this agreement shall be filed with the Agency. The Contractor and the Contractor's surety shall defend, indemnify, and save harmless the State, any affected third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material, or process, or any trademark or copyright, and shall indemnify the State for any costs, expenses, and damages including reasonable attorney's fees which it may be obliged to pay by reason of any infringement at any time during the prosecution or after the completion of the work.

107.04 FEDERAL-AID PROVISIONS. The Contractor acknowledges that pursuant to the provisions of Title 23 USC, and Acts amendatory thereto, as well as any and all other Federal legislation appropriating funds to the State, the Federal Government may pay a portion of the cost of this project. The above act of Congress provides that the construction work and labor on any Federal-Aid project in Vermont shall be done in accordance with its laws and under the direct supervision of the State of Vermont, Agency of Transportation, subject to the inspection and approval of the US Department of Transportation or appropriate Federal agency and in accordance with the rules and regulations made pursuant thereto. Therefore, the construction work will be subject to such inspection by the US Department of Transportation or appropriate Federal agency or its agent as deemed necessary to meet the above requirements. Such inspection will in no sense make the Federal Government a party to this Contract and will in no way interfere with the rights of either party hereunder.

107.05 SANITARY PROVISIONS. The Contractor shall provide and maintain, in a neat and sanitary condition, such accommodations for the use of its employees as necessary to comply with the requirements and regulations of the State or local Boards of Health at no expense to the Agency.

107.06 PLANT PEST CONTROL REQUIREMENTS. Soil and soil moving equipment are subject to plant quarantine regulations. In general, these regulations provide for cleaning soil from equipment before it is moved from a project. Complete information may be secured from State or Federal plant pest control inspectors.

107.07 PUBLIC CONVENIENCE AND SAFETY.

(a) General. The Contractor shall conduct all work so as to ensure the least possible obstruction to traffic. The safety and convenience of the general public and the residents along the highway within the construction area and the protection of persons and property shall be provided for by the Contractor as specified in Subsection 104.04.

(b) Dust Control. The Contractor shall use all necessary dust control on haul road(s) and maintenance yard(s) in the same manner as required for materials sources and disposal areas in Subsection 105.27. Dust control on haul road(s) and maintenance yard(s) shall be performed in accordance with Section 609, and will not be paid for directly, but will be considered incidental to all other Contract items. The Contractor shall perform all dust control directed by the Engineer on the haul road(s) and/or maintenance yard(s); unless otherwise provided, dust control will not be paid for directly, but will be considered incidental to all other Contract items.

The Engineer will direct the use of all necessary dust control within the limits of the construction performed under the Contract. Under those contracts which contain pay items for dust control, the dust control within the construction area shall be performed in accordance with the requirements of Section 609 and will be paid for under the appropriate Contract item(s). Under those contracts which do not contain pay items for dust control, the necessary dust control shall be performed in accordance with the requirements of Section 609 and the cost will not be paid for directly, but will be considered incidental to all other Contract items.

(c) Stored Materials. Materials stored within the construction area shall be placed so as to cause a minimum obstruction to the traveling public and snow removal operations.

(d) Fire Hydrants. Fire hydrants located within the construction area shall be kept accessible to fire apparatus at all times and no material or obstruction shall be placed within 4.5 m (15 feet) of any such hydrants.

(e) Adjoining Ways. Sidewalks, gutters, drainage inlets, and portions of highways adjoining the roadway under construction shall be obstructed only when necessary. If a sidewalk is obstructed, temporary pedestrian access meeting the requirements of ADA and the MUTCD shall be provided around the obstructed area.

(f) Lane Restrictions. When the total useable width of a traveled way will be decreased to 4.3 m (14 feet) or less for a period longer than one working day, the Contractor shall notify the Engineer of the date of the first day and the anticipated period of time such a lane restriction will be in effect. This notification shall be provided at least two weeks prior to the beginning of the lane restriction so that the Engineer may provide proper notification to the Oversized/Overweight Section of the Commercial Vehicle Enforcement Unit of the Department of Motor Vehicle and the Agency's Communications Section. When the date of the removal of the restriction becomes known, the Contractor shall notify the Engineer so that notification can be provided to these entities.

107.08 TRAFFIC CONTROL DEVICES.

(a) General. All approach signs shown on the Plans shall be installed prior to beginning other work. Additional traffic control devices necessary for work on any portion of the project shall also be installed prior to beginning work on that portion. All traffic control devices shall conform to the latest version of the MUTCD. Use of metal drums as traffic control devices is prohibited.

The Contractor shall furnish, erect, and maintain all signs, barricades, lights, signals, and other traffic control devices necessary for the protection of the work and safety of the traveling public.

(b) Existing Pavement Markings. Whenever existing pavement markings conflict with desired traffic patterns within a construction or detour area or otherwise create a potentially misleading, confusing, or hazardous condition for the traveling public, the markings will be completely removed or obliterated by the Contractor to the satisfaction of the Engineer. Painting over the existing lines is not acceptable. Unless otherwise specified in the Contract, no direct payment will be made for this work, which will be considered incidental to other Contract items.

(c) Warning Signs. The Contractor shall erect warning signs in advance of any location on the project where operations interfere with the use of the road by traffic and all locations where the new work crosses or coincides with an existing road.

(d) Detour Signs. The Contractor shall provide and maintain throughout the project acceptable warning, direction, and detour signs at all closures and intersections; along the construction and detour routes, the contractor shall provide and maintain acceptable warning, direction, and detour signs directing traffic around the closed portion or portions of the highway so that the temporary detour route(s) shall be indicated clearly throughout its (their) entire length(s).

(e) Closed Highways/Sidewalks. Highways closed to traffic shall be protected by barricades and/or other approved barriers, which shall be reflectorized or illuminated.

When a section of an existing sidewalk is closed to pedestrians, suitable barricades and warning signs conforming to ADA and the MUTCD shall be installed. If channelizing devices are used to establish a temporary pedestrian route, those devices shall conform to the MUTCD.

(f) Delineation. Delineation will be required through the construction area as shown on the Plans or as directed by the Engineer.

(g) Flashers. Flashers may be required by the Engineer for use on signs and barricades to call attention to special or hazardous conditions.

(h) Costs Incidental. The cost of furnishing, fabricating, installing, maintaining, and removing traffic control devices shall be considered incidental to other items in the Contract unless otherwise specified.

(i) Failure to Install, Maintain, Remove. If the Contractor fails to satisfactorily install, maintain or remove traffic control devices, the Engineer may have such installations made, maintained, or removed, and the cost thereof shall be deducted from the monies due the Contractor.

107.09 RESPONSIBILITY FOR USE OF FLAGGERS. As conditions warrant, the Contractor shall employ one or more flaggers at any location on the project where equipment or construction operations will interfere with the movement or safety of the traveling public. This includes operations where equipment enters, leaves or crosses normal traffic lanes being used or set aside for the traveling public and locations where heavy equipment is operating adjacent to areas where traffic is moving. Flaggers may not be required at locations manned by uniformed traffic officers assigned for the protection of the traveling public as a pay item of the Contract. Attention is directed to the provisions of Section 108 as they may apply to the use of flaggers. Where needed to assure safe ingress and egress for activities associated with the construction of the project, the Engineer may require the use of flaggers at locations off of the project site.

The dress, equipment, and procedures of all flaggers shall conform to the requirements in the MUTCD and Section 630.

107.10 RAILWAY-HIGHWAY PROVISIONS. If the Contractor is required or elects to haul materials across the tracks of a railway other than on a public highway, the Contractor shall make arrangements with the railway for a new private crossing or for the use of an existing private crossing. All work to be performed within a railroad right-of-way by the Contractor in the construction of railway-highway separation structures or at grade crossings shall be done in accordance with the Contract. The Contractor shall use all care and precaution in order to avoid crashes, damage, or unnecessary delay or interference with the railway company's trains and other property. The Contractor shall carry Public Liability and Property Damage Insurance as stipulated elsewhere in these Specifications or other Contract Documents.

107.11 USE OF EXPLOSIVES.

(a) General. The Contractor shall use the utmost care to protect life and property and, whenever directed by the Engineer, shall reduce the number and size of explosive charges. Blasting mats shall be used when required by regulation or deemed necessary. The Contractor shall notify each person, company, corporation, or public utility that owns, leases, or occupies property or structures near the site of the work of plans to use explosives; notice shall be given sufficiently in advance to enable people to take such steps to protect their property or structure from injury as they may deem necessary. Provision of notice shall not relieve the Contractor of responsibility for any damage resulting from the Contractor's blasting operations. All persons within the danger zone of blasting operations shall be warned, a warning whistle shall be sounded,

and the zone cleared just prior to blasting. A sufficient number of flaggers shall be stationed outside the danger zone to stop all approaching traffic during blasting operations. Explosives shall be used only during daylight hours and shall be handled only by competent, trained workers; particular care shall be taken to ensure that no unexploded charges remain in the work area unattended and when constructions operations cease for the day. All explosives shall be stored securely, all storage locations shall be clearly marked "DANGEROUS-EXPLOSIVES," and all storage locations shall be supervised and controlled by a competent, trained person at all times. All explosives and highly flammable materials shall be stored and used in strict conformity with all Federal, State, and local laws, rules, and regulations. Attention is directed to VOSHA *Safety and Health Standards for* Construction, Subpart U, Blasting and the Use of Explosives.

(b) Liability. Each of the insurance policies required for a project shall include coverage for injury to persons and injury or destruction of any property arising out of the storage and use of explosives.

(c) Insurance. The Contractor acknowledges full responsibility and assumes full liability for any and all damage or injury to persons or property caused either directly or indirectly by the Contractor's or a subcontractor's use of explosives. The liability of the Contractor shall apply equally to damages or injury to persons or property whether said injury or damage occurs within or outside of the right-of-way. The cost of all precautionary measures shall not be paid for directly, but all costs therefore shall be included in the bid prices for the pay items under the Contract.

(d) Blasting Cap Danger. The Contractor and/or the Contractor's agents shall take all precautions necessary to prevent premature explosions of electric blasting caps individually or when they are connected into a circuit.

The Contractor and/or the Contractor's agents acknowledge and are hereby advised of the potential hazard of a premature explosion of electric blasting caps due to propagation of radio frequency energy by transmitters of radio and the related radio services such as television and radar. Mobile and fixed radio, cellular telephone, radar, television, and related transmitters are in general use in the State of Vermont, including police departments, fire departments, political subdivisions, utility companies, commercial carriers, private and public enterprises, and individuals.

(e) Warning Signs; Costs Incidental. Prior to blasting operations the Contractor shall install warning signs in conformance with the MUTCD. Warning signs shall be located in prominent positions at least 370 m (1200 feet) from the point of blasting and visible to any person approaching the blasting point. Payment for furnishing, erecting and maintaining warning signs shall be considered incidental to other items in the Contract.

(f) Documentation of Structure Condition. It shall be the responsibility of the Contractor to document the existing condition of all structures that have potential for damage. This documentation shall be in the form of a video or pictures, with sufficient description, and shall be supplied to the Engineer prior to any blasting on the project. The costs of preparing this documentation will not be paid for directly, but shall be considered incidental to all Contract items.

(g) Blast Surveys. The Contractor shall monitor all blasts and provide a report to the Engineer that shall indicate the Peak Particle Velocity (PPV) of the blast. The PPV sensitivity as reported shall range from less than 0.5 mm/s (0.02 in/s) to more than 125 mm/s (5.0 in/s). The Engineer reserves the right to request more than one instrument to monitor the blasting if there is a need for monitoring in more than one direction from the blasting area. The costs of the monitoring and preparing the reports will not be paid for directly, but shall be considered incidental to all Contract items.

107.12 PROTECTION AND RESTORATION OF PROPERTY.

(a) General. The Contractor shall:

(1) Not enter upon private property for any purpose without obtaining written permission;

(2) Be responsible for the preservation of all public and private property along and adjacent to the work;

(3) Use every precaution necessary to prevent damage or injury to public and private property;

(4) Protect from disturbance or damage all land monuments and property markers until an authorized agent has witnessed or otherwise referenced their locations, monuments, and property markers;

(5) Not move any land monuments and property markers until directed by the Engineer; and

(6) Protect all trees, shrubs, and other plants not marked by the Engineer for removal from damage by construction operations.

(b) Protection of Existing Infrastructure. The Contractor shall make sure that any portions of the existing roadway and existing structures which are to be retained for public travel are left in as good condition as when the Contractor commenced work. The Contractor shall not move or use equipment on any pavement or structure in a manner that may or does cause damage

(c) Contractor's Responsibility. The Contractor shall be responsible for all claims involving damage or injury to, or destruction of, property of any type resulting from any act, omission, neglect, or misconduct of the Contractor's manner or method of executing the work, due to the Contractor's non-execution of said work, or due to defective work or materials. The Contractor's responsibility shall not be released until the work has been completed and accepted and the applicable statute of limitations has expired.

(d) Restoration of Damaged Property. When any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the work or in consequence of the non-execution thereof on the part of the Contractor, such property shall be restored at the Contractor's expense to a condition similar or equal to that existing before such damage or injury was done or the Contractor shall make good such damage or injury in an acceptable manner.

(e) Cleaning Traffic Signals and Street Lighting. When the Contractor's operations compromise the functionality of existing traffic signals and/or street lighting equipment, the Engineer may require the Contractor to clean said equipment prior to project completion. Cleaning of traffic signals shall include all vehicle and pedestrian signal face lenses (inside and outside). Further, the inside of the controller cabinet shall be vacuumed and any vent filter shall be replaced; cleaning of streetlights shall include both the lens (inside and outside) and the reflector. The cleaning of electrical equipment shall be done by a traffic signal/electrical contractor. Any equipment that is damaged in the cleaning process shall be repaired or replaced at the Contractor's expense. The costs for cleaning will not be paid for directly, but will be considered incidental to other items in the Contract.

(f) Ground Vibration Limits. The maximum Peak Particle Velocity (PPV) of ground vibration in any of the three mutually perpendicular components of particle velocity for the following structure types shall be limited as follows:

	PPV in mm/s (in/sec)	
Type of Structure	Frequencies < 40 Hertz	Frequencies > or = 40 Hertz
Modern Homes (drywall interior)	19 (0.75)	50 (2.0)
Older Homes (plaster on wood or lath)	13 (0.50)	50 (2.0)
Non-Residential Structures		
Underground Utilities		

The Agency reserves the right to lower the PPV limit in areas where there may be structures or elements with a higher sensitivity to ground vibration. Adherence to this specification does not waive the Contractor's responsibility for damage as specified in this Subsection and in Subsection 107.16.

107.13 PROTECTION AND RESTORATION OF UTILITIES AND SERVICES.

(a) General. The Contractor shall take proper precaution during construction to avoid damage to public and private services. These services include, but are not limited to gas, water, sewer and drainage pipes, springs, wells, septic tanks, cesspools, telephone, telegraph, television, and other communication and electrical services. Services may be located on or adjacent to the project, above, on, or under the ground, and may not be shown on the Plans.

(b) Dig-Safe. The Contractor shall comply with the requirements of Dig-Safe, Title 30 V.S.A. Chapter 86, Sections 7001 - 7008.

(c) Notice of Work. At commencement or resumption of construction, the Contractor shall notify the owners, operators, occupants, or lessees of all the public or private services of any work to be done on, over, under, adjacent to, or in proximity to said utilities during the construction of the project. Further, the Contractor shall again notify the aforesaid parties seven (7) to fourteen (14) calendar days in advance of starting such work to enable them to take steps as they may deem necessary to protect their property or structures from damage. Provision of notice shall not relieve the Contractor of its responsibility for any damages resulting from the Contractor's work.

(d) Owner Access. Owners, employees, or agents of public or private services located within the project limits shall be allowed free and full access with the tools, materials, and equipment necessary to install, operate, maintain, place, replace, relocate, and remove service facilities. No compensation will be paid to the Contractor for any inconvenience caused by working with these parties or around or with their services.

(e) Service Relocation. The exact location of any service facility relocated within the project limits shall be as directed by the Engineer.

(f) Cooperation. The Contractor shall cooperate with the owners of any of the aforementioned services in order that the service removal and/or relocation operation will progress in a reasonable manner, that duplication or temporary relocation work may be reduced to a minimum, and that services rendered by the concerned parties will not be unnecessarily interrupted.

(g) Service Interruption. If in connection with the work interruption in service occurs, the Contractor shall promptly notify the owner or the owner's authorized representative and cooperate with the owner to promptly restore service. In no case shall interruption to water or sewer service be allowed to exist outside of normal working hours without the substitution of acceptable alternate service.

(h) Fire Hydrants. No work shall be undertaken around fire hydrants until provisions for continued service have been approved by the local fire authority.

(i) Responsibility for Damage. The Contractor shall be responsible for all damages done to services from the beginning of construction to the satisfactory completion of the project, including all damages to water supplies and sewage systems, including but not limited to damage to springs and wells, septic tanks, cesspools, and underground pipes, whether located within or outside the project right-of-way or whether or not shown on the Plans, except as otherwise provided in the Contract.

(j) Water; Investigation of Claims. The Agency will receive and investigate all claims relating to damage to springs, wells, and water supply systems. The Contractor will be notified of the results of the investigation. If it is determined that the damage is the responsibility of the State, the Contractor will not be liable and will be reimbursed by the State for expenses incurred in providing temporary water service and repairing the damage.

(k) Restoration of Service by Agency. If the Contractor fails to restore a service or to make good on a damage or injury to service(s), the Engineer may proceed to repair, rebuild, or otherwise restore the service as deemed necessary and the cost thereof will be deducted from any monies due, or which may become due, the Contractor under the Contract.

107.14 PROTECTION OF HISTORICAL AND ARCHAEOLOGICAL SITES. When the Contractor's excavation operations encounter sites or artifacts of historical or archaeological significance, the operations shall be immediately discontinued. The Engineer will contact archaeological authorities and give them 48 hours to determine the appropriate action to be taken. When directed by the Engineer, the Contractor shall excavate the site in a manner that will preserve the artifacts encountered and/or remove them for delivery to the custody of proper state authorities; such excavation will be considered and paid for with Contract pay items or as Extra Work.

107.15 FOREST PROTECTION.

(a) General. When working within or adjacent to forests or other plant growth, the Contractor shall satisfactorily burn or otherwise dispose of all valueless trees and logs, stumps, roots, brush, weeds, grass, and other objectionable material. Disposal of such material shall be in conformity with the laws, rules, and regulations of the State of Vermont pertaining thereto and other authority having jurisdiction governing the protection of forests and in carrying out work within forests. When working within or adjacent to National Forest Lands, the Contractor shall comply with the requirements set forth in the Forest Service Special Use Permit included in the Contract. Before a fire is kindled on or in the vicinity of any project, the Contractor shall obtain the necessary permits from the State Agency of Natural Resources and the local fire prevention officials. Copies of permits shall be available on the project. Fires must either be thoroughly wet down when construction operations are suspended for the day or the remains shall be attended until work begins again. Night burning will not be allowed.

(b) Work In Forest Areas. The Contractor shall observe all sanitary laws, rules, and regulations with respect to the performance of work in forest areas. The Contractor shall keep forest areas in orderly condition, obtain permits for the construction and maintenance of all construction camps, stores, warehouses, residences, latrines, cesspools, septic tanks, and other structures in accordance with the requirements of the Forest Supervisor.

(c) Forest Fires. The Contractor and all subcontractors shall take appropriate action to prevent forest fires. If a fire is out of control on or near the project, the Contractor and all subcontractors shall do everything within their power to suppress the fire, shall immediately notify the Town Fire Warden or other known forest officials of the location and extent of the fire and shall cooperate with forest officials to suppress the fire once they have assumed control of the firefighting operation.

(d) Fires Caused By Contractor's Operation; Costs. The Contractor shall reimburse the Federal government, State, and political subdivisions for all expenses of suppressing a forest fire caused by its operations and shall be responsible to landowners for any and all damage caused by a fire.

107.16 RESPONSIBILITY FOR DAMAGE CLAIMS.

(a) General. The Contractor shall defend, indemnify and save harmless the municipality(ies), the State, the Agency, and railroad(s) and all of their officers, agents, and employees from all suits, actions, or claims of any character, name, and description brought for or on account of any injuries or damages received or sustained by any person, persons, or property that arise out of, relate to, or are in any manner connected with the Contractor's work or the supervision of the Contractor's work on the project; or by or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or by or on account of any act of omission, neglect, or misconduct of the Contractor; or by or on account of any claims or amounts recovered for any infringement of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the Workers Compensation Act, or any other law, bylaw, ordinance, order, or decree. The State shall notify the Contractor in the event of any such claim or suit, and the Contractor shall immediately retain counsel and otherwise provide a complete defense against the entire claim or suit.

After a final judgment or settlement the Contractor may request recoupment of specific defense costs and may file suit in Washington Superior Court requesting recoupment. The Contractor shall be entitled to recoup costs only upon a showing that such costs were entirely unrelated to the defense of any claim arising from an act or omission of the Contractor.

The Contractor shall indemnify the State and its officers and employees in the event that the State, its officers or employees become legally obligated to pay any damages or losses arising from any act or omission of the Contractor.

(b) Right to Retention of Funds. So much of the money due the Contractor under and by virtue of the Contract as shall be considered necessary by the Agency for such purpose may be retained for the use of the State. If no money is due, the Contractor's surety shall be held until such suit or suits, action or actions, or claim or claims for injuries or damages shall have been resolved and suitable evidence to that effect furnished by the Agency.

(c) Submission of Damage Claims. With regard to each and every damage claim, the Contractor shall:

(1) Provide the claimant with a damage claim form for the submission of damage claims to the Contractor and Agency;

(2) Pay, settle, or otherwise resolve the claim;

(3) Submit the claim to the insurance carrier, with a copy to the Agency;

(4) Treat all claimants with respect.

107.17 OPENING SECTIONS OF PROJECT TO TRAFFIC.

(a) General. Opening of a section of a project to traffic prior to substantial completion of the entire Contract may be desirable in some instances. Discussions concerning such an opening shall involve, but are not limited to, the Regional Construction Engineer, Project Manager, District Transportation Administrator, and, when appropriate, local municipal officials. Such an opening shall be made when directed by the Engineer and documented in a Written Order. Such an opening shall not constitute acceptance of the work or a part thereof or a waiver of any provisions of the Contract.

(b) Maintenance; Expense. On any section opened by direction of the Engineer prior to substantial completion of the Contract, the Contractor shall not be required to assume any expense entailed in maintaining the road for traffic beyond that required of a Contractor when opening a section of roadway to traffic. When extraordinary work is required to open a section of work prior to substantial completion of the Contract, the Engineer in his/her sole discretion may determine that compensation for any additional expense incurred by the Contractor to maintain traffic and allowance of additional time needed to complete the work will be made to the Contractor.

(c) Delayed Completion of Project. If the Contractor delays completion of shoulders, drainage structures, or other features of the work, the Engineer will notify the Contractor in writing and establish a reasonable period of time in which the work shall be completed. If the Contractor fails to complete the work by the time specified, the Engineer may order all or a portion of the project opened to traffic at no additional cost to the Agency. On sections that are ordered to be opened, the Contractor shall conduct the remainder of construction operations so as to cause the least obstruction and disruption to the traveling public, including vehicular and pedestrian traffic, adjacent landowners, and commercial businesses. The Contractor shall not receive any additional compensation due to the added cost caused by opening such section(s) to traffic.

(d) Opening Project to Traffic for Winter Season. As specified in Subsection 104.04, the Contractor shall open the roadway for the winter shutdown period from December 1st to April 15th. However, when this work is being done because the Contractor did not complete the work before the Contract Completion Date, any work that is not covered by a pay item in the Contract shall be considered incidental to the original Contract items and shall be performed at no additional cost to the Agency. This shall include any work required by the Agency's District Transportation Administrator(s) and/or municipal highway or public works officials to aid in the performance of winter maintenance activities. None of the time associated with the performance of this work shall be considered for an extension of time under Subsection 108.11. Furthermore, the Contractor shall not be entitled to any additional compensation for the completion of remaining work that has to be performed under the influence of pedestrian and/or vehicular traffic.

(e) Compensation for Work on Opened Sections. Except as provided for in this Subsection, notwithstanding any other provision of the Contract Documents, the Contractor shall receive no additional compensation for work on a section of the project that has been opened to traffic as described herein.

107.18 CONTRACTOR'S RESPONSIBILITY FOR WORK.

(a) General. Until acceptance of the project by the Engineer the Contractor shall be responsible therefore and shall take every precaution against injury or damage to any part thereof by the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work before acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God, of a public enemy, or governmental authorities. For purposes of this paragraph the term work shall exclude Contractor owned, rented, or leased materials, equipment, and incidentals.

(b) Suspension of Work. When work is suspended for any reason, the Contractor shall be responsible for the project and shall take precautions to prevent damage to the project, provide for normal drainage, and erect any necessary temporary structures, signs, or other facilities solely at the Contractor's expense. During a period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established plantings, seedings, and soddings furnished under the Contract and take adequate precautions to protect new tree growth and other important vegetative growth against injury.

(c) Winter Maintenance. The performance by the State, a subdivision thereof, or other authorized agent of any snowplowing, salting, and/or sanding shall not relieve the Contractor of its responsibility as outlined herein or elsewhere in the Contract.

107.19 NO PERSONAL LIABILITY OF PUBLIC OFFICIALS. It being understood that in all such matters relative to the Contract that they act solely as agents and representatives of the State, neither the Secretary, Deputy Secretary, the Director of Program Development, Engineer, or their authorized representatives shall be liable, either personally or as officials of the State, for their actions pursuant to authority granted to them by the Contract.

107.20 NO WAIVER OF LEGAL RIGHTS.

(a) General. Upon completion of the work, the Agency will expeditiously make final inspection and notify the Contractor of acceptance. Acceptance of the project, however, will not preclude or prevent the Agency from correcting any measurement, estimate, or certificate made before or after completion of the work; and the Agency will not be precluded or prevented from recovering from the Contractor, the Contractor's surety, or both any overpayment it may have made by failure on the part of the Contractor to fulfill the Contractor's obligations under the Contract. A waiver on the part of the Agency of any breach of any part of the Contract shall not be held to be a waiver of any other or subsequent breach.

(b) Latent Defects, Fraud, and Gross Mistakes. Without prejudice to the terms of the Contract, the Contractor shall be liable to the Agency for latent defects, fraud, and such gross errors, omissions, or mistakes as may amount to fraud, and as regards the Agency's rights under any warranty or guaranty.

107.21 FURNISHING RIGHT-OF-WAY. It will be the responsibility of the Agency or appropriate political subdivision to secure all of the permanent rights-of-way which may be necessary for a construction contract and to make said rights-of-way completely and physically available to the Contractor. Any additional rights-of-way and/or additional rights to use land outside of the right-of-way as shown on the Plans which the Contractor desires for its own convenience shall be obtained and paid for by the Contractor.

107.22 BUY AMERICA PROVISIONS.

(a) General. All steel products permanently incorporated into Federal-Aid projects shall be products that have been entirely manufactured within the United States. All manufacturing processes of the steel or iron material in a product (i.e., smelting and any subsequent process which alters the steel material's physical form or shape or changes its chemical composition) must occur within the United States to be considered of domestic origin. This includes processes such as rolling, extending, machining, bending, grinding, and drilling.

(b) Use of Foreign Materials. This requirement does not prevent a minimal use of foreign materials, provided the cost of foreign materials used does not exceed 0.1 percent of the total Contract price or $2,500, whichever is greater. The cost of foreign steel or iron is defined as its value delivered to the project. The Contractor shall notify the Engineer if it intends to use any foreign materials on the project.

(c) Coatings on Steel/Iron. In accordance with 23 CFR 635.410, iron has been added to the materials now subject to the Buy America requirements, and the action of applying a coating to a covered material (i.e., steel and iron) is now deemed a manufacturing process subject to Buy America. Coating includes epoxy coating, galvanizing, painting, and any other coating that protects or enhances the value of a material subject to requirements of Buy America. Buy America requirements of 23 CFR 635.410 are applicable to all Federal-Aid highway construction projects (NHS and non-NHS).

107.23 DEFENSE OF LAWSUITS - CHALLENGE TO JURISDICTION AND WAIVER OF IMMUNITY. When defending any claim that may arise under the Contract, the Contractor shall not raise or impose any defense involving the jurisdiction of the tribunal before which said claim is pending, the immunity of the State of Vermont, governmental nature of the State, or the provision of any statutes respecting suits against the said State of Vermont without obtaining the express advance permission of the Vermont Attorney General's Office.

107.24 INTEREST. Notwithstanding any statutory or other provisions to the contrary, interest on monies owed pursuant to the Contract shall be paid as follows:

(a) Claims for Adjustment or Dispute – Pre-Decision or Judgment. Interest shall be allowed the Contractor on a decision or judgment for money in a claim for adjustment or dispute. Pre-decision or judgment interest shall be calculated for twenty-one (21) days after the date the money would have been paid in a bi-weekly or final estimate, or the date of the claim, whichever is later, but for the failure of the Agency to make the payment to the date of decision or judgment, at a simple rate equal to the weekly average 1-year constant maturity Treasury yield, as published by the Board of Governors of the Federal Reserve System, for the calendar week preceding the date of the decision or judgment

(b) Claims for Adjustment or Dispute – Post-Decision or Judgment. Interest shall be allowed the Contractor on a decision or judgment for money in a claim for adjustment or dispute. Post-decision or judgment interest shall be calculated from the date of decision or judgment to the date of payment at a simple rate equal to the weekly average 1-year constant maturity Treasury yield, as published by the Board of Governors of the Federal Reserve System, for the calendar week preceding the date of the decision or judgment.

SECTION 108 - PROSECUTION AND PROGRESS

108.01 SUBLETTING OR ASSIGNMENT OF CONTRACT.

(a) General. The Contractor shall not sublet, assign, sell, transfer, or otherwise dispose of the Contract or any portion thereof, or of its right, title, or interest therein to any individual, firm, corporation, or other entity without the written consent of the Engineer. The Contractor must file with the Agency copies of all executed subcontracts and other documents. An approved subcontractor shall not in turn sublet or assign any of the work pertaining to the subcontract without the Contractor obtaining further permission from the Agency. In no event shall Agency approval release the Contractor from responsibility and liability under the Contract and bonds.

(b) Performance of the Contract Work. The Contractor shall perform Contract work with its own organization amounting to at least 50 percent of the total Contract work amount, minus "Specialty Items." The Contractor's own organization includes only workers employed and paid directly by the Contractor and equipment owned, leased, or rented by it from a non-debarred individual or entity, with or without operators. The term "own organization" does not include employees or equipment of a subcontractor, assignee, agent, or supplier of the Contractor. When determining whether the Contractor is in compliance with this 50 percent requirement, the following shall apply:

(1) The cost of materials and manufactured products to be purchased or produced under the Contract shall be included in the amount upon which the 50 percent requirement is computed.

(2) The percentage of subcontracted work shall be based on the Contract, rather than subcontract, unit prices. If only a part of a Contract item is to be sublet, its proportional value shall be determined on the same basis.

(3) When a firm sells materials to a Contractor and performs the work of incorporating the materials into the project, these actions must be considered in combination and as constituting a single subcontract.

(c) "Specialty" Items. The cost of "Specialty Items" may be deducted from the total Contract price before computing the amount of work required to be performed by the Contractor's own organization. Specialty items will be designated as such in the project Special Provisions and may be performed by subcontract.

(d) Performance Requirements. The Contractor and its subcontractor(s) shall, in the staffing and administration of the Contract, comply with the following performance requirements:

(1) Commercially Useful Function. The Contractor and subcontractor(s) must each perform a "commercially useful function." This means that the Contractor/subcontractor is responsible for the execution of a distinct element of the work of a Contract and carries out its responsibilities by actually performing, managing, and supervising the work involved. The Contractor/subcontractor must have the latitude to independently:

a. Select contracts to be bid;

b. Determine prices to be quoted;

c. Select material suppliers;

d. Hire, fire, supervise, and pay employees; and

e. Direct or cause the direction of the management and policies of the firm.

The Contractor/subcontractor may not broker work for another firm or act as a bidding conduit.

(2) Contractor to Furnish Competent Representative; Safety Officer; Others. To ensure that any subcontracted work is performed in accordance with the Contract requirements, the Contractor shall be required to furnish:

a. A competent, reliable English-speaking representative employed by the Contractor who has full authority to direct performance of the work in accordance with the Contract requirements and who is responsible for all construction operations on the project regardless of who performs the work.

b. A competent, reliable English-speaking employee designated as the safety officer who is authorized to receive orders and to issue binding directions concerning safety to all persons except Agency representatives associated with the project, whether employed by the Contractor, subcontractors, or material suppliers.

c. Such other individual(s) from the Contractor's organization as the Agency's Construction Engineer determines is (are) necessary to ensure the performance of the Contract, e.g., supervisory, managerial and engineering personnel.

(3) Employees on Payroll. The Contractor/subcontractor is not permitted to place on the payroll the employees of another firm for the purpose of avoiding Federal or State regulations or the provisions of the Contract.

108.02 NOTICE TO PROCEED. The Contractor shall not commence construction operations until Contract bonds have been filed, the Contract Documents have been signed on the part of the State, and the Regional Construction Engineer has given the Contractor written notice to proceed.

The "Notice to Proceed" will stipulate the date on which the Contractor may begin construction and from which date Contract time will be charged.

108.03 PROSECUTION AND PROGRESS.

(a) CPM Progress Schedule. Within ten calendar days after the award of the Contract, the Contractor shall submit to the Engineer for approval a CPM progress schedule. The CPM progress schedule shall show the proposed sequence of work and when the Contractor proposes to complete the various items of work within the time(s) established in the Contract. During the progress of the work, the Contractor shall confer with the Engineer concerning performance of the work in accordance with the approved schedule. The approved schedule shall be used as a basis for establishing major construction operations and for checking the progress of the work.

(b) Performance of the Work. The work shall be performed from as many points, in as many parts, at times, in a manner, and with sufficient materials, equipment, and labor so as to ensure its completion within the time(s) set forth in the Contract.

(c) Resumption of Work After Discontinuance With Consent. Should the performance of the work be discontinued by the Contractor for any reason, the Contractor shall notify the Engineer at least 24 hours before resuming operations.

108.04 LIMITATIONS OF OPERATIONS. The Contractor shall conduct the work at all times in a manner and sequence that will ensure the least interference with traffic. The Contractor shall have due regard to the location of detours and to the provisions for handling traffic. The Contractor shall not commence work to the prejudice or detriment of work previously started. The Engineer may require the Contractor to complete an area on which work is in progress before work is commenced on other area(s) if the opening of the area in progress is essential to public convenience.

108.05 CHARACTER OF WORKERS, METHODS, AND EQUIPMENT.

(a) General. The Contractor shall at all times employ sufficient labor and equipment to perform the several classes of work to full completion in the manner(s) and time(s) required by the Contract Documents.

(b) Workers' Skill and Experience. All workers shall have sufficient skill and experience to properly perform the work assigned to them. Workers engaged in specialty or skilled work shall have sufficient skill, experience and experience with equipment required to perform such work properly and satisfactorily.

(c) Electrical Work. All electrical work shall be performed by or under the supervision of a licensed electrician (master or journeyman). Electrical work shall be defined as any work which involves making connections to electrical components or splices in wiring that are, or will be, carrying 100 V or more. "Under the supervision of" means that the licensed electrician employed on the project shall be physically present on the project and must be actively supervising the work.

(d) Removal of Workers from Project. Any person employed by the Contractor or a subcontractor who in the opinion of the Engineer does not perform work in a proper and skillful manner or is intemperate or disorderly shall, at the written order of the Engineer, be removed forthwith by the Contractor or subcontractor employing such person and shall not be employed again in any portion of the work without the approval of the Engineer.

(e) Failure to Remove Worker from Project. If the Contractor fails to remove a person or persons as required above, or fails to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may withhold all estimates which are or may become due and/or may suspend the work by written notice until the Contractor complies with the order.

(f) Equipment Sufficiency. All equipment used to perform the work shall be of sufficient size and mechanical condition to meet requirements of the work and to produce work of satisfactory quality. Equipment used on the project shall not cause injury to the roadway, adjacent property, or other highways.

(g) Methods and Equipment Not Prescribed. When the methods and equipment to be used by the Contractor are not prescribed in the Contract, the Contractor is free to use any methods or equipment that it demonstrates to the satisfaction of the Engineer will accomplish the work in conformity with the requirements of the Contract, and provided they pose no safety risk to the workers, inspection staff, traveling public, or general public.

(h) Methods and Equipment Prescribed. When the Contract specifies that the work be performed by the use of certain methods and equipment, those methods and equipment shall be used unless otherwise authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the Contract, the Contractor shall request authorization from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with Contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet Contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved or in Contract time as a result of authorizing a change in methods or equipment.

(i) Removal of Machinery and Equipment. The Contractor shall not remove from the project any item of machinery or equipment after it has been placed on the project without the prior consent of the Engineer, which consent shall not be unreasonably withheld. Reasonableness shall be tested by the needs of the project and not by the needs of any other project in which the Contractor may be engaged.

108.06 WAGES AND CONDITIONS OF EMPLOYMENT.

(a) General. The Contractor and all subcontractors shall comply with the provisions and requirements of all Federal and State labor laws and with the wage requirements set forth in detail in the Contract. In case of conflicts between wage determinations made by the US Department of Labor and the minimum wage established by statute, the larger of the two amounts shall be the minimum wage for that classification.

(1) Fair Labor Standards Act – The Fair Labor Standards Act (FLSA) of 1938, as amended, 29 USC 201.

a. General. No law requires Federal or State agencies to insert in their contracts a clause to ensure compliance by the Contractor with the FLSA. However, the FLSA most likely applies to work under a construction Contract with the Federal Government or that is financed with the aid of the Federal Government. The FLSA requires payment of a minimum hourly rate as well as overtime pay for work in excess of 40 hours in each workweek. Moreover the overtime provisions of the FSLA and of the Eight-Hour Law are not mutually exclusive. Therefore, a Contractor's employees covered by the FLSA are most likely also covered by the overtime provisions of other, applicable laws.

The FLSA, sometimes known as the "Wage-and-Hour-Law," applies to individual workers who are engaged in commerce or in the production of goods for commerce as defined in the FLSA. Workers on virtually all Agency construction jobs are included under these terms. If a worker carries materials or moves equipment across state lines, unloads or guards materials or equipment arriving from other states, or performs other functions in commerce in the course of performing work, that worker is covered under the FLSA. Also, if the job is one to repair, reconstruct, enlarge, or improve an existing instrumentality of commerce such as a highway, bridge, or road, the worker is likewise covered under the Act while working on the job, including municipal streets if they are available to and are regularly used by interstate traffic.

New construction is covered by the FLSA when the project(s) is(are) part of and directly related to the functioning of an existing instrumentality of commerce. Coverage is therefore extended to construction workers on highways in the "Interstate System" or on other roads built to serve as part of a network carrying interstate traffic. In this regard, workers engaged in work preparatory to actual construction such as surveying, clearing, or grading are also covered.

b. Minors. Under the FLSA, the minimum age for general employment in the construction industry is 16 years. The minimum age is 18 years for employment in occupations declared to be hazardous by the US Secretary of Labor. Included in this category are the occupations of motor-vehicle driver and helper. Children 14 and 15 years old may be employed for a limited number of hours and under certain conditions in office work; they may not be employed in any manner at covered construction sites.

c. Contacts for More Information. The above is general information concerning the applicability of the FLSA to the highway construction industry. Contractors and subcontractors must obtain more detailed information from the Wage and Hour and Public Contracts Divisions, United States Department of Labor, John F. Kennedy Federal Building, Government Center, Boston, Massachusetts 02203-2211.

(2) Contract Work Hours and Safety Standards Act.

a. General. The Contract Work Hours and Safety Standards Act (Work Hours Act) requires Federal construction contractors and subcontractors to pay time and one-half after 40 hours a week; work under the Federal-Aid Highway Act (USC Title 23, Section 101, *et. seq.*) and all other construction financially assisted in whole or part by the Federal Government is covered by the Work Hours Act. The Work Hours Act applies to all contracts for work financed in whole or in part by loans or grants by the United States or instrumentalities thereof under any "Federal Statute" providing wage standards for the type of work covered. See Part IV, Subparts 7, 8, and 9 of the "Required Contract Provisions Federal-Aid Construction Contracts."

b. Computation of Overtime; No Defense. Overtime shall be computed on the basic rate of pay. It is not a defense that laborers and mechanics accepted or agreed to accept less than the required rate of wages or voluntarily made refunds.

(3) Davis-Bacon Act. Where the Contract includes Davis – Bacon wage rate requirements, the following also applies.

a. General. The wage rate determination of the US Secretary of Labor which has been incorporated in the proposal may not contain all job classifications necessary for the work contemplated under the project. The Contractor is independently responsible for ascertaining area practice with respect to the necessity, or lack thereof, for the use of any job classifications in the prosecution of the work contemplated by the project; no inference concerning prevailing area practices relative to their use may be drawn from the omission of these job classifications. Further, the omission of a job classification shall not be

construed as establishing governmental liability for increased labor cost.

b. Missing Job Classification(s)/Wage Rate(s). The Contractor shall submit to the Agency any requests for missing job classifications and proposed wage rates.

c. Vermont Labor Laws. The Contractor's attention is directed to the provisions and requirements of the Vermont Workers Compensation Act and to Vermont statutes regulating employment of minors.

108.07 LABOR AND RENTAL PREFERENCE. In accordance with Vermont Statutes Annotated, Title 19 Section 17, the Contractor shall give preference to Vermont labor and trucks owned in Vermont. This requirement shall not apply to any highway project, or any part thereof, financed with Federal funds.

108.08 MEETING PERSONNEL REQUIREMENTS. Contractors are encouraged to use the services of the local offices of the State Department of Employment and Training to meet their personnel requirements. Recruitment of workers in all occupations and skills is conducted by the State Employment and Training Services, initially from the immediate labor market areas, and when workers with the required skills are not available locally, through the nationwide workforce clearance system of the US Employment Service.

108.09 TEMPORARY SUSPENSION OF THE WORK.

(a) General. The work may be suspended by the Engineer, wholly or in part, for such period or periods as necessary on account of:

(1) Unsuitable weather conditions.

(2) Failure on the part of the Contractor to carry out instruction or an order given, to perform satisfactory work, or to perform one or more provisions of the Contract.

(3) Any other conditions which, in the judgment of the Engineer, make work impractical, dangerous, harmful to the environment, or in violation of a permit or other authorization for the project.

(b) Authority of Agency Safety Officer. In the absence of the Engineer, the Agency Safety Officer, or person acting in that role, shall have authority to suspend work when s/he determines that the suspension of work is warranted for a safety violation on the job site. The period of time work is suspended due to a serious safety violation will not be justification for an extension of time under Subsection 108.11 or for additional compensation.

(c) Authority of Agency Hazardous Materials and Waste Coordinator. In the absence of the Engineer, the Agency Hazardous Materials and Waste Coordinator, or person acting in that role, shall have authority to suspend work when s/he determines that the suspension of work is warranted for an environmental violation on the job site. The period of time work is suspended due to a serious environmental violation will not be justification for an extension of time under Subsection 108.11 or for additional compensation.

(d) Seasonal Closure. From December 1st to April 15th, exclusive, no construction work of any kind shall be done except by written permission of the Engineer, and only under such conditions as specified therein.

(e) Seasonal Closure Procedure. Construction procedure prior to closing down the project for seasonal closure shall be as specified in Subsection 104.04.

(f) Contractor Suspension of Work. The Contractor shall not suspend the work without permission of the Engineer. Such permission will not be unreasonably withheld.

(g) Contract Applicable. If the work is suspended for any reason, all appropriate requirements of the Contract shall continue.

108.10 SUSPENSIONS OF WORK ORDERED BY THE ENGINEER.

(a) Additional Compensation/Time Request; Time Limit. If the performance of all or any portion of the work is suspended or delayed by the Engineer for an unreasonable period of time not originally anticipated, customary, or inherent to the construction industry, and the Contractor believes that additional compensation and/or Contract time is due as a result of the suspension or delay, the Contractor shall submit to the Engineer in writing a request for adjustment within seven calendar days of receipt of the notice to resume work, and not thereafter. The request shall set forth the reasons and support for the adjustment requested. No Contract adjustment will be allowed unless the Contractor has submitted the request for adjustment within the time prescribed.

(b) Evaluation of Request. Upon receipt, the Engineer will evaluate the Contractor's request. If the Engineer agrees that the cost and/or time required for the performance of the Contract has increased as a result of the suspension/delay and the suspension/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 not caused by weather, the Engineer will make an adjustment (excluding profit) and modify the Contract accordingly. The Engineer will notify the Contractor whether or not an adjustment of the Contract is warranted. To the extent that performance would have been suspended or delayed by any other cause or an adjustment is provided for or excluded under some other term or condition of the Contract, no Contract adjustment will be allowed under this Subsection.

108.11 DETERMINATION OF EXTENSION OF CONTRACT TIME FOR COMPLETION.

(a) General; Request for Extension of Contract Completion Date. When a definite date or a fixed number of days for completion is specified in the proposal and Contract, and when the Contractor fails to substantially complete the work within the Contract time specified due to unforeseen conditions beyond the control and without fault or negligence of the Contractor, the Contractor will be credited additional contract completion time on a full day basis as provided in part (b) of Subsection 108.11. The Finals Engineer will submit to the Contractor a "Request for Extension of Time Form" containing a preliminary review of extension of time in accordance with part (b) of Subsection 108.11. If the Contractor concurs with the preliminary review, the Contractor shall sign and return the form to the Finals Engineer within 60 calendar days of the date of presentation (the "60 day period.") If the Contractor disputes the preliminary review, the Contractor shall notify the Finals Engineer within the 60 day period and provide supportive documentation regarding the dispute. Upon receipt of a dispute, the Finals Engineer will research, consult with the Resident Engineer and the Construction Engineer, and provide a response to the Contractor. The Contractor may appeal this decision as provided in Subsection 105.20. Notwithstanding Subsections 105.02 and 105.20, failure to notify the Finals Engineer of a dispute within the 60 day period shall constitute concurrence with the preliminary review and be deemed a waiver of the Contractor's right to appeal, in which case the extension of time will be processed without the Contractor's signature.

No extension of time will be required when a Substantial Completion Date is established prior to the Contract Completion Date, as modified by applicable change orders.

(b) Determination of Contract Completion Date Extension. Whenever the work is delayed or suspended through no fault of the Contractor, a Contract Completion Date extension may be made by the Engineer in the following circumstances:

(1) Delay by the Agency in awarding the Contract and/or in issuance of the Notice to Proceed.

(2) Federal or State laws passed subsequent to the date of the Contract adversely affecting progress of the work.

(3) Acts of God, including but not limited to unusually severe storms of extended duration or impact which could not generally be anticipated by the Contractor, either during the bidding process or during construction, and catastrophic weather events such as floods, droughts, fires, hurricanes, tornadoes, earthquakes, or landslides.

(4) Suspension of Major Items of work by order of the Engineer. In such cases, the time for completion will be extended an amount equal to the elapsed time between effective dates of order to suspend and order to resume.

(5) Differing Site Conditions pursuant to Subsection 104.08.

(6) Significant Changes in the Character of the Work pursuant to Subsection 109.04.

(7) Extra Work ordered by the Engineer pursuant to Subsection 104.03.

(8) Delays in the issuance of permits, approvals, or other government regulatory action that are not attributable to the Contractor, including but not limited to delays attributable to changes in design submitted by the Contractor, delays in submittals, errors in submittals, and the Contractor's means and methods of construction.

(9) Court orders, including but not limited to temporary restraining orders, preliminary and permanent injunctions, or judgments that are not attributable to the Contractor, including but not limited to the Contractor's means and methods of construction.

(10) Industry-wide labor unrest.

(11) Industry-wide material or supply shortages not reasonably anticipated by the Contractor at the time the Contract was entered.

(12) If satisfactory completion of the Contract with any authorized extension and increases requires the performance of work in greater quantities than those set forth in the proposal, the Contract time allowed for performance of the work will be increased in the same

ratio that the total cost of the work actually performed bears to the total cost in the proposal. However, when additional time is added to the Contract by change order/supplemental agreement, the number of days added will be deducted from the number of days calculated in the method above. Also, if more days are added by change order/supplemental agreement than would have been by the previously mentioned method, the Contractor will not have the excess days deducted. Additional time may be allowed for unusual circumstances when cost alone is not a determining factor in time required to perform the additional work. Any change in the final Contract time shall be computed to the nearest full day.

(13) Delay caused by a shortage of materials, but only when the Contractor furnishes to the Engineer documentary proof that a diligent effort has been made to obtain the materials from all known sources and the inability to obtain the materials when originally planned did in fact cause a delay in final completion of the entire work, and the delay could not be avoided by revising the sequence of the Contractor's operations. The Contractor shall notify the Engineer in writing of the causes of delay caused by material shortages no later than 15 calendar days from the beginning of any such delay and not thereafter.

(14) Any other conditions which in the opinion of the Director of Program Development warrants consideration for an extension of time.

108.12 FAILURE TO COMPLETE WORK ON TIME.

(a) Time Essential Element. Time is an essential element of the Contract. The Contractor shall plan its progress schedule and vigorously press the progress of the work in order to complete the Contract on or before the Contract Completion Date set forth in the Contract.

(b) Manner, Sequence, or Schedule Required. Whenever the Special Provisions of the Contract call for any portion or portions of the work to be performed in any particular manner or for any portion or portions of the work to be completed pursuant to a certain sequence or schedule prior to the date of completion of the entire Contract, the Contractor shall punctually comply with the related instructions, dates, and periods of time.

(c) Liquidated Damages; General; Days Charged. For each working day on which any work remains incomplete after the Completion Date specified in the Contract for completion of the work involved there shall be deducted from any monies due the Contractor the amount shown in the following table, unless otherwise specified in the Contract. The deduction is not a penalty, but is liquidated damages to defray the cost to the Agency to administer the Contract, including but not limited to the cost of engineering, inspection, supervision, inconvenience to the public, obstruction of traffic, and interference with business. Due account shall be provided for any adjustment of the Contract time for completion of the work under the provisions of Subsection 108.11.

DAILY CHARGE FOR LIQUIDATED DAMAGES
FOR EACH WORKING DAY OF DELAY

Original Contract Amount		
From More Than	To And Including	Daily Charge Per Day of Delay
$ 0	$ 300,000	$ 700.00
300,000	500,000	900.00
500,000	1,000,000	1,300.00
1,000,000	1,500,000	1,500.00
1,500,000	3,000,000	1,900.00
3,000,000	5,000,000	2,200.00
5,000,000	10,000,000	2,700.00
10,000,000	20,000,000	4,200.00
20,000,000+	---------	6,600.00

Should the Contractor elect to work on Saturdays, Sundays, Holidays, or days from December 1st to April 15th, exclusive, after the Contract Completion Date, the Contractor will be charged liquidated damages for such days worked.

(d) No Waiver. Permitting the Contractor to continue to finish the work or any part of the work after the time fixed for its completion or after the date to which the time for completion may have been extended shall not operate as a waiver on the part of the Agency of any of its rights under the Contract.

(e) Liability for Liquidated Damages. The Contractor covenants and agrees that should the amount of monies due or that may become due the Contractor be less than the amount of ascertained liquidated damages, the Contractor and the Contractor's surety shall be liable to the State for the deficiency.

(f) Liquidated Damages Cutoff Date. No liquidated damages will be charged after the establishment of a Substantial Completion Date.

108.13 TERMINATION OF CONTRACT.

(a) General; Notice. Upon written notice from the Engineer or other proof satisfactory to the Secretary, the Secretary will give notice in writing to the Contractor and the Contractor’s surety of delay, neglect, or default if the Contractor:

(1) fails to begin the work under the Contract within the time specified in the “Notice to Proceed;”

(2) in the opinion of the Engineer, fails to perform the work with sufficient workers and equipment or with sufficient materials to ensure the prompt completion of said work;

(3) in the opinion of the Engineer, performs the work unsuitably or neglects or refuses to remove materials or to redo or replace work rejected as defective and unsuitable;

(4) discontinues the prosecution of the work without authorization of the Engineer;

(5) fails to resume work that has been discontinued within a reasonable time after notice to do so;

(6) becomes insolvent, is declared bankrupt, or commits any act of bankruptcy or insolvency;

(7) allows any final judgment to stand against the Contractor unsatisfied for a period of ten calendar days;

(8) makes an assignment for the benefit of creditors; or

(9) in the opinion of the Engineer, fails, for any cause whatsoever, to carry on the work in an acceptable and timely manner.

(b) Failure of Contractor to Proceed; Termination. If the Contractor or the Contractor's surety does not proceed in accordance with the notice within a period of ten calendar days after notice, the Agency may, without violating the Contract, terminate the Contract by taking performance of the work out of the hands of the Contractor. The Agency may appropriate and use any or all materials and equipment on the project as are suitable and acceptable and may enter into an agreement for the completion of the Contract, according to the terms and provisions thereof or use such other methods as, in the discretion of the Engineer, will be required for the completion of the Contract in an acceptable manner and in the best interest of the Agency.

(c) Agency's Costs. All costs and charges incurred by the Agency, together with the costs of completing the work under contract, shall be deducted from any monies due or which may become due the Contractor. If the expense incurred by the Agency is less than the sum which would have been payable under the Contract had it been completed by the Contractor, the Contractor shall be entitled to receive the difference; if the expense exceeds the sum which would have been payable under the Contract, the Contractor and the Contractor's surety shall be liable and shall pay to the Agency the amount of the excess.

108.14 TERMINATION OF CONTRACT FOR CONVENIENCE.

(a) General. The Agency may, by written order to the Contractor, terminate the Contract or any portion thereof when such termination would be in the best interest of the Agency.

Any such termination shall be effected by delivery to the Contractor an Order of Termination specifying the termination is for the convenience of the Agency, the extent to which performance of work under the Contract is terminated, and the effective date of the termination.

In the event such termination occurs, without fault and for reasons beyond the control of the Contractor, all completed items of work as of the date of termination will be paid for at the Contract bid price. Payment for partially completed work will be made either at agreed prices or by force account methods provided elsewhere in the Contract.

Pursuant to Subsection 109.07, no compensation will be allowed for items eliminated from the Contract.

Upon request the Contractor shall make all Contract-related records available to the Agency.

(b) Contractor Obligations. After receipt of the Order of Termination and except as otherwise directed by the Engineer, the Contractor shall immediately proceed to:

(1) To the extent specified in the Order of Termination, stop work under the Contract on the date specified.

(2) Place no further orders or subcontracts for materials, services, and/or facilities except as may be necessary for completion of such portion(s) of the work under the Contract as is (are) not terminated.

(3) Terminate and cancel all orders or subcontracts for materials, services, and/or facilities except as may be necessary for completion of such portion(s) of the work under the Contract as is (are) not terminated.

(4) Submit to the Engineer a material inventory list, certified as to quantity and quality of materials in its possession or in transit to the project.

(5) Transfer to the Agency all completed or partially completed plans, drawings, information, and other property which, if the Contract had been completed, would be required to be furnished to the Agency.

(6) Take other action as may be necessary or as directed by the Engineer for the protection and preservation of the property related to the Contract which is in the possession of the Contractor and in which the Agency has or may acquire any interest.

(c) Claim by Contractor. After receipt of the Order of Termination from the Agency, the Contractor shall submit any claim for additional damages or costs not covered herein or elsewhere in the Contract within 60 days of the effective termination date, and not thereafter.

Should the Contractor fail to submit a claim within the 60 day period, the Agency may, at its sole discretion, based on information available to it, determine what, if any, compensation is due the Contractor and pay the Contractor the determined amount.

(d) Materials. At the option of the Agency, acceptable materials included in the material inventory in subpart (b)(4) above that have been obtained by the Contractor for the work but which have not been incorporated into the work may be purchased from the Contractor at actual cost delivered to a location prescribed by the Engineer or otherwise disposed of as mutually agreed.

Payment for materials included in the material inventory chosen to be purchased by the Agency will be made at actual cost delivered to the project or storage site designated by the Engineer, including transportation charges, to which 10 percent overhead and profit will be added.

(e) Idle Equipment. Idle equipment time claimed by the Contactor will be paid as follows:

(1) Contractor Owned Equipment. For the portion of any claim relating to idle equipment time for equipment owned by the Contractor, the Contractor will be entitled to recover equipment rates based on the Contractor's internal ownership costs. Recovery for idle equipment time shall not be based on published rental rates.

(2) Rented Or Leased Equipment. For the portion of any claim relating to idle equipment time for equipment rented or leased by the Contractor, the Contractor will be entitled to recover the lesser of the actual rental costs

or fair market rental costs, and the amount shall not exceed 30 days rental.

(3) Limitations On Recovery For Idle Equipment. Claims for idle equipment time, whether for Contractor owned equipment or leased/rented equipment, following termination of the Contract pursuant to this Subsection are limited to a maximum of 30 days and may not include any operating expenses.

(f) Negotiation; No Anticipated Profit. Negotiation to settle a timely claim shall be for the sole purpose of reaching a settlement equitable to both the Contractor and the Agency. Settlement shall be based on actual costs incurred by the Contractor plus overhead and profit as specified in Subsection 109.06. Consequential damages, loss of overhead, loss of overhead contribution of any kind, and/or loss of anticipated profits on work not performed shall not be included in the Contractor's claim and will not be considered, allowed, or included as part of any settlement.

(g) Records. The Contractor shall make available to the Agency all cost records relevant to a determination of an equitable settlement.

(h) Contractual Responsibilities Continue. Termination of the Contract, or portion thereof, shall not relieve the Contractor of its contractual responsibilities for work completed and shall not relieve the Contractor's Surety of its obligation for and concerning any just claim arising out of the work performed.

108.15 TERMINATION OF CONTRACTOR'S RESPONSIBILITY.

(a) Completion and Acceptance. Whenever the project(s) provided for by the Contract has (have) been completely performed by the Contractor, all parts of the work have been approved and accepted by the Engineer, and all Contract Documents complied with, the Contractor will then be released from further obligations except as set forth in the bonds provided, and the Agency will provide the Contractor with a Completion and Acceptance Memorandum.

(b) Limited Completion and Acceptance. If the Contract includes work at more than one location as separate projects or as separate locations on a single project, the Agency may accept the

work at any location when the work at that location is completely finished and all responsible parties agree to acceptance in the same manner as a normal final inspection. If a portion of the Contract is accepted by the Engineer, and all Contract Documents related thereto are complied with, the Contractor shall remove all construction warning signs from that portion and the Contractor will then be released from further obligations as to that portion except as set forth in the bonds provided. If substantial completion of the work is accomplished, but additional work is required to achieve final acceptance, the Agency may accept the work under the Contract with exceptions and/or reservations.

108.16 DELAYS - COMPENSABLE AND NON-COMPENSABLE.

(a) Compensable Delays. The Engineer may allow additional compensation for the time-related issues specifically enumerated in this Subsection only if the delays and other time-related issues result from:

(1) Differing Site Conditions pursuant to Subsection 104.08; or

(2) Significant Changes in the Character of the Work pursuant to Subsection 109.04; or

(3) Suspensions of Work Ordered by the Engineer pursuant to Subsection 108.10.

(b) Recoverable Costs. Only the following costs may be recovered for Compensable Delays under part (a) of this Subsection:

(1) The costs provided for in Subsection 109.06 and properly documented and maintained pursuant to that Subsection.

(2) Field Office Overhead. The actual cost paid by the Contractor to third parties for Field Office rental, utilities, and routine cleaning, plus 5% for Contract supervision, overhead, and profit.

(3) Home Office Overhead. Unabsorbed Home Office Overhead is only recoverable pursuant to Subsection 108.14.

(c) Non-Recoverable Costs. The following costs are not recoverable under the Contract:

(1) Home office overhead in excess of that provided in Subsection 109.06.

(2) Loss of profit in excess of that provided in Subsection 109.06.

(3) Loss of productivity and/or inefficiencies in labor.

(4) Consequential damages, such as loss of interest or investment with respect to funds at issue in the dispute.

(5) Attorneys' fees, mediation expenses, claims analysis, or preparation expenses.

(6) Costs attributable to the Contractor's failure to advance the work in a reasonable manner.

(d) Non-Compensable Delays. The Engineer may allow an extension of the Contract Completion Date or the Interim Completion Date but may not allow additional compensation except for those situations specifically enumerated in part (a) of this Subsection.

(e) Failure to Perform Adequately. Failure to perform the work continuously and effectively with adequate work force and as scheduled for the full time allowed will be cause for denial of a time extension that might otherwise be allowed.

SECTION 109 - MEASUREMENT AND PAYMENT

109.01 MEASUREMENT OF QUANTITIES.

(a) General. All work completed under the Contract will be measured by the Engineer according to SI or U.S. Customary units, as required by the Contract Documents.

The measurement and determination of the number of units of each pay item will be made as specified in this Section and as are specifically described under the "Method of Measurement" and "Basis of Payment" subsections for each item.

(b) Area. Unless otherwise specified in the Contract area computations will be made horizontally, and no deductions will be made for individual fixtures having an area of 1 m^2 (10 square feet) or less; measurements for area computations will be the neat dimensions shown on the Plans or authorized in writing by the Engineer.

(c) Structures. Structures will be measured according to neat lines shown on the Plans or as altered to fit field conditions in accordance with the method of measurement stated in the Contract.

(d) Volumes. Volumes of excavation and borrow pits will be calculated from cross-sections and the use of average end area formulae or by another approved method. Volumes of other work, e.g. Cement Masonry or Removal of Concrete or Masonry, will be calculated by using arithmetical formulae. Where the volume is bounded by varying dimensions and there is no simple volumetric formula applicable, frequent cross-sections will be taken and the volume computed from average end area formulae. Other methods of measurement for small quantities may be authorized when approved in writing by the Engineer.

(e) Length Measurement. All items measured by the meter (linear foot) will be measured parallel to the base or foundation upon which the item is placed, unless otherwise shown on the Plans.

(f) Metric Ton; Ton. The term “metric ton” is used to indicate a mass of 1000 kg. The term “ton” means the English short ton consisting of 2000 pounds. All materials that are measured, or proportioned by mass (weight), shall be done so on accurate, approved scales by competent, qualified personnel.

(g) Bituminous Materials Measurements.

(1) General. Bituminous materials will be measured by the liter (gallon) or kilogram [hundredweight (CWT)]. Volumes of bituminous materials will be measured at 15°C (60° F) or will be corrected to the volume at 15°C (60° F) using ASTM D 1250 for asphalt or ASTM D 633 for tar.

(2) Shipping of Bituminous Materials; Correction. When liquid bituminous materials are shipped by truck or transport, net certified mass (weight) or volume subject to correction for loss or foaming may be used for computing quantities.

(h) Cement. Cement will be measured by the kilogram [hundredweight (CWT)].

(i) Timber. Timber will be measured by the cubic meter [thousand feet board measure (MFBM)] actually incorporated in the work. Measurement will be based on nominal widths and thicknesses and the in place length of each piece.

(j) Lump Sum.

(1) General. The term "lump sum" when used as a unit of measurement for an item of payment means complete payment for the work described in the item description.

(2) Everything Included. When a complete structure or structural unit (in effect, "lump sum" work) is specified as the unit of measurement, the unit will be construed to include all labor, tools, equipment, material, necessary fittings, accessories and incidentals necessary to complete the work.

(k) Rental. Rental of equipment will be measured by time in hours of actual work time and the necessary travel time of the equipment within the limits of the project.

(l) Final Bridge Quantities. In order to save engineering resources and expedite payment of the final estimate, the Agency will pay for the original plan quantities, exclusive of estimated overrun allowances, for all bridge quantities if the Agency and the Contractor agree to the acceptance of the plan quantities by the time the final survey is made. However, if either the Contractor or the State challenges the quantities, final quantities will be computed in accordance with the Contract. When one or more changes in design generate changes in quantities, final quantities shall be based on final measurements

(m) Where the conversion of U.S. Customary to SI quantity measurements is required, the following conversion factors shall apply:

From U.S. Customary to SI Unit	Multiply U.S. Customary Unit by
foot to meter	0.3048
mile to kilometer	1.609
square foot to square meter	0.0929
cubic foot to cubic meter	0.0283
square yard to square meter	0.8361
cubic yard to cubic meter	0.7646
acre to hectare	0.4047
CWT to kilograms	45.36
gallons to liters	3.785
MGAL to cubic meter	3.785
MFBM to cubic meter	2.359
ton to metric ton	0.9072

(n) Where the conversion of SI to U.S. Customary quantity measurements is required, the following conversion factors shall apply:

From SI to U.S. Customary Unit	Multiply SI Unit by
meter to foot	3.281
kilometer to mile	0.6214
square meter to square foot	10.76
cubic meter to cubic foot	35.31
square meter to square yard	1.196
cubic meter to cubic yard	1.308
hectare to acre	2.471
kilograms to CWT	0.0220
liters to gallons	0.2642
cubic meter to MGAL	0.2642
cubic meter to MFBM	0.4238
metric ton to ton	1.102

109.02 PURCHASES OF MATERIALS BASED UPON AGENCY MEASUREMENTS.

(a) Estimates Are Not Guarantees. The Agency does not furnish or guarantee estimates of measurements of borrow, gravel, sands, soils, fill, and other construction materials to be used on the project for the benefit and/or convenience of the Contractor either in dealings with sellers of those materials or any other purpose.

(b) Purchase of Materials. Except by written agreement, with a copy of the agreement furnished to the Agency prior to removal of materials for the project, the Contractor shall not purchase

materials on terms that require payment on the basis of the estimates of measurement made by the Agency.

109.03 SCOPE OF PAYMENT.

(a) General. The Contractor shall receive and accept the compensation provided in the Contract as full payment:

(1) For furnishing all materials, labor, tools, and equipment and performing all work contemplated and required under the Contract;

(2) For all loss or damage arising out of the work from the actions of the elements, or from any unforeseen difficulties or obstructions which may arise or be encountered during the prosecution of the work until its acceptance by the Agency.

(3) For all risks of every description connected with the prosecution of the work; and

(4) For all expenses incurred by or in consequence of the temporary suspension or discontinuance of the work for any infringement of patent, trademark, or copyright, and for completing the work in an acceptable manner according to the Contract Documents.

(b) Payment of Estimates; Obligations of Contractor. The payment of any current or final estimate shall not prejudice or affect the obligation of the Contractor under the Contract, at its own cost and expense, to repair, correct, renew, or replace any defects or imperfections in the project and its appurtenances or the strength of or quality of materials used on the project; payment of an estimate, including a final estimate, shall not relieve the Contractor from the payment of any and all damages due or attributed to defects or imperfections.

(c) Damage Claims and Liabilities; Payment by Agency. Relative to damage, labor and materials, and other claims against the Contractor or project, no monies payable under the Contract or any part thereof shall become due and payable if the Agency so elects until the Contractor satisfies the Agency that the Contractor has fully settled or paid all damage, labor, or materials claims and all liabilities incurred in connection with the work; if it so elects, the Agency may pay any or all claims or

liabilities wholly or in part and deduct the amount or amounts so paid from any biweekly or final estimate(s).

(d) Written Evidence of Releases. If it so elects, the Agency may require the Contractor to furnish written evidence of release from all claims and obligations connected with the work.

109.04 SIGNIFICANT CHANGES IN THE CHARACTER OF WORK.

(a) General. At any time during work the Engineer reserves the right to make, in writing, changes in quantities and alterations in the work as are deemed necessary or desirable to satisfactorily complete the project. Changes in quantities and alterations in the work will not invalidate the Contract or release the Contractor's surety, and the Contractor shall perform the work as altered.

(b) Significant Alteration/Change to Character of Work; Adjustment to Contract. If the alterations or changes in quantities significantly change the character of the work under the Contract, whether or not changed by different quantities or alterations, a monetary adjustment will be made to the Contract; loss of anticipated profits shall not be included. The basis for the adjustment shall be agreed upon prior to the performance of the work. If a basis cannot be agreed upon, an adjustment will be made as the Engineer determines to be fair and equitable.

(c) Alterations/Changes Not Significant. 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.

(d) Significant Change Defined. The term "significant change" shall be construed to apply only to the following circumstances:

(1) 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

(2) When a major item of work, as defined, is increased in excess of 25 percent above or decreased below 75 percent of the original Contract quantity. Any allowance for an increase in quantity shall apply only to that portion in excess of 125 percent of the original Contract item quantity; any allowance for a decrease in

quantity below 75 percent shall apply to the actual amount of work performed.

(e) Major Item Defined. A major item of work is any bid item that has a total bid value greater than 20 percent of the total bid amount of the Contract.

109.05 COMPENSATION FOR ALTERED PLANS OR QUANTITIES.

(a) General. When alterations in the Plans or quantities of work are ordered and performed as provided in Subsection 104.02 and when such changes or alterations result in an increase or decrease of not more than 25 percent of the total original Contract amount, or the length of the project is not increased or decreased more than 25 percent of the original length shown in the Contract, the Contractor shall accept payment in full at the Contract unit price for the actual quantities of work done.

(b) Adjustment When Exceeded. When changes or alterations result in a sum total change of more than 25 percent of the total cost of the Contract calculated from the original bid quantities and the original Contract unit prices, or a length increased or decreased more than 25 percent, and a demand is made by the Contractor or the Agency, a negotiated Supplemental Agreement shall be signed by both parties setting forth the necessity for the change and an adjustment of unit prices agreed upon as satisfactory to both parties.

In order to bring a claim for additional compensation, the Contractor shall meet all applicable requirements of Subsection 105.20.

(c) No Further Allowance. No further payments will be made for changes/alterations, including no further allowances for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting directly from the changes/alterations or indirectly from unbalanced allocation of overhead expense among the Contract items by the Contractor and subsequent loss of expected reimbursements therefore or from any other cause.

109.06 EXTRA AND FORCE ACCOUNT WORK. Extra work ordered and accepted as specified in Subsection 104.03 will be paid for on a unit price or lump sum basis under a Supplemental Agreement. The agreement will be made before the work is started. When the Engineer deems it impractical to handle any Extra Work ordered on a unit price or

lump sum basis, a Supplemental Agreement will be made and the work will be ordered done and paid for on a force account basis as follows:

Any additional costs for Public Liability Insurance and Property Damage Insurance that are required in the Contract will be allowed and reimbursed at the actual cost to the Contractor.

(a) Labor. For all machine or equipment operators, other workers, and supervisors in direct charge of the specific operation, the Contractor shall receive the actual wages agreed upon before beginning the work and were paid to the workers performing the work, to which shall be added an amount equal to 10 percent for profit. If the Contractor elects to use employee(s) more skilled than required to perform the extra work, the Agency reserves the right to allow compensation for said employee(s) to be capped at 125% of the applicable Davis-Bacon wage rate of the base skill level required to perform the work.

Workers Compensation Insurance, Unemployment Compensation Insurance, and Social Security charges on labor items as paid by the Contractor will be allowed. Other employee insurances (health, disability, e.g.) being paid by the Contractor just prior to the work being ordered will also be allowed, provided the Contractor submits an applicable notarized insurance rate schedule from its insurance agent. The Contractor shall submit an Agency form indicating all applicable insurances and overhead items for each employee involved in the extra work.

The Contractor will be allowed an additional 10% of the actual wages paid to the employee as compensation for administration charges and any other additional costs. Additional cost or charge for the Superintendent shall not be allowed.

(b) Materials. The Contractor shall receive the actual cost including freight charges (both as submitted on original receipted bills) for all materials furnished and used. Ten percent shall be added thereto for overhead, profit and any other costs incurred in supplying the materials. Vermont sales tax shall not be included.

(c) Equipment. The Contractor will be reimbursed as described below. Equipment that is used shall be specifically described by year, manufacturer, model number, and any other information required to identify the appropriate hourly rate in the Rental Rate Blue Book published by Equipment Watch (“Blue Book”). In

the event the Contractor elects to use equipment of a higher rental value than equipment suitable for the work, payment will be made at the rate applicable to suitable equipment.

(1) Contractor Owned Equipment.

a. Ownership Costs. The Contractor will be reimbursed for its ownership costs for self-owned equipment at the rates agreed to before the work begins. These rates shall be on an hourly basis and shall not exceed the monthly ownership rates listed in the current Blue Book divided by 176. The rates will be adjusted for depreciation as computed and published in the Blue Book rate adjustment tables, but will not be adjusted as recommended on the Blue Book regional adjustment maps. The rates for ownership costs will be total reimbursement to the Contractor for all non-operating costs of the equipment, including depreciation, insurance, taxes, interest, storage, overhead, repairs, and profit. The maximum duration for reimbursement in a day shall not exceed eight hours unless the equipment actually is operated for more than eight hours on a particular day, in which case the rate shall be paid for all hours the equipment actually worked on that day.

b. Operating Costs. The rates for operating costs include fuel, lubricants, other operating expendables, and preventative and field maintenance. The Contractor will be reimbursed the amount derived as the product of the number of hours of actual use multiplied by the Blue Book estimated operating cost per hour. Operating costs do not apply to equipment idle time. Operating costs do not include the operators' wages.

Except as otherwise provided, the rates to be used for computation shall be those in effect at the time the force account work is performed as reflected in the applicable publication of the Blue Book.

c. In the event that an ownership cost rate and/or an operating cost rate is not established in the Blue Book for a particular piece of equipment, the Engineer shall establish a rate(s) for that piece of equipment consistent with its costs and expected life. The Contractor shall make no charge for small tools that are considered as having a replacement value of less than $500.

(2) Rented Equipment. In the event the Contractor does not own a specific type of equipment and must rent, the Contractor will be reimbursed the actual cost for the equipment, as submitted by invoice, for the time that the equipment is used to accomplish the work. Vermont sales tax shall not be included.

The Agency reserves the right to limit the hourly rate to the maximum amount allowed by Blue Book in the event that the prime contractor is a subsidiary of, or has a close affiliation to, the firm supplying the rented equipment.

(3) Maximum Amount Payable. The maximum amount of reimbursement for the ownership cost of Contractor owned equipment or the rental cost of rented equipment is limited to the original purchase price of the equipment.

(4) Equipment Downtime. No rental cost or operating cost will be paid for downtime for either rented equipment or Contractor owned equipment.

(5) Transportation Costs. The Contractor will be paid for the reasonable documented cost of transporting both Contractor owned and rented equipment to the work location and back to its original location or a new location if the cost is less.

(d) Subcontracted Work. The Contractor shall receive the actual cost, as submitted on original receipted bills, for all extra and force account work subcontracted to others. Ten percent shall be added thereto for overhead, profit and any other costs incurred to perform the subcontracted work. However, the Agency reserves the right to use the force account procedures as depicted

previously in this subsection in the event that the cost of reimbursable subcontracted work is deemed excessive.

The compensation as herein provided shall be received by the Contractor as payment in full for Extra Work done on a force account basis. The Contractor's representative and the Engineer shall compare records of Extra Work on a force account basis at the end of each day. Copies of these records shall be made on Agency forms provided for this purpose and shall be signed by both the Engineer and Contractor's representative. All requests for compensation for Extra Work done on a force account basis, including original receipted bills to verify cost and freight charges for all materials, shall be submitted to the Agency as soon as possible; however, if the required request, invoices, and other documentation are not filed before 90 days have lapsed following final acceptance of the project, the costs associated with such Extra and force account work shall not be reimbursable.

109.07 ELIMINATED ITEMS. Should any item(s) contained in the Contract be found unnecessary for proper completion of the work, the Engineer may, upon written order to the Contractor, eliminate the item(s) from the Contract; such action shall have no effect on the other provisions of the Contract and shall in no way invalidate the Contract. No compensation will be allowed for items eliminated from the Contract

109.08 PARTIAL AND FINAL PAYMENTS.

(a) General. Partial payments, computed upon the basis set forth in the Contract, will be made by the Engineer. On or before the Saturday of each alternate week during satisfactory progress of the work, the Engineer will make a biweekly estimate of the amount of work performed and will compute and report the value thereof under the Contract. Such estimates may be approximate only and not be based on actual measurements. All biweekly and partial estimates will be paid in full except as set forth below, and no payment will be made when the total value of the work done since the last estimate amounts to less than $500.

(b) Tax Compliance. If the Contractor is found to not be in good standing with respect to, or in full compliance with a plan to pay, any and all taxes due the State as required in Title 32 VSA Section 3113, money otherwise owed to the Contractor will be withheld from one or more biweekly estimates and the final estimate.

(c) Claims and Withholdings. For the protection of the State, creditors and, other claimants of the Contractor, payment for all or part of one or more biweekly estimates and/or the final payment as determined by the final estimate may be held for the use of the State, if the Agency so elects, until the Contractor has fully settled for or paid for all materials and equipment used in or upon the work and labor done in connection therewith and fully settled for or paid for all damage claims or liabilities incurred in connection with said work. Upon satisfactory settlement of all such accounts, the final estimate will be paid to the Contractor.

(d) Final Payments. Payment of the Final Estimate will be made when an agreement is reached between the Agency and the Contractor regarding the final quantities of all Contract pay items, the Acceptance Date as defined in Subsection 101.02 is established, all materials and certifications are accepted, and all other project requirements have been met. The Finals Engineer will present the Agency's determination of final quantities to the Contractor. If the Contractor wishes to dispute the final quantities, the Contractor shall notify the Finals Engineer within 60 calendar days of the date of presentation (the "60 day period") of final quantities. The Contractor shall indicate which specific quantities are being disputed and provide supportive documentation regarding the disputed quantities. The Contractor may request a 30 day extension to review the quantities by notifying the Finals Engineer within the 60 day period. Upon receipt of a dispute, the Finals Engineer will research, consult with the Resident Engineer and the Construction Engineer, and provide a response to the Contractor. The Contractor may appeal this decision as provided in Subsection 105.20. Notwithstanding Subsections 105.02 and 105.20, failure by the Contractor to notify the Finals Engineer of dispute of final quantities within the 60 day period (or 90 calendar days from the date of presentation if a 30 day extension is granted) will be deemed as agreement to the final quantities as presented, and deemed a waiver of the Contractor's right to appeal.

Following the resolution of final quantities, the Finals Engineer will present the Contractor with close-out documents consisting of the Final Estimate for signature and a "Status of Claims" form. Failure by the Contractor to sign the Final Estimate and "Status of Claims" form within 20 days will result in closure of the Contract, provided that there are no claims on file with the Agency.

At the discretion of the Finals Engineer, the Contractor may be presented with close-out documents concurrent with the final quantities. In such case, notwithstanding Subsections 105.02 and 105.20, failure by the Contractor to notify the Finals Engineer of dispute of final quantities within applicable time durations specified in this Subsection will be deemed as agreement to the final quantities as presented, and closure of the Contract without the Contractor's signature will result.

In cases when presentation of final quantities to the Contractor indicates that the Agency has overpaid the Contract, the Contractor shall remit payment to the Agency by the end of the 60 day period, unless the Contractor is appealing final quantities. Failure to make payment may result in notification to the Agency's Prequalification Committee by the Construction Engineer, and/or may result in set off pursuant to the Bulletin 3.5 Compliance requirements in the Contract.

(e) Retainage. The Agency shall not withhold retainage on the Contract; the Contractor shall not withhold retainage on any subcontract; and subcontractors shall not withhold any retainage on any of their subcontracts.

109.09 THIS SUBSECTION RESERVED

109.10 FINAL PAY QUANTITY. When a Contract item is designated in the Contract Documents as (FPQ), then this item shall be considered a Final Pay Quantity item. The Contract quantity shall be considered the final pay quantity for the item, unless the Plan dimensions of any portion for measurement of the item or the Contract quantity of that item are revised by the Engineer, or the Contract quantity of the item or any portion of the Contract quantity of the item is eliminated.

If the dimensions of any portion for measurement of the item or the Contract quantity of the item is revised, and the revision results in an increase or decrease in the Contract quantity of the item, the final pay quantity for the item will be revised in the amount represented by the changes in the dimensions or by the imposed revision. If the item is eliminated, the Contract quantity for the item will be eliminated. If a portion of the item is eliminated, the Contract quantity will be revised in the amount represented by the eliminated portion of the item.

No adjustment will be made to the Contract quantity for an FPQ pay item, except as allowed under this Subsection.

DIVISION 200

EARTHWORK

SECTION 201 - CLEARING

201.01 DESCRIPTION. This work shall consist of the performance of all clearing, grubbing, and thinning and trimming operations within the limits of the project.

201.02 CLEARING. Clearing shall consist of cutting and disposing of all trees, stumps, down timber, stubs, brush, bushes, and debris from all areas extending from the centerline to 3 m (10 feet) beyond the top limits of all cut sections or from the centerline to 3 m (10 feet) outside the toes of slopes in all fill sections, but in no case beyond applicable right-of-way limits. Clearing areas shall also include any other areas shown in the Contract Documents.

Where structures are to be constructed, clearing shall include the area within the structure limits. The lateral limits shall provide a clear distance of 6 m (20 feet) beyond the outside of the structure.

Any trees designated for removal under another Contract item are excluded from this work.

Branches of trees extending into and over the roadway shall be carefully trimmed as directed by the Engineer. All branches of trees overhanging the roadbed shall be carefully removed to a minimum height of 6 m (20 feet) above the finished grade.

Clearing operations shall be done in such a manner that the present growth will blend with the limits of construction and a natural appearance will be attained.

The Contractor shall carefully protect and guard all trees, shrubs, and vegetation, within or adjacent to the construction area, that the Engineer directs to be saved. The Contractor shall take every precaution to avoid any damage to public utility lines, buildings, or other property. If it is deemed impractical to fell the tree as a whole, it shall be removed in sections according to standard practices of professional tree removal. No machine or appliance shall be used on any part of the work that may in any manner injure, sear, or kill trees and shrubs, within or adjacent to the construction area, that have been designated to be saved, or are outside the area above described for clearing and grubbing. With the preceding exceptions, all trees and shrubs, down timber, stubs, brush, and other objectionable material shall be removed and disposed of from areas to be cleared before grading operations begin in the areas.

Where trees that are to be left standing have become scarred by the Contractor's operations, the cuts or scars shall be repaired by properly cutting, smoothing the wood if necessary, and treating with a product prepared especially for tree surgery. Any repairing or painting required shall be considered incidental to the lump sum price for Clearing and Grubbing, Including Individual Trees and Stumps.

In areas where embankments are to be constructed more than 1.5 m (5 feet) in depth measured below subgrade, all stumps shall be cut off as close to the ground as is practical. Stumps shall not exceed 150 mm (6 inches) above the ground surface at the base. Stumps located outside of the construction limits of cut and embankment areas shall be cut flush with or below the surface of the ground or as directed by the Engineer. Stumps that cannot be cut flush shall be removed.

201.03 GRUBBING. Grubbing shall consist of removing and disposing of all stumps, roots, duff, grass, turf, debris, or other objectionable material within excavation limits, and within fill limits where the embankments are to be made to a depth less than 1.5 m (5 feet) below subgrade. Grubbing areas shall also include any other areas shown in the Contract Documents. The grubbing shall progress in such a manner to prevent erosion as required in Subsection 105.23.

The excavated section left below the subgrade by removals shall be backfilled with approved excavated material or borrow and compacted to conform to the surrounding area.

201.04 REMOVING SINGLE TREES AND STUMPS. Removing single trees and stumps shall consist of removing and disposing of single trees and stumps as shown in the Contract Documents or as directed by the Engineer. The work shall be in accordance with Subsections 201.02 and 201.03, and shall include backfilling of stump holes with a suitable material as directed by the Engineer.

201.05 THINNING AND TRIMMING.

(a) General. Thinning and trimming shall consist of selective cutting and trimming beyond the limits of clearing and grubbing to clear brush; remove undesirable growths, dead trees, vegetation, and stumps; thin out trees; trim branches; allow for passage of overhead wires; or improve visibility at locations shown on the Plans or directed by the Engineer.

The methods employed in any of the operations shall conform in all details with approved horticultural practices.

All branches or limbs removed shall be cut flush with the supporting trunk or limb. When directed by the Engineer, all cut surfaces over 25 mm (1 inch) in diameter shall be treated with a standard tree wound dressing.

Trees, stumps, and brush removed shall be cut at least flush with the ground surface.

(b) For Signs. Thinning and trimming for signs shall consist of selective cutting and trimming to provide full visibility for a sign at a single designated sign location.

The Contractor shall remove all woody stemmed growth including brush, saplings, trees and tree limbs growing within or projecting into the required clear viewing area for the designated sign to the minimum horizontal and vertical dimensions shown on the Plans or as directed by the Engineer. The clearance and removal methods used shall conform to the requirements of Subsection 201.05.

The dimensions are for the standard area of sign visibility, however the Contractor shall not cut, trim or clear any vegetation outside the right-of-way limits. The Resident Engineer will designate the right-of-way limits. All measurements of the area are horizontal measurements.

In performing this work, the Contractor shall not use any chemical growth retardants, poisons, or defoliants.

201.06 DISPOSAL. In the interest of conservation, the Contractor shall salvage all sound wood 100 mm (4 inches) or more in diameter for marketable timber or firewood, or for other acceptable uses. Unless otherwise specified, all marketable timber and wood that are to be removed within the clearing area shall become the property of the Contractor. In general, marketable timber is understood to mean logs 2.4 to 4.8 m (8 to 16 feet) in length plus appropriate trimming allowance and having a diameter of at least 250 mm (10 inches) measured inside the bark at the small end.

All other trees, stumps, logs, branches, protruding roots, brush, duff, weeds, shrubs, debris, rubbish, and other objectionable material shall be disposed of by the Contractor in compliance with applicable laws of the State of Vermont.

Burying of trees, stumps, and debris will be permitted at locations shown on the Plans. Additional areas within the right-of-way will require the Engineer's written permission.

On National Forest Lands, the Contractor shall comply with the requirements set forth in the Forest Service Special Use Permit included in the Contract for the specific project and in accordance with Subsection 107.15.

Before any fires are kindled on or adjacent to the project, the Contractor shall obtain the necessary permits from the State Agency of Natural Resources and the local fire prevention officials. Copies of permits shall be available on the project.

Whenever elm trees are cut or removed, all portions of the trees shall be disposed of by burning, if allowed, or burying. If disposal is by burying, portions shall be covered by at least 300 mm (12 inches) of earth.

201.07 METHOD OF MEASUREMENT. The quantity of Clearing and Grubbing, Including Individual Trees and Stumps will not be measured for payment unless the construction limits are changed. When the designed roadway limits are changed, altering the designed areas to be cleared and grubbed, an adjustment for the increased or decreased area will be measured in hectares (acres). No adjustment will be made for changes involving less than 0.04 ha (0.1 acre).

The quantity of single trees and stumps removed to be measured for payment will be on a unit basis for each for the various classes. The class of the trees will be determined by circumferential measurement at a distance of 1.4 m (4.5 feet) above the ground line. Small trees are classified as trees measuring 1000 mm (40 inches) or less [approximately 300 mm (12 inches) in diameter]. Medium trees are classified as trees measuring more than 1000 mm (40 inches) [approximately 300 mm (12 inches) in diameter] and less than 3000 mm (120 inches) [approximately 900 mm (36 inches) in diameter]. Large trees are classified as trees measuring 3000 mm (120 inches) or more. A stump is designated as that portion of the tree remaining after the trunk has been severed having a circumferential measurement of more than 1000 mm (40 inches) measured at the point of cutoff, and is classified for size the same as a single tree.

The quantity of Thinning and Trimming to be measured for payment will be the number of hectares (acres) thinned and trimmed in the complete and accepted work, as determined by using horizontal measurements.

Thinning and Trimming For Signs will be measured as a unit for each sign's viewing area cleared as designated on the Plans or by the Engineer.

201.08 BASIS OF PAYMENT. The accepted quantity of Clearing and Grubbing, Including Individual Trees and Stumps will be paid for at the Contract lump sum price. Progress payments will be made based on the percentage of total area cleared.

When the designed roadway limits are changed, altering the designed areas to be cleared and grubbed, an adjustment for the increased or decreased area will be made by Change Order/Supplemental Agreement.

The accepted quantity of single trees or stumps removed will be paid for at the Contract unit price for each. Payment for single trees will include removal and disposal of stumps when required. Single small trees and stumps ordered removed, whose circumferential measurement is 1000 mm (40 inches) or less, will not be paid for directly but will be considered incidental to other Contract items. Payment for backfilling for stumps removed shall be incidental to the appropriate removal item. Payment for removal of overhanging branches, blowdowns, and other clearing directed by the Engineer after initial clearing is complete shall be incidental to the unit price bid for Clearing and Grubbing, Including Individual Trees and Stumps.

The accepted quantity of Thinning and Trimming will be paid for at the Contract unit price per hectare (acre).

The accepted quantity of Thinning and Trimming for Signs will be paid for at the Contract unit price for each location designated in the Contract.

If the Contract does not contain a quantity for a Contract item listed in this Section, but such work is required, the work will not be paid for directly but will be considered incidental to all other Contract items.

Payment as indicated will be full compensation for performing the work specified, including disposal, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
201.10 Clearing and Grubbing, Including Individual Trees and Stumps	Lump Sum
201.11 Clearing and Grubbing, Including Individual Trees and Stumps	Hectare (Acre)
201.15 Removing Medium Trees	Each
201.16 Removing Large Trees	Each
201.20 Removing Medium Stumps	Each
201.21 Removing Large Stumps	Each
201.30 Thinning and Trimming	Hectare (Acre)
201.31 Thinning and Trimming for Signs	Each

SECTION 202 - DEMOLITION AND DISPOSAL OF BUILDINGS

202.01 DESCRIPTION. This work shall consist of the removal, wholly or in part, and the satisfactory disposal of all buildings, including accessories and appurtenances, erosion prevention and sediment control, and the backfilling of holes and pits when required.

202.02 GENERAL CONSTRUCTION REQUIREMENTS. Basements shall be completely cleared of all unsuitable materials debris, partition walls, and supports. Concrete or masonry floors or foundations shall be removed to a depth not less than 600 mm (2 feet) below subgrade or 300 mm (1 foot) below final ground level. Floors below these levels shall be broken or holes approximately 300 by 300 mm (1 × 1 foot) shall be provided at 3 m (10 feet) intervals to provide vertical drainage.

Septic tanks, cesspools, or other underground tanks and appurtenant pipes shall be broken down or removed. Contents shall be disposed of in accordance with applicable regulations.

Basements or cavities left by building removal shall be either filled with suitable material to the level of the existing ground and thoroughly compacted, or the area shall be regraded to present a smooth, free-draining surface. A combination of filling and regrading methods may be used. Where filling and regrading operations occur within the limits of construction, manipulation and placement of material shall conform to Subsection 203.11. All regraded areas shall be seeded and mulched in accordance with Section 651 and to the satisfaction of the Engineer.

All fences and debris shall be removed from the parcel, and the area shall be cleaned up and graded to the satisfaction of the Engineer.

All materials resulting from the demolition shall become the property of the Contractor and shall be disposed of or recycled in accordance with all applicable laws, rules, regulations, and protocols.

The Contractor shall provide for the discontinuance of all utility services including, but not limited to, electricity, telephone, sewer, water, and gas lines and utility meters. The Contractor shall be held responsible for any claim arising from failure to provide for the discontinuance of such utility services. If permission has been given to the previous owner to occupy a building until a specified date, the previous owner shall not be required to pay rent to the Contractor or to move on a date earlier than that specified. The Contractor shall provide for the discontinuance of all utility services after the specified date.

The Agency shall not be responsible for any changes in the condition of the buildings, or for loss of fixtures or equipment, at any time.

Once work has commenced, the Contractor shall make every reasonable effort to complete the demolition and disposal of each Contract item in a continuous manner to ensure the safety and well being of the public.

The Contractor shall erect suitable fences around unfilled basements and other dangerous locations created by the work.

The Contractor shall be responsible for finding, opening, and maintaining all disposal areas and shall comply with all environmental rules and regulations, zoning ordinances, development plans, land use plans, and land capability plans.

202.03 METHOD OF MEASUREMENT. The quantity of Demolition and Disposal of Building to be measured for payment will be on a unit basis for each building, as shown on the Plans.

202.04 BASIS OF PAYMENT. The accepted quantity of Demolition and Disposal of Building will be paid for at the Contract unit price for each building specified in the Contract. Payment will be full compensation for removing, disposing and/or recycling of buildings; for excavating, backfilling, and regrading incidental to their removal; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. When seed, mulch, other turf establishment items, and/or erosion prevention and sediment control items are not part of the Contract, they shall be considered incidental to the Demolition and Disposal of Building item.

Payment will be made under:

Pay Item	Pay Unit
202.10 Demolition and Disposal of Building	Each

SECTION 203 - EXCAVATION AND EMBANKMENTS

203.01 DESCRIPTION. This work shall consist of excavating and grading roadways, runways and railways (including the removal of slides), borrow pits, waterways, channels, intersections, approaches, and steps in hillside embankments; excavating unsuitable material from the construction area and beneath embankment areas, surfaces, and pavements; excavating selected material found in the construction area for specific use in the construction; constructing and removing detours shown on the Plans or directed by the Engineer; trimming and shaping of slopes; and disposing of all unsuitable or surplus excavated material. The work shall also consist of placing material in embankments and the grading of all material placed up to subgrade to the tolerance specified in the Plans.

The work is classified as follows:

(a) Common Excavation. Common Excavation shall consist of the removal of all material, which can be accomplished with normal excavating machinery, encountered in grading the project and not classified to be removed as Solid Rock Excavation, Muck Excavation, Channel Excavation, Excavation of Surfaces and Pavements, or Excavation for Structures.

Excavation required beyond the finished slope neat lines for slope stabilization, removal of sod and unsuitable material other than muck located in embankment areas, removal and stockpiling of topsoil, and removal of unsuitable material existing at or below subgrade elevation in excavation areas is also classified as Common Excavation.

(b) Solid Rock Excavation. Solid Rock Excavation shall consist of the removal of hard igneous, metamorphic, or sedimentary rock that requires blasting or the use of rippers; detached rock; boulders; mortared stone masonry; or concrete each having a volume of 1.5 m^3 (2 cubic yards) or more; and portland cement concrete pavement including any bituminous surface overlay material, encountered in the limits of excavation.

(c) Unclassified Excavation. Unclassified Excavation shall consist of Common Excavation and Solid Rock Excavation as classified above and not measured separately.

(d) Muck Excavation. Muck Excavation shall consist of the removal, disposal, and backfill of a saturated or unsaturated mixture of soils and organic matter encountered below the original ground line in an embankment area that is not suitable to be used as foundation material regardless of its moisture content.

(e) Channel Excavation of Earth. Channel Excavation of Earth shall consist of the removal of all material, which can be accomplished with normal excavating machinery, encountered in the excavation, except as classified as Channel Excavation of Rock, for widening, deepening, and straightening of existing channels and waterways, or in the construction of new channels; and any other excavation designated to be removed as channel excavation as shown on the Plans or as directed by the Engineer.

(f) Channel Excavation of Rock. Channel Excavation of Rock shall consist of the removal of rock in definite ledge formation that requires blasting or the use of rippers; and detached rock, boulders, stone masonry, and concrete each having a volume of 1.5 m^3 (2 cubic yards) or more encountered in the excavation for widening, deepening, and straightening of existing channels and waterways, or in the construction of new channels.

(g) Unclassified Channel Excavation. Unclassified Channel Excavation shall consist of Channel Excavation of Earth and Channel Excavation of Rock as classified above and not measured separately.

(h) Excavation of Surfaces and Pavements. Excavation of Surfaces and Pavements shall consist of the removal and disposal of existing surfaces and pavements that are located outside other excavation and embankment limits.

(i) Borrow. Borrow shall consist of material required for the construction of embankments or for other portions of the work, and obtained from approved sources located outside the limits of the right-of-way, unless otherwise shown on the Plans or directed by the Engineer.

Borrow is further classified as Earth Borrow, Sand Borrow, Granular Borrow, or Rock Borrow.

(j) Gravel Backfill for Slope Stabilization. Gravel Backfill for Slope Stabilization shall consist of approved gravel placed against slopes and any other places designated for use of this material.

(k) Shoulder Berm Removal. The removal of the shoulder berm shall consist of removing the berm of debris and sand resulting from guardrail that is to be retained. The removal may be performed by hand labor or mechanical means. The Contractor shall remove the berm down to the proper line and grade for the shoulder from which the berm is being removed. The removed sand and fine debris may be scattered into the turf on the roadway slope outside the point of shoulder unless otherwise directed by the Engineer. Larger debris such as stones in excess of 50mm (2 inches) in diameter, automobile parts, wood, glass, and other bulky items shall be disposed of properly by the Contractor.

203.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Classification of Soils.....703.01
Earth Borrow.....703.02
Sand Borrow.....703.03
Granular Borrow 703.04
Rock Borrow 703.05
Gravel Backfill for Slope Stabilization 704.07
Backfill for Muck Excavation 704.09

203.03 GENERAL CONSTRUCTION REQUIREMENTS. Prior to the beginning of excavation, grading, and embankment operations in any area, all necessary clearing and grubbing in that area shall have been completed in accordance with Section 201.

All slopes in cut and embankment sections, ditches, and waterways, whether old or newly constructed, shall be satisfactorily cleaned and cleared of obstructions and left in a neat and trim condition. Excavation shall be performed in accordance with the Contract or as directed by the Engineer.

The construction area shall be maintained to ensure proper drainage at all times. Where traffic is maintained, care shall be exercised to keep the portion of the roadway or the traveled way open to traffic in a satisfactory condition as per Subsection 104.04.

All suitable material removed by excavating shall be used in the formation of embankments as shown on the Plans or as directed by the Engineer. Any excavation that cannot be incorporated in embankments shall be disposed of as directed by the Engineer. No material shall be wasted without permission of the Engineer.

The Contractor shall be responsible for the stability of all constructed embankments and shall replace, at no cost to the Agency, any portions that have become displaced and that are not attributable to the unavoidable movement of the natural ground upon which the embankment is made or to an Act of God.

Unless directed by the Engineer, borrow material shall not be placed until all suitable material has been excavated and placed in the embankments, except when Sand Borrow or Granular Borrow is shown on the Plans or when Granular Borrow is required by the Engineer for use under embankments or used with material from excavation in making embankments. Should a surplus of excavated material result from the Contractor placing more borrow than required, the amount of this surplus will be measured by the Engineer and 115 percent of the total surplus will be deducted from the total quantity removed from the borrow source.

When not otherwise shown in the Contract Documents, at all bridge approaches in excavation areas excavation for additional subbase shall be made to a depth of 1.2 m (4 feet) below finish grade for a distance not less than 15 m (50 feet) from the end of the bridge. The transition depth from normal subgrade level to any extra depth level shall be at a rate of 1:25 (vertical:horizontal).

All work performed under this Section shall conform to Section 105.

<u>203.04 EXCAVATION</u>. Any loose material resulting from breakage and slides shall be removed and disposed of as directed by the Engineer.

Excavated material shall be sorted so that the best material is placed in embankments beneath the traveled way.

The Contractor shall not excavate or remove any material outside the limits of the excavation slope and grade lines shown on the Plans unless authorized in writing by the Engineer. Grading shall be to full cross-section width at subgrade before placing of any type of subbase or pavement, except that partial-width construction is permissible where necessary for the maintenance of traffic, and shall be done within the allowable tolerances as indicated on the Plans.

The Contractor shall strip ledge and then notify the Engineer that the area is ready for cross-sectioning prior to making any rock excavation. Any ledge removed prior to the taking of cross-sections will be paid for as Common Excavation. The Contractor may use other means of locating the rock line with the approval of the Engineer.

When excavating solid rock by the blasting method, the Contractor shall drill slope holes to the full depth of the rock lift along the line and plane of inclination of the slope, as shown on the Plans or as otherwise directed by the Engineer. Spacing for the slope holes shall not exceed 1 m (3 feet), center to center of holes. The diameter of the slope holes shall be not greater than 75 mm (3 inches). The line of blast holes shall be drilled parallel to the plane of the slope holes. No portion of any blast hole in this line shall be closer than 1.2 m (4 feet) to the proposed finished slope. No portion of any blast hole larger than 75 mm (3 inches) in diameter will be permitted closer than 4 m (12 feet) to the proposed finished slope.

When it is shown on the Plans that concrete shall be placed on or against the limits of rock excavation, care shall be taken to avoid disturbing, shattering, or removing rock outside such limits. Any costs incurred due to the unauthorized removal, shattering, or disturbing of the material outside the indicated limits shall be at the Contractor's expense.

The explosives used in the slope holes along the line of the finished slope and the adjacent slope holes shall be explosives for pre-splitting use only, prepared and packaged by explosives manufacturing firms and approved by the Engineer.

The slope holes along the line of the finished slope shall be loaded with approved explosives containing not more than 750 g of explosive per meter (0.5 pounds per foot) of hole depth. The spaced charges on a detonating cord shall be equal in length to the full depth of the hole. If spacers are used, the holes shall be completely stemmed so that uniform breakage of the rock will result from top to bottom of the hole. A bottom charge of not more than 3.5 kg (8 pounds) of explosive may be used. No explosive charge shall be placed within 750 ± 150 mm (30 ± 6 inches) of the collar of the finished slope holes.

The Contractor shall complete the drilling, loading, stemming, and blasting of the slope holes at least 8 m (25 feet) in advance of any other blasting.

In areas other than along the proposed finished rock cut slopes and adjacent slope holes, the spacing of holes, distribution of explosives, the methods of relief, and fractional second delay blasting shall be adjusted by the Contractor. The Contractor shall make adjustments according to the characteristics and structure of the rock encountered in order to obtain the required finished slopes with a minimum of overbreak.

The depth of the rock lift within any one excavation area will be approved by the Engineer and shall be reduced by the Contractor if the proper alignment of the slope holes cannot be maintained.

203.05 MUCK EXCAVATION. The material shall be excavated to the widths and depths shown on the Plans or as required to give a stable foundation for the placement of necessary backfill, embankment, or subbase material. The excavation of this material shall be handled in a manner that will prevent the entrapment of muck within the backfill.

Unless otherwise specifically shown in the Contract Documents, the material that has been excavated under this Contract item shall be spread on the fill slopes as shown on the Plans or as directed by the Engineer. If provision is not shown in the Contract Documents for the disposition of the muck excavation, or if, in the opinion of the Engineer, its use on the slopes is impractical, then the excavated material shall be disposed of by the Contractor, in accordance with Subsection 203.09.

The backfilling of the excavated area shall immediately follow the excavation of the muck so that any soft material that is pushed ahead of the backfill can be removed.

The material used for backfilling the excavated area up to the ground line or water level, whichever is higher, shall be rock or other granular material selected from the excavation, if available. When this material is not available, it shall be obtained as Granular Borrow from an approved source.

After removal of the muck and prior to backfilling, the Contractor shall allow the Engineer adequate time to take all necessary measurements for determining the volume removed.

203.06 CHANNEL EXCAVATION. The area where the channel is to be excavated shall be cleared and grubbed as required. The work involved shall be considered as incidental work to Channel Excavation when Clearing and Grubbing, Including Individual Trees and Stumps is not a Contract item.

The channel shall be excavated to the lines, grades, and cross-sections shown on the Plans or as ordered by the Engineer. All suitable material excavated shall be used in the formation of roadway embankments or for other construction purposes as shown on the Plans or as directed by the Engineer. Unsuitable material or waste material, when directed by the Engineer, shall be wasted and disposed of by the Contractor at no additional compensation in accordance with Subsection 203.09.

Where any part of an existing bridge, substructure, or other structure is outside the limits of the excavation for the new work, such part shall be removed to 300 mm (1 foot) below the proposed limits or to the elevations shown on the Plans or as directed by the Engineer.

203.07 EXCAVATION OF SURFACES AND PAVEMENTS. All excavation shall be made strictly to the required alignment, grade, and cross-sections shown on the Plans, or as directed by the Engineer for areas located outside of the limits of roadway excavation and embankment.

All suitable materials removed shall be used, as far as practical, in the formation of embankments and at other locations as directed by the Engineer.

The completed excavation shall be properly graded and shaped prior to receiving any cover or top dressing.

203.08 BORROW. Opening, maintaining, and closing borrow pits shall be in accordance with Section 105. The simultaneous extraction of more than one borrow item from a given pit will require the written permission of the Engineer.

203.09 DISPOSAL OF SURPLUS EXCAVATION AND WASTE MATERIAL. All surplus excavation and waste material shall be deposited as shown on the Plans or as authorized in writing by the Engineer. Excavated material shall not be wasted unless authorized by the Engineer. Compaction requirements for surplus or waste material used to flatten slopes outside the embankment limits shown on the Plans may be waived; however, placement procedures shall ensure a stable fill slope.

Disposal of all surplus or waste material shall be in accordance with Section 105.

Disposal of surplus or waste material will not be paid for directly but shall be considered as incidental work pertaining to the grading or excavation Contract item from which the material was obtained.

When sufficient on-site disposal areas are not shown on the Plans, it shall be the responsibility of the Contractor to locate disposal areas in accordance with Section 105 and any applicable permits.

203.10 HAUL ROADS. Particular care shall be taken in the locating of haul roads. In wooded areas, haul road width shall be minimized and placed at approximate right angles or angled away from the view of oncoming traffic and, where feasible, shall incorporate one bend to eliminate the tunnel effect. Large and well-shaped trees shall be preserved.

203.11 EMBANKMENTS.

(a) Preparation of Embankment Area. When embankments are to be made on a hillside, the slope of the original ground on which the embankments are to be constructed shall be stepped and properly drained as the fill is constructed in accordance with the Plans or as directed by the Engineer.

(b) Use of Materials. The excavated rock, ledge, boulders, and stone, except where required in the construction of other items or otherwise directed, shall be used in the construction of embankments to the extent of the project requirements and, generally, shall be placed to form the base of an embankment. When shown on the Plans, certain portions of rock excavation may be reserved for special use such as rock fill, for embankment construction at locations below high water, or at locations susceptible to erosion.

Frozen material shall not be used in the construction of embankments. The embankments or successive layers of the embankments shall not be placed upon frozen material. Placement of material other than rock shall stop when the sustained ambient air temperature, below 0 °C (32 °F), prohibits attainment of the required compaction. If the material is otherwise acceptable, it shall be stockpiled and reserved for future use when its condition is acceptable to the Engineer for use in embankments.

The Engineer may require certain select material from excavation or borrow to be used adjacent to structures to obtain the required compaction or to protect them from damage. All material being placed in embankments at locations where piles are to be driven shall pass a 225 mm (9 inch) square screen opening.

(c) Procedure for Placing and Spreading. When an embankment is to be constructed across open water or across swampy, wet ground, the first layer of the fill shall be rock or material meeting the requirements for Granular Borrow.

The first layer of the embankment may be constructed in one thickness of rock or material meeting the requirements of Granular Borrow, to the minimum elevation at which equipment may be operated, as directed by the Engineer. Above this elevation, the embankment shall be constructed as specified below. Material from excavation on the project shall be used to the extent available and when not available shall be obtained from sources of Granular Borrow or Rock Borrow when authorized in writing by the Engineer.

When trucks are used to place earth from excavation or borrow, the material shall be deposited on the layer of embankment being constructed, bladed or dozed into place, and shaped and compacted. Dumping directly onto previously constructed layers will not be permitted.

Embankments of either earth or rock material shall be placed in horizontal layers of uniform thickness and across the full section width. When it is impractical to construct a full width layer across an embankment, partial width layers may be authorized, provided the full width procedure is resumed as soon as practical. Logs, stumps, waste material, and oversized cobblestones or boulders shall not be placed within the structural embankment area. They may be placed outside the structural embankment area at locations directed by the Engineer or, when authorized, disposed of as surplus material. Initial layers shall begin at the deepest part of the fill. Except for the first layer of fill over swampy ground and cleared areas, the loose layer thickness shall be limited to 200 mm (8 inches). When conditions necessitate, the Engineer may authorize layers in excess of 200 mm (8 inches) but not more than 600 mm (24 inches). The Contractor shall make all necessary excavations up to 600 mm (24 inches) deep so that the Engineer can determine moisture, density, and stability, solely at the Contractor's expense.

Effective spreading equipment shall be used on each layer to obtain uniform thickness. Cobblestones or boulders having their least dimension greater than the loose layer thickness being placed shall be removed prior to compaction. Each layer shall be compacted as specified, and, if necessary, stabilized prior to a successive layer being placed. Each layer shall be kept crowned to shed water. As the compaction of each layer progresses, continuous leveling and manipulating will be required to ensure uniform density, a uniform and satisfactory moisture content, and acceptable stability. The last lift constructed each day shall be graded, crowned, and rolled to ensure adequate drainage.

When A4, A5, A6, or A7 cohesive soils, as identified in table 703.01A, have excess moisture and cannot effectively be air dried or dried by manipulation, the Contractor may layer or mix the material with dry A1, A2, or A3 granular soils in order to obtain acceptable compaction and stability. The Contractor is responsible for making prudent use of available granular excavation from the project prior to being authorized the use of Granular Borrow. The combined loose thickness of mixed or layered materials prior to compaction shall not exceed 400 mm (16 inches).

During the construction of the embankments, if bulging, cracking, or unstable movement occurs, the placing of the fill material shall be stopped, retarded, or corrected to allow the material to stabilize as directed by the Engineer. Rutting, rolling, shoving, or other displacement in excess of 150 mm (6 inches) under the action of construction equipment may be considered evidence of stability problems.

When soft or wet clay or silt excavation is being used between layers of reasonably clean stable rock fill, the rock embankment layers shall not exceed 600 mm (24 inches) in loose measurement. The clay or silt layers shall not exceed 200 mm (8 inches) in loose measurement.

If embankments are to be constructed by using rock excavation, all reasonable precaution must be taken to ensure a solid embankment. The fill shall be made in uniform layers consistent with the size of the rock being used, but not to exceed 600 mm (24 inches) in thickness. Individual pieces of rock or boulders with their least dimension exceeding the thickness of the layer being placed shall either be reduced to an acceptable size or placed outside the structural embankment area in such a manner that all voids are filled.

Rock shall not be dumped over the end of a fill. Rock shall be deposited on the fill and distributed by blading or dozing to ensure proper placement in the embankment so that voids, pockets, and bridging are reduced to a minimum.

If embankment material must be deposited on only one side of abutments, wingwalls, piers, or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of, or excessive pressure against, the structure. Unless otherwise specified, the fill adjacent to bridge abutments shall not be placed higher than the bridge seat elevations until the superstructure is in place. When an embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be conducted so that the embankment is always at approximately the same elevation on both sides of the structure.

For structures that can displace longitudinally as a result of unequal horizontal loading against their ends, such as a cantilever designed superstructure supported by piers only, backfill shall be placed on both ends of the structure simultaneously, with the lift differential between opposite ends limited to 150 mm (6 inches). Should the backfilling operation cause any undesired displacement, the Contractor shall remove and replace the fill in a manner that will not adversely affect the structure’s position, solely at the Contractor’s expense.

(d) Compaction. Each layer between the design embankment limits shown on the Plans shall be uniformly compacted by the use of compaction equipment to not less than 90 percent of the material's maximum dry density as determined by AASHTO T 99, Method C. The material in the top 600 mm (24 inches) of any embankment, immediately below the subgrade, shall be compacted to not less than 95 percent of the maximum dry density. Field density determination will be made in accordance with AASHTO T 191, Sand Cone Method; AASHTO T 310, Nuclear Method; or other approved procedures. Field moisture determination will be made in accordance with AASHTO T 99 or measured in accordance with AASHTO T 310, Nuclear Method. Locations within the embankment limits where waste materials have been placed shall be compacted to the extent that stability is ensured.

All fill material shall be compacted at a moisture content determined by the Engineer to be suitable for obtaining the required density. The moisture content in each layer under construction shall not exceed 2 percent above the optimum moisture content, and it shall be less than that quantity that will cause the embankment to become unstable during compaction. The Engineer will consider sponginess, shoving, or other displacement under heavy equipment sufficient evidence of a lack of stability under this requirement, and the Contractor shall stop or retard further placement of material in the area affected to allow the material to stabilize.

When the moisture content of the material in the layer under construction is less than the amount necessary to obtain the required compaction by mechanical compaction methods, water shall be added by pressure distributors or other approved equipment. Water may also be added in excavation or borrow pits. The water shall be uniformly and thoroughly incorporated into the soil by disking, harrowing, blading, or other approved methods. This manipulation may be omitted for sand and gravel. When the moisture content of the material is in excess of 2 percent above the optimum moisture content, dry material shall be thoroughly incorporated into the wet material, or the wet material shall be aerated by disking, harrowing, blading, rotary mixing, or other approved method; or compaction of the layer of wet material shall be deferred until the layer has dried to the required moisture content by evaporation.

The density requirements do not apply to those portions of embankments constructed of material so coarse that it cannot be properly tested with a conventional density testing apparatus. Instead, the material shall be compacted to the satisfaction of the Engineer.

In areas inaccessible to power rolling, the embankment material shall be placed in uniform horizontal layers of not more than 150 mm (6 inches) in depth and compacted by means of approved mechanical tampers to the density requirements specified above. The use of hand tamps will not be permitted.

Additionally, the following requirements apply to airport compaction:

(1) Rolling operations shall continue until the embankment is compacted to not less than 90 percent of maximum density for cohesive soils, and 95 percent of maximum density for noncohesive soils.

(2) Under all areas to be paved, the top 225 mm (9 inches) of the embankment shall be compacted to a density of not less than 95 percent of maximum density for cohesive soils, and 100 percent for noncohesive soils, unless otherwise shown in the Contract Documents.

(3) In areas designed for the use of aircraft, the determination of maximum density and optimum moisture content will be performed according to AASHTO T 180, Method D, with correction for coarse particles in accordance with AASHTO T 224.

(4) The determination of in-place density and in-place moisture content will be performed according to AASHTO T 191, T 310, or other methods approved by the Engineer.

203.12 SUBGRADE. The subgrade shall be constructed to the lines, grades, and cross-sections shown on the Plans. After all drainage structures have been installed and the subgrade has been shaped correctly, the subgrade shall be brought to a firm, unyielding surface compacted to attain at least 95 percent of the maximum dry density. This density will be determined by AASHTO T 99, Method C.

A power grader or other approved equipment shall be used during the placement and compaction to obtain the specified cross-section.

Areas of soft, yielding, or otherwise unsuitable material that will not compact readily shall be removed, replaced with a suitable material, and properly compacted as directed by the Engineer.

All loose rock or boulders encountered at subgrade in the earth excavation shall be removed or broken off to a depth not less than 300 mm (12 inches) below the subgrade.

In excavation areas, the ground shall not be excavated or disturbed below the subgrade except as shown in the Contract Documents or as directed by the Engineer. All ditches and drains shall be constructed so they will effectively drain the construction area before the placement of any subbase or surface course material. In handling materials, tools, and equipment, the Contractor shall protect the subgrade from damage. Vehicles should not travel in a single track and form ruts. If ruts are formed, the subgrade shall be reshaped and compacted. Any pockets of clay, sand, or soft material that may have been left in the subgrade shall be removed and replaced with approved material and properly compacted at the Contractor's expense. The subgrade shall be kept in a condition that it will drain. Subbase, base, or surface material shall not be deposited on the subgrade until the subgrade has been checked and approved by the Engineer. After the subgrade has been approved, the Contractor shall not perform hauling or move equipment that will distort the cross-section over the subgrade.

A tolerance of 15 mm (1/2 inch) above or below the finished subgrade will be allowed provided that this tolerance is not maintained for a distance longer than 20 m (50 feet) and that the required cross-section is maintained. Grading shall be done with a power grader or other approved equipment to conform to the requirements as specified above.

For airport construction, the field density will be determined in accordance with Subsection 203.11(d). In fill sections, stones or rock fragments larger than 100 mm (4 inches) in their greatest dimension will not be permitted in the top 150 mm (6 inches) below subgrade.

203.13 METHOD OF MEASUREMENT.

(a) Excavation. The quantity of all excavation items to be measured for payment will be the number of cubic meters (cubic yards) of the material removed from the areas shown on the Plans or as directed by the Engineer. The quantity will be measured in its original position by cross-sections and computed by the method of average end areas. When impractical, other acceptable methods involving three-dimensional measurement may be used to determine the quantity. The limits shall not exceed those shown on the Plans or authorized in writing by the Engineer. The method of mass centers for computing volumes will be allowed only when the method has been used in the original design computations. Excavation requiring more than one handling prior to final placement in embankments will not be measured for payment for the additional handling unless specifically stated in the Contract.

(1) Common Excavation. Excavation for stepping of original ground under hillside embankments will not be measured for payment.

Excavation for removal of soft spots in the subgrade of embankment areas and the material required for replacement will not be measured for payment. Any costs will be considered included in the Contract items involved.

However, where the embankments were constructed as part of another contract, the quantities of excavation for removal of soft spots and the material for replacement will be measured for payment.

(2) Solid Rock Excavation. The measurement limits for solid rock excavation will coincide with the depth shown on the Plans or as directed by the Engineer. Excavation below subgrade will not be measured. Measurement limits for determining the amount of solid rock excavation will be that amount actually removed up to a limit 300 mm (12 inches) outside of and parallel to the slope lines shown on the Plans or as directed by the Engineer. Measurement for payment will not be made for rock removed beyond these limits unless authorized. If natural fissures or faults exist making removal of rock beyond these limits necessary, the Engineer will authorize removal in writing, and the limits of excavation will be adjusted accordingly.

(3) Unclassified Excavation. The quantity of Unclassified Excavation to be measured for payment will be the number of cubic meters (cubic yards) of material excavated as shown on the Plans or as directed by the Engineer. There shall be no differentiation made between common or solid rock excavation for this item.

(4) Muck Excavation. The quantity of Muck Excavation to be measured for payment will be the number of cubic meters (cubic yards) of material excavated as shown on the Plans or as directed by the Engineer.

(5) Channel Excavation of Earth. The quantity of Channel Excavation of Earth to be measured for payment will be the number of cubic meters (cubic yards) of material excavated from its original position. No differentiation will be made between the channel excavation of dry or wet material.

Where Excavation (Common, Solid Rock, or Unclassified) and Channel Excavation occur jointly or separately at the same location, measurement for Channel Excavation will be made only below the lower limits of Common, Solid Rock, or Unclassified Excavation.

(6) Channel Excavation of Rock. Measurement limits for determining the amount of Channel Excavation of Rock will be as specified in Subsection 203.13(a) (2).

Where Excavation (Common, Solid Rock, or Unclassified) and Channel Excavation occur jointly or separately at the same location, measurement for Channel Excavation will be made only below the lower limits of Common, Solid Rock, or Unclassified Excavation.

(7) Excavation of Surfaces and Pavements. The quantity of Excavation of Surfaces and Pavements to be measured for payment will be the number of cubic meters (cubic yards) of material removed and disposed of, measured in its original position. The measurement limits of excavation will not exceed those shown on the Plans or directed by the Engineer.

(b) Borrow. The quantity of borrow to be measured for payment of the type indicated, except Sand Borrow, will be the number of cubic meters (cubic yards) of the material removed and used in the complete and accepted work from approved borrow sources measured in its original position. The quantity of Granular Borrow used to replace solid rock excavated below subgrade will be allowed and measured for payment to a depth not to exceed 75 mm (3 inches). Any solid rock excavated below this depth shall be replaced by the Contractor with material from Solid Rock Excavation or Granular Borrow, furnished and placed at the Contractor's expense.

For small quantities of borrow, with the written permission of the Engineer, the quantity to be measured for payment of the type of borrow indicated will be the number of cubic meters (cubic yards) of material used in the complete and accepted work, as determined by the vehicle loads using three-dimensional measurements. A load ticket including truck identification and date of delivery shall be furnished to the Engineer upon delivery for each load delivered to the site. All vehicles shall be loaded to at least their water level capacity, and any load designated shall be leveled at the point of delivery when directed by the Engineer. All quantities computed from vehicle load measurement will be divided by a factor of 1.15 and the resulting volume paid at the Contract unit price for those Contract items.

Stripping of pits to obtain borrow will not be paid for separately but will be considered incidental to the various borrow Contract items.

Any material removed or excavated from a borrow pit before cross-sections and measurements have been taken will not be paid for. No borrow quantity will be allowed that is not taken from measured borrow pits, unless otherwise agreed upon in writing by the Engineer and the Contractor.

Should more borrow be placed than required, resulting in a waste of excavated material, or should embankments be constructed beyond the neat lines shown on the Plans, unless otherwise authorized in writing by the Engineer, 115 percent of the amount of such waste or excess will be deducted from the total amount of specified borrow being used.

When requested by the Contractor and authorized in writing by the Engineer, material specified to be measured by the cubic meter (cubic yard) may be measured by mass (weighed) and the mass (weight) converted to cubic meters (cubic yards) for payment purposes. Factors for conversion from mass (weight) measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before the method of measurement of pay quantities is used.

The simultaneous extraction of more than one borrow item from a given pit will require the written permission of the Engineer, and the method of measurement shall be as specified by the Engineer.

(1) Earth Borrow. With the written permission of the Engineer, the method of measurement for Earth Borrow may be changed to the number of cubic meters (cubic yards) in place in the complete and accepted work multiplied by a factor of 1.15.

When material from excavation is removed and either used for payment under another Contract item or diverted for the Contractor's use, such as the construction of haul roads, the quantity measured for these uses will be multiplied by a factor of 1.15. The resulting quantity will be deducted from the total quantity of Earth Borrow.

(2) Sand Borrow. The quantity of Sand Borrow to be measured for payment will be the number of cubic meters (cubic yards) placed in the complete and accepted work, as determined by the plan dimensions of the compacted material. No allowance will be made for material placed to a greater depth or width than that shown on the Plans unless authorized in writing by the Engineer.

(3) Granular Borrow. With the written permission of the Engineer, the method of measurement for Granular Borrow may be changed to the number of cubic meters (cubic yards) in place in the complete and accepted work multiplied by a factor of 1.15.

(4) Rock Borrow. When obtained from previously blasted or stockpiled sources, the quantity of Rock Borrow to be measured for payment will be the number of cubic meters (cubic yards) of blasted material measured in the pile before removal divided by a factor of 1.35.

(c) Gravel Backfill for Slope Stabilization. The quantity of Gravel Backfill for Slope Stabilization to be measured for payment will be the number of cubic meters (cubic yards) placed in the complete and accepted work. Measurements will be confined to the limits shown on the Plans or as directed by the Engineer.

(d) Shoulder Berm Removal. The quantity of Shoulder Berm Removal to be measured for payment shall be the number of meters (linear feet) of shoulder from which the berm was properly removed, measured from the beginning point of removal to the end point of removal.

203.14 BASIS OF PAYMENT. The accepted quantities as measured will be paid for at the Contract unit price per cubic meter (cubic yard) for the specified Contract items except for Shoulder Berm Removal, which will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for performing the work specified, including any drilling and blasting required, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

No added compensation will be made for any special manipulation or delay resulting in the drying or wetting of soils necessary to obtain the required compaction. The entire cost of such manipulation and delay will be considered included in the Contract unit price for the excavation Contract item involved.

Compensation for the construction of embankments, as defined in Subsection 203.11, shall be considered incidental to the various excavation items. Water added to embankment material to aid in compaction will not be paid for directly but will be considered incidental to the Contract items involved.

All work and material required to grade, loam, seed, and mulch waste areas, borrow pits, and haul roads, as specified, to eliminate unsightly conditions and prevent erosion will not be paid for directly but will be considered incidental to the various types of excavation and borrow.

Material used for backfilling voids created by the removal of unsuitable material below subgrade and on slopes will be paid for at the Contract unit price per cubic meter (cubic yard) for the particular Contract item used in making the backfill. If the particular Contract item required for backfill is not included in the Contract, a Change Order/Supplemental Agreement for this Contract item will be negotiated, with the exception of backfilling for Muck Excavation, which shall be incidental to the item.

The work specified in Subsection 203.12 will not be paid for directly but will be considered as incidental work pertaining to the excavation and borrow Contract items

On borrow projects, solid rock removed beyond the authorized limit, as specified for solid rock measurement, may be paid at the Contract unit price for other excavation or borrow items in the Contract, whichever unit price is the least, provided the material is used in constructing approved embankments.

When the subgrade has been prepared by others under another contract, the excavation necessary to bring the subgrade to the required grade and cross-section or for the removal of soft spots in the subgrade will be paid for as Common Excavation.

All grading and shaping required after removing material paid for as Excavation of Surfaces and Pavements will not be paid for directly but will be considered incidental to this Contract item.

Payment will be made under:

Pay Item	Pay Unit
203.15 Common Excavation	Cubic Meter (Cubic Yard)
203.16 Solid Rock Excavation	Cubic Meter (Cubic Yard)
203.17 Unclassified Excavation	Cubic Meter (Cubic Yard)
203.20 Muck Excavation	Cubic Meter (Cubic Yard)
203.25 Channel Excavation of Earth	Cubic Meter (Cubic Yard)
203.26 Channel Excavation of Rock	Cubic Meter (Cubic Yard)
203.27 Unclassified Channel Excavation	Cubic Meter (Cubic Yard)
203.28 Excavation of Surfaces and Pavements	Cubic Meter (Cubic Yard)
203.30 Earth Borrow	Cubic Meter (Cubic Yard)
203.31 Sand Borrow	Cubic Meter (Cubic Yard)
203.32 Granular Borrow	Cubic Meter (Cubic Yard)
203.33 Rock Borrow	Cubic Meter (Cubic Yard)
203.35 Gravel Backfill for Slope Stabilization	Cubic Meter (Cubic Yard)
203.40 Shoulder Berm Removal	Meter (Linear Foot)

SECTION 204 - EXCAVATION FOR STRUCTURES

204.01 DESCRIPTION. This work shall consist of the excavation and backfill or disposal of all material removed.

All excavation for structures below the designated slope or subgrade line as shown on the Plans shall be included in this work.

The work is classified as follows:

(a) Trench Excavation. Trench Excavation shall consist of excavation for the construction of new culverts and pipes of 1.2 m (4 foot) clear span and under, conduits, culvert headwalls, drop inlets, manholes, catch basins, leaching basins, underdrains, concrete steps, and other minor structures, and drainage ditches at the inlet and outlet of drainage structures 1.2 m (4 foot) clear span and under; excavation for the removal of all existing drainage structures; exploratory excavation for locating underground utility services and/or other structures; and any other excavation designated to be removed under this Contract item.

(1) Trench Excavation of Earth. Trench Excavation of Earth shall consist of all material excavated within the limits shown in the Contract Documents, except boulders measuring 0.5 m^3 (18 cubic feet) or more, solid rock, mortared stone masonry, and concrete; and the removal of all existing pipes 1.2 m (4 foot) and under, regardless of material.

(2) Trench Excavation of Earth, Exploratory. Exploratory excavation to locate underground utility services and/or other structures shall be conducted where directed by the Engineer and shall be classified as Trench Excavation of Earth, Exploratory. The Contractor shall utilize protective measures during this excavation to avoid damage to any underground service or structure. When necessary, the Contractor shall cooperate with representatives of the utility company(ies) in order to avoid damage to the utilities by permitting the utility company(ies) to erect suitable supports, props, shoring, or other means of protection.

(3) Trench Excavation of Rock. Trench Excavation of Rock shall consist of all solid rock in formation, or boulders measuring 0.5 m^3 (18 cubic feet) or more, excavated within the limits shown in the Contract Documents. All mortared stone masonry and concrete irrespective of the size of its components, excavated within the above limits, shall likewise be considered as rock.

(b) Structure Excavation. Structure Excavation shall consist of excavation for the construction of foundations and substructures of all structures over 1.2 m (4 foot) clear span, pipe culverts and storm sewers of over 1.2 m (4 foot) clear span, grade separation structures, retaining walls, cribs, and any other excavation designated to be removed under this Contract item. If temporary bracing, sheeting, or other means of supporting the excavation is required, Construction Drawings shall be submitted in accordance with Section 105.

(c) Granular Backfill for Structures. Granular Backfill for Structures shall consist of approved material placed within the limits shown on the Plans or directed by the Engineer.

204.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Coarse Aggregate for Concrete ..... 704.02(a)
Crushed Gravel for Subbase, Fine Graded ..... 704.05(a)
Granular Backfill for Structures 704.08

Concrete shall have a minimum 28 day compressive strength of 20 MPa (3000 psi) and shall conform to the requirements of Section 541.

When approved in writing by the Engineer, material meeting the gradation requirements for Coarse Aggregate for Concrete may be substituted for Granular Backfill for Structures under footings.

When approved in writing by the Engineer, material meeting the gradation requirements for Crushed Gravel for Subbase, Fine Graded may be substituted for Granular Backfill for Structures.

204.03 GENERAL CONSTRUCTION REQUIREMENTS. The locations and elevations for excavation shown on the Plans shall be considered as approximate only. The Engineer may order removal of poor foundation material below the designed elevation and replacement with an approved material.

All suitable excess excavated material shall be used in the formation of embankments, at other locations shown on the Plans, or as directed by the Engineer. The Contractor shall haul and dispose of the material at no additional compensation.

All work performed under this Section shall conform to Section 105.

204.04 PRESERVATION OF CHANNEL. Unless otherwise shown on the Plans or directed by the Engineer, the Contractor shall confine excavation operations to the site of the proposed structure. The natural streambed shall not be disturbed without permission of the Engineer. Materials from foundation or other excavation shall not be deposited within a stream area.

204.05 FOOTING MODIFICATIONS. When it is necessary to modify the designed footings as shown on the Plans, the Engineer will issue a written order for such changes in elevations or dimensions required to provide a satisfactory foundation.

204.06 PREPARATION OF FOUNDATION. The foundation pits shall be excavated so that the footings are the full lengths and widths shown on the Plans. The footings shall be constructed with full horizontal beds. Unless otherwise specified or authorized in writing, foundations shall be constructed in the dry. The site shall be dewatered to or below the footing elevation or lowest elevation of a structural component.

The excavation shall be carried to either ledge or a solid foundation, unless otherwise specified. If sloping ledge is encountered, the foundation shall be stepped as directed by the Engineer. All loose material shall be removed, and all seams in the rock shall be cleaned out and filled with concrete or as directed by the Engineer. No excavation shall be done below the elevations shown on the Plans unless authorized in writing by the Engineer. Any material excavated without authority shall be replaced with concrete or as directed by the Engineer at the Contractor's expense.

When the footing is to be constructed on an excavated surface other than rock, particular care shall be taken not to disturb the bottom of the excavation. No excavation shall be done below the elevations shown on the Plans, unless authorized in writing by the Engineer. Any material excavated without authority shall be replaced with approved backfill and thoroughly compacted in accordance with Subsection 204.08(a) at the Contractor's expense.

When poor foundation material is encountered at the designed foundation level, it shall be removed as Structure Excavation or Trench Excavation and replaced with Granular Backfill for Structures or other suitable material as shown on the Plans or as directed by the Engineer, and thoroughly compacted in accordance with Subsection 204.08(a).

204.07 BEDDING FOR STRUCTURES. Excavation and preparation of the bed for a structure shall conform to the specification for the specific structure being installed.

204.08 BACKFILL.

(a) General. All spaces excavated and not occupied by structures or select backfill shall be backfilled with material from excavation, unless otherwise specified. The Contractor shall backfill up to the elevation of existing ground or 600 mm (2 feet) over the pipe, whichever is less, as shown on the Plans or as directed by the Engineer.

All backfill material shall be placed in 150 mm (6 inch) maximum (loose measure) horizontal layers, and each layer shall be thoroughly compacted by means of air or mechanical tampers. Backfill material placed within the limits of Trench Excavation or Structure Excavation shall have a maximum stone size less than 75 mm (3 inches).

Compaction by means of hand tamping will not be permitted.

Where backfill is to be placed on both sides of a structure, the layers on both sides shall be brought up simultaneously and at approximately the same level to avoid unbalanced pressure. Care shall be taken to prevent wedging action against the structure.

(b) Backfill of Trenches. The backfill shall be carried to the uppermost level of the trench or subgrade. No stones or blasted ledge exceeding 75 mm (3 inches) in diameter shall come in contact with pipes during backfill operations.

(c) Backfill of Structures. No backfill material shall be placed against a newly completed structure until the concrete has cured for seven days or until it has obtained 85 percent of the designed compressive strength, and then only with the permission of the Engineer.

Evidence of satisfactory compaction of the backfill adjacent to structures will consist of the attainment of the density required for the adjacent embankment material by testing at least every third layer in accordance with Subsection 203.11(d).

204.09 METHOD OF MEASUREMENT.

(a) Trench Excavation. The quantity of Trench Excavation of Earth, Trench Excavation of Earth, Exploratory, or Trench Excavation of Rock to be measured for payment will be the actual number of cubic meters (cubic yards) excavated up to the maximum dimensions as follows:

(1) The horizontal dimensions for excavation for culverts and pipes (excluding underdrain and carrier pipe) shall be the distance between vertical planes 500 mm (18 inches) outside of the interior lines of the culvert or pipe.

(2) The horizontal dimensions for drop inlets, manholes, end sections, and other minor structures shall be 500 mm (18 inches) outside the exterior lines of the structure.

(3) The width dimensions for underdrain shall be shown on the Plans.

(4) The depth dimension for culverts, pipes, underdrain, drop inlets, manholes, and other minor structures shall be the vertical dimension from the original ground surface or bottom limits of other excavation to the bottom of authorized excavation.

(5) When culverts, pipes, underdrains, drop inlets, manholes, and other minor structures are in embankment areas, the natural ground line as cross-sectioned shall be the uppermost level of computation, unless otherwise specified. Vertical measurements will be used for the depth in making computations of Trench Excavation as follows:

a. 100 percent of the volume for the first 1.5 m (5 feet) of vertical depth.

b. 150 percent of the volume below the first 1.5 m (5 feet) of vertical depth.

(6) When Trench Excavation of Rock and Drilling and Blasting of Solid Rock Subgrade occur at the same location, the quantity of Trench Excavation of Rock will be measured for payment below the subgrade.

(7) The quantity of any material that the Engineer directs to be removed after the embankments have been placed will be included in the total amount for Trench Excavation.

(8) In measuring masonry or concrete as Trench Excavation of Rock, for all openings having cross-sectional areas of 0.5 m^2 (4 square feet) or less, the volume will be included as part of the rock. For all openings having cross-sectional areas greater than 0.5 m^2 (4 square feet), the volume will be deducted and not allowed as either Trench Excavation of Rock or Trench Excavation of Earth.

(9) The quantity of Trench Excavation of Earth, Exploratory to be measured for payment will be the number of cubic meters (cubic yards) of excavation, regardless of depth, for locating underground utility services and/or other structures where directed by the Engineer.

(b) Structure Excavation. The quantity of Structure Excavation to be measured for payment will be the number of cubic meters (cubic yards) measured and computed by average end area method whenever practical, as follows:

(1) Vertically. Between the original ground surface or the bottom limits of any other excavation item, whichever is the lower elevation, and the bottom of the structure excavation;

or

Between the original ground surface or the bottom limits of any other excavation item, whichever is the lower elevation, to 500 mm (18 inches) below the bottom neat lines of any part of a structural component falling outside any horizontal pay limits established for its footings.

Where Excavation (Common, Solid Rock, or Unclassified), Channel Excavation, and Structure Excavation occur at the same location, measurement for Channel Excavation will be made only below the lower limits of Excavation and measurement for Structure Excavation will be made only below the lower limits of Channel Excavation.

The removal of authorized material below the elevation of the bottom of the excavation as shown on the Plans will be measured in accordance with the following table:

Vertical Depth Below Bottom of Excavation Indicated on the Plans		Volume of Structure Excavation Multiplied by:
Meters	feet	
0 to 0.5	0 to 1	100%
Over 0.5 to 2.0	Over 1 to 5	150%
Over 2.0 to 3.0	Over 5 to 10	450%
Over 3.0 to 5.0	Over 10 to 15	750%
Over 5.0	Over 15	(paid as Extra Work)

Where a foundation or component of a structure is designed or directed to be placed on ledge, an average 150 mm (6 inches) maximum allowance for overbreakage will be allowed for measurement. Additional overbreakage shall be at the Contractor's expense.

(2) Horizontally. Between vertical planes 500 mm (18 inches) outside the neat lines of footings, beams, or other structural components, and parallel thereto except for the following:

The horizontal measurements of the Structure Excavation for reinforced concrete boxes shall be the overall width of the box, plus 500 mm (18 inches) on each side, and the length of the structure, plus 500 mm (18 inches) on each end.

The horizontal measurements for corrugated plate arches shall be the width of each abutment, plus 500 mm (18 inches) on each side, and the length of the arch, plus 500 mm (18 inches) on each end.

The horizontal measurements for pipes and pipe arches having a diameter or span over 1200 mm (48 inches) shall be between vertical planes 1 m (3 feet) outside the exteriors of each side, and the length of the pipes or pipe arches plus 500 mm (18 inches) on each end.

When footings are not used, the neat lines shall be the junction line between the new concrete and the old masonry or ledge.

(c) Granular Backfill for Structures. The quantity of Granular Backfill for Structures to be measured for payment will be the number of cubic meters (cubic yards) placed in the complete and accepted work within the confines of the limits shown on the Plans or as directed by the Engineer.

When Coarse Aggregate for Concrete or Crushed Gravel for Subbase, Fine Graded is substituted for Granular Backfill for Structures, it will be measured and paid for as Granular Backfill for Structures.

204.10 BASIS OF PAYMENT. The accepted quantities for Trench Excavation, Trench Excavation of Earth, Exploratory, Structure Excavation, and Granular Backfill for Structures will be paid for at the Contract unit price per cubic meter (cubic yard) for each of the Contract items specified in the Contract. Payment will be full compensation for performing the work specified, including placement and compaction of backfill, disposal or placement in embankments of all surplus material, and the cleaning up of the site following completion of construction operations, and for furnishing all labor, materials, tools, equipment, sheeting, bracing, and incidentals necessary to complete the work.

Unless otherwise specified, Structure Excavation will include all sheeting, bracing, dewatering, siltation control, preparing and submitting Construction Drawings where required, and incidentals necessary for properly constructing, in the dry, a foundation or structural component.

All material removed beneath a vertical depth of 5 m (15 feet) below the bottom of Structure Excavation limits shown on the Plans, or changes in sheeting, bracing, or dewatering necessitated by excavating below the 5 m (15 foot) limit, will be paid for as Extra Work.

No differentiation will be made in Structure Excavation between the excavation of wet or dry material, earth, gravel, boulders, rock, old masonry, or reinforced concrete.

When exploratory excavation is conducted exclusively for the purpose of locating existing underground utility services and/or other structures when directed by the Engineer, the costs of such excavation, regardless of depth, will be paid for at the Contract unit price bid per cubic meter (cubic yard) for Trench Excavation of Earth, Exploratory. Payment will be full compensation for all labor, materials, tools, equipment and incidentals necessary to complete the work, including locating and protecting existing underground utility services and/or other structures, and for restoring the work area to the satisfaction of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
204.20 Trench Excavation of Earth	Cubic Meter (Cubic Yard)
204.21 Trench Excavation of Rock	Cubic Meter (Cubic Yard)
204.22 Trench Excavation of Earth, Exploratory	Cubic Meter (Cubic Yard)
204.25 Structure Excavation	Cubic Meter (Cubic Yard)
204.30 Granular Backfill for Structures	Cubic Meter (Cubic Yard)

SECTION 205 - DRILLING AND BLASTING

205.01 DESCRIPTION. Except as otherwise specified, this work shall consist of the drilling and blasting of rock to remain in place.

205.02 DRILLING AND BLASTING OF SOLID ROCK. Holes shall be drilled to the approximate depth and at the approximate spacing shown on the Plans or as directed by the Engineer.

Following the drilling, explosives shall be placed in each hole and then detonated. The amount of explosive shall be sufficient to shatter and rearrange the rock for the full depth of the drill holes. Blasting shall be done progressively from the lower level to the top level. The removal of the blasted rock is not required under the work in this Section.

205.03 DRILLING AND BLASTING OF SOLID ROCK SUBGRADE. Subgrade areas shall be shattered to the dimensions shown on the Plans or directed by the Engineer.

The area of blasted rock subgrade shall extend sufficiently beyond the beginning and end of cut areas to ensure the shattering of all rock to a depth of 1.2 m (4 feet) below the bottom of subbase material elevation to eliminate water pockets.

After detonation, any rock protruding above the bottom of subbase shall be removed. When directed by the Engineer, the Contractor shall excavate a trench across the blasted rock to determine if the rock is broken and rearranged to a depth of 1.2 m (4 feet) below the bottom of subbase. Afterwards, the trench shall be backfilled with the rock removed.

205.04 METHOD OF MEASUREMENT. The quantity of Drilling and Blasting of Solid Rock to be measured for payment will be the number of meters (linear feet) of drill holes drilled and detonated in accordance with this Section.

The quantity of Drilling and Blasting of Solid Rock Subgrade to be measured for payment will be the number of square meters (square yards) of subgrade plan area drilled and detonated in accordance with this Section, measured at the bottom of subbase.

The number of cubic meters (cubic yards) of excavation required by the Engineer to inspect the depth of shattered and rearranged rock, computed at a maximum width of 750 mm (30 inches), will be measured for payment as Trench Excavation of Earth.

Any area designated as Trench Excavation of Rock will not be included in the measurement and payment for Drilling and Blasting of Solid Rock Subgrade.

205.05 BASIS OF PAYMENT. The accepted quantities as measured will be paid for at the Contract unit price per meter (linear foot) or square meter (square yard), as applicable, for the specified Contract items. Payment will be full compensation for performing the work specified including any necessary stripping of rock below the bottom of subbase and refilling with approved material to the bottom of subbase, the removal of blasted subgrade rock that may swell above subgrade, and its disposition on the project as shown in the Plans or as directed by the Engineer.

Excavation and backfill required to inspect the depth of broken rock below subgrade will be paid for at the Contract unit price per cubic meter (cubic yard) for Trench Excavation of Earth.

Payment will be made under:

Pay Item	Pay Unit
205.10 Drilling and Blasting of Solid Rock	Meter (Linear Foot)
205.20 Drilling and Blasting of Solid Rock Subgrade	Square Meter (Square Yard)

SECTION 208 – COFFERDAMS

208.01 DESCRIPTION. This work shall consist of the construction, material excavation within, dewatering, maintenance and removal of cofferdams in accordance with the Contract Documents.

The work will be classified as follows:

(a) Cofferdam. This item shall consist of providing a method for the purpose of constructing, in the dry, a specific foundation or other component of a structure in accordance with Contract requirements. This may involve the design, construction, maintenance, and removal of a watertight structure or may involve alternate methods of de-watering and stabilizing the specific site. Construction of foundation seals per Contract or as required per Contractor plans and schedule of operations is also within the scope of work for the Cofferdam item. The Contractor shall obtain any and all necessary permits or clearances for alternate methods.

A cofferdam may have only two or three sides depending upon the particular location and the Contractor's design.

Cofferdam Excavation, Earth. This item shall consist of all material excavated within the pay limits as set forth in these specifications or indicated on the Plans except solid rock, mortared stone masonry, concrete, and boulders measuring 0.5 cubic meters (cubic yards) or more.

Cofferdam Excavation, Rock. This item shall consist of all solid rock material excavated within the pay limits as set forth in these specifications or indicated on the Plans, including all solid rock, mortared stone masonry, concrete, and boulders measuring 0.5 cubic meters (cubic yards) or more.

208.02 MATERIALS. Concrete used in a cofferdam foundation seal or for replacing overbreakage shall have a minimum 28 day compressive strength of 20 MPa (3000 psi) and shall conform to the requirements of Section 501 or Section 541.

208.03 GENERAL CONSTRUCTION REQUIREMENTS. The locations and elevations for excavation shall be as indicated on the Plans. The Engineer may order removal of poor foundation material below the normal designated elevation and replacement with an approved material.

All suitable excess excavated material shall be used in the formation of embankments as indicated on the Plans, or as directed by the Engineer. The material shall be hauled and disposed of with no additional compensation to the Contractor.

208.04 PRESERVATION OF CHANNEL. Unless otherwise indicated on the Plans or ordered by the Engineer, the Contractor, in performing the excavation, shall confine excavating operations to the site of the proposed structure and to the limits of the cofferdam. The natural stream bed shall not be disturbed without permission of the Engineer.

208.05 FOOTING MODIFICATIONS. When it is necessary to modify a footing from the detail shown on the Plans in order to provide a satisfactory foundation, the Engineer shall issue a written order for such changes in elevations or dimensions.

208.06 PREPARATION OF FOUNDATION. The foundation pits shall be excavated so that the footings will be the full lengths and widths indicated on the Plans. The footings shall be constructed with full horizontal beds. Unless otherwise specified or authorized by written order, foundations shall be constructed in the dry. In the dry means foundations and other structural components being constructed are not in or under water. The site shall be dewatered to, or below, the bottom of footing elevation or lowest elevation of a structural component.

The excavation shall continue to either ledge or a solid foundation, unless otherwise specified. If sloping ledge is encountered, the foundation shall be stepped as directed by the Engineer. All loose material shall be removed and all seams in the rock shall be cleaned out and filled with concrete or as directed by the Engineer. No excavation shall be done below the elevations indicated on the Plans unless directed by the Engineer in writing. Any material so excavated without authority shall be replaced with concrete or as directed by the Engineer at the Contractor's expense.

When the footing is to be constructed on an excavated surface other than rock, particular care shall be taken not to disturb the bottom of the excavation. No excavation shall be performed below the elevations indicated on the Plans unless directed by the Engineer in writing. Any material excavated without authority shall be replaced with approved backfill, which shall be thoroughly compacted in accordance with Section 204, at the Contractor's expense.

When poor foundation material is encountered at the foundation design elevation, it shall be removed as Cofferdam Excavation, Earth or Cofferdam Excavation, Rock and replaced with Granular Backfill for Structures or other suitable material, as indicated on the Plans or as directed by the Engineer, and thoroughly compacted in accordance with Section 204.

208.07 COFFERDAMS. The Contractor shall prepare detailed plans and a schedule of operations for each cofferdam specified in the Contract. Construction Drawings shall be submitted in accordance with Section 105.

The Professional Engineer is responsible for ensuring that the proposed cofferdam meets the following criteria:

(a) the design is structurally stable for all conditions to be encountered (e.g., soils, water, forces, and loadings);

(b) the design and details conform with the Contract and the applicable AASHTO requirements in the *Standard Specifications for Highway Bridges*;

(c) the design and details are in conformance with applicable safety codes;

(d) the size and shape are adequate to construct the foundation and structural components specified;

(e) the cofferdam is adequately watertight for proper performance of the work; and

(f) any foundation seal is adequate to achieve its design function.

One copy of the plans and schedule of operations shall be submitted to the Resident Engineer for Agency use.

The submittal shall include plan, elevation and section details indicating the following:

(a) the waterway;

(b) information regarding the cofferdam and any foundation seal - indicate if a seal is required to ensure the structural integrity of the cofferdam during dewatering and foundation construction and inspection;

(c) substructure location;

(d) dimensions of any temporary restrictions that are to be placed in the waterway, e.g. barges, lines, earth dams, causeways, temporary diversion channels and access bridging;

(e) the location, dimensions, clearances, and other relevant information for any temporary scaffolding or netting;

(f) dewatered heads, taking into consideration fluctuations of water levels;

(g) details for screening, pumping and filtering discharge;

(h) a statement as to whether or not any equipment will be removed at night; and

(i) a schedule or sequence of operations - include placement of the foundation seal, time from placement to dewatering, and foundation construction and inspection.

The Contractor will be responsible for performing the work in accordance with the submitted details and schedule of operations. All welding shall be performed in accordance with Subsection 506.10.

Cofferdam construction shall conform to AASHTO Standard Specifications for Highway and Bridge Construction, Division II, Section 1.4.

Cofferdams shall be constructed so as to protect freshly placed concrete against damage from sudden rising of the water level and to prevent damage to the foundation or other structural component by erosion. The cofferdam shall be constructed so that no timber, bracing, or forms will extend into the foundation or other structural component.

In the event the Contractor elects to place fill material in the stream to facilitate access to, or be part of, a cofferdam operation, it shall be clean stone fill.

208.08 PUMPING. Pumping from or dewatering of the interior of any cofferdam enclosure shall be performed so that disturbance of the subsoil or freshly placed concrete will not occur. Dewatering of a sealed cofferdam will be in conformance with the Contractor's sequence or schedule of operations. Pumping during the construction of a foundation or other structural component shall be from a suitable sump separated from the concrete work.

The discharge from any pumping operation, filtration system, or settling basin shall conform to the requirements of Section 105 and the Contract.

208.09 INSPECTION OF FOUNDATION PIT. Immediately following the completion of each foundation pit, the Contractor shall notify the Engineer, who shall approve the depth of the pit and the nature of the foundation before the placement of the concrete.

208.10 BEDDING FOR STRUCTURES. Excavation and preparation of the bed for a structure shall conform to the specifications for the specific structure being installed.

208.11 METHOD OF MEASUREMENT.

(a) Cofferdam. The quantity to be measured for payment will be on a lump sum basis for each cofferdam specified on the Plans or in the Contract.

(b) Cofferdam Excavation, Earth. The quantity to be measured for payment will be the number of cubic meters (cubic yards) of earth excavated from within the pay limits of the cofferdam as set forth in these specifications or as shown on the Plans.

The removal of earth excavation authorized by the Engineer below the elevation of the bottom of the excavation, as indicated on the Plans, will be factored in accordance with the appropriate table:

METRIC

Vertical Depth Below Bottom of Excavation indicated on the Plans	Volume of Excavation Multiplied by:
0 to 300 mm	100 percent
Over 300 to 1500 mm	150 percent
Over 1500 to 3000 mm	450 percent
Over 3000 to 4500 mm	750 percent
Over 4500 mm	(Paid by Supplemental Agreement)

ENGLISH

Vertical Depth Below Bottom of Excavation indicated on the Plans	Volume of Excavation Multiplied by:
0 to 1 foot	100 percent
Over 1 to 5 feet	150 percent
Over 5 to 10 feet	450 percent
Over 10 to 15 feet	750 percent
Over 15 feet	(Paid by Supplemental Agreement)

(c) Cofferdam Excavation, Rock. The quantity to be measured for payment will be the number of cubic meters (cubic yards) of rock excavated from within the pay limits of the cofferdam as set forth in these specifications or as shown on the Plans.

The removal of rock excavation authorized by the Engineer below the elevation of the bottom of the excavation, as indicated on the Plans, will be factored in accordance with the table shown above.

Where a foundation or component of a structure is designed or directed to be placed on ledge, a maximum of 150 mm (6 inches) average allowance for overbreakage will be allowed. Additional overbreakage will be at the Contractor's expense.

(d) Bottom of Excavation. The bottom of excavation shall be as indicated on the Plans.

When a foundation seal is specified in the Contract, the bottom of excavation shall be considered to be the bottom of the excavation required for the foundation seal. For a seal proposed by the Contractor, no excavation shall be measured for payment below the bottom of excavation as indicated on the Plans.

208.12 BASIS OF PAYMENT. The accepted quantity of Cofferdam will be paid for at the Contract lump sum price, which price shall be full compensation for the preparation of detailed plans and schedule of operations, performing the work specified, and the furnishing of all labor, tools, equipment, materials, and incidentals necessary to complete the work, including the cost of altering the cofferdam, foundation seals, sheeting, bracing, dewatering, installation and maintenance of siltation and sedimentation control measures for treating cofferdam discharge, incidentals necessary for properly constructing the foundation or structural component, maintaining the cofferdam in a dewatered condition, and removing the cofferdam when no longer required.

The accepted quantities of Cofferdam Excavation, Earth and Cofferdam Excavation, Rock will be paid for at the Contract unit price per cubic meter (cubic yard) for each of the pay items in the Contract, which price shall be full compensation for performing the work specified and the furnishing of all labor, materials, tools, equipment, disposal of surplus material, and any other incidentals necessary to complete the work.

Payment for Cofferdam will be made as follows:

A payment of 75% of the lump sum bid price will be made when excavation within the limits of the structural unit is completed, and the cofferdam has been successfully dewatered.

The remaining 25% of the lump sum price will be paid:

(a) When the cofferdam is completely removed; or

(b) If the Contract Documents require the cofferdam to be left in place, when the associated foundation or other component of a structure is completed.

If the Engineer (by written order) requires that the cofferdam be left in place and this requirement is not specified in the Contract Documents, a Supplemental Agreement will be processed in accordance with Section 109.

Payment will be made under:

Pay Item	Pay Unit
208.30 Cofferdam Excavation, Earth	Cubic Meter (Cubic Yard)
208.35 Cofferdam Excavation, Rock	Cubic Meter (Cubic Yard)
208.40 Cofferdam	Lump Sum

SECTION 210 - COLD PLANING

210.01 DESCRIPTION. This work shall consist of the removal and the satisfactory disposal and clean up of road, airport, or bridge pavements by cold planing.

210.02 EQUIPMENT AND OPERATION. The equipment shall consist of a power operated planing machine or grinder capable of accurately establishing profile grades by referencing from both the existing pavement and from an independent grade control. The equipment shall have a positive means for controlling cross slope elevations. The planer shall have sufficient mass (weight) to perform all types of planing without lifting. Sufficient and positive down pressure is to be provided on the drum assembly at all times when planing. The cutting head shall be maintained so that the depth of cut is within a tolerance of 3 mm (1/8 inch) throughout the width of the head. The equipment shall also have an effective means of preventing dust from escaping into the air.

210.03 GENERAL CONSTRUCTION REQUIREMENTS. The bituminous surface shall be removed to the depth, width, grade, and typical cross-section as shown on the Plans or as directed by the Engineer. No variation from the typical cross-section of more than 3 mm (1/8 inch) will be allowed. Any bituminous surfaces adjacent to objects such as scuppers, expansion joints, drop inlets, and curbs that are inaccessible to the cold planer shall be removed by means of other approved equipment.

Unless otherwise specified, the planed material shall become the property of the Contractor and shall be removed from the project and disposed of properly. All dust and other remaining material shall be immediately removed with a power vacuum sweeper to the satisfaction of the Engineer. The resulting surface on bridges shall be left in a condition to receive tar emulsion or, if shown on the Plans, a membrane, or as directed by the Engineer. The Contractor shall exercise reasonable care to ensure no damage occurs to the portland cement concrete deck when removing pavement from bridges.

When traffic shall be maintained for any period of time on a cold planed area, the following conditions apply:

(a) All planed and sawed cross roadway butt joints of 19 mm (3/4 inch) depth or greater shall have a temporary wedge of bituminous concrete pavement installed as directed by the Engineer.

(b) The Contractor shall repave any cold planed areas within 14 calendar days of planing or when directed by the Engineer, provided that any cold planed area that is not repaved the same day as it is cold planed has proper and adequate tapers installed before the end of the working day in which the cold planing is performed. Should the area remain unpaved for a period of more than 14 calendar days without the approval of the Engineer, no payment whatsoever will be made for the cold planing. If the Contractor lays down temporary pavement to avoid the above non-payment for cold planing, temporary pavement and subsequent cold planing shall be at the Contractor's expense. Traffic cones will be placed along the longitudinal drop-off as directed by the Engineer.

(c) The temporary pavement wedge and taper shall be totally removed prior to placing the permanent final pavement at cold planed locations. All costs involved with installing and removing a temporary pavement wedge and/or taper will not be paid for directly, but will be considered incidental to the Contract item Cold Planing, Bituminous Pavement.

(d) Cold planed areas susceptible to ponding of water shall be drained by cutting slots through the adjoining non-milled area. The slots shall then be filled with materials satisfactory to the Engineer. All costs of cutting and filling the slots will not be paid for directly but will be considered incidental to the Contract item Cold Planing, Bituminous Pavement.

210.04 METHOD OF MEASUREMENT. The quantity of Cold Planing, Bituminous Pavement to be measured for payment will be the number of square meters (square yards) of surface from which bituminous pavement has been removed to the depth shown on the Plans.

210.05 BASIS OF PAYMENT. The accepted quantity of Cold Planing, Bituminous Pavement will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing all labor, tools, and equipment, including the vacuum sweeper, necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
210.10 Cold Planing, Bituminous Pavement	Square Meter (Square Yard)

SECTION 213 - MILLED RUMBLE STRIPS

213.01 DESCRIPTION. This work shall consist of texturing bituminous concrete pavement to construct rumble strips, disposing of waste millings, and cleaning up the pavement to the satisfaction of the Engineer.

213.02 EQUIPMENT. The equipment for milling rumble strips shall consist of a power operated machine with a rotary type cutting head of a size that will provide milled depressions as shown on the Plans. The cutting head(s) shall have cutting tips arranged to provide a smooth cut.

The cutting head(s) shall be on a suspension independent from that of the power unit to allow the tool to self align with the slope, and/or any irregularities, of the surface being milled. The cutting tool shall be equipped with guides to provide consistent alignment of each cut in relation to the roadway and to provide uniformity and consistency throughout the project. Equipment that tears, distorts, or otherwise damages the pavement adjacent to the milled depressions will not be allowed.

213.03 GENERAL CONSTRUCTION REQUIREMENTS. Rumble strips shall be milled to the finished dimensions, locations, and tolerances shown on the Plans in accordance with these specifications or as directed by the Engineer.

Unless otherwise specified, the milled material shall become the property of the Contractor. This material shall be removed from the project and properly disposed of by the Contractor. All dust and other remaining material shall be immediately removed with a power vacuum sweeper to the satisfaction of the Engineer.

213.04 METHOD OF MEASUREMENT. The quantity of Milled Rumble Strips to be measured for payment will be the longitudinal length in meters (linear feet) of treated surface measured on the pavement marking line adjacent to or within the installed rumble strip. The measurement will reflect the limits of rumble strip slots placed per Plan spacing and will include the non-milled lengths between adjacent slots.

213.05 BASIS OF PAYMENT. The accepted quantity of Milled Rumble Strips will be paid for at the Contract unit price per meter (linear foot). Payment shall be full compensation for furnishing all labor, tools, and equipment, including the vacuum sweeper, necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
213.10 Milled Rumble Strips	Meter (Linear Foot)

DIVISION 300

SUBBASE AND BASE COURSES

SECTION 301 – SUBBASE

301.01 DESCRIPTION. This work shall consist of furnishing and placing one or more courses of approved gravel, crushed gravel, dense graded crushed stone, or other proportioned material on a prepared surface or at other locations.

301.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Coarse Aggregate for Concrete.....704.02
Gravel for Subbase.....704.04
Crushed Gravel for Subbase.....704.05
Dense Graded Crushed Stone for Subbase.....704.06

Certifications required shall be submitted in conformance with Subsection 700.02.

At the option of the Contractor, unless otherwise specified in the Contract, processed glass aggregate (PGA) or recycled concrete aggregate (RCA) may be used to partially replace natural aggregate in materials specified to meet the requirements of Subsections 704.04, 704.05, and 704.06. In no case shall PGA and RCA be blended under this Section.

PGA shall be a crushed and screened material with 95 percent passing a 25.0 mm (1 inch) sieve, and not more than 3 percent of the material passing the 4.75 mm (No. 4) sieve shall pass a 75 μm (No. 200) sieve.

Materials used to produce PGA shall consist of recycled glass food or beverage containers. Small amounts (less than 5 percent total) of china dishes, ceramics, plate (window or mirror) glass, or other glass products will be allowed in PGA. The PGA material shall not contain more than a trace of screw tops, plastic cap rings, or other contaminants. Amounts of contaminants greater than 1 percent by mass (weight) shall be grounds for rejection of the entire PGA batch. Glass containers containing, or having contained, toxic or hazardous materials will not be allowed and, when present, shall be grounds for rejecting the entire stockpile of PGA or PGA subbase blends.

Materials used to produce RCA shall consist of recycled concrete that has been crushed to aggregate dimensions of 6 inches or less. Small amounts of brick, block or mortar may be present in the RCA at a level not to exceed a total of five percent by weight. The RCA material shall not contain more than trace amounts of wire, steel or plastic that were associated with the original placement of the concrete or bituminous material or unreacted cementitious materials. No additional wire, steel or plastic may be added to the RCA. No discernable amounts of oils, fats, soaps, surfactants or organic contaminants shall be present in the RCA. Hazardous materials or concrete structures used to contain hazardous materials will not be allowed and when present shall be grounds for rejection of the entire stockpile of RCA or RCA subbase blends.

PGA and RCA materials shall be subjected to process control testing. PGA subbase blends shall not contain more than 10 percent by mass (weight) of PGA. RCA subbase blends shall not contain more than twenty-five percent RCA. The final blend shall conform to the specified gradation for the subbase material. The blending process shall be complete to ensure that as thorough a distribution and as uniform a mixture as practicable has been obtained. Process control tests shall be performed at a minimum frequency of one test per 2000 m^3 (2500 yd^3) of material produced by a stable process. A copy of each test result shall be given to the Engineer.

Prior to the use of any PGA subbase blend, the Contractor shall submit in writing, for preliminary approval of the Engineer, information identifying the sources and locations from which PGA material to be used on the project will be obtained. The Contractor shall also submit certified test results verifying that the PGA material will be in compliance with the Contract requirements. Once the sources of PGA are approved, quality assurance samples may be taken by the Engineer.

PGA subbase blends must be approved for use on the project by the Engineer in writing prior to being placed on a project. In-place blending of PGA with other materials will not be permitted.

The supplier of PGA shall provide a Type A Certification that the crushed glass material to be used does not contain toxic or hazardous substances. The supplier of RCA shall provide a Type A certification that the concrete to be used does not contain toxic or hazardous substances.

The supplier of the blended subbase material shall provide a Type C Certification that the blended aggregate meets all specified gradation and cleanliness requirements.

When specified for use on the project or as directed by the Engineer, Subbase, RAP shall include cold planed grindings which have been screened or crushed by the Contractor in order that 100% passes the 37.5 mm (1 ½ inch) sieve prior to blending.

The grindings shall be blended in equal proportions (50% by mass (weight)) with material meeting the requirements of Subbase of Crushed Gravel, Fine Graded as specified in Table 704.05A.

301.03 GENERAL CONSTRUCTION REQUIREMENTS. The subbase material shall be placed on a prepared surface with an approved spreader box or by use of other approved mechanical spreading equipment. Dumping directly on the subgrade will not be permitted. A bulldozer may be used instead of a spreader box, provided that the subbase material is first placed on the previously laid subbase and then completely removed from the area where it was first deposited.

Should segregation of the subbase occur, the Contractor shall remove and replace the material or rework it until uniform grading is obtained.

If material below subgrade becomes intermixed with the subbase, resulting in an unacceptable product, the mixture shall be removed and replaced with new subbase material.

The maximum compacted layer thickness for all subbase materials is 300 mm (12 inches). Where the finished depth of the subbase is to be greater than 300 mm (12 inches), it shall be placed and compacted in two or more layers of approximately equal thickness. In the placement of layers, all joints shall be staggered at least 300 mm (12 inches).

After each layer of subbase material is placed, it shall be graded to obtain a smooth, even surface as specified in Subsection 301.05. Following grading operations, the subbase shall be thoroughly compacted as specified in Subsection 301.06. If required, water shall be uniformly applied over the subbase materials during compaction in the amount necessary for proper consolidation. Materials containing PGA or RCA shall be compacted in the same manner as materials that do not contain recycled materials. Care will be taken to prevent excessive moisture contents in subbase materials prior to compaction. If needed, the Contractor may use material meeting the requirements of Subsection 704.02, Table 704.02B as filler to achieve the design grade when the variation of the surface is less than 25 mm (1 inch).

When it is necessary to maintain traffic over the subbase, 50 percent of the width of the roadway shall be constructed at a time. The portion under construction shall have the subbase material placed, graded, and compacted before opening to traffic. Subsequent traffic damage to the material shall be entirely the Contractor's responsibility. If the subbase loses its shape, the Contractor shall loosen, regrade, and compact as necessary.

When it is necessary to maintain traffic over the subbase, or where construction hauling occurs over the subbase, the upper 50 mm (2 inches) of subbase shall be scarified (to restore permeability in the subbase surface), compacted, and regraded as required, or replaced just prior to the placement of any pavement.

If roadway shoulders are to remain unpaved, subbase or other designated material to be placed in the shoulder area after final roadway paving shall be placed in accordance with Subsection 402.03.

301.04 SPECIFIC CONSTRUCTION REQUIREMENTS.

(a) Subbase of Gravel. Only uniformly graded gravel from the pit shall be used. The Contractor shall manipulate the material in the pit to eliminate non-uniformly graded pockets of material.

(b) Subbase of Crushed Gravel. When stockpiling, care shall be taken to prevent segregation in the pile.

(c) Subbase of Dense Graded Crushed Stone. When stockpiling, care shall be taken to prevent segregation in the pile.

301.05 SURFACE TOLERANCE. The surface of the compacted subbase will be tested by the Engineer at selected locations. The variation of the surface shall at no point exceed 25 mm (1 inch). This variation shall not be maintained for a distance longer than 15 m (50 feet). The required crown and superelevation shall be maintained. All humps or depressions exceeding the specified tolerances shall be corrected by reshaping or removing defective work and replacing it with new material as directed by the Engineer. Any new material used to replace removed material shall meet the applicable gradation specification listed in Subsection 301.02.

301.06 COMPACTION. Compaction of each layer shall continue until a density of not less than 95% of the maximum dry density has been achieved.

When 1000 m^3 (1250 yd^3) or more of subbase material is to be placed as part of the Contract, the maximum dry density shall be determined by the Contractor in accordance with AASHTO T 180, Method D, as modified by the Agency's Materials and Research Section. Laboratory moisture-density tests shall be performed to ensure a standard error of the mean maximum dry density of less than 20 kg/m^3 (one pcf). Typically, this will necessitate at least five, but no more than ten, replications of the test. The Contractor shall provide the Engineer with all test results and calculations for determining the maximum dry density, at least 10 days prior to subbase placement. The maximum dry density shall be determined after any change in source, regardless of quantity, and confirmed by repetition of the selected test method at a frequency of 10,000 m^3 (12,500 yd^3) when the prescribed standard error can be attained by five or less replicate tests. If more than five replicate tests are required to meet the prescribed standard error, the maximum dry density shall be confirmed at a frequency of every 5000 m^3 (6250 yd^3). The Engineer may reduce this frequency with the approval of the Materials and Research Engineer after the initial two maximum dry density determinations.

When less than 1000 m^3 (1250 yd^3) of subbase material is to be placed as part of the Contract, the maximum dry density will be determined by the Agency in accordance with AASHTO T 180, Method D, as modified by the Agency's Materials and Research Section.

Field density testing will be performed by the Agency in accordance with AASHTO T310 at locations determined by the Engineer. Compaction operations shall proceed such that the target field density as determined in accordance with this Subsection is achieved.

301.07 METHOD OF MEASUREMENT. The quantity of subbase to be measured for payment will be the number of cubic meters (cubic yards) of the type specified for use in the complete and accepted work, as determined by the plan dimensions of the compacted material, including any filler material used to achieve the design grade.

The quantity of Subbase of Crushed Gravel, Fine Graded, Truck Measurement to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by vehicle loads using three-dimensional measurement. All loads designated shall be leveled at the point of delivery when directed by the Engineer. A load ticket shall be furnished to the Engineer with each load delivered to the job site.

When specified to be paid by mass (weight), the quantity of Subbase of Crushed Gravel, Fine Graded to be measured for payment will be the number of metric tons (tons) of material in place in the complete and accepted work, as determined from the load tickets.

The quantity of Subbase, RAP to be measured for payment will be the number of metric tons (tons) of material in place in the complete and accepted work, as determined from the load tickets.

When subbase material is required for extra depth at bridge approaches, the quantity to be measured for payment will be the number of cubic meters (cubic yards) measured in place for this purpose between the lines shown on the Plans.

Materials containing PGA or RCA will be measured in the same manner as subbase materials that do not contain PGA or RCA.

301.08 BASIS OF PAYMENT. The accepted quantity of subbase will be paid for at the Contract unit price per cubic meter (cubic yard) or metric ton (ton) for the type specified. Payment will be full compensation for furnishing, blending, transporting, testing, placing, grading, and compacting the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Truck measurement, when not specified in the Contract, may be used when ordered by the Engineer. Truck measurement will be converted to in-place volume measurement by dividing by a factor of 1.15.

No additional payment will be made for filler material used as a replacement for the specified subbase material.

No payment will be made for the following:

(a) Material forced into or mixed with the subgrade material.

(b) Material placed to a depth greater than shown on the Plans.

(c) Water used to obtain required compaction.

(d) Removal and replacement of subbase material.

(e) Scarifying, recompacting, or regrading of subgrade or subbase layers, when required.

Payment will be made under:

Pay Item	Pay Unit
301.15 Subbase of Gravel	Cubic Meter (Cubic Yard)
301.25 Subbase of Crushed Gravel, Coarse Graded	Cubic Meter (Cubic Yard)
301.26 Subbase of Crushed Gravel, Fine Graded	Cubic Meter (Cubic Yard)
301.28 Subbase of Crushed Gravel, Fine Graded	Metric Ton (Ton)
301.35 Subbase of Dense Graded Crushed Stone	Cubic Meter (Cubic Yard)
301.40 Subbase, RAP	Metric Ton (Ton)

SECTION 303 - ASPHALT TREATED PERMEABLE BASE

303.01 DESCRIPTION. This work shall consist of furnishing and placing one or more courses of crushed gravel or crushed stone, plant mixed with bituminous material, on a prepared surface.

303.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Bituminous Material..... 702.01
Asphalt Binder..... 702.02
Emulsified Asphalt..... 702.04
Aggregate for Asphalt Treated Permeable Base..... 704.03

The grade of asphalt binder shall be as shown on the Plans, unless otherwise specified in the Contract.

The materials shall be combined and graded to meet the following composition limits by mass (weight):

Square Openings Sieve Size	Percent Passing by Mass (Weight)	Production Tolerance (Percent)
37.5 mm (1 1/2 inch)	95 to 100	--
25.0 mm (1 inch)	80 to 95	±5
12.5 mm (1/2 inch)	30 to 60	±6
4.75 mm (No. 4)	6 to 20	±7
2.36 mm (No. 8)	3 to 14	--
75 µm (No. 200)	0 to 3	--
Asphalt Content, %	1.5 to 3.0	±0.4
Mixing Temp. Range	95°-135°C (200°-275°F)	--

No work shall be started until the Contractor has submitted the mix design to the Engineer and received the Engineer's approval. The mix design shall indicate the percentage of each ingredient to be used in the mixture. No change in the approved mix design shall be made without the written approval of the Engineer.

303.03 WEATHER LIMITATIONS. Asphalt Treated Permeable Base shall not be placed between November 1 and May 1. When it is in the public interest, the Engineer may extend the dates of the paving season. The material shall not be placed when the ambient air temperature at the paving site in the shade and away from artificial heat is 5 °C (40 °F) or lower. No material shall be placed on any frozen subbase regardless of the temperature.

303.04 BITUMINOUS MIXING PLANT AND TESTING. All plants used by the Contractor for the production of Asphalt Treated Permeable Base shall conform to all the requirements of Subsection 406.05. The use of surge bins or a drum-mix plant will not be allowed.

303.05 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be heated to the temperature specified in Subsection 702.06 in a manner that will avoid local overheating. A continuous supply of bituminous material shall be furnished to the mixer at a uniform temperature.

303.06 PREPARATION OF AGGREGATES. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damaging the aggregate and depositing soot and unburned fuel on the aggregate.

303.07 MIXING. The dried aggregate sizes shall be proportioned to meet the composition limit and thoroughly mixed prior to adding the bituminous material.

The dried aggregates shall be combined with the bituminous material in such a manner as to produce a mixture that when discharged from the mixing unit is at the temperature specified in the mix design.

The Engineer will approve the quantity of bituminous material for each batch. The bituminous material shall be measured or gauged and introduced into the mixer in the quantity approved by the Engineer for the particular material being used and at the temperature as specified.

After the required quantities of aggregate and bituminous material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured. In any event, for a batch plant, the mixing time will be regulated by the Engineer, and a suitable locking means shall be provided for this regulation.

All plants shall have a positive means of eliminating oversized and foreign materials from being incorporated into the mixer.

303.08 HAULING EQUIPMENT. Trucks used for hauling bituminous mixture shall have tight, clean, smooth metal bodies. The Contractor shall apply a thin coat of a non-petroleum based or soap solution to prevent the mixture from adhering to the truck bodies.

Each truck body shall have a cover of canvas or other suitable material of such size sufficient to protect the mixture from the weather. When necessary to ensure delivery of material at the specified temperature, truck bodies shall be insulated, and covers shall be securely fastened.

303.09 PLACING EQUIPMENT. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly, capable of being heated if necessary, and capable of spreading and finishing the mixture without segregation for the widths and thicknesses specified. The screed shall be adjustable to provide the desired cross-sectional shape. The finished surface shall be of uniform texture and evenness and shall not show any indication of tearing, shoving, or pulling of the mixture. The machine shall, at all times, be in good mechanical condition and shall be operated by competent personnel.
Pavers shall be equipped with the necessary attachments, designed to operate electronically, for controlling the grade of the finished surface.

The adjustments and attachments of the paver will be checked and approved by the Engineer before placement of Asphalt Treated Permeable Base.

303.10 ROLLERS. Rollers shall be of the steel-wheel type and shall be in good mechanical condition, operated by competent personnel, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The mass (weight) of each roller shall be sufficient to compact the mixture to the required density without excessive crushing of the aggregate. Rollers shall be equipped with water tanks and sprinkling bars for wetting the rolls.

303.11 SPREADING AND FINISHING. Immediately before placing the Asphalt Treated Permeable Base, the existing prepared surface shall be cleaned of all loose or deleterious material.

Contact surfaces of cold joints, curbing, gutters, and manholes shall be coated with a thin, uniform coat of Type RS-1 emulsified asphalt immediately prior to placement of the Asphalt Treated Permeable Base against them.

The Contractor shall protect all exposed surfaces that are not to be treated from damage during all phases of the paving operation.

The bituminous mixture shall be spread and finished with the specified equipment. The mixture shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, has the required thickness and conforms to the grade and cross-section contour specified. Bituminous concrete pavers shall be used to distribute the mixture over the entire width or over such partial width as may be practical.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture shall be spread and leveled by hand tools.

Bituminous mixture shall not be produced so late in the day as to prohibit the completion of spreading and compaction of the mixture during daylight hours, unless night paving has been approved for the project.

Trucking over material already placed will not be permitted until the material has been thoroughly compacted and has been permitted to cool to 60 °C (140 °F). When the bituminous concrete pavement consists of more than one layer, each layer shall be compacted as specified and allowed to cool to ambient air temperature before the next layer is applied.

303.12 COMPACTION. The surface shall be rolled when the mixture has reached a temperature in the range of 60°C-95°C (140°F-200°F), is in the proper condition, and when the rolling does not cause undue displacement, cracking, or shoving.

The Mix shall be compacted by two static passes of a nominal nine metric ton (10 ton) steel wheel roller, unless otherwise directed by the Engineer.

To prevent adhesion of the mixture to the rolls, they shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons, or with mechanical tampers.
Other combinations of rollers and/or methods of compacting may be used if approved in writing by the Engineer.

Unless otherwise specified, the longitudinal joint shall be rolled first. Next, the Contractor shall begin rolling at the low side of the pavement and shall proceed toward the center or high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller should be kept in as continuous operation as practical. Rolling shall continue until all roller marks and ridges have been eliminated. Rollers will not be permitted to park on any freshly laid mixture and shall set back a sufficient distance behind the paver so that a parked roller will not leave any roller depressions.

Care shall be exercised to prevent contamination of, or damage to, the asphalt treated permeable base course. If, in the opinion of the Engineer, areas of the compacted mixture that become loose and broken, mixed with dirt, or in any way defective, damaged, or contaminated, shall be removed and replaced by the Contractor at no expense to the Agency. Any area showing an excess or deficiency of bitumen shall be removed and replaced.

303.13 JOINTS. Joints between old and new pavements or between successive day's work shall be made to ensure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a joint constructed.

Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 150 mm (6 inches) from any joint in the lower courses of base. Transverse joints shall not be constructed closer than 300 mm (12 inches) to the transverse joint constructed in lower courses.

303.14 SURFACE TOLERANCE. The Asphalt Treated Permeable Base shall be finished to within a grade tolerance of 15 mm (1/2 inch) provided that this tolerance is not maintained for a distance longer than 15 m (50 feet) and that the required crown or superelevation is maintained.

The surface will be tested by the Engineer using a straightedge at least 5 m (16 feet) in length at selected locations parallel with the centerline. Any variations exceeding 4.5 mm (3/16 inch) between any two contact points shall be satisfactorily eliminated. A straightedge of at least 3 m (10 feet) in length may be used on a vertical curve. The straightedges shall be provided by the Contractor.

If directed by the Engineer, depressions shall be corrected by using a mix conforming to the requirements of bituminous concrete pavement. Payment for this material will be at the Contract unit price for the Contract item Asphalt Treated Permeable Base.

303.15 TRAFFIC CONTROL. Whenever traffic must be maintained during a paving operation, uniformed traffic officers and/or flaggers shall be stationed at each end of the section being paved and at other locations as required by the Engineer. The traffic officers or flaggers shall conform to the requirements of Section 630.

Whenever one-way traffic is maintained by the Contractor, the traveling public shall not be stopped or delayed more than ten minutes, unless otherwise directed by the Engineer. Two-way traffic shall be maintained during non-working hours.

303.16 METHOD OF MEASUREMENT. The quantity of Asphalt Treated Permeable Base to be measured for payment will be the number of metric tons (tons) of mixture used in the complete and accepted work, as determined from the load tickets.

303.17 BASIS OF PAYMENT. The accepted quantity of Asphalt Treated Permeable Base will be paid for at the Contract unit price per metric ton (ton). Payment will be full compensation for furnishing, mixing, hauling, and placing the material specified and for furnishing signs, labor, tools, equipment, and incidentals necessary to complete the work.

The cost of furnishing testing facilities and supplies at the plant will be considered included in the Contract item unit price of Asphalt Treated Permeable Base.

The cost of obtaining, furnishing, transporting, and providing the straightedges required for Asphalt Treated Permeable Base will be paid for under the Contract item Testing Equipment, Bituminous.

When not specified as a Contract item, the cost of Uniformed Traffic Officers or Flaggers will not be paid for directly but will be considered incidental to the Contract item Asphalt Treated Permeable Base.

Payment will be made under:

Pay Item	Pay Unit
303.30 Asphalt Treated Permeable Base	Metric Ton (Ton)

SECTION 310 - RECLAIMED STABILIZED BASE

310.01 DESCRIPTION. This work shall consist of pulverizing the existing pavement together with underlying base course material to the depth and width specified on the Plans or in the Contract, adding aggregate materials as required or as ordered by the Engineer, adding the stabilizing agent indicated on the Plans, mixing the components thoroughly and shaping and compacting the stabilized material to the desired grade and density.

310.02 MATERIALS. The pulverized material shall consist of the existing pavement blended with underlying subbase material and/or additional aggregate material and shall conform to the following gradation:

Sieve size	Percent by Mass Passing Square Mesh Sieves
75 mm (3 inches)	100
37.5 mm (1 ½ inches)	80 – 100
4.75 mm (#4)	30 - 60

Additional aggregate material added to make up grading deficiencies and/or to correct roadway geometry shall meet the requirements of Subsection 704.05 for Subbase of Crushed Gravel, Fine Graded.
Water for stabilization shall conform to the requirements of Section 745.

310.03 EQUIPMENT. Pulverization shall be accomplished with a machine having positive depth control adjustments and capable of reducing the pavement material to the specified size. The pulverizing equipment shall meet the approval of the Engineer. Equipment such as a milling machine or a rock crushing plant will not be permitted.

The mixer shall be a self-propelled mixer. The mixing rotor, or rotors, shall have positive depth control to ensure a uniform depth of mixing. When Stabilization Asphalt is designated as the stabilizing agent, the mixer shall also be a combined mixer and liquid distributor. The mixer shall meet the approval of the Engineer.

The equipment for distributing the designated stabilizing agent shall be uniformly adjustable and shall be equipped to accurately verify the rate of application of the stabilizing agent at any time.

The rollers used to compact the Reclaimed Stabilized Base material shall be as specified in Subsection 310.07.

The power grader and any replacement graders shall have grade control automation.

310.04 CONSTRUCTION. The moisture content of the pulverized materials shall be uniform and within the range approved by the Agency's Materials & Research Engineer prior to the addition of the stabilizing agent. If necessary, the materials shall be manipulated with equipment approved by the Engineer to decrease the moisture content or moisture shall be added to increase the moisture content to bring it into an approved range.

The pulverized reclaimed base material shall be stabilized by thoroughly mixing the stabilizing agent with the pulverized material and regrading and compacting the resulting mixture.
When a stabilizing or dust control agent is not exclusively specified on the Plans, water shall be used as that agent to meet all requirements of this Section.

Stabilization with water shall not be performed during rainstorms nor when the ambient air temperature is below 5°C (40º F). The Contractor shall pulverize only that area of pavement that can be stabilized during the same working day.

310.05 TESTING. The Contractor shall perform all process control and quality control sampling and testing.

Process control sampling and testing shall involve taking a set of four (4) representative excavated samples from the test section, after the test section has been pulverized. The four (4) samples shall be taken at random, representing the four-quarter segments of the test section. The four (4) samples shall be sieved to determine if the process can produce the required gradation or if additional materials must be added. Following the completion of the sieve analysis, using the AASHTO T 27 procedure modified to include air drying of the material only, the materials shall be physically combined to produce a representative sample.

A moisture/density curve, representing the combined sample, shall be generated in accordance with AASTHO T 180, Method C, using a minimum of five (5) different moisture contents to determine the maximum density and optimum moisture.

The Contractor shall perform quality control tests for density using a nuclear gauge in accordance with AASHTO T 238, Method B (per compacted lift of stabilized material).

A minimum of six (6) nuclear gauge tests per lane kilometer (0.6 lane mile) of compacted reclaimed base material shall be performed. Additional tests shall be performed as necessary or as directed by the Engineer. The Contractor shall verify that the minimum target density is maintained prior to resurfacing. The Contractor shall also perform quality control tests for uniform gradation of the pulverized material at a minimum rate of one (1) test per lane kilometer (0.6 lane mile).

The Contractor shall provide the Engineer with written copies of all process control and quality control results, including test locations. These test results will not be used to determine acceptance of the Reclaimed Stabilized Base material.

Acceptance testing will be performed by Agency personnel.

310.06 TEST SECTION. The Contractor shall construct a test section to assure the Engineer that the Contractor's equipment and procedure(s) are suitable for the work specified and capable of achieving the minimum target density approved by the Engineer.

The test section shall be full roadway width and of a length approved by the Engineer. No further recycling shall be performed until all aspects of the test section and the target density are approved by the Engineer. The Contractor shall use the same equipment for building both the accepted test section(s) and performing the Reclaimed Stabilized Base work on the project unless equipment substitution is approved by the Engineer. The Engineer may require an additional test section and additional process control sampling to investigate the suitability of substituted or changed equipment. The costs of such additional testing will not be paid for directly, but will be considered incidental to the Reclaimed Stabilized Base item.

If the test section does not meet the requirements of this specification, or the density achieved does not meet the minimum target density, then the Contractor shall modify the procedure and either construct another test section or reconstruct the original test section until suitable results are obtained.

310.07 SHAPING AND COMPACTING. Shaping and compacting shall be done immediately after pulverizing. The base material shall be finished within a grade tolerance of ±10 mm (±3/8 inch), provided that this deviation is not maintained for a distance longer than 15 m (50 feet) and provided that the required crown or superelevation is maintained.

When additional aggregate material is added to the previously reclaimed roadway to correct geometric deficiencies, said material shall be subject to a second pass of the reclamation equipment to achieve a homogenous subbase and shall be shaped, graded, and compacted.

The Contractor shall maintain the centerline location of the roadway. The Contractor shall also be responsible for the necessary survey required to re-establish banking as shown on the Plans or as directed by the Engineer.

Compaction of the reclaimed stabilized base shall be accomplished by successive passes of a vibratory sheeps foot or pad foot roller of at least 225 KN (25 tons) of dynamic force. Final rolling shall be accomplished by a smooth steel wheel vibratory roller of at least 120 KN (13 tons) of dynamic force. The material shall be compacted to achieve at least the minimum target density approved by the Engineer.

The optimum moisture content shall be maintained throughout the duration of the project stabilizing and compaction process. Ninety-five percent (95%) of the maximum density shall be used as the minimum target density during construction, upon approval by the Engineer, in accordance with Subsections 310.05 and 310.06.

310.08 CURING AND STABILITY. The completed and cured Reclaimed Stabilized Base may be opened to traffic as approved by the Engineer. Required density and moisture content of the finished base shall be maintained until it is paved over. Any imperfections discovered shall be repaired by the Contractor as directed by the Engineer at no additional cost to the Agency.

The stabilized material shall be allowed to cure to a condition such that the free moisture content is reduced to 1.0% or less before bituminous concrete pavement is placed on it.

310.09 METHOD OF MEASUREMENT. The quantity of Reclaimed Stabilized Base to be measured for payment will be the number of square meters (square yards) constructed to the depth specified, complete in place in the accepted work. No allowance will be made for overlapping areas.

The quantity of additional aggregate material used to correct gradation or geometric deficiencies to be measured for payment will be the number of metric tons (tons) of Subbase of Crushed Gravel, Fine Graded complete in place in the accepted work as determined by weight tickets.

In the event that the depth of base to be stabilized has to be adjusted in the field, the first 50 mm (2 inches) of additional or decreased depth will not be paid for directly, but will be considered incidental to the Reclaimed Stabilized Base item. If the change in depth is greater than 50 mm (2 inches), the number of square meters (square yards) pulverized at the revised depth will be multiplied by the result of dividing the total depth actually pulverized by the original depth designated on the Plans to create an equivalent number of square meters (square yards) for which payment will then be made.

310.10 BASIS OF PAYMENT. The accepted quantity of Reclaimed Stabilized Base will be paid for at the Contract unit price per square meter (square yard). Payment shall be full compensation for furnishing, handling, transporting, and placing the necessary materials; pulverizing, adding or removing moisture; shaping, placing, and compacting the designated materials; constructing tests strips; conducting tests; maintaining the finished base until it is paved over and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

No additional compensation will be provided for multiple passes of the reclamation equipment and additional shaping, grading, and compacting.

Water used to adjust the moisture content prior to stabilization, for stabilization when water is used as the stabilizing agent, for compacting the pulverized material and for dust control after the reclamation will not be paid for directly, but will be considered incidental to the Reclaimed Stabilized Base item.

The accepted quantity of Subbase of Crushed Gravel, Fine Graded used to correct gradation or geometric deficiencies will be paid for at the Contract unit price per metric ton (ton) under the appropriate Contract item.

Payment will be made under:

Pay Item	Pay Unit
310.20 Reclaimed Stabilized Base	Square Meter (Square Yard)

DIVISION 400

SURFACE COURSES AND PAVEMENT

SECTION 401 - AGGREGATE SURFACE COURSE

401.01 DESCRIPTION. This work shall consist of furnishing and placing a wearing course of approved aggregate on a prepared surface.

401.02 MATERIALS. Materials shall meet the requirements of the following Subsection:

Aggregate for Surface Course and Shoulders.....704.12

401.03 PLACING. The aggregate shall be placed and properly shaped using equipment that allows the typical cross-section and design grade to be attained. Should aggregate segregation occur, the Contractor shall remove and replace the segregated material or manipulate it until uniform gradation is obtained.

The maximum layer thickness for placement of any aggregate surface material shall be 150 ± 50 mm (6 ± 2 inches) after compaction. All layers shall be placed and compacted at approximately equal thickness. In the placement of layers, all joints shall be staggered at least 300 mm (12 inches).

After each layer of surface material is placed, it shall be thoroughly compacted to a uniform density of not less than 95 percent of the maximum dry density determined by AASHTO T 99, Method C. Suitable and effective equipment, meeting the approval of the Engineer, shall be used to obtain a true and even surface during compaction. All holes or depressions found during the compacting shall be filled with additional material, reworked, and compacted. If required, water shall be uniformly applied over the aggregate material during compaction in an amount necessary to produce proper consolidation. The aggregate shall be thoroughly compacted with an approved power roller with a mass (weight) not less than 7 metric tons (8 tons), or an approved rubber tired roller, or by other approved methods.

401.04 METHOD OF MEASUREMENT. The quantity of Aggregate Surface Course to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by the Plan dimensions of the compacted material or as ordered by the Engineer. No allowance will be made for material placed to a depth greater than that shown on the Plans unless ordered by the Engineer.

401.05 BASIS OF PAYMENT. The accepted quantity of Aggregate Surface Course will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to the item Aggregate Surface Course.

Payment will be made under:

Pay Item	Pay Unit
401.10 Aggregate Surface Course	Cubic Meter (Cubic Yard)

SECTION 402 - AGGREGATE SHOULDERS

402.01 DESCRIPTION. This work shall consist of furnishing and placing shoulders of approved aggregate on a prepared surface.

402.02 MATERIALS. Materials shall meet the requirements of the following Subsection:

Aggregate for Surface Course and Shoulders..... 704.12

When specified for use on the project or as directed by the Engineer, Aggregate Shoulders, RAP, shall be grindings from cold planed bituminous concrete pavement crushed or screened by the Contractor such that 100% of the material passes the 37.5 mm (1 ½ inch) sieve prior to placement.

402.03 PLACING. Shoulder material shall be placed with a machine that has been approved by the Engineer. The Contractor shall demonstrate to the Engineer the proposed placement procedure. If necessary, the procedure shall be adjusted to avoid grooving, marking, or other damage to the final pavement course.

Unless otherwise directed by the Engineer or shown on the Plans, the aggregate shall be placed in one course and shall not be placed until the adjacent wearing surface has been completed.

Should segregation occur, the Contractor shall remove and replace the segregated material or manipulate it until uniform gradation is obtained.

402.04 COMPACTION. The shoulder material shall be rolled with an approved roller after shaping, with a mass (weight) not less than 7 metric tons (8 tons), until thoroughly compacted. Water shall be applied to the material as necessary to obtain proper compaction. Should irregularities in the shoulder material develop during or after rolling, they shall be corrected.

Compaction around mailbox turnouts, driveways, and other obstacles shall be accomplished with equipment designed for that purpose and approved by the Engineer.

The maximum layer thickness for placement of any aggregate shoulder material shall be 150 ± 50 mm (6 ± 2 inches) after compaction. All layers shall be placed and compacted at approximately equal thickness. In the placement of layers, all joints shall be staggered at least 300 mm (12 inches).

After each layer of surface or shoulder material is placed, it shall be thoroughly compacted to a uniform density of not less than 95 percent of the maximum dry density determined by AASHTO T 99, Method C. Suitable and effective equipment, meeting the approval of the Engineer, shall be used to obtain a true and even surface during compaction. All holes or depressions found during the compacting shall be filled with additional material, reworked, and compacted as shown on the Plans. If required, water shall be uniformly applied over the aggregate material during compaction in an amount necessary to produce proper consolidation.

402.05 METHOD OF MEASUREMENT. The quantity of Aggregate Shoulders, In Place to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by the Plan dimensions of the compacted material or as ordered by the Engineer. No allowance will be made for material placed to a depth greater than that shown on the Plans unless ordered by the Engineer.

The quantity of Aggregate Shoulders, Truck Measurement to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by vehicle loads using three dimensional measurements. All vehicles shall be loaded to at least their water level capacity and any loads designated shall be leveled at the point of delivery when directed by the Engineer. A printed load ticket, which indicates truck identification and date and time of delivery, shall be furnished to the Engineer with each load delivered to the job site.

Truck measurement, when not specified in the Contract, may be used when ordered by the Engineer. Truck measurement will be converted to in-place measurement by dividing by 1.15.

When specified to be paid by mass (weight), the quantity of Aggregate Shoulders to be measured for payment will be the number of metric tons (tons) used in the complete and accepted work, as determined from the load tickets.

402.06 BASIS OF PAYMENT. The accepted quantity of Aggregate Shoulders will be paid for at the Contract unit price per cubic meter (cubic yard) or metric ton (ton). Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Water used for obtaining the required compaction will not be paid for separately but will be considered incidental to the Aggregate Shoulders item in the Contract.

Payment will be made under:

Pay Item	Pay Unit
402.10 Aggregate Shoulders, In Place	Cubic Meter (Cubic Yard)
402.11 Aggregate Shoulders, Truck Measurement	Cubic Meter (Cubic Yard)
402.12 Aggregate Shoulders	Metric Ton (Ton)
402.13 Aggregate Shoulders, RAP	Metric Ton (Ton)

SECTION 404 - SURFACE TREATMENT MATERIALS

404.01 DESCRIPTION. This work shall consist of furnishing and applying bituminous treatment when required on an approved surface.

404.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Bituminous Material	702.01
Emulsified Asphalt	702.04
Tar Emulsion	702.05
Application Temperatures	702.06

All additives for emulsified asphalts must be approved prior to their use.

404.03 WEATHER LIMITATIONS. Bituminous material shall be applied only when the following conditions prevail:

(a) The ambient air temperature is at least 5 °C (40 °F) in the shade, and rising.

(b) The road surface is sufficiently dry.

(c) Weather conditions or other conditions are favorable and are expected to remain so for the performance of satisfactory work.

Bituminous material shall not be applied between November 1st and May 1st.

404.04 EQUIPMENT. The equipment used by the Contractor shall include transporting equipment, a bituminous distributor, and equipment for heating bituminous material.

(a) Distributor. The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surfaces up to 4.6 m (15 feet) at the specified rate for the item being placed. Distributor equipment shall include suitable hand spray nozzle and hose, a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

Distributors may be required to apply a 7.3 m (24 foot) wide strip at one time.

The mass (weight) of the loaded distributor shall not exceed the legal load limit.

Each pressure distributor shall be equipped with a squeegee and pouring pot, and labor shall be furnished to use the tools.

Each pressure distributor shall be equipped with a measuring stick.

Traveling or stationary plants or other equipment of proven performance may be used by the Contractor instead of the specified equipment if approved.

(b) Transporting Equipment. Tanks for motor transport trucks shall be made of either steel or aluminum with a minimum capacity of 5.5 m^3 (1500 gallons), insulated, equipped with baffle plates to prevent surging, and equipped with the necessary units in order to heat the bituminous content in accordance with these specifications. Heating of motor transport truck tanks by distributors to bring the material to the proper temperature will not be permitted. The Contractor shall furnish the necessary heating units for the motor transport trucks and the operators for the heating units.

404.05 PREPARATION OF SURFACES. All surfaces to be treated shall be patched, cleaned of loose or objectionable material, and free of irregularities to provide a reasonably smooth and uniform surface.

404.06 APPLICATION OF BITUMINOUS MATERIALS. The application rates of bituminous material shall be as directed by the Engineer.

The application shall not be made on more than 50 percent of the width of the road surface at a time, unless all traffic is detoured, in which case the application may be full width.

(a) Tar Emulsion. Prior to treating the surface, it shall be wet with water by truck application or other methods approved by the Engineer. Any surplus water shall be removed so there is not any puddling.

The tar emulsion shall be spread in two uniform coats, each coat to be applied at the rate of 0.5 to 0.9 L/m^2 (0.1 to 0.2 gallons per square yard) as directed by the Engineer. The time lapse between the first and second application shall be left to the discretion of the Engineer but should not exceed 24 hours. Each coat shall be applied either by the use of soft rubber squeegees or by brushes of approved quality. At least 24 hours shall elapse before any other bituminous material is applied.

(b) Emulsified Asphalt. Emulsified asphalt shall be applied between the temperature ranges specified in Section 702 by pressure distributors or other methods approved by the Engineer.

404.07 TRAFFIC CONTROL. To control traffic during bituminous surface treatment operations, flaggers shall be used in accordance with Section 630.

Signs informing the traveling public that bituminous surface treatment operations are underway shall be erected at each end of the section under construction during the day. The signs shall be designed, worded, and erected in a manner approved by the Engineer. The signs shall be removed at the end of each day's work unless the condition of the road, as determined by the Engineer, requires otherwise.

All traffic shall be kept off the bituminous material until the penetration is complete and the prime or seal coat will not "pick up" under traffic, or until cover material has been placed and lightly rolled.

On projects where it is necessary to maintain traffic, the traffic shall be controlled by using a pilot car traveling at a low speed.

404.08 THIS SUBSECTION RESERVED

404.09 MAINTENANCE. The Contractor shall maintain the treated surfaces until the Contract is completed and the work accepted. Holes or irregularities shall be repaired by filling with material acceptable to the Engineer. All maintenance work will be considered as part of the item and shall be included in the Contract unit price.

404.10 PROTECTION OF STRUCTURES AND TREES. The Contractor shall use care in applying bituminous material and protecting surfaces of adjacent structures and trees from being spattered with the material.

404.11 METHOD OF MEASUREMENT. The quantity of Tar Emulsion to be measured for payment will be the number of liters (gallons) or kilograms [hundredweight (CWT)] used in the complete and accepted work.

The quantity of Emulsified Asphalt to be measured for payment will be the number of kilograms [hundredweight (CWT)] used in the complete and accepted work.

404.12 BASIS OF PAYMENT. The accepted quantities of the specified material will be paid for at the Contract unit price per liter (gallon) or kilogram [hundredweight (CWT)] for the specified material applied. Payment will be full compensation for furnishing, transporting and placing the material and for furnishing all materials, signs, traffic control, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
404.45 Tar Emulsion	Liter (Gallon)
404.46 Tar Emulsion	Kilogram (CWT)
404.65 Emulsified Asphalt	Kilogram (CWT)

SECTION 406 – MARSHALL BITUMINOUS CONCRETE PAVEMENT

406.01 DESCRIPTION. This work shall consist of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with these specifications and the specific requirements of the type of surface being placed, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

406.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Performance-Graded Asphalt Binder 702.02
Emulsified Asphalt, RS-1 ..... 702.04
Aggregate for Marshall Bituminous Concrete Pavement..... 704.10(a)

The grade of Performance-Graded (PG) asphalt binder used to produce bituminous concrete pavement shall be as shown on the Plans.

406.03 COMPOSITION OF MIXTURE.

(a) Gradation. For each pavement type, the materials shall be combined and graded to meet the limits specified in the following table:

TABLE 406.03A - PERCENTAGE BY MASS PASSING SQUARE MESH SIEVE

Sieve Size	Type I	Type II	Type III	Type IV	Type V
31.5 mm (1 ¼ inch)	100				
25.0 mm (1 inch)	95 – 100	100			
19.0 mm (¾inch)	74 – 86	95 – 100	100		
12.5 mm (½inch)	60 – 80	64 – 88	95 – 100	100	
9.5 mm (⅜ inch)	---	50 – 82	70 – 90	95 – 100	100
4.75 mm (No. 4)	35 –60	32 – 62	42 – 75	48 – 78	85 – 100
2.36 mm (No. 8)	25 – 45	22 – 45	28 – 56	28 – 56	66 – 88
1.18 mm (No. 16)	---	13 – 35	14 – 41	14 – 41	45 – 67
600 µm (No. 30)	10 – 25	8 – 27	7 – 31	7 – 31	27 – 53
300 µm (No. 50)	---	3 – 20	3 – 22	3 – 22	13 – 40
75 µm (No. 200)	2 - 6	2 – 6	2 – 6	2 – 6	2 – 7
Total Aggr.	94 – 97	93 – 97	92 – 97	92 – 95	91 – 93
Bitumen (% of Total Mix)	3 - 6	3 - 7	3 - 8	5 – 8	7 – 9

(b) Design Criteria. The materials shall be combined and graded to meet the following criteria:

TABLE 406.03B - DESIGN CRITERIA

Marshall Test Properties	Medium Duty Bituminous Concrete Pavement – 50 blows/side	Bituminous Concrete Pavement – 75 blows/side
Air Voids %	3.0 – 5.0	3.0 – 5.0
Voids in the Mineral Aggregate (VMA) % Type I	13.0 min.	13.0 min.
VMA % Type II	14.0 min.	14.0 min.
VMA % Type III	15.0 min.	15.0 min.
VMA % Type IV	16.0 min.	16.0 min.
Stability, Newtons (Pounds)	5340 (1200) min.	8010 (1800) min.
Flow, millimeters (0.01 inches)	2.0 – 4.5 (8.0 – 18.0)	2.0 – 4.0 (8.0 – 16.0)
% Stone Screenings (Fine Aggregate Portion) Passing 2.36 mm (No. 8) sieve	60.0 min.	75.0 min.

TABLE 406.03B1 - PG BINDER GRADE SELECTION

RAP CONTENT	BINDER GRADE
≤ 20.0%	PG 58-28
20.0% < to < 25.0%	PG 52-34
25.0% ≤ to ≤ 50.0%[1]	footnote 1

1 - The Contractor shall determine the grade of PG binder necessary so that when combined with the RAP asphalt cement, the composite asphalt material grades at a PG 58-28 as a minimum. The maximum acceptable low end temperature is -28°C (-18°F) and the minimum acceptable high end temperature is 58°C (136°F). The Engineer will sample haul units from the plant and have the material extracted for grading at the Agency's Materials and Research Laboratory in Berlin, VT to verify the binder grade of the mix being supplied. The Contractor's Quality Control Plan shall specify a grading frequency and include an action plan for when test results verify that the grade of PG binder is less than a PG 58-28.

(1) Air Voids (Va). The percent of air voids of the mixture shall be calculated by the following formula:

$$Va = 100 \times ((Gmm - Gmb)/Gmm)$$

where:

Gmm = Maximum specific gravity of uncompacted mixture (AASHTO T 209)
Gmb = Bulk specific gravity of compacted mixture (AASHTO T 166, Method A)

Unless otherwise noted on the Plans, all bituminous concrete pavement shall be designed in conformance with the design criteria for Bituminous Concrete Pavement.
Unless otherwise specified for highways, Type I shall be used for base course, Types I or II shall be used for binder course, and Types II, III, or IV shall be used for wearing course. Unless otherwise specified for bridges, Type IV shall be used for binder course.

Type V mix will be designed to meet the gradation criteria of Subsection 406.03(a) only.

The mix design shall have a filler/asphalt ratio ranging between 0.50 and 0.90.

(c) Mix Design. The Marshall Method of Mix Design will be used to develop a mix that will meet the specified Design Criteria. A copy of all test data,used in developing the mix design, including graphs, may be required with the submittal of the mix design.

The job-mix formula for each mixture shall establish a single percentage of aggregate passing each sieve and a single percentage of bituminous material to be added to the aggregate. No change in the job-mix formula may be made without the written approval of the Materials and Research Engineer. The job-mix formula must fall within the master range of the specification as shown in Subsection 406.03(a).

No work shall be started until the Contractor has submitted and the Materials and Research Engineer has approved a mix design including cold feed and hot bin gradations, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required in the Marshall Method of Mix Design. For mix designs containing RAP, the dry and wet mixing times shall be adjusted to assure moisture from the RAP is completely dissipated prior to adding the liquid PG binder.

The Materials and Research Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement, finishing, or compaction characteristics are determined by the Engineer to be unsatisfactory.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of 10 working days shall be allowed for testing and evaluation of the submitted mix design. Once a mix design is approved, the job-mix formula is valid until a change is made in aggregate source, PG asphalt binder grade, or asphalt source.

(d) Control of Mixtures. The plant shall be operated so that no intentional deviations are made from the job-mix formula. The gradation of the actual mixture shall not vary from the job-mix formula by more than the following tolerances:

TABLE 406.03C – PRODUCTION TESTING TOLERANCES

Aggregate larger than 2.36 mm (No. 8) sieve	±	6.0 %
Aggregate passing the 2.36 mm (No. 8) sieve and larger than the 75 µm (No. 200) sieve	±	4.0 %
Aggregate passing 75 µm (No. 200) sieve	±	1.0 %
Temperature of Mixture	±	11°C (20°F)
Air Voids	=	4.0± 1.0%

The quantity of PG asphalt binder introduced into the mixer shall be that quantity specified as a percentage in the accepted job-mix formula and for batch plants will be accepted on the basis of the mass (weight) on the printed weight slip. For the use of drum-mix plants, the quantity of PG asphalt binder shall be specified as a percentage in the accepted job-mix formula and will be accepted on the basis of the percentage printed on the demand ticket from the approved automatic digital recording device in the plant.

For those projects having 2000 metric tons (tons) or less of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

If an analyzed sample is outside of the testing tolerances and/or other design criteria, immediate adjustments shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with these Specifications. With the permission of the Engineer, the plant may continue production pending results of these tests, but if the Engineer deems that it is in the best interest of the project, the Engineer may at any time order plant production stopped. In this event, additional adjustments shall be made and tested on a trial basis until the deficiency is corrected.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance sampling and testing will be conducted by Agency personnel in accordance with the Agency's Quality Assurance Program as approved by FHWA.

For those projects having more than 2000 metric tons (tons) of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

The Contractor shall operate in accordance with an approved Quality Control (QC) Plan, hereinafter referred to as the "QC Plan", sufficient to assure a product meeting the Contract requirements. The QC Plan shall meet the requirements of Subsection 106.03. An example "outline" is available through the Agency Materials and Research Laboratory's Bituminous Concrete Section.

The QC Plan shall address all elements that affect the quality of the Plant Mix, including but not limited to the following:

a. Job-Mix formula(s)
b. Bituminous concrete mix Plan details
c. Stockpile management
d. Name of Plan Administrator
e. Name of Process Control Technician(s)
f. Mixing
g. Frequency and tests for Quality Control
h. For mix designs containing ≥ 25.0 percent RAP, indicate the following: RAP percentage, PG Grade of virgin binder determined, testing frequency of mix to verify composite PG Grade, and actions to be taken when test results are outside of PG Grade limits.

The QC Plan shall incorporate the following personnel with the specified minimum requirements and qualifications:

a. Plan Administrator. This individual shall be a Quality Assurance Technologist certified by the New England Transportation Technician Certification Program (NETTCP).

b. Process Control Technician (PCT). This individual shall be certified as a "Hot Mix Asphalt (HMA)" Plant Technician by NETTCP. The PCT may have an interim certification from NETTCP as an HMA Plant Technician. Alternatively, the PCT may be a trainee performing duties under the direct supervision of a NETTCP certified technician, as specified in the VAOT approved QC Plan. In this case the Plan should address the following:

1. A training period shall continue for a minimum of 30 working days, at which point the supervising certified technician shall sign off on the trainee.

2. Upon completion of the training period and having been validated (signed off), the trainee will be qualified to work on QA projects without direct supervision for the remainder of the current construction season.

The PCT shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the job-mix formula(s). The PCT shall periodically inspect all equipment used in mixing to assure it is operating properly and that mixing conforms to the mix design(s) and other Contract requirements.

The QC Plan shall specify how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The QC Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

The QC Plan shall detail the coordination of the activities of the Plan Administrator and the PCT. The Plan Administrator shall be available to respond to the Engineer within one hour of a request.

Bituminous concrete pavement shall be sampled, tested, and evaluated by the Contractor for each mix type (each mix design) for each project on a continuous production basis in accordance with the following minimum quality control guidelines:

TABLE 406.03D - MINIMUM QUALITY CONTROL GUIDELINES

Test Action	Frequency	Test Method
Temperature of Mix	1 per 250 metric ton (ton) at plant (truck)	Verified Thermometer
Air Voids	1 per 500 metric ton (ton)	AASHTO T 269 (T 166, T 209)
Cold Feed Gradation (1)	1 per day	AASHTO T 27
PG Asphalt Binder content	1 per 500 metric ton (ton)	Batch Slip
Extracted Gradations	1 per 500 metric ton (ton)	AASHTO T 30 AASHTO T 164 AASHTO T 308
Fine Aggregate, Coarse Aggregate, and Recycled Asphalt Pavement (RAP) Moisture Content (2)	2 times daily minimum (3)	AASHTO T 255
Fine Aggregate, Coarse Aggregate, and RAP Specific Gravities	Day of initial paving and 1 per week (4)(5)(6)	AASHTO T 84 AASHTO T 85
RAP PG Asphalt Binder content	1 per day	AASHTO T 164 AASHTO T 308
Determine composite PG binder grade(7)	1 per 5000 metric ton (ton)	AASHTO R 29

1 - Include percent “fractured faces” and “thin and elongated” of particles retained on the No. 4 (4.75 mm) sieve and above.
2 - This requirement is for drum-mix plants only.
3 - Evenly spaced intervals throughout the day and when new material is being added to the stockpiles and utilized in the mix.
4 - Or 1 per every 5000 metric tons (tons), whichever is greater.
5 - Current (within the previous 2 to 10 days) specific gravities will need to be supplied prior to beginning paving operations.
6 - New specific gravities will be required when either absorbed asphalt is determined to be a negative or at the request of the Materials and Research Engineer.
7 - For mix containing > 25.0 percent RAP.

Upon approval of the Materials and Research Engineer, the Contractor may utilize innovative equipment or techniques not included in the specifications to produce or monitor the production of the mix.

(e) Quality Acceptance.

(1) General. Bituminous concrete mixtures designated under these specifications will be sampled once per sublot on a statistically random basis, tested, and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following acceptance guidelines:

TABLE 406.03E - ACCEPTANCE GUIDELINES

PROPERTIES	POINT OF SAMPLING	LOT SIZE	SUBL OT SIZE	TEST METHOD
Air Voids	Truck at Plant	3000 Metric Ton (Ton)	500 Metric Ton (Ton)	AASHTO T 269 (T 166, T 209)

1 - Reference Subsection 106.03.
2 - Varies based on projected lot size.

(2) Lot Size. For the purpose of evaluating acceptance test properties, the representative tonnage of bituminous material within each lot shall be 3000 tons. The final resultant partial lot shall be processed as a full lot if it consists of four or more acceptance samples. If the final resultant partial lot consists of less than four acceptance samples, it will be combined with the previous lot.

(3) Sublot Size. A sublot shall be 500 tons with the exception of the final sublot of a partial lot, which will consist of the quantity of material required to complete the partial lot.

(4) Pay Factor (PF) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Level (RQL) of 50%, the PF for each lot of bituminous concrete mixture, based on "air voids" test results, will be determined using the following equation:

$$PF(av) = ((0.28PWL + 75) / 100) - 1.0$$

(5) Rejectable Material.

a. Rejection by Contractor. The Contractor may at any time elect to remove any defective material and replace it with new material at no expense to the Agency. Any such new material will be sampled, tested, and evaluated for acceptance.

b. For those lots with a PWL less than 50% and greater than or equal to 25%, the PF for each lot of bituminous concrete mixture, based on "air voids" test results, will be determined using the following equation:

$$PF(av) = ((2.16PWL - 29)/100) - 1.0$$

For those lots with a PWL less than 25%, the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency.

(f) Boxed Samples. If daily testing and inspection functions are required to comply with provisions of the Agency's Quality Assurance Program and plant inspectors are not available to perform these tasks, then box samples will be taken by the Engineer at the project site to afford verification of mixture volumetrics/properties. Boxed samples will be processed at the Agency Central Laboratory in Berlin, Vermont and results reported to the.

(g) Certification. For projects that are designated as Level 3 in accordance with the Agency's Quality Assurance Program, a Type D Certification shall be furnished in accordance with Subsection 700.02 for each day's production of material for non-mainline paving.

406.04 WEATHER AND SEASONAL LIMITATIONS. The bituminous material shall not be placed when the ambient air temperature and temperature at the paving site in the shade and away from artificial heat is below 5°C (40°F) for courses 35 mm (1 ¼ inches) or greater in compacted thickness or below 10°C (50°F) for courses less than 35 mm (1 ¼ inches) in compacted thickness.

Bituminous material shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

Bituminous material shall not be applied between November 1st and May 1st. Bituminous wearing course materials shall not be applied before May 15th or after October 15th.

When it is in the public interest, the Construction Engineer may adjust the ambient air temperature requirements, pavement temperature requirements, or extend the dates of the paving season.

406.05 BITUMINOUS MIXING PLANT AND TESTING. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold storage bins. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

All existing plants shall be inspected and obtain approval each construction season by an authorized representative of the Agency. Written notification shall be given for any plant which has not been inspected so that an authorized representative of the Agency may inspect said plant prior to any mixing operation for Agency projects. A minimum of ten business days shall be allowed for the scheduling of the inspections. The plant shall be in operation at the time of inspection.

Plants used for the preparation of bituminous mixtures shall conform to all requirements specified in part (a) below, except that scale requirements shall apply only where mass (weight) proportioning is used. In addition, batch mixing plants shall conform to the requirements specified in part (b) below, continuous mixing plants shall conform to the requirements specified in part (c) below, and drum-mix plants shall conform to the requirements specified in part (d) below.

Scales for the weighing of materials shall conform to the restrictions specified herein and shall meet all specifications, tolerances, and regulations which have been or may be adopted periodically by the Director of Standards of the Vermont Department of Agriculture, and shall be subject to approval by the Materials and Research Engineer. The scales shall be checked and sealed as deemed necessary to assure accuracy.

Producers located outside Vermont shall observe all annual hopper scale mass, measurement, and seal requirements of their respective State or location.

(a) Requirements for All Plants. The Contractor shall give the Materials and Research Engineer a two working day notice of intent to produce bituminous mixture so that arrangements can be made for plant inspection and control.

The plants shall be so designed, coordinated, and operated as to produce a uniform mixture within the mix design approved for the project.

The Contractor shall indemnify and hold the State harmless for any hazardous waste generated from plant operations in producing materials for use in Agency Contracts. The Contractor shall be responsible for properly disposing of such waste at no additional cost to the State.

All plants shall have automatic controls which coordinate the proportioning, timing, and discharge of mixture by the operation of a single switch or button. In addition to these controls, the plant shall have an approved recording system.

The recording system shall be capable of printing the total net mass (weight) of the load. Each weigh slip shall be automatically printed with the date and time of batching, shall show project and truck identification, and shall indicate the approved mix design number being produced.

All originals of recorded data pertaining to the weighing or proportioning of bituminous concrete, after recording, shall become the property of the Agency.

(1) Truck Scales. Approved truck scales shall be provided at each plant. The scale platform shall be of such length and width that it will conveniently accommodate

all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft.

These scales may be used for spot checking the accuracy of the recording equipment. Any variance exceeding 0.5% of the net mass (weight) shall result in immediate corrective action by the Contractor.

A weatherproof building of sufficient size to house the scale operator and the Inspector shall be provided. It shall have adequate lighting, both natural and artificial, and it shall be adequately and safely heated.

If the Contractor's printer breaks down, the Contractor may continue to operate for the remainder of that day, provided the following conditions are met:

a. The Engineer grants permission to operate and

b. The Materials and Research Engineer assigns an Inspector to record the total aggregate and asphalt mass (weight) for each batch on the appropriate ticket.

(2) Equipment for Preparation of Bituminous Material. Tanks for storage of bituminous material shall be insulated and capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications. The heating system shall provide uniform heating of the entire contents of the tanks.

Heating shall be accomplished by steam or oil coils, electricity, or other means so that no flame shall come in contact with the heating tank.

A circulating system for bituminous material shall be of adequate capacity to provide proper and continuous circulation between storage tank and the proportioning units during the entire operating period.

The discharge end of the circulating pipe shall be maintained below the surface of the bituminous

material in the storage tank to prevent the discharging of hot bituminous material into the open air.

All pipe lines and fittings shall be steam or oil jacketed or otherwise properly insulated to prevent heat loss.

(3) Feeder for Dryer. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregate into the dryer so that uniform production and uniform temperatures will be obtained.

(4) Dryer. The dryer shall be capable of heating and drying the mineral aggregates to specification requirements without leaving any visible unburned oil or carbon residue on the aggregate when it is discharged from the dryer. Black smoke from the exhaust stack shall not be permitted. Drying shall continue until all moisture is removed. If unusually wet aggregate is being used, the input to the dryer shall be reduced to an amount which the dryer is capable of drying.

(5) Screens. Plant screens shall have the capacity and size range to separate the aggregates into sizes for proportioning so that they may be recombined within the limits of the specifications. The screen over the "fines bin" shall have a maximum square opening of 5.0 mm (3/16 inch).

Slotted screens may be used when approved by the Materials and Research Engineer. Screens are not applicable to drum-mix plants.

(6) Cold Storage Bins. The plant shall have cold bin storage of sufficient capacity to ensure a uniform and continuous operation.

The bins shall be so constructed as to prevent any intermingling of aggregates from one bin to another. The use of loaders or trucks which are larger in width than the bins being charged shall not be allowed. The blending of two or more aggregates in the same bin shall not be permitted.

For all bituminous concrete supplied for use on Agency projects, uniform feeding of all fine aggregates shall be accomplished by the use of a variable speed continuous belt feeder on each cold storage bin of fine aggregate.

(7) Hot Bins. The plant shall include hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The hot storage shall consist of at least four bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

When more than 15% of the material is undersized for that bin, based on the sieve analysis of hot bins used in determining the job-mix formula, all bins shall be emptied and the cause for such condition shall be corrected.

Each bin shall be provided with a free-flowing overflow pipe of such size and at such a location as to prevent backing up of material into other bins or into contact with the screen. This overflow material shall not be fed back into the system or into any accepted stockpiles.

All bins shall be equipped with a sensor device to indicate the position of the aggregate in the bins at the lower quarter point. An automatic plant shutoff device shall operate to interrupt the batching process when any aggregate bin becomes empty.

Adequate additional dry storage shall be provided when mineral filler is required. The system shall have a device to feed the mineral filler accurately and uniformly at adjustable rates consistent with the percent required. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

Adequate and convenient facilities shall be provided to obtain representative aggregate samples from each bin.

Hot bins are not applicable to drum-mix plants.

(8) Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Metering devices for bitumen shall be accurate to within plus or minus two percent of the amount of bitumen delivered when tested for accuracy.

The section of the bitumen flow line between the charging valve and the spray bar shall be provided with a three-way valve and outlet whereby the rate of delivery of the metering device may be checked by actual mass.

Suitable means shall be provided, either by steam, oil-jacketing, or other insulation, for maintaining the specified temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

(9) Thermometric Equipment. An armored thermometer shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit ~~to~~ for accurately indicating the temperature of the bitumen.

The plant shall also be equipped with an approved recording thermometer, pyrometers, or other approved recording thermometric instruments placed at the discharge chute of the dryer.

The Materials and Research Engineer may reject questionable thermometric instruments, may direct replacement of any instrument with an approved temperature recording apparatus, and may further require that daily temperature charts be filed with the Materials and Research Engineer.

(10) Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time, unless otherwise approved by the Materials and Research Engineer.

(11) Dust Collectors. The plant shall be equipped with adequate dust collectors so that exhaust will not be dispersed into the atmosphere. Provisions shall be made to waste or uniformly reintroduce all or any part of the heavier dust particles from primary collectors into the flow of aggregate.

The introduction of baghouse fines into bituminous concrete mixes will be allowed when the fines are introduced by an approved metering or weighing system which uniformly introduces the fines.

The Materials and Research Engineer has the authority to withdraw the approval for use of baghouse fines at any time that the bituminous concrete pavement mix provided by the Contractor is unsatisfactory as determined by the Materials and Research Engineer.

(12) Testing Facilities. The Contractor shall provide a weatherproof building, with at least 22 square meters (240 square feet) of floor space, in which to house and use the testing equipment. This building shall be maintained for the use of the Agency Engineers or Inspectors, and shall be located so that details of the Contractor's plant are plainly visibly from at least one window of the building. Adequate lighting, heating, and electrical connections shall be provided 24 hours per day. Proper means for ventilation shall be provided.

The method of heating shall be such that a minimum temperature of 21°C (70°F) will be maintained at all times. Sanitary toilet facilities with lavatory, with proper sewage disposal, shall be furnished for the use of Agency personnel. Cleaning supplies shall be furnished by the Contractor. A private telephone service, dedicated for the use of Agency personnel, shall be provided in the laboratory. An internet connection that provides a minimum speed of 700 Kbps (Kilobits Per Second) download, without utilizing compression algorithms, shall be provided in the laboratory and dedicated for the use of Agency personnel. The connection bandwidth speed shall be verifiable using an online speed test.

The Contractor must have its office space separate from the office space used by Agency personnel. The Contractor's office space shall be located to afford privacy to Agency personnel.

A trailer type mobile laboratory may be used only in conjunction with a temporary plant. Any plant that occupies or has occupied the same location for more than one year will be classified as a permanent plant and will require a permanent building for a laboratory.

The facility shall be equipped with the following standard commercial quality equipment. Substitutes may be provided upon approval of the Materials and Research Engineer.

One - Air conditioner for the capacity of the building capable of maintaining a maximum temperature below 25°C (77°F).

Two - Two kilogram (5 pound) minimum capacity fire extinguishers, either ABC Dry Chemical or Carbon Dioxide, of standard commercial quality.

One - Standard office desk with drawers, locks, and keys, 1200 mm x 750 mm (4 feet x 2 ½ feet) (minimum dimensions).

One - Adjustable office chair.

Two - Adjustable drafting stools.

One - Electric calculator, four function, ten column, with memory.

Two - Bench sections and storage compartments. The benches shall be approximately 900 mm (36 inches) high, 600 mm (24 inches) wide and three meters (10 feet) long.

One/Two - Approved exhaust fan(s) and hood(s) shall be provided over the stoves and extractors. The exhaust fan(s) shall be high volume axial flow, at least 300 mm (12 inches) in diameter.

One - Water cooler with supply of potable water.

One - Sink with faucet within the office, with a continuous supply of pressurized clean water for the duration of the project. The sink shall drain to the outside of the office.

The facility shall be equipped with the following test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

One - Marshall Test Set Reference AASHTO T 245 including:

One – Automatic Bituminous Compactor.
Two – Compaction molds with base plates.
One – Stability mold.
One – Flow meter.
One – Motorized compression and testing machine.
One – Water bath capable of maintaining a temperature of 60° ± 1°C (140° ± 2°F).
One – Motorized 3000 g (6.6 pound) centrifuge extractor with two small bowls with covers and two large bowls with covers, and/or an ignition oven that conforms to the apparatus requirements of AASHTO T 308 "Standard Method of Test Method for Determining the Asphalt Binder Content of Hot-Mix Asphalt (HMA) by the Ignition Method" with the following related equipment: two full sets of sample basket(s), two catch pans, and one set of safety equipment as defined in AASHTO T 308.
One - Full set of 200 mm (8 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.
One- Full set of 300 mm (12 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.
One - Electronic balance, 6000 g (13.2 pound) minimum capacity.
One - Motorized sieve shaker with either rocking and tapping action or circular and tapping action capable of holding at least six sieves and one pan.
One - Mechanical aggregate shaker with a 0.028 m^3 (1.0 ft^3) capacity plus necessary screens. This may be placed in a separate enclosure outside of the trailer.

One - Platform beam scale sensitive to 5.0 g (0.01 pound) with a minimum capacity of 45 kg (100 pounds).
One - Sample splitter, 63.5 mm (2½ inch) chute.
Two - Square pointed shovels; one long handled, one short handled.
Two - Double burner hot plates, variable temperature.
Twelve - Tin pans, 267 mm x 267 mm x 25 mm (10½ inches x 10½ inches x 1 inch).
One - 0.028 m^3 (1.0 ft^3) minimum capacity electric oven.
One - Flat triangular trowel.
One - Brass wire bristle brush.
One - Standard floor brush.
One - Standard table brush.

Filter papers for duration of project.

Two - 40 mm (1½ inch) soft bristle paint brushes.
One - Automatic timer (interval 0-30 minutes).
One - Sample Splitter (riffles) chute width 25 mm (1 inch).
Two - Flexible spatulas with 150 mm (6 inch) long blade.
One - 10 L (10 quart) pail.
Two - Pair lined, heat resistant gloves.
Two - Hand scoops (size #1).
Two - Metal thermometers, 10 to 260°C (50 to 500°F), approximately 200 mm (8 inches) long with a 45 mm (1¾ inch) head.
Two - Laboratory thermometers, capable of reading at least 60°C in 1°C (140°F in 2°F) increments.
One - Cold chisel, approximately 40 mm (1½ inches) wide.
Two - Volumetric flasks having a capacity of at least 2000 mL (68 ounces); for use with the flask, a rubber stopper, and a connection, either molded in the flask or attached to the rubber stopper.
Two - Volumetric flasks having a capacity of at least 4000 mL (135 ounces); for use with the flask, a rubber stopper and a connection, either molded in the flask or attached to the rubber stopper.

One - Vacuum pump or water aspirator for evacuating air from the container. Vacuum system must be capable of removing entrapped air by subjecting the contents to a partial vacuum and maintaining a residual pressure of 3.7 ± 0.3 kPa (1.1 ± 0.1 inches Hg) for 15 ± 2 minutes. The vacuum system shall be equipped with a residual pressure manometer which reads in kilopascals (inches Hg), and a pressure release valve.

One - Plastic funnel to introduce mix into volumetric flask.

One - Syringe to adjust water level in flask.

Xylol for use as an asphalt solvent shall be furnished by the Contractor for the duration of the project.

For drum-mix plants, the facility shall be equipped with the following additional test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

One - Microwave oven with a minimum interior volume of 0.028 m^3 (1.0 ft^3) with defrost as well as normal mode of operation.

Six - Ovenproof glass dishes approximately 300 mm x 300 mm x 40 mm (12inches x 12 inches x 1½ inches).

All of the foregoing testing equipment shall be in good condition, calibrated and/or verified according to the Contractor's QC Plan schedule and/or the Agency provided schedule as applicable, and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The above mentioned equipment is for a one plant operation only. In the event the Contractor chooses to use more than one plant, the Contractor shall provide adequate laboratory facilities as deemed necessary by the Materials and Research Engineer for making tests.

(13) Safety Requirements. Adequate and safe stairways to the mixer platform shall be provided, and guarded ladders to other plant units shall be located where required for accessibility to plant operations.

All heated pipe lines adjacent to work areas, gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space. This space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. Adequate overhead protection shall be provided where necessary.

(14) Surge or Storage Bins. Surge or storage bins will be permitted for use in the production of bituminous items provided they are approved and inspected by the Materials and Research Engineer. A surge or storage bin shall be capable of storing the mix without any degradation of its properties. The surge or storage bins shall be covered during inclement weather to protect the stored mix from the elements. Should circumstances preclude paving operations, the Agency will not be obligated to purchase mix remaining in a surge or storage bin.

For continuous mixing and drum-mix plants, an approved recording weigh system shall be used on all surge bins.

When a surge bin is used in conjunction with a batch plant, the determination of pay quantities for the applicable Contract item shall be in accordance with the following procedure:

a. The plant will produce mix with the printer operating according to the standard requirements for this device. The mix will be deposited in the surge bin. A sequentially numbered ticket will be prepared for every normal load produced.

b. As each truck is loaded from the surge bin, the driver will be given the ticket previously prepared when the mix was produced for that bin. The truck driver will then deliver the ticket to the paving Inspector upon reaching the paving site.

c. The mass (weight) shown on the ticket will not be the actual mass (weight) of the mix contained in the truck since the truck was loaded from the surge bin. The bin shall be completely emptied at the end of every day, circumstances permitting, and all tickets delivered to the paving Inspector.

d. Any rejected or held over material shall be weighed on the platform truck scales. This quantity shall be deducted from the daily totals.

e. When paving ramps or other areas where a definite quantity is desired, the material required will be weighed on the platform scales and appropriate adjustments made in the daily totals obtained from the printer. These masses (weights) will be entered on the ticket or a separate ticket provided.

f. The plant Inspector will sign the first ticket of each day instead of initialing it. If the Inspector changes during the day, this procedure will be followed for each change. At the end of each day, the plant Inspector will inspect the storage bin to determine that it is empty and so note on the last ticket.

g. The paving Inspector will acknowledge receipt of the material at the paving site by initialing the lower right-hand corner of each ticket.

h. All standard checks of the weighing apparatus at the plant will be made at the prescribed intervals.

i. All mix produced for commercial customers and/or other projects must be discharged from bins other than those used for this project or directly from the pugmill into the haul vehicle; such mix shall not be loaded from the bin used for this project.

j. All surge bins shall be emptied each day unless written permission is obtained from the Materials and Research Engineer.

(b) Requirements for Batching Plants.

(1) Weigh Box or Hopper. The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales of ample size to hold a full batch without hand raking or running over.

The weigh box or hopper shall be supported on fulcrums and knife edges constructed so that they will not be easily thrown out of alignment or adjustment.

All edges, ends, and sides of weighing hoppers shall be free from contact with any supporting rods of columns or other equipment that will in any way affect proper functioning of the hopper. Also, there shall be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials.

The discharge gate of the weigh box shall be hung so that the aggregate will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing for the next batch.

(2) Aggregate Scales. Scales for any weigh box or hopper shall be springless dial or load cell with digital readout and shall be of standard make and design sensitive to 0.1% of the maximum load that may be required. Dials shall be free of vibration and shall be located to be plainly visible and readable to the operator at all times.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of ten 20 kg (50 pound) test masses (weights) or by other methods approved by the Materials and Research Engineer. All test masses (weights) shall be certified annually by the Division of Weights and Measures.

(3) Bitumen Bucket. The bucket for weighing bitumen shall be of sufficient capacity to hold and weigh the amount required for a batch in a single weighing.

The filling system and bucket shall be designed, sized, and shaped so that bitumen will not overflow, splash, or spill outside the confines of the bucket during filling and weighing.

The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units. It shall be able to deliver the bitumen in a thin uniform sheet or in multiple sprays over the full length of the mixer within a period of 15 consecutive seconds.

(4) Bitumen Scales. Bituminous material shall be weighed on scales that conform to the specifications for the weighing of aggregate. The value of the minimum graduation shall not exceed 1.0 kg (2.0 pounds).

(5) Mixer Unit for Batch Method. The plant shall include an approved, twin pugmill type batch mixer, jacketed or insulated and capable of producing a uniform mixture within the applicable job-mix tolerance. The mixer shall be so constructed as to prevent leakage and designed to provide a means of adjusting clearance between the mixer blades and liner plates.

(6) Recording. The recording system of the batch plant shall print the mass (weight) of the bitumen, the mass (weight) of the aggregate, and the total combined mass (weight) of both in addition to printing the combined net mass (weight) of each load.

(c) Requirements for Continuous Mixing Plants.

(1) Aggregate Proportioning. The plant shall be able to accurately proportion aggregate from each bin by mass (weight). The unit shall include interlocked feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to control the rate of flow of aggregate from each bin compartment. The opening shall be rectangular with one dimension adjustable by positive mechanical means. Locks shall be provided on each gate. Calibrated gauges with minimum graduations not exceeding 2.5 mm (0.1 inch) shall be provided for each gate to establish gate openings.

(2) Calibration of Aggregate Feed. The plant shall include a method to calibrate gate openings by means of test samples. The materials fed out of the bins through separate openings shall be bypassed to a suitable test box with the material for each compartment being confined in a separate box section. The plant shall be able to conveniently handle test samples with a mass (weight) of up to 365 kg (800 pounds) and to weigh them on accurate scales.

(3) Synchronization of Aggregate Feed and Bituminous Feed. Satisfactory interlocking control of the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source shall be provided. This control shall be accomplished by interlocking mechanical means or by another method under the Materials and Research Engineer's control and approved by the Materials and Research Engineer.

(4) Mixer. The plant shall include an approved twin, pugmill type continuous mixer, insulated or jacketed, and capable of producing a uniform mixture within the applicable job-mix tolerance. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix.

The mixer shall carry a manufacturer's plate indicating the net volumetric contents at several heights on a permanent gauge. The plate shall also indicate the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by the following formula:

Mixing time in seconds = Pugmill dead capacity in kilograms (pounds)

Pugmill output in kilograms (pounds) per second

The masses (weights) shall be determined by tests made under the direction of the Materials and Research Engineer.

(d) Requirements for Drum-Mix Plants.

(1) Aggregate Cold Bin Feeders. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. The feeding orifice shall be adjustable. Gravity type feeders will not be permitted. Indicators graduated to not more than 2.5 mm (0.1 inch) shall be provided on each orifice. Each aggregate feeder shall be interlocked so that production is interrupted if one or more cold bins become empty or the flow is obstructed.

(2) Mineral Filler System. When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall be able to feed the mineral filler at adjustable rates accurately and uniformly.

The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed. The filler shall be fed so that no filler is lost as fugitive dust.

(3) Aggregate Weighing Equipment. All aggregates, including mineral filler, shall be weighed by a continuous weighing device, either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of the National Bureau of Standards Handbook 44 and shall be installed according to the scale manufacturer's recommendations by a technician licensed by the Division of Weights and Measures. Any other type of weighing device shall be approved by the Materials and Research Engineer prior to use.

(4) Bitumen Control Unit. The bitumen shall be proportioned by a meter. A flow switch that will interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to 16°C (60°F).

(5) Proportioning Controls. All proportioning controls for aggregates, mineral filler, and bitumen shall be located at the panel which controls the mixer and temperature. The panel shall have a master control capable of increasing or decreasing the production rate without having to reset the individual controls.

a. Aggregate Feed Rate Control. The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The control shall maintain an aggregate flow accuracy such that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total mass (weight) of bituminous mixture per interval of time. When separate addition of mineral filler is required, it shall be added with an accuracy of 0.5% on the basis stated above for aggregates. The rate of aggregate flow shall be displayed on a meter and it shall be based on mass (weight) or percentage of dry aggregates.

b. Aggregate Mass (Weight) Indicator. The plant shall have an aggregate mass (weight) indicator which will display in the control room the mass of combined aggregates and mineral filler; it shall continuously accumulate the dry aggregate mass (weight) of material during the production period, generally one day. The indicator shall be resettable to zero and lockable.

c. Aggregate Moisture Compensator. The plant shall have a moisture compensation device capable of electronically changing the wet mass (weight) of aggregate to dry aggregate mass (weight). The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1%.

d. Bitumen Control. The plant shall have a bitumen control capable of presetting the actual bitumen content directly as a percentage based on total mass (weight) of mixture. The maximum gradation on the bitumen control shall be 0.1%. The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.

e. Bitumen Quantity Indicator. The plant shall have a bitumen quantity indicator in the control room indicating the accumulated quantity of bitumen during the production period, generally one day. The quantity indicated may be either mass (weight) or volume at 16°C (60°F). The indicator shall be resettable to zero and lockable.

(6) Recording of Proportions. The plant shall be equipped with an automatic digital recording device approved by the Materials and Research Engineer that simultaneously records the accumulated mass (weight) of both dry aggregate and bitumen separately during production time and on demand. All recordings shall show the date, including day, month and year, and time to the nearest minute for each print. The original recordings shall become the property of the Agency.

(7) Calibration of Feed Rates. The feed rates of aggregates from the cold bins, mineral filler when used and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous weighing device and the bitumen through the meter, respectively. The feed rates shall be checked periodically or at the direction of the Materials and Research Engineer.

(8) Automatic Aggregate Sampling Device. The plant shall have an automatic aggregate sampling device which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing.

The sampling tray shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to it mixing with bitumen.

(9) Mixer Unit. The plant shall have a drum mixer, approved by the Materials and Research Engineer, having an automatic burner control and capable of producing a uniform mixture within the job-mix tolerances. The mixture shall be discharged into a hot bituminous surge or storage bin meeting the requirements of this Section.

406.06 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be uniformly heated to the specified temperature. A continuous supply of the bituminous material shall be provided to the mixer at a uniform temperature at all times.

406.07 PREPARATION OF AGGREGATES. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid depositing soot or unburned fuel on the aggregate.

Immediately after heating, the aggregates shall be screened and conveyed into separate bins ready for batching and mixing with bituminous material.

If required to meet the gradation requirements, mineral filler shall be added in a manner approved by the Materials and Research Engineer after the aggregates have passed through the dryer.

The above preparation of aggregates does not apply for drum-mix plants.

406.08 MIXING. The dried aggregates shall be combined with the bituminous material in a manner that will produce a mixture which, when discharged from the mixing unit, shall be at the temperature specified on the approved mix design unless otherwise directed by the Materials and Research Engineer.

The dried aggregates shall be combined in the mixer in the appropriate proportions required to meet the job-mix formula and be thoroughly mixed prior to adding the bituminous material. Dry mix times shall be increased as deemed necessary by the Materials and Research Engineer in such cases that RAP material is introduced into the mixer.

The bituminous material shall be measured and introduced into the mixer in the amount determined by the Materials and Research Engineer for the material being used and at a temperature in accordance with Subsection 702.06, unless otherwise directed by the Materials and Research Engineer.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained. The wet mixing time shall be regulated by the Materials and Research Engineer and a suitable locking mechanism shall be provided for such regulation.

All plants shall have a means of eliminating oversized and foreign material from being incorporated into the mixer.

406.09 HAULING EQUIPMENT. To prevent the mixture from adhering to the beds, trucks used for hauling bituminous mixture shall have tight, clean, and smooth metal beds which have been thinly coated with a bond release agent. Petroleum based products will not be permitted.

The trucks used for hauling bituminous mixture shall be compatible with the equipment used for placing the bituminous mixture. Trucks are not to be cleaned and/or emptied on surfaces to be paved.

Each truck shall have a cover of canvas or other suitable material of sufficient size to extend over all sides of the haul vehicle to afford protecting the mix from the weather. When necessary to assure placement of material at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

406.10 PLACING EQUIPMENT. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly capable of being heated if necessary and capable of spreading the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross sectional shape.

Pavers shall be in good mechanical condition, equipped with all necessary attachments, and designed to operate electronically for controlling the grade of the finished surface. Bituminous pavers shall distribute the mixture over the entire width or over such partial width as may be practical. Additionally, pavers shall be equipped such that, upon extension of the screed a distance of 450 mm (18 inches) or more, auger extensions shall be used as directed by the Engineer.

The adjustments and attachments of the paver shall be checked and approved by the Engineer before placement of bituminous material.

Bituminous concrete pavers shall be equipped with a sloped plate to produce a tapered or notched tapered edge at longitudinal joints. The sloped plate shall produce a tapered or notched tapered edge having a minimum face slope of 1 vertical: 3 horizontal. The plate shall be able to accommodate compacted mat thicknesses from 35 mm to 100 mm (1¼ inches to 4 inches). The bottom of the sloped plate shall be mounted 10 mm to 15 mm (⅜ inch to ½ inch) above the existing pavement.

Bituminous pavers shall be equipped with a joint heater of at least 6250 BTU/min (110,000 W) capacity to heat the longitudinal edge of the previously placed mat to a surface temperature of 95°C (200°F), or higher if necessary, to achieve bonding of the newly placed mat with the previously placed mat without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately ahead of the screed. The joint heater shall be equipped with automated controls which shut off the burners when the paving machine stops and reignites them with the forward movement of the paver. The joint heater shall heat the entire area of the previously placed wedge to the required temperature. Heating to the point of 95°C (200°F) or higher shall immediately precede placement of the bituminous material.

406.11 ROLLERS. Rollers shall be in good mechanical condition, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The mass (weight) of the rollers shall be sufficient to compact the mixture to the required density without crushing the aggregate. Rollers shall be equipped with tanks and sprinkling bars for wetting the rolls or tires.

Pneumatic-tired rollers shall be equipped with appropriate skirts at all times and be preheated prior to use in order to avoid picking. The Contractor shall remove all picked material from the surface.

Vibratory rollers shall have separate controls for energy and propulsion. They shall be equipped with automatic cutoffs that stop the vibration prior to the roller stopping and/or reversing its direction of travel.

406.12 CONDITIONING OF EXISTING SURFACE. All surfaces shall be cleaned and sprayed with an emulsion meeting the requirements of Emulsified Asphalt, RS-1 before placing of any bituminous mixture, unless otherwise ordered by the Engineer. The emulsion shall be applied under pressure at a rate of 0.05 to 0.14 L/m² (0.01 to 0.03 gallons/yd^2). The application shall be made just prior to the placement of the bituminous concrete mixture and shall progress sufficiently ahead of the paving so that the surface to be paved will be “tacky”. Equipment used to apply the emulsion shall meet the requirements for distributors specified in Subsection 404.04.

Prior to paving, bridge decks shall be treated as detailed on the Plans.

Prior to paving, all large cracks in the bituminous surface shall be thoroughly cleaned and filled with a bituminous material or mixture approved by the Engineer. Large cracks are defined as at least 25 mm (1 inch) in width.

Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Emulsified Asphalt, RS-1 immediately before the bituminous concrete mixture is placed against them.

If there are deficiencies that require corrective action in the base course constructed under the Contract, a bituminous concrete mix approved by the Engineer shall be used to bring the base course to the designed grade and contour.

Where Bituminous Concrete Pavement is used to resurface existing pavements and the existing pavement contains irregularities, depressions, or waves, such deficiencies shall be eliminated by the use of extra bituminous material for spot leveling to bring existing base to uniform section and grade before placing of the required courses of bituminous concrete pavement.

406.13 PLACING AND FINISHING. The finished surface shall be of uniform texture and evenness and shall not show tearing, shoving, or pulling of the mixture.

At the time of discharge from the haul vehicle, the bituminous mixture shall be within 6°C (10°F) of the compaction temperature for the approved mix design.

The Contractor shall, during all phases of the paving operation, protect from damage all exposed surfaces that are not to be treated.

The bituminous mixture shall be placed and finished with the specified equipment, shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness, and shall conform to the grade and elevation specified.

When operating in tandem on multi-lane paving, the pavers shall be of the same type and have the same characteristics. Material for leveling may be spread by the use of a grader, if approved by the Engineer.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, luted, and compacted by hand methods.

All material shall be produced early enough in the day in order that the completion of spreading and compaction of the mixture will occur during daylight hours, unless night paving has been approved for the project.

No traffic will be permitted on placed material until the material has been thoroughly compacted and has cooled to 60°C (140°F) unless otherwise authorized by the Engineer.

The use of water to cool the pavement will not be permitted.

The Agency may require that all work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, be completed prior to placing the wearing course when such work could cause damage to the pavement.

When bituminous concrete pavement is to be placed on a bridge deck having a waterproofing membrane, a rubber-tired or rubber tracked paver shall be used to place the binder course of pavement.

On projects where traffic will be maintained, the Contractor may be required to schedule daily paving operations such that at the end of each work day all travel lanes of the roadway on which work is being performed will be paved to the same limits or as directed by the Engineer.

Suitable permanent aprons or temporary fillets shall be constructed at side road intersections and driveways as directed by the Engineer within 24 hours of adjacent mainline paving. Permanent aprons shall be constructed within 5 working days of adjacent mainline paving. Reasonable access to and from the mainline mat shall be maintained at all times.

406.14 COMPACTION. Immediately after the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, tearing, or shoving. Should the mix exhibit these characteristics, and the Contractor is unable to remedy these conditions to the satisfaction of the Engineer, both placement and approval of the mix design will be terminated.

The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally, one breakdown roller will be needed for each paver used in the spreading operation.

Leveling courses shall be compacted using a self-propelled pneumatic-tired roller unless otherwise directed in writing by the Engineer. On base, binder, and wearing courses, the initial or breakdown rolling shall be done by using a two-axle tandem roller; intermediate rolling shall be done by using a two-axle tandem roller or self-propelled pneumatic-tired roller; and final rolling shall be done by using an additional two or three-axle tandem roller. The equipment used for shoulder construction shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

To prevent adhesion of the mixture to the rollers, the rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid and petroleum products will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hand tampers, smoothing irons, or mechanical tampers coated with a non-petroleum based bond release agent. On depressed areas, a trench roller or cleated compression strips under the roller may be used to transmit compression to the depressed area.

Unless otherwise directed, the longitudinal joint shall be rolled first and then rolling shall begin at the low side of the pavement and proceed towards the center or high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller shall be kept in as continuous an operation as practicable. Rolling shall continue until all roller marks and ridges have been eliminated.

Rollers shall not be stopped or parked on new, freshly placed bituminous material.

Any mixture that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced with fresh hot mixture which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bitumen shall be removed and replaced. These replacements shall be at the Contractor's expense.

Should the Contractor choose to use vibratory rollers, the following additional criteria shall govern their operation:

Vibratory rollers may be used when operated at an amplitude, frequency, and speed that produces a mat conforming to specifications and which prevent the creation of transverse ridges in the mat. Vibratory rollers may be used as a breakdown roller, an intermediate roller, or a finish roller. They shall not be used as a substitute for a pneumatic-tired roller on leveling courses, nor shall they be used for compacting lifts of pavement under 25 mm (1 inch) in depth. A single vibratory roller shall not be used alone as the breakdown, intermediate and finish roller, but may be used as any one of the rollers in the roller train.

If the Engineer determines that unsatisfactory compaction is being obtained, unacceptable surface distortion is occurring, or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment and proceed in accordance with the fourth paragraph of this Subsection. All requirements of this Subsection shall apply regardless of compaction equipment used.

The Contractor assumes full responsibility for, and shall repair at the Contractor's expense, all damages which may occur to highway components and adjacent property if vibratory compaction equipment is used.

If the Agency elects to not take cores of any pavement course, the Density Pay Factor (PF(d)) will be considered equal to 0.000.

Leveling courses will not be analyzed for density.

For projects less than or equal to 0.8 km (0.5 miles) in length, Bituminous Concrete Pavement and Medium Duty Bituminous Concrete Pavement will be analyzed for density according to the procedure specified below.

The density of the compacted pavement shall be at least 92.5%, but not more than 96.5%, of the corresponding daily average maximum specific gravity for each mix type (each mix design) of bituminous mix placed during each day. For material that falls outside of this range, payment will be made by adjusting the daily production totals in accordance with the following Table:

TABLE 406.14A – DENSITY PAY FACTORS

AVERAGE DENSITY	DENSITY PAY FACTOR, PF(d)
90.5% - 90.9%	- 0.100
91.0% - 91.4%	- 0.075
91.5% - 91.9%	- 0.050
92.0% - 92.4%	- 0.025
92.5% - 93.4%	0.000
93.4% - 95.4%	0.010
95.5% - 96.5%	0.000
96.6% - 97.0%	- 0.025
97.1% - 97.4%	- 0.050
97.5% - 98.0%	- 0.075
98.1% - 98.5%	- 0.100

For material with an average density that is less than 90.5% or in excess of 98.5%, the Construction Engineer will evaluate whether the material will be removed and replaced by the Contractor at no expense to the Agency or a greater penalty imposed.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores extracted and provided by the Contractor.

Acceptance testing to verify density of the compacted pavement will be done by averaging the densities of a minimum of 4 cores for each day's production for each type of bituminous mix placed, excepting shim/leveling courses.

The cores taken for acceptance testing will be the final cores taken for determination of densities.

For projects greater than 0.8 km (0.5 miles) in length, Bituminous Concrete Pavement and Medium Duty Bituminous Concrete Pavement will be analyzed for density according to the procedures specified in Subsections 406.14 (a) and 406.14 (b).

(a) Quality Level Analysis. Compacted bituminous concrete pavement specified to be sampled and tested using bituminous concrete pavement core samples for the purpose of determining density will be analyzed by utilizing the statistical quality level analysis "Percent Within Limits" (PWL) method as defined in Subsection 106.03.

(b) Quality Acceptance.

(1) Bituminous concrete mixtures will be sampled once per sublot using a stratified random sampling procedure in accordance with ASTM D 3665 and tested and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following guidelines:

TABLE 406.14B- ACCEPTANCE GUIDELINES

PROPERTY	POINT OF SAMPLING	LOT SIZE	TEST METHOD
Density	Compacted In-Place	Daily -24 Hour Max	AASHTO T166 Method A, T 209

(2) For the purpose of evaluating acceptance test properties, a lot shall consist of the total quantity of bituminous concrete mixture compacted in-place during any one day's production to a maximum of 24 hours. Sampling shall be performed at the rate of one sample per lane kilometer (0.6 mile), with the exception that there shall not be fewer than six samples taken per any one day's production. The quantity represented by each sample shall constitute a sublot.

(3) Density Pay Factor (PF(d)) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Limit (RQL) of 60%, the PF for each lot of bituminous concrete mixture, based on density test results, will be determined by using the applicable equation below:

Where $85 \leq PWL \leq 100$, $PF(d) = ((0.20\ PWL + 83) / 100) - 1.0$

or

Where $60 \leq PWL < 85$, $PF(d) = ((0.40\ PWL + 66) / 100) - 1.0$

The PF for each lot of bituminous concrete mixture used for low production activities not associated with any traveled way paving operations will be 1.0. Low production activities are defined as those not associated with traveled way paving operations and having a maximum daily production of 500 metric tons (tons) of bituminous concrete mixture.

(4) The density of the compacted pavement shall not be less than 92.5% nor more than 96.5% of the corresponding maximum specific gravity for each mix type (each mix design) placed per lot.

(5) It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores provided by the Contractor in accordance with the coring protocol below.

(c) Coring Protocol. Original core sampling locations will be restricted to travel lanes only and will not include those areas within 150 mm (6 inches) of a longitudinal joint nor within 15 m (50 feet) of a transverse joint. That area encompassing a longitudinal tapered joint will not be selected as a sampling location. Independent shoulder and mat area core sampling locations may be selected by the Engineer to afford verification of Subsection 406.14(b)(4).

Original core sampling locations will be selected by the Engineer or designee in accordance with ASTM D 3665 within two working days of the bituminous mixture being placed. The Contractor will be advised in writing of the selected sampling locations.

The Contractor may challenge whether any particular original sample location(s) is representative of any particular lot by notifying the Engineer. This notification shall be made immediately upon the sublot location(s) being selected, conveyed to the Contractor, and being prior to extracting the cores, and shall be further documented in any Contractor job records citing just reasoning for recommending a reselection of original sample location(s).

Upon receipt by the Engineer of a challenge from the Contractor, the Engineer will evaluate it within one working day and notify the Contractor in writing of either acceptance or rejection of the challenge. Rejection of a challenge will result in the Engineer using the original core sampling locations for the determination of density data in any compaction pay factor calculations. Acceptance of a challenge will result in the Engineer selecting alternate core sampling location(s) for those challenged samples. Alternate core sampling location(s) will be selected by the Engineer by use of a new random number(s) to determine a new longitudinal coordinate(s) within the sublot in question. The transverse coordinate(s) of the original core sampling location(s) will be used in conjunction with the new longitudinal coordinate(s) to determine the alternate sampling location(s). The alternate core sampling location(s) will not be subject to further challenge and will be used for the determination of density data in any compaction pay factor calculations. The Contractor will be notified in writing of the final core sampling location(s).

Within one working day of final selection of the core sampling locations, the Contractor shall core in the presence of the Engineer or designee and shall deliver the samples to the Engineer, in a suitable container provided by the Contractor, on the same day the samples are taken. The Engineer will identify and record the core samples. Any cores not delivered in a suitable container will be rejected and new cores taken at the Contractor's expense. The Contractor shall fill the core holes, at the Contractor's expense, with hot (minimum 90˚C (200˚F)) bituminous concrete pavement on the same day that cores are taken. Failure to comply with the provisions of this paragraph may result in payment being withheld for the representative lot of bituminous material.

Cores shall be taken in accordance with the 2004 version of AASHTO T 230, Method B. Agency personnel will process core samples within ten working days and will relay test results to both the Engineer and Contractor. Testing will be performed in accordance with AASHTO T 166, Method A for bulk specific gravity (B) and AASHTO T 209 for maximum specific gravity (M) from tests performed at the plant lab for that day. All cores will be sawcut. The Contractor shall mark the cores for sawcutting in the presence of the Engineer or designee for verification of cut locations. The degree of compaction (DC) will be determined as follows:

$$DC = (B/M) \times 100$$

To satisfy the requirements of part (d) of this Subsection, physical core samples will be retained for a period of two working days from the time that DC test results are relayed to the Engineer and Contractor. In addition, any subsequently "retested" or "recored" samples, as defined in part (d), will be retained to the point of fully satisfying part (d).

(d) Core Result Verification. Upon the test results required in part (c) being relayed to both parties (the Engineer and Contractor), any individual core sample result considered to be an outlier as determined in accordance with ASTM E 178 will enter a core result verification process as defined herein. This process will consider only those core samples processed by the Agency as acceptance tested samples and does not preclude the provisions of Subsection 490.14(e).

The core result verification process consists of four levels as follows:

(1) Level 1. The Agency will perform a statistical analysis on all lots of core sample compaction values to investigate any presence of statistical outlier(s) as determined in accordance with Table 1 of ASTM E 178 at a 5% significance level. In cases where a statistical outlier is not detected, all core sample results as reported under part (c) will be used in any compaction pay factor calculations.

When an outlier is determined to exist, the core sample representing that outlying result will be retested to ensure procedural integrity (support information accuracy, testing methodology, and mathematical accuracy). The core sample "retested" results will replace the original “outlier” core sample results for any future calculations within this Level. Should it be verified at this point that an outlier does in fact exist or the core sample retested results vary from those originally obtained, the options to either party will be either to compute any compaction pay factors using all core sample test results derived through this Level or to proceed to Level 2.

(2) Level 2. Level 1 outlier core sample results will be replaced by virtue of "recored" sample results to be obtained under this Level. The recoring location shall be at the same transverse offset as the original location and shall be offset longitudinally forward 450 mm (18 inches) from the original location. The recored sample will be tested as specified in part (c) and may reenter Level 1 analysis of this Subsection up to and including the point of ensuring procedural integrity. The recored sample will not reenter Level 2 analysis.

Upon receiving recored sample test results of this Level, the options to either party will be either to compute any compaction pay factors using those recored sample test results or to state reasons for belief that said recored sample test results are in error. Receipt of reasons shall be cause for this verification process to proceed to Level 3.

(3) Level 3. A final attempt at field resolution of core sample test results will be addressed under this Level by introduction of a third party testing facility. Selection of such a facility will be discussed and mutually agreed upon by both parties prior to beginning construction activities and will not be included in project QC or acceptance testing processes. Any findings of a third party facility will become final and will not be subject to further review. Payment to a third party for services rendered will be borne by the party having provided the Level 2 reasons leading to Level 3.

The recored samples from Level 2 shall be provided to the third party testing facility. The facility will process the recored samples and provide results to both the Agency and Contractor. Upon receipt of the third party recored sample test results, the options to either party will be either to compute any compaction pay factors using these results or to proceed to Level 4.

(4) Level 4. At this level, the Agency and Contractor will defer to Subsection 105.02. Both parties shall submit to the Director of Program Development a written report describing the disparity, all subsequent actions taken to date, all documentation related to these actions, and a proposed course of action for settlement. The Director will review the submittals and all relevant project records and act in accordance with Subsection 105.02.

If the Contractor does not concur with any final decision by the Director, the Contractor may seek other remedies specified under Subsection 105.02 and the Contract.

(e) Rejected Material. For those lots with a PWL less than 60% and having satisfied the requirements of part (d), the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency provided one of the following are met:

- lot standard deviation (s) greater than 2.0 or
- lot average density ($\bar{x}$) greater than 98.0% or
- lot average density ($\bar{x}$) less than 90.0%.

In addition, and at the discretion of the Contractor, any lot of rejected material not meeting any of the above criteria may be removed and replaced at no additional cost to the Agency. If removal and replacement is not implemented, any lot of rejected material not meeting any of the above conditions will have any compaction pay factors calculated as follows:

$$PF(d) = (- 0.05625 \ \bar{x}^2 + 10.575 \ \bar{x} - 496.125) - 1.0$$

In such cases that this Subsection applies, any PF(d) as computed above will be the solitary pay adjustment to the representative lot as per the provisions of Subsections 406.18 and 406.19. Other applicable pay adjustments of the representative lot will be considered to equal 1.00.

406.15 JOINTS. Joints between old and new pavements, or between successive day's work, shall have a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a transverse joint constructed.

Transverse butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at a location approved by the Engineer, where the pavement has a true surface as determined by the use of a straightedge at least 4.9 m (16 feet) long. The transverse joint shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to depositing new paving mixture.

Transverse tapered joints shall be formed by ramping down the last 450 to 600 mm (18 to 24 inches) of the course being placed to match the lower surface. Care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to resuming paving. As the paver places new mixture on the taper area, placement shall proceed such that an evenly graduated deposit of mixture will complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake and properly rolled, with coarse material discarded.

Longitudinal joints that have become cold shall be coated with Emulsified Asphalt, RS-1 before the adjacent mat is placed. If directed by the Engineer, such joints shall be cut back to a clean vertical edge prior to coating with the emulsion.

Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 150 mm (6 inches) from any joint in the lower courses of pavement. Transverse joints shall not be constructed nearer than 300 mm (12 inches) from the transverse joints constructed in lower courses.

Those projects having a centerline length in excess of 5 km (3 miles) shall also be subject to the following provisions:

(a) General. For the purpose of evaluating longitudinal joint compaction acceptance, a lot shall consist of the total project length of joint constructed per pavement course and total project quantity of bituminous concrete mixture compacted in place per pavement course. Sampling on constructed joints shall be performed by way of minimum 150 mm (6 inch) diameter core samples taken at the rate of two per joint kilometer (two per joint mile) per lot. Sample locations will not include those areas within 15 m (50 feet) of a transverse joint. Each individual core sample shall represent a project sublot. Once selected per that method in part (b) below, sample locations will become final and not subject to revision, nor will any core sample be subject to the provisions of Subsection 406.14 (d).

(b) Sampling. Bituminous concrete mixtures will be sampled once per sublot on a stratified random sampling procedure in the longitudinal direction in accordance with ASTM D 3665. For a longitudinal butt joint, the transverse location of the sample shall be centered on the visible surface joint line. For a tapered joint, the transverse location of the sample shall be offset from the visible surface joint line approximately 50% of the taper width as directed by the Engineer. Joint core samples shall be taken between any adjacent travel lanes and between any travel lane and shoulder provided the shoulder material was placed as a separate construction operation. All samples will be tested and evaluated by the Agency for each mix type (each mix design), excluding leveling/shim courses, for each project in accordance with the following:

TABLE 406.15A – ACCEPTANCE GUIDELINES

Property	Point of Sampling	Lot Size	Test Method
Density	Compacted-In-Place	Project (1)	AASHTO T 166, Method A and T 209

For determining the degree of compaction, the maximum specific gravity (Gmm) used in the calculation shall be the average of the two Gmm values of the materials placed to construct the joint. The calculated compaction of any individual joint core sample shall not be less than 90.0% of the corresponding maximum specific gravity of the average of the two Gmm values for each mix type (each mix design) placed per lot.

(c) Longitudinal Joint Pay Factor (PF(j)) Determination. In such case that an individual core sample (sublot) is above the minimum compaction as specified in part (b) above, it shall be defined as above minimum.

Upon completion of any individual lot, the percentage of sublots equal to or above the acceptable minimum compaction shall be defined as the lot Percent Above Minimum (PAM) and shall be used as the basis for determining pay factors as follows:

For $85 \leq PAM \leq 100$, $PF(j) = 0.01$
For $75 \leq PAM < 85$, $PF(j) = 0.00$
For $0 \leq PAM < 75$, $PF(j) = -0.01$

406.16 SURFACE TOLERANCE. The surface will be tested by the Engineer using a straightedge at least 4.9 m (16 feet) in length at selected locations parallel with the centerline. Any variations exceeding 3 mm (1/8 inch) between any two contact points shall be satisfactorily eliminated. A straightedge at least 3 m (10 feet) in length may be used on a vertical curve. The straightedges shall be provided by the Contractor in accordance with Subsection 631.06.

For those projects having a centerline length of 0.8 km (0.5 miles) or greater, the surface roughness of the wearing course will be additionally measured by the Engineer or the Engineer's designee with an Agency provided Road Surface Profiler (RSP) to determine a surface tolerance pay factor (PF(r)). The Engineer will contact the Agency's Pavement Management Section Project Manager to arrange for surface testing.

The surface will be tested by Agency personnel by traveling at highway speeds once in each direction on two-lane/two-way non- limited access State Highways and other Routes as applicable. For those two-way limited or non-limited access highways containing truck or passing lanes, only the rightmost lane will be tested in any given direction. The reported International Roughness Index (IRI) value will be the average as calculated based upon travel in both directions. Two-lane divided Interstate Highways and other applicable limited access highways will have both of the passing and travel lanes tested at highway speeds, with the reported IRI value being the average as calculated based upon travel in both lanes. For those Interstate or other applicable limited access highways having both barrels of the highway constituting the project, the reported IRI value will be that average value as calculated based on travel in both lanes of both barrels.

Prior to the highway being surface tested, all Contract items shall be complete such that the project could be deemed substantially complete, unless otherwise directed by the Engineer, including but not limited to all guardrail, bridge joints, and permanent pavement markings installed, including all side road markings, and there shall not be lane closures or equipment present that would impede highway travel. Additionally, and prior to the highway being surface tested, the highway surface shall be dry and free of snow, ice, and loose debris, and the ambient air temperature shall be a minimum of 5°C (40°F).

The roughness value used in the applicable formula below will be the average of the International Roughness Index (IRI) values measured by the RSP in each lane. The roughness associated with any anomalous features beyond the control of the Contractor, such as bridges that remain unpaved, will be eliminated from the calculations of the final project average. The corresponding Surface Tolerance Pay Factor (PF(r)) will be determined as follows and applied to the corresponding lot as defined below:

Limited Access Highways: $PF(r) = (- 0.0029\ IRI + 1.1500) – 1.0$
All Other State Routes: $PF(r) = (- 0.0029\ IRI + 1.1786) – 1.0$

For the purpose of evaluating surface tolerance acceptance, a lot shall consist of the total project quantity of wearing surface of bituminous concrete pavement constructed and measured in place. Said measurement shall include all shoulders, side roads, drives, and any other miscellaneous mix as measured by the Engineer.

406.17 TRAFFIC CONTROL. Whenever traffic must be maintained during a paving operation, uniformed traffic officers and/or flaggers shall be stationed at each end of the section being paved and at such other locations as may be required by the Engineer. The uniformed traffic officers or flaggers shall conform to the requirements of Section 630.

Whenever one-way traffic is maintained by the Contractor, the traveling public shall not be delayed more than 10 minutes unless otherwise directed by the Engineer. Two-way traffic shall be maintained during non-working hours.

406.18 METHOD OF MEASUREMENT. The quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement to be measured for payment will be the number of metric tons (tons) for a lot of mixture (each type) complete in place in the accepted work as determined from the weigh tickets.

The quantities of all applicable Pay Adjustments calculated for the project will be determined as specified below.

When applicable, and when the air voids pay factor, PF(av), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine an Air Voids Pay Adjustment, (PA(av)), to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(av) = PF(av) \times Q \times B$$

When boxed samples are taken to determine mix properties, PF(av) shall be assumed as equal to 0.000 for a “single day” lot. Additionally, when the RQL of 50% is not attained for a lot, all other applicable pay factors for that lot shall not be greater than 1.000.

When applicable, and when the density pay factor, PF(d), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Mat Density Pay Adjustment, (PA(d)), to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(d) = PF(d) \times Q \times B$$

When applicable, and when the surface tolerance pay factor, PF(r), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of wearing surface of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed will be multiplied by such pay factor to determine a Surface Tolerance Pay Adjustment, (PA(r)), to the tonnage placed (Q) for that lot as based on the Contract bid price (B), as follows:

$$PA(r) = PF(r) \times Q \times B$$

When applicable, and when the longitudinal joint pay factor, PF(j), for a lot of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Longitudinal Joint Compaction Pay Adjustment, (PA(j)), to the tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(j) = PF(j) \times Q \times B$$

When the material for any lot is removed from the project under any provisions of the Contract, no payment will be made for that material nor for any applicable Pay Adjustments under this Section.

406.19 BASIS OF PAYMENT. The accepted quantity of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement will be paid for at the Contract unit price per metric ton (ton). Payment shall be full compensation for furnishing, mixing, hauling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for Pay Adjustments shall be debited or credited against the Contract prices (Lump Units) bid for the applicable Pay Adjustment items.

The costs of furnishing testing facilities and supplies at the plant will be considered included in the Contract unit price of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, as appropriate.

The costs of obtaining, furnishing, transporting, and providing the straightedges required by Subsection 406.16 will be paid for under the appropriate Section 631 pay item included in the Contract.

The cost of taking cores for acceptance testing and filling the cored holes will be incidental to the Contract item being cored. All other costs associated with obtaining samples for acceptance testing will be incidental to the cost of the Section 406 pay item. The cost of traffic control for taking cores for acceptance testing and filling the core holes will be paid under the appropriate Section 630 Contract item.

When not specified as items in the Contract, the costs of cleaning and filling joints and cracks, sweeping and cleaning existing paved surfaces, the emulsified asphalt applied to tack these surfaces, and tacking of manholes, curbing, gutters, and other contact surfaces will not be paid for directly, but will be incidental to the item of Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, as appropriate.

Bituminous concrete mixture approved by the Engineer for use in correcting deficiencies in the base course constructed as part of the Contract will not be paid for as Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, but will be incidental to the Contract item for the specified type of base course.

The bituminous concrete mixture used to correct deficiencies in an existing pavement or to adjust the grade of a bituminous concrete surface completed under the Contract will be paid for at the Contract unit price for Bituminous Concrete Pavement or Medium Duty Bituminous Concrete Pavement, as appropriate.

Payment will be made under:

Pay Item	Pay Unit
406.25 Bituminous Concrete Pavement	Metric Ton (Ton)
406.27 Medium Duty Bituminous Concrete Pavement	Metric Ton (Ton)
406.28 Air Voids Pay Adjustment	Lump Unit
406.29 Mat Density Pay Adjustment	Lump Unit
406.30 Surface Tolerance Pay Adjustment	Lump Unit
406.31 Longitudinal Joint Compaction Pay Adjustment	Lump Unit

SECTION 409

THIS SECTION RESERVED

SECTION 415 - COLD MIXED RECYCLED BITUMINOUS PAVEMENT

415.01 DESCRIPTION. This work shall consist of cold planing and crushing and/or screening the existing bituminous pavement, adding additional asphalt emulsion, and mixing and repaving of the material to the depths, lines, and grades shown on the Plans.

Recycling of the existing pavement shall be performed in a manner that does not disturb the underlying materials.

415.02 MATERIALS. The emulsified asphalt for Cold Mixed Recycled Bituminous Pavement shall meet the requirements of Section 404 and/or be as recommended by the Contractor as a result of Subsection 415.08 and as approved by the Engineer. The grade and initial application rate, based on emulsion rate-density curves (AASHTO T 245 - Mod., 50 blows) developed from test section material, shall be recommended by the Contractor and accepted by the Engineer. The value for the emulsion rate shall be based on the optimum for achieving maximum density. The exact application rate may be varied by the Contractor as required by existing pavement conditions and approved by the Engineer.

The Cold Mixed Recycled Bituminous Pavement shall meet the following gradation requirements for extracted aggregate taken from the pulverized material:

Sieve Size	Percent Passing
37.5 mm (1½ inches)	100
25.0 mm (1 inch)	90-100
4.75 mm (No. 4)	30- 70
75 µm (No. 200)	0- 12

415.03 EQUIPMENT. The Contractor shall furnish a self-propelled machine capable of planing the existing bituminous pavement to the depth shown on the Plans in one pass. The machine shall be equipped with standard automatic depth controls and must maintain a constant cutting depth and width. The machine shall be capable of producing the proper size material required, or additional screening and/or crushing will be required. Oversized particles shall be reduced to proper size by crushing.

Mixing equipment shall be provided which is capable of mixing the sized bituminous material and liquid binder into a homogeneous mixture. The mixing equipment shall be equipped with weighing and metering devices which assure that the correct amount of sized material and proper amount of emulsion are introduced into the Cold Mixed Recycled Bituminous mixture. The method of depositing the mixed material shall be such that segregation does not occur.

Placing of the Cold Mixed Recycled Bituminous Pavement shall be accomplished with a self-propelled bituminous paver. The Cold Mixed Recycled Bituminous material shall be spread without segregation to the lines and grades shown on the Plans or as directed by the Engineer. If a pick-up machine is used to feed a windrow of the bituminous material into the paver hopper, the pick-up machine shall be capable of picking up the entire windrow down to the underlying materials.

The number, mass, and type of rollers shall be sufficient to obtain the required uniform density, full depth, while the mixture is in a workable condition. A rubber tire roller shall perform the initial rolling after the emulsion initially "breaks" (indicated by color change from brown to black).

415.04 WEATHER AND SEASONAL LIMITATIONS. Recycling operations shall not be performed when the ambient air temperature is below 10°C (50°F), when the surface temperature of the pavement to be recycled is below 10°C (50°F), when the weather is foggy or rainy, or when weather conditions or predicted weather conditions are such that proper mixing, spreading and compacting of the recycled material cannot be accomplished.

When it is in the public interest for servicing traffic, the Construction Engineer may adjust the ambient air and/or pavement temperature requirements or extend the dates of the recycling season.

415.05 MOISTURE. The Contractor may add, under positive control, a small amount of water to the planed material to facilitate uniform mixing with the emulsion. The water may be added prior to the mixing phase of the operation. The water shall be added carefully so as not to cause any adverse affect.

415.06 COMPACTION. Compaction shall be performed while the emulsion is in a workable state. The Cold Mixed Recycled Bituminous Pavement material shall be finished within a grade tolerance of ± 12mm (½ inch), provided that this deviation is not maintained for a distance longer than 15 meters (50 feet), and provided that the required crown or superelevation is maintained.

The Cold Mixed Recycled Bituminous Pavement shall be compacted to a minimum of 95% of the target density approved by the Engineer in accordance with Subsection 415.08.

415.07 CURING AND STABILITY. The Cold Mixed Recycled Bituminous Pavement may be opened to traffic as approved by the Engineer.

Hot mixed bituminous concrete pavements shall not be placed until the Cold Mixed Recycled Bituminous Pavement material has been allowed to cure and the free moisture content is reduced to a maximum of one and one-half percent (1½%).

The required density shall be achieved and maintained until a hot mixed bituminous concrete pavement has been placed. Any additional compactive effort or repair of imperfections in the Cold Mixed Recycled Bituminous material shall be performed as directed by the Engineer at no additional compensation to the Contractor.

415.08 CONTROL SECTION. The Contractor shall be responsible for performing all Process Control and Quality Control sampling and testing.

Process Control sampling and testing shall involve taking a set of four representative samples from the test section. The samples may be taken either before or after the cold recycling process. The four samples shall be combined to represent a uniform sample for determining maximum density. The material used, including that used for the Marshall series to determine the optimum emulsion rate, shall be in a processed pulverized state replicating the state which the material will be in immediately prior to the point when the emulsified asphalt is introduced during the recycling process.

The Contractor shall perform the Marshall Design series tests to determine the maximum density. A maximum density shall be obtained by performing a series of tests using the 50 blow Marshall Design method (AASHTO T 245 - Mod.). The series of Marshall tests shall be prepared using a minimum of five different percentages of emulsion. The maximum density obtained from these tests shall be used as the recommended target density to be approved by the Engineer.

The Contractor shall perform all tests necessary to verify that the target density is achieved and maintained prior to placement of a hot bituminous overlay. The necessity for additional testing will be determined by the Engineer. The Contractor shall provide the Engineer with the original copies of all Marshall Design series, Process Control, and Quality Control test results.

The Contractor shall construct a control section to assure the Engineer that the Contractor's equipment and procedure are suitable for the work specified and are capable in achieving the density specified. If the control section does not meet the requirements of this specification, or the density achieved does not appear suitable, the Contractor shall modify his/her procedure and either construct another control section or reconstruct the original until acceptable results are obtained. The suitability of results will be determined by the Engineer.

The length of the control section shall be 150 m to 300 m (500 feet to 1000 feet). No further recycling shall be performed on the project until all aspects of the test section are approved by the Engineer.

415.09 METHOD OF MEASUREMENT. The quantity of Cold Mixed Recycled Bituminous Pavement to be measured for payment will be the number of square meters (square yards) of existing pavement which has been recycled in an acceptable manner as determined by actual surface measurements of the lengths and widths of the recycled area as shown on the Plans or as directed by the Engineer. No additional compensation will be made for overlapping areas.

The quantity of Emulsified Asphalt, Cold Mix to be measured for payment will be the number of kilograms [hundredweight (CWT)] used in the complete and accepted work.

415.10 BASIS OF PAYMENT. The accepted quantity of Cold Mixed Recycled Bituminous Pavement will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Emulsified Asphalt, Cold Mix will be paid for at the Contract unit price per kilogram [hundredweight (CWT)] for the specified material applied. Payment will be full compensation for furnishing, transporting, and placing the material and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
415.20 Cold Mixed Recycled Bituminous Pavement	Square Meter (Square Yard)
415.25 Emulsified Asphalt, Cold Mix	Kilogram (CWT)

SECTION 417 - BITUMINOUS CRACK SEALING

417.01 DESCRIPTION. This work shall consist of furnishing and placing crack sealing material in the cracks of existing bituminous concrete pavement.

417.02 MATERIALS. Materials shall meet the requirements of the following Subsection:

Joint Sealer, Hot Poured ..... 707.04(a)

The Contractor shall provide the Engineer with a copy of the material manufacturer's recommendations pertaining to heating, application, and reheating prior to the beginning of operations or the changing of materials.

417.03 EQUIPMENT. Equipment shall meet the approval of the Engineer and shall be maintained in working condition at all times.

(a) Air Compressor. Air compressors shall be portable and capable of furnishing not less than 2.8 m^3 (3.7 yd^3) of air per minute at not less than 620 kPa (90 psi) pressure at the nozzle. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water.

(b) Hand Tools. Hand tools shall consist of brooms, shovels, metal bars with chisel-shaped ends, squeegees, and any other tools which may be required to accomplish the work.

(c) Melting Kettle. The melting kettle shall be a double boiler, indirect fired portable type. The space between the inner and outer shells shall be filled with a suitable heat transfer oil or substitute having a flash point of not less than 277°C (531°F). The kettle shall be equipped with a satisfactory means of agitating the joint sealer. This may be accomplished by continuous stirring with mechanically operated paddles and/or by a continuous circulating gear pump attached to the heating unit. The kettle shall be equipped with thermostatic control calibrated between 93°C and 288°C (200°F and 550°F). The kettle shall be mounted on rubber tires and be equipped with a metal shield beneath the firebox to protect the pavement.

(d) Application Wand. The application wand shall apply a controlled flow of material via an insulated or heated hose. The nozzle shall distribute the material as called for on the Plans or this specification. A pressure regulator shall be provided to regulate pressure at the nozzle. A bypass line into the holding tank is required for use when the nozzle is shut off.

(e) Router. Equipment for preparing cracks shall be a rotary impact type cutter or a diamond-blade crack saw which will provide a reservoir of specified dimensions.

(f) Hot-Air Lance. Equipment for blowing clean and drying cracks and joints shall be a propane gas and compressed air burner (ATAFA unit or approved equivalent) operating at 1650°C (3000°F) at a velocity of 915 m/s (3000 ft/s).

417.04 TEMPERATURE LIMITATIONS. The ambient air temperature shall be in the range of 5°C (40°F) to 40°C (104°F) and the pavement temperature shall be in the range of 10°C (50°F) to 60°C (140°F).

When it is in the public interest, the Construction Engineer may adjust the specified ambient air and/or pavement temperature requirements.

417.05 PREPARATION.

(a) General. Care must be taken in the preparation of all cracks to receive sealant material. All cracks must be clean, dry, and heated to ensure optimal bonding of the sealant material to the existing pavement.

(b) Bituminous Crack Sealing. All routed cracks shall be filled with sealant in the same workday as directed by the Engineer.

Cracks of 3 mm (1/8 inch) to 20 mm (3/4 inch) in width shall be shaped into a square cross section of approximately 20 mm (3/4 inch) in width by 20 mm (3/4 inch) in depth using a router or crack saw. All cracks to be sealed shall be routed or saw cut. All material removed from the cracks shall be immediately removed from the pavement. Cracks greater than 20 mm (3/4 inch) in width shall only be prepared and sealed at the direction of the Engineer.

Following crack routing or saw cuts, the entire pavement area shall be cleaned using a power broom or blower device. Special care must be exercised in urban areas to ensure that the pavement area is cleaned after the crack sealing operation and to minimize the creation of dust in the cleaning process. Immediately prior to the application of the sealer material, all cracks shall be cleared of loose pavement, vegetation, sand, dust, and any other debris using the hot-air lance. The full length of the cracks shall be heated with the hot-air lance to improve bonding of the sealant and pavement. Care shall be taken not to burn or char the pavement. Any charred pavement shall be cut out and removed and the crack prepared and resealed.

Areas of high density cracking indicating a structural failure should not be prepared for sealing as directed by the Engineer.

(c) Bituminous Crack Sealing, "Blow and Go" Method. Bituminous Crack Sealing, "Blow and Go" Method shall be performed in accordance with part (b) of this Subsection, with the exception that no routing or saw cutting will be required prior to cleaning and sealing the crack.

417.06 PLACING OF SEALER. The joint sealer material shall be heated and applied at the temperature specified by the manufacturer and approved by the Engineer. Any material that has been heated above the manufacturer's specification shall not be used. Material that is reheated or held at temperature for an extended period of time may be used as allowed by the manufacturer's specification and approved by the Engineer. The Contractor shall provide the Engineer with a suitable device for verifying the sealant temperature in the kettle and at the application site. Sealant application temperature shall not be lowered below the manufacturer's recommended temperature to address pooling problems at the end of the rout. This problem shall be addressed by using sealant material with appropriate flow characteristics to prevent pooling.

All routed cracks shall be fully filled with joint sealer material. A strike-off device may be used to facilitate placement of the material provided it has a maximum width of 40 mm (1 ½ inches). The joint sealer material should be struck off such that only a thin film band 2 mm (1/16 inch) or less is left on the pavement. Optimally, the pavement aggregate should be visible through the thin film band.

Any over application or spills are to be removed to the satisfaction of the Engineer. Any sealed areas with damaged or contaminated sealer or visible voids are to be removed, prepared, and resealed. Any filled areas that have sunk below the surface more than 2 mm (1/16 inch) shall be repaired by applying additional material.

The sealant material shall be applied while the cracks/joints are still hot from the hot-air lance preparation. Any loose material on the surface or in the crack, which may contaminate the joint sealer or impede bonding of the sealant to the pavement, is to be removed by hand tools prior to crack sealing. No crack sealing material shall be applied in a crack that is wet or where frost, snow, or ice is present.

No vehicles or equipment should be allowed on the newly placed sealant material until it has cooled as specified by the manufacturer. If the pavement must be reopened to traffic prior to air cooling, the cooling process may be accelerated with water or other coolant as specified by the manufacturer and approved by the Engineer. As a last resort, sealant may be protected against tire pick-up by dusting with a fine sand, mineral dust or similar material as approved by the Engineer. Any procedure used to accelerate cooling time must be approved by the Engineer and be in compliance with the manufacturer's application specifications. Costs for all material and labor for dusting or cooling shall not be paid for directly, but shall be considered incidental to Bituminous Crack Sealing.

417.07 METHOD OF MEASUREMENT. The quantities of Bituminous Crack Sealing and Bituminous Crack Sealing, "Blow and Go" Method to be measured for payment will be the number of kilograms (pounds) of joint sealer complete and in place in the accepted work.

417.08 BASIS OF PAYMENT. The accepted quantities of Bituminous Crack Sealing and Bituminous Crack Sealing, "Blow and Go" Method will be paid for at the Contract unit price per kilogram (pound). Payment shall be full compensation for handling and placing the sealant material, including the cleaning and preparation of cracks, the removal and disposal of all bituminous grindings, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be under:

Pay Item	Pay Unit
417.10 Bituminous Crack Sealing	Kilogram (Pound)
417.20 Bituminous Crack Sealing, "Blow and Go" Method	Kilogram (Pound)

SECTION 490 - SUPERPAVE BITUMINOUS CONCRETE PAVEMENT

490.01 DESCRIPTION. This work shall consist of constructing one or more courses of bituminous mixture on a prepared foundation in accordance with these specifications and the specific requirements of the type of surface being placed, and in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the Plans or established by the Engineer.

490.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Performance-Graded Asphalt Binder 702.02
Emulsified Asphalt, RS-1 ..... 702.04
Aggregate for Superpave Bituminous Concrete Pavement .. 704.10(b)

Performance-Graded (PG) asphalt binder and aggregate shall meet requirements relating to Superpave criteria, where so specified.

The grade of PG asphalt binder used to produce Superpave bituminous concrete pavement shall be as shown on the Plans.

490.03 COMPOSITION OF MIXTURE.

(a) Gradation. For each pavement type, the materials shall be combined and graded to meet the limits specified in the following table:

TABLE 490.03A - SPECIFICATION RANGE CHART

Mix Type	MS	IS	IIS	IIIS	IVS	VS
Nominal Maximum Size	37.5 mm (1 ½inch)	25.0mm (1inch)	19.0 mm (3/4 inch)	12.5mm (1/2 inch)	9.5mm (3/8 inch)	4.75mm 3/16inch)
Sieve Size	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max	Min - Max
50.0 mm(2 inch)	100 - x					
37.5 mm (1 ½ inch)	90 - 100	100 - x				
25.0 mm (1inch)	x - 90	90 - 100	100 - x			
19.0 mm (3/4 inch)	--	x - 90	90 - 100	100 - x		
12.5 mm (1/2 inch)	--	--	x - 90	90 - 100	100 - x	100 - x
9.5 mm (3/8 inch)	--	--	--	x - 90	90 - 100	95 - 100
4.75 mm (No. 4)	--	--	--	--	x - 90	90 - 100
2.36 mm (No. 8)	15 - 41	19 - 45	23 - 49	28 - 58	32 - 67	--
1.18 mm (No. 16)	--	--	--	--	--	30 - 60
75 µm (No. 200)	0.0 – 6.0	1.0 – 7.0	2.0 – 8.0	2.0 – 10.0	2.0 – 10.0	6.0 – 12.0

The combined aggregate gradation shall be classified as fine graded when the job-mix formula contains a greater percentage of material passing than the Primary Control Sieve (PCS) control points as specified below. The primary control point accounts for allowable tolerances.

PCS Control Point for Mixture Nominal Maximum Aggregate Size

Nominal Maximm Aggregate Size	37.5 mm (1 ½inch)	25.0mm (1 inch)	19.0 mm (3/4inch)	12.5 mm (1/2inch)	9.5 mm (3/8inch)
Primary Control Sieve	9.5 mm (3/8 inch)	4.75mm (No. 4)	4.75 mm (No. 4)	2.36 mm (No. 8)	2.36 mm (No. 8)
PCS Control Point (% Passing)	53%	46%	53%	43%	51%

All coarse graded mixes shall meet the requirements of AASHTO M 323.

(b) Design Criteria. The number of Gyrations at N_{design} (for example 50, 65, or 80) is determined by the Agency and shall be as detailed on the Plans. Design criteria for Superpave mixtures shall be as follows:

TABLE 490.03B - DESIGN CRITERIA

TEST PROPERTIES						
	All Traffic (ESAL) Levels					
Air Voids	4.0% (±1.0% Production Tolerance)					
Dust Proportion (Filler/Asphalt Ratio)	0.60 - 1.20 (Wet Sieve) (Dry Sieve for Production: 0.50 - 1.20)					
	Nominal Maximum Size Mix by Mix Type - mm (inches)					
	37.5 (1½) MS	25.0 (1) IS	19.0 (3/4) IIS	12.5 (1/2) IIIS	9.5 (3/8) IVS	4.75 (3/16) VS
Voids in Mineral Aggregate (VMA) %	11.5 min.	12.5 min.	13.5 min	14.5 min.	15.5. min.	16.5 min.
	Traffic Level (ESALs)					
	<300,000	300,000 - 3,000,000		>3,000,000		
Compaction Parameters	$N_{initial}$ = 6 N_{design} = 50 N_{max} = 75	$N_{initial}$ = 7 N_{design} = 65 [1] N_{max} = 115		$N_{initial}$ = 8 N_{design} = 80 [2] N_{max} = 160		
Voids Filled With Asphalt (VFA) %	70.0 – 80.0 [4,5]	65.0 – 78.0 [5]		65.0 – 75.0 [3,5]		
PG BINDER GRADE SELECTION						
RAP CONTENT	BINDER GRADE					
≤ 20.0%	PG 58-28					
20.0% < to < 25.0%	PG 52-34					
25.0% ≤ to ≤ 50.0%[6]	footnote 6					

(1) When estimated design traffic levels are between 300,000 and 1 million ESALs, the Agency may at its discretion specify $N_{initial}$ at 6, N_{design} at 50, and N_{max} at 75.

(2) When estimated design traffic levels are between 3 and < 10 million ESALs, the Agency may at its discretion specify $N_{initial}$ at 7, N_{design} at 65, and N_{max} at 115.

(3) For design traffic levels > 3,000,000 ESALs, the specified VFA range for 9.5 mm (3/8 inch) nominal maximum size mixtures shall be 73.0 to 76.0% and for 4.75 mm (3/16 inch) nominal maximum size mixtures shall be 75.0 to 78.0%.

(4) For a Type IS pavement with ESALs < 300,000, Table 490.03B will apply with the exception of the VFA percentage, which shall have a range from 67.0 to 80.0%. For a Type IVS, 9.5 mm (3/8 inch) pavement with ESALs < 1,000,000, Table 490.03B will apply with the exception of the VFA percentage, which shall have a range from 70.0 to 82.0%.

(5) For a Type MS pavement, all traffic levels (ESALs), Table 490.03B will apply with the exception of the VFA percentage, which shall have a lower limit of 64.0%.

(6) The Contractor shall determine the grade of PG binder necessary so that when combined with the RAP asphalt cement, the composite asphalt material grades at a PG 58-28 as a minimum. The maximum acceptable low end temperature is -28°C (-18°F) and the minimum acceptable high end temperature is 58°C (136°F). The Engineer will sample haul units from the plant and have the material extracted for grading at the Agency's Materials and Research Laboratory in Berlin, VT to verify the binder grade of the mix being supplied. The Contractor's Quality Control Plan shall specify a grading frequency and include an action plan for when test results verify that the grade of PG binder is less than a PG 58-28.

Aggregate Consensus Properties	Traffic Level (ESALs)	
	< 30,000,000	≥ 30,000,000
Fractured Faces Coarse Aggregate, % min	95/90	100/100
Uncompacted Void Content of Fine Aggregate, % min	45	45
Sand Equivalent, % min	45	50
Flat and Elongated, % max	10	10

The following relationships are used to derive the various design criteria test properties (Reference AASHTO R 35 "Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)"):

Air Voids (V_a)

$$V_a = 100 \times ((G_{mm} - G_{mb})/G_{mm})$$

Dust Proportion (DP)

$$DP = P_{0.075}/P_{be};\ P_{be} = P_b - ((P_s \times G_b) \times ((G_{se} - G_{sb})/(G_{se} \times G_{sb})))$$

Voids in Mineral Aggregate (VMA)

$$VMA = 100 - ((G_{mb} \times P_s)/G_{sb})$$

Voids Filled With Asphalt (VFA)

$$VFA = 100 \times ((VMA - V_a)/VMA)$$

Where:

G_{mm} = Maximum specific gravity of uncompacted mixture (AASHTO T209)
G_{mb} = Bulk specific gravity of compacted mixture (AASHTO T166, Method A)
$P_{0.075}$ = Percent, by mass, of the material passing the 75 µm(No. 200) sieve
P_{be} = Effective asphalt binder content, expressed as percent, by mass, of mix
P_b = Asphalt content, as percent of total mass of mixture
P_s = Aggregate, as percent of total mass of mixture
G_b = Specific gravity of asphalt cement
G_{se} = Effective specific gravity of aggregate
G_{sb} = Bulk specific gravity of aggregate

Unless otherwise specified for highways, Superpave bituminous concrete pavement mixtures will be used as follows: Types MS or IS will be used for base course, Types IS or IIS for binder course, and Types IIS, IIIS, IVS, or VS for wearing course. Unless otherwise specified or directed by the Engineer, Type IVS or VS shall be used for binder course on bridges.

(c) Mix Design. For Superpave Bituminous Concrete Pavement mixes AASHTO R 35 "Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt" will be the method used to develop a mix that will meet the specified Design Criteria in accordance with AASHTO M 323 "Standard Specification for Superpave Volumetric Mix Design." A copy of all design test data used in developing the mix design, including graphs, may be required with the submittal of the mix design or anytime following as directed by the Materials and Research Engineer.

The four principal parts of the Superpave Mix Design Method include:

(1) Select materials (aggregate and PG asphalt binder; PG grade shall be as specified in the Plans).
(2) Select design aggregate structure.
(3) Select design asphalt binder content.
(4) Evaluate moisture sensitivity (AASHTO T 283 "Standard Test Method for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage" is referenced, with a Tensile Strength Ratio (TSR) minimum criterion of 80%).

The job-mix formula (JMF) for each mixture shall establish a single percentage of aggregate passing each sieve, a single percentage of bituminous material to be added to the aggregate, a single percentage for VMA, and a single percentage for VFA. No change in the job-mix formula may be made without the written approval of the Materials and Research Engineer. The job-mix formula must fall within the master range of the specification as shown in Subsections 490.03(a) and 490.03(b). The job mix formula shall include values for the following sieves: 50 mm (2 inch), 37.5 mm (1 ½ inch), 25.0 mm (1 inch), 19.0 mm (3/4 inch), 12.5 mm (1/2 inch), 9.5 mm (3/8 inch), 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 600 µm (No. 30), 300 µm (No. 50), 150 µm (No. 100) and 75 µm (No. 200).

No work shall be started until the Contractor has submitted and the Materials and Research Engineer has approved a mix design including cold feed and hot bin gradations, mixing times, the percentage of each ingredient including bitumen, the job-mix formula from such a combination, and the optimum mixing and compaction temperatures as required by AASHTO M 323. The stockpile and hot bin gradation data shall be derived by wet sieve analysis. For mix designs containing RAP, the dry and wet mixing times shall be adjusted to assure moisture from the RAP is completely dissipated prior to adding the liquid PG binder.

The Materials and Research Engineer may approve changes in the design's job-mix formula or discontinue use of the design if placement, finishing, or compaction characteristics are determined by the Materials and Research Engineer to be unsatisfactory.

At the time the above mix design is submitted, the Contractor shall indicate and make available for sampling and testing the PG asphalt binder and stockpiles of all aggregates proposed for use.

A minimum of three weeks shall be allowed for the testing and evaluation of the submitted Superpave mix design. Once a mix design is approved, the job-mix formula is valid until a change is made in aggregate source, PG asphalt binder grade, or asphalt source. If a change is made in aggregate source, a new mix design shall be submitted and a minimum three week evaluation period shall be allowed prior to resuming production. If a change is made in the PG asphalt binder grade or PG asphalt source, a new PG asphalt binder selection evaluation shall be submitted and a minimum three week evaluation period allowed prior to resuming production.

(d) Control of Mixtures. The plant shall be operated so that no intentional deviations are made from the job-mix formula. The gradation of the actual mixture shall not vary from the job-mix formula by more than the following tolerances:

TABLE 490.03C – PRODUCTION TESTING TOLERANCES

Aggregate larger than 2.36 mm (No. 8) sieve	±	6.0 %
Aggregate passing the 2.36 mm (No. 8) sieve and larger than the 75 µm (No. 200) sieve	±	4.0 %
Aggregate passing 75 µm (No. 200) sieve	±	1.0 %
Temperature of Mixture	±	11°C (20°F)
Air Voids	=	4.0± 1.0%
VMA	=	JMF[1]± 1.0%
VFA	=	JMF[1]± 5.0%[2]

1 - JMF stands for the most current Job-Mix Formula value as approved by the Materials and Research Engineer or the Materials and Research Engineer's designee.
2 – The VFA value shall not exceed 80.0% at any time for Type I, II, III, and IV mixes. Type V mixes may be adjusted upward to 82.0% upon written approval of the Materials and Research Engineer, and only on a case by case basis.
3 – Mix temperatures shall not exceed 180°C (355°F).

The quantity of PG asphalt binder introduced into the mixer shall be that quantity specified as a percentage in the accepted job-mix formula for batch plants and will be accepted on the basis of the mass (weight) on the printed weight slip. For the use of drum-mix plants, the quantity of PG asphalt binder shall be specified as a percentage in the accepted job-mix formula and will be accepted on the basis of the percentage printed on the demand ticket from the approved automatic digital recording device in the plant.

For those projects having 2000 metric tons (tons) or less of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

If an analyzed sample is outside of the testing tolerances and/or other design criteria, immediate adjustments shall be made by the Contractor. After the adjustment, the resulting mix will be sampled and tested for compliance with these Specifications. With the permission of the Engineer, the plant may continue production pending results of these tests, but if the Engineer deems that it is in the best interest of the project, the Engineer may at any time order plant production stopped. In this event, additional adjustments shall be made and tested on a trial basis until the deficiency is corrected.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance sampling and testing will be conducted by Agency personnel in accordance with the Agency's Quality Assurance Program as approved by FHWA.

For those projects having more than 2000 metric tons (tons) of any individual mix type (individual mix design) of bituminous concrete mixture, control of those mixtures will be analyzed by utilizing the following procedure:

The Contractor shall operate in accordance with an approved Quality Control (QC) Plan, hereinafter referred to as the "QC Plan", sufficient to assure a product meeting the Contract requirements. A single QC Plan shall be submitted for all applicable work under the Contract. The QC Plan shall meet the requirements of Subsection 106.03. An example "outline" is available through the Agency Materials and Research Laboratory's Bituminous Concrete Section.

The QC Plan shall address all elements that affect the quality of the Plant Mix, including but not limited to the following:

a. Job-Mix formula(s)
b. Bituminous concrete mix Plan details
c. Stockpile management
d. Name of Plan Administrator
e. Name of Process Control Technician(s)
f. Mixing
g. Frequency and tests for Quality Control
h. For mix designs containing > 25.0 percent RAP, indicate the following: RAP percentage, PG Grade of virgin binder determined, testing frequency of mix to verify composite PG Grade, and actions to be taken when test results are outside of PG Grade limits.

The QC Plan shall incorporate the following personnel with the specified minimum requirements and qualifications:

a. Plan Administrator. This individual shall be a Quality Assurance Technologist certified by the New England Transportation Technician Certification Program (NETTCP).

b. Process Control Technician (PCT). This individual shall be certified as a "Hot Mix Asphalt (HMA)" Plant Technician by NETTCP. The PCT may have an interim certification from NETTCP as an HMA Plant Technician. Alternatively, the PCT may be a trainee performing duties under the direct supervision of a NETTCP certified technician, as specified in the VAOT approved QC Plan. In this case the Plan should address the following:

1. A training period shall continue for a minimum of 30 working days, at which point the supervising certified technician shall sign off on the trainee.

2. Upon completion of the training period and having been validated (signed off), the trainee will be qualified to work on QA projects without direct supervision for the remainder of the current construction season.

3. The PCT shall utilize test results and other quality control practices to assure the quality of aggregates and other mix components and control proportioning to meet the job-mix formula(s). The PCT shall periodically inspect all equipment used in mixing to assure it is operating properly and that mixing conforms to the mix design(s) and other Contract requirements.

4. The QC Plan shall specify how these duties and responsibilities are to be accomplished and documented and whether more than one PCT is required. The QC Plan shall include the criteria utilized by the PCT to correct or reject unsatisfactory materials.

   The QC Plan shall detail the coordination of the activities of the Plan Administrator and the PCT. The Plan Administrator shall be available to respond to the Engineer within one hour of a request.

   Superpave bituminous concrete pavement shall be sampled, tested, and evaluated by the Contractor for each mix type (each mix design) for each project on a continuous production basis in accordance with the following minimum quality control guidelines:

TABLE 490.03D - MINIMUM QUALITY CONTROL GUIDELINES

Test Action	Frequency	Test Method
Temperature of mix	1 per 250 metric ton (ton) at plant (truck)	Verified Thermometer
Air Voids	1 per 500 metric ton (ton)	AASHTO T 269 (T 166, T 209)
Cold Feed Gradation (1)	1 per day	AASHTO T 27
PG Asphalt Binder content	1 per 500 metric ton (ton)	Batch Slip
Extracted Gradations	1 per 500 metric ton (ton)	AASHTO T 30 AASHTO T 164 AASHTO T 308
Fine Aggregate, Coarse Aggregate, and Recycled Asphalt Pavement (RAP) Moisture Content (2)	2 times daily minimum (3)	AASHTO T 255
Fine Aggregate, Coarse Aggregate, and RAP Specific Gravities	Day of initial paving and 1 per week (4)(5)(6)	AASHTO T 84 AASHTO T 85
RAP PG Asphalt Binder content	1 per day	AASHTO T 164 AASHTO T 308
Determine composite PG binder grade(7)	1 per 5000 metric ton (ton)	AASHTO R 29

1 - Include percent “fractured faces” and “thin and elongated” of particles retained on the No. 4 (4.75 mm) sieve and above.
2 - This requirement is for drum-mix plants only.
3 - Evenly spaced intervals throughout the day and when new material is being added to the stockpiles and utilized in the mix.
4 - Or 1 per every 5000 metric tons (tons), whichever is greater.
5 - Current (within the previous 2 to 10 days) specific gravities will need to be supplied prior to beginning paving operations.

6 - New specific gravities will be required when either absorbed asphalt is determined to be a negative or at the request of the Materials and Research Engineer.
7 - For mix containing > 25 percent RAP.

Upon approval of the Materials and Research Engineer, the Contractor may utilize innovative equipment or techniques not included in the specifications to produce or monitor the production of the mix.

(e) Quality Acceptance.

(1) General. Bituminous concrete mixtures designated under these specifications will be sampled once per sublot on a statistically random basis, tested, and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following acceptance guidelines:

TABLE 490.03E - ACCEPTANCE GUIDELINES

PROPERTIES	POINT OF SAMPLING	LOT SIZE	SUBLOT SIZE	TEST METHOD
Air Voids	Truck at Plant	3000 Metric Ton (Ton)	500 Metric Ton (Ton)	AASHTO T 269 (T 166, T 209)

1 - Reference Subsection 106.03.
2 - Varies based on projected lot size.

(2) Lot Size. For the purpose of evaluating acceptance test properties, the representative tonnage of bituminous material within each lot shall be 3000 tons. The final resultant partial lot shall be processed as a full lot if it consists of four or more acceptance samples. If the final resultant partial lot consists of less than four acceptance samples, it will be combined with the previous lot.

(3) Sublot Size. A sublot shall be 500 tons with the exception of the final sublot of a partial lot, which will consist of the quantity of material required to complete the partial lot.

(4) Pay Factor (PF) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Level (RQL) of 50%, the PF for each lot of bituminous concrete mixture, based on "air voids" test results, will be determined using the following equation:

$$PF(av) = ((0.28PWL + 75) / 100) - 1.0$$

(5) Rejectable Material.

a. Rejection by Contractor. The Contractor may at any time elect to remove any defective material and replace it with new material at no expense to the Agency. Any such new material will be sampled, tested, and evaluated for acceptance.

b. For those lots with a PWL less than 50% and greater than or equal to 25%, the PF for each lot of bituminous concrete mixture, based on "air voids" test results, will be determined using the following equation:

$$PF(av) = ((2.16PWL - 29)/100) - 1.0$$

For those lots with a PWL less than 25%, the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency.

(f) Boxed Samples. If daily testing and inspection functions are required to comply with provisions of the Agency's Quality Assurance Program and plant inspectors are not available to perform these tasks, then box samples will be taken by the Engineer at the project site to afford verification of mixture volumetrics/properties. Boxed samples will be processed at the Agency Central Laboratory in Berlin, Vermont and results reported to the Engineer.

(g) Certification. For projects that are designated as Level 3 in accordance with the Agency's Quality Assurance Program, a Type D Certification shall be furnished in accordance with Subsection 700.02 for each day's production of material for non-mainline paving.

490.04 WEATHER AND SEASONAL LIMITATIONS. Superpave bituminous concrete pavement shall not be placed when the ambient air temperature and temperature at the paving site in the shade and away from artificial heat is below 5°C (40°F) for courses 35 mm (1 ¼ inches) or greater in compacted thickness or below 10°C (50°F) for courses less than 35 mm (1 ¼ inches) in compacted thickness.

Bituminous material shall not be placed on a wet or frozen surface or when weather or other conditions would prevent the proper handling, finishing, or compacting of the material, unless otherwise approved by the Engineer.

Bituminous material shall not be applied between November 1st and May 1st. Bituminous wearing course materials shall not be applied before May 15th or after October 15th.

When it is in the public interest, the Construction Engineer may adjust the ambient air temperature requirements, pavement temperature requirements, or extend the dates of the paving season.

490.05 BITUMINOUS MIXING PLANT AND TESTING. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until they have been delivered to the cold storage bins. The storage yard shall be maintained neat and orderly and the separate stockpiles shall be readily accessible for sampling.

All existing plants shall be inspected and obtain approval each construction season by an authorized representative of the Agency. Written notification shall be given for any plant which has not been inspected so that an authorized representative of the Agency may inspect and approve said plant prior to any mixing operation for Agency projects. A minimum of ten business days shall be allowed for the scheduling of the inspections. The plant shall be in operation at the time of inspection.

Plants used for the preparation of bituminous mixtures shall conform to all requirements specified in part (a) below, except that scale requirements shall apply only where mass (weight) proportioning is used. In addition, batch mixing plants shall conform to the requirements specified in part (b) below; continuous mixing plants shall conform to the requirements specified in part (c) below; and drum-mix plants shall conform to the requirements specified in part (d) below.

Scales for the weighing of materials shall conform to the restrictions specified herein and shall meet all specifications, tolerances, and regulations which have been or may be adopted periodically by the Director of Standards of the Vermont Department of Agriculture, and shall be subject to approval by the Materials and Research Engineer. The scales shall be checked and sealed as deemed necessary to assure accuracy.

Producers located outside Vermont shall observe all annual hopper scale mass, measurement, and seal requirements of their respective State or location.

(a) Requirements for All Plants. The Contractor shall give the Engineer a two working day notice of intent to produce bituminous mixture so that arrangements can be made for plant inspection and control.

The plants shall be so designed, coordinated, and operated as to produce a uniform mixture within the mix design approved for the project.

The Contractor shall indemnify and hold the State harmless for any hazardous waste generated from plant operations in producing materials for use in Agency Contracts. The Contractor shall be responsible for properly disposing of such waste at no additional cost to the State.

All plants shall have automatic controls which coordinate the proportioning, timing, and discharge of mixture by the operation of a single switch or button. In addition to these controls, the plant shall have an approved recording system.

The recording system shall be capable of printing the total net mass (weight) of the load. Each weigh slip shall be automatically printed with the date and time of batching, shall show project and truck identification and shall indicate the approved mix design number being produced.

All originals of recorded data pertaining to the weighing or proportioning of bituminous concrete, after recording, shall become the property of the Agency.

(1) Truck Scales. Approved truck scales shall be provided at each plant. The scale platform shall be of such length and width that it will conveniently accommodate all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft.

These scales may be used for spot checking the accuracy of the recording equipment. Any variance exceeding 0.5% of the net mass (weight) shall result in immediate corrective action by the Contractor.

A weatherproof building of sufficient size to house the scale operator and the Inspector shall be provided. It shall have adequate lighting, both natural and artificial, and it shall be adequately and safely heated.

If the Contractor's printer breaks down, the Contractor may continue to operate for the remainder of that day, provided the following conditions are met:

a. The Engineer grants permission to operate and

b. The Materials and Research Engineer assigns an Inspector to record the total aggregate and asphalt mass (weight) for each batch on the appropriate ticket.

(2) Equipment for Preparation of Bituminous Material. Tanks for storage of bituminous material shall be insulated and capable of heating the material, under effective and positive control at all times, to the temperature requirements set forth in the specifications. The heating system shall provide uniform heating of the entire contents of the tanks.

Heating shall be accomplished by steam or oil coils, electricity, or other means so that no flame shall come in contact with the heating tank.

A circulating system for bituminous material shall be of adequate capacity to provide proper and continuous circulation between storage tank and the proportioning units during the entire operating period.

The discharge end of the circulating pipe shall be maintained below the surface of the bituminous material in the storage tank to prevent the discharging of hot bituminous material into the open air.

All pipe lines and fittings shall be steam or oil jacketed or otherwise properly insulated to prevent heat loss.

(3) Feeder for Dryer. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregate into the dryer so that uniform production and uniform temperatures will be obtained.

(4) Dryer. The dryer shall be capable of heating and drying the mineral aggregates to specification requirements without leaving any visible unburned oil or carbon residue on the aggregate when it is discharged from the dryer. Black smoke from the exhaust stack shall not be permitted. Drying shall continue until all moisture is removed. If unusually wet aggregate is being used, the input to the dryer shall be reduced to an amount which the dryer is capable of drying.

(5) Screens. Plant screens shall have the capacity and size range to separate the aggregates into sizes for proportioning so that they may be recombined within the limits of the specifications. The screen over the "fines bin" shall have a maximum square opening of 5.0 mm (3/16 inch).

Slotted screens may be used when approved by the Materials and Research Engineer. Screens are not applicable to drum-mix plants.

(6) Cold Storage Bins. The plant shall have cold bin storage of sufficient capacity to ensure a uniform and continuous operation.

The bins shall be so constructed as to prevent any intermingling of aggregate from one bin to another. The use of loaders or trucks which are larger in width than the bins being charged shall not be allowed. The blending of two or more aggregates in the same bin shall not be permitted.

For all bituminous concrete supplied for use on Agency projects, uniform feeding of all fine aggregates shall be accomplished by the use of a variable speed continuous belt feeder on each cold storage bin of fine aggregate.

(7) Hot Bins. The plant shall include hot storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. The hot storage shall consist of at least four bins arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

When more than 15% of the material is undersized for that bin, based on the sieve analysis of hot bins used in determining the job-mix formula, all bins shall be emptied and the cause for such condition shall be corrected.

Each bin shall be provided with a free-flowing overflow pipe of such size and at such a location as to prevent backing up of material into other bins or into contact with the screen. This overflow material shall not be fed back into the system or into any accepted stockpiles.

All bins shall be equipped with a sensor device to indicate the position of the aggregate in the bins at the lower quarter point. An automatic plant shutoff device shall operate to interrupt the batching process when any aggregate bin becomes empty.

Adequate additional dry storage shall be provided when mineral filler is required. The system shall have a device to feed the mineral filler accurately and uniformly at adjustable rates consistent with the percent required. The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed.

Adequate and convenient facilities shall be provided to obtain representative aggregate samples from each bin. Hot bins are not applicable to drum-mix plants.

(8) Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Metering devices for bitumen shall be accurate to within plus or minus two percent of the amount of bitumen delivered when tested for accuracy.

The section of the bitumen flow line between the charging valve and the spray bar shall be provided with a three-way valve and outlet whereby the rate of delivery of the metering device may be checked by actual mass.

Suitable means shall be provided, either by steam, oil-jacketing, or other insulation, for maintaining the specified temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

(9) Thermometric Equipment. An armored thermometer shall be fixed in the bituminous feed line at a suitable location near the discharge valve at the mixer unit for accurately indicating the temperature of the bitumen.

The plant shall also be equipped with an approved recording thermometer, pyrometers, or other approved recording thermometric instruments placed at the discharge chute of the dryer.

The Materials and Research Engineer may reject questionable thermometric instruments, may direct replacement of any instrument with an approved temperature recording apparatus and may further require that daily temperature charts be filed with the Materials and Research Engineer.

(10) Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time, unless otherwise approved by the Materials and Research Engineer.

(11) Dust Collectors. The plant shall be equipped with adequate dust collectors so that exhaust will not be dispersed into the atmosphere. Provisions shall be made to waste or uniformly reintroduce all or any part of the heavier dust particles from primary collectors into the flow of aggregate.

The introduction of baghouse fines into bituminous concrete mixes will be allowed when the fines are introduced by an approved metering or weighing system which uniformly introduces the fines.

The Materials and Research Engineer has the authority to withdraw the approval for use of baghouse fines at any time that the bituminous concrete pavement mix provided by the Contractor is unsatisfactory as determined by the Materials and Research Engineer.

(12) Testing Facilities. The Contractor shall provide a weatherproof building, with at least 22 square meters (240 square feet) of floor space, in which to house and use the testing equipment. This building shall be maintained for the use of the Agency Engineers or Inspectors, and shall be located so that details of the Contractor's plant are plainly visible from at least one window of the building. Adequate lighting, heating, and electrical connections shall be provided 24 hours per day. Proper means for ventilation shall be provided. The method of heating shall be such that a minimum temperature of 21°C (70°F) will be maintained at all times. Sanitary toilet facilities with lavatory, with proper sewage disposal, shall be furnished for the use of Agency personnel. Cleaning supplies shall be furnished by the Contractor. A private telephone service, dedicated for the use of Agency personnel, shall be provided in the laboratory. An internet connection that provides a minimum speed of 700 Kbps (Kilobits Per Second) download, without utilizing compression algorithms, shall be provided ini the laboratory and dedicated for the use of Agency personnel. The connection bandwidth speed shall be verifiable using an online speed test.

The Contractor must have its office space separate from the office space used by Agency personnel. The Contractor's office space shall be located to afford privacy to Agency personnel.

A trailer type mobile laboratory may be used only in conjunction with a temporary plant. Any plant that occupies or has occupied the same location for more than one year will be classified as a permanent plant and will require a permanent building for a laboratory.

The facility shall be equipped with the following standard commercial quality equipment. Substitutes may be provided upon approval of the Materials and Research Engineer.

One - Air conditioner for the capacity of the building capable of maintaining a maximum temperature below 25 °C (77°F).

Two - Two kilogram (5 pound) minimum capacity fire extinguishers, either ABC Dry Chemical or Carbon Dioxide, of standard commercial quality.

One - Standard office desk with drawers, locks, and keys, 1200 mm x 750 mm (4 feet x 2 ½ feet) (minimum dimensions).

One - Adjustable office chair.

Two - Adjustable drafting stools.

One - Electric calculator, four function, ten column, with memory.

Two - Bench sections and storage compartments. The benches shall be approximately 900 mm (36 inches) high, 600 mm (24 inches) wide and three meters (10 feet) long.

One/Two - Approved exhaust fan(s) and hood(s) shall be provided over the stoves and extractors. The exhaust fan(s) shall be high volume axial flow, at least 300 mm (12 inches) in diameter.

One - Water cooler with supply of potable water.

One - Sink with faucet within the office, with a continuous supply of pressurized clean water for the duration of the project. The sink shall drain to the outside of the office.

With the exception of the electronic balance, the following equipment may be placed in a supplemental unit outside the plant's approved testing facility. Such supplemental work space and its location must be approved by the Materials and Research Engineer. All equipment must be firmly and securely attached to a stable base to ensure proper and accurate test results.

One - Superpave Gyratory Compactor (SGC) as specified in AASHTO T 312 "Standard Method of Test for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor"; and a minimum of two (2) specimen molds specifically designed for use with the SGC provided. Calibration of the SGC shall be done at the initial setup, whenever the unit is disrupted/moved, at the start of each construction season and as directed by the Materials and Research Engineer.

One - Forced draft oven, thermostatically controlled, capable of maintaining any desired temperature setting from room temperature to 260 °C (500°F), to within 3 °C (37.4°F), and capable of holding two (2) SGC specimen molds upright and two (2) metal oven pans, with a surface area of 0.25 m^2 (2 1/3 ft^2) each.

One - Electronic balance, 10 kg (22 pound) minimum capacity, sensitive/readable to 0.1g (.0002 pound).

One - Sand Equivalent Test (Clay Content) Apparatus setup; reference AASHTO T 176 (Mechanical Shaker Method, Section 5.3.1 of T176).

Two - Metal oven pans having a surface area of approximately 0.25 m^2 (2 1/3 ft^2).

The facility shall be further equipped with the following test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

One - Motorized 3000 g (6.6 pound) centrifuge extractor with two small bowls with covers and two large bowls with covers, and/or an ignition oven that conforms to the apparatus requirements of AASHTO T 308 "Standard Method of Test for Determining the Asphalt Content of Hot-Mix Asphalt (HMA) by the Ignition Method" with the following related equipment: two full sets of sample basket(s), two catch pans, and one set of safety equipment as defined in T308.

One - Full set of 200 mm (8 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.

One - Full set of 300 mm (12 inch) diameter sieves full height, pans, and covers necessary for testing all bituminous items required on the project.

One - Motorized sieve shaker with either rocking and tapping action or circular and tapping action capable of holding at least six sieves and one pan.

One - Mechanical aggregate shaker with a 0.028 m^3 (1.0 ft^3) capacity plus necessary screens. This may be placed in a separate enclosure outside of the trailer.

One - Platform beam scale sensitive to 5.0 g (.01 pound) with a minimum capacity of 45 kg (100 pounds).

One - Sample splitter, 63.5 mm (2 ½ inch) chute.

Two - Square pointed shovels; one long handled, one short handled.

Two - Double burner hot plates, variable temperature.

Twelve - Tin pans, 267 mm x 267 mm x 25 mm (10 ½ inches x 10 ½ inches x 1 inch).

One - 0.028 m^3 (1.0 ft^3) minimum capacity electric oven.

One - Flat triangular trowel.

One - Brass wire bristle brush.

One - Standard floor brush.

One - Standard table brush.

Filter papers for duration of project.

Two - 40 mm (1 ½ inch) soft bristle paint brushes.

One - Automatic timer (interval 0 - 30 minutes).

One - Sample Splitter (riffles) chute width 25 mm (1 inch).

Two - Flexible spatulas with 150 mm (6 inch) long blade.

One - 10 L (10 quart) pail.

Two - Pair lined, heat resistant gloves.

Two - Hand scoops (size #1).

Two - Metal thermometers, 10 to 260°C (50 to 500°F), approximately 200 mm (8 inches) long with a 45 mm (1 ¾ inch) head.

Two - Laboratory thermometers, capable of reading at least 60 °C in 1 °C (140°F in 2°F) increments.

One - Cold chisel, approximately 40 mm (1 ½ inches) wide.

Two - Volumetric flasks having a capacity of at least 2000 mL (68 ounces); for use with the flask, a rubber stopper and a connection, either molded in the flask or attached to the rubber stopper.

Two - Volumetric flasks having a capacity of at least 4000 mL (135 ounces); for use with the flask, a rubber stopper and a connection, either molded in the flask or attached to the rubber stopper.

One - Vacuum pump or water aspirator for evacuating air from the container. Vacuum system must be capable of removing entrapped air by subjecting the contents to a partial vacuum and maintaining a residual pressure of 3.7 ± 0.3 kPa (1.1 ± 0.1 inches Hg) absolute pressure for 15 ± 2 minutes. The vacuum system shall be equipped with a residual pressure manometer which reads in kilopascals (inches Hg) and a pressure release valve.

One - Plastic funnel to introduce mix into volumetric flask.

One - Syringe to adjust water level in flask.

Xylol for use as an asphalt solvent shall be furnished by the Contractor for the duration of the project.

For drum-mix plants, the facility shall be equipped with the following additional test equipment and supplies. Substitutes may be provided upon approval of the Materials and Research Engineer.

One - Microwave oven with a minimum interior volume of 0.028 m^3 (1.0 ft^3) with defrost as well as normal mode of operation.

Six - Ovenproof glass dishes approximately 300 mm x 300 mm x 40 mm (12 inches x 12inches x 1 ½ inches).

All of the foregoing testing equipment shall be in good condition, calibrated and/or verified according to the Contractor's QC Plan schedule and /or the Agency provided schedule as applicable, and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The above mentioned equipment is for a one plant operation only. In the event the Contractor chooses to use more than one plant, the Contractor shall provide adequate laboratory facilities as deemed necessary by the Materials and Research Engineer for making tests.

(13) Safety Requirements. Adequate and safe stairways to the mixer platform shall be provided, and guarded ladders to other plant units shall be located where required for accessibility to plant operations.

All heated pipe lines adjacent to work areas, gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected.

Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space.

This space shall be kept free of drippings from the mixing platform. A platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. Adequate overhead protection shall be provided where necessary.

(14) Surge or Storage Bins. Surge or storage bins will be permitted for use in the production of bituminous items provided they are approved and inspected by the Materials and Research Engineer. A surge or storage bin shall be capable of storing the mix without any degradation of its properties. The surge or storage bins shall be covered during inclement weather to protect the stored mix from the elements. Should circumstances preclude paving operations, the Agency will not be obligated to purchase mix remaining in a surge or storage bin.

For continuous mixing and drum-mix plants, an approved recording weigh system shall be used on all surge bins.

When a surge bin is used in conjunction with a batch plant, the determination of pay quantities for the applicable Contract item shall be in accordance with the following procedure:

a. The plant will produce mix with the printer operating according to the standard requirements for this device. The mix will be deposited in the surge bin. A sequentially numbered ticket will be prepared for every normal load produced.

b. As each truck is loaded from the surge bin, the driver will be given the ticket previously prepared when the mix was produced for that bin. The truck driver will then deliver the ticket to the paving Inspector upon reaching the paving site.

c. The mass (weight) shown on the ticket will not be the actual mass (weight) of the mix contained in the truck since the truck was loaded from the surge bin. The bin shall be completely emptied at the end of every day, circumstances permitting, and all tickets delivered to the paving Inspector.

d. Any rejected or held over material shall be weighed on the platform truck scales. This quantity shall be deducted from the daily totals.

e. When paving ramps or other areas where a definite quantity is desired, the material required will be weighed on the platform scales and appropriate adjustments made in the daily totals obtained from the printer. These masses (weights) will be entered on the ticket or a separate ticket provided.

f. The plant Inspector will sign the first slip of each day instead of initialing it. If the Inspector changes during the day, this procedure will be followed for each change. At the end of each day, the plant Inspector will inspect the storage bin to determine that it is empty and so note on the last ticket.

g. The paving Inspector will acknowledge receipt of the material at the paving site by initialing the lower right-hand corner of the ticket.

h. All standard checks of the weighing apparatus at the plant will be made at the prescribed intervals.

i. All mix produced for commercial customers and/or other projects must be discharged from bins other than those used for this project or directly from the pugmill into the haul vehicle; such mix shall not be loaded from the bin used for this project.

j. All surge bins shall be emptied each day unless written permission is obtained from the Materials and Research Engineer.

(b) Requirements for Batching Plants.

(1) Weigh Box or Hopper. The equipment shall include a means for accurately weighing each bin size of aggregate in a weigh box or hopper suspended on scales and of ample size to hold a full batch without hand raking or running over.

The weigh box or hopper shall be supported on fulcrums and knife edges constructed so that they will not be easily thrown out of alignment or adjustment.

All edges, ends, and sides of weighing hoppers shall be free from contact with any supporting rods of columns or other equipment that will in any way affect proper functioning of the hopper. Also, there shall be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials.

The discharge gate of the weigh box shall be hung so that the aggregate will not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing the next batch.

(2) Aggregate Scales. Scales for any weigh box or hopper shall be springles dial or load cell with digital readout and shall be of standard make and design sensitive to 0.1% of the maximum load that may be required.

Dials shall be free of vibration and shall be so located to be plainly visible and readable to the operator at all times.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of ten 20 kg (50 pound) test masses (weights) or by other methods approved by the Materials and Research Engineer. All test masses (weights) shall be certified annually by the Division of Weights and Measures.

(3) Bitumen Bucket. The bucket for weighing bitumen shall be of sufficient capacity to hold and weigh the amount required for a batch in a single weighing.
The filling system and bucket shall be designed, sized, and shaped so that bitumen will not overflow, splash, or spill outside the confines of the bucket during filling and weighing.

The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units. It shall be able to deliver the bitumen in a thin uniform sheet or in multiple sprays over the full length of the mixer within a period of 15 consecutive seconds.

(4) Bitumen Scales. Bituminous material shall be weighed on scales that conform to the specifications for the weighing of aggregate. The value of the minimum graduation shall not exceed 1.0 kg (2.0 pounds).

(5) Mixer Unit for Batch Method. The plant shall include an approved, twin pugmill type batch mixer, jacketed or insulated and capable of producing a uniform mixture within the applicable job-mix tolerance. The mixer shall be so constructed as to prevent leakage and designed to provide a means of adjusting clearance between the mixer blades and liner plates.

(6) Recording. The recording system of the batch plant shall print the mass (weight) of the bitumen, the mass (weight) of the aggregate, and the total combined mass (weight) of both in addition to printing the combined net mass (weight) of each load.

(c) Requirements for Continuous Mixing Plants.

(1) Aggregate Proportioning. The plant shall be able to accurately proportion aggregate from each bin by mass (weight). The unit shall include interlocked feeders mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to control the rate of flow of aggregate from each bin compartment. The opening shall be rectangular with one dimension adjustable by positive mechanical means. Locks shall be provided on each gate. Calibrated gauges with minimum graduations not exceeding 2.5 mm (0.1 inches) shall be provided for each gate to establish gate openings.

(2) Calibration of Aggregate Feed. The plant shall include a method to calibrate gate openings by means of test samples. The materials fed out of the bins through separate openings shall be bypassed to a suitable test box with the material for each compartment being confined in a separate box section. The plant shall be able to conveniently handle such test samples with a mass (weight) of up to 365 kg (800 pounds) and to weigh them on accurate scales.

(3) Synchronization of Aggregate Feed and Bituminous Feed. Satisfactory interlocking control of the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source shall be provided. This control shall be accomplished by interlocking mechanical means or by another method under the Materials and Research Engineer's control and approved by the Materials and Research Engineer.

(4) Mixer. The plant shall include an approved twin pugmill type continuous mixer, insulated or jacketed, and capable of producing a uniform mixture within the applicable job-mix tolerance. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix.

The mixer shall carry a manufacturer's plate indicating the net volumetric contents at several heights on a permanent gauge. The plate shall also indicate the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by the following formula:

$$\text{Mixing time in seconds} = \frac{\text{Pugmill dead capacity in kilograms (pounds)}}{\text{Pugmill output in kilograms (pounds) per second}}$$

The masses (weights) shall be determined by tests made under the direction of the Materials and Research Engineer.

(d) Requirements for Drum-Mix Plants.

(1) Aggregate Cold Bin Feeders. The plant shall have a device at each cold bin to feed the aggregate accurately and uniformly. The feeding orifice shall be adjustable. Gravity type feeders will not be permitted. Indicators graduated to not more than 2.5 mm (0.1 inch) shall be provided on each orifice. Each aggregate feeder shall be interlocked so that production is interrupted if one or more cold bins become empty or the flow is obstructed.

(2) Mineral Filler System. When mineral filler is to be added, it shall be fed from a bin and feeder separate from the aggregate cold bins. The system shall be able to feed the mineral filler at adjustable rates accurately and uniformly.

The feeder shall be interlocked so that production is interrupted if the bin becomes empty or the flow is obstructed. The filler shall be fed so that no filler is lost in the form of fugitive dust.

(3) Aggregate Weighing Equipment. All aggregates, including mineral filler, shall be weighed by a continuous weighing device, either as it is proportioned by the individual feeders or after all materials have been deposited on a common belt. Belt scales shall meet the requirements of the National Bureau of Standards Handbook 44 and shall be installed according to the scale manufacturer's recommendations by a technician licensed by the Division of Weights and Measures. Any other type of weighing device shall be approved by the Materials and Research Engineer prior to use.

(4) Bitumen Control Unit. The bitumen shall be proportioned by a meter. A flow switch designed to interrupt production if the bitumen flow is discontinued shall be installed in the delivery line between the meter and the mixer. A temperature compensating device shall be installed in conjunction with the meter to correct the quantity of asphalt to 16 °C (60°F).

(5) Proportioning Controls. All proportioning controls for aggregates, mineral filler, and bitumen shall be located at the panel which controls the mixer and temperature. The panel shall have a master control capable of increasing or decreasing the production rate without having to reset the individual controls.

a. Aggregate Feed Rate Control. The plant shall have an adjustable feed rate control for each aggregate cold bin feeder and mineral filler feeder. The control shall maintain an aggregate flow accuracy such that the variation of material per interval of time shall not exceed an amount equal to 1.5% of the total mass (weight) of bituminous mixture per interval of time. When separate addition of mineral filler is required, it shall be added with an accuracy of 0.5% on the basis stated above for aggregates. The rate of aggregate flow shall be displayed on a meter and it shall be based on mass (weight) or percentage of dry aggregates.

b. Aggregate Mass (Weight) Indicator. The plant shall have an aggregate mass (weight) indicator which will display in the control room the mass of combined aggregates and mineral filler; it shall continuously accumulate the dry aggregate mass (weight) of material during the production period, generally one day. The indicator shall be resettable to zero and lockable.

c. Aggregate Moisture Compensator. The plant shall have a moisture compensation device capable of electronically changing the wet mass (weight) of aggregate to dry aggregate mass (weight). The compensator may be set manually based on moisture tests performed on composite aggregate samples. The maximum graduations on the compensator shall be 0.1%.

d. Bitumen Control. The plant shall have a bitumen control capable of presetting the actual bitumen content directly as a percentage based on total mass (weight) of mixture. The maximum gradation on the bitumen control shall be 0.1%. The asphalt delivery system shall be coupled with the aggregate delivery system to automatically maintain the required proportions as the aggregate flow varies.

e. Bitumen Quantity Indicator. The plant shall have a bitumen quantity indicator in the control room indicating the accumulated quantity of bitumen during the production period, generally one day. The quantity indicated may be either mass (weight) or volume at 16 °C (60°F). The indicator shall be resettable to zero and lockable.

(6) Recording of Proportions. The plant shall be equipped with an automatic digital recording device approved by the Materials and Research Engineer that simultaneously records the accumulated mass (weight) of dry aggregate and bitumen separately during production time and on demand. All recordings shall show the date, including day, month, and year, and time to the nearest minute for each print. The original recordings shall be come the property of the Agency.

(7) Calibration of Feed Rates. The feed rates of aggregates from the cold bins, mineral filler when used and bitumen shall be established for each mix type initially by passing the individual aggregates and mineral filler over the continuous weighing device and the bitumen through the meter, respectively. The feed rates shall be checked periodically or at the direction of the Materials and Research Engineer.

(8) Automatic Aggregate Sampling Device. The plant shall have an automatic aggregate sampling device which will divert a representative combined aggregate sample, including mineral filler, into a hopper or container for the purpose of gradation testing.

The sampling tray shall cut the full width and depth of the aggregate flow. The sampling point shall be after the aggregate is proportioned and prior to its mixing with bitumen.

(9) Mixer Unit. The plan shall have a drum mixer, approved by the Materials and Research Engineer, having an automatic burner control and capable of producing a uniform mixture within the job-mix tolerances. The mixture shall be discharged into a hot bituminous surge or storage bin meeting the requirements of this Section.

490.06 PREPARATION OF BITUMINOUS MATERIAL. The bituminous material shall be uniformly heated to the specified temperature. A continuous supply of the bituminous material shall be provided to the mixer at a uniform temperature at all times.

490.07 PREPARATION OF AGGREGATES. The aggregate for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid depositing soot or unburned fuel on the aggregate.

Immediately after heating, the aggregates shall be screened and conveyed into separate bins ready for batching and mixing with bituminous material.

If required to meet the gradation requirements, mineral filler shall be added in a manner approved by the Materials and Research Engineer after the aggregates have passed through the dryer.

The above preparation of aggregates does not apply for drum-mix plants.

490.08 MIXING. The dried aggregates shall be combined with the bituminous material in a manner that will produce a mixture which, when discharged from the mixing unit, shall be at the temperature specified on the approved mix design unless otherwise directed by the Materials and Research Engineer.

The dried aggregates shall be combined in the mixer in the appropriate proportions required to meet the job-mix formula and thoroughly mixed prior to adding the bituminous material. Dry mix times shall be increased as deemed necessary by the Materials and Research Engineer in such cases that RAP material is introduced into the mixer.
The bituminous material shall be measured and introduced into the mixer in the amount determined by the Materials and Research Engineer for the material being used and at a temperature in accordance with Subsection 702.06, unless otherwise directed by the Materials and Research Engineer.

After the required amounts of aggregate and bituminous material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is obtained. The wet mixing time shall be regulated by the Materials and Research Engineer and a suitable locking mechanism shall be provided for such regulation.

All plants shall have a means of eliminating oversized and foreign material from being incorporated into the mixer.

490.09 HAULING EQUIPMENT. To prevent the mixture from adhering to the beds, trucks used for hauling bituminous mixture shall have tight, clean, and smooth metal beds which have been thinly coated with a bond release agent. Petroleum based products will not be permitted.

The trucks used for hauling bituminous mixture shall be compatible with the equipment used for placing the bituminous mixture. Trucks are not to be cleaned and/or emptied on surfaces to be paved.
Each truck shall have a cover of canvas or other suitable material of sufficient size to extend over all sides of the haul vehicle to afford protecting the mix from the weather. When necessary to assure placement of material at the specified temperature, truck beds shall be insulated and covers shall be securely fastened.

490.10 PLACING EQUIPMENT. The bituminous concrete paver shall be a self-propelled unit with an activated screed or strike-off assembly capable of being heated if necessary and capable of spreading the mixture without segregation for the widths and thicknesses required. The screed shall be adjustable to provide the desired cross sectional shape.

Pavers shall be in good mechanical condition, equipped with all necessary attachments, and designed to operate electronically for controlling the grade of the finished surface. Bituminous pavers shall distribute the mixture over the entire width or over such partial width as may be practical. Additionally, pavers shall be equipped such that, upon extension of the screed a distance of 450 mm (18 inches) or more, auger extensions shall be used as directed by the Engineer.

The adjustments and attachments of the paver shall be checked and approved by the Engineer before placement of bituminous material.

Bituminous concrete pavers shall be equipped with a sloped plate to produce a tapered or notched tapered edge at longitudinal joints. The sloped plate shall produce a tapered or notched tapered edge having a minimum face slope of 1 vertical: 3 horizontal. The plate shall be able to accommodate compacted mat thicknesses from 35 mm to 100 mm (1 ¼ inches to 4 inches). The bottom of the sloped plate shall be mounted 10 mm to 15 mm (⅜ inch to ½ inch) above the existing pavement.

Bituminous pavers shall be equipped with a joint heater of at least 6250 BTU/min (110,000 W) capacity to heat the longitudinal edge of the previously placed mat to a surface temperature of 95 °C (200°F), or higher if necessary, to achieve bonding of the newly placed mat with the previously placed mat without undue breaking or fracturing of aggregate at the interface. The surface temperature shall be measured immediately ahead of the screed. The joint heater shall be equipped with automated controls which shut off the burners when the paving machine stops and reignites them with the forward movement of the paver. The joint heater shall heat the entire area of the previously placed wedge to the required temperature. Heating to the point of 95 °C (200°F) or higher shall immediately precede placement of the bituminous material.

490.11 ROLLERS. Rollers shall be in good mechanical condition, operated by competent personnel, capable of reversing without backlash, and operated at speeds slow enough to avoid displacement of the bituminous mixture. The mass (weight) of the rollers shall be sufficient to compact the mixture to the required density without crushing the aggregate. Rollers shall be equipped with tanks and sprinkling bars for wetting the rolls or tires.

Pneumatic-tired rollers shall be equipped with appropriate skirts at all times and be preheated prior to use in order to avoid picking. The Contractor shall remove all picked material from the surface.

Vibratory rollers shall have separate controls for energy and propulsion. They shall be equipped with automatic cutoffs that stop the vibration prior to the roller stopping and/or reversing its direction of travel.

490.12 CONDITIONING OF EXISTING SURFACE. All surfaces shall be cleaned and sprayed with an emulsion meeting the requirements of Emulsified Asphalt, RS-1 before placing of any bituminous mixture, unless otherwise ordered by the Engineer. The emulsion shall be applied under pressure at a rate of 0.05 to 0.14 L/m² (0.01 to 0.03 gallons/yd^2). The application shall be made just prior to the placement of the bituminous concrete mixture and shall progress sufficiently ahead of the paving so that the surface to be paved will be “tacky”. Equipment used to apply the emulsion shall meet the requirements for distributors specified in Subsection 404.04.

Prior to paving, bridge decks shall be treated as detailed on the Plans.
Prior to paving, all large cracks in the bituminous surface shall be thoroughly cleaned and filled with a bituminous material or mixture approved by the Engineer. Large cracks are defined as at least 25 mm (1 inch) in width.

Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Emulsified Asphalt, RS-1 immediately before the bituminous concrete mixture is placed against them.

If there are deficiencies that require corrective action in the base course constructed under the Contract, a bituminous concrete mix approved by the Engineer shall be used to bring the base course to the designed grade and contour.

Where Superpave Bituminous Concrete Pavement is used to resurface existing pavements and the existing pavement contains irregularities, depressions, or waves, such deficiencies shall be eliminated by the use of extra bituminous material for spot leveling to bring existing base to uniform section and grade before placing of the required courses of bituminous concrete.

490.13 PLACING AND FINISHING. The finished surface shall be of uniform texture and evenness and shall not show tearing, shoving, or pulling of the mixture.

At the time of discharge from the haul vehicle, the bituminous mixture shall be within 6 °C (10°F) of the compaction temperature for the approved mix design.

The Contractor shall, during all phases of the paving operation, protect from damage all exposed surfaces which are not to be treated.

The bituminous mixture shall be placed and finished with the specified equipment, shall be struck off in a uniform layer to the full width required and of such depth that each course, when compacted, shall have the required thickness and shall conform to the grade and elevation specified.

When operating in tandem on multi-lane paving, the pavers shall be of the same type and have the same characteristics. Material for leveling may be spread by the use of a grader, if approved by the Engineer.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture shall be spread, raked, luted, and compacted by hand methods.

All material shall be produced early enough in the day in order that the completion of spreading and compaction of the mixture will occur during daylight hours, unless night paving has been approved for the project.

No traffic will be permitted on placed material until the material has been thoroughly compacted and has cooled to 60 °C (140°F) unless otherwise authorized by the Engineer.

The use of water to cool the pavement will not be permitted.

The Agency may require that all work adjacent to the pavement, such as guardrail, cleanup, and turf establishment, be completed prior to placing the wearing course when such work could cause damage to the pavement.

When bituminous concrete pavement is to be placed on a bridge deck having a waterproofing membrane, a rubber-tired or rubber tracked paver shall be used to place the binder course of pavement.

On projects where traffic will be maintained, the Contractor may be required to schedule daily paving operations such that at the end of each work day all travel lanes of the roadway on which work is being performed will be paved to the same limits or as directed by the Engineer.

Suitable permanent aprons or temporary fillets shall be constructed at side road intersections and driveways as directed by the Engineer within 24 hours of adjacent mainline paving. Permanent aprons shall be constructed within 5 working days of adjacent mainline paving. Reasonable access to and from the mainline mat shall be maintained at all times.

490.14 COMPACTION. Immediately after the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking, tearing, or shoving. Should the mix exhibit these characteristics, and the Contractor is unable to remedy these conditions to the satisfaction of the Engineer, both placement and approval of the mix design will be terminated.

The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally, one breakdown roller will be needed for each paver used in the spreading operation.

Leveling courses shall be compacted using a self-propelled pneumatic-tired roller unless otherwise directed in writing by the Engineer. On base, binder, and wearing course, the initial or breakdown rolling shall be done by using a two-axle tandem roller; intermediate rolling shall be done by using a two-axle tandem roller or self-propelled pneumatic-tired roller; and final rolling shall be done by using an additional two or three-axle tandem roller. The equipment used for shoulder construction shall be sufficient to obtain the required compaction while the mixture is in a workable condition.

To prevent adhesion of the mixture to the rollers, the rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid and petroleum products will not be permitted.

Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hand tampers, smoothing irons or mechanical tampers coated with a non-petroleum based bond release agent. On depressed areas, a trench roller or cleated compression strips under the roller may be used to transmit compression to the depressed area.

Other combinations of rollers and/or methods of compacting may be used if approved in writing by the Engineer, provided the compaction requirements are met.

Unless otherwise directed, the longitudinal joint shall be rolled first and then rolling shall begin at the low side of the pavement and proceed towards the center or high side with lapped rollings parallel to the centerline. The speed of the roller shall be slow and uniform to avoid displacement of the mixture, and the roller should be kept in as continuous an operation as practicable. Rolling shall continue until all roller marks and ridges have been eliminated.

Rollers shall not be stopped or parked on new, freshly placed bituminous material.

Any mixture that becomes loose and broken, mixed with dirt or is in any way defective shall be removed and replaced with fresh hot mixture which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of bitumen shall be removed and replaced. These replacements shall be at the Contractor’s expense.

Should the Contractor choose to use vibratory rollers, the following additional criteria shall govern their operation:

Vibratory rollers may be used when operated at an amplitude, frequency, and speed that produces a mat conforming to specifications and which prevent the creation of transverse ridges in the mat. Vibratory rollers may be used as a breakdown roller, an intermediate roller, or a finish roller. They shall not be used as a substitute for a pneumatic-tired roller on leveling courses, nor shall they be used for compacting lifts of pavement under 25 mm (1 inch) in depth. A single vibratory roller shall not be used alone as the breakdown, intermediate, and finish roller, but may be used as any one of the rollers in the roller train.

If the Engineer determines that unsatisfactory compaction is being obtained, unacceptable surface distortion is occurring, or damage to highway components and/or adjacent property is occurring using vibratory compaction equipment, the Contractor shall immediately cease using this equipment and proceed in accordance with the fourth paragraph of this Subsection. All requirements of this Subsection shall apply regardless of compaction equipment used.

The Contractor assumes full responsibility for, and shall repair at the Contractor's expense, all damages which may occur to highway components and adjacent property if vibratory compaction equipment is used.

If the Agency elects to not take cores of any pavement course, the Density Pay Factor (PF(d)) will be considered equal to 0.000.

Leveling courses will not be analyzed for density.

For projects less than or equal to 0.8 km (0.5 miles) in length, Superpave Bituminous Concrete Pavement will be analyzed for density according to the procedure specified below.

The density of the compacted pavement shall be at least 92.5%, but not more than 96.5%, of the corresponding daily average maximum specific gravity for each mix type (each mix design) of bituminous mix placed during each day. For material that falls outside of this range, payment will be made by adjusting the daily production totals in accordance with the following Table:

TABLE 490.14A – DENSITY PAY FACTORS

AVERAGE DENSITY	DENSITY PAY FACTOR, PF(d)
90.5% - 90.9%	- 0.100
91.0% - 91.4%	- 0.075
91.5% - 91.9%	- 0.050
92.0% - 92.4%	- 0.025
92.5% - 93.4%	0.000
93.4% - 95.4%	0.010
95.5% - 96.5%	0.000
96.6% - 97.0%	- 0.025
97.1% - 97.4%	- 0.050
97.5% - 98.0%	- 0.075
98.1% - 98.5%	- 0.100

For material with an average density that is less than 90.5% or in excess 98.5%, the Construction Engineer will evaluate whether the material will be removed and replaced by the Contractor at no expense to the Agency or a greater penalty imposed.

It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores extracted and provided by the Contractor.

Acceptance testing to verify density of the compacted pavement will be done by averaging the densities of a minimum of 4 cores for each day's production for each type of bituminous mix placed, excepting shim/leveling courses.

The cores taken for acceptance testing will be the final cores taken for determination of densities.

For projects greater than 0.8 km (0.5 miles) in length, Superpave Bituminous Concrete will be analyzed for density according to the procedures specified in Subsections 490.14 (a) and 490.14 (b).

(a) Quality Level Analysis. Compacted bituminous concrete pavement specified to be sampled and tested using bituminous concrete pavement core samples for the purpose of determining density will be analyzed by utilizing the statistical quality level analysis "Percent Within Limits" (PWL) method as defined in Subsection 106.03.

(b) Quality Acceptance.

(1) Bituminous concrete mixtures will be sampled once per sublot using a stratified random sampling procedure in accordance with ASTM D 3665 and tested and evaluated by the Agency for each mix type (each mix design) for each project in accordance with the following guidelines:

TABLE 490.14B – ACCEPTANCE GUIDELINES

PROPERTY	POINT OF SAMPLING	LOT SIZE	TEST METHOD
Density	Compacted In-Place	Daily – 24 Hour Max	AASHTO T166 Method A, T 209

(2) For the purpose of evaluating acceptance test properties, a lot shall consist of the total quantity of bituminous concrete mixture compacted in-place during any one day's production to a maximum of 24 hours. Sampling shall be performed at the rate of one sample per lane kilometer (0.6 mile), with the exception that there shall not be fewer than six samples taken per any one days production. The quantity represented by each sample shall constitute a sublot.

(3) Density Pay Factor (PF) Determination. Where the PWL value, as defined in Subsection 106.03, equals or exceeds the Rejectable Quality Limit (RQL) of 60%, the PF for each lot of Superpave bituminous concrete mixture, based on density test results, will be determined by using the applicable equation below:

Where $80 \leq PWL \leq 100$, $PF(d) = ((0.10\ PWL + 92) / 100) - 1.0$

or

Where $60 \leq PWL < 80$, $PF(d) = ((0.50\ PWL + 60) / 100) - 1.0$

The PF for each lot of Superpave bituminous concrete mixture used for low production activities not associated with any traveled way paving operation will be 1.0. Low production activities are defined as those not associated with traveled way paving operations and having a maximum daily production of 500 metric tons (tons) of Superpave bituminous concrete mixture.

(4) The density of the compacted pavement shall not be less than 92.5% nor more than 96.5% of the corresponding maximum specific gravity for each mix type (each mix design) placed per lot.

(5) It shall be the responsibility of the Contractor to conduct whatever process control the Contractor deems necessary. Acceptance testing will be conducted by Agency personnel using cores provided by the Contractor in accordance with the coring protocol below.

(c) Coring Protocol. Original core sampling locations will be restricted to traveled lanes only and will not include those areas within 150 mm (6 inches) of the top of a longitudinal joint nor within 15 m (50 feet) of a transverse joint. That area encompassing a longitudinal tapered joint will not be selected as a sampling location. Independent shoulder and mat area core sampling locations may be selected by the Engineer to afford verification of Subsection 490.14(b)(4).

Original core sampling locations will be selected by the Engineer or designee in accordance with ASTM D 3665 within two working days of the bituminous mixture being placed. The Contractor will be advised in writing of the selected sampling locations.

The Contractor may challenge whether any particular original sample location(s) is representative of any particular lot by notifying the Engineer. This notification shall be made immediately upon the sublot location(s) being selected, conveyed to the Contractor, and being prior to extracting the cores, and shall be further documented in any Contractor job records citing just reasoning for recommending a reselection of original sample location(s).

Upon receipt by the Engineer of a written challenge from the Contractor, the Engineer will evaluate it within one working day and notify the Contractor in writing of either acceptance or rejection of the challenge. Rejection of a challenge will result in the Engineer using the original core sampling locations for the determination of density data in any compaction pay factor calculations. Acceptance of a challenge will result in the Engineer selecting alternate core sampling location(s) for those challenged samples. Alternate core sampling location(s) will be selected by the Engineer by use of a new random number(s) to determine a new longitudinal coordinate(s) within the sublot in question. The transverse coordinate(s) of the original core sampling location(s) will be used in conjunction with the new longitudinal coordinate(s) to determine the alternate sampling location(s). The alternate core sampling location(s) will not be subject to further challenge and will be used for the determination of density data in any compaction pay factor calculations. The Contractor will be notified in writing of the final core sampling location(s).

Within one working day of final selection of the core sampling locations, the Contractor shall core in the presence of the Engineer or designee and shall deliver samples to the Engineer, in a suitable container provided by the Contractor, on the same day the samples are taken. The Engineer will identify and record the core samples. Any cores not delivered in a suitable container will be rejected and new cores taken at the Contractor's expense. The Contractor shall fill the core holes, at the Contractor's expense, with hot (minimum 90˚C (200˚F)) bituminous concrete pavement on the same day that the cores are taken. Failure to comply with the provisions of this paragraph may result in payment being withheld for the representative lot of bituminous material.

Cores, 150 mm (6 inch) in diameter, shall be taken in accordance with the 2004 version of AASHTO T 230, Method B. Agency personnel will process core samples within ten working days and will relay test results to both the Engineer and Contractor. Testing will be performed in accordance with AASHTO T 166, Method A for bulk specific gravity (B) and AASHTO T 209 for maximum specific gravity (M) from tests performed at the plant lab for that day. All cores will be sawcut. The Contractor shall mark the cores for sawcutting in the presence of the Engineer or designee for verification of cut locations. The degree of compaction (DC) will be determined as follows:

$$DC = (B/M) \times 100$$

To satisfy the requirements of part (d0 of this Subsection, physical core samples will be retained for a period of two working days from the time that DC test results are relayed to the Engineer and Contractor. In addition, any subsequently "retested" or "recored" samples, as defined in part (d), will be retained to the point of fully satisfying part (d).

(d) Core Result Verification. Upon the test results required in part (c) being relayed to both parties (the Engineer and Contractor), any individual core sample result considered to be an outlier as determined by ASTM E 178 will enter a core result verification process as defined herein. This process will consider only those core samples processed by the Agency as acceptance tested samples and does not preclude the provisions of Subsection 490.14 (e).

The core result verification process consists of four levels as follows:

(1) Level 1. The Agency will perform a statistical analysis on all lots of core sample compaction values to investigate any presence of statistical outlier(s) as determined in accordance with Table 1 of ASTM E 178 at a 5% significance level. In cases where a statistical outlier is not detected, all core sample results as reported under part (c) will be used in any compaction pay factor calculations.

When an outlier is determined to exist, the core sample representing that outlying result will be retested to ensure procedural integrity (support information accuracy, testing methodology, and mathematical accuracy). The core sample "retested" results will replace the original “outlier” core sample results for any future calculations within this Level. Should it be verified at this point that an outlier does in fact exist or the core sample retested results vary from those originally obtained, the options to either party will be either to compute any compaction pay factors using all core sample test results derived through this Level or to proceed to Level 2.

(2) Level 2. Level 1 outlier core sample results will be replaced by virtue of “recored" sample results to be obtained under this Level. The recoring location shall be at the same transverse offset as the original location and shall be offset longitudinally forward 450 mm (18 inches) from the original location. The recored sample will be tested as specified in part (c) and may reenter Level 1 analysis of this Subsection up to and including the point of ensuring procedural integrity. The recored sample will not reenter Level 2 analysis.

Upon receiving recored sample test results of this Level, the options to either party will be either to compute any compaction pay factors using those recored sample test results or to state reasons for belief that said recored sample test results are in error. Receipt of reasons shall be cause for this verification process to proceed to Level 3.

(3) Level 3. A final attempt at field resolution of core sample test results will be addressed under this Level by introduction of a third party testing facility. Selection of such a facility will be discussed and mutually agreed upon by both parties prior to beginning construction activities and will not be included in project QC or acceptance testing processes. Any findings of a third party facility will become final and will not be subject to further review. Payment to a third party for services rendered will be borne by the party having provided the Level 2 reason leading to Level 3.

The recored samples from Level 2 shall be provided to the third party testing facility. The facility will process the recored samples and provide results to both the Agency and Contractor. Upon receipt of the third party recored sample test results, the options to either party will be either to compute any compaction pay factors using these results or to proceed to Level 4.

(4) Level 4. At this level, the Agency and Contractor will defer to Subsection 105.02. Both parties shall submit to the Director of Program Development a written report describing the disparity, all subsequent actions taken to date, all documentation related to these actions, and a proposed course of action for settlement. The Director will review the submittals and all relevant project records and act in accordance with Subsection 105.02.

If the Contractor does not concur with any final decision by the Director, the Contractor may seek other remedies specified under Subsection 105.02 and the Contract.

(e) Rejected Material. For those lots with a PWL less than 60% and having satisfied the requirements of part (d), the Engineer will require complete removal of the representative lot and replacement with mix meeting Contract requirements at no additional cost to the Agency provided one of the following are met:

-lot standard deviation (s) greater than 2.0 or
-lot average density ($\bar{x}$) greater than 98.0% or
-lot average density ($\bar{x}$) less than 90.0%.

In addition, and at the discretion of the Contractor, any lot of rejected material not meeting any of the above criteria may be removed and replaced at no additional cost to the Agency. If removal and replacement is not implemented, any lot of rejected material not meeting any of the above conditions will have any compaction pay factors calculated as follows:

$$PF(d) = (- 0.05625 \ \bar{x}^{2} + 10.575 \ \bar{x} - 496.125) - 1.0$$

In such cases that this Subsection applies, any PF(d) as computed above will be the solitary pay adjustment to the representative lot as per the provisions of Subsections 490.18 and 490.19. Other applicable pay adjustments of the representative lot will be considered to equal 1.00.

490.15 JOINTS. Joints between old and new pavements, or between successive day's work, shall have a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a transverse joint constructed.

Transverse butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at a location approved by the Engineer, where the pavement has a true surface as determined by the use of a straightedge at least 4.9 m (16 feet) long. The transverse joint shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to depositing new paving mixture.

Transverse tapered joints shall be formed by ramping down the last 450 to 600 mm (18 to 24 inches) of the course being placed to match the lower surface. Care shall be taken in raking out and discarding the coarser aggregate at the low end of the taper, and in rolling the taper. The taper area shall be thoroughly coated with Emulsified Asphalt, RS-1 just prior to resuming paving. As the paver places new mixture on the taper area, placement shall proceed such that an evenly graduated deposit of mixture will complement the previously made taper. Shovels may be used to add additional mixture if necessary. The joint shall be smoothed with a rake and properly rolled, with coarse material discarded.

Longitudinal joints that have become cold shall be coated with Emulsified Asphalt, RS-1 before the adjacent mat is placed. If directed by the Engineer, such joints shall be cut back to a clean vertical edge prior to coating with the emulsion.

Unless otherwise directed by the Engineer, longitudinal joints shall be offset at least 150 mm (6 inches) from any joint in the lower courses of pavement. Transverse joints shall not be constructed nearer than 300 mm (12 inches) from the transverse joints constructed in lower courses.

Those projects having a centerline length in excess of 5 km (3 miles) shall also be subject to the following provisions:

(a) General. For the purpose of evaluating longitudinal joint compaction acceptance, a lot shall consist of the total project length of joint constructed per pavement course and total project quantity of bituminous concrete mixture compacted in place per pavement course. Sampling on constructed joints shall be performed by way of minimum 150 mm (6 inch) diameter core samples taken at the rate of two per joint kilometer (two per joint mile) per lot. Sample locations will not include those areas within 15 m (50 feet) of a transverse joint. Each individual core sample shall represent a project sublot. Once selected per that method in part (b) below, sample locations will become final and not subject to revision, nor will any core sample be subject to the provisions of Subsection 490.14 (d).

(b) Sampling. Superpave Bituminous concrete mixtures will be sampled once per sublot on a stratified random sampling procedure in the longitudinal direction in accordance with ASTM D 3665. For a longitudinal butt joint, the transverse location of the sample shall be centered on the visible surface joint line. For a tapered joint, the transverse location of the sample shall be offset from the visible surface joint line approximately 50% of the taper width as directed by the Engineer. Joint core samples shall be taken between any adjacent travel lanes and between any travel lane and shoulder provided the shoulder material was placed as a separate construction operation. All samples will be tested and evaluated by the Agency for each mix type (each mix design), excluding leveling/shim courses, for each project in accordance with the following:

TABLE 490.15A – ACCEPTANCE GUIDELINES

Property	Point of Sampling	Lot Size	Test Method
Density	Compacted-In-Place	Project (1)	AASHTO T 166, Method A and T 209

For determining the degree of compaction, the maximum specific gravity (Gmm) used in the calculation shall be the average of the two Gmm values of the materials placed to construct the joint. The calculated compaction of any individual joint core sample shall not be less than 90.0% of the corresponding maximum specific gravity of the average of the two Gmm values for each mix type (each mix design) placed per lot.

(c) Longitudinal Joint Pay Factor (PF(j)) Determination. In such case that an individual core sample (sublot) is above the minimum compaction as specified in part (b) above, it shall be defined as above minimum.

Upon completion of any individual lot, the percentage of sublots equal to or above the acceptable minimum compaction shall be defined as the lot Percent Above Minimum (PAM) and shall be used as the basis for determining pay factors as follows:

For $85 \leq PAM \leq 100$, $PF(j) = 0.01$
For $75 \leq PAM < 85$, $PF(j) = 0.00$
For $0 \leq PAM < 75$, $PF(j) = -0.01$

490.16 SURFACE TOLERANCE. The surface will be tested by the Engineer using a straightedge at least 4.9 m (16 ft) in length at selected locations parallel with the centerline. Any variations exceeding 3 millimeters (1/8 inch) between any two contact points shall be satisfactorily eliminated. A straightedge at least 3 meters (10 feet) in length may be used on a vertical curve. The straightedges shall be provided by the Contractor in accordance with Subsection 631.06.

For those projects having a centerline length of 0.8 km (0.5 miles) or greater, the surface roughness of the wearing course will be additionally measured by the Engineer or the Engineer's designee with an Agency provided Road Surface Profiler (RSP) to determine a surface tolerance pay factor (PF(r)) . The Engineer will contact the Agency's Pavement Management Section Project Manager to arrange for surface testing.

The surface will be tested by Agency personnel by traveling at highway speeds once in each direction on two-lane/two-way non- limited access State Highways and other Routes as applicable. For those two-way limited or non-limited access highways containing truck or passing lanes, only the rightmost lane will be tested in any given direction. The reported International Roughness Index (IRI) value will be the average as calculated based upon travel in both directions. Two-lane divided Interstate Highways and other applicable limited access highways will have both of the passing and travel lanes tested at highway speeds, with the reported IRI value being the average as calculated based upon travel in both lanes. For those Interstate or other applicable limited access highways having both barrels of the highway constituting the project, the reported IRI value will be that average value as calculated based on travel in both lanes of both barrels.

Prior to the highway being surface tested, all Contract items shall be complete such that the project could be deemed substantially complete, unless otherwise directed by the Engineer, including but not limited to all guardrail, bridge joints, and permanent pavement markings installed, including all side road markings, and there shall not be lane closures or equipment present that would impede highway travel. Additionally, and prior to the highway being surface tested, the highway surface shall be dry and free of snow, ice, and loose debris, and the ambient air temperature shall be a minimum of 5°C (40°F).

The roughness value used in the applicable formula below will be the average of the International Roughness Index (IRI) values measured by the RSP in each lane. The roughness associated with any anomalous features beyond the control of the Contractor, such as bridges that remain unpaved, will be eliminated from the calculations of the final project average. The corresponding Surface Tolerance Pay Factor (PF(r)) will be determined as follows and applied to the corresponding lot as defined below:

Limited Access Highways: $PF(r) = (-0.0029\ IRI + 1.1500) - 1.0$
All Other State Routes: $PF(r) = (-0.0029\ IRI + 1.1786) - 1.0$

For the purpose of evaluating surface tolerance acceptance, a lot shall consist of the total project quantity of wearing surface of bituminous concrete pavement constructed and measured in place. Said measurement shall include all shoulders, side roads, drives, and any other miscellaneous mix as measured by the Engineer.

490.17 TRAFFIC CONTROL. Whenever traffic must be maintained during a paving operation, uniformed traffic officers and/or flaggers shall be stationed at each end of the section being paved and at such other locations as may be required by the Engineer. The uniformed traffic officers or flaggers shall conform to the requirements of Section 630.

Whenever one-way traffic is maintained by the Contractor, the traveling public shall not be delayed more than 10 minutes unless otherwise directed by the Engineer. Two-way traffic shall be maintained during non-working hours.

490.18 METHOD OF MEASUREMENT. The quantity of Superpave Bituminous Concrete Pavement to be measured for payment will be the number of metric tons (tons) for a lot of mixture (each type) complete in place in the accepted work as determined from the weigh tickets.

The quantities of all applicable Pay Adjustments calculated for the project will be determined as specified below.

When applicable, and when the air voids pay factor, PF(av), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine an Air Voids Pay Adjustment, (PA(av)), to the accepted tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(av) = PF(av) \times Q \times B$$

When boxed samples are taken to determine mix properties, PF(av) shall be assumed as equal to 1.000 for a “single day” lot. Additionally, when the RQL of 50% is not attained for a lot, all other applicable pay factors for that lot shall not be greater than 1.000.

When applicable, and when the density pay factor, PF(d), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Mat Density Pay Adjustment, (PA(d)), to the accepted tonnage placed (Q) for that based on the Contract bid price (B), as follows:

$$PA(d) = PF(d) \times Q \times B$$

When applicable, and when the surface tolerance pay factor, PF(r), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of wearing surface of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Surface Tolerance Pay Adjustment, (PA(r)), to the tonnage placed (Q) for that lot per based on the Contract bid price (B), as follows:

$$PA(r) = PF(r) \times Q \times B$$

When applicable, and when the longitudinal joint pay factor, PF(j), for a lot of Superpave Bituminous Concrete Pavement is less than or more than 0.000, the measured quantity of Superpave Bituminous Concrete Pavement placed that day will be multiplied by such pay factor to determine a Longitudinal Joint Pay Adjustment, (PA(j)), to the tonnage placed (Q) for that lot based on the Contract bid price (B), as follows:

$$PA(j) = PF(j) \times Q \times B$$

When the material for any lot is removed from the project under any provisions of the Contract, no payment will be made for that material nor for any applicable Pay Adjustments under this Section.

490.19 BASIS OF PAYMENT. The measured quantity of Superpave Bituminous Concrete Pavement will be paid for at the Contract unit price per metric ton (ton) Payment shall be full compensation for furnishing, mixing, hauling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for Pay Adjustments shall be debited or credited against the Contract prices (Lump Units) bid for the applicable Pay Adjustment items.
The costs of furnishing testing facilities and supplies at the plant will be considered included in the Contract unit price of Superpave Bituminous Concrete Pavement.

The costs of obtaining, furnishing, transporting, and providing the straightedges required by Subsection 490.16 will be paid for under the appropriate Section 631 pay item included in the Contract.

The cost of taking cores for acceptance testing and filling the core holes will be incidental to the Contract item being cored. All other costs associated with obtaining samples for acceptance testing will be incidental to the cost of the Section 490 pay item. The cost of traffic control for taking cores for acceptance testing and filling the core holes will be paid under the appropriate Section 630 Contract item.

When not specified as items in the Contract, the costs of cleaning and filling joints and cracks, sweeping and cleaning existing paved surfaces, the emulsified asphalt applied to tack these surfaces, and tacking of manholes, curbing, gutters, and other contact surfaces will not be paid for directly, but will be incidental to the item Superpave Bituminous Concrete Pavement.

Superpave bituminous concrete mixture approved by the Engineer for use in correcting deficiencies in the base course constructed as part of the Contract will not be paid for as Superpave Bituminous Concrete Pavement, but will be incidental to the Contract item for the specified type of base course.

Superpave bituminous concrete mixture used to correct deficiencies in an existing pavement or to adjust the grade of a bituminous concrete surface completed under the Contract will be paid for at the Contract unit price for Superpave Bituminous Concrete Pavement.

Payment will be made under:

Pay Item	Pay Unit
490.30 Superpave Bituminous Concrete Pavement	Metric Ton (Ton)
490.31 Air Voids Pay Adjustment	Lump Unit
490.32 Mat Density Pay Adjustment	Lump Unit
490.33 Surface Tolerance Pay Adjustment	Lump Unit
490.34 Longitudinal Joint Compaction Pay Adjustment	Lump Unit

DIVISION 500

STRUCTURES

SECTION 501- HPC STRUCTURAL CONCRETE

501.01 DESCRIPTION. This work shall consist of furnishing and placing high performance portland cement concrete for structures and incidental construction.

The portland cement concrete shall consist of a homogeneous mixture of cement, fine aggregate, coarse aggregate, water, admixtures, and pozzolans, proportioned and mixed according to these Specifications.

501.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Portland Cement..... 701.02
Portland-Pozzolan Cement..... 701.05
Blended Silica Fume Cement..... 701.06
Portland Blast-Furnace Slag Cement 701.07
Tar Emulsion..... 702.05
Fine Aggregate for Concrete..... 704.01
Coarse Aggregate for Concrete..... 704.02
Lightweight Coarse Aggregate for Structural Concrete..... 704.14
Asphalt-Treated Felt 707.08
PVC Waterstop 707.10
Bonding Agents……...707.16
Stay-in-Place Corrugated Metal Forms (SIPCMF) 715.05
Concrete Curing Materials..... 725.01
Air-Entraining Admixtures .....725.02(b)
Retarding Admixtures.....725.02(c)
Water-Reducing Admixtures ..... 725.02(f)
Water-Reducing and Retarding Admixtures.....725.02(g)
Water-Reducing, High Range Admixtures .....725.02(h)
Water-Reducing, High Range, and Retarding Admixtures....725.02(i)
Accelerating Admixtures .....725.02(j)
Water-Reducing and Accelerating Admixtures .....725.02(k)
Low Shrinkage Admixtures…….....725.02(l)
Mineral Admixtures..... 725.03
Silica Fume .....725.03(b)
Ground Granulated Blast-Furnace Slag (GGBFS)..... 725.03(c)
Polystyrene Insulation Board 735.01
Blanket Insulation Material..... 735.02
Pipe Insulation 740.08
Water..... 745.01

The coarse aggregate shall be conditioned so that 24 hours prior to the anticipated concrete placement time, the total moisture percentage is a minimum of 0.75% greater than the absorption percentage for the aggregate. The minimum moisture percentage shall be maintained throughout the 24 hour period.

Precast concrete stay-in-place forms (prestressed deck panels) shall conform to the requirements of Section 510.

501.03 CLASSIFICATION AND PROPORTIONING. The following classes of concrete are included in these specifications and shall be used as shown on the plans:

TABLE 501.03A (Metric)

HP Class	Req.[2] Cem. Mat. (kg/m^3)	Max. Water-Cem. Mat. Ratio	Max. Slump (mm)	Air Content (%)	Coarse Aggregate Gradation Table	28Day[1] Comp. Strength (MPa)	28Day[1] Modulus of Rupture (MPa)
AA	419	0.40	180	7.0 ± 1.5	704.02A	30	4.48
A	362	0.44	180	7.0 ± 1.5	704.02B	30	4.48
B	335	0.49	180	7.0 ± 1.5	704.02C	25	4.48
SCC[3]	362[6]	0.44	N/A	7.0 ± 1.5	N/A	30	N/A
LW	391	0.44	150	7.0 ± 1.5	704.14	30	N/A

[1]The listed 28-day compressive strength or modulus of rupture will serve as the basis of designing or approving the concrete mix.
[2]See additional (Metric unit) tables below for required cementitious materials.
[3]Additional requirements for Class SCC are as follows:

Inverted slump cone flow[4] (mm)		56 Day Permeability[5] (Coulombs)	VSI Rating	T_{50} (Seconds)	
Min	Max			Min	Max
500	700	2500	=/< 1	2	5

[4]A higher maximum flow greater than 700 mm may be allowed if the Visual Stability Index (VSI) is 1 or less.
[5] The permeability may be tested prior to 56 days but results must still be 2500 Coulombs or less.
[6]A 20% fly ash or 25% GGBFS replacement of total cement content is required.

SCC = Self Consolidating Concrete
LW = Lightweight

TABLE 501.03A (English)

HP Class	Req.[2] Cem. Mat. (lbs/yd^3)	Maximum Water-Cem. Mat. Ratio	Max. Slump (in)	Air Content (%)	Coarse Aggregate Gradation Table	28Day[1] Comp. Strength (psi)	28Day[1] Modulus of Rupture (psi)
AA	705	0.40	7	7.0 ± 1.5	704.02A	4000	650
A	611	0.44	7	7.0 ± 1.5	704.02B	4000	650
B	564	0.49	7	7.0 ± 1.5	704.02C	3500	650
SCC[3]	611[6]	0.44	N/A	7.0 ± 1.5	N/A	4000	N/A
LW	660	0.44	6	7.0 ± 1.5	704.14	4000	N/A

[1]The listed 28-day compressive strength or modulus of rupture will serve as the basis of designing or approving the concrete mix.
[2]See additional (English unit) tables below for required cementitious materials.
[3]Additional requirements for Class SCC are as follows:

Inverted slump cone flow[4] (Inches)		56 Day Permeability[5] (Coulombs)	VSI Rating	T_{50} (Seconds)	
Min	Max			Min	Max
20	28	2500	=/< 1	2	5

[4]A higher maximum flow greater than 700 mm may be allowed if the Visual Stability Index (VSI) is 1 or less.
[5] The permeability may be tested prior to 56 days but results must still be 2500 Coulombs or less.
[6]A 20% fly ash or 25% GGBFS replacement of total cement content is required.

SCC = Self Consolidating Concrete
LW = Lightweight

Required Cementitious Materials
(Metric Units)

HP Class	Cement (kg/m³)		Fly Ash (kg/m³)		Silica Fume Admixture (kg/m³)		Cementitious Materials (kg/m³)
AA	311	+	84	+	24	=	419
A	266	+	72	+	24	=	362
B	244	+	67	+	24	=	335
LW	313	+	78	+	0	=	391

OR

HP Class	Cement (kg/m³)		GGBFS (kg/m³)		Silica Fume Admixture (kg/m³)		Cementitious Materials (kg/m³)
AA	290	+	105	+	24	=	419
A	248	+	90	+	24	=	362
B	227	+	84	+	24	=	335
LW	293	+	98	+	0	=	391

OR

HP Class	Blended Silica Fume Cement (8.0%) (kg/m³)		Fly Ash (kg/m³)		Cementitious Materials (kg/m³)
AA	335	+	84	=	419
A	290	+	72	=	362
B	268	+	67	=	335

OR

HP Class	Blended Silica Fume Cement (8.0%) (kg/m³)		GGBFS (kg/m³)		Cementitious Materials (kg/m³)
AA	314	+	105	=	419
A	272	+	90	=	362
B	251	+	84	=	335

OR

Required Cementitious Materials
(English Units)

HP Class	Cement (lbs/cy)		Fly Ash (lbs/cy)		Silica Fume Admixture (lbs/cy)		Cementitious Materials (lbs/cy)
AA	524	+	141	+	40	=	705
A	449	+	122	+	40	=	611
B	412	+	113	+	40	=	565
LW	528	+	132	+	0	=	660

OR

HP Class	Cement (lbs/cy)		GGBFS (lbs/cy)		Silica Fume Admixture (lbs/cy)		Cementitious Materials (lbs/cy)
AA	489	+	176	+	40	=	705
A	418	+	153	+	40	=	611
B	384	+	141	+	40	=	565
LW	495	+	165	+	0	=	660

OR

HP Class	Blended Silica Fume Cement (8.0%) (lbs/cy)		Fly Ash (lbs/cy)		Cementitious Materials (lbs/cy)
AA	564	+	141	=	705
A	489	+	122	=	611
B	452	+	113	=	565

OR

HP Class	Blended Silica Fume Cement (8.0%) (lbs/cy)		GGBFS (lbs/cy)		Cementitious Materials (lbs/cy)
AA	529	+	176	=	705
A	458	+	153	=	611
B	424	+	141	=	565

If bagged silica fume is being used, the total number of bags for the batch shall be the least number of whole bags required - round fractional numbers of bags required down to the next whole number. The maximum amount of silica fume used shall be 24 kg/m³ (40 lbs/cy). The total batch weight of silica fume ignored shall be substituted with portland cement. Exceptions: For a one cubic yard batch, use 50 lbs of silica fume. For a one cubic meter batch, use 34 kilograms of silica fume.

If the blended silica fume cement contains silica fume at a rate other than that required for the approved design mix, the Contractor shall provide additional silica fume or cement, as required, to provide concrete meeting the mix design requirements. The additional cement or silica fume provided shall be of the same brand and type as contained in the silica fume cement blend.

Type A Water-Reducing or Type D Water-Reducing and Retarding, or Type F Water-Reducing, High Range, or Type G Water-Reducing, High Range, and Retarding Admixture shall be required to produce a workable mixture. The use of an accelerating or water-reducing-accelerating admixture to alter the setting characteristics of concrete mixtures shall be employed only with the approval of the Engineer. The use of chlorides or admixtures containing chlorides is prohibited. All admixtures will be considered incidental to the work and included in the Contract unit price of the concrete.

The Contractor, following mix design criteria and procedures outlined by the Agency, shall submit the mix design, required data, and test results to the Structural Concrete Engineer for review and approval. For initial submittals, a minimum of two weeks shall be allowed for evaluation of the submitted mix design, test results and required data. No production of concrete for the project shall commence until the Structural Concrete Engineer has reviewed and approved the concrete mix design.

The concrete materials shall be proportioned using the absolute volumes method in accordance with the requirements for each class as specified in Table 501.03A or a reviewed and approved alternate mix design. The volumetric proportioning method such as that outlined in ACI Standard 211.1, *Recommended Practice for Selecting Proportions for Normal Weight Concrete*, or other approved volumetric proportioning methods shall be employed in the mix design.

Production activities shall operate so that no intentional deviations are made from the reviewed and approved mix design. If test results indicate a failure to obtain the 28-day compressive strength as specified in Table 501.03A as tested in accordance with AASHTO T 22 or AASHTO T 97, changes to the mix design shall be made with no extra payment. Changes may include, but are not limited to, using additional cementitious materials, changing the sources of cementitious materials or aggregates, using a high range water-reducer or other additives, or, if necessary obtaining concrete from another supplier.

Also, in lieu of the high performance concrete mix specifications provided herein, the Contractor may submit (for the Structural Concrete Engineer's and Engineer's review and acceptance) a high performance portland cement concrete mix, provided the following requirements are met:

A minimum of thirty (30) calendar days – thirty seven (37) calendar days, if the first time the mix is being submitted – prior to placement (or prior to the pre-placement meeting, if one is required), the Contractor shall submit (for approval) the mix design for the class of concrete specified. The mix design(s) shall be submitted to the Agency's Materials and Research Laboratory, 1716 Barre-Montpelier Rd., Berlin, Vermont 05602, attention Structural Concrete Engineer. No class of concrete shall be placed on a project until the mix design is approved. The mix design must contain the following (including name and source of materials):

Saturated Surface Dry or Dry Weights
Compressive Strength
Cement Content in kg/cubic meter (lbs/cubic yard)
Mineral Admixture Content (each) in kg/cubic meter (lbs/cubic yard)
Air Content
Water/Cementitious Material Ratio
Chemical Admixtures (types, brand names, dosages)
Laboratory Test Results (strength, air content, water/cement ratio, slump)
Alkali-Silica Reactivity (ASR) AASHTO T 303 modified. The modification shall be run using the proposed job cementitious material proportioning with the aggregate found to have the highest ASR potential. The expansion shall be below 0.10%.

The first time a mix design is submitted, the Contractor shall include permeability test results for (a minimum of) three (3) 4 inch diameter x 8 inch high (100 mm diameter x 200 mm high) test cylinders, made and cured in accordance with AASHTO T 22. The information shall include the individual results from testing 3 specimens, but no specimen shall exceed the maximum specified. Testing shall be performed by a Cement

and Concrete Reference Laboratory (CCRL) qualified laboratory. The maximum allowed rapid chloride ion coulomb permeability result as tested per AASHTO T 277 is 2000, tested at 56 days from the date specimens were cast.

The first time a mix design is submitted, the Contractor shall include ASR – AASHTO T 303 test data from both fine and coarse aggregates**.** Testing shall be performed by a CCRL qualified laboratory. If potentially reactive aggregates are to be used in a mix design, then proposed mitigation method(s) and test results shall be provided. The AASHTO T 303 test shall be run again with the proposed mitigation method(s) and using the proposed job cementitious material proportioning. The maximum allowable mortar bar expansion when tested per AASHTO T 303 (with proposed mitigation method(s), as described previously, if required) shall be 0.10%.

The cylinder test results shall be submitted with the following data regarding fabrication of the specimens:

Size of Batch
Type of Mixer
Mixing Time
Type of Cure
Age Upon Delivery

After the materials to be furnished by the Contractor have been reviewed and accepted, no proposed change in the source, proportions, or characteristics of the materials shall be made without the review and acceptance of the Engineer. No new materials shall be used until such materials and their proportions have been reviewed and accepted by the Engineer. In no case shall concrete from more than one batch plant be permitted on the same structure without prior written approval of the Engineer.

The Engineer may order concrete production and delivery suspended and a new mix or altered mix design submitted if components or final product material characteristics are determined to be out of tolerances, unsatisfactory, or if proposed changes in the source, proportions, or characteristics of the materials are proposed. No production of concrete for the project shall resume until the Structural Concrete Engineer has reviewed and accepted the new or altered mix design. For evaluation, new mix design submittals shall be considered as initial mix design submittals.

The various classes of concrete shall have air content by volume as specified. The entrained air shall be obtained by the use of an approved admixture.

Strict adherence to the requirements of Subsection 501.07 is required when using concrete with mineral admixtures. The setting time may be retarded in cool weather. The Resident Engineer, after consultation with the Agency's Structural Concrete Engineer, may require that the curing period, as designated in Table 501.17, be extended.

501.04 BATCHING. Measuring and batching of materials shall be done at an approved batch plant. Batch plants shall have an inspection completed prior to the first concrete placement on an Agency project if it has been longer than 12 calendar months from the last inspection. Request for inspection and required documentation must be received by the Structural Concrete Engineer a minimum of 15 working days prior to the date of the requested inspection. All deficiencies shall be corrected and verified a minimum of 3 working days prior to the first concrete placement for any Agency project. The batch plant shall meet the requirements of AASHTO M 157, except as modified and shall be maintained in good repair at all times and shall be subject to a periodic inspection by an authorized representative of the Agency. The batch plant shall have an approved method of storing, measuring, and dispensing approved mineral admixtures.

All new or relocated concrete batch plants offered for Agency approval shall be equipped for semi-automatic batching and proportioning of all cementitious material, aggregates, water and for automatic insertion of admixtures. The plants shall be equipped to automatically and accurately record (in English and metric units) the quantity of all aggregates, cementitious material and the water incorporated into each batch and shall identify and record the addition of the required admixtures.

Proper facilities shall be provided for the Engineer to inspect ingredients and processes used in the batching and delivery of the concrete. The Contractor shall, without charge, afford the Engineer all reasonable facilities for securing samples to determine whether the concrete is being furnished in accordance with these Specifications.

The Contractor shall give the Engineer 24-hour notice of intent to place concrete so that arrangements can be made for laboratory inspection and control. Failure to give notice which causes postponement of placing operations shall not be reason for determining extension of Contract time per specifications of Subsection 108.11 of the Standard Specifications for Construction.

(a) Semiautomatic Batch Plants. When actuated by a starting mechanism, the semiautomatic batch controller shall start the mass measuring (weighing) operation of the materials and stop the flow automatically when the designated mass (weight) has been reached. It shall be interlocked to ensure that the discharge mechanism cannot be opened until the mass (weight) is within the tolerance specified in Subsection 501.04 (d).

Water and admixtures may be batched in a weigh batcher or by volume in a volumetric device. When actuated, volumetric controls shall start the measuring operation and stop the flow automatically when the designated volume has been reached.

(b) Testing Laboratory. The Contractor shall provide at the plant site a weatherproof building or room for the use of Agency personnel as a testing laboratory. The Contractor shall attain and maintain a qualified laboratory status in accordance with the current edition of the Agency's Qualified Laboratory Program. Failure to comply with this program may result in suspension or revocation of acceptance testing at the facility.

The laboratory shall have a minimum gross internal area of 14 m^2 (150 square feet) with a layout providing a minimum internal width of 2.1 m (7 feet), in which to house and use the equipment specified. Should the Contractor elect to provide additional equipment relevant to testing of portland cement concrete and materials, the gross inside floor area of the laboratory shall be increased in proportion to the area required to house and operate the additional equipment. If the additional equipment is to be operated on a bench, the length of bench sections shall also be proportionally increased. An adequate method of ventilation, lighting, heating, and necessary electrical or gas connections shall be provided. Sanitary toilet facilities with lavatory shall be available for use by Agency personnel at the plant site. A dedicated private telephone service shall be provided in the laboratory. A dedicated internet connection, which provides Agency personnel a minimum speed of 700 Kbps (Kilobits Per Second) download, without utilizing compression algorithms, shall be provided in the laboratory. The connection bandwidth speed shall be verifiable using an online speed test.

The laboratory shall be equipped with the following:

1 Standard office desk, with lockable drawers or a separate lockable two-drawer file cabinet and chair.

1 VTrans' Qualified Laboratory Binder with Producer equipment calibration data

1 Bench section(s) at least 600 mm (2 feet) wide providing a minimum of 2.6 m^2 (28 square feet) of working area with undercounter shelving.

1 Standard laboratory stool.

1 Fully automatic electronic calculator with eight digit capacity.

1 Standard laboratory sink and faucet provided with an adequate supply of water meeting the requirements of Subsection 745.01. The sink shall drain to the outside of the laboratory.

1 Bench brush.

1 Floor brush.

1 Motorized 203 mm (8 inch) sieve shaker (with adjustable timer) with sieving operation conducted by means of lateral and vertical motion of the sieve accompanied by jarring action with the following 203 mm (8 inch) diameter sieves: 9.5 mm (3/8 inch), 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 600 μm (No. 30), 300 μm (No. 50), 150 μm (No. 100), plus pan and cover.

1 Mechanical aggregate shaker (with adjustable timer) with a 0.0283 m^3 (1 cubic foot) capacity with the following screens: 45 mm (1 3/4 inch), 37.5 mm (1 1/2 inch), 25 mm (1 inch), 19 mm (3/4 inch), 12.5 mm (1/2 inch), 9.5 mm (3/8 inch), 6.3 mm (1/4 inch), 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), and pan. The aggregate shaker may be placed in a separate enclosed area or be shielded for dust and sound. When the aggregate shaker is placed in a separate enclosed area, there shall be a minimum of 1.5 m (5 feet) of clear space measured from the front frame of the shaker outward. The enclosed area shall be well lighted and ventilated. Also, the shaker shall have an adjacent bench section approximately 900 mm (36 inches) high, 600 mm (24 inches) deep and 1250 mm (50 inches) long.

1	Electronic balance with a minimum capacity of 22 kg (50 pounds) accurate to 0.1 g (0.0002 pound). If separate fine and coarse aggregate scales are to be used, the fine aggregate scale shall meet AASHTO M 231 4.2 Table 2 Class G2 with a minimum capacity of 800 grams (1.75 lbs) and readable to 0.1g (0.0002 lbs). The coarse aggregate scale shall meet AASHTO M 231 4.2 Table 2 Class G5 with a minimum capacity of 22 kg (50 lbs) and readable to 1 gram (0.002 lbs).
1	Double burner hot plate, in which both burners are hot, with variable temperature.
5	Metal pans, nominal size, 230 by 230 by 50 mm (9 × 9 × 2 inches).
3	Metal pans, nominal size, 230 by 330 by 50 mm (9 × 13 × 2 inches).
1	Sample splitter, 63.5 mm (2 1/2 inch) chute.
1	250 mm (10 inch) blunted trowel.
1	1.25 by 1.25 m (4 × 4 feet) minimum heavy canvas for quartering samples.
1	Brass wire bristle brush.
1	Pair, heat resistant gloves.
2	38 mm (1 1/2 inch) soft bristle paint brushes.
3	355 mL (12 ounce) clear graduated glass bottles.
1	Reference color comparison chart with five organic plate number colors. Reagent sodium hydroxide solution (3 percent) in sufficient quantity for the duration of the project.

Acceptable substitutes for the aforementioned equipment may be provided when approved by the Materials and Research Engineer.

Batching operations shall not begin until the testing laboratory has been approved as being in compliance with these Specifications and all equipment and equipment calibration requirements of the current VTrans Quality Assurance Program and Qualified Laboratory Program documents. Removal of any equipment, except at the direction of the Engineer, will revoke any prior approvals and/or qualifications and require the termination of batching operations.

The building or room designated as a testing laboratory shall be maintained in a clean condition by the producer and kept free of all articles not necessary for the testing of materials. Cleaning supplies shall be furnished by the Contractor.

(c) Bins and Scales. The batch plant shall include bins, weighing hoppers, and scales with adequate separate compartments for fine aggregate and for each required separate size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided so that when required, the material may be added slowly in minute quantities and shut off with precision. Means of removing the overload of any one of the several materials shall be provided. Hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments shall be ample to prevent spilling under any working condition. All batch plant structures shall be properly leveled and maintained in that condition within the tolerance required by the design of the mass measuring (weighing) mechanism.

The scales for determining the mass (weight) of aggregate and cementitious material shall be comprised of a suitable system of levers or load cells. The levers or load cells will determine the mass (weight) consistently within 0.5 percent under operating conditions, with loads indicated either by means of a beam with balance indicator, a full-reading dial, or a digital read-out or display.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of 22.68 kg masses (50 pound weights) or by other methods approved by the Engineer. All exposed fulcrums, clevises, and similar working parts of scales shall be kept clean. When beam-type scales are used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached. Poises shall be designed to be locked in any position to prevent unauthorized change of position. All mass measuring (weighing) and indicating devices shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls.

The scales shall be serviced and their accuracy verified annually by a hopper scale service person licensed by the Division of Weights and Measures of the Vermont Department of Agriculture. For Vermont plants, an inspector representing the Division of Weights and Measures shall witness all testing conducted by the service person and will attach a seal to each hopper scale, provided it meets the current specifications, tolerances, and regulations adopted by the Division of Weights and Measures. Standard test masses (weights) used to determine the accuracy of hopper scales shall be certified yearly by the Division of Weights and Measures in accordance with their established standards.

The ready-mixed concrete producer shall hire a licensed hopper scale service person for annual checking and service of scales. In addition, Vermont producers shall schedule an inspection with the Division of Weights and Measures between February 15th and April 30th of each year. After April 30th, Vermont plants without current seals affixed to the hopper scales will not be permitted to supply concrete to Agency projects, unless otherwise directed by the Engineer or until the seals are affixed.

Out of state concrete producers shall observe all annual hopper scale mass measurement (weighing) and seal requirements of their respective states of location.

(d) Accuracy of Plant Batching. For weighed ingredients, accuracy of batching is determined by comparison between the desired mass (weight) and the actual scale reading; for volumetric measurement of water and admixtures, accuracy is determined by checking the quantity either by mass (weight) on a scale or by volume in a calibrated container.

Chemical admixture containers or scales shall be calibrated annually by a qualified admixture distributor representative.

Batching shall be conducted to accurately measure the desired quantities within the following tolerances:

Cement:	± 1 percent	Aggregates:	± 2 percent
Water:	± 1 percent	Chemical Admixtures:	± 3 percent
Mineral Admix.:	+ 10 percent, - 1 percent		

(e) Storage and Proportioning of Materials.

(1) Portland Cement. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved mass measuring (weighing) device. The bulk cement-weighing hopper shall be properly sealed and vented to preclude dusting during operation. Facilities shall be provided for the sampling of cement at the batch plant, either from the storage silo or from the weighing hopper. This device shall be a permanent installation located so as to allow safe and easy access. It shall provide a sample that represents the true nature of the material being used.

(2) Water. Water may be measured either by volume or by mass (weight). When measurement is by meter, the water meter shall be so located that the measurements will not be affected by variable pressure and temperature in the water supply line.

Measuring tanks shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tanks.

All water metering methods shall be verified/calibrated on an annual basis or at any time there is a question of accuracy. All water added to the concrete at any point shall be through an approved metering method.

(3) Aggregates. In stockpiling aggregates, the location and preparation of the sites shall be subject to the approval of the Engineer. Stockpiles shall be formed on hard well-drained areas that prevent contamination from underlying material and accumulation of excessive moisture.

Aggregates from different sources or of different gradations shall not be stockpiled together. Only rubber-tired equipment shall be permitted to operate on aggregate stockpiles.

Stockpiles shall be constructed as follows:

a. If the stockpile is to be made using mechanical equipment (front end loader, clam bucket, rock ladder, radial stacker, or other approved equipment), the stockpile shall be made in such a manner that segregation is kept to a minimum.

b. If the stockpile is to be made by dumping from trucks in multiple layers, each layer shall be approximately 1.2 m (4 feet) in depth. Each layer shall be completely in place before commencing the next layer. Care shall be taken that successive layers do not "cone" down over the previous layer.

c. No equipment shall be used to haul aggregate over the stockpiled material except to deposit the material for the layer being placed. It shall be the responsibility of the Contractor that the aggregate be kept free from deleterious material or degradation.

Stockpiles shall be maintained in such a manner that twice the anticipated aggregate requirement for any Agency project placements will be on hand and available for sampling and testing at least 48 hours before mixing operations for the placements are scheduled to begin. The Engineer may modify this requirement when special aggregates are required.

Aggregates shall be handled from stockpiles or other sources to the batch plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates, except lightweight coarse aggregate, produced or handled by hydraulic methods and washed aggregates shall be stockpiled or binned for draining at least 12 hours before being batched. In case the aggregates contain high

or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required by the Engineer.

d. Lightweight coarse aggregate stockpiles shall be presoaked for a minimum period of 48 hours immediately prior to use. Soaking shall be accomplished by continuous sprinkling or other suitable means that will provide a uniform moisture content throughout the stockpile.

(4) Admixtures. The Contractor shall follow an approved procedure for adding the necessary amount(s) of admixture(s) to each batch. Admixture(s) shall be dispensed in such a manner that will ensure uniform distribution of the material throughout the batch within the required mixing period. Except as specified herein, all admixtures shall be added to the batch at the plant, unless otherwise authorized by the Engineer.

All dispensers shall include visual inspection aids such as graduated transparent cylinders. A separate dispenser shall be provided for each liquid admixture. Storage and dispensing systems for liquid admixtures shall be equipped so as to allow thorough circulation and/or agitation of all liquid in the system. This shall be required prior to the first batching of concrete for Agency projects in any calendar year and periodically thereafter at intervals not to exceed 60 calendar days for the duration of the period the plant is supplying concrete for Agency projects. If the circulation method is used, the admixture shall be circulated until a complete exchange of admixture is achieved. If an agitation method is used, the method shall be subject to approval by the Engineer.

Storage and dispensing systems for liquid admixtures shall be sufficiently protected to prevent freezing of admixtures at all times.

It shall be the responsibility of the Contractor to use the quantity of Agency approved admixtures needed to obtain concrete meeting the requirements of the Contract. All admixtures will be approved by the Engineer prior to incorporation into the mix.

a. Air-Entraining Admixture. Air-entraining admixture shall be used as required to obtain the specified air content.

b. Water-Reducing, Retarding, and Water-Reducing and Retarding Admixtures. Dosages shall be those recommended by the Manufacturer, unless otherwise approved by the Engineer.

(5) Fly Ash or GGBFS. Fly Ash or GGBFS shall be stored at the batch plant in separate storage or holding bins or other approved holding container and shall be protected from rain and moisture.

501.05 MIXING AND DELIVERY.

(a) General. Concrete may be mixed at the site of construction, at a central point, or wholly or in part in transit mixers. The production of concrete shall meet the requirements of AASHTO M 157 with the following additional requirements:

(1) All concrete shall reach its final position in the forms within 1.5 hours after the cement has been added to the aggregates. When the ambient air temperature is 16 °C (60 °F) or above, the elapsed time may be reduced as necessary as directed by the Engineer or in accordance with Subsection 501.07(a).

(2) The Engineer may authorize the addition of water at or near the site, or the use of admixtures, prior to concrete discharge, at the Contractor's expense.

(3) The addition of water in excess of the design water-cementitious material ratio for purposes of meeting the slump limits will not be permitted. Concrete that is not within the specified slump or water/cementitious limits at time of placement shall not be used.

(4) Each load of concrete delivered at the job site shall be accompanied by a State of Vermont Batch Slip signed by the authorized Agency representative, if present, at the plant.

(5) The Contractor shall provide direct communication service from the site of the work to the batch plant that shall be available to the Engineer at all times during concrete operations. The cost of this service will be considered incidental to the work.

(6) When use of a Water-Reducing, High Range Admixture or Water-Reducing, High Range, and Retarding Admixture is specified for deck concrete, the contractor shall submit, for the Engineer's approval, the following information: Admixture manufacturer, admixture addition rate, and when the admixture is to be added to the mixture (i.e., at the plant, on project, or a combination thereof). In order to obtain the required slump, a representative from the concrete producer is required on the project to determine the final admixture dosage for each load of concrete. This representative shall be responsible for adding the Water-Reducing, High Range Admixture or Water-Reducing, High Range, Retarding Admixture and Air Entraining Admixture to the mixer. The dosage shall be applied by means of a dispenser, or by other means as approved by the Engineer. The Contractor shall provide QC concrete testing personnel to confirm the concrete is within specifications for the required work.

(7) Not including initial mixing revolutions, all concrete shall be discharged into the forms before 300 revolutions of the drum or blades. The total revolutions may be increased as directed by the Engineer.

Mortar shall be mixed in an approved mixer at the site of placement or in transit mixers when approved by the Engineer. The Engineer will withdraw approval for use of transit mixers, if necessary, to ensure a quality product or if the rate of delivery cannot be coordinated with finishing requirements.

(b) Stationary Mixers. When a stationary mixer is used for the complete mixing of the concrete, the mixing time for mixers having a capacity of 7.5 m^3 (10 cubic yards) or less shall be not less than 90 seconds. For mixers of more than 7.5 m^3 (10 cubic yards) capacity, the mixing time shall be determined by the concrete producer. The time is valid provided mixer efficiency tests prove the concrete is satisfactory for uniformity and strength. The plant shall be equipped with a timing device that will not permit the batch to be discharged before the predetermined mixing time has elapsed. Vehicles used in hauling shall comply with the requirements of Subsection 501.05(c).

(c) Transit Mixers. Transit mixers and agitators shall be subject to a periodic inspection by an authorized representative of the Agency. Such equipment shall bear a currently dated inspection "sticker" supplied by the Agency indicating that the transit mixer or agitator conforms to the Agency's requirements.

Transit mixers shall be equipped with a water-measuring tank with a visible sight gauge for use when the water for the batch is supplied from the transit mixer tank. The gauge shall be clean and legibly graduated. Measuring tanks shall be provided with outside drain valves or other means to check their calibration. These should be easily opened for checking at any time.

No transit mixer or agitator shall be charged with the ingredients of the concrete unless an authorized Agency representative is present and authorizes it. This requirement may be waived by the Engineer if a batch slip accompanies the delivery vehicle to the site.

Electrically actuated revolution counters shall be required on all transit mixers except on mixers charged at central mix plants and utilized as agitator trucks only.

If bagged mineral admixtures are being used, transit mixer maximum load size shall be limited to 80 percent of the manufacturer's rated mixing capacity**.** Also, legal vehicle load restrictions shall not be exceeded. The mixer shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

If bagged mineral admixtures are being used, agitators, when loaded, shall also not exceed 80 percent of the manufacturer's rated mixing capacity or legal load restrictions and shall be capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

The Engineer may require the Contractor to perform uniformity tests on a transit mixer or agitator. Two samples shall be taken. The first shall be after 15% of the load volume discharge and the second prior to 85% of the load volume discharge. Slump and air content shall be performed on each sample. The maximum difference in air content between the two samples shall be 1%. For slumps of concretes with specified slumps of 100 mm (4 inches) or less, the maximum difference shall be 25 mm (1 inch). For concretes with a specified slump greater than 100 mm (4 inches), the maximum difference shall be 38 mm (1.5 inches). If both conditions are not met, then the Contractor will be required to either modify the mixing procedure and/or batching sequence, or that transit mixer or agitator will not be allowed to deliver concrete to the project. The Contractor will be required to perform uniformity tests to confirm the changes have satisfactory results.

All mechanical details of the mixer or agitator such as water measuring and discharge apparatus, condition of the blades, speed of rotation of the drum, general mechanical condition of the unit and clearance of the drum shall be checked before a further attempt to use the unit will be permitted.

Mixers and agitators shall be kept free from accumulation of hardened concrete or mortar. The mixing blades shall be rebuilt or replaced when any part or section is worn 19 mm (3/4 inch) or more below the original height of the manufacturer’s design. A copy of the manufacturer’s design, showing the dimensions and arrangements of blades shall be available to the Engineer at the plant at all times.

The mixing of concrete containing silica fume is very important and shall be mixed in accordance with the appropriate situation:

1. When silica fume is added to the batch by bags or in bulk from a silo, each batch of concrete shall be mixed for not less than 150 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the mixing speed. The mixing and agitating speeds shall be found on the metal plate on the mixer.

2. When silica fume is blended with cement or a combination of cement and mineral admixture at the cement plant prior to being delivered to the concrete plant, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of the equipment as the mixing speed. The mixing and agitating speeds shall be found on the metal plate on the mixer. If inconsistent test results are obtained or the batch of concrete appears not to be completely mixed, the mixing revolutions shall be extended as necessary.

When a transit mixer or agitator is used for transporting concrete, mixing during transport shall be continuous and at the speed designated by the manufacturer of the equipment as agitating speed. Failure to do so is cause for rejection of the concrete.

Transit mixers and agitators assigned to a project shall not be used for other purposes until the desired work is completed at the site, and shall arrive at the project within the cycle that anticipated placement conditions dictate. The interval between loads shall be controlled in order that concrete in place shall not become partially hardened prior to placing succeeding batches. The plant capacity and transportation facilities shall be sufficient to ensure continuous delivery at the rate required.

Before discharging transit mix from a transit mixer that has been operating at agitating speed, the drum or blades shall be rotated approximately one minute at mixing speed. The same procedure shall apply to agitators if admixtures, water, or other ingredients are added to the mix in the field.

If additional mixing water is required to maintain the specified slump and is added with the permission of the Engineer, a minimum of 20 revolutions of the transit mixer drum at mixing speed shall be required before discharge of any concrete. At no time shall the total water introduced into any mix exceed the maximum water- cementitious material ratio shown in Table 501.03A.

Upon discharge of the concrete from the drum, a sufficient amount of water shall be charged into the drum to properly cleanse the drum. This water shall not be used as a part of the next succeeding batch but shall be discharged from the drum prior to the charging of the drum with the concrete ingredients. The drum shall be completely emptied before receiving materials for the succeeding batch. Retempering of concrete or mortar that has partially hardened, by remixing with or without additional materials, shall not be permitted.

501.06 FIELD TESTS. The Contractor shall provide assistance, equipment, materials, and curing for field sampling and testing as required by the Engineer. All costs shall be included in the Contract unit prices under Section 631. The Engineer shall perform all acceptance sampling and testing in accordance with the Agency's Quality Assurance Program. For bridge deck pours, the Contractor shall perform all on-site Quality Control (QC) sampling and testing. The person performing the QC sampling and testing shall have, as a minimum, current ACI Concrete Field Testing Technician Grade I Certification.

(a) Sampling. Sampling for tests shall be taken in accordance with AASHTO T 141 or other procedures approved by the Agency.

(1) Changes. Any time that there is a change, whether modified at the batch plant, en route, or at the site, in the source or proportions of materials (cement, water, aggregate, admixture, etc.) from a previously QC tested load, additional QC sampling and testing shall be performed on the modified load prior to incorporating the concrete into the work.

(2) Beginning of Load Sampling. Beginning of Load Sampling is sampling for QC testing purposes that is taken before 15% of the load has been discharged. For certain loads, Beginning of Load Sampling may be permitted or required by the Engineer. If Beginning of Load Sampling is performed, the following modifications to the slump and air content limits shall be in effect for possible QC acceptance. :

a. The maximum slump shall be within 10 mm (0.5 inch) of the values listed in Table 501.03A for the Class of concrete being tested.

b. The air content shall be within the range shown in Table 501.03A for the class of concrete being tested plus 0.5% above the upper limit. While these limits shall be in effect for Beginning of Load Sampling, loads that meet these criteria are not guaranteed to be within the acceptance testing criteria when acceptance testing is performed, and thus the load may still fail the acceptance testing.

(b) Slump Tests. Slump tests shall be made in accordance with AASHTO T 119. Slump tests shall not be required for Class SCC.

(c) Air Content Tests. Air content tests shall be made in accordance with the pressure method in AASHTO T 152, for acceptance or rejection, with the exception that for Class SCC the air meter shall be filled in one lift by using a scoop and dropping the concrete into the center of the pot from a distance of 150 mm (6 inches) from the top edge of the pot with no rodding. Only tap the sides of the pot prior to running the test.

(d) Compressive Strength Tests.

(1) General. The number of compressive strength tests performed should be in accordance with the guidance given in the current edition of the VTrans Materials Sampling Manual, which is dependent upon the QAP level for each project. The Engineer may order additional tests as deemed necessary.

Compressive test cylinders shall be made in accordance with AASHTO T 23, and tested for compressive strength in accordance with AASHTO T 22.
For Class SCC, the cylinders shall be filled in one lift using a scoop and dropping the concrete into the center of the mold from a distance of 150 mm (6 inches) from the top edge. The mold shall not be rodded, vibrated, or tapped on the sides.

(2) Categories of Testing.

a. Acceptance testing utilizes specimens to determine the compliance with strength requirements for the project. All test cylinders used for quality acceptance testing shall be stored in an approved curing box until they are shipped to the central laboratory.

Acceptance testing shall be performed at 28 days.

b. Job control testing utilizes specimens to determine whether adequate curing procedures are being followed and for early form removal or early loading of structure. All job control specimens shall be stored on the structure and shall receive the same curing and protection from the elements as the concrete that they represent up until 24 hours before anticipated testing of specimens.

c. Specimen curing requirements shall be as follows or as directed by the Engineer:

Number of Specimens	Category	Location of Curing
2*	Acceptance - 28 days	Curing Box
2*	Job Control - Applicable Curing Period	On Structure

*3 for Class LW only.

(e) Additional Tests for Class SCC. Flow tests shall be performed in accordance with ASTM C 1611, Procedure B. Do not tamp the self-consolidating concrete inside the cone. The concrete

flow will be tested on the first 2 loads and at a minimum of every 30 m³ (40 cy), including the yardage of the first two loads.

T_{50} Spread Flow tests shall be performed in accordance with ASTM C 1611, Appendix X.1. The T_{50} shall be performed every time the flow test is run.

Visual Stability Index (VSI) tests shall be performed in accordance with ASTM C 1611, Appendix X.1 and shall be performed on each completed flow test.

501.07 WEATHER AND TEMPERATURE LIMITATIONS-PROTECTION OF CONCRETE. The temperature of the concrete just prior to placement in the forms shall not be less than 10 ºC (50 ºF) nor more than 29 ºC (85 ºF), except that Concrete, High Performance Class AA mix shall not exceed 27 ºC (80 ºF) just prior to placement. Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits.

Placement and curing procedures shall be approved by the Engineer prior to actual placement.

(a) Hot Weather Concrete. Placement of concrete during hot weather may be limited by the Engineer based on an assessment of temperature, humidity, wind velocity, and sun radiation conditions.

No concrete shall be placed when the ambient air temperature is, or is expected to be, above 32 ºC (90 ºF). However, no Concrete, High Performance Class AA mix shall be placed when the ambient air temperature is, or is expected to be, above 29 ºC (85 ºF) during the placement, except by written permission of the Engineer.

(b) Cold Weather Concrete.

(1) General. When it is necessary to place concrete or mortar at or below an ambient air temperature of 5 °C (40 °F), concrete temperatures shall be maintained by an approved method and the work protected by adequate housing, covering and heating, or insulated forms.

The Contractor shall have on the job, ready to install prior to starting any placing operation adequate equipment meeting the approval of the Engineer for

heating and protecting the materials and freshly placed concrete.

No concrete shall be placed when the temperature of the surrounding atmosphere is lower than -12 °C (10 °F) except by written permission of the Engineer.

No concrete shall be placed in any superstructure or thin section under cold weather conditions (ambient air temperature of 5 ºC (40 ºF) or less) without written permission of the Engineer.

(2) Heating of Materials. The heating equipment shall be capable of heating the materials uniformly. Aggregates shall not be heated over 66 °C (150 °F). If water is heated in excess of 60 °C (140 °F), the water shall be mixed with the aggregate before the cementitious material is added. The materials shall be heated in such a manner, for such a period of time, and in such quantity as to produce concrete having a uniform temperature within the specified temperature range at the time of placing. Materials containing frost or frozen lumps shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. When aggregates are heated in bins, steam-coil or water-coil heating, or other methods that will not be detrimental to the aggregates, may be used.

(3) Antifreeze Compounds. Salts, chemicals, or other foreign materials shall not be used in the mix to lower the freezing point of the concrete.

(4) Preparation of Forms. Before placing concrete; ice, snow, and frost shall be completely removed from the forms.

Concrete shall not be placed on a surface or in forms that are frozen, have surface temperatures below 0 ºC (32 ºF), or that contain frozen materials. The frozen surface or forms shall be completely thawed the day previous to the placing of the concrete and shall be kept continuously thawed until the concrete is poured.

(5) Housing. The Contractor shall furnish sufficient canvas and framework or other suitable type of housing to enclose and protect the structure. The sidewalls of the housing for protecting abutments and piers shall be completely built before the placing of any concrete. They shall be constructed independent of the forms and bracing and with space large enough to provide for form removal and initial finishing of concrete as required during the heating period. Joists adequately spaced to prevent sagging shall support the top of the housing. The housing shall be completely built and the heat applied before placing any concrete.

Bridge decks, floor slabs, and roof slabs placed when the ambient air temperature is below 5 °C (40° F) shall be protected by a housing which also encloses the space beneath and which extends approximately 300 mm (12 inches) outside the edge of the floor. Alternatively, the deck may be insulated in accordance with part (b)(8)b. below.

When the temperature readings taken on or in the concrete indicate the temperature of the concrete may fall below 10 °C (50 °F), the Contractor shall, without exposing the concrete, immediately build the necessary enclosures around the area involved and supply heat to ensure curing conditions as specified in Subsection 501.17. The enclosure shall be removed when directed by the Engineer.

(6) Heating the Enclosure. The enclosure shall be heated in such a manner that the temperature of the concrete and the enclosed air shall be kept above 10 °C (50 °F), but recommended to be no more than 11 °C (20 °F) above the concrete temperature, for the designated curing period. During this time, the concrete shall be kept continuously wet to provide proper curing. After the curing period, the temperature shall be gradually lowered to that of the surrounding atmosphere, taking at least 48 hours for the transition but at no time exceeding a 0.5 °C (1 °F) change per hour.

When dry heat is used, a means of maintaining atmospheric moisture shall be supplied. The Contractor shall maintain adequate fire protection and shall provide personnel to keep the heating units in continuous operation. When operations are in locations where water levels may fluctuate, the supports for heating equipment shall be built so that the heating equipment can be raised and steam lines shall be placed above the probable high water level.

When using direct fired or indirect fired heaters, the enclosure shall be well ventilated to avoid accumulation of carbon dioxide and carbon monoxide.

When using hydronic heaters, a heat transfer fluid that circulates through a series of hoses, the heat transfer hoses shall be laid on top of the vapor barrier, for example plastic, then covered with approved insulating materials or by other approved method for retaining heat.

(7) Temperature Records. The Contractor shall provide an automatic temperature recorder to continuously record concrete curing temperatures and ambient air temperatures for the entire curing period. Recording thermometers shall be capable of measuring and recording temperatures within the range of -20 to 100 °C (-4 to 212 °F) with maximum graduations of 5 °C (10 °F).

Temperature sensors shall be carefully placed within the curing enclosure or the concrete to ensure that temperatures are measured at typical locations. Recorder accuracy shall be certified once every 12 months, and the certificate displayed with each recorder. The Engineer may make random checks of each recorder. On each recorder chart, the Engineer shall indicate the location of the representative concrete, date of placement, and time of start and finish of the record. At the completion of the curing period, the recorder charts shall be given to the Engineer.

When the Contractor places concrete at more than one location within the specified curing period, additional recorders shall be furnished to provide temperature records at each location.

(8) Insulated Forms.

a. General. When authorized by the Engineer, the concrete forms shall be completely covered with an approved insulating material.

To prevent loss of heat, immediately upon completion of concrete placement, all exposed surfaces shall be covered with a double thickness of burlap or cotton mats. This covering will be designed to prevent loss of moisture from the concrete and then covered with sufficient hay, straw, or insulated mats to prevent loss of heat from the concrete during the curing period. Tarpaulins shall be used as additional cover when directed.

To prevent excessive heat build up, provisions shall be made for loosening of insulation to provide ventilation and the subsequent cooling of the concrete if the surface temperature of the concrete approaches 38 °C (100 °F). In no case shall this temperature drop below 10 °C (50 °F) during the curing period.

The following table shall be used as a guide in determining the outside temperature at which concrete walls, piers, abutments, or floor slabs above ground shall be protected with blanket insulation.

TABLE 501.07A
MINIMUM AIR TEMPERATURE ALLOWABLE
FOR ALL CLASSES OF CONCRETE

Concrete Thickness		Insulation Rating of R-4		Insulation Rating of R-8	
mm	in.	°C	°F	°C	°F
150	6	5	40	-2	29
300	12	-2	28	-18	0
450	18	-11	13	-34	-29
600	24	-18	0	-48	-55
900	36	-33	-27	---	---
1200	48	-40	-40	---	---
1500	60	-40	-40	---	---

b. Bridge Decks, Floor Slabs, and Roof Slabs. Immediately upon completion of the finishing, the surface shall be protected as specified under part (b)(5) above. When approved in writing by the Engineer, the Contractor may insulate the top and bottom of the slab as specified in Table 501.07A instead of constructing a heated housing. This insulating material shall be installed immediately upon the completion of finishing in such a way that the fresh concrete surface is not marred.

c. Concrete With Water-Reducing, High Range Admixture or Water-Reducing, High Range, and Retarding Admixture. These admixtures are not to be used if the ambient temperature is below 10 ºC (50 ºF) at the time of placement, or if it is forecasted to drop below 10 ºC (50 ºF) and within 24 hours after completion of the placement, unless hot water is used or the concrete temperature is maintained in accordance with Subsection 501.07(b), subparts (5) and (7).

501.08 THIS SUBSECTION RESERVED

501.09 FORMS. Construction Drawings including falsework and form work plans shall be submitted by the Contractor in accordance with Section 105 before being used. In all cases, the Contractor shall be responsible for, and shall make good, any injury arising from inadequate forms. The Engineer shall inspect and accept all forms prior to concrete placement. Unless the Plans specifically allow for the use of stay-in-place forms, such forms shall not be used in the construction of any superstructure or bridge deck. Stay-in-place forms will only be allowed in the construction of substructure elements in locations where the Engineer agrees that removable formwork is impossible to use.

(a) Falsework. In general, falsework that cannot be founded upon a solid footing shall be supported by falsework piling.

The Engineer may require the Contractor to employ screw jacks or hardwood wedges to take up any slight settlement in the falsework.

(b) Construction. Forms shall be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations including vibration. Forms shall be constructed and maintained so as to prevent the opening of joints due to shrinkage of the lumber. Sealer/caulking as approved by the Engineer shall be used where forms abut structural steel members, such as top flanges of beams and girders, etc.

Forms shall be filleted and chamfered at all sharp corners, unless otherwise shown on the Plans or directed by the Engineer, and shall be given a bevel or draft in the case of all projections, such as girders and copings to ensure easy removal.

Falsework and forms for slabs, beams, and girders shall be constructed to provide camber shown on the Plans or ordered by the Engineer.

Falsework and forms for Class SCC shall be designed with consideration given to concrete placement rates, mix temperature, additives, and placement procedures that effect hydrostatic pressure of the concrete. Forms shall be water tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations, including vibration, which should not be needed.

(c) Form Lumber. All face form lumber for exposed surfaces shall be concrete form exterior grade plywood, not less than five ply and not less than 19 mm (3/4 inch) in thickness. In computing stud spacing, plywood shall be considered 25 mm (1 inch) lumber provided that the grain of three of the plys runs perpendicular to the studs.

Form lumber for unexposed surfaces may be dressed tongue and groove, dressed shiplap, or square edge sized four sides of uniform width and thickness. It shall have a minimum thickness, after finishing, of 19 mm (3/4 inch).

All form lumber shall be sound and free from loose or rotten knots, knotholes, checks, splits, or wanes showing on the surface in contact with the concrete. Used face form lumber, having defects or patches which may produce work inferior to that resulting from new material, shall not be used.

Other form material may be used with permission of the Engineer.

(d) Studs. Studs shall have a minimum nominal size of 51 by 152 mm (2 × 6 inches), except that 51 by 102 mm (2 × 4 inch) nominal size studs may be used for pours not exceeding 1.1 m (3 1/2 feet) in height. Studs shall be spaced center to center not more than 16 times the actual thickness of the form lumber.

Studs shall be capped at the top with a plate of not less than 51 by 152 mm (2 × 6 inches) nominal size, carefully selected as to straightness. All joints in plates shall be scabbed 1.2 m (4 feet) each way to provide continuity.

(e) Wales. All wales shall be at least 102 by 152 mm nominal size (4 × 6 inches, minimum section) or equivalent and shall be scabbed at least 1.2 m (4 feet) each side of joints to provide continuity. A row of wales shall be placed within 150 mm (6 inches) of the bottom of each pour unless studding can be extended below the bottom of the pour and secured by wales fastened to ties in the previous pour. Wales shall have a maximum spacing of 900 mm (36 inches).

(f) Form Ties. Metal ties or anchorages within the forms shall be constructed to permit their removal to a depth of at least 25 mm (1 inch) from the face without injury to the concrete.

Wire ties shall be used only in locations where they will not extend through surfaces exposed in the finished work and then only when authorized.

The cavities shall be filled with cement mortar in accordance with Subsection 501.16.

(g) Walls. Where the bottom of the form is inaccessible, the lower form boards shall be left loose or other provisions made so that extraneous material may be removed from the form immediately before placing the concrete.

(h) Surface Treatment. All forms shall be treated with commercial form oil prior to placing reinforcement and wood forms shall be saturated with water immediately before placing the concrete. Any material that will adhere to or discolor the concrete shall not be used.

(i) Metal Forms. The specifications for forms regarding design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and oiling also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms that do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

(j) Removal of Forms. The forms, or their supports, for any portion of a structure shall not be removed without the approval of the Engineer. Forms under arches, beams, floor slabs, pier caps, or special designs may be removed upon approval of the Engineer after the concrete attains 85 percent of the minimum compressive strength as specified in Table 501.03A.

If field operations are not controlled by cylinder tests, the following periods for removal of forms and supports, exclusive of days when the ambient air temperature is below 5 °C (40 °F), may be used as a guide:

Arch Center	14 Days
Centering under Beams	14 Days
Supports under Flat Slabs	14 Days
Floor Slabs	14 Days
Vertical Wall Surfaces	24 Hours
Columns	24 Hours
Sides of Beams	12 Hours
Top Slabs R.C. Box Culverts	14 Days

When field operations are controlled by compressive strength tests, the removal of forms and supports may begin when the concrete is found to have the required strength. In no case shall the number of curing days be less than specified in Table 501.17A**.**

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own dead load.

(k) Stay-in-Place Corrugated Metal Forms (SIPCMF) for Superstructure Deck Slabs.

(1) Use. Use of SIPCMF for superstructure deck slab construction shall be subject to the following requirements:

a. Fascia overhangs shall be formed with removable forms. The forms used shall leave the resulting concrete flat-surfaced.

b. Any bay, constructed in stages such that a longitudinal joint is required, shall be formed with removable forms.

(2) Design Requirements. The following requirements shall govern the design of SIPCMF:

a. Design span shall be the clear span of form plus 50 mm (2 inches) measured parallel to the form flute (also referred to as the form valley).

b. Design load shall be the sum of the weight of forms, bar reinforcement, plastic concrete, and 2.7 kPa (55 psf) for construction loads.

c. Unit working stress shall not exceed 0.725 of the specified minimum yield strength of the material.

d. Dead load deflection shall not exceed 1/180 times the form span length or 13 mm (1/2 inch), whichever is less.

e. Physical design properties shall be computed with the requirements of the American Iron and Steel Institute Specifications for the Design of Cold Formed Steel Structural Members, latest edition.

(3) Construction Requirements. The following construction requirements shall apply to the use of SIPCMF:

a. The Contractor shall submit Construction Drawings for SIPCMF in accordance with Subsection 105.03. These Drawings shall contain the following information as a minimum:

1. A layout showing the compression and tension region of each beam/girder.

2. The method of SIPCMF attachment for the compression and tension regions.

3. Geometric properties of each type of panel being used.

4. Identification of the supplier of the SIPCMF.

5. The number, location, and type of panels being used within each girder bay.

6. Panel laps, taking into account the direction of concrete pours.

7. The specifications for the material used to fill the flutes.

8. Any other material data, erection information, or miscellaneous notes that may be required.

b. Handling and Installation. Care and protection shall be given the metal form sheets, supports, and accessory items during handling, shipping, and storage. During loading, hoisting, and unloading operations, extra precaution and care shall be taken to prevent damage to ends, corners, and edges of form sheets, supports, and accessory items. If the form units and accessories are to be stored prior to installation, they shall not be placed in contact with the ground and shall be adequately covered or protected to keep them dry.

Form supports shall be placed in direct contact with the flange of beam/girder/stringer or floorbeam. All attachments shall be made by permissible welds, bolts, clips, or other approved means. The welding of form supports to steel not considered weldable or to portions of flanges subject to tensile stresses shall not be permitted. Welds and welding shall be in accordance with Subsection 506.10, with the exception that a 3 mm (1/8 inch) fillet weld will be permitted.

Form sheets shall not be permitted to rest directly on the flanges. They shall be securely fastened to form supports by self-tapping screws and shall have a minimum bearing length of 25 mm (1 inch) at each end. Transverse construction joints shall be located at the bottom of a valley. A 6 mm (1/4 inch) diameter weep hole shall be drilled at the lower end of each flute or valley.

Screed and pouring runway supports shall not be located directly on the form sheets, form supports, or reinforcing steel. No loose sheets or miscellaneous hardware shall be left on the structural slab at the end of the working day.

The corrugated metal sheets shall be fabricated for the placement sequence used, with the joints between sections of sheets overlapped or securely fastened to eliminate differential deflections. Any exposed form metal where galvanizing has been damaged shall be cleaned and repaired to the satisfaction of the Engineer.

(4) Inspection Procedures. The following three step inspection procedure will be used to check the soundness of the concrete deck against the SIPCMF:

a. Not less than two days after completion of a concrete structural slab pour, but prior to the next slab pour, one panel of the SIPCMF shall be removed from the most recently completed pour of each span, at a location selected by the Engineer, in order to provide visual evidence that the concrete mix or the construction procedures are obtaining the desired results. If the concrete mix or the construction procedures are varied significantly within a pour, such as a change in the extent of vibration or change in the workability of the mix, another section of forming shall be removed to verify that the new procedures are yielding desirable results.

b. After the concrete has attained 85% of the specified design strength, the Engineer will spot-check the underside areas of the steel forms by sounding with a suitable weight hammer. If honeycomb or voided areas are detected, the SIPCMF at that location shall be removed for a visual inspection.

c. A minimum of two percent of the total SIPCMF area shall be removed for visual inspection of the concrete surface. The amount of sounding and form removal may be moderated, at the Engineer's discretion, after a substantial amount of the slab has been constructed and inspected, if the Contractor's methods of construction and results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slab.

If, after removing a section of form, the concrete is found to be defective, additional panels shall be removed as directed by the Engineer. All defective concrete shall be repaired to match the adjacent concrete in section and color to the satisfaction of the Engineer.

The Contractor shall provide all facilities required for the safe, suitable, and convenient means of access to the forms for the Engineer's inspection procedures.

The form sections shall be removed by a metal saw or air-carbon-arc gouging with minimum damage to the concrete. Cuts shall only be sufficiently deep to sever the form. Any other method of removal shall be submitted to the Structures Engineer for approval. Cuts parallel to the corrugations in the forms shall be located on the sloping surface midway between a crest and valley. Cuts parallel to the supporting beams/girders shall be made through the supporting angles taking care not to damage the structural steel beams/girders.

The Contractor will not be required to replace the forms which have been removed.

501.10 PLACING CONCRETE.

(a) Workforce. The Contractor shall have sufficient skilled personnel at all times during the concreting operations to properly place, consolidate, and finish the concrete. If, in the opinion of the Engineer, the Contractor does not have sufficient skilled personnel to handle the concrete properly, the Engineer may postpone the start of the concreting operations until such time as the Contractor has remedied this condition.

(b) Pre-Placement Meeting. For deck pours and all pours with Class SCC, or as required by the Engineer, a pre-placement meeting shall take place at least 7 calendar days before concrete placement. Attendees at the pre-placement meeting shall include, but not be limited to, the Contractor's Project Superintendant, the Engineer, the Agency's Structural Concrete Engineer, and the concrete producer. The Contractor shall provide a placement plan detailing the horizontal length of the pour(s), and, if applicable, all location(s) at which the self-consolidating concrete will be deposited, and the timing of the placement.

(c) Placement Limitations. All concrete shall be placed in daylight, unless otherwise authorized in writing by the Engineer. Authorization to place concrete at any other time shall not be given unless an adequate lighting system is provided prior to beginning the concreting operation.

Concrete shall not be placed under adverse environmental conditions that the Engineer determines will interfere with acceptable placement and/or finishing operations.

Concrete shall not be placed until the depth and character of the foundation, the apparent adequacy of the forms and falsework and the placing of the reinforcing steel have been approved by the Engineer. The interior of the forms shall be clean of all debris before concrete is placed.

The Contractor shall submit to the Engineer a schedule of batching, delivery, and placement prior to the beginning of the concreting operations. The Contractor shall comply with the requirements of Subsection 501.05.

Equipment and tools necessary for handling materials and performing all parts of the work shall meet the approval of the Engineer as to design, capacity, and mechanical condition and must be on the site before the work is started. Any equipment, in the judgment of the Engineer, that proves inadequate to obtain results prescribed shall be improved or new equipment substituted or added.

For simple spans, concrete should be deposited by beginning at the lower end of the span and working toward the upper end. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. For continuous spans, where required by design considerations, the concrete placing sequence shall be as shown on the Plans or in the Special Provisions.

Concrete shall not be deposited in the forms more than 2 m (6 feet) from its final position, except that for Class SCC the concrete shall not be deposited in the forms more than 6 m (20 feet) horizontally from its final position.

Dropping of unconfined self-consolidating concrete more than 1.5 m (5 feet) will not be permitted.

Concrete shall not be deposited in running water.

The rate of placing the concrete shall be so regulated that no excessive stresses are placed on the forms. Concrete in all slabs, decks, girders, or ribs of arches shall be placed in one continuous operation, unless otherwise specified.

Concrete shall be placed in continuous horizontal layers, the thickness of which shall not exceed 450 mm (18 inches), unless otherwise directed by the Engineer. Each succeeding layer shall be placed before the underlying layer has taken initial set and shall be consolidated in a manner that will eliminate any line of separation between the layers. When it is necessary, by reason of any emergency, to place less than a complete horizontal layer at one operation, such layer shall terminate in a vertical bulkhead.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or straining the ends of projecting reinforcing bars.

(d) Placement of Overlays. Unless otherwise shown on the Plans, existing expansion joints and dams shall be maintained through the overlay. A bulkhead equal in width to that of the joint shall be installed to the required grade and profile prior to placing the overlay material. Expansion dam treatment shall be as shown on the Plans.

Screed rails shall be placed and fastened in position to ensure finishing the new surface to the required profile. Supporting rails shall be anchored in such a manner as to provide horizontal and vertical stability. Screed rails shall not be placed so as to create a recess in the overlay surface and shall not be treated with form oil.

A construction dam or bulkhead shall be installed in case of major delay in placement. During minor delays of one hour or less, the end of the placement shall be protected from drying with several layers of wet burlap.

For a period of at least one hour before the placement of overlay material, the prepared surface shall be flooded with water. After removal of all free water, the overlay material shall be deposited on the damp surface and manipulated so as to coat the horizontal and vertical surfaces to be covered. The rate of progress shall be controlled so as to prevent the drying of previously deposited material.

(e) Use of Chutes. Chutes, troughs, and pipes used in placing concrete shall be arranged so as to avoid segregation of the materials and the displacement of the reinforcement and shall be approved by the Engineer. Aluminum chutes, troughs, or pipes will not be permitted.

All chutes, troughs, and pipes shall be kept clean and free of hardened concrete by thoroughly flushing with water after each run. Open troughs or 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.

Dropping of unconfined concrete more than 1.5 m (5 feet) or depositing a large quantity at any point and running or working it along the forms will not be permitted.

(f) Use of Vibrators. Unless otherwise specified, the concrete shall be consolidated with mechanical vibrators, of an approved type and design, operating within the concrete. When required, vibrating may be supplemented by hand spading with suitable tools to ensure proper and adequate consolidation. Vibrators shall be manipulated to work the concrete thoroughly around the reinforcement and imbedded fixtures and into corners and angles of the forms to produce surfaces free of imperfections. Vibrators shall not be used as a means to cause concrete to flow or run into position instead of placing. The vibration at any point shall be of sufficient duration to accomplish consolidation but shall not be prolonged to the point where segregation occurs.

Vibrators shall have non-metallic or rubber coated heads. Vibrating machines shall at no time be left running unattended in the concrete.

When it is necessary by reason of an emergency to discontinue the placing of a monolithic section, the use of vibrators shall cease. Vibrators shall not again be used until a sufficient depth of fresh concrete is placed to prevent any possibility of the effect of vibration on the concrete already in place and in no case shall this depth be less than 600 mm (2 feet).

The number of vibrators used shall be ample to consolidate the incoming concrete immediately after it is deposited in the form. The Contractor shall have at least one spare vibrator in serviceable condition at the site of the structure in which more than 20 m^3 (25 cubic yards) of concrete are to be placed. The vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute under load. The vibration shall be of sufficient intensity and duration to cause plasticity, settlement, and complete consolidation of the concrete without causing segregation. The vibrator shall visibly affect a mass of concrete of 50 mm (2 inch) slump over a radius of at least 450 mm (18 inches).

Unless otherwise specified, Class SCC shall not be consolidated with mechanical vibrators. If the Engineer requests the use of a vibrator, it shall be of an approved type and design, operating within the concrete. To avoid segregation of the concrete, it shall be used as little as possible .

(g) Blasting Operation. All blasting operations within 60 m (200 feet) of any concrete work shall be completed prior to the placement of the concrete. Regardless of the above limitation on blasting operations, the Contractor shall be responsible for any damage resulting from blasting operations.

501.11 DEPOSITING CONCRETE UNDERWATER.

(a) General. Concrete shall not be deposited under water except as specified by the Contract Documents or upon approval of the Engineer and shall be subject to the following specifications:

(1) The Contractor shall submit for the Structural Concrete Engineer's approval a Portland cement concrete mix design per the following requirements:

A minimum of thirty-seven (37) calendar days prior to placement (or prior to pre-placement meeting, if one is required), the Contractor shall submit (for review and acceptance) the mix design for the class of concrete specified. The mix design(s) shall be submitted to the Agency's Materials and Research Laboratory, 1716 Barre-Montpelier Rd., Berlin, Vermont 05602, attention Structural Concrete Engineer. No class of concrete shall be placed on a project until the mix design is reviewed and accepted. The mix design must contain the following and state the names and sources of all materials:

Saturated Surface Dry or Dry Weights
Compressive Strength
Cement Content in kg/cubic meter (lbs/cubic yard)
Mineral Admixture Content (each) in kg/cubic meter (lbs/cubic yard)
Air Content
Water/Cementitious Material Ratio
Chemical Admixtures (types and dosages)
Laboratory Test Results (strength, air content, water/cementitious material ratio, slump)

(2) Mix Design Requirements. High Performance Concrete, Class SCC shall be the preferred mix design for depositing concrete underwater. If Class SCC is not used then the following requirements shall apply:

a. The mix shall contain a minimum of 356 kg/cubic meter (600 lbs/cubic yard) of cementitious material with: a minimum of 25% GGBFS substitution, or a minimum of 20% Fly Ash substitution, or other approved mineral admixture substitution at an approved rate.

b. Air content shall be 7.0% +/- 1.5%.

c. The maximum water/cementitious material ratio shall be 0.45. When a water-reducing, high range admixture has been included in the reviewed and accepted mix design, the concrete shall not demonstrate segregation at the proposed spread, as determined by the Engineer, but at no time shall the spread be less than 500 mm (20 inches).

d. If needed for a cofferdam and/or seal design, the concrete shall provide a minimum 28 day design strength of 20 MPa (3000 psi). Otherwise, minimum strength requirements for underwater concrete shall be as specified in the Contract Documents or approved by the Engineer.

(b) Placement. When placing concrete underwater, the Contractor shall use a tremie or an alternate method of conveyance, approved by the Engineer, which minimizes the mixing of fresh concrete and water. A tremie shall have a hopper at the top that empties into a watertight tube at least 250 mm (10 inches) in diameter. The discharge end of the tube on the tremie shall include a device to seal out water while the tube is first filled with concrete. An inflatable ball will not be permitted. The device shall keep its shape and float without danger of deflation,.

The placement shall be continuous to the elevations shown on the Plans and the resulting concrete shall be monolithic and homogeneous.

Concrete shall not be deposited in water having a temperature of 2 °C (35 °F) or below. When the water temperature is between 2 and 5 °C (35 and 40 °F), the mixing water, the aggregates, or both shall be heated as specified in Subsection 501.07(b).

A tremie shall be constructed of heavy-gauge steel pipe and consist of ~~a~~ watertight joints between the tremie sections with a diameter of not less than 250 mm (10 inches). The tremie hopper shall have a capacity of at least 0.4 m^3 (1/2 cubic yard). When a batch is dumped into the hopper, the flow of the concrete shall be induced by slightly raising the discharge tube, always keeping it in the concrete.

Tubes shall be kept continuously submerged in concrete during discharge. The depth that the tube is submerged in concrete and the height of the concrete in the tube shall be sufficient to prevent water from entering the tube. The Contractor shall continuously monitor the difference in elevation between the top of the concrete and the end of the discharge tube.

Horizontal movement of discharge tubes through the concrete will not be allowed.

For minor quantities, at the sole discretion of the Engineer, a direct pumping method may be approved. If a direct pumping method is to be implemented, the pipe discharging the concrete shall consist of heavy-gauge steel sections. The Contractor shall demonstrate the ability to pump the concrete without the pump line surging or otherwise moving in the water as concrete is being pumped.

501.12 PUMPING. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The pump shall be capable of pumping concrete within the specified slump limits. The use of aluminum pipe as a conveyance for the concrete will not be permitted.

The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. The equipment shall be arranged so that no resulting vibrations may damage freshly placed concrete.

501.13 CONSTRUCTION JOINTS.

(a) Location of Construction Joints. Joints shall be formed at the location shown on the Plans. Any variation or new location of joints shall require written permission of the Engineer. Feather edges at construction joints will not be permitted. Joints shall be formed with inset form work so that each layer of concrete will have a thickness of not less than 150 mm (6 inches).

(b) Joining Fresh Concrete to Previously Set Concrete. In joining fresh concrete to concrete that has hardened, the surface shall be roughened in such a manner that will not leave loosened particles or damaged concrete at the surface and be thoroughly cleaned of all laitance, loose, and foreign material. Immediately prior to the placing of the new concrete, the surface shall be saturated with water. When shown on the Plans or ordered by the Engineer, the surface shall be thoroughly coated with a very thin coating of mortar, neat cement grout, or approved bonding agent and all forms drawn tight against the face of the concrete. The neat cement mortar or bonding agent shall not be allowed to dry out before being covered with fresh concrete.

(c) Filled Construction Joints. Filled construction joints shall contain a preformed cork joint filler or other preformed joint filler that may be shown in the Contract Documents. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joints, that portion of the joint to be filled shall be formed with a separate material (other than the preformed joint filler) that can easily be removed prior to placement of the above indicated filler.

(d) Water Stops. Approved water stops shall be placed at locations shown on the Plans. They shall form continuous watertight joints.

(e) Bond Breakers. Bond breakers shall be one of the following materials as shown on the Plans: asphalt-treated felt, pipe insulation, or tar emulsion.

501.14 EXPANSION JOINTS. All joints shall be constructed according to details shown on the Plans.

(a) Filled Compression and Expansion Joints. Filled compression and expansion joints shall be made with a preformed self-expanding cork joint filler or other preformed joint filler that may be shown in the Contract Documents. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joint, that portion of the joint to be filled shall be formed with a separate material (other than the expansion joint filler) that can easily be removed prior to placement of the above indicated filler.

(b) Special Types of Expansion Joints. Special types of expansion joints may be used when shown on the Plans or ordered by the Engineer.

501.15 THIS SUBSECTION RESERVED

501.16 CONCRETE FINISHING.

(a) Formed Concrete. Unless otherwise specified, the surface of formed concrete shall be finished immediately after form removal.

All concrete surfaces shall be given a dressed finish. If further finishing is required, exposed surfaces shall be given a rubbed finish. Other finish classes may be shown on the Plans for designated surfaces.

(1) Dressed Finish. The dressed finish work shall begin within 12 hours after removal of forms and shall continue until completed. All fins and irregular projections shall be removed from all surfaces except from those that are not to be exposed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar composed of the same type of cement and fine aggregate and mixed in the same proportions used in the class of the concrete being finished. Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured a minimum of 72 hours in accordance with Subsection 501.17. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete.

The joint shall be left exposed to its full length with clean and true edges.

(2) Aesthetic Finish. In addition to a dressed finish the following work shall be performed:

a. Repairs/Patching. Areas that contain minor defects shall be repaired. Minor defects are defined as holes, honeycombing, or spalls, which are 150 mm (6 inches) or less in diameter, that do not penetrate deeper than 25 mm (1 inch) into the concrete. Surface voids or "bugholes" that are less than 6 mm (1/4 inch) in diameter and less than 3 mm (1/8 inch) deep need not be repaired. Repairs shall be made using an overhead and vertical concrete repair material satisfactory to the Engineer. The repair material shall be cured as specified by the manufacturer. Repairs shall be approved by the Engineer.

(b) Float Finish. This finish for horizontal surfaces shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be made uniform by longitudinal or transverse floating.

Immediately after float finishing, the surface shall be given a broom finish, burlap drag finish, or left smooth as determined by the Engineer.

(c) Bridge Seats. Surfaces of bridge seats under bearing devices shall be level. The entire bridge seat surface shall be smoothed with a magnesium float.

(d) Finishing Bridge Decks.

(1) General. The Contractor shall follow the procedures and details for placing the deck in accordance with the pre-pour meeting. The procedure shall provide for adequate labor, equipment, and material supply to complete placement of concrete on the entire deck, or specified portion thereof. If, during the placement, unforeseen circumstances delay the progression of the pour to a point where the concrete begins to lose plasticity the Contractor shall be prepared to place a bulkhead, as directed by the Engineer.

Approval of the method and equipment will not relieve the Contractor of full responsibility for obtaining the required surface finish.

Prior to texturing, the finished concrete surface shall be examined by the Contractor and the Engineer using a straightedge. The straightedge shall be not less than 3 m (10 feet) long. While the concrete is still plastic, surface depressions shall be filled with concrete as the placement progresses. The added concrete shall be worked sufficiently into the underlying concrete to ensure that it creates a single monolithic layer. Surface irregularities greater than 3 mm (1/8 inch) in 3 m (10 feet) in either the longitudinal or the transverse direction shall be corrected in a manner acceptable to the Engineer. When a bituminous concrete surface is to be placed on a bridge deck, the deviation shall not be greater than 6 mm (1/4 inch). When a sheet membrane is being applied, sharp ridges shall not be allowed. Thin mortar or laitance, which may have accumulated ahead of the finishing machine screed, shall be removed from the work site. These materials shall not be used to fill depressions.

If the bridge deck concrete does not meet the above smoothness requirements, the Contractor shall remove high spots up to 13 mm (1/2 inch) high by means of grinding. Any other corrections shall be made only with the written approval of the Engineer. The use of bush hammers will not be allowed. No concrete shall be removed that will result in a concrete slab thickness less than that shown on the Plans.

Any deck that cannot be corrected by a method satisfactory to the Engineer shall be removed and replaced at the Contractor's expense.

Sidewalks shall receive their final finish with a fine bristled broom.

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(2) Bridge Decks With No Asphalt Wearing Surface. After finishing, the surface shall be given a suitable texture with an artificial turf drag made of molded polyethylene. The selection of turf drag should be capable of producing a surface texture with a horizontal peak to peak distance ranging from 0.5 mm to $\leq$ 6.35 mm (0.02 inch to $\leq$ 0.25 inch) and having a peak to peak amplitude of 0.1 mm to 20 mm (0.005 inch to 0.8 inch). Select a turf drag material that will minimize tearing and rolling of coarse aggregate from the surface.

The Contractor shall apply texture in a transverse direction by hand methods. Other directions may be allowed with the approval of the Engineer. All texturing shall be performed from a work bridge immediately following the finishing operations and prior to curing operations. A second work bridge will be required for curing purposes unless a method using a single work bridge has been approved by the Engineer.

One pass of the turf drag over the finished area is desired. The drag shall leave a seamless strip between passes. Texture resulting from the drag shall stop within 375 mm (15 inches) of the curb face, rail anchor bolts, or edge of deck. Any build up of concrete at the beginning or end of the pass shall be hand troweled to provide an even transition. An acceptable broom finish may be applied to small areas of deck surface where a turf drag cannot be operated.

The drag should produce a transverse, skid resistant micro-texture acceptable to the Engineer, but should not tear the surface. If the drag is not producing an acceptable micro-texture, the Contractor shall adjust the means and methods until an acceptable micro-texture is achieved.

The Contractor shall check the drag material before the deck pour and from time to time during finishing for tears, worn surface, or hardened concrete. The Contractor should clean or replace the drag as often as necessary to maintain a well-defined micro-texture.

The turf drag should not be applied when the surface is so wet or plastic that the ridges formed flow back into the valleys when the drag has passed, nor should dragging be delayed until the concrete is so hard that sharp ridges cannot be formed by the drag.

If the 10 minute maximum, as specified in Subsection 501.17(c), for applying the wet cure cannot be met, then fogging of the area shall be performed in a manner that keeps the relative humidity above the evaporation rate of the concrete surface, but not so excessive that water begins to collect on the surface prior to texturing or other surface manipulating procedures.

(3) Bridge floors shall be struck off and finished by an approved self-propelled finishing machine. This machine will be supported on suitable rails and equipped with adjustable strike-off or finishing screeds capable of producing the required finish surface for the full width of the bridge from face to face of curbs. Machines shall be kept in true adjustment. Machines shall not be used until proper adjustments have been made and the adjustments have been checked and approved by the Engineer.

Finishing machine rail supports shall be accurately set and of substantial construction so that the finished deck surface will conform to the profile and transverse sections shown in the Plans. Finishing machine rail supports shall be placed and adjusted to properly provide for the deflection of forms, falsework, and structural supporting members which will occur during the placement of the concrete. The finishing machine rail supports shall be spaced at a maximum of 600 mm (2 feet) on center and of sufficient design as to secure the rail to prevent it from falling off the support. Sufficient time shall be provided prior to beginning concreting operations for the finishing machine to be operated over the full length of the bridge deck segment to be placed. This test run shall be made with the screed adjusted to its finishing position. While operating the finishing machine in this test, the screed rails shall be checked for deflection and proper adjustment, the cover on slab reinforcement measured, and the controlling dimensions of slab reinforcement and forms checked.

After the concrete has been placed, it shall be struck off by a self-propelled finishing machine and the operation repeated as necessary to produce a uniformly consolidated, dense, smooth surface. The final passage of the finishing machine shall result in a uniform surface at the required grade and slope over its entire area.

In areas which are inaccessible to finishing machines, use of approved manual vibratory-equipped power screeds with approved grade control method may be used, with approval of the Engineer. Straightness shall be checked as specified in Subsection 501.16(d)(1) to ensure a smooth ride and seamless transition to the finishing machine's finished area. If manual vibratory-equipped power screeds are used, then initial vibration of the concrete for consolidation in those areas shall be of the minimal duration possible to avoid over vibration and loss of air entraining of the surface concrete in these areas.

Hand finishing shall be allowed only in areas inaccessible to finishing machines or manually driven vibratory-equipped power screeds. Hand screeds or bullfloats shall be magnesium and 250 mm (10 inches), or more, in width. Care shall be taken not to overwork the concrete surface during any finishing operation. Straightness shall be checked as specified in Subsection 501.16(d)(1) to ensure a smooth ride and seamless transition to the finishing machine's finished area.

The Contractor shall furnish a work bridge or bridges of an approved type, capable of spanning the entire width of the deck, supported on the finishing machine rails, and supporting at least a 2.2 kN (500 pound) load without deflection to the concrete slab surface.

(4) Screed rails shall be rigidly set to grade and supported sufficiently on adjustable chairs so as to allow no deflection in the rails under operating conditions. Screed guides or chairs shall be supported on structural members where possible. Sufficient screed rails shall be provided so that all rails necessary for any one continuous pour may be preset and graded before the start of concreting operations. The removal of screed rails and exposed chairs shall be accomplished without walking in the fresh concrete.

The Contractor shall furnish a minimum of one work bridge of an approved type, capable of spanning the entire width of the deck and supporting at least a 2.2 kN (500 pound) load without deflection to the concrete slab surface.

After the concrete is placed, it shall be struck off by one of the following methods:

a. A self-propelled concrete finishing machine used as specified in part (d)(2) above; or

b. An approved mechanical vibrating screed exerting a force of not less than 175 N/m (12 pounds per foot), the vibrations of which shall be of not less than 6500 vibrations per minute when checked by a vibration reed-type tester, uniform throughout its entire length and adjusted so as not to drive the aggregate more than 6 mm (1/4 inch) below the surface;

After the preliminary screeding, floats shall be operated with a combined longitudinal and transverse motion, planing off the high areas and floating the material removed into the low areas. Each pass shall lap the previous pass by 50 percent of the length of the float.

Hand finishing shall be allowed only in areas inaccessible to finishing machines or manually driven vibratory-equipped power screeds. Hand screeds or bullfloats shall be magnesium and 250 mm (10 inches), or more, in width. Care shall be taken not to overwork the concrete surface during any finishing operation. Straightness shall be checked as specified in Subsection 501.16(d)(1) to ensure a smooth ride and seamless transition to the finishing machine's finished area.

501.17 CURING CONCRETE.

(a) General. Water for use in curing concrete shall conform to the provisions of Subsection 745.01.

Effective cure time shall be only the time that the concrete has been maintained in a wet condition with the concrete surface temperature above 10 °C (50 °F). If the concrete is not maintained in a wet condition and/or the concrete surface temperature drops below 10 °C (50 °F), it shall not be counted as effective cure time. The cure period will be extended 4 hours for every 1 hour the concrete is below 10 °C (50 °F), beginning when the concrete temperature is raised to or exceeds the minimum curing temperature.

Regardless of the curing medium specified, the entire surface of the newly placed concrete shall be kept damp. This shall be achieved by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The moisture shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate in a quantity sufficient to cause a flow or washing of the surface.

The atomized flow shall be applied continuously until the surfaces can be covered by the specified curing mediums. For bridge barriers, curbs, and sidewalks the curing method shall be applied within 15 minutes of the completion of the finishing process.

TABLE 501.17A
CURING OF CONCRETE COMPONENTS

Type of Construction	Curing Methods	Effective Cure Time (Days)
Substructure	501.17(b)(1),(2),(3),(5),(7),(8)	7
Superstructure	501.17(b)(2),(8)	10
Retaining Walls	501.17(b)(1),(2),(5),(6),(8)	7
Headwalls	501.17(b)(1),(2),(5),(6),(8)	7
Sidewalks, Curbs, and Gutters	501.17(b)(2),(8)	7

(b) Methods of Curing. All exposed surfaces of newly placed concrete shall be cured by one of the following specified methods:

(1) Water Curing. Curing with water shall be by continuously sprinkling or flooding of all exposed surfaces for the entire required curing period.

(2) Burlap Curing. The entire exposed surface of the concrete shall be covered with two layers of approved burlap that has been pre-soaked with water. The burlap shall then be covered with a lapped layer of white polyethylene sheeting. Once the concrete superstructure has hardened sufficiently, a stream of water (per soaker hose or other device) shall be continuously applied under the polyethylene sheeting until the cure period is complete.

(3) Sand Cover. The entire exposed surface of the concrete shall be covered with at least 75 mm (3 inches) of approved sand that shall be kept wet for the entire curing period.

(4) White Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white polyethylene sheeting, maintained and fastened to provide a nearly airtight condition in contact with the surface where possible. If, in the opinion of the Engineer, this cover is not adequately provided or maintained to ensure the proper conditions for concrete cure, then white polyethlyene sheeting cure shall be terminated and another method substituted.

(5) White Burlap-Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white burlap-polyethylene sheeting. The burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All joints shall be lapped a minimum of 450 mm (18 inches). The burlap shall be kept damp throughout the curing period.

(6) Membrane Forming Curing Compound. White pigmented or fugitive dye membrane curing solution may be used for curing concrete in minor drainage structures. All other use of curing compound shall be approved in writing by the Engineer. When membrane curing is used, the exposed concrete shall be thoroughly sealed immediately after the free water has left the surface. The concrete inside the forms shall be sealed immediately after the forms are removed and necessary finishing has been done. The solution shall be applied in one or two separate applications. If the solution is applied in two increments, the second application shall follow the first application within 30 minutes. Satisfactory equipment shall be provided, together with means to properly control and ensure the direct application of the curing solution on the concrete surface so as to result in a uniform coverage of the surface area at the rate of 275 mL/m^2 (1 gallon for each 150 square feet).

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the solution shall be applied to the affected portions equal in curing value to that specified above.

Should the surface be subject to continuous injury or the use of curing compound result in a streaked or blotchy appearance, the method shall be stopped and water curing applied.

Only curing compounds approved by the Agency's Materials and Research Section may be used.

(7) White Polyethylene Sheeting with Sand Cover. This method may be used only when approved by the Engineer and shall conform to the requirements of part (b)(4) above. The airtight condition shall be obtained by the addition of a uniform sand cover at a minimum depth of 50 mm (2 inches).

(8) Pre-dampened cotton mats. The entire exposed surface of the concrete shall be covered with a blanket of cotton mats that has been pre-dampened with water. The mats shall be maintained in a damp condition until the curing period is complete.

(c) Bridge Decks. For bridge decks the curing method shall promptly follow the screed machine, within a maximum lag time of 10 minutes and without interruption. If this lag time cannot be met, then fogging of the area shall be performed in a manner that keeps the relative humidity above the evaporation rate of the concrete surface, but not so excessive that water begins to collect on the surface prior to texturing or other surface manipulating procedures.

If, in the opinion of the Engineer, the Contractor's curing procedure is not producing an adequate cure, the Engineer may direct a change in the cure method at no additional cost to the Agency.

501.18 LOADING OF CONCRETE. After the concrete has been placed and the finishing operations concluded, it shall not be walked on or disturbed in any manner, including removal of forms, for a minimum period of 18 hours. If retarder is used as an admixture, this minimum period may be extended as directed by the Engineer.

(a) Substructure. No backfill material shall be placed against a newly completed structure unless the concrete cure is maintained in accordance with Table 501.17A, and until the field cured test cylinders have attained 85 percent of the compressive strength specified in Table 501.03A. However, the Contractor may erect forms for subsequent concrete placement on footings after 18 hours have elapsed from the time that the footing placement was completed, provided the concrete has sufficient strength to allow it to be worked on without damage, and proper cure is maintained.

Static loads, such as forms, reinforcing steel, or other materials necessary for construction, may be placed on any concrete after it has been in place 72 hours, or a compressive strength of 12.4 MPa (1800 pounds per square inch) has been obtained, provided proper curing is maintained. Superimposed loads from subsequent concrete pours will not be allowed on any substructure unit or section in place until the field cured test cylinders have attained 85 percent of the compressive strength specified by Table 501.03A, and provided curing of the supporting section is maintained in accordance with Table 501.17A.

(b) Superstructure. Static loads, such as forms, granite curbing, cast-in-place concrete curb, and other materials necessary for deck construction, may be placed on deck concrete as long as the field cured test cylinders for this concrete have attained 85 percent of the compressive strength specified in Table 501.03A or 7 days, whichever is longer, as long as the proper curing is maintained, and the materials are spread out uniformly to avoid point loading.

The Contractor shall keep bridge floors free of all motor vehicles, transit mixers, and heavy construction equipment until the curing period is satisfactorily completed, the field cured test cylinders for the bridge floor concrete have attained the compressive strength specified in Table 501.03A, and the field cured test cylinders for the curb concrete have attained 85 percent of the compressive strength specified in Table 501.03A.

(c) Vertical Joint. Concrete shall not be placed against a vertical construction joint until the previously placed concrete has been in place a minimum of 72 hours.

The Contractor must not allow loads that are in excess of the legal loads permitted by the laws of the State to travel over the completed structure, except with written permission of the Engineer.

501.19 METHOD OF MEASUREMENT. The quantity of Concrete of the High Performance Class specified, to be measured for payment will be the number of cubic meters (cubic yards) of the class of concrete specified in the complete and accepted work, as determined by the prismoidal method using dimensions shown on the Plans or as directed by the Engineer, including the volume of superstructure precast concrete stay-in-place forms, but excluding the volume of steel or other stay-in-place forms and form filling materials. No deductions will be made for the volume of concrete displaced by steel reinforcement, structural steel, expansion joint material, scuppers, weep holes, conduits, tops of piles, scoring, chamfers or corners, inset panels of 38 mm (1 1/2 inches) or less in depth, or any pipe less than 200 mm (8 inches) in diameter.

501.20 BASIS OF PAYMENT. The accepted quantities of the Contract items specified will be paid for at the Contract unit prices. Payment will be full compensation for performing the work specified, including designing the mix, satisfactory finishing and curing, and for furnishing all forms, materials, including joint filler and bond breaker, labor, tools, admixtures, equipment, including automatic temperature recording units, trial batches, and incidentals necessary to complete the work.

The cost of heating materials and protecting the concrete against cold weather, and any additional cost for cement, will not be paid for separately but will be considered incidental to the Contract unit prices for Section 501.

The cost of furnishing testing facilities and supplies at the batch plant and the setting of inserts, bench marks, and bridge plaques furnished by the Agency will not be paid for separately but will be considered incidental to the Contract unit price(s) for High Performance concrete.

Costs for all materials, labor and incidentals for steel or other stay-in-place forms and form filling materials will not be paid for separately, but will be considered incidental to the Contract unit price(s) for High Performance concrete.

Payment will be made under:

Pay Item	Pay Unit
501.32 Concrete, High Performance Class AA	Cubic Meter (Cubic Yard)
501.33 Concrete, High Performance Class A	Cubic Meter (Cubic Yard)
501.34 Concrete, High Performance Class B	Cubic Meter (Cubic Yard)
501.35 Concrete, High Performance Class SCC	Cubic Meter (Cubic Yard)
501.36 Concrete, High Performance Class LW	Cubic Meter (Cubic Yard)

SECTION 502 - SHORING SUPERSTRUCTURES

502.01 DESCRIPTION. This work shall consist of furnishing the necessary shoring, or vertically jacking of any structure or bearing to a position immediately above its present location, holding it in position during any construction process, lowering it to its supports, removing all shoring or falsework, and cleaning up of the site.

502.02 CONSTRUCTION DRAWINGS. Construction Drawings shall be submitted in accordance with Section 105. The Contractor shall submit the drawings and associated calculations, procedures**,** and details to the Structures Engineer at least four weeks prior to the anticipated start of work.

502.03 CONSTRUCTION REQUIREMENTS. Associated details**,** procedures**,** and calculations for shoring and jacking shall be prepared by a Professional Engineer (Structural or Civil) using Section 506 and the latest version of the AASHTO *LRFD Bridge Design Specifications*.

The Contractor shall be responsible for the strength, capacity, and performance of the construction method(s) employed.

When components and/or materials that are not otherwise specified for removal are removed from the structure during shoring operations and the components and/or materials are to be re-installed in the construction, the components and/or materials shall be carefully removed and salvaged by the Contractor.

Components and/or materials to be retained and re-installed shall be stored at the location specified in the Contract or as directed by the Engineer.

The Contractor shall take every precaution necessary to prevent damage to remaining components and/or materials and those to be retained for re-installation. Damage to remaining structure components and/or materials and to those to be re-installed shall be repaired or replaced by the Contractor both to the satisfaction of the Engineer and at no additional cost to the Agency.

502.04 METHOD OF MEASUREMENT. The quantity of Shoring Superstructure to be measured for payment will be on a lump sum basis for each location in the complete and accepted work specified in the Contract or ordered by the Engineer.

Unless otherwise specified in the Contract, all work for removing, salvaging, stockpiling, and re-installing existing structure components and/or materials during the Contractor's shoring operations will not be measured for payment, but will be considered incidental to Shoring Superstructure.

The quantity of Shoring Superstructure Bearings to be measured for payment will be on a unit basis for each bearing shored in the complete and accepted work in accordance with the Contract or ordered by the Engineer.

502.05 BASIS OF PAYMENT. The accepted quantity of Shoring Superstructure will be paid for each location specified at the Contract lump sum price. Payment will be full compensation for preparing and submitting construction drawings, details, procedures, and calculations as specified, performing the work specified including assuming all liability for the structure being shored and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the work.

The accepted quantity of Shoring Superstructure Bearings will be paid for at the Contract unit price for each. Payment will be full compensation for preparing and submitting construction drawings, details, procedures, and calculations as specified, performing the work specified including assuming all liability for the structure being shored and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the work.

When the structure or bearing has been jacked and blocked onto its temporary position, a payment of 75 percent of the Contract unit price will be allowed. The remaining 25 percent will be paid when all shoring or falsework has been removed and the site cleaned up.

Payment will be made under:

Pay Item	Pay Unit
502.10 Shoring Superstructure	Lump Sum
502.11 Shoring Superstructure Bearings	Each

SECTION 503

THIS SECTION RESERVED

SECTION 504 - FURNISHING EQUIPMENT FOR DRIVING PILING

504.01 DESCRIPTION. This work shall consist of furnishing the equipment required to drive piles.

504.02 EQUIPMENT.

(a) General. Prior to beginning test pile or production pile driving, the Contractor shall obtain approval for the pile driving equipment. During the pile driving operations, no changes to the approved equipment will be permitted without the Engineer's permission. The Contractor shall obtain from the Engineer a copy of the PILE AND DRIVING EQUIPMENT DATA FORM. The Contractor shall complete this form in every detail and shall submit copies to the Geotechnical Consultant employed by the Contractor, (when load tests are required) and the Engineer so that a wave equation analysis may be performed. At least 14 calendar days prior to the beginning of any pile driving, the Contractor shall furnish for the Engineer's approval specifications and applicable information to verify the capacity and capability of the proposed hammer.

(b) Hammers. The type of hammer or driver shall be adequate in size to develop sufficient energy to drive the type and length of pile specified to the maximum ultimate pile capacity or nominal axial pile resistance shown on the Plans.

Each hammer shall be equipped with an anvil or clamp suitable for transmitting the driving force to the pile. The valve mechanism and the other parts of the air or diesel hammer shall be maintained in first class condition to ensure that the length of stroke for a single-acting hammer and the design number of blows per minute for a double-acting hammer will be obtained.

The drive head shall be axially aligned with the hammer and pile and shall be guided by leads and not be free-swinging. It shall fit around the pile head in such a manner as to prevent transfer of torsional forces during driving while maintaining proper alignment of the hammer and pile.

The pile driving equipment shall not induce a compressive stress greater than 90 percent of the yield stress of the pile material. In addition, the pile driving equipment shall be capable of driving the pile to the required ultimate capacity at a blow count of between 3 and 15 blows per 25 mm (1 inch) as indicated by the wave equation analysis program (WEAP).

(c) Leads and Bracing. The Contractor shall locate and brace each pile so that upon driving, its final position and alignment will be as specified and as shown on the Plans. The selection of leads or form of bracing must be adequate to align and restrain the piling during placement. If the leads or bracing are not adequate to place the piling to within the specified tolerance, the Contractor shall modify the leads or system of bracing until it obtains results acceptable to the Engineer.

(d) Hammer Cushion. All impact pile driving equipment except gravity hammers shall be equipped with a suitable thickness of hammer cushion material to prevent damage to the hammer or pile and to ensure uniform driving behavior. Hammer cushions shall be made of durable manufactured materials, such as Micarta, provided in accordance with the hammer manufacturer's guidelines. Wood, wire rope, or asbestos hammer cushions will not be permitted. A striker plate, as recommended by the hammer manufacturer, shall be placed on the hammer cushion to ensure uniform compression of the cushion material.

The hammer cushion shall be inspected in the presence of the Engineer prior to beginning pile driving at each substructure unit or after each 100 hours of pile driving, whichever is less.

Hammer cushions shall be replaced when either damaged or worn to 75 percent of their original thickness.

(e) Saximeter. The Contractor shall provide a Saximeter or equivalent device to assist the Inspector in collecting data to monitor blow count (for all hammer types), stroke (for open end diesel hammers only), or kinetic energy (if hammer is equipped with proximity switches for measuring impact velocity). The Saximeter shall be completely charged and in sound working order prior to Agency use and shall be available for the duration of the pile driving operation. Pile driving operations shall not be conducted without the use of a Saximeter.

The Saximeter shall perform the following functions:

(1) Detect hammer blow automatically, using sound recognition circuit, or manually, via keypad.

(2) Automatically count blows and determine blows per minute (BPM) for all impact hammers.

(3) Calculate the stroke for open end diesel hammers, either in metric or English units.

(4) Store the following in memory: blow count, penetration and average stroke or BPM.

(5) Permit viewing of results on built in screen.

(6) Permit data transfer to PC or printer.

For hammers equipped with proximity switches the Saximeter shall acquire Hammer Impact Velocity data by communicating with a transmitter mounted on the hammer, and use this information to calculate the Hammer Kinetic Energy.

The Saximeter shall operate on rechargeable batteries. Batteries and recharger shall be supplied by the Contractor.

(f) Other Equipment. Other equipment required and not specified in this Section shall be suitable for the use intended and shall be approved by the Engineer.

504.03 GENERAL. The type and size of the equipment for driving piling shall be approved by the Engineer prior to being moved onto the project. Unsatisfactory equipment shall be removed from the site and replaced with satisfactory equipment when directed by the Engineer.

504.04 METHOD OF MEASUREMENT. The quantity of Furnishing Equipment for Driving Piling to be measured for payment will be on a lump sum basis for furnishing the equipment to drive all piles required on the project.

504.05 BASIS OF PAYMENT. The accepted quantity of Furnishing Equipment for Driving Piling will be paid for at the Contract lump sum price. Payment will be full compensation for furnishing and mobilizing the required equipment to the project and demobilizing equipment from the project, including the erecting, dismantling, and all incidentals necessary to complete the work.

When the equipment for driving piles has been set up and driving operations have started, a payment of 50 percent of the Contract unit price will be allowed. The remaining 50 percent will be paid when pile-driving operations are complete and the equipment has been removed from the site.

The cost of all labor and materials, including operation and maintenance of the equipment for driving piles when used in connection with the driving of piles, with the exception of the costs specified in this Subsection, will be considered as being included in the Contract unit price(s) for the type(s) of piles being driven.

Payment will be made under:

Pay Item	Pay Unit
504.10 Furnishing Equipment for Driving Piling	Lump Sum

SECTION 505 – PILING

505.01 DESCRIPTION. This work shall consist of furnishing and driving piles of the size and type specified, making field splices and performing pile load tests.

505.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Bar Reinforcement 713.01
Steel Piling 730.01
Steel Sheet Piling 730.02

Receipt of approved mill test reports and verification that they correspond to the heat or lot numbers marked on the piles is required before the piles are driven.

505.03 FURNISHING OF PILING.

(a) General. Piling shall be of the type and size shown on the Plans. The lengths shown for a structure are for estimating purposes only, unless otherwise specified.

(b) Steel Piling. Steel piling up to and including 6 m (20 feet) in length shall be furnished in one unwelded piece.

Steel piling over 6 m (20 feet) in length shall be furnished with not more than the number of splices allowed by Table 505.05A.

(c) Permanent Steel Sheet Piling. The length, type, and classification of permanent steel sheet piling shall be as shown on the Plans.

(d) Temporary Sheet Piling. When temporary sheet piling is shown on the Plans, the project quantities shall include an estimated quantity of temporary sheet piling. The temporary piling is estimated for specific locations. With the approval of the Engineer it may be used, and paid for, at other appropriate locations.

The Contractor shall submit Construction Drawings in accordance with Section 105. The drawings shall be submitted to the Construction Engineer for documentation purposes only at least four weeks prior to the anticipated start of work. The length, type, classification, and necessary quantity of Temporary Sheet Piling at each location shall be calculated and detailed by a Professional Engineer (Structural or Civil). The design and details shall be signed, stamped, and dated by the Contractor's Professional Engineer.

505.04 DRIVING OF PILING.

(a) General. Piling other than sheet piling shall not be driven until the excavation has been made to the elevation shown for the bottom of the entire footing. In embankment areas, the fill shall be completed to the bottom of the footing elevation prior to driving any piles. Any material forced up between the piles shall be removed at the Contractor's expense to the correct elevation before concrete for the foundation is placed.

Driving shall be done in a manner that will not damage or overstress the piles.

All piling shall be driven to the required maximum ultimate axial pile capacity or nominal axial pile resistance and to the penetration depth as shown on the Plans. Under no condition shall the required maximum ultimate axial pile capacity or nominal axial pile resistance be less than that shown on the Plans except upon written approval of the Engineer. When the Contractor proposes to use a vibratory or sonic method for driving of piling, the Engineer reserves the right to require the Contractor to demonstrate that such methods are capable of driving the piles to the penetration and resistance shown on the Plans. Acceptance of this method shall be based on load tests on one or more piles driven by sonic or vibratory methods or verification of required maximum ultimate axial pile capacity or nominal axial pile resistance of one or more piles with an air, or diesel hammer. Verification of required maximum ultimate axial pile capacity or nominal axial pile resistance of sonic or vibratory driven piles shall be at the Contractor's expense.

Piling shall not be driven within 35 m (115 feet) of any concrete footings or structures that have not cured for at least seven days or attained 85 percent of their designed compressive strength.

Piling that penetrates a very soft stratum overlying a hard stratum shall penetrate the hard material sufficiently to rigidly fix the ends. Piles pushed up by driving adjacent piles or by any other cause shall be redriven to the required maximum ultimate axial pile capacity or nominal axial pile resistance and to the required penetration depth as shown on the Plans.

Any pile damaged during installation, driven out of its proper location, or driven below the elevation shown on the Plans or by the Engineer, shall be corrected at the Contractor's expense by one of the following methods approved by the Engineer:

(1) Withdrawing and replacing with a new and, if necessary, longer pile.

(2) Driving a second pile adjacent to the defective pile.

(3) Splicing the pile or extending the footing to properly enclose the pile.

The driving operation shall be continuous in the sequence determined by the Engineer and shall, in general, either start at the center of the foundation and proceed each way or start at the outside row and work progressively across the footing. Piling shall be driven in conformity with the requirements shown on the Plans or as ordered by the Engineer and shall be either vertical or battered as shown.

(b) Tolerances. Piling after driving shall not vary more than 20 mm/m (1/4 inch per foot) from vertical or the specified batter. The Engineer may require that driving be stopped in order to check the pile for plumb. Pulling or pushing laterally on piles to correct out-of-plumb errors, or splicing a section that meets the tolerances for plumb in this section on an out-of-plumb section will not be permitted. Piles for trestle bents shall be so driven that the cap may be placed in its proper location without inducing excessive stresses in the piling.

The tops of foundation piling after driving shall not vary from the position shown on the Plans by more than 150 mm (6 inches) and shall have a minimum of 150 mm (6 inches) of concrete encasement.

The rotation about the vertical axis of the pile shall not vary by more than 5 degrees from that shown on the Plans.

The Contractor shall demonstrate how the tolerances will be met to the satisfaction of the Engineer prior to driving. If the verticality, location, and/or rotation tolerances specified herein are exceeded, the extent of corrective measures will be evaluated by the Engineer. If in the judgment of the Engineer corrective measures are necessary, suitable measures shall be designed and constructed by the Contractor. The Contractor shall bear all costs, including delays, associated with the corrective action.

(c) Pile Load Tests. Pile load tests, when required, shall be performed prior to driving any production piles. When not driven as a permanent production pile, the test pile shall be driven in the vicinity of the substructure footing, at a location acceptable to the Engineer.

When pile load tests are required, the Contractor shall provide the services of a Geotechnical Consulting firm for the purpose of dynamic and/or static testing of the test pile(s). A list of approved Geotechnical Consultants may be obtained from the Agency's Materials and Research Section, telephone: (802) 828-2561.

A static load test pile shall not be used as a permanent production pile. A dynamic load test pile may be used and paid for as a permanent production pile if it meets all of the following requirements:

(1) After testing is completed, the test pile meets all of the requirements for a permanent production pile (that is, it is driven to the required maximum ultimate axial pile capacity or nominal axial pile resistance and to the required penetration depth as shown on the Plans);

(2) The test pile is driven at the correct location and with the correct batter and has not failed under test loading, i.e., is not damaged, does not exceed maximum number of splices, etc.); and

(3) Use of the test pile as a permanent production pile is approved by the Engineer.

(d) Determination of the Maximum Ultimate Axial Pile Capacity or Nominal Axial Pile Resistance. These values shall be determined by dynamic loading tests, static loading tests, wave equation analysis, or a combination thereof as follows:

(1) Static Load Test. Static pile load tests shall be performed by the procedures set forth in ASTM D 1143, using the quick load test method, except that the test shall be taken to plunging failure or the capacity of the loading system. Testing equipment and measuring systems shall conform to ASTM D 1143 with the following exceptions:

a. The loading system shall be capable of applying 200 percent of the ultimate pile capacity.

b. The jack, load cell, and reaction system shall be capable of withstanding 200 percent of the ultimate pile capacity shown on the Plans. The load cell shall have been calibrated within the previous six months.

The load shall be applied to the pile through a hydraulic jack acting against a weighed platform or reaction pile system. The Contractor shall submit to the Engineer, for approval, detailed plans of the proposed loading apparatus prepared by a Professional Engineer. The apparatus shall be constructed to allow the various increments of the load to be placed gradually without causing vibration to the test pile.

The failure load for the pile shall be defined as follows:

For piles 610 mm (24 inches) or less in diameter or width, the failure load of a pile test under axial compressive load is that load which produces a settlement at failure of the pile head equal to:

$$SF = S + (3.81 + 0.008D) \quad \text{[Metric]}$$
$$SF = S + (0.15 + 0.008D) \quad \text{[English]}$$

where:

SF	=	Settlement at failure in millimeters (inches)
D	=	Pile diameter or width in millimeters (inches)
S	=	Elastic deformation of total pile length in millimeters (inches)

The top elevation of the test pile shall be determined immediately after driving and again just before load testing to check for heave. Any pile that heaves more than 0.25 inch (6 mm) shall be redriven or jacked to the original elevation prior to testing. Unless otherwise specified in the Contract, a minimum three-day waiting period shall be observed between the driving of any anchor piles or the load test pile and commencement of the load test.

(2) Dynamic Load Test. Dynamic monitoring of the test piles shall be conducted by the Contractor's Geotechnical Consultant and results will be used by the Engineer to verify that the required maximum ultimate axial pile capacity or nominal axial pile resistance has been met.

In addition to equipment and services to dynamically monitor the pile driving, the Contractor's Geotechnical Consultant shall perform wave equation analyses (WEAP) as necessary to determine the suitability of the pile driving equipment proposed by the Contractor and to determine the preliminary driving criteria for testing. The Geotechnical Consultant shall submit copies of the wave equation analysis a minimum of 14 calendar days prior to the beginning of any pile driving. Also, the Geotechnical Consultant shall perform a laboratory case pile wave analysis (CAPWAP) for each test pile to verify the field results.

The Geotechnical Consultant shall provide a preliminary and final written report including all data collected and the results of both the WEAP and CAPWAP for each test pile in accordance with ASTM D 4945. The preliminary report shall be presented to the Engineer prior to the completion of static load tests, when required, and the final report shall be submitted following completion of all load tests.

The effective capacity of battered piles shall be reduced by the following factors:

Batter	Factor
1 to 12	0.99
2 to 12	0.97
3 to 12	0.95
4 to 12	0.92

As a guide, a pile may be considered driven to refusal when the driving resistance is 15 blows per 25 mm (1 inch) or 10 blows per 13 mm (½ inch), but only when the hammer stroke is equal to or above the required stroke as specified in the wave equation analysis. This refusal value may be adjusted by the Engineer according to the results of the dynamic pile monitoring.

The Contractor's driving operations shall be monitored with a pile driving analyzer supplied and operated by the Contractor's Geotechnical Consultant during the installation and restriking of the test piles. Both dynamic and static pile load tests shall be performed on the test pile prior to driving production piles at any substructure. Production pile driving procedures may be adjusted based on the results from the pile driving analyzer. Dynamic monitoring shall be performed in accordance with ASTM D 4945 with equipment capable of determining the maximum force, velocity, and transmitted energy as well as the ultimate static bearing capacity computed by the case method for each pile tested. Gauges shall be attached to the pile approximately 1 m (3 feet) below the pile head and connected with a cable to recording instruments on the ground, away from the pile. The gauge system shall include two accelerometers, two strain transducers, and a junction box. Dynamic monitoring shall be

performed with the assistance of the Contractor, as specified in this Subsection.

The Contractor may be required by the Engineer to modify the test pile driving operation based on the results from the pile driving analyzer.

The Geotechnical Consultant shall furnish the pile driving analyzer and supplemental equipment specified in these Specifications. All test piles shall be monitored using the pile driving analyzer. The Contractor shall make the test piles available for drilling and tapping holes prior to driving. The Geotechnical Consultant shall furnish equipment, materials, and labor necessary for drilling and tapping holes in the test piles for attaching the monitoring instruments. The Contractor shall provide the following support equipment:

a. Access. The Contractor shall provide the Geotechnical Consultant's personnel safe and reasonable means of access to the pile head for attaching transducers. A platform having a minimum size of 1.2 x 1.2 m (4 × 4 feet) shall be equipped so that it may be raised to the top of the pile while the pile is located in the leads.

b. Power Source. The Contractor shall furnish an electric power source for the pile driving analyzer. If a field generator is used as the power source, it shall be equipped with functioning meters for monitoring voltage and frequency levels. Single-phase, 10 A, 115 V AC with line frequency of 60 Hz shall be provided.

Dynamic measurements shall be taken by the Geotechnical Consultant during full length driving of all test piles and during all restriking of the test piles. The stresses in the piles shall be monitored to ensure that the driving stresses do not exceed 90 percent of the yield stress of the pile. The Contractor shall reduce the energy transmitted to the pile by using cushions or reducing the energy of the hammer in order to maintain the above criteria.

The Contractor shall assist in preparing the piles to be monitored with the necessary gauge attachments on opposite sides of the pile. The gauges shall be attached by drilling and threading the appropriate size holes. The estimated time for performing the above tasks is approximately 30 minutes per section of pile driven. The Geotechnical Consultant shall do the drilling and tapping of holes in each section to be driven. The Contractor shall assist in moving and giving access to the piles. All drilling and tapping of holes shall be done on the ground.

After the gauge attachments are prepared and all gauges and cables are removed from the pile segment, the Contractor shall lift and spot the pile according to normal procedures. The pile shall be made available for the installation of gauges after placing the pile in the leads. The Contractor shall then send one person up to the pile head to assist the Geotechnical Consultant in attachment of the gauges. Time required to ascend, complete the attachments, and descend is estimated to be approximately one hour.

Pile driving during monitoring is typical of conventional driving. The cable from the gauges hangs freely down along the pile and to the monitoring equipment. The Geotechnical Consultant may temporarily stop the pile driving during the monitoring to review the data or change gauges or other equipment. The Contractor shall assist and cooperate with the Geotechnical Consultant as required during dynamic monitoring. Delays to pile driving due to dynamic monitoring after pile driving has begun should not exceed more than one hour per pile.

When the level of the gauges approaches the ground, the driving shall be halted to remove the gauges from the pile. The time required for removal of gauges is estimated to be about 30 minutes. If additional driving is required, the Contractor shall complete the pile splice and shall repeat the process of attaching gauges at the top of the next segment. The gauges shall be attached prior to continuation of driving.

Restriking of all test piles is required. The minimum time between the end of initial driving and restriking shall be 48 hours. Prior to restriking the test piles, the dynamic testing gauges shall be reattached to the pile and the pile hammer shall be warmed up by striking at least 20 blows on another pile. Restrike shall consist of either 50 mm (2 inches) of penetration or 30 hammer blows, whichever occurs first.

(3) Wave Equation Analysis. When load tests are not specified, the Engineer will verify the required maximum ultimate axial pile capacity or nominal axial pile resistance based on the Agency's wave equation analysis.

(e) Steel Sheet Piling. Permanent sheet piling shall be left in place as part of the finished structure. Temporary sheet piling shall not become a part of the finished structure but shall be removed after it has served its purpose in the construction.

(f) Steel Piling. Unless otherwise specified, the driving point of all piling, including test piling, shall be reinforced. Point reinforcement may be either a commercially fabricated weldment or a casting designed to protect the end of the pile during driving or for seating the pile on ledge. Point reinforcement details shall conform to the Contract requirements and shall be approved by the Engineer. Requirements for commercially fabricated weldments are:

(1) Fabrication Drawings and welding procedures shall be submitted to the Structures Engineer for approval in accordance with the requirements in Subsection 105.03.

(2) Weldments shall be fabricated so that the direction of rolling of weldment plates is in the same direction as the axis of the pile.

Pile flanges shall be welded to the outside faces of a pile point with a continuous bevel groove weld. The depth of the groove weld shall be at least 50 percent of the pile flange thickness but in no case less than 8 mm (5/16 inch).

The minimum thickness of the cutting edge of the point shall be 25 mm (1 inch) or 150 percent of the flange thickness of the pile, whichever is greater.

When the Contract requires the piles to be driven to point bearing on ledge, the ledge bearing surface of the point shall have at least five cutting wedges, a minimum of one centered along the strong axis of the web and one on each corner of the flanges.

505.05 SPLICES.

(a) Splices for Steel Piling. Splices shall be made in accordance with details shown on the Plans at the locations approved by the Engineer.

Splices will be allowed as shown in the following table:

TABLE 505.05A
ALLOWABLE SPLICES

Length of Steel Piling		Maximum Number of Splices Allowed
meters	Feet	
Over 6 to and including 18	Over 20 to and including 60	1
Over 18 to and including 37	Over 60 to and including 120	3
Over 37 to and including 55	Over 120 to and including 180	5

All piles to be spliced shall be cut square and even, and the flanges shall be beveled in accordance with an approved welding procedure. Webs shall be cut so that full bearing is obtained between the two surfaces. The splice shall be made in such a manner that the spliced pile shall be straight and true.

Welds shall be continuous and develop the full strength of the parts being welded

When a substructure unit contains only a single row of piles, only one pile splice shall be allowed in the top 6 m (20 ft) of that substructure unit.

(b) Splices for Steel Sheet Piling. Splicing will not be permitted unless authorized in writing by the Engineer.

505.06 WELDING. Welding shall conform to the requirements of Subsection 506.10.

505.07 CUTTING OF PILING. Piling shall be cut to the elevation shown on the Plans or as ordered by the Engineer. Cut-offs shall remain the property of the Contractor.

505.08 METHOD OF MEASUREMENT. The quantities to be measured for payment will be measured as follows:

(a) Piling.

(1) Steel Piling will be the total number of meters (linear feet) for each pile driven, accepted, and left in place, measured to the nearest meter (linear foot).

If a test pile is driven within foundation limits and subsequently accepted as permanent foundation piling, measurement for payment as Steel Piling will be made for the test pile.

If a test pile is driven outside of foundation limits, no measurement for payment as Steel Piling will be made for the test pile.

(2) Steel sheet piling will be the total number of square meters (square feet) of Permanent Steel Sheet Piling driven, accepted, and left in place after cut-off; or the total number of square meters (square feet) of Temporary Steel Sheet Piling driven, as shown on the Plans or directed by the Engineer, and retracted after use.

(b) Pile Loading Tests. Pile Loading Tests will be measured in units of one for each load tested pile. Any necessary retests shall be at the Contractor's expense.

505.09 BASIS OF PAYMENT. The accepted quantities of piling will be paid for at the Contract unit prices as follows:

(a) Steel Piling of the size specified will be paid for at the Contract unit price per meter (linear foot).

(b) Steel Sheet Piling of the type specified will be paid for at the Contract unit price per square meter (square foot).

Payment for the above specified items will be full compensation for furnishing, transporting, storing, handling, and placing the material specified, including metal collars, metal shoes, reinforcing material for ends of steel piling, reinforcing steel, splices, wales, and braces for steel sheet piling, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Dynamic Pile Loading Test will be paid for at the Contract unit price for each. Payment will be full compensation for providing, cooperating with, and assisting the Geotechnical Consultant in the performance of dynamic testing; for providing dynamic testing equipment; for restriking the test pile; for cutting off the test pile at the elevation directed by the Engineer; for preparing and submitting geotechnical reports; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for furnishing and driving test piling driven outside of foundation limits will be included in the unit price bid for Dynamic Pile Loading Test.

The accepted quantity of Static Pile Load Test will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, and driving the test pile and test equipment, including hydraulic jacks and loading apparatus; for providing, cooperating with, and assisting the Geotechnical Consultant during testing; for providing the settlement measuring devices, load cells, etc., required to perform the static pile load test as detailed in Subsection 505.04(b); for cutting off the test pile at the elevation directed by the Engineer; for preparing and submitting geotechnical reports; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
505.10 Steel Piling, HP 250 x 62 (HP 10 × 42)	Meter (Linear Foot)
505.15 Steel Piling, HP 310 x 79 (HP 12 × 53)	Meter (Linear Foot)
505.155 Steel Piling, HP 310 x 93 (HP 12 × 63)	Meter (Linear Foot)
505.16 Steel Piling, HP 310 x 110 (HP 12 x 74)	Meter (Linear Foot)
505.165 Steel Piling, HP 310 x 125 (HP 12 x 84)	Meter (Linear Foot)
505.17 Steel Piling, HP 360 x 108 (HP 14 x 73)	Meter (Linear Foot)
505.18 Steel Piling, HP 360 x 132 (HP 14 x 89)	Meter (Linear Foot)
505.19 Steel Piling, HP 360 x 152 (HP 14 x 102)	Meter (Linear Foot)
505.20 Steel Piling, HP 360 x 174 (HP 14 x 117)	Meter (Linear Foot)
505.35 Permanent Steel Sheet Piling	Square Meter (Square Foot)
505.36 Temporary Steel Sheet Piling	Square Meter (Square Foot)
505.40 Static Pile Loading Test	Each
505.45 Dynamic Pile Loading Test	Each

SECTION 506 - STRUCTURAL STEEL

506.01 DESCRIPTION. This work shall consist of furnishing, erecting, and when specified, coating fabricated metal structures and structural components.

506.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Paint	708.01
General Requirements for Structural Steel	714.01
Structural Steel	714.02
High-Strength Low-Alloy Structural Steel	714.03
Carbon Steel Bolts and Nuts	714.04
High-Strength Bolts, Nuts, and Washers	714.05
Heat-Treated Structural Bolts	714.06
Anchor Bolts, Bearing Devices	714.08
Welded Stud Shear Connectors	714.10
Steel Tubing	714.11
Direct Tension Indicators	714.12
Tension Control Assemblies	714.13
Iron Castings	715.01
Bronze Castings	715.02
Galvanizing	726.08
Metalizing	726.09

Unless otherwise specified in the Contract, all steel shall be high-strength low-alloy structural steel conforming to AASHTO M 270M/M 270, Grade 345W (Grade 50W).

All materials shall conform to the prescribed AASHTO or ASTM specifications, and no substitutions will be allowed.

506.03 GENERAL FABRICATION REQUIREMENTS. Material furnished under this Section that is permanently incorporated into a Federal-Aid project shall be entirely manufactured and coated in the United States.

Except as modified below, fabrication shall be performed in accordance with the latest editions of the applicable AASHTO design code, ANSI/AASHTO/AWS D1.5 hereinafter designated as AWS D1.5, and interim specifications in effect on the date of the Contract. Unless otherwise indicated in the Contract, the applicable AASHTO design code shall be the latest edition of the AASHTO LRFD Bridge Design Specifications .

Prior to performing any work under this Section, the Fabricator must have received approval for all Fabrication Drawings, welding procedures and any special Contract requirements and have notified the Structures Engineer at least seven days in advance of fabrication. The Contractor shall bear full responsibility and costs for all materials ordered, raw materials stockpiled, or for work performed prior to approval of the Fabrication Drawings or written authorization from the Structures Engineer.

All work shall be performed by the Fabricator indicated on the approved Fabrication Drawings unless otherwise authorized in writing by the Structures Engineer.

Structural steel furnished under this Section shall be fabricated in a plant having an AISC Major Steel Bridges (cbr) Certification and in a plant approved by the Agency prior to award of the Contract. Minor steel components including but not limited to downspouts, scuppers, and pedestrian hand railings may be fabricated in a fabrication plant that does not have an AISC Major Steel Bridges (cbr) Certification provided the fabrication plant is approved in writing by the Structures Engineer prior to the award of the Contract. All plants without certification shall have an organization, operation and equipment capable of producing a product equal to a certified plant.

The Fabricator shall demonstrate full capability for fabricating material(s) meeting the requirements of the Contract. Failure to meet Contract requirements will result in rejection of the material being fabricated and the termination of the ability to fabricate material for the State.

All plants must satisfy the following minimum requirements:

(a) Reference Materials. The plant shall have a library containing the latest editions of the following publications:

(1) AWS A5.0, A5.5, A5.17, A5.20, A5.23, C2.18, D1.1, D1.2, D1.3, D1.4, and D1.5.

(2) AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Parts I and II.

(3) AISC Quality Criteria and Inspection Standards, A Guide to the Shop Painting of Structural Steel, Manual of Steel Construction, and Structural Steel Detailing.

(4) Vermont *Standard Specifications for Construction*.

(5) AASHTO LRFD *Bridge Design Specifications*.

(6) AASHTO LRFD *Bridge Construction Specifications*.

(7) AASHTO *Standard Specifications for Welding of Structural Steel Highway Bridges*.

(8) AREMA specifications, when applicable.

(9) American Society for Nondestructive Testing (ASNT) SNT-TC-1A.

(10) SSPC *Steel Structures Painting Manual*, Volumes 1 and 2.

(11) AASHTO/NSBA G1.1-1999.

In addition to the above, access to the latest editions of any applicable ASTM standards is required.

(b) Files. The Fabricator shall maintain an organized file containing:

(1) Records of material purchased.

(2) Inventory of material in stock.

(3) Certification records of all material and welding supplies.

(c) Personnel. Fabrication personnel shall meet the following minimum requirements:

The Fabricator's representative responsible for inspection, testing and quality matters shall be qualified and certified in accordance with the provisions of AWS QC 1, entitled *Standard for Qualification and Certification of Welding Inspectors*.

Welders shall be certified for each process and position of prequalified joints in the approved welding procedures, including tacking, in accordance with AWS D1.5 for all structural bridge items and ANSI/AWS D1.1, hereinafter designated as AWS D1.1, for items not covered in AWS D1.5.

(d) Material Fabrication Facilities.

(1) All fabrication shall be performed in an enclosed permanent structure, unless otherwise approved by the Structures Engineer.

To meet minimum requirements, a plant shall have the following:

a. Dry storage for manual electrodes and fluxes.

b. Ovens with proper temperature ranges for drying electrodes and fluxes.

c. Calibrated tools, gauges, tapes, and instruments.

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d. Suitable preheating equipment and means for measuring preheat.

e. DC and AC manual shielded metal arc welding equipment capable of at least 500 A output.

f. Mechanically guided burning equipment.

g. Machine shop facilities sufficient to perform the work specified.

h. Facilities and equipment for applying shop paint to perform the work specified.

i. Blast cleaning equipment suitable for preparing a surface meeting the requirements of Subsection 506.14.

j. Suitable storage for materials and finished products.

(2) A plant engaged in fabrication of plate girders, rolled beams, and other main member components requiring continuous welds over 600 mm (2 feet) in length shall also have the following equipment:

a. Automatic arc equipment.

b. Semiautomatic arc equipment.

c. Stud welding equipment capable of installing a 22 mm (7/8 inch) diameter stud, when applicable.

d. Equipment suitable for heat curving or heat cambering.

e. Hydraulic jacking equipment suitable for aligning and positioning structural components.

(3) Adequate office facilities and equipment for the Agency's Quality Assurance Inspector shall be separate from the Quality Control facilities and shall include the following:

a. A standard office desk with drawers, locks, and keys.

b. Adjustable office chair.

c. Telephone.

d. Plan rack and file cabinet with lock and keys.

e. The following tools shall be available for the Inspector's use:

Weld gauges, micrometer, dry and wet film paint gauge, 3 m (10 foot) steel tape, 30 m (100 foot) steel tape, 2 m (6 foot) straightedge, temperature and marking crayons, ambient air thermometer, a level at least 600 mm (2 feet) long and a 600 mm (2 foot) carpenter's square.

The Engineer reserves the right to reject inadequate office facilities and require suitable alternatives.

(e) Testing Equipment. When code requirements necessitate nondestructive testing for quality control or quality assurance, the Fabricator shall have available the necessary nondestructive testing equipment for material or weld inspection (such as magnetic particle, radiograph, ultrasonic, or dye penetrant) or employ an outside inspection firm to fulfill the necessary nondestructive test requirements of the code. Nondestructive tests shall be performed in accordance with the applicable code in effect on the date of the Contract.

506.04 DRAWINGS AND PROCEDURES.

(a) General. As soon as practical after award of the Contract, the Fabricator shall prepare Fabrication Drawings in accordance with Section 105. Drawings, details, and welding procedures must be submitted as a complete package for each structure sufficiently in advance of fabrication to allow for review, resubmittals, and approval.

The Agency will review Fabrication Drawings, details, and procedures for their compliance with the Contract. The Agency uses AASHTO/NSBA G1.1-1999, Section 4 as the basis for review of structural steel Fabrication Drawings. The Agency assumes no responsibility for dimensions and other information calculated by the Fabricator. The Fabricator is responsible for the fit of all components. If errors occur that cause problems during erection, the Contractor is responsible to make acceptable corrections.

The Agency is responsible for all principal dimensions and material properties contained in the Contract. The Fabricator and Contractor are responsible for bringing to the Agency's attention any errors or discrepancies they discover.

The Fabricator is responsible for dimensioning members and ordering material to compensate for weld shrinkage, distortion, elastic deformation, sweep, slope, machining, waste from cutting, and other incidentals that are affected by the fabrication process.

(b) Details. Details not shown on the Plans that are necessary for completing the Fabrication Drawings shall be developed by the Fabricator.

The Fabrication Drawings shall provide a material list on each sheet for tabulating the number of pieces, piece marks, description, dimensions, type of material, and mass (weight) of each piece. When the Contract item pay unit is on a per kilogram (pound) basis, the mass (weight) of each piece shall be extended and summarized for each sheet as specified in Subsection 506.24. Mass (weight) extensions (extended weights) shall be submitted to the Agency upon completion of fabrication.

All welds shown on the Fabrication Drawings shall identify, by symbol, the applicable procedure(s) and appropriate nondestructive testing requirements. A separate symbol must be used to identify each approved welding procedure. When more than one procedure is available, the Fabricator may identify several procedures for any given weld.

(c) Welding Procedures. Detailed welding procedures shall be prepared in accordance with the provisions of the applicable AWS/ANSI/AASHTO code revisions and submitted in accordance with the following:

(1) Welding procedures for each structure shall be a separate package of consecutively numbered sheets. Each sheet of the set shall identify the project name, number, structure, and procedure qualification record.

(2) All procedures shall be prequalified. Procedure qualification test records shall be submitted along with each procedure. Heat input values during welding shall be shown for each procedure. The minimum heat input shall be 1.4 kJ/mm for material 10 to 19 mm (35 kilojoules per inch for material 3/8 to 3/4 inch) in thickness and 2.0 kJ/mm for material over 19 mm (50 kilojoules per inch for material over 3/4 inch) in thickness.

$$\text{Kilojoules per Millimeter} = \left(\frac{\text{Volts} \times \text{Amps} \times 0.06}{\text{Travel Speed in Millimeters per Minute}} \right)$$

[Metric]

$$\text{Kilojoules per Inch} = \left(\frac{\text{Volts} \times \text{Amps} \times 0.06}{\text{Travel Speed in Inches per Minute}} \right)$$

[English]

(3) Procedure specifications shall be presented in a format similar to Form E-1 of AWS D1.1, Appendix E, or Form E-2 of AWS D1.5, Appendix IV. Procedure qualification test records shall be presented in a format similar to Form E-2 of AWS D1.1, Appendix E, or Form E-1 of AWS D1.5, Appendix IV.

(4) Details of welded joints not prequalified under AWS D1.5, Section 2.6 shall be qualified.

(d) Revisions. Adjacent to or incorporated with the title box of each sheet shall be a revision record box including provision for: date of revision, symbol of revision number, revision made by, and description of each revision. As changes or revisions are made to previously approved sheets, the appropriate information shall be recorded, a revision number symbol placed adjacent to the appropriate detail, and the sheet resubmitted for approval. It is the Fabricator's responsibility to transfer all "as noted" corrections to the originals.

Revisions of welding procedures shall also be resubmitted, as they occur.

506.05 QUALITY ACCEPTANCE. Quality Acceptance is inspection of fabrication by the Agency or the Agency's representative to verify compliance with these Specifications.

(a) Scope of Work. Inspection will include the examination of materials, processes, quality of work, reports, and test results; the performance of tests specified; the evaluation of reports and tests; the approval, disapproval, or rejection of materials, processes, quality of work, reports, and test results; or other work specified or directed by the Engineer.

(b) Control of Work. The Inspector is a representative of the Engineer and will perform all the duties assigned and delegated to the Engineer in Section 105 as they pertain to the Contract with the exception of quantities of materials and payment thereof. The Inspector will witness, interpret, and accept or reject all testing.

The Inspector will have the authority to reject any material or work that does not conform to the Contract requirements. Inspection of the work will conform to the requirements of the applicable AWS/ANSI/AASHTO codes and specifications referenced in the Contract.

(c) Tools and Equipment. Inspectors are expected to furnish their own personal safety equipment. They may make use of any tools the Fabricator is required to make available; however, the Fabricator is responsible for verifying that the equipment is properly calibrated and in working order.

506.06 QUALITY CONTROL.

(a) General. Quality Control is the inspection, testing, and management of quality matters necessary for producing a product that conforms to the requirements of the Contract. The Fabricator is responsible for Quality Control.

The Fabricator is responsible for performing all nondestructive tests required by the Contract and any nondestructive tests necessary to determine the extent of metallurgical defects discovered in the base metal.

(b) Qualifications of Inspectors. The Fabricator's representative responsible for Quality Control shall be an AWS Certified Welding Inspector (CWI), qualified and certified in accordance with the provisions of AWS QC 1.

(c) Nondestructive Testing. The Fabricator shall notify the Agency sufficiently in advance of any scheduled nondestructive testing so that all tests can be witnessed by an Agency Inspector. Nondestructive tests shall be performed in accordance with AWS D1.5.

Personnel performing and interpreting nondestructive tests (radiographic, magnetic particle, ultrasonic and dye penetrant) shall be NDT certified for Level II qualification in accordance with the American Society for Nondestructive Testing, Recommended Practice Number SNT-TC-1A.

(d) Ultrasonic Testing. Ultrasonic testing will not be permitted as a substitute for radiographic testing; however, ultrasonic testing may be used by the Fabricator to determine the extent of discontinuities, laminations, and inclusions discovered in any weld or base metal.

506.07 MATERIAL IDENTIFICATION.

(a) Material Certifications. Certifications shall be prepared in accordance with Subsection 700.02. Prior to any fabrication or stockpile payment for material the Contractor shall furnish the Agency's Inspector one copy of all Type C Certification material test reports. Any material not properly identified or lacking acceptable test information shall not be incorporated in the work. If no Quality Acceptance Inspector is assigned or available when fabrication begins or at the time of the raw material stockpile payment, it is the Contractor's responsibility to ensure that Contract requirements are complied with.

Prior to shipment of any material, a copy of all Type C Certification material test reports and all applicable Type A Certifications, both pertaining to the items to be shipped, shall be sent to the Agency's Materials and Research Section. Acceptable certifications received by the Agency are a pre-requisite to payment for any fabricated material.

(b) Material Traceability. The origin of each piece of material to be incorporated in a product shall be clearly identified at all times during the fabrication of the product. If fabrication operations could obliterate the identity, the Fabricator may use a low-stress die stamp placed in an area not exposed on the finished structure. The die stamp character size shall be a minimum of 3 mm (1/8 inch) and a maximum of 6 mm (1/4 inch). Nonmetallic materials shall be identified to the satisfaction of the Engineer.

When requested, the Contractor shall furnish an affidavit certifying that throughout the fabrication operation identification of the steel has been maintained in accordance with this Specification.

When a steel stamp identification is used at a tension joint transition, the impression shall be placed on the thicker of the members.

506.08 BASE METAL REQUIREMENTS. When backing bars, extension bars, and runoff plates are part of a welding process, the material used shall be of the same chemistry as the base metal.

Discontinuities, laminations, inclusions, or other anomalies discovered in the base metal during the manufacturing process shall be individually evaluated. The Agency may require nondestructive testing to determine the extent of the defect. Repair procedures or replacement will be approved on an individual case basis.

Rolled beams shall be ordered from the mill without camber.

Primary stress carrying material (e.g., flanges, webs, splice plates, and lateral connection plates) shall be ordered and prepared so that the direction of rolling is parallel to the stress in the member.

Members identified as “fracture critical” shall be subject to additional base metal requirements as specified in Subsection 506.11.

Members or components of members designated in the Contract as requiring Charpy V-Notch (CVN) testing, or members subject to tensile or compressive stress as specified in Subsection 714.01 shall be identified as a main member and shall therefore be subject to the requirements of main members.

506.09 PREPARATION OF BASE METAL. Material flame cuts by any thermal cutting process shall be made with an approved mechanically guided torch. The Fabricator shall use preheating, post heating, or control of the cutting process to ensure that flame cut edges of main members of structural steel [e.g., AASHTO M 270M/M 270, Grade 345W (Grade 50W) or Grade 345 (Grade 50)] are not flame hardened. Flame cut edges that will not be included in a permanent weld shall have a Rockwell Hardness Value not greater than C30.

Pieces that are to be bent during fabrication shall be done so in accordance with AWS D1.5 and the applicable design code as defined in Subsection 506.03.

Cold bending of main members will not be permitted without written approval of the Agency. This approval may limit the radius of curvature and require nondestructive testing to verify that no internal distress or separation has occurred. Expenses incurred in performing any such nondestructive test examination shall be the responsibility of the Fabricator.

506.10 WELDING.

(a) General. All design details, quality of work, procedures, and inspection of welding shall conform to the requirements of the AWS D1.5 Bridge Welding Code. For welding items other than those covered in AWS D1.5, one of the following publications shall be adhered to:

ANSI/AWS D1.1 Structural Welding Code - Steel
ANSI/AWS D1.2 Structural Welding Code - Aluminum
ANSI/AWS D1.3 Structural Welding Code - Sheet Steel
ANSI/AWS D1.4 Structural Welding Code - Reinforcing Steel

Welding will not be permitted without approved welding procedures and Fabrication Drawings meeting the requirements of Subsection 506.04.

Welding and inspection of shear connectors shall conform to the requirements of Section 508.

Stitch welds are not permitted; however, the skip and fill technique may be used when applicable to prevent distortion.

Prior to performing any corrective weld repairs, the Fabricator shall:

(1) Submit the proposed repair procedure to the Inspector in writing. Corrective procedures for radiographed butt welds may be included in the welding procedure.

(2) Receive written authorization from the Agency to proceed. Repair procedures detailed in an approved welding procedure may be authorized by the Agency's Inspector.

The Fabricator will be permitted a maximum of two repairs on any given welded joint. Should nondestructive test inspection indicate weld rejection after two repairs, the Agency may reject the entire weld and require its removal.

(b) Welding Processes. Shielded metal arc welding (SMAW) conforming to AWS D1.5, Section 1 shall be deemed prequalified. Submerged arc welding (SAW), flux core arc welding (FCAW), and gas metal arc welding (GMAW) shall be subject to qualification testing as described in AWS D1.5, Section 5 prior to approval. Other processes may be approved, on a project by project basis, provided procedure qualification results meet the specified acceptance criteria.

Submerged arc welding shall be used for all principal welds:

(1) The fully automatic process shall be used for attaching cover plates, flange to web welds, and attaching connection or stiffener plates to girder webs.

(2) The semiautomatic process may be used when joint length, position, or physical location restricts the use of the automatic process.

The manual shielded metal arc process shall be limited to attaching connection plates to rolled beams, welding bearing assemblies, repairs, tack welding, joints under 600 mm (24 inches) in length, minor attachments, and other applications where the use of an automatic process is impractical.

When prior authorization has been granted, the gas metal arc welding (GMAW) and flux cored arc welding (FCAW) processes will be limited to indoor shop welding of bearing devices, scuppers, sign fixtures, light fixtures, and low stressed members or components.

Gas metal arc welding short circuit arc (GMAW-S) will not be permitted.

Any gas shielded process subject to wind velocities in excess of 8.0 km/h (5 miles per hour) shall be protected by the use of a draft barrier(s).

(c) Shop Welding. The Fabricator shall maintain a file of the qualifications of all welders, welding operators, and tackers qualified in accordance with AWS D1.5, Section 5. Requalification may be required in accordance with AWS D1.5, Section 6. AWS D1.1 shall be adhered to for welding of items not covered in AWS D1.5.

Groove welds shall be started and terminated with extension bars or runoff plates.

Fillet welds shall be performed in the flat or horizontal position unless restricted by member size or physical position.

(d) Field Welding. Welding performed in the field shall be done by welders or welding operators who have an AWS Certification designating them as qualified in the appropriate category for Structural Welding for the Agency.

The Agency's qualification requirements for field welding are contained in the *Manual for Field Welding*. This document may be obtained from the Agency's Construction Section. The Contractor shall have a copy for use any time field welding is anticipated.

The axis of any weld used to attach miscellaneous construction fixtures to main members as defined in Subsection 714.01 shall be in the same direction as the primary stress in the member and shall be approved in writing by the Engineer.

Welding performed in the field is subject to all of the requirements of Subsection 506.10. The shielded metal arc welding (SMAW) process is the only process approved for field welding.

Welding of miscellaneous construction fixtures such as form supports, screed supports, and reinforcing steel chairs to any portion of the bridge structure will not be permitted without approved drawings and welding procedures. Any increase in material thickness made necessary by reduced allowable stresses resulting from such welding shall be at the Contractor's expense. Approval for any welding requiring an increase in material thickness must be obtained before the affected structural steel is fabricated.

Shear connectors shall be installed in accordance with Section 508.

(e) Process and Procedure Qualification.

(1) General. Welding processes and procedures requiring qualification shall be qualified in accordance with AWS D 1.5.

Welding and testing of samples shall be witnessed by an Agency Inspector or an authorized representative of a testing agency that is AWS certified in accordance with the provisions of AWS QC 1.

Process and procedure qualification record tests shall be reported in a format similar to those provided in AWS D15.

Procedure specifications shall be reported in a format similar to those provided in AWS D1.5.

(2) Acceptance Requirements. The basis for acceptance shall conform to the requirements of AWS D1.5. AWS D1.1 shall be used only for those items not covered in AWS D1.5.

506.11 FRACTURE CRITICAL MEMBERS. The Agency will identify in the Contract the members or member components that are categorized as "fracture critical."

Material for members or member components identified as “fracture critical” shall be furnished and fabricated in conformance with the requirements of AWS D1.5 for fracture critical components.

Welding performed on fracture critical members or components, and testing, shall be witnessed by an Agency representative. Qualification acceptance for any welding procedure shall be based on the results of mechanical tests and chemical analysis of deposited weld metal. Procedure requirements and basis of acceptance shall meet the requirements in AWS D1.5 for fracture critical components.

506.12 ASSEMBLY

(a) Camber. Beams and girders shall be fabricated to the camber indicated on the approved Fabrication Drawings.

(b) Curved Girders. Welded girders with radii less than 230 m (750 feet) shall be fabricated by cutting the flange plates to the required curvature. Each plate shall be flame cut simultaneously on both edges to reduce unbalanced shrinkage stresses. The flange plate lengths between shop splices shall not be less than 6 m (20 feet). Web plates shall be aligned to the center of the flange plates.

If the final curvature is not as specified after the flanges have been welded to the web, the girder shall be corrected by application of heat in accordance with an approved procedure.

(c) Heat Curving and Cambering. The final horizontal curvature and vertical camber shall be measured only after the member has cooled. The member shall be supported in a manner that will ensure accurate measurements for sweep and camber. The web shall be in a vertical position for measuring curvature and in a horizontal position for measuring camber.

Heating shall be performed in such a manner that the temperature of the steel does not exceed 610 °C (1125 °F). Artificial cooling will not be permitted until a member has cooled to 315 °C (600 °F). Under no conditions will water be permitted for cooling. Air may be used subject to the approval of the Inspector. Any member heated in excess of 650 °C (1200 °F) shall be rejected.

(d) Finish. All sharp corners and edges that are marred, cut, or roughened in handling shall be rounded to a 1.6 mm (1/16 inch) radius by grinding.

(e) Connections and Bolting. The materials and fabrication procedure shall comply with the provisions of Subsection 506.19.

(f) Bearing Connections. Field bearing connections shall not be permitted. Connections in bearing may require different tolerances of fit. Terms used to define the fit of connections are:

(1) Tight Fit (Welded Ends Only). Fifty percent of the projected bearing area shall be in contact within 0.5 mm (0.02 inch) with a permissible variation of 1.6 mm (1/16 inch) for the remaining 50 percent of projected area.

(2) Grind to Bear. Seventy-five percent of the projected area shall be in contact within 0.25 mm (0.01 inch) with a permissible variation of 0.8 mm (1/32 inch) for the remaining projected area.

(3) Mill to Bear. One hundred percent of the projected bearing area shall be in full contact.

(g) Intermediate Stiffeners. Where tight fit of intermediate stiffeners is specified, 50 percent of the projected bearing area shall be in contact within 0.5 mm (0.02 inch) with a permissible variation of 1.6 mm (1/16 inch) for the remaining 50 percent of the projected bearing area.

(h) Straightening Material. Straightening or repair of any member or component will be subject to written approval by the Agency. Procedures will be required describing in detail the distortion to be corrected and all procedures for heating, cooling, verifying final dimensions, and nondestructive tests.

506.13 TOLERANCES. Rolled steel plates, shapes, and bars shall be supplied to the permissible tolerances specified in ASTM A 6/A 6M. The camber and sweep of fabricated rolled members shall be subject to the same dimensional tolerances specified for welded members in AWS D1.5.

The metal bearing surface of any masonry bearing plate shall be flat, with a maximum permissible variation of 1 mm (0.04 inch) from a plane determined by any three of its corners.

There will be no permissible tolerance for over grinding. Welded butt joints shall be finished so that the final thickness of the joint is not less than the thickness of the thinner adjacent plate. Welded butt joints subjected to only compressive stresses shall be finished so the final thickness of the joint is not less than the ordered thickness of the thinner plate.

The Fabricator is responsible for straightening to specification tolerances any weldments that may have been distorted through stress relieving during the galvanizing process.

506.14 SURFACE PREPARATION. All materials shall be blast cleaned to the grade specified as defined by the pictorial surface preparation standard SSPC-VIS 1.

Further preparation shall conform to the following:

(a) Surfaces to Remain Uncoated. Surfaces may be blast cleaned either before or after fabrication.

The final surface appearance after fabrication shall be at least equivalent to preparation grade SSPC-SP10.

(b) Surfaces to be Galvanized or Metalized. Prior to galvanizing or metalizing, all corners and edges of steel plates, shapes, etc., shall be ground to a 1.6 mm (1/16 inch) radius.

(c) Surfaces to be Painted. All material to be painted shall be cleaned in accordance with the appropriate painting item(s) in the Contract.

506.16 MARKING, STORING, AND SHIPPING.

(a) Marking. Each member shall be identified with an erection mark corresponding with the member identification mark on the approved Fabrication Drawings.

Identification marks may be painted on members that will receive field coats of paint.

Identification marks on unpainted steel shall be impressed into the member (with a low-stress stamp) in a non-stressed or low stressed area of the member. The Fabricator shall identify to the Contractor the procedure used for marking material.

(b) Storing. Material at the Fabricator's plant shall be stored above ground on platforms, skids, or other suitable supports. It shall be kept clean, properly drained, and protected from unwanted corrosion. Free circulation of air shall be provided around all surfaces.

Girders and beams shall be stored in the upright position, supported at their ends or points of bearing. Long members (e.g., columns and chords) shall be supported at sufficient points to prevent damage from deflection.

Special care shall be taken for unpainted steel to ensure that it has the opportunity to weather uniformly.

In addition to the requirements specified above, material or raw material stockpile storage shall be subject to any other storage criteria deemed necessary by the Engineer in accordance with Subsection 106.09.

(c) Shipping. Beams and girders shall be transported in the upright position. If the member's size or shape prohibits shipment in the upright position, the Fabricator shall submit a proposed method and details of shipment to the Agency for approval.

The Fabricator shall not ship any material, either to the project or to another manufacturer, without the Agency's approval. The Agency's Inspector will place a seal of approval on all material that has been accepted and will approve the loading, positioning, and anchorage of all material being shipped.

506.17 FIELD HANDLING AND STORING. The Contractor is responsible for providing equipment that is adequate for safely lifting and placing, without damage, all material furnished. Permanent distortion caused by handling or storage will be cause for rejection.

The edges of nicks or bumps caused by handling shall be carefully ground to a 2 mm (1/16 inch) radius.

The storage requirements in Subsection 506.16 shall be applicable for all material stored in the field.

506.18 ERECTION.

(a) Methods and Equipment. Cranes, lifting devices, and other equipment for all structural steel erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the structural steel. However, the Contractor shall lift and erect curved girders so that the web of the girder is maintained vertical within a 10 degree vertical tolerance.

The Contractor shall submit Construction Drawings in accordance with Section 105 for the methods and sequence of structural steel erection, the temporary bracing, and the equipment to be used for the erection. The erection plan shall include the necessary computations to indicate the magnitude of stress in the segments during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed. The erection plan shall contain provisions for all stages of construction, including temporary stoppages.

(1) Curved Girders. The Contractor shall include additional information in the erection plan for curved girders as indicated in AASHTO LRFD *Bridge Construction Specifications* Section 11.8.2.

The structural steel may be used for support of equipment prior to placement of the deck only with the written permission of the Engineer. The proposed use of structural steel for support of equipment shall be detailed in the erection plan.

Submittal of the erection plan is for documentation purposes only, and shall in no way be construed as approval of the proposed method of erection. Unless otherwise directed by the Engineer, the Contractor shall follow the erection plan as submitted.

(b) Assembly.

(1) Parts shall be accurately assembled as shown on the Contract Plans, Fabrication Drawings, or erection drawings, following match marks when provided. Material shall be carefully handled so that no members or pieces will be bent, broken, or damaged.

Hammering that will injure or deform members will not be permitted. Bearing surfaces and contact surfaces shall be clean. Members shall be erected to the position specified and externally supported until all connections have been completed.

(2) Drift pins shall be used to align and center the connections of main and secondary members. Only light drifting will be permitted. Any member subjected to drifting that results in distortion of the member or elongation of the holes will be rejected. Cylindrical erection pins, the same size as the hole, shall be used at least in the extreme corners of all main member connections.

Main members have been match marked and shop reamed to fit a specified profile and should fit together easily.

Main members shall not be reamed larger than the hole size indicated on the approved Fabrication Drawings without written authorization from the Engineer.

Secondary members may be subjected to limited field reaming. Reaming or drilling to connect misaligned holes will not be permitted without the approval of the Engineer. Reaming of secondary members shall be approved by the Engineer on a case by case basis prior to the reaming. Reaming or drilling shall not cause elongation of any hole more than 1.6 mm (1/16 inch) for 75 percent of the holes in any subassembly and 3.2 mm (1/8 inch) for the remaining 25 percent of the subassembly (diaphragm, lateral bracing, etc.). Reaming that produces results in excess of these limits will be cause for rejection. Assembled parts requiring drilling or reaming shall be disassembled to remove any burrs or shavings.

Pins used for hinged connections and bearings shall be inserted with care and aligned so the members take full and even bearing. Nuts shall be adequately tightened and locked in position either by upsetting the threads or tack welding the nut to the bolt.

(3) The correction of minor misfits involving reaming (within specified limits) and cutting will be considered a legitimate part of the erection. However, errors in shop fabrication that prevent proper assembly shall be reported immediately to the Engineer. The Engineer shall approve any corrective action prior to it occurring.

506.19 BOLTING AND CONNECTIONS.

(a) General. Connections shall be made with high-strength bolts conforming to AASHTO M 164M (AASHTO M 164). Bolts and nuts shall be furnished by the same supplier. Bolts, nuts, and washers shall be packaged and shipped so they are kept dry. When not in transit, bolts, nuts, and washers shall be stored indoors under dry, ventilated conditions. All bolts and nuts shall be adequately and uniformly lubricated. Bolts and nuts not properly lubricated shall be cleaned and relubricated prior to installation in accordance with applicable specifications.

Bolt holes are specified as 2 mm (1/16 inch) larger in diameter than the bolt.

Bolt holes shall be fabricated to the requirements of the AASHTO *LRFD Bridge Construction Specifications*, Section 11.4.8, except that holes shall not be punched full-size unless otherwise permitted in the Contract Documents or approved by the Engineer.

(b) Bolted Parts. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or other interposed compressible material. All joint contact surfaces and areas adjacent to bolt holes shall be free of scale, burrs, dirt, and other foreign material that may prevent solid seating of the parts.

Prior to assembly, contact surfaces of galvanized stress-carrying members shall be lightly brushed or blasted to a dull gray appearance.

Faying surfaces of bolted connections shall meet the Class B slip coefficient value of not less than 0.50 as specified by AASHTO.

Splices and field connections of main members shall have all holes filled with high-strength bolts or cylindrical drift pins, with bolts fully tightened before external support systems are removed.

(c) Installation. Bolted connections shall be assembled with a hardened washer under the turned element. Hardened steel washers shall be used under both the head and the nut when bolts are used for the following connections:

(1) Oversized holes (fabricated as per Contract).

(2) Replacing existing bolts or rivets.

(3) Oversized and irregular hole conditions caused from field drilling or reaming.

(4) Connections between new steel and existing steel.

Where an outer face of the bolted parts has a slope of more than 1:20 (vertical:horizontal) with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

Bolts installed with the stem vertical shall have the heads up. Bolts installed with the stem horizontal shall have the head towards the weather unless clearance restrictions dictate otherwise.

Normally the nut will be the tightened element; however, if the position of bolt entering or wrench operation clearances prohibit this procedure the bolt may be the turned element.

Tightening of a bolt group shall progress systematically from the most rigid part of the joint to its free edges.

Previously tightened bolts shall be re-tightened until all bolts in the connection are tightened to the minimum required tension.

Recalibration of a wrench may be required any time there appears to be a significant change in the condition of bolt tightening.

All bolts in a connection shall first be brought to a “snug tight” condition. “Snug tight” is defined as initial tension sufficient to bring all the plies of the connection into firm contact while the drift pins remain in the connection. Snugging shall progress systematically, beginning at the most rigid part of the connection and progressing to the free edges until the connection is fully compacted.

All high-strength bolts shall be tightened to the specified tension as soon after installation as feasibly possible. Under no circumstances shall bolts be left untightened for more than five days after installation unless specific requirements to do so are indicated in the Contract or directed by the Engineer. Bolts left in place beyond five days without specific requirements in the Contract or as directed by the Engineer shall be removed and replaced with new bolts at the Contractor's expense.

Bolts shall be tightened to develop a tension not less than 5 percent in excess of the minimum bolt tension specified in Table 506.19A by either the calibrated wrench, turn of the nut, torque, tension control assembly ("twist-off"), or direct tension indicator method. Bolts shall not be tightened to more than the maximum tension specified in Table 506.19A.

Bolts shall be tensioned by the Contractor in the presence of the Engineer using one of the following methods:

(1) Calibrated Wrench Method. A random sample of not less than three bolt and nut assemblies of each diameter, length, grade, and type to be used in the work shall be checked a minimum of each working day in a device capable of indicating bolt tension.. The test shall be performed on each wrench to be used to determine the working torque for the wrench. Variations in the number or location of washers will require separate checks. Additional calibration of the wrenches being used shall be performed as directed by the Engineer.

All powered wrenches shall be adjusted to stall or cut-out at the specified tension. Power wrenches without cut-outs will not be permitted.

(2) Turn of the Nut Method. All bolts shall be tightened by the applicable amount of nut or head rotation specified in Table 506.19B. During the tightening operation, there shall be no rotation of the part not turned by the wrench.

A random sample of not less than three bolt and nut assemblies of each diameter, length, grade, and type to be used in the work shall be checked each working day in a device capable of indicating bolt tension. The test shall demonstrate that the method of estimating the "snug tight" condition and controlling turns from "snug tight" to be used by the bolting crew(s) develops a tension of at least 5 percent in excess of the minimum bolt tension specified in Table 506.19A, and not more than the maximum tension specified in Table 506.19A. Separate checks will be required for each diameter fastener with hardened washers placed under the nut and/or bolt head as they will be used in the structure. Variations in the number or location of washers will require separate checks.

(3) Torque Method. Manual torque wrenches for installation shall be supplied by the Contractor, calibrated yearly, and each accompanied by a certificate indicating its date of calibration. A random sample of not less than three bolt and nut assemblies of each diameter, length, grade, and type to be used in the work shall be checked a minimum of each working day in a device capable of indicating bolt tension. The test shall be performed on each wrench to be used to determine the working torque for the wrench. Additional calibration of the wrenches shall be performed as directed by the Engineer. Separate checks will be required for each diameter fastener with hardened washers placed under the nut and/or bolt head as they will be used in the structure. Variations in the number or location of washers will require separate checks.

This method may be used to "touch up" bolts previously tightened and that may have been loosened by the tightening process or as a means of bringing all bolts in any given connection to the specified tension.

(4) Tension Control Assembly Method. A tension control assembly consists of a tension control bolt with a spline end and a suitable nut and washer. This method shall be employed when installing "button" or "dome" headed high strength bolts.

All bolts shall be tightened by the application of torque to the nut and counter-torque to the spline end of the bolt using an approved spline drive installation tool. A random sample of not less than three tension control assemblies of each diameter, length, grade, and type to be used in the work shall be checked a minimum of each working day in a device capable of indicating bolt tension. The test shall be performed to verify that the spline twist-off develops a tension of at least 5 percent in excess of the minimum bolt tension specified in Table 506.19A, and not more than the maximum tension specified in Table 506.19A. Additional verification of the tension control assemblies shall be performed as directed by the Engineer. Separate checks will be required for each diameter fastener with hardened washers placed under the nut and/or bolt head as they will be used in the structure. Variations in the number or location of washers will require separate checks.

(5) Direct Tension Indicator Method. Direct tension indicators (DTIs) are compressible washers capable of indicating that a specified minimum bolt tension has been attained. DTIs installed with high strength bolts to indicate bolt tension shall be subjected to field verification testing prior to installation and the installation requirements specified below.

DTIs installed with high-strength bolts to indicate bolt tension shall be placed under the head of the bolt with the protrusions facing the head of the bolt, and the nut shall be turned, with a hardened washer underneath it, to tension the fastener. If for reasons of installation or inspection accessibility it is necessary to place the DTI under the turned element, the DTI shall be oriented so that the protrusions face outward from the work, and a hardened washer shall be placed between the DTI and the turned element.

The bolt, DTI, hardened washer and nut assembly used in the verification testing device and installed in the work shall be such that at least 3 and preferably not more than 5 threads are located in the grip. The grip is defined as the distance between the bearing face of the nut and the bolt head.

Bolts used in the verification test and installed in the work shall not be tightened to a "no-visible" gap condition such that all of the DTI protrusions are completely compressed. A visible gap must remain in at least one space after installation. It is permissible to have no entries and still have a visible gap. The tension in the bolt becomes indeterminate when no visible gap exists and may exceed the maximum tension of the fastener.

The Contractor shall supply 5 mil tapered feeler gages, a calibrated bolt tension-measuring device and equipment necessary to perform field verification testing and inspection of tensioned bolts. The feeler gages, fasteners, and impact and manual wrenches shall be the same as that to be used in the work.

The Contractor shall obtain the services of a qualified technical advisor employed by the DTI manufacturer to make at least one site visit to assist the Contractor and to assure the proper installation and use of DTIs. This requirement may be waived by the Engineer if the Contractor can demonstrate to the Agency's satisfaction successful use of DTIs on previous projects for the Agency.

Verification testing shall be performed in a calibrated bolt tension measuring device, such as a Skidmore-Welhelm Calibrator, with a special flat insert (supplied by the Contractor) replacing the normal bolt head-holding insert. The special insert allows the DTI to be located on the flat front face of the tension measuring device for ease of observation and improved access for measuring the DTI gap during testing.

The verification testing shall demonstrate that the DTIs were properly manufactured. The fastener shall develop a tension of at least 5 percent in excess of the minimum bolt tension specified in Table 506.19A when the DTI has been compressed to allow entries for fewer than half the number of spaces, and the fastener shall not plastically deform when the DTI is compressed to the maximum allowable limit for the project.

Three verification tests are required to be performed on random samples of each combination of fastener rotational-capacity lot, DTI lot and DTI position (under the nut or bolt head) used on the project. All three tests must pass for the DTI and assembly combination to be approved. Testing shall be performed at the project site by the Contractor and witnessed by the Engineer.

When testing for the normal DTI position, the nut shall be turned with the bolt head against the DTI restrained from turning with another wrench. When testing with the DTI under the turned element, the turned element shall be placed on the flat front face of the tension measuring device and the unturned element will be in the rear held by another wrench.

a. Verification Test. The verification test shall be conducted in two stages as follows:

1. Stage 1. Tension the fastener to the Verification Tension load specified in Table 506.19C for the grade and size of fastener. If an impact wrench is used, tension to a load two-thirds below the required load and use a manual wrench to attain the required tension. Determine and record the number of entries of a 5 mil feeler gage in the spaces between the protrusions. When using coated (galvanized or epoxy coated) DTIs under the turned element, there shall be at least one entry of the feeler gage. The DTI lot will be rejected if the number of entries is less than the value in column 3 of Table 506.19C, or for coated DTIs used under the turned element, there are no entries.

2. Stage 2. Further tension the fastener beyond the verification load with a manual wrench until there are no entries for the 5 mil feeler gage but a visible gap exists in at least one space. Note and record the load in the bolt at this condition (the maximum allowable limit of DTI compression) and remove the fastener from the tension measuring device. The capability of the bolt to tolerate the maximum allowable limit of DTI compression is determined in two ways. The simplest is to hand turn the nut down the complete thread length of the bolt, excluding thread runout. If this is successful, then the bolt has not undergone significant plastic deformation and the assembly passes the verification test. Alternatively, if the nut cannot be turned down the complete thread length, the DTI lot will be rejected unless the load recorded is less than 95% of the average load measured in the rotational capacity test of the fastener lot as specified in the applicable AASHTO design code, in which case the assembly is deemed to have passed the test.

Bolts and DTIs used in verification tests shall be marked and shall not be reused in the work.

If the bolts are too short to be tested in the tension measuring device, Stage 1 of the Verification Test for the DTI shall be conducted on a longer bolt. Stage 2 of the Verification Test shall be conducted for the short bolt with the short bolt in a convenient hole in the work. The fastener assembly shall be tensioned with a manual wrench until there are no entries for the 5 mil feeler gage but a visible gap exists in at least one space. The fastener shall then be disassembled.

Subsequently, the nut must be run down, by hand, for the complete thread length of the bolt excluding thread runout. The DTI lot will be rejected if the nut cannot be assembled to this thread length. Three verification tests are required as specified above.

b. Installation. Installation of fasteners utilizing DTIs shall be conducted in two steps as follows:

1. Step 1. All of the bolts in a connection shall be installed to a snug tight condition. Snugging shall progress systematically beginning at the most rigid part of the connection and progressing to the free edges until the connection is fully compacted. At the snug tight condition all of the DTIs shall be inspected with the feeler gage to verify that they meet the number listed in column 3 of Table 506.19C. If the number of entries is less than the values specified in the Table, the fastener must be removed and another DTI installed, followed by re-snugging of the fastener. This is required because a fastener's tension may have relaxed during the snugging of adjacent fasteners. A compressed DTI does not rebound if the fastener tension is reduced. If a DTI which has fewer entries were left in place, it would give a false indication of bolt tension.

2. Step 2. The bolts in the connection shall then be further tensioned to the point that the number of entries for a 5 mil feeler gage meets the number listed in Column 5 of Table 506.19C. Tightening shall progress systematically beginning at the most rigid part of the connection and progressing to the free edges. Drift pins shall be removed during this process. Several cycles may be required. If the fastener is tightened so that no visible gap in any space remains, the bolt and DTI shall be removed and replaced by a new properly tightened fastener and DTI.

TABLE 506.19A (METRIC)
BOLT TENSION
AASHTO M 164M (ASTM A 325M) BOLTS

Nominal Bolt Diameter (mm)	Minimum Bolt Tension (kN)*	Maximum Bolt Tension (kN)**
M16	91.0	117.0
M20	142.0	182.7
M22	176.0	225.9
M24	205.0	263.7
M27	267.0	342.9
M30	326.0	419.4
M36	475.0	610.2

* Equal to 70 percent of specified maximum tensile strength of bolts.

** Equal to 90 percent of specified maximum tensile strength of bolts.

TABLE 506.19A (ENGLISH)
BOLT TENSION
AASHTO M 164 (ASTM A 325) BOLTS

Nominal Bolt Diameter (inches)	Minimum Bolt Tension (pounds)*	Maximum Bolt Tension (pounds)**
1/2	12,050	15,500
5/8	19,200	24,700
3/4	28,400	36,500
7/8	39,250	50,500
1	51,500	66,200
1 1/8	56,450	72,600
1 1/4	71,700	92,200
1 3/8	85,450	109,800
1 1/2	104,000	133,700

* Equal to 70 percent of specified maximum tensile strength of bolts.

** Equal to 90 percent of specified maximum tensile strength of bolts.

TABLE 506.19B
NUT ROTATION FROM SNUG TIGHT CONDITION
AASHTO M 164M (ASTM A 325M)
[AASHTO M 164 (ASTM A 325)] BOLTS

Bolt Length (as 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 and other face sloped not more than 1:20 (v:h) (bevel washer not used)	Both faces sloped not more than 1:20 (v:h) from normal to bolt axis (bevel washers not used)
Up to and including 4 diameters	(120 °) 1/3 turn	(180 °) 1/2 turn	(240 °) 2/3 turn
Over 4 diameters but not exceeding 8 diameters	(180 °) 1/2 turn	(240 °) 2/3 turn	(300 °) 5/6 turn
Over 8 diameters but not exceeding 12 diameters	(240 °) 2/3 turn	(300 °) 5/6 turn	(360 °) 1 turn

Nut rotation is relative to bolt, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn (180 degrees) and less, the tolerance shall be ± 30 degrees; for bolts installed by 2/3 turn (240 degrees) and more, the tolerance shall be ± 45 degrees.

For bolt lengths exceeding 12 diameters, the required rotation must be determined by actual test in a suitable tension device simulating the actual conditions.

Table 506.19C (Metric) – AASHTO M 164 M(ASTM A 325M) Direct Tension Indicators

Bolt Size	Verification Tension[1] (kN)	Verification Required number of Entries[2,3]	Number of DTI Spaces between Protrusions	Installation Required Number of Entries[2,4]
M16	96	3-4	4	0-2
M20	149	3-5	5	0-2
M22	185	3-5	5	0-2
M24	215	3-5	5	0-2
M27	280	4-6	6	0-3
M30	342	4-7	7	0-3
M36	499	5-8	8	0-4

Table 506.19C (English) – AASHTO M 164 (ASTM A 325)
Direct Tension Indicators

Bolt Size (in.)	Verification Tension (kips)[1]	Verification Required number of Entries[2,3]	Number of DTI Spaces between Protrusions	Installation Required Number of Entries[2,4]
½	13	3-4	4	0-2
5/8	20	3-4	4	0-2
3/4	29	3-5	5	0-2
7/8	41	3-5	5	0-2
1	54	4-6	6	0-3
1-1/8	59	4-6	6	0-3
1-1/4	75	4-7	7	0-4
1-3/8	89	4-7	7	0-4
1-1/2	108	5-8	8	0-4

[1] Verification tension is 1.05 x the minimum tension in Table 506.19A.

[2] An entry occurs when a 5 mil tapered feeler gage fits into the space between DTI protrusions and touches the bolt shank.

[3] For coated DTIs under the turned element at least one entry is required.

[4] For coated DTIs under the turned element no entries are allowed.

(d) Acceptance of Bolt Tensioning. The installation and tightening of bolted connections shall be observed to determine if the tightening procedure is working properly and the correct tension has been achieved. The Engineer will observe and verify the checking of impact wrenches used for the calibrated wrench method. The Engineer will also observe and verify the checking of manual torque wrenches used for the torque method.

The Contractor shall provide a tension measuring device, such as a Skidmore-Wilhelm Calibrator, that has been calibrated within the last year and is accompanied by a certificate verifying its date of calibration. The wrench shall be calibrated yearly and accompanied by a certificate indicating the date of calibration.

Before the installation of fasteners in the work, the Engineer shall check the marking, surface condition, and storage of bolts, nuts, and washers and the faying (contact) surfaces of joints for compliance with the Contract requirements.

With the exception of inspecting direct tension indicators and the tension control assemblies, the Engineer will inspect fasteners after installation by applying the inspecting wrench to a minimum of 10 percent of the bolts, but not less than two bolts, selected at random in each connection. The actual torque value of each inspected bolt will be determined as the head or nut is rotated 5 degrees in the tightening direction. This value shall be within the minimum and maximum job inspecting torque values as determined during the calibration of the inspection torque wrench using the bolt tension values specified in Table 506.19A.

The Engineer will determine the inspection torque at least once each day by tightening five bolts of the diameter, length, and grade being used in the work in a device capable of indicating actual bolt tension. The job inspecting torque shall be taken as the average of three values thus determined after rejecting the high and low values. The inspecting wrench shall then be applied to the tightened bolts in the work and the torque necessary to turn the nut or head 5 degrees [approximately 25 mm at a 300 mm radius (1 inch at a 12 inch radius)] in the tightening direction shall be determined. Either the Engineer, or at the Engineer's option the Contractor in the presence of the Engineer, shall use the inspection wrench.

Bolt tension for fasteners with DTIs shall be verified by the use of a manual inspection torque wrench (which indicates torque by means of a dial) or by using 5 mil tapered feeler gages provided and operated by the Contractor.

All bolts installed using DTIs shall be inspected after snug tightening and again after full tensioning, with 100% of the bolts inspected visually and 10% of the bolts in any connection (but not less than two) inspected by feeler gage. If the installation of inspected bolts is accepted, then the connection shall be accepted as properly tensioned. If any bolt in a connection does not pass inspection, then all (100%) of the bolts in that connection shall be inspected with the feeler gage. Any bolt which does not pass inspection as described herein shall be further tensioned if required, or if over tensioned, removed and replaced by a new properly tensioned bolt and DTI.

Bolts installed using tension control assemblies shall be visually inspected for consistent "twist-off" and thread stick out.

If any bolt in a connection is found to have a torque value below the minimum or above the maximum job inspecting torque, all bolts in that connection shall be inspected. All under-tightened bolts shall be tightened and reinspected. All over-tightened bolts shall be loosened and the bolt and nut removed for visual inspection of the bolt and nut threads. If there is visible thread damage or the nut does not spin freely on the bolt when turned by hand without the aid of a wrench, a new bolt and nut shall be installed.

Undamaged fasteners may be reinstalled with the following exception: Galvanized bolts, AASHTO M 253M (AASHTO M253) bolts, tension control assemblies, and direct tension indicators shall not be reused.

This specification does not recognize standard torques determined from tables or from formulas which are assumed to relate torque to tension. Testing using such standard torques shall not be considered valid. Inspection torques must be determined directly from calibrations performed at the project site reflecting actual work conditions.

The procedure specified is intended for inspection of bolted connections and verification of pretension within 24 hours of tensioning the joint. If verification of bolt tension is required after a passage of a period of time and exposure of the completed joints, the procedures will provide an indication of bolt tension that is of questionable accuracy. Procedures appropriate to the specific situation should be used for verification of bolt tension. This might involve use of the inspection procedure, or might require the development and use of alternate procedures.

An additional required inspection step is to check the bolt thread stickout on the nut side after installation to the final specified gap to look for inconsistency of pattern. Any stickouts greater than the other bolts shall be investigated and discarded (e.g. if necking down of the bolt has occurred or the wrong length bolt was used). The end of the properly installed bolt shall be at least flush with the nut or stick out not more than three threads.

The Engineer shall be provided with safe access in accordance with Section 105 to conduct all inspection deemed necessary during and after the installation of the bolts. If the Engineer determines that the access provided is unsafe, work will be ordered to halt until such time the access is made safe. Any delays incurred by the unsafe access will not be cause for a monetary, material or delay claim.

506.20 THIS SUBSECTION RESERVED

506.21 STRAIGHTENING BENT MATERIAL. Damaged, bent, or misaligned structural steel may only be straightened or corrected by procedures approved by the Agency. The method of repair proposed by the Contractor shall be submitted as Construction Drawings for approval in accordance with Section 105. No corrective work shall be performed without Agency approval. Heating limitations and procedures shall conform to the requirements of Subsection 506.12.

Members or parts to be heat straightened must be free of stress from external forces other than those necessary and used in conjunction with the application of heat. Following straightening, the surface of the metal shall be free of any evidence of distortion or fracture. Required nondestructive tests shall be performed by NDT Level II or III personnel at the Contractor's expense.

506.22 FIELD CLEANING. When assembly of the fabricated structural components is complete, any rust, scale, dirt, grease, or other foreign material shall be removed from the metal components.

If the components are new steel which are metalized or galvanized or which are to remain unpainted, the cost of such necessary cleaning will not be paid for directly, but will be considered incidental to the Section 506 items in the Contract.

506.23 UNCOATED STEEL. Care must be taken to keep chemicals and oils from contacting the exposed surfaces of unpainted steel during storage, erection, and construction of the deck.

(a) Staining of Masonry. The Contractor shall protect all concrete and masonry from staining due to oxide formation on the steel.

(b) Cleaning of Steel. After all concrete has been placed, the outside surface of the fascia beams and bottom surface of their lower flanges shall be cleaned of all foreign material to a uniform appearance. The Engineer may require the exposed surfaces to be blast cleaned to preparation grade SSPC-SP10 defined by SSPC-VIS 1. The use of acids for cleaning is prohibited.

506.24 METHOD OF MEASUREMENT.

(a) Bids on a Kilogram (Pound) Basis. The quantity of Structural Steel, or other material being paid under this item, to be measured for payment will be the number of kilograms (pounds) used in the complete and accepted work. The mass (weight) of the material to be measured for payment under this item will be computed based on the approved Fabrication Drawings, as follows:

(1) Mass (weight) determined by the volume of material will be computed on the basis of the following densities:

Material	kg/m^3	$lbs./ft^3$
Aluminum, alloy	2800	173
Bronze, cast	8600	536
Copper, alloy	8600	536
Copper, sheet	8900	558
Iron, cast	7100	445
Iron, wrought	7800	487
Lead, sheet	11 300	707
Steel; rolled, cast, copper bearing, silicon, nickel and stainless	7850	490

For any material not listed above, the material will be paid for by actual mass (weight) as measured on a certified scale.

(2) The mass (weight) of rolled structural shapes will be computed on the basis of their nominal mass per meter (weight per foot) as shown on the Plans or, if not shown on the Plans, by the masses (weights) shown in the current edition of the AISC Manual.

The mass (weight) of rolled shapes will be based on the overall net length shown on the approved Fabrication Drawings, with no allowance for milling, finishing, or overrun, and with no deduction for cuts, clips, copes, or open holes.

(3) The mass (weight) of plates will be based on the net finished dimensions shown on the approved Fabrication Drawings, with no allowance for milling, finishing, tolerance, or overrun, and with no deductions for copes, clips, and open holes. The masses (weights) of beveled plates or curved surface plates will be based on the finished maximum thickness shown on the approved Fabrication Drawings.

For gusset plates, scupper components, slotted plates, and similar minor fixtures the net finished dimensions will be the minimum rectangular dimensions from which the parts are cut, except when it is practical to cut the parts in multiples from pieces of larger dimensions, in which case the mass (weight) will be based on the dimensions of the larger pieces, making necessary allowance for the material lost in cutting.

The net finished dimensions of flange plates will be the nominal width and the finished length measured along the centerline of the flange without deduction for width transitions, bevels, or chamfers.

The net finished dimensions of the webs of all girders and of the webs of rigid frame legs will be the actual area of the web as detailed on the approved Fabrication Drawings.

(4) The mass (weight) of fabricated metal items such as U-bolts, welding studs, and lugs will be based on the overall net dimensions of the finished product as shown on the approved Fabrication Drawings.

(5) All welding shall be considered as incidental work to the fabrication, and no measurement will be made for the mass (weight) of weld metal used.

(6) Measurement for castings will be by mass (weight) measured on scales.

(7) When it is specified that any part of the material is to be measured by actual mass (weight), finished work shall be weighed in the presence of the Inspector. In such case, the scales shall have been certified for accuracy within a one-year period.

(8) When the Contract includes bearings or bearing connections as part of this work, the mass (weight) of anchor bolts to be embedded in concrete will be based on the nominal dimensions shown on the approved Fabrication Drawings with no deduction for deformations but including the mass (weight) of nuts and washers. The mass (weight) of pins, pintels, and rollers will be based on the overall finished dimensions shown on the approved Fabrication Drawings with no deductions for threads, open holes, or pockets or allowance for excess diameter required for finishing.

(9) The mass (weight) of permanent shop and field bolts, nuts, direct tension indicators, and washers incorporated into the structure and temporary erection bolts, nuts, and washers shall be incidental to the Structural Steel item and no measurement will be made for mass (weight) of the bolts, nuts, direct tension indicators, and washers.

(b) Bids on Lump Sum Basis. The quantity of Structural Steel, or other material being paid under this item, to be measured for payment will be the number of units for each structure complete and accepted as specified in the Contract.

506.25 BASIS OF PAYMENT. The accepted quantity of Structural Steel will be paid for at the Contract unit price per kilogram (pound) for the items specified in the Contract. Payment will be full compensation for furnishing, detailing, handling, transporting, and placing the materials specified, including nondestructive testing of welds; for preparing the surface of new steel to be galvanized, metalized, or to remain unpainted; for necessary field cleaning; for sealer coating of metalized surfaces; for metalizing or galvanizing of surfaces unless otherwise paid for; for furnishing and implementing the erection plan, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for Structural Steel on a lump sum basis will be full compensation for performing all work specified and for furnishing all labor, materials, tools, equipment, erection plan(s), and incidentals necessary to complete the work.

The costs of surface preparation of new steel to remain unpainted or to be galvanized or metalized will not be paid for directly, but will be considered incidental to the Section 506 items in the Contract.

Surface preparation of rehabilitated or reconditioned steel, whether it is to receive protective coating(s) or it is to remain uncoated; surface preparation of galvanized steel that is to receive additional protective coating(s); and surface preparation of new steel that is to receive protective coating(s), except for the sealer coating of metalized surfaces are not included in any Contract item in Section 506. The costs of this work will be paid under the appropriate painting item(s) in the Contract.

The Engineer may authorize progress payments in the following manner:

(a) A maximum of 75 percent of the estimated quantity may be paid when the steel has been delivered to the site.

(b) A maximum of 95 percent of the estimated quantity may be paid when the steel has been erected, falsework removed, extended weights have been received and checked, and painting of connections and “touch up” completed where required.

(c) After completion and acceptance of all work under this Section, 100 percent of the quantity will be paid.

All nondestructive testing and required quality control activities will be considered incidental to fabrication, and no separate payment will be made.

Payment will be made under:

Pay Item		Pay Unit
506.50	Structural Steel, Rolled Beam	Kilogram (Pound)
506.55	Structural Steel, Plate Girder	Kilogram (Pound)
506.56	Structural Steel, Curved Plate Girder	Kilogram (Pound)
506.57	Structural Steel, Truss	Kilogram (Pound)
506.60	Structural Steel	Kilogram (Pound)
506.75	Structural Steel	Lump Sum

SECTION 507 - REINFORCING STEEL

507.01 DESCRIPTION. This work shall consist of furnishing and placing bar reinforcement, dowels, wire, welded wire reinforcement (WWR), and mechanical bar connectors.

507.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Bar Reinforcement	713.01
Mechanical Splices for Bar Reinforcement	713.02
Cold Drawn Steel Wire	713.04
Welded Wire Reinforcement (WWR)	713.05
Coated Bar Reinforcement	713.07

Spiral reinforcement for columns may be bar reinforcement or cold-drawn steel wire.

507.03 FABRICATION AND SHIPMENT.

(a) General. Bar reinforcement shall be cold bent to the shapes required..

Bar reinforcement shall be fabricated, bundled, tagged, marked, and shipped in accordance with the CRSI *Manual of Standard Practice*. The Fabricator shall maintain records that will provide traceability of identifying heat numbers for all material being fabricated for Agency projects or Contract orders referencing materials covered under this Section.

(b) Submittals. Prior to fabricating materials, the Contractor shall submit in accordance with Subsection 105.03 Fabrication Drawings of the reinforcement with splice details. The submittal shall include material lists, material designations, bending details, and manufacturer's literature for any securing materials.

507.04 PROTECTION OF MATERIAL. Reinforcing steel shall be protected from damage at all times by storing on blocking, racks, or platforms. When placed in the work, the reinforcing steel shall be free from dirt, detrimental scale, paint, oil, or other foreign substances.
All systems for handling and storing coated reinforcement shall have padded contact areas. Epoxy coated reinforcement stored on a project shall be covered with canvas or other suitable material that will effectively protect it against damage from ultraviolet light.

All damaged areas of reinforcement coating shall be repaired with materials and procedures recommended by the coating manufacturer. The materials and procedures must be approved by the Resident Engineer prior to the repairs. The epoxy coating shall be repaired prior to installation of the reinforcement. Repair prior to installation does not relieve the Contractor from repairing areas damaged during placement.

All repairs shall be inspected and accepted by the Resident Engineer prior to placing concrete. All bars with total damage, including previously repaired areas, greater than 2 percent of the bar surface area shall be rejected.

When cutting coated reinforcement, a cutting torch shall not be used. The use of a power hacksaw is acceptable. All cut ends shall be repaired as required for damaged areas.

507.05 PLACING AND FASTENING REINFORCING STEEL. Steel reinforcement shall be placed in the position shown on the Plans and held securely in place during the placing of concrete. Placement tolerances for reinforcing steel shall be 5 mm (1/4 inch) for cover and clearance and 25 mm (1 inch) for spacing of bars. Stirrups and spirals shall pass around main tension members and be securely attached to those members.

Reinforcing steel shall be spaced as specified from the face of the forms. Horizontal layers shall be spaced vertically by means of approved supports. Support material within 40 mm (1 1/2 inches) of a finished concrete surface shall be stainless steel, epoxy, plastic coated galvanized steel, or plastic.

Bar reinforcement shall not be further bent or straightened from the curvature produced at initial fabrication except when approved by the Engineer. If heating is approved for field bends, the temperature should not exceed that which produces a dull red color in the bar.

Bars spaced 300 mm (12 inches) apart or greater shall be tied at every intersection. Bars spaced less than 300 mm (12 inches) apart shall be tied at every other intersection. If reinforcement shows signs of distress during construction, the Engineer may direct additional tying.

Welding procedures shall be submitted for approval for any type of reinforcement welding. Welding of reinforcement steel will not be permitted without written permission of the Engineer. Welding shall conform to the requirements of Subsection 506.10. Special care shall be taken so that no undercut will occur and reduce the effective area of the reinforcing bars.

Tie wires and supports used for installation of coated reinforcement shall be coated with or be constructed of plastic, epoxy, or other approved materials that will prevent damage to the bar surface.

Horizontal mats of reinforcing steel shall have lines of support not exceeding 1 m (4 foot) spacing in either direction. Additional individual chairs may be required in the area of the fascia.

Reinforcement placed in any member shall be inspected and approved before any concrete is placed. Mechanical bar connectors shall be installed per the manufacturer's instructions.

507.06 PLACING DOWELS. Dowels shall be placed in existing concrete or ledge at locations shown on the Plans. Where Type IV mortar is to be used, holes shall be drilled to the depth shown on the Plans and shall be at least 25 mm (1 inch) greater in diameter than the dowel. Where approved adhesives are used, the manufacturer's recommendations shall be followed for hole sizing. Dowels shall be grouted with Type IV mortar or other approved material.

507.07 SPLICES. All reinforcement shall be furnished in the lengths shown on the Plans. No splicing of any type, except where shown on the Plans, will be permitted without the written approval of the Engineer.

Welded butt splices or mechanical splices shall be used only when specified in the Contract or with written approval of the Engineer.

507.08 LAPPING. Sheets of WWR shall overlap not less than the wire spacing and be securely fastened at the ends and edges. The edge lap shall be not less than the wire or bar spacing.

507.09 BAR LISTS. Bar lists and bending schedules shall be prepared by the vendor. It is the Contractor's responsibility to verify the vendor's bar lists and schedules for quantity, size, and shape of bar reinforcement for constructing the structural components shown in the Contract Documents or made a part thereof. If a Reinforcing Steel Schedule is provided in the Plans, it is solely for the purpose of arriving at an estimated quantity and any errors shall not be considered cause for an adjustment of the Contract unit price. Upon delivery of the fabricated material, one copy of the shipping schedule and tabulation of masses (weights) shall be furnished to the Engineer.

507.10 METHOD OF MEASUREMENT. The quantity of Reinforcing Steel, Epoxy Coated Reinforcing Steel, and Galvanized Reinforcing Steel to be measured for payment will be the total number of kilograms (pounds) of reinforcing bars, dowels, wire, and WWR used in the complete and accepted work except as otherwise provided, computed on the following basis:

(a) The mass (weight) of bars, wire, and dowels will be measured as either:

(1) The product of the length as shown on the approved shop bar lists and the standard mass per meter (weight per foot) of length as adopted by the CRSI, or

(2) If approved by the Engineer, the mass (weight) on a certified Bill of Lading from the reinforcement supplier. The Bill of Lading must be broken down and sub-totaled based on individual bar marks and types of reinforcement.

(b) The mass (weight) of WWR will be measured as either:

(1) The computed mass (weight) in accordance with the details shown on the Plans based on the standard mass (weight) accepted by the trade for the unit of material specified, or

(2) If approved by the Engineer, the mass (weight) on a certified Bill of Lading from the reinforcement supplier. The Bill of Lading must be broken down and sub-totaled based on individual bar marks and types of reinforcement.

(c) Measurement for payment will not be made for any clips, wire, or other material that may be used by the Contractor for keeping the reinforcing bars in their correct position.

(d) Measurement for payment will be adjusted for any material accepted with an overall dimensional length less than or greater than the 25 mm (1 inch) CRSI tolerance.

(e) When the substitution of bars of greater diameter than specified is permitted by written authorization of the Engineer, payment will be made for only the mass (weight) of steel that would have been required if the specified diameter had been used. In case short bars are used when full length bars are shown on the Plans, the mass (weight) to be measured will be only the equivalent of the mass (weight) of full length bars as if they had been used, with no allowance for laps.

The quantity of Drilling and Grouting Dowels to be measured for payment will be for the length of hole in meters (linear feet) to be drilled as shown on the Plans. If not shown on the Plans, the depth of drilled holes shall be 600 mm (2 feet). The dowel will be measured as Reinforcing Steel.

The quantity of Mechanical Bar Connectors will be the number of mechanical connectors installed in the complete and accepted work.

507.11 BASIS OF PAYMENT. The accepted quantities of Reinforcing Steel of the type specified will be paid for at the Contract unit price per kilogram (pound). Payment will be full compensation for furnishing, handling, welding, and placing the material specified and for furnishing all labor, fastening devices, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Drilling and Grouting Dowels will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for drilling the dowel hole, grouting the dowel in the hole, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

When the Contract does not contain a quantity for Drilling and Grouting Dowels, this work will not be paid for directly but will be considered as incidental to other Contract items.

The accepted quantity of Mechanical Bar Connectors will be paid for at the Contract unit price for each.

Payment will be full compensation for furnishing, handling, placing, and joining the materials; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
507.15 Reinforcing Steel	Kilogram (Pound)
507.16 Drilling and Grouting Dowels	Meter (Linear Foot)
507.17 Epoxy Coated Reinforcing Steel	Kilogram (Pound)
507.18 Galvanized Reinforcing Steel	Kilogram (Pound)
507.19 Mechanical Bar Connector	Each

SECTION 508 - SHEAR CONNECTORS

508.01 DESCRIPTIONS. This work shall consist of furnishing and welding shear connectors.

508.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Welded Stud Shear Connectors 714.10

508.03 WEATHER LIMITATIONS. Application of stud shear connectors or other welding on shear connectors shall not be done when the base metal temperature is below -18 °C (0 °F) or when the surface is wet or exposed to falling rain or snow.

508.04 PLACING, INSPECTING, AND TESTING.

(a) General. The Contractor shall install the shear connectors as detailed in the Contract and the approved structural steel fabrication drawings. Shear connectors shall be placed, inspected, and tested in accordance with the latest edition of AWS D 1.5.

When the base metal temperature of a member to which automatically welded shear connectors are to be attached is less than 2.0 °C (35 °F), the following requirements shall apply:

(1) Base Metal in Compression Only. The Contractor has the option of obtaining an approved welding procedure for application of the studs or preheating the base metal to a minimum of 10 °C (50 °F).

(2) Base Metal in Tension or Stress Reversal Zones. The base metal shall be preheated to a minimum of 20 °C (70 °F).

The base metal of all portions of a member in tension to which shear connectors are to be welded shall be preheated to 20 °C for thicknesses up to 40 mm (70 °F for thicknesses up to 1 1/2 inches); preheated to 65 °C for thicknesses over 40 to 65 mm (150 °F for thicknesses over 1 1/2 to 2 1/2 inches); and preheated to 110 °C for thicknesses over 65 mm (225 °F for thicknesses over 2 1/2 inches). Preheating applies to either shop or field applied shear connectors.

If, during the progress of the work, inspection and testing indicate that the shear connectors being furnished are not satisfactory, the Contractor shall make changes in the welding procedure, welding equipment, and type of shear connector as necessary to provide satisfactory results. Such changes shall be made at the Contractor's expense.

(b) Studs. Installation and acceptance of stud shear connectors shall be in accordance with the latest edition of AWS D1.5.

After being allowed to cool, the first two studs welded on each beam or girder shall be bent 45 degrees by striking the stud with a hammer. If failure occurs in the weld zone of either stud, the procedure shall be corrected, and two additional studs shall be successfully welded and tested before any more studs are welded to the beam or girder. The Contractor shall promptly inform the Engineer of any changes in the welding procedure. After the studs have been welded to the beams, the Engineer will make a visual inspection, and each stud will be given a light blow with a hammer. Any stud that does not emit a ringing sound when given a light blow with a hammer, that has been repaired by welding, or that has less than normal reduction in height due to welding shall be struck with a hammer and bent 15 degrees from the correct axis of installation. In the case of a repaired weld, the stud shall be bent 15 degrees in the direction that will place the repaired portion of the weld in the greatest tension. Studs that crack either in the weld or in the shank shall be replaced.

All tested shear connectors that show no sign of failure shall be left in the bent position.

The Engineer may select additional studs to be subjected to the bend test specified above.

508.05 METHOD OF MEASUREMENT. The quantity of Shear Connectors to be measured for payment will be on a lump sum basis for all the shear connectors installed in the complete and accepted work at each structure specified.

508.06 BASIS OF PAYMENT. The accepted quantity of Shear Connectors will be paid for at the Contract lump sum price for each structure specified. Payment will be full compensation for detailing, furnishing, transporting, handling, preheating, and welding of the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
508.15 Shear Connectors	Lump Sum

SECTION 509 - LONGITUDINAL DECK GROOVING

509.01 DESCRIPTION. This work shall consist of saw cutting longitudinal grooves into the surface of a concrete deck at the locations indicated in the Plans.

509.02 MATERIALS AND EQUIPMENT. Use multibladed wet saw cutting equipment using circular saw blades. The Engineer may allow the use of single blade, circular saw equipment, where it is determined such equipment is necessary to complete the work as required.

The equipment the Contractor proposes to use will be subject to the approval of the Engineer prior to use.

Water shall meet the requirements of Section 745.

509.03 CONSTRUCTION DETAILS. The Contractor is hereby notified that concrete curing requirements may have a significant effect upon the specific time at which saw cut grooving may be performed. The Contractor shall be familiar with the limits imposed by these factors and conduct operations accordingly.

Start saw cutting only after the specified curing period has elapsed, unless otherwise allowed by the Structural Concrete Engineer. Cut longitudinal grooves parallel to the centerline of roadway using a single pass. Space the center-to-center of grooves at 19 mm ± 2 mm (3/4” ± 1/16”). Cut all grooves rectangular in shape conforming to the following dimensions:

Width: 2.5 mm (+ 0.5 mm, - 0.0 mm) ((3/32”) (+ 1/32”, - 0.0”))
Depth: 4 mm (± 2 mm) ((5/32”)(± 1/16”))

During the grooving operations, the Engineer will verify, at random, that the minimum groove depth is being achieved. Should the Engineer determine that minimum groove depth is not being achieved, the Contractor shall stop grooving operations and make all adjustments necessary to achieve the minimum depth. The Contractor shall go back and correct any previous grooves to bring them into conformance with the specification.

Prior to beginning grooving operations, the Contractor shall supply the Engineer with two (2) accurate, easily readable gauges with which to verify groove depth. The gauges shall come with applicable manufacturer’s instructions.

Terminate grooves within the following limits unless otherwise indicated in the Contract Documents:

Location	Closest Allowable Distance	Farthest Allowable Distance
Drainage Structure:	100 mm (4 inches)	380 mm (15 inches)
Face of Curb or Barrier:	100 mm (4 inches)	380 mm (15 inches)
Joint System (Dimension measured perpendicular to the centerline of the joint system):	100 mm (4 inches)	380 mm (15 inches)

The Contractor shall use a self-contained system to continuously collect any slurry or debris created by the grooving operation such that it does not accumulate on the surface.

509.04 METHOD OF MEASUREMENT**.** The quantity of Longitudinal Deck Grooving to be measured for payment will be the number of square meters (square yards) of deck satisfactorily grooved in the complete and accepted work, measured transversely between curb or barrier and longitudinally between the ends of the deck, computed to the nearest whole square meter (square yard). No deduction will be made for areas left ungrooved near concrete railing, joints, or other objects embedded in the deck.

509.05 BASIS OF PAYMENT. The accepted quantity of Longitudinal Deck Grooving will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for performing the work specified and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
509.10 Longitudinal Deck Grooving	Square Meter (Square Yard)

SECTION 510 – PRESTRESSED CONCRETE

510.01 DESCRIPTION. This work shall consist of manufacturing, transporting, and erecting precast prestressed concrete members.

510.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Portland Cement 701.02
High Early Strength Portland Cement 701.04
Blended Silica Fume Cement 701.06
Tar Emulsion 702.05
Fine Aggregate for Concrete 704.01
Coarse Aggregate for Concrete 704.02
Mortar, Type I 707.01
Mortar, Type IV 707.03
Asphalt-Treated Felt 707.08
PVC Waterstop 707.10
Bar Reinforcement 713.01
Prestressing Strand 713.06
Structural Steel 714.01-714.05
Concrete Curing Materials 725.01
Air-Entraining Admixtures ..... 725.02(b)
Retarding Admixtures ..... 725.02(c)
Water-Reducing Admixtures ..... 725.02(f)
Water-Reducing and Retarding Admixturse ..... 725.02(g)
Water-Reducing, High Range Admixtures ..... 725.02(h)
Water-Reducing, High Range, and Retarding Admixtures ..... 725.02(i)
Accelerating Admixtures ..... 725.02(j)
Water-Reducing and Accelerating Admixtures ..... 725.02(k)
Low Shrinkage Admixtures ..... 725.02(l)
Mineral Admixtures 725.03
Silica Fume ..... 725.03(b)
Ground Granulated Blast-Furnace Slag (GGBFS) ..... 725.03(c)
Polystyrene Insulation Board 735.01
Blanket Insulation Material 735.02
Pipe Insulation 740.08
Water 745.01

510.03 GENERAL FABRICATION REQUIREMENTS.

(a) General. The manufacture of the prestressed units shall be in accordance with the latest editions of PCI MNL-116 *Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products* and PCI MNL 135-00 *Tolerance Manual for Precast and Prestressed Concrete Construction*, except as modified in this Section.

(b) Qualification. The prestressed members shall be manufactured in a plant that has been certified by the Prestressed Concrete Institute under its Plant Certification Program for prestressed concrete.

(c) Quality Control. The Fabricator shall demonstrate a level of quality control testing that satisfies the Agency as to its ability and commitment to produce concrete to the requirements of this Section. A satisfactory program of quality control shall include gradation and moisture determinations of the aggregates, as well as slump, air content, and strength determinations of the concrete. These tests shall be performed at regular and suitable intervals and actively used to maintain the quality of the concrete within the specified requirements.

510.04 DESIGN AND DRAWINGS. As soon as practical after award of the Contract, Fabrication Drawings, calculations, and pertinent data shall be submitted in accordance with Section 105. In addition to the requirements in Section 105, the following shall be included:

(a) The dimensions of the sections to be fabricated.

(b) The concrete mix design, including but not limited to the following:

(1) Batch weights specifying dry or saturated surface dry.

(2) Material names and sources.

(3) Aggregate properties and date tested.

(4) Chemical and physical properties of cementitious material.

(5) Admixture names and sources.

(6) Lab data that shall include, but not be limited to:

a. Slump.

b. Air Content.

c. Temperature.

d. Ratio of Water/Cementitious Material.

e. Cylinder breaks for 3, 7, and 28 days cured in the same manner as the piece to be fabricated.

f. 56 day Rapid Chloride Ion Permeability – AASHTO T 277 test data. The information shall include the individual results from testing 3 specimens, but no specimen shall exceed the maximum specified in Subsection 510.05 (b)(6). Testing shall be performed by a CCRL qualified laboratory.

g. Alkali-Silica Reactivity (ASR) – AASHTO T 303 test data from both fine and coarse aggregates**.** Testing shall be performed by a CCRL qualified laboratory.

(7) Alkali-Silica Reactivity (ASR) – If potentially reactive aggregates are to be used in a mix design, then proposed mitigation method(s) and test results must be provided. The AASHTO T 303 test must be run again with the proposed mitigation method(s) and using the proposed job cementitious material proportioning. The proposed mitigation method(s) shall reduce expansion to below 0.10%.

If a mix design, including the testing results, has been submitted and approved within a 12 month period for the manufacture of prestressed concrete units, it may be used in lieu of submitting an additional mix design. However, if any change in the material sources or properties has occurred, then a new mix design with lab test data will be required regardless of previous approval.

(c) The sources and properties of the materials proposed for use.

(d) The methods of prestressing, including certified calibration charts for all jack and gauge combinations.

(e) Tensioning calculations for prestress strands that include gauge pressure, elongations**,** and movement of anchorage abutments.

(f) The method and sequence of strand detensioning.

(g) The placement of reinforcing steel and prestress strands.

(h) The type of surface finish and how the finish will be obtained.

(i) The curing method, detailing sequence and duration.

(j) The grouting procedure.

(k) The design of the lifting attachments.

(l) Transportation, handling, and storage details.

(m) The installation procedure.

(n) Description of Quality Control procedures.

All design details shall be in accordance with the most recent edition of the Vtrans *Structures Design Manual* available on the Agency's website and the AASHTO *LRFD Bridge Design Specifications.*

510.05 CONCRETE.

(a) Batch plant equipment, materials, and batching procedures shall conform to the following provisions of Section 501:

501.04	BATCHING, paragraphs 1 and 3 only.
501.04(b)	Testing Laboratory.
501.04(c)	Bins and Scales.
501.04(d)	Accuracy of Plant Batching.
501.04(e)	Storage and Proportioning of Materials.
501.05	MIXING AND DELIVERY, for plants not located in the State, the Agency has the option of waiving the requirements of Part (a)(4) and Part (c), paragraphs 1 and 3 only.

(b) Concrete for prestressed members shall conform to the following:

(1) Compressive strength at 28 days, as determined in accordance with AASHTO T 22, of not less than the design compressive strength shown on the Plans. When a 28-day test result is below the specified strength, all concrete represented by that test shall be unacceptable for the requirements of this Section. The Engineer reserves the right to reject all members that were manufactured from this concrete.

(2) The cementitious material content in the mix design shall be between 363 and 475 kg/m³ (611 and 800 pounds per cubic yard) of concrete.

(3) The percent of air entrainment shall be 7 percent with a tolerance of +/- 2 percent, as tested in accordance with AASHTO T 152.

(4) The temperature of the concrete at the time of placement shall be between 10 and 29 ºC (50 and 85 ºF), as tested in accordance with AASHTO T 309.

(5) The maximum water-cementitious material ratio shall be 0.44. When a water-reducing, high range admixture (AASHTO M 194, Type F or Type G) has been included in the approved mix design, the concrete shall not demonstrate segregation at the proposed slump.

(6) The maximum allowed rapid chloride ion coulomb permeability result as tested per AASHTO T 277 is 2000, tested at 56 days from the date specimens were cast.

(7) The maximum allowable mortar bar expansion when tested per AASHTO T 303 (with proposed mitigation method(s), as described previously, if required) shall be 0.10%.

(c) The proposed concrete mix design, including performance history and all requests for variance from the material requirements of these Specifications, shall be submitted for review and acceptance as part of Subsection 510.04. The Structural Concrete Engineer may require 8 weeks for testing, review and acceptance of the mix design.

(d) Any admixture containing calcium chloride shall not be used. Type II, Type III, or Blended Silica Fume portland cement may be used. Only one type of cement and only one source of that type shall be used for the prestressed units required for any one structure.

510.06 INSPECTION. Materials furnished and the work performed under Section 510 shall be inspected by the Agency. The inspector will have the authority to reject any material or work that does not meet the requirements of these Specifications. Advance notification of at least one week shall be provided by the Fabricator to the Agency's Engineer and Structural Concrete Engineer indicating the fabrication start date.

Prior to shipment of any members, the Materials and Research Engineer will have approved all applicable material certifications required in accordance with Subsection 700.02.

510.07 PRESTRESSING. Prestressing shall be accomplished by the pre-tensioning method.

The Fabricator shall provide all equipment necessary for the prestressing operations. Prestressing shall be done with approved jacking equipment. Hydraulic jacks shall be equipped with pressure gauges or other indicating devices. The combination of jack and pressure gauge, or other tensioning system, shall be accompanied by a certified calibration chart showing the relationship between the gauge reading and force in the ram for both ascending and descending movements of the ram. The calibration date of each combination jack and gauge or indicating device shall be within the 12-month period immediately prior to the start of work.

If other types of jacks are used, calibrated proving rings or other devices shall be furnished so that the jacking force may be accurately determined.

Suitable precautions shall be taken by the Fabricator to prevent accidents due to breaking of the prestressing steel or slippage of the grips during prestressing operations.

The tensioning operation shall proceed until the calculated gauge reading has been reached. The elongation of each strand shall then be measured. If the measured elongation differs from the theoretical by more than 5 percent, the tensioning operation shall be stopped, and the cause of the discrepancy determined prior to continuing.

Immediately after tensioning, the final position of each strand shall be marked for the purpose of checking possible strand relaxation.

510.08 FABRICATION.

(a) Pre-Production Meeting. Unless the Engineer deems, in writing, that a pre-production meeting is unnecessary, then a pre-production meeting shall be held a minimum of seven (7) calendar days prior to beginning concrete placement. The pre-production meeting shall be attended by, and including but not limited to, the Crew Supervisor, Plant Manager, Inspector or Inspector's Supervisor, and Project Manager and/or Designer.

(b) Forming Members. Side forms shall be supported without the use of ties or spreaders within the body of the member. Any defects or damage due to form work, stripping, or handling may be cause for rejection. Forms for interior voids or holes in the members shall be constructed of a material that will adequately resist breakage or deformation during concrete placement and that will not materially increase the mass (weight) of the members. Interior void forms shall be accurately positioned as shown on the Plans and secured to prevent displacement during concrete placement. All voids shall be adequately vented to prevent damage to the members during curing. Each void shall contain a suitably located drain hole. Holes or cutouts for anchoring devices, diaphragm connections, openings for connection rods, recesses for grout holes for railing bolts, and any other related details shown on the Plans shall be provided for in the members. Where diaphragm dowels do not pass through the member, the dowels may be attached by use of an approved anchorage embedded in the concrete member.

(c) Placing Transverse Conduits and Tendons. Each tendon to be post-tensioned shall be encased in an approved conduit. Unless otherwise shown on the Plans, the ratio of cross-sectional area of the tendon to be encased to the interior cross-sectional area of the conduit shall not exceed 0.4, except when a steel bar is used as a tendon, the inside diameter of the conduit shall be at least 10 mm (3/8 inch) greater than the diameter of the bar. Conduit that has been crushed or has opened seams shall not be used.

The conduit shall be rigidly constructed, completely sealed, accurately placed, and securely fastened to maintain the desired profile during concreting. No conduit shall be located more than 6 mm (1/4 inch) from the position shown on the Plans. Bundling of conduits will not be permitted.

(d) Placing Prestress Strands. Prestress strands shall be accurately placed in position to achieve the center of gravity of the steel as shown on the approved shop drawings. Prestress strands shall be protected against corrosion and be free of nicks, kinks, dirt, rust, oil, grease, and other deleterious substances.

(e) Bar Reinforcement. Bar reinforcement shall be furnished and installed in conformance with Subsections 507.03, 507.04, 507.05, and 507.07.

(f) Pre-Tensioning. The prestress strands shall be stressed by jacking in accordance with Subsection 510.07, and in the presence of an Agency representative. The jacking force exerted and the elongation produced shall be recorded. Several units may be cast and stressed at one time in a continuous line. Sufficient space shall be maintained between the ends of the units to permit access for cutting strands after the concrete has attained the required strength.

(g) Thermal Effects. For abutment anchorage set-ups where the strands are anchored to abutments that are independent from the form, thermal adjustments shall be made if the ambient temperature at the time of tensioning differs by more than 15 ºC (25 ºF) from the concrete temperature prior to placement and if the net force differential is greater than 2.5%. Consideration shall be given to partial bed length usage and adjustments made when the net effect on the length of the bed used exceeds the allowable. The thermal coefficient of steel shall be taken as 12×10^{-6}/ºC (6.5×10^{-6}/ºF).

(h) Placing Concrete. Concrete shall not be deposited in the forms until the Agency representative has approved placement of the reinforcement, conduits, anchorages, and prestressing strand. The concrete shall be vibrated internally, externally, or a combination thereof to the required consolidation. The vibrating shall be done with care and in such a manner that:

(1) Concrete is uniformly consolidated.

(2) Displacement of reinforcement, conduit, voids, and prestressing strand is avoided.

(3) Acceptable finish surfaces are produced.

(i) De-tensioning. No stress shall be transferred to the concrete until 80 percent of the design compressive strength (f'c) has been attained. The compressive strength shall be determined by cylinders tested in accordance with Subsection 510.09. The prestressing strands shall be released in the de-tensioning pattern detailed on the shop drawing. If de-tensioning is accomplished by single strand release, each strand shall be cut by gradually heating the strand at both ends of the member simultaneously. A minimum length of 125 mm (5 inches) of strand shall be heated to prevent any shock or snap when the strand is finally severed. Each strand shall be cut at all spaces between members cast continuously, before starting de-tensioning on the following strand in sequence.

(j) Dimensional Tolerances. All dimensional tolerances shall be in accordance with the latest editions of PCI MNL – 116 *Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products* and PCI MNL 135-00 *Tolerance Manual for Precast and Prestressed Concrete Construction,* unless otherwise noted in the Contract Documents or as approved by the Engineer. Camber shall be measured as soon as possible after detensioning and at approximately the same time for each product piece. Camber shall be noted for process monitoring/consistency of production.

(1) Dimensional Tolerances for Prestress Deck Panel.

Vertical position of strand group (measured from bottom of panel)	+0, -3 mm (+0,-1/8 inch)
Dunnage	± 150 mm (± 6 inches)
Warping (distance from nearest adjacent corner)	5 mm per m (1/16 inch per foot)
Finish of strands (minimum extension beyond ends of panel)	100 mm (4 inches)

(k) Repairs/Patching. Projecting strands shall be torch cut unless otherwise specified on the Plans. If strands are required to be recessed**,** the recess shall be thoroughly cleaned and patched with Mortar, Type IV. The mortar shall be wet cured for three days or as specified by the manufacturer. Units that contain minor defects caused by manufacture or handling may be repaired at the manufacturing site. Minor defects are defined as holes, honeycombing, or spalls, which are 150 mm (6 inches) or less in diameter, that do not penetrate deeper than 25 mm (1 inch) into the concrete. Surface voids or "bugholes" that are less than 16 mm (5/8 inch) in diameter and less than 6 mm (1/4 inch) deep need not be repaired. Repairs shall be made using an overhead and vertical concrete repair material satisfactory to the Engineer. The repair material shall be cured as specified by the manufacturer. Repairs shall be approved by the Engineer.

(l) Cracking. Cracks less than 0.25 mm (0.01 inch) in width shall be sealed by a method approved by the Engineer. Cracks in excess of 0.25 mm (0.01 inch) may be cause for rejection. At the Engineer's discretion, cracked members shall be repaired or replaced at the Contractor's expense. De-tensioning procedures causing web splitting or other member cracking shall be revised before de-tensioning the next bed.

(m) Deck Panel Rejection Criteria.

(1) Any crack transverse or diagonal to strand pattern and crossing more than one strand.

(2) Any crack parallel to a strand and longer than 33% of the panel length.

(3) Cracks shorter than 33% of the panel length and present at more than 12% of the total number of strands in the panel.

(4) Voids or honeycombed areas with exposed strands.

(5) Any other reason the Engineer determines could have an adverse impact on the structural integrity of the deck panel.

(n) Finishing Riding Surfaces with No Asphalt Wearing Surface. All exposed riding surfaces not covered with an asphalt wearing surface shall be given a turf drag finish in accordance with Subsection 501.16.

(o) Welding. All welding shall conform to the requirements of Subsection 506.10.

510.09 CONCRETE TESTING.

(a) General. Prestressed members shall be manufactured in a plant that maintains a quality control laboratory that meets the requirements of the Agency's Qualified Laboratory Program, available on the Agency's website. The laboratory shall be complete with equipment for measuring the properties of fresh and hardened concrete. As a minimum, the laboratory shall be equipped with a compression testing machine, curing room, or chamber, apparati for measuring slump and air entrainment, and a complete set of aggregate sieves. The compression testing machine shall be power operated and capable of applying the load continuously rather than intermittently, and without shock.

(b) Testing of Compressive Strength. Specimens shall be standard cylinders made by the Fabricator in accordance with AASHTO T 23. Fabrication of test specimens shall be witnessed by an Agency representative. Molds for forming test specimens shall conform to AASHTO M 205 and shall be supplied by the Fabricator. For each bed of pre-tensioned members, the Fabricator shall make for the Agency the following minimum number of specimens:

(1) Six specimens to determine strength prior to de-tensioning. These specimens shall be cured from the time of casting, under the same conditions as the concrete in the work.

(2) Four specimens to determine compliance with the 28-day strength requirement. The specimens shall be cured under the same conditions as the member from the time of casting until the member is removed from the form. At that time, the specimens shall be moved to storage where curing shall continue under standard conditions in accordance with AASHTO T 23. These specimens shall be retained by the Fabricator for testing by the Agency.

The average of the compressive strengths of two specimens shall constitute a test result. Specimens shall be tested either at the Agency's Materials and Research Section laboratory, or at the manufacturer's plant laboratory. An Agency representative will witness all tests. Unless otherwise specified, de-tensioning shall only be permitted after two successive specimens have been tested and the average strength of these specimens is equal to or greater than the strength required in the Contract for de-tensioning.

If the average strength of specimens from a member does not reach the 28-day design strength within 28 days, the member shall be rejected.

510.10 CURING.

(a) General. All curing methods shall be subject to the Engineer's approval. Where the Fabricator elects to cure by method(s) other than low pressure steam or radiant heat as described below, the Fabricator shall submit with the Fabrication Drawings complete details of the proposed method(s) for approval.

The Fabricator shall provide one automatic temperature recorder for every 30 m (100 feet) of casting bed. The recorder shall continuously record curing temperature for the entire curing period. Temperature sensors shall be carefully placed within the curing enclosure to ensure that ambient temperatures are measured at typical locations. Recorder accuracy shall be certified at least once every 12 months, and the certificate displayed with the recorder. Calibration and certification shall be performed by either the manufacturer, the supplier, or an independent laboratory. Random temperature checks of each recorder may be made by an Agency representative. Each recorder chart shall indicate the casting bed, date of casting, time of start and finish of record, and the mark number of prestressed units being cured. At the completion of the curing period, the recorder charts shall be given to the Agency representative. Temperatures recorded on the charts shall be used to determine whether the prestressed units have been cured in accordance with the specifications and the approved Fabrication Drawings.

Curing by the approved method shall continue uninterrupted until the start of de-tensioning operations. De-tensioning shall be accomplished immediately after the steam curing or heat curing has been discontinued. After the de-tensioning is complete, the unit shall be wet cured for seven (7) days.

(b) Curing with Low-Pressure Steam or Radiant Heat.

(1) Immediately upon completing placement of the concrete for each unit, an enclosure shall be placed over the casting bed. This enclosure shall be suitable for containing the live steam or heat. The Fabricator shall make these covers available for inspection prior to casting.

(2) When low pressure steam methods are used for curing, precautions shall be taken to prevent live steam from being directed on the concrete or forms in such a way as to cause localized high temperatures.

(3) When radiant heat is used for accelerated curing, all exposed concrete surfaces shall be covered with plastic sheeting. Radiant heat may be applied by means of a circulation pipe containing steam, hot oil, or hot water, or by electric heating elements.

(4) The concrete shall be allowed to attain its initial set before commencing accelerated curing. This waiting period shall not exceed four hours from time of placement for concrete with no retarder added, or eight hours from the time of placement for concrete with retarder. During this initial curing period, while waiting for the initial set to take place, the temperature within the enclosure shall be maintained between 10 and 27 ºC (50 and 80 ºF).

(5) During the initial application of heat or steam, the ambient air temperature within the enclosure shall increase at a rate not exceeding 20 ºC (40 ºF) per hour until the maximum curing temperature is reached. The maximum curing temperature shall not exceed 71 ºC (160 ºF). The selected curing range shall be as approved on the Working Drawings. The maximum temperature shall be held until the concrete has reached a minimum of 80 percent of f'c, unless otherwise specified in the Contract.

510.11 HANDLING. Handling and installation of prestressed members shall be performed with members in an up-right position and with points of support and direction of reactions in approximately the same locations as designated for the final position of the members in the structures. The Contractor must receive authorization from the Agency prior to shipment or erection of any members.

Care shall be taken during storage, hoisting, and handling of the precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced at the Contractor's expense.

510.12 INSTALLATION.

(a) Prestressed Concrete Members.

(1) Methods, Equipment and Erection. Cranes, lifting devices, and other equipment for all prestressed concrete member erection shall be of adequate design and capacity to safely erect, align and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the prestressed concrete member.

Construction Drawings for prestressed concrete member erection shall be submitted in accordance with Section 105. The erection plan shall include the methods and sequence of prestressed concrete member erection, temporary bracing requirements, the equipment to be used for the erection, the necessary computations to demonstrate that all of the erection equipment has adequate capacity for the work to be performed, and provisions for all stages of construction, including temporary stoppages. When the Fabricator designed lifting hooks will be used by the Contractor, computations indicating the magnitude of stress in the segments during erection are not required, unless otherwise ordered by the Engineer.

The prestressed concrete members may be used for support of equipment prior to placement of the deck only with written permission of the Engineer. The proposed use of the prestressed members for support of equipment shall be detailed in the erection plan.

Submittal of the erection plan is for documentation purposes only and shall in no way be construed as approval of the proposed method of erection. The Contractor shall follow the erection plan as submitted.

(2) Initial Post-tensioning. Initial post-tensioning shall not commence until 24 hours after the last prestressed unit has been placed. The Contractor shall insert post-tensioning strand in the conduits and pull to 13.3 kN (3.0 kips) tension.

(3) Grout. Grout shall be placed according to the requirements of Subsection 510.13.

(4) Fairing Surface. This work shall consist of placing grout between precast members as required for fairing out any unevenness between adjacent units. Mortar, Type IV shall be used. Placement shall be at the same time mortar is placed to fill shear keys between members and in accordance with Subsection 510.13.

The mortar shall be placed to eliminate unevenness, forming a smooth surface from the higher beam edges to the lower surface. The finished surface shall be feathered smoothly and be free of depressions or sharp edges.

(5) Final Post-tensioning. Strands shall be tensioned in accordance with the requirements of Subsection 510.14.

(b) Prestressed Deck Panels.

(1) Panels shall be installed as shown on the Plans. The temporary supports shall be attached to the top of the flange of the girder with an adhesive, approved by the Engineer, in accordance with the manufacturer's recommendations. The temporary supports shall be cut in the field to the required height after the blocking depth has been determined.

(2) Panels shall not be used to support heavy loads, such as additional deck panels, until the top slab is cast and cured. Construction loads on individual panels shall be uniformly applied and shall not exceed an average loading of approximately 2000 Pa (40 pounds per square foot).

(3) After the panels have been placed on temporary supports, the area under the ends of the panels and over the girder flanges up to the bottom of the panels shall be completely filled with Concrete, High Performance Class AA (or other material, as specified on the Plans). Temporary support/grout dams for precast deck panels shall consist of continuous, high density, expanded polystyrene strips (grout dam) with a minimal compressive strength of 380 Pa (55 psi). If leveling screws are used, a 27.2 kg per cubic meter (1.7 pounds per cubic foot) polyethylene foam shall be used as a grout dam. The concrete shall be wet cured until a minimum of 85 percent of f'c is attained by the average strength of two field cured cylinders prior to placement of the cast-in-place deck. If leveling screws are used, they shall be completely removed and the holes filled with grout prior to the placement of deck concrete.

(4) Prior to placing the deck concrete, laitance or other contaminates that would interfere with full bond to the panels shall be removed by an approved method.

510.13 GROUT.

(a) The Fabricator shall sandblast surfaces to be grouted to ensure a clean, oil-free, roughened surface.

(b) Grout used to fill shear keys, leveling screw voids, transverse tie anchor recesses, dowel holes, and for fairing joints shall be Mortar, Type IV. Acceptable grout materials shall be those included on the Approved Products list on file with the Agency's Materials and Research Section. Additional aggregates shall not be added to the material during field mixing.

The Contractor shall submit a grouting procedure proposal to the Engineer, including a premix name brand for approval.

For testing, 6 neat 50 mm (2 inch) cubes shall be molded and cured in accordance with AASHTO T 106 (ASTM C 109). The average compressive strength of 3 cubes at 3 days shall be a minimum of 7 MPa (1000 psi) and a minimum of 35 MPa (5000 psi) in 28 days.

(c) The surface to be grouted shall be thoroughly cleaned, wetted, and free of all standing water.

The grout shall be mixed using a mechanical mixer according to the manufacturer's recommendations and shall be readily pourable so that it completely fills the shape of the shear keys or holes, depending on the product being installed. The placement of the grout for each shear key shall be continuous. The grouting of each shear key shall be completed in its entirety within a single working day.

The Contractor, with the written permission of the Engineer, has the option to use ready mixed mortar for the grouting process. However, the maximum quantity that can be delivered in a single load is one cubic meter (1.25 cubic yard), which must be delivered and placed within the time limits set by the manufacturer.

(d) All exposed grout shall be cured for a period of not less than three days by the wetted burlap method in accordance with Section 501. Curing shall commence immediately following completion of grouting of individual shear keys. During this curing period, the Contractor shall not apply any additional post-tensioning force.

510.14 TRANSVERSE POST-TENSIONING. Transverse post-tensioning strands shall not be bonded to the concrete. Post-tensioning strands shall be protected against corrosion as specified in the Contract.

Post-tensioning of strands shall not commence until a minimum compressive strength of 10 MPa (1500 psi) has been attained in the grout and the grout has cured for three days.

Strands shall be stressed in the following sequence: Before grouting, the strands shall be pulled with a maximum force of 13.3 kN (3.0 kips). After the grout has attained required strength and proper cure time is complete, the strands shall be pulled to a final 133.4 kN (30.0 kips) tension. The sequence shall begin by pulling the inner-most strands first, then proceeding symmetrically towards the members ends. The inner strands shall be rechecked to ensure the strands have 133.4 kN (30.0 kips) tension. In the case where the Plans call for top and bottom strands, the sequence shall be followed using an initial pull of 66.7 kN (15.0 kips), top and bottom, followed by a sequence using a final (total) pull of 133.4 kN (30.0 kips) tension.

510.15 METHOD OF MEASUREMENT. The quantities of Prestressed Concrete Box Beams and Voided Slabs to be measured for payment will be the number of meters (linear feet) of the types and sizes of prestressed concrete members used in the complete and accepted work.

The quantity of Grouting Shear Keys to be measured for payment will be the number of meters (linear feet) of grouted shear keys in the complete and accepted work.

Prestressed deck panels and concrete support beds for the panels will not be separately measured for payment, but will be considered within the volume measurement limits for payment of superstructure concrete.

510.16 BASIS OF PAYMENT. The accepted quantities of Prestressed Concrete Box Beams and Voided Slabs will be paid for at the Contract unit price per meter (linear foot) for the types and sizes of prestressed concrete members specified. Payment will be full compensation for detailing, fabricating, repairing, sandblasting, quality control testing, transporting, handling, and installing the materials specified, including the concrete, reinforcement, prestressing steel, transverse ties, enclosures for prestressing steel, anchorages, mortar, anchor rods, any other material contained within or attached to the members, for furnishing and implementing the erection plan, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Grouting Shear Keys will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for providing all materials and performing the work specified herein, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any other grouting work, such as fairing out unevenness between adjacent units and filling leveling screw holes, transverse anchor recesses, and dowel holes, is considered incidental to the work for prestressed concrete members.

Payment will be made under:

Pay Item	Pay Unit
510.21 Prestressed Concrete Box Beams	Meter (Linear Foot)
510.22 Prestressed Concrete Voided Slabs	Meter (Linear Foot)
510.23 Prestressed Concrete Girders	Meter (Linear Foot)
510.24 Grouting Shear Keys	Meter (Linear Foot)

SECTION 511

THIS SECTION RESERVED

SECTION 513

THIS SECTION RESERVED

SECTION 514 - WATER REPELLENT, SILANE

514.01 DESCRIPTION. This work shall consist of furnishing and applying a penetrating-type protective sealer on concrete surfaces.

514.02 MATERIALS. The material shall be a one-component material consisting of a penetrating-type sealer which does not alter the color or texture of the Portland cement concrete.

Acceptable penetrating-type sealers shall be those appearing on the Approved Products List on file with the Agency's Materials and Research Section.

514.03 PACKAGING, DELIVERY, AND STORAGE. The material shall be delivered to the project in original, manufacturer's unopened containers and stored in accordance with the manufacturer's recommendations.

514.04 PREPARATION OF SURFACES. All surfaces on which the protective sealer is to be applied shall be clean and thoroughly dry to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations. Dirt, grease, curing compounds, asphalt, or other foreign materials shall be removed from the concrete surface before application of the sealer.

514.05 APPLICATION. The material shall be applied to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations.

In the absence of specific recommendations from the manufacturer, the protective sealer shall not be applied to new concrete surfaces that are less than 14 days old. The concrete surfaces shall be free from precipitation for 48 hours prior to application of the sealer. Application of the sealer shall be completed within 40 days of original concrete placement.

514.06 PROTECTION. After application of the sealer, the concrete surfaces shall be protected to the satisfaction of the Engineer and in accordance with the manufacturer's recommendations.

514.07 METHOD OF MEASUREMENT. The quantity of Water Repellent, Silane to be measured for payment will be the number of liters (gallons) of solution applied in the complete and accepted work, measured to the nearest liter (gallon).

514.08 BASIS OF PAYMENT. The accepted quantity of Water Repellent, Silane will be paid for at the Contract unit price per liter (gallon). Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
514.10 Water Repellent, Silane	Liter (Gallon)

SECTION 516 - EXPANSION DEVICES

516.01 DESCRIPTION. This work shall consist of furnishing and installing expansion devices.

516.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Joint Sealer, Preformed Neoprene 707.06
Preformed Fabric Material..... 707.07
Joint Sealer, Butyl Rubber Tape 707.12
Asphalt Plug Bridge Joint 707.15
Structural Steel..... 714.02
High-Strength Low-Alloy Structural Steel 714.03
Carbon Steel Bolts and Nuts 714.04
High-Strength Bolts, Nuts, and Washers 714.05
Welded Stud Shear Connectors..... 714.10
Epoxy Bonding Compound..... 719.02
Galvanizing……..726.08
Metalizing……726.09

516.03 FABRICATION DRAWINGS. The Fabricator of the expansion devices furnished under this Section shall submit detailed Fabrication Drawings in accordance with Sections 105 and 506.

516.04 FABRICATION. Material furnished under this Section shall conform to all applicable provisions of Section 506.

Assemblies shall be fabricated to the designed roadway cross-section within 3 mm (1/8 inch) tolerance of the theoretical dimensions at any point.

Unless otherwise specified, all expansion devices shall be galvanized or metalized.

Extruded cellular and strip type sealers shall be furnished in one continuous piece without splices.

When it is specified that a neoprene seal be bonded to a steel surface that is not galvanized, the contact surface area shall be blast cleaned and properly primed with adhesive. Contact surfaces of neoprene seals that will be bonded with an adhesive shall be cleaned and primed in accordance with the seal manufacturer's instructions.

Expansion devices shall be fabricated, assembled, and certified by one supplier. Each device shall be completely shop assembled and shipped as a whole unit except that curb or other assemblies designed to be attached and adjusted by field bolting may be removed for transport. Angles or other suitable sections shall be furnished to secure opposite halves of a unit during shipment. Temporary shipping attachments shall be attached by bolting; welding will not be permitted.

516.05 INSTALLATION. Expansion devices shall be installed in conformance with the plans and all applicable provisions of Section 506.

Final gap adjustments of an expansion joint assembly shall be made during installation in accordance with the movement chart shown on the Plans, Fabrication Drawings, or as directed by the Engineer.

Joint assemblies shall be properly positioned within 3 mm (1/8 inch) of theoretical crown and straightness and attached to the structure by anchorages furnished with the assembly or as specified in the Contract. Prior to the placement of the concrete, all steel surfaces that will be embedded in concrete shall be coated with epoxy bonding compound. Application of the epoxy bonding compound shall be done in accordance with the manufacturer's recommendations.

516.06 METHOD OF MEASUREMENT. The quantity of Bridge Expansion Joint of the type specified to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work, measured along its centerline.

516.07 BASIS OF PAYMENT. The accepted quantity of Bridge Expansion Joint of the type specified will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for detailing, furnishing, handling, transporting, and placing the material specified, including nondestructive testing of welds, surface preparation,

protective coating, and epoxy bonding compound, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
516.10 Bridge Expansion Joint, Asphaltic Plug	Meter (Linear Foot)
516.11 Bridge Expansion Joint, Vermont	Meter (Linear Foot)
516.12 Bridge Expansion Joint, Finger Plate	Meter (Linear Foot)

SECTION 519 – SHEET MEMBRANE WATERPROOFING, TORCH APPLIED

519.01 DESCRIPTION. This work shall consist of the application of reinforced asphalt, synthetic resin, or coal-tar based preformed sheet membrane to bridge decks to serve as a waterproof barrier between the concrete deck and the bituminous concrete surface pavement. The system shall include the use of a prime coat over the horizontal deck surface and an acceptable polyurethane liquid membrane on the lower portion of the curb face and adjacent deck area.

519.02 MATERIALS. This material shall consist of an approved prefabricated reinforcement of synthetic nonwoven material, thoroughly impregnated and coated with styrene-butadiene-styrene (SBS) modified bitumen. The system shall include a primer which provides an adhesive bond between the concrete deck and the membrane.

Acceptable torch applied membrane systems shall be those included on the Approved Products List on file with the Agency's Materials and Research Section.

519.03 WEATHER LIMITATIONS. Waterproofing shall not be done in rainy weather or when the temperature is below 5°C (40°F) without the authorization of the Engineer.

519.04 SURFACE PREPARATION. The surface of the deck shall have a smooth, fine-textured finish. All honeycombed areas and surface cavities shall be cleaned and filled with approved patching materials. The entire deck shall be abrasive blast cleaned to achieve an anchor profile that is clean and free of laitance, oil, and foreign materials. Prior to blasting, the surface shall be dry and free of sharp protrusions.

519.05 CONSTRUCTION DETAILS.

(a) General. All work performed shall be in accordance with the manufacturer's recommendations. The entire system shall be applied by an individual (Applicator) certified by the manufacturer. The Engineer shall receive written certification from the manufacturer regarding the Applicator's qualifications at least seven days prior to the application of any system component. The certification shall apply only to the named individual(s) performing the application. A manufacturer's representative shall be present at all times during the installation of the membrane system.

(b) Surface Condition. Prior to application of primer, the concrete deck shall be cured such that the moisture content reaches 6% or less. Except on minor areas of the deck as approved by the Engineer, torching or other forms of rapidly evaporating free moisture from the surface will not be allowed to achieve initial surface conditions. Cracks should be blown out to ensure excess water is not present. The Contractor shall supply a portable electronic surface moisture meter capable of measuring the moisture content of concrete surfaces in percent.

Immediately prior to application of the primer, the deck shall be cleaned by brooms and compressed air free of oil. The concrete surfaces shall be inspected and approved by the Engineer and the Applicator prior to priming.

(c) Application of Primer. The air temperature for primer application shall be at least 5˚C (40˚F) and rising.

The primer shall consist of one coat covering the entire deck with an overall coverage rate of 5 m^2/liter (200 ft^2/gal) or as specified by the manufacturer.

The primer shall be applied by brush, roller, or sprayer.

The primer shall cure tack-free in accordance with the manufacturer's recommendations before application of the waterproofing membrane.

(d) Application of Membrane. The waterproofing membrane shall be applied by equipment approved by the Engineer. The equipment shall be capable of applying the membrane in a uniform manner onto the prepared substrate in accordance with the manufacturer's recommendations to assure bond with the primed surface and elimination of air bubbles. In small areas, the membrane shall be hand welded by torch around drains, joints, and along the curb as directed by the Engineer. The Applicator shall be responsible for the protection of adjacent areas.

The membrane shall be installed in a shingled pattern so that water is permitted to drain to the low areas of the deck without accumulating against seams. Laps shall be staggered at the beginning and ends of rolls, shall overlap the previous roll and shall be sealed in accordance with the manufacturer's recommendations. Prior to suspension of work for any reason, all exposed edges shall be heated, troweled, and sealed in accordance with the manufacturer's recommendations.

Damaged membrane or membrane that is not properly bonded to the deck surface shall be patched or repaired in accordance with the manufacturer's recommendations.

519.06 PROTECTION OF MEMBRANE. No traffic shall be permitted on an exposed membrane surface. Care shall be exercised to prevent damage to the completed membrane, especially during paving operations. All damaged areas shall be cleaned and patched to the satisfaction of the Engineer.

The specified bituminous overlay shall be placed on the membrane within three days after application.

A rubber tired or rubber-tracked paver shall be used to place the bottom course of bituminous mix.

The temperature of the bituminous concrete pavement to be placed on the membrane shall be as recommended by the membrane manufacturer and approved by the Engineer.

The Contractor shall maintain a small supply of portland cement on the project during the time of paving. The cement dust shall be sparingly cast over the membrane surface to reduce tackiness and thereby prevent the paver or truck tires from sticking to the membrane and damaging it.

The paver operator shall be directed not to ride the curb lines while paving such areas since the screed shoe may damage the polyurethane sealant on the vertical curb face.

519.07 PROTECTION OF EXPOSED SURFACES. The Contractor shall exercise care in the application of the waterproofing materials to prevent surfaces not receiving treatment from being spattered or marred. Particular reference is made to the face of curbs, copings, finished surfaces, substructure exposed surface, and outside faces of the bridge. Any material that spatters on these surfaces shall be removed and the surfaces cleaned to the satisfaction of the Engineer.

519.08 METHOD OF MEASUREMENT. The quantity of Sheet Membrane Waterproofing, Torch Applied to be measured for payment will be the number of square meters (square yards) of the specified type used in the complete and accepted work. Measurement will be based on the horizontal distance between the face of the curbs and the horizontal length of membrane installed. Any material specified to be lapped up the face of the curb will not be included in the measured quantity.

519.09 BASIS OF PAYMENT. The accepted quantity of Sheet Membrane Waterproofing, Torch Applied will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing, transporting, handling, and placing the waterproofing system specified, including primer, mastic, polyurethane membrane sealant, and surface preparation, and for furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under

	Pay Item	Pay Unit
519.20	Sheet Membrane Waterproofing, Torch Applied	Square Meter (Square Yard)

SECTION 522 – LUMBER AND TIMBER

522.01 DESCRIPTION. This work shall consist of detailing, furnishing, fabricating, transporting, framing, and placing or erecting lumber, structural timber, or structural glued laminated timber; installing hardware; and applying preservative treatment.

522.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Joint Sealer, Hot Poured .....707.04(a)
Coatings for Wood..... 708.05
Structural Lumber and Timber 709.01
Miscellaneous Hardware, Shapes, and Fabricated Materials..... 709.01(h)
Nonstructural Lumber..... 709.02
Structural Glued Laminated Timber 709.03
Timber Preservative..... 726.01
Copper Naphthenate Solution..... 726.04
Waterproofing Pitch 726.05
Galvanizing…….. ..... …... 726.08

Unless otherwise specified, all metal parts and hardware shall be galvanized.

522.03 GENERAL FABRICATION REQUIREMENTS. Glued laminated timber furnished under this Section shall be fabricated by an AITC licensed laminator and shall comply with ANSI/AITC A190.1. In addition to being a licensed laminator, the Fabricator must demonstrate the capability to fabricate the end products specified.

Unless otherwise specified, all material shall be fabricated prior to preservative treatment.

Dimensions and bolt hole locations of prefabricated material shall be within a tolerance of 2 mm (1/16 inch) of the details specified.

522.04 DRAWINGS. Unless otherwise specified, as soon as practical after award of the Contract, the Contractor shall prepare and submit Fabrication Drawings for glued laminated timber in accordance with Section 105.

The Contractor shall prepare and submit Construction Drawings for structural timber erection in accordance with Section 105.

The erection plan shall include methods and sequence of structural timber erection, temporary bracing requirements, the equipment to be used for the erection, the necessary computations to indicate the magnitude of stress in the segments during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed, and provisions for all stages of construction, including temporary stoppages. The Contractor shall follow the erection plan as submitted.

522.05 STORAGE. Timber, lumber, and glued laminated materials stored on the site shall be kept in orderly piles, open stacked, and on supports that provide at least 300 mm (12 inches) of ground clearance. For outside storage, the ground area in the vicinity of the material shall be cleared of grass, weeds, and rubbish. Free circulation of air shall be provided between the tiers, courses, and the ground.

Timber, lumber, and glued laminated timber (treated or untreated) shall be stored under cover. The covering shall adequately protect these materials from direct and blowing rain or snow while providing full circulation of air.

Fabricated material shall be stored in a manner that will prevent dimensional changes in the members prior to assembly.

522.06 HANDLING. Material shall be carefully handled to avoid damaging the edges or surface and to keep it clean.

Materials shall be picked up or moved with slings or other devices that will not damage or mar the surface. Peavies, cant hooks, timber dogs, or other pointed tools will not be permitted.

Cranes, lifting devices, and other equipment for all structural timber erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the structural timber members.

522.07 FRAMING. Timber, lumber, and glued laminated timber shall be accurately cut and framed to a close fit in such a manner that the joints will have full and even bearing over the entire contact surface. Mortises shall be true to size for their full depth, and tenons shall fit snugly. Except as indicated in the Contract, shimming will not be permitted in making joints, and open joints will not be accepted. Nails and spikes shall be driven with the heads set flush with the surface of the wood. Except as directed by the Engineer, structure framing and boarding shall be constructed square, plumb, and straight.

When permitted by the Engineer, forms or temporary braces may be attached to treated material. Upon removal, any holes, cuts, or abrasions shall be treated in accordance with Subsection 522.13.

522.08 CONNECTIONS.

(a) Holes for Bolts, Dowels, Rods, and Lag Screws. Holes for metal round drift-bolts or dowels shall be bored with a bit 2 mm (1/16 inch) less in diameter than the drift-bolt or dowel to be used. The diameter of holes for metal square drift-bolts or dowels shall be equal to the least dimension of the drift-bolt or dowel.

Except as required for timber connectors in part (d) of this Subsection, holes for machine bolts shall be bored with a bit the same diameter as the bolt.

Holes for round wood dowels shall be bored with a bit the same diameter as the dowel.

Holes for rods shall be bored with a bit 2 mm (1/16 inch) greater in diameter than the rod.

Lead holes for lag screws, wood screws and spikes shall conform to requirements specified within the latest edition of the AITC Timber Construction Manual.

(b) Countersinking. Countersinking shall be done wherever smooth faces are required. All recesses in treated lumber and timber formed for countersinking shall be painted with copper naphthenate solution. Recesses likely to collect injurious materials shall be filled with a hot-poured joint sealer or other material, as directed by the Engineer.

(c) Bolts and Washers. A washer of the size and type specified shall be used under all bolt heads and nuts that would otherwise come in contact with wood.

All nuts shall be effectively locked after they have been finally tightened.

(d) Timber Connectors. In addition to wood dowels, bolts, and rods, timber (wood member) connectors may be the split ring, shear plate, or spike grid type. The split ring and shear plate types shall be installed in precut grooves of dimensions as recommended by the manufacturer. The spike grid type shall be forced into the contact surfaces of the wood members joined by means of pressure equipment. All connectors of this type at any given joint shall be embedded simultaneously and uniformly.

Bolt holes shall be perpendicular to the face of the material and 2 mm (1/16 inch) larger in diameter than the bolt.

(e) Framed Bents. Framed bents shall be constructed in accordance with AASHTO *LRFD Bridge Construction Specifications* and interim specifications in effect on the date of the Contract.

522.09 TRUSSES. Trusses, when completed, shall show no irregularities of line. Chords shall be straight and true from end to end in horizontal projection and, in vertical projection, shall show a smooth curve through panel points conforming to the correct camber. All bearing surfaces shall fit accurately. Uneven or rough cuts at the points of bearing shall be cause for rejection of the piece containing the defect.

522.10 TRUSS HOUSING. The finished appearance of the housing is considered of primary importance. Special care shall be taken to secure a high quality of work and finish on this portion of the structure.

Unless otherwise directed by the Engineer, housing and railings shall be constructed after the removal of the falsework and the adjustment of the trusses to correct alignment and camber.

522.11 DECKING.

(a) Plank Flooring. Plank material shall be of dimension lumber of the grade specified.

Unless otherwise specified, all material shall be surfaced four sides (S4S).

Single layer plank floors shall consist of a single thickness of dimension lumber planks supported by stringers or floor beams. The planks shall be laid heart side down, with 6 mm (1/4 inch) openings between them. Each plank shall be securely spiked to each supporting member. The planks shall be carefully graded as to thickness and so laid that no two adjacent planks vary in thickness by more than 2 mm (1/16 inch). Unless otherwise specified, the lengths of transverse planks on stringers shall be full width of the designed cross-section.

Two-ply plank floors shall consist of two layers of dimension lumber planks supported on stringers or floor beams. Each plank of the top course shall be securely fastened to the lower course. At the ends of the bridge, if required, the decking shall be beveled to match the approach surfaces. For stringer supports, the top course of planks may be laid either diagonal or parallel to the centerline of roadway. Joints in the top layer shall be staggered at least 1 m (3 feet) and care shall be taken to securely fasten the ends of each plank. For floor beam supports, unless otherwise specified, the lengths of transverse top course planks shall be full width of the designed cross-section.

(b) Nail Laminated Decking. Nail laminate deck material shall be furnished and installed in accordance with the Contract or as ordered by the Engineer. Deck material shall be of the grade specified. Unless otherwise specified, in transverse applications the lengths of planks shall be full width of the designed cross-section. Each plank shall be spiked to the preceding plank at each end and at intervals of approximately 450 mm (18 inches) with the spikes driven alternately near the top and bottom edges. The spikes shall be of sufficient length to pass through two planks and at least halfway through a third plank.

When timber nailing strips are used, every other plank shall be toe-nailed to every other nailing strip. The size of the spikes shall be as shown on the Plans or as directed by the Engineer.

When shown on the Plans or authorized by the Engineer, the laminated decking may be attached to steel supports by the use of approved galvanized metal clips. Care shall be taken to have each strip vertical and tight against the preceding one and bearing evenly on all supports.

(c) Glued Laminated Decking. Glued laminated decking material shall be furnished and installed in accordance with the Contract, approved Fabrication Drawings, or as directed by the Engineer.

522.12 SAWN LUMBER STRINGERS. Stringers shall be sized at bearings and shall be placed in position so that knots near edges will be in the compression portions of the stringers.

Outside stringers may have butt joints with the ends cut on a taper, but interior stringers shall be lapped to take bearing over the full width of the floor beam or cap at each end. The lapped ends of untreated stringers shall be separated at least 15 mm (1/2 inch) for the circulation of air and shall be securely fastened by drift-bolting where specified. When stringers are two panels in length, the joints shall be staggered.

Cross-bridging between stringers shall be neatly and accurately framed and securely toe-nailed with at least two nails in each end. All cross-bridging members shall have full bearing at each end against the sides of stringers. Unless otherwise specified, cross-bridging shall be placed at the center of each span.

522.13 PRESERVATIVE TREATMENT.

(a) Pressure Treatment. Timber, lumber, and glued laminated timber shall be pressure treated with the type of preservative specified in the Contract. When a specific type or options are not specified, Type II preservative shall be used. Prior to handling or erecting pressure treated timber, lumber, or glued laminated timber the Contractor shall read and provide a copy of any Material Safety Data Sheets (or Consumer Information Sheets required for the material) to the Resident Engineer. The Contractor shall also provide the Resident Engineer with a plan detailing clean-up, storage, and disposal procedures for pressure treated sawdust and cutoffs.

(1) Treatment of Cuts, Abrasions and Holes. Cuts, abrasions, and holes bored after treatment shall be treated with two coats of copper naphthenate solution. Cuts and abrasions shall be carefully trimmed prior to treatment. Holes left unfilled shall be filled with wooden plugs treated with copper naphthenate solution.

(2) Temporary Attachments. Holes remaining after the removal of nails and spikes used to attach temporary forms or bracing to treated material shall be filled by driving galvanized nails or spikes flush with the surface or plugging the holes with wooden plugs treated with copper naphthenate solution.

(b) Untreated Timber, Lumber and Glued Laminated Timber. For untreated timber, lumber, and glued laminated timber, all cuts, notches, bore holes, contact surfaces and other areas specified by the Contract shall be treated with two coats of copper naphthenate solution.

(c) Field Treatment. When field applications of preservative are specified, the materials shall be furnished, prepared, and applied in accordance with AWPA Standard M4.

522.14 PAINTING. The surface of any material to be painted or stained shall be dry and free of dirt, dust, oil, or other foreign materials. Unless otherwise specified, all surfaces shall be coated with a prime coat and one finish coat.

522.15 METHOD OF MEASUREMENT. The quantity of Structural Lumber and Timber and of Nonstructural Lumber to be measured for payment will be the number of cubic meters (thousand feet board measure – MFBM) incorporated into the complete and accepted work, as computed from the nominal cross-section sizes and the actual in-place lengths of members. Final accepted in-place length of any member will be determined as the maximum length of a member as projected along one edge-line, measured to the next 0.25 m (1 foot) increment. Further measurement shall not be made for cutoffs or actual stock lengths. For longitudinal nail-laminated decking, longitudinal plank decking, and runners, member length will be measured as the overall superstructure length of in place decking and runners, measured to the next 0.25 m (1 foot) increment.

If round timbers and English units are specified, the number of board feet will be computed by the Vermont Log Rule: Board Feet = (DxRxL)/12; where D = diameter in inches, measured under the bark at the small end; R = D/2; and L = length in feet.

The quantity of Structural Glued Laminated Timber to be measured for payment will be on a lump sum basis for each structure or each structural unit in the complete and accepted work.

522.16 BASIS OF PAYMENT. The accepted quantities of Structural Lumber and Timber and of Nonstructural Lumber will be paid for at the Contract unit prices per cubic meter (thousand feet board measure – MFBM). Payment for each quantity will be full compensation for detailing, fabricating, furnishing, transporting, handling, placing or erecting, and painting or treating the material specified, including all hardware and timber connectors; for providing all falsework, forms, bracing, sheeting, or other timber used for erection purposes; for furnishing and implementing the erection plan, when required; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Structural Glued Laminated Timber will be paid for at the Contract lump sum price. Partial payments will be made as follows:

1. The first payment of 50% of the lump sum price will be made upon the original delivery of the timbers to the project, provided the materials are acceptable and certified.

2. The remaining 50% will be paid when the installation is complete and the work accepted.

   Payments for the quantity of Structural Glued Laminated Timber will be full compensation for detailing, fabricating, furnishing, transporting, handling, placing or erecting, and painting or treating the material specified, including all hardware and timber connectors; for providing all falsework, forms, bracing, sheeting, or other timber used for erection purposes; for furnishing and implementing the erection plan, when required; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
522.20 Structural Lumber and Timber, Untreated	Cubic Meter (MFBM)
522.25 Structural Lumber and Timber, Treated	Cubic Meter (MFBM)
522.30 Nonstructural Lumber, Untreated	Cubic Meter (MFBM)
522.35 Nonstructural Lumber, Treated	Cubic Meter (MFBM)
522.40 Structural Glued Laminated Timber	Lump Sum

SECTION 523

THIS SECTION RESERVED

SECTION 524 - JOINT SEALER

524.01 DESCRIPTON. This work shall consist of furnishing and placing a joint sealer of the type specified at the locations shown on the Plans.

524.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Joint Sealer, Hot Poured ..... 707.04(a)
Joint Sealer, Cold Poured ..... 707.04(b)
Backer Rod ..... 707.04(c)
Joint Sealer, Polyurethane 707.05
Bond Breaker..... 707.05(c)
Asphaltic Plug Joint Binder……707.15

Joints sawn in bituminous concrete pavement shall be filled and sealed with hot poured or cold poured joint sealer or asphaltic plug joint binder, appropriate backer rod, and an approved bond breaker.

524.03 TEMPERATURE LIMITATIONS. The joint sealer shall be applied per manufacturer's recommendations, however, the ambient air and pavement temperatures must be greater than 5 °C (40 °F) at the time of application.

524.04 SAWED JOINTS. Roadway or bridge deck joints shall be formed by means of concrete floor sawing equipment capable of dry cutting the designed joint in a single pass.

The joint shall be cut and sealed in one continuous operation. The sawed joint shall not be exposed to traffic until after the sealer has been placed, cured, and is not subject to "picking."

When placing new bituminous concrete pavement, each lift of pavement shall be scored with a single blade cut to a depth of 75 percent of the lift thickness, at the location of the center of the proposed joint. This work shall be completed prior to exposing the location to traffic or, where traffic is not maintained, the same working day that the lift of pavement is placed.

The sawed joint in the newly placed wearing course shall be cut and sealed within 24 hours of paving. If the joint location will not be exposed to traffic, the Engineer may allow the Contractor an additional 48 hours to cut and seal the joint.

The width of the sawed joint shall be as shown on the Plans or may be adjusted by the Engineer for seasonal temperature variations. The depth of the sealant shall be approximately 50 percent of the width of the sawn joint when hot or cold poured materials are specified in the Contract.

The equipment for sawing the single blade cut shall be on the project and approved by the Engineer prior to beginning paving operations.

524.05 PREPARATION OF JOINTS. Surfaces to which the joint sealer is to adhere shall be free of all foreign material, including curing compound, oil, dirt, sawing film, laitance, and rust. All surfaces shall be thoroughly dry before placing of sealers.

(a) For Poured or Preformed Joint Sealers. Prior to placing poured or preformed joint sealers, the vertical faces of the sawed joint and the horizontal pavement surfaces within 25 mm (1 inch) of the joint edge shall be thoroughly blast cleaned to improve joint sealant adhesion. The resulting dust, blasting debris, etc. shall be removed with a blast of high-pressure air or industrial vacuum equipment.

Regardless of the cleaning method used, the Contractor shall take all necessary precautions to avoid contaminating the other project construction work with the removed dust and debris.

(b) For Polyurethane Joint Sealer. Prior to placing polyurethane joint sealer, the concrete surface shall be blast cleaned to remove surface mortar and expose underlying aggregate. Blast cleaning equipment shall be such that no oil is introduced into the air line. Surfaces formerly sealed with other sealers shall be bush hammered or sawed to clean the material and then blast cleaned.

Steel surfaces shall be blast cleaned to the bare metal. Primer shall be applied immediately after the blast cleaning is completed.

Epoxy mortar surfaces shall be cleaned by use of suitable solvents or by blast cleaning as required.

524.06 PLACEMENT.

(a) Joint Sealer, Hot Poured. The material shall be heated in a double walled, oil-jacketed kettle equipped with positive temperature controls that allow the sealer to be heated to, and maintained within, a range of 200 to 210 °C (390 to 410 °F) or such other temperature range as recommended by the sealant manufacturer. The kettle shall arrive on the project empty.

Heating of the sealant to the placement temperature and maintaining the sealer at placement temperature shall not exceed six hours. The Contractor shall empty the kettle before heating more material. New material shall not be added to a partially filled kettle and cooled material shall not be reheated.

Prior to pouring the sealant into the joint, a heat resistant backer rod shall be placed in the bottom of the joint. The rod shall be 3 mm (1/8 inch) greater in diameter than the joint width to ensure a leak-proof seal and to maintain the proper depth of sealant. The rod shall be specifically manufactured for use with hot poured sealants.

The hot sealant shall be poured into the joint in a single layer, except that multiple layers will be permitted if lateral flow is a problem. The joint shall be slightly overfilled, and the excess sealant shall be leveled with a U- or V-shaped squeegee to provide a thin layer of sealant spread over the blast cleaned, horizontal, pavement surfaces adjacent to the joint.

(b) Joint Sealer, Cold Poured. The two-component material shall be mixed in the container in which it is furnished using 100 percent of both components. Mixing shall be accomplished with a variable speed drill and mixing paddle operated at speeds not greater than 400 rpm for a period of not less than five minutes. Mixing by hand will not be permitted.

The mixed sealant may be transferred to a smaller clean container for ease of pouring. All mixed sealants must be placed within the 30 to 45 minute pot life of the material.

Prior to pouring the sealant into the joint, a backer rod shall be placed in the bottom of the joint. The rod shall be 3 mm (1/8 inch) greater in diameter than the joint width to ensure a leak-proof seal and to maintain the proper depth of sealant. The rod shall be specifically manufactured for use with poured sealants.

The sealant shall be poured into the joint in a single layer, except that multiple layers will be permitted if lateral flow is a problem. The joint shall be slightly overfilled, and the excess sealant shall be leveled with a U- or V-shaped squeegee to provide a thin layer of sealant spread over the blast cleaned, horizontal, pavement surfaces adjacent to the joint.

(c) Joint Sealer, Polyurethane. Polyurethane joint sealer shall be placed as shown on the Plans in accordance with the manufacturer's recommendations. Joint sealer shall not be installed until concrete has been in place for 28 days.

A foam spacer, approved by the Engineer, shall be installed in such a manner to control the depth of the sealer and give support during its cure time. The foam spacer shall fit tightly against the sides of the opening beneath the sealer.

Polyurethane coated tape, or other strip material approved by the Engineer, shall be applied to those surfaces where bond is not desired.

Primer material(s) shall be applied strictly as specified by the joint sealer manufacturer on the surfaces to which the joint sealer is intended to adhere. Primed surfaces that may have been contaminated by dirt or other foreign material shall be cleaned and primed again prior to the application of the joint sealer.

The finished surface of the joint sealer shall present a smooth, even appearance. Only minimum tooling of horizontal joints will be allowed. Overlaying or shimming material shall not be applied over material that has cured.
When it is necessary to place a portion of a joint, the edge of the cured material shall be primed as specified by the manufacturer prior to placing additional sealer.

Any joint sealer that is not completely bonded to the intended surface after being in place for 72 hours shall be removed, the joint prepared again, and the application repeated as specified.

(d) Asphaltic Plug Joint Binder. Asphaltic plug joint binder shall only be used in the saw cut joint as indicated in the Plans.

The material shall be heated in a double-walled, oil-jacketed kettle equipped with positive temperature controls that allow the sealant to be heated to such temperature range as recommended by the sealant manufacturer. The kettle shall arrive on the project empty. Heating of the sealant to the placement temperature and maintaining the sealer at placement temperature shall not exceed the time interval recommended by the manufacturer. The Contractor shall empty the kettle before heating more material. New material shall not be added to a partially filled kettle and cooled material shall not be reheated.

Prior to pouring the sealant into the joint, a heat resistant backer rod shall be placed in the bottom of the joint. The rod shall be 3 mm (1/8 inch) greater in diameter than the joint width to ensure a leak-proof seal and to maintain the proper depth of sealant. The rod shall be specifically manufactured for use with hot poured sealants.

The hot sealant shall be poured into the joint in a single layer, except that multiple layers will be permitted if lateral flow is a problem. The joint shall be slightly overfilled, and the excess sealant shall be leveled with a U or V-shaped squeegee to provide a thin layer of sealant spread over the blast cleaned, horizontal pavement surfaces adjacent to the joint.

524.07 JOINT PROTECTION. The completed joint shall be protected against damage from traffic during the curing time.

Polyurethane joint sealer shall be covered with impervious material to prevent contact with linseed oil-mineral spirits mixtures, paints, or other materials containing mineral spirits and similar solvents.

524.08 METHOD OF MEASUREMENT. The quantity of Joint Sealer, of the kind specified, to be measured for payment will be the number of meters (linear feet) or the number of liters (gallons) used in the complete and accepted work.

524.09 BASIS OF PAYMENT. The accepted quantity of Joint Sealer, of the kind specified, will be paid for at the Contract unit price. Payment will be full compensation for furnishing, handling, placing, and installing the specified materials, including any required backer rod or bond breaker; for preparing, including saw cutting where required, and cleaning the joint prior to installing the sealer; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Payment will be made under:

Pay Item	Pay Unit
524.10 Joint Sealer, Hot Poured	Liter (Gallon)
524.11 Joint Sealer, Hot Poured	Meter (Linear Foot)
524.12 Joint Sealer, Cold Poured	Liter (Gallon)
524.13 Joint Sealer, Cold Poured	Meter (Linear Foot)
524.20 Joint Sealer, Polyurethane	Liter (Gallon)
524.21 Joint Sealer, Polyurethane	Meter (Linear Foot)

SECTION 525 - BRIDGE RAILINGS

525.01 DESCRIPTION. This work shall consist of furnishing and erecting bridge railing and performing repairs to existing bridge railing.

525.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV 707.03
Grease Rustproof`ing Compound..... 708.04
Anchor Bolts, Bridge Railing 714.07
Galvanizing……..726.08
Metalizing……726.09
Delineation Devices..... 728.04
Preformed Fabric Bearing Pads..... 731.01
Bearing Pads……731.02
Metal Hand Railing 732.01
Galvanized Box Beam Bridge Railing 732.03
Steel Beam Bridge Railing 732.04

Concrete shall meet the requirements of Section 501 for High Performance Concrete, Class A or High Performance Concrete, Class SCC. If High Performance Concrete, Class A is used then a shrinkage compensating admixture shall be added during the initial concrete mixing phase or as recommended by the chemical manufacturer product representative.

Reinforcing steel shall meet the requirements of Section 507.

525.03 FABRICATION DRAWINGS. The Fabricator of steel components furnished under this Section shall submit detailed Fabrication Drawings in accordance with Sections 105 and 506.

The Contractor shall submit a bending schedule for concrete bridge railing reinforcement in accordance with Sections 105 and 507.

These requirements do not apply to work performed under part (d) of Subsection 525.06.

525.04 FABRICATION.

(a) Steel Components. Material furnished under this Section shall conform to the applicable provisions of Section 506. Railing shall be fabricated in a plant approved by the Structures Engineer.

Unless otherwise specified, all ferrous metal railing components shall be galvanized.

(b) Concrete Forms. Forms shall conform to the railing design shown in the Plans and forming requirements of Section 501. Forms shall be constructed to allow for checking and correcting the railing alignment and grade after the concrete has been placed and prior to initial set. The forms shall be reinforced in such a manner that finishing of the railing tops will not disturb the final adjusted alignment.

525.05 CONSTRUCTION TOLERANCES. Tolerances for railing components shall meet the requirements of the latest edition of the AASHTO *LRFD Bridge Construction Specifications*.

525.06 INSTALLATION.

(a) General. Railings shall be installed in conformance with the applicable provisions of Sections 501, 506, 507, and these specifications. Alignment, grade, and clearances at joints shall be adjusted to the satisfaction of the Engineer.

Posts shall be adjusted and aligned to the satisfaction of the Engineer prior to placing any mortar.

Unless otherwise specified, removed railing shall become the property of the Contractor and shall be removed from the project.

Sleeves for hand railing shall be secured and accurately aligned prior to placement of any concrete.

Galvanized surfaces that have been scratched or have received minor abrasions shall be repaired in accordance with Subsection 726.08 or as directed by the Engineer.

(b) Painting. Railing required to be painted shall be coated in accordance with the appropriate painting item(s) in the Contract.

Wherever bridge railing panels are nested or overlapped full length, the surfaces on both panels that will be in contact with each other shall be coated with a grease rustproof compound.

(c) Delineation. Delineation devices shall be of the design shown on the Plans and shall be securely fastened to the bridge railing posts as shown on the Plans or as directed by the Engineer.

(d) Bridge Railing Repair. Bridge railing repair of the Type specified shall be performed at the locations indicated in the Plans and as directed by the Engineer.

(1) Bridge Railing Repair, Type I. Type I bridge railing repair shall consist of installing new heavy duty steel beam panels and offset blocks on existing fascia-mounted or curb-mounted posts spaced at 1.9 meters (6.25 feet) or less.

(2) Bridge Railing Repair, Type II. Type II bridge railing repair shall consist of installing new nested heavy duty steel beam panels and offset blocks on existing fascia-mounted or curb-mounted posts spaced greater than 1.9 meters (6.25 feet).

(3) Bridge Railing Repair, Type III. Type III bridge railing repair shall consist of installing new heavy duty steel beam panels and offset blocks on new fascia-mounted or curb-mounted posts utilizing existing anchor bolts.

525.07 METHOD OF MEASUREMENT. The quantity of Removal of Existing Bridge Railing or Reset Existing Bridge Railing to be measured for payment will be the number of meters (linear feet) of existing railing dismantled and disposed of, or repaired and reset, between the limits specified or as ordered by the Engineer.

The quantity of Bridge Railing of the type specified to be measured for payment will be the number of meters (linear feet) of the type of rail used in the complete and accepted work. Measurement will be made along the face of the rail from end to end or between the pay limits specified. No deductions or additions will be made for joints.

The quantity of Bridge Railing Repair of the Type specified to be measured for payment will be the number of meters (feet) of railing repaired in the complete and accepted work, measured within the limits shown on the Plans or as directed by the Engineer. No additional measurement will be made for nested beam panels.

525.08 BASIS OF PAYMENT. The quantity of Removal of Existing Bridge Railing or Reset Existing Bridge Railing will be paid for at the Contract unit price bid per meter (linear foot). Payment will be full compensation for dismantling and disposing of, or for repairing and resetting, existing railing and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Bridge Railing of the type specified will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for detailing, furnishing, handling, placing, delineating, galvanizing, applying grease rustproof compound, and painting the railing components; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Bridge Railing Repair of the Type specified will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for detailing, treating, furnishing, handling, and placing railing components; for bolts and hardware necessary for installing railing components; for all work necessary for verifying and adjusting post height and/or bolt spacing of existing posts; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Removal and disposal of existing railing components required for performing Bridge Railing Repair of the Type specified will be paid for under Contract item 525.10.

Payment will be made under:

	Pay Item	Pay Unit
525.10	Removal of Existing Bridge Railing	Meter (Linear Foot)
525.11	Reset Existing Bridge Railing	Meter (Linear Foot)
525.33	Bridge Railing, Galvanized 2 Rail Box Beam	Meter (Linear Foot)
525.335	Bridge Railing, Galvanized 3 Rail Box Beam	Meter (Linear Foot)
525.34	Bridge Railing, Galvanized 4 Rail Box Beam	Meter (Linear Foot)
525.41	Bridge Railing, Galvanized HD Steel Beam/Fascia Mounted	Meter (Linear Foot)
525.44	Bridge Railing, Galvanized HDSB/ Fascia Mounted/Steel Tubing	Meter (Linear Foot)
525.50	Bridge Railing Repair, Type I	Meter (Linear Foot)
525.55	Bridge Railing Repair, Type II	Meter (Linear Foot)
525.60	Bridge Railing Repair, Type III	Meter (Linear Foot)
525.70	Bridge Railing, Concrete F-Shape	Meter (Linear Foot)

SECTION 526

THIS SECTION RESERVED

SECTION 527 - MAINTENANCE OF STRUCTURES AND APPROACHES

527.01 DESCRIPTION. This work shall consist of the maintenance of existing structure(s) and approaches within the project limits.

527.02 ROAD MAINTENANCE. The Contractor shall maintain all highway sections within the confines of the work under the Contract to the satisfaction of the Engineer. When traffic is to be maintained over the present highway, the full width of the roadway shall be maintained.

The maintenance shall be done by means of an approved road grader or other approved equipment of a type that will be efficient in keeping the roadway in a reasonably smooth and passable condition for traffic and shall be subject to the approval of the Engineer. The material for and the necessary filling of holes and similar depressions that develop in the roadway shall be included in the Contract price for this item. If, in the opinion of the Engineer, the Contractor fails to maintain a reasonably smooth roadway surface, and fails to fix the same after written notification, the Engineer will make the necessary provisions to maintain the roadway surface, and the cost shall be deducted from any money due or to become due under the Contract.

527.03 BRIDGE MAINTENANCE. When traffic is maintained over an existing structure, the Contractor shall keep all parts of the structure safe for the legal or posted load of the structure including satisfactory maintenance of the substructure, superstructure, and the bridge surface. The Contractor shall strengthen, patch, shore, or renew any part or parts of this substructure or superstructure when necessary for the safety of the traveling public.

If the existing structure over which traffic is being maintained becomes unsafe for public travel, and if, on written order by the Engineer, the Contractor fails to make satisfactory repairs, the Engineer will make the necessary provisions to repair the structure, and the cost will be deducted from any monies due under the Contract.

527.04 METHOD OF MEASUREMENT. The quantity of Maintenance of Structures and Approaches to be measured for payment will be on a lump sum basis.

527.05 BASIS OF PAYMENT. The accepted quantity of Maintenance of Structures and Approaches will be paid for at the Contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to properly maintain substructures, superstructure(s), and roadway approaches.

Payment for this work will be made periodically as follows:

(a) 50 percent of the Contract lump sum price will be paid after all required repairs to the bridge(s) or approaches have been made to the satisfaction of the Engineer and traffic is being maintained over the existing bridge(s) and approaches.

(b) The remaining 50 percent of the Contract lump sum price will be paid when traffic is permanently moved to the new/rehabilitated bridge(s) and approaches.

When the Contract specifically provides for Item 607, Roadway Patrol Maintenance, the Contract item Maintenance of Structures and Approaches shall only cover maintenance of the existing structure(s).

Payment will be made under:

Pay Item	Pay Unit
527.10 Maintenance of Structures and Approaches	Lump Sum

SECTION 528 - TEMPORARY BRIDGE

528.01 DESCRIPTION. This work shall consist of the design, construction, maintenance, and removal of a temporary bridge, its substructures and approaches.

528.02 MATERIALS. The Contractor may use any material or combination of materials that will conform to the requirements of this Subsection and meet the approval of the Engineer. The Engineer reserves the right to reject materials and details that are structurally unsafe for the use proposed.

Unless specifically permitted in the Contract or upon written authorization of the Construction Engineer, the use of pipes will not be allowed for temporary bridges.

Unless otherwise authorized on the approved drawings, all main load carrying members shall be continuous between supports. Splices will only be approved for:

(a) A fully bolted connection, with high-strength bolts, designed for its location in accordance with the AASHTO *LRFD Bridge Design Specifications*.

(b) A fully welded connection designed, welded, inspected, and tested in accordance with the AASHTO *LRFD Bridge Design Specifications* and AWS requirements. Any welded connection performed in the absence of and without the approval of the Agency's Welding Inspector will not be approved.

Any welding done for work under this Section must be detailed on the Working Drawings and performed in conformance with Section 506.

528.03 DRAWINGS. Working Drawings shall be prepared by the Contractor for the proposed work under this item in accordance with Section 105. Drawings for the bridge approaches shall include plan, profile, typical section, and specific cross-sections for the temporary roadway and channel (when applicable) with complete details and identification of materials to be used. Geometrics of the temporary bridge and its approaches shall be adequate for the volume of traffic served and individual conditions encountered.

Plan, elevation, and section views of the structure shall include size and spacing of all members or components for:

Abutments
Piers
Main supporting members or stringers
Floor system
Diaphragms and lateral bracing
Railing (bridge and approach)
Curbs
Bearings
Other applicable information

528.04 DESIGN AND CONSTRUCTION DETAILS. The design and structural details of the temporary bridge, its substructures and approaches shall be signed, stamped, and dated by a Professional Engineer (Structural or Civil).

In designing and constructing a temporary bridge, the Contractor shall provide for the waterway and clearances shown on the Plans. When temporary bridge requirements are not shown on the Plans, the opening area shall be at least equal to 40 percent of the waterway provided for the 100-year event (Q 100) for the new structure, with a clear height equal to a ten-year event (Q 10) headwater; this waterway to be adequate for safely conveying a mean annual flood (Q 2.33) at a headwater no greater than what would be created by the existing structure during a ten-year event.

Fill placed in or adjacent to the stream shall be clean granular or rock material meeting the requirements of Subsection 703.04 or 703.05 and protected with sufficient stone to prevent erosion to a Q 10 headwater elevation (based on the new structure). Any fill placed in the stream to protect the temporary bridge and approaches shall be removed to the satisfaction of the Engineer upon completion of the project. The sizing of any temporary bridges to be left in place between January 1st and May 1st, or for any period greater than seven months shall be approved by the Engineer. Questions regarding hydraulic information not furnished shall be addressed to the Engineer.

(a) Roadway. Approach embankments shall be constructed of acceptable fill material, compacted to adequately support design loading requirements. A minimum of 380 mm (15 inches) of approved gravel or other acceptable surfacing material shall be provided for the full width of the typical section.

When the Contract Plans designate paved approaches, the approaches shall be paved with a minimum 50 mm (2 inches) wearing course of Type III or Type IV bituminous concrete pavement and the approaches and bridge shall have temporary pavement markings applied as per Section 646. Bituminous concrete pavement shall conform to the requirements of Section 406 or 490, except the mix design submittal and plant inspection requirements set forth in Section 406 or 490 will not be required. The Engineer may also waive weather limitations. The temporary pavement shall extend for the full length of the approaches and the full clearance width described below.

Turnouts with adequate space for two-way traffic shall be provided at each end of a one-way structure or coordinated with traffic signalization, if used.

(b) Bridge.

(1) Loading. Unless otherwise specified, all temporary bridge structures shall be designed for an MS-18 (HS-20) or HL-93 live load, and for all other applicable forces, in accordance with the AASHTO *Standard Specifications for Highway Bridges* or *LRFD Bridge Design Specifications*. Sidewalks and pedestrian structures shall be designed for a minimum live load of 2.9 kPa (60 pounds per square foot).

(2) Clearances. A one-way temporary bridge shall have a minimum clear width between faces of railing of 4.4 m (14 feet, 6 inches). A two-way temporary bridge shall have a minimum clear width between faces of railing of 7.3 m (24 feet). Sidewalks and pedestrian bridges shall have a minimum clear width of 1.2 m (4 feet) between faces of railing or edge of curb and face of railing. A minimum vertical clearance of 4.3 m (14 feet) shall be provided for vehicular traffic and 2.4 m (8 feet) for pedestrian traffic.

(3) Erection. As part of the Working Drawings submittal, the Contractor shall, dependent upon the type of structure being erected, include the information required under Section 506 or 510 pertaining to erection or installation. Submittal of the computations indicating magnitude of stresses in the segments is not required.

(c) Railing. Approach railing and temporary barrier rail shall conform to Subsection 621.07.

Details for either rail system or combination thereof shall conform to applicable AASHTO requirements. Rail sections shall be continuous from the approaches across the structure. Approach railing shall be provided for a minimum of 7.65 m (25 feet) off the ends of any structure and shall be provided for all approach fill slopes steeper than 1:3 (vertical:horizontal).

The free end of any steel beam rail shall be protected with a W-beam end section RE-6 (rounded) as defined in the Guide to Standardized Highway Barrier Rail Hardware, flared to a 1.25 m (4 foot) offset. The free end of any concrete barrier rail shall be flared horizontally to a 1.25 m (4 foot) offset for a minimum panel length 3 m (10 feet) and project a maximum of 150 mm (6 inches) above the adjacent roadway surface.

The top of the steel beam railing shall be 760 ± 25 mm (30 ± 1 inch) above the adjacent surface and the concrete barrier railing shall be 790 ± 25 mm (31 ± 1 inch) above the adjacent surface.

Vehicular bridge rail posts and anchorage shall be designed to withstand a horizontal loading of 8.76 kN/m (600 pounds per foot) applied 530 mm (1 foot, 9 inches) above the deck surface. Pedestrian railing and posts shall provide protection for a height of 1070 mm (42 inches) above the walkway surface and be designed to withstand a horizontal loading of 730 N/m (50 pounds per foot) applied 1070 mm (42 inches) above the walkway surface.

When a pedestrian walkway is specified or used in conjunction with vehicular traffic, a 300 by 300 mm (12 × 12 inch) curb separation shall be provided. Curbs shall be anchored to withstand a horizontal loading of 3.65 kN/m (250 pounds per foot). The outside pedestrian railing shall be a combination of vehicular and pedestrian railing. The pedestrian railing shall be constructed to limit clearance between horizontal rail components to 150 mm (6 inches).

When temporary barrier rail is specified or used as a movable rail system (e.g., adjusting traffic flow patterns), the "concrete median barrier" specified herein shall be used. An adequate connection shall be provided when concrete median barrier is used in combination with standard steel beam rail.

(d) Walkways and Approaches. Temporary bridges with walkways, temporary pedestrian bridges, walkways, and approaches to walkways shall be designed and constructed to provide width, grade, surface, etc. in conformance with the requirements set forth in the current ADA standards for sidewalks.

528.05 MAINTENANCE AND LIABILITY. The Contractor shall maintain each temporary bridge and its approaches in conformance with Contract requirements and to the satisfaction of the Engineer. The Contractor shall assume all liability for the installation, maintenance, and removal of the temporary bridge and its approaches. Unless otherwise specified, all rights-of-way on private property required for the performance of this work shall be provided by the Contractor.

Costs for replacing the loss of any part of the temporary bridge or its approaches shall be included in the unit price for the temporary bridge item except as provided in Subsection 107.18.

528.06 METHOD OF MEASUREMENT. The quantity of One-Way Temporary Bridge, Two-Way Temporary Bridge, or Temporary Pedestrian Bridge measured for payment will be on a lump sum basis for each type specified, in the complete and accepted work.

528.07 BASIS OF PAYMENT. The accepted quantity of One-Way Temporary Bridge, Two-Way Temporary Bridge, or Temporary Pedestrian Bridge will be paid for at the Contract lump sum price for each type specified. Payment will be full compensation for designing, detailing, constructing, maintaining, and removing the bridge and its approaches, including placing and removing pavement and pavement markings when paved approaches are required.

When Working Drawings have been submitted and approved in accordance with Section 105, a payment of 10 percent of the lump sum price will be allowed. When a temporary bridge, its substructures, and approaches have been fully constructed and accepted by the Engineer, a further payment of 65 percent of the lump sum price will be allowed. When the temporary bridge and its approaches have been removed, a further payment of 15 percent of the lump sum price will be allowed. The remaining 10 percent of the lump sum price will be paid when the site is cleaned up and vegetation has been established to the satisfaction of the Engineer.

Unless otherwise specified as a separate Contract item, the costs of all approach and bridge railing associated with the temporary bridge will be considered to be included in the Contract lump sum price for Temporary Bridge.

Payment will be made under:

Pay Item	Pay Unit
528.10 One-Way Temporary Bridge	Lump Sum
528.11 Two-Way Temporary Bridge	Lump Sum
528.12 Temporary Pedestrian Bridge	Lump Sum

SECTION 529 - REMOVAL OF STRUCTURES AND BRIDGE PAVEMENT

529.01 DESCRIPTION. This work shall consist of the removal, wholly or in part, and the satisfactory disposal of all structures, including accessories and appurtenances, bridge pavements, and the backfilling of holes when required.

529.02 GENERAL. Unless otherwise specified, all materials resulting from the Removal of Structures and Removal of Bridge Pavements shall become the property of the Contractor, who shall properly dispose of them.

529.03 REMOVAL OF BRIDGE PAVEMENTS. The removal of pavement on bridges shall include the removal of bituminous concrete material. If removal is by cold planing, work shall be done in accordance with Section 210. Removal methods shall be subject to the approval of the Engineer and shall be such as to prevent any damage to the remaining surface. Sealants or membranes shall remain in place as shown on the Plans or directed by the Engineer. Any necessary deck repair will be paid for as shown on the Plans, except damage caused by Contractor's negligence shall be repaired at the Contractor's expense.

529.04 REMOVAL OF STRUCTURES. The Contractor shall dismantle the structure and shall remove the dismantled members or materials. Removal of structures spanning bodies of water will be conducted so as to avoid dropping materials into the water. The entire site of the old structure shall be restored to a condition satisfactory to the Engineer.

The existing concrete or masonry shall be removed by drilling, chipping, or other methods approved by the Engineer. All cut surfaces, unless otherwise specified, shall be on a reasonably vertical or horizontal plane with sharp straight corners. Existing reinforcing steel to be retained shall be carefully preserved and cleaned for use in the new construction. Existing reinforcing steel damaged beyond reuse as determined by the Engineer shall be replaced by splicing a bar of equal diameter to the damaged bar in a manner approved by the Engineer at no additional compensation to the Contractor. Holes for expansion bolts or dowels shall be drilled in the retained concrete at the locations shown on the Plans.

When the material from the structure is to be retained by the Agency or others, or is to be reused in the construction, it shall be carefully dismantled by the Contractor and all adhering concrete removed. Materials to be retained or reused shall be stored at the location specified in the Contract or as directed by the Engineer. When the existing superstructure steel is to be retained for future use, the Contractor shall take every precaution necessary to prevent damage to the existing steel. Damage to the existing steel caused by the Contractor's operations shall be repaired by the Contractor to the satisfaction of the Engineer at no additional cost to the Agency.

Where portions of existing structures are to be removed, the portions indicated shall be removed to the lines shown on the Plans, or as directed by the Engineer, in such a manner as to leave the remainder of the structure undamaged and in proper condition for the intended use. Any damages to the portions remaining in service shall be satisfactorily repaired by the Contractor at no additional cost to the Agency. Explosives will not be permitted for partial removal of any structure.

Removed parts of the existing structure that are to be reused in the new construction shall be safeguarded, cleaned, or otherwise prepared as shown on the Plans or in the Contract and incorporated into the work as shown on the Plans or as directed by the Engineer.

529.05 METHOD OF MEASUREMENT. The quantity of Removal of Bridge Pavement to be measured for payment will be the number of square meters (square yards) of bridge deck from which bituminous pavements have been removed as shown on the Plans or ordered by the Engineer.

The quantity of Removal of Structure to be measured for payment will be as follows:

(a) Removal of Structure will be on a unit basis for each removal at the locations shown on the Plans.

(b) Partial Removal of Structure will be on a unit basis for removal of the materials between the limits shown on the Plans.

(c) Removal of Concrete or Masonry will be the number of cubic meters (cubic yards) or square meters (square yards) of concrete or masonry measured in place and removed between the limits shown on the Plans or as ordered by the Engineer.

529.06 BASIS OF PAYMENT. The accepted quantity of Removal of Bridge Pavement will be paid for at the Contract unit price per square meter (square yard). The accepted quantity of Removal of Structure and of Partial Removal of Structure will be paid for at the Contract unit price per each. The accepted quantity of Removal of Concrete or Masonry will be paid for at the Contract unit price per cubic meter (cubic yard) or square meter (square yard). Payment will be full compensation for the removal and disposal of the specified items; for removal, salvage, and stockpiling of components and materials specified in the Contract; for excavating, backfilling, regrading, and performing site restoration incidental to the removal of specified items; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Removal of Bridge Pavement, when not included as a separate pay item, will not be paid for directly, but will be considered incidental to either Removal of Structure or Partial Removal of Structure as specified in the Plans.

Payment will be made under:

Pay Item		Pay Unit
529.10	Removal of Bridge Pavement	Square Meter (Square Yard)
529.15	Removal of Structure	Each
529.20	Partial Removal of Structure	Each
529.25	Removal of Concrete or Masonry	Cubic Meter (Cubic Yard)
529.26	Removal of Concrete or Masonry	Square Meter (Square Yard)

SECTION 530

THIS SECTION RESERVED

SECTION 531 - BRIDGE BEARING DEVICES

531.01 DESCRIPTION. This work shall consist of furnishing and installing bridge bearing devices.

531.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Structural Steel	714.02
High-Strength Low-Alloy Structural Steel	714.03
High-Strength Bolts, Nuts, and Washers	714.05
Anchor Bolts, Bearing Devices	714.08
Galvanizing	726.08
Metalizing	726.09
Bearing Pads	731.02
Elastomeric Material	731.03
Stainless Steel	731.05
Brass Rings	731.07
PTFE Material	731.08

Unless otherwise specified, all materials shall conform to Section 14 of the AASHTO *LRFD Bridge Design Specifications*, Section 14 of the Vtrans *Structures Design Manual* available on the Agency's website, Section 18 of AASHTO *LRFD Bridge Construction Specifications*, and all AASHTO or ASTM specifications specified in this Section. Substitutions will not be allowed unless approved on the Fabrication Drawings.

531.03 FABRICATION DRAWINGS. The Fabricator of bearings furnished under this Section shall submit detailed Fabrication Drawings, bonding procedures, welding procedure specifications, and welder qualification test records in accordance with Sections 105. Fabrication Drawings shall identify the number of layers of vulcanized sheets and corresponding sheet thicknesses to be used for fabricating the bearing pad and shall include detailed procedures for bonding these sheets together.

531.04 FABRICATION.

(a) General. Material furnished under this Section shall conform to all applicable provisions of Subsections 506.03 through 506.16. Bearings shall be fabricated in a plant having as a minimum an AISC Major Steel Bridges (cbr) Certification or in a plant approved by the Agency prior to the award of the Contract. Plants that are not certified must satisfy the requirements of Subsection 506.03.

During any welding, surfaces in contact with the elastomer shall be restricted to 93°C (200° F), and surfaces in contact with PTFE shall be restricted to 148°C (300°F). Temperatures shall be determined by temperature indicating wax pencils or other suitable means.

All corners and edges of steel plates shall be ground to a 1.6 mm (1/16 inch) radius.

Bearing devices shall be fabricated, assembled, and certified by one supplier. Anchor bolt assemblies may be fabricated and supplied by an alternate supplier.

Alternate configurations for bearings from that shown in the Plans may be submitted for approval. Any alternate submitted shall be designed and stamped in accordance with Subsection 105.03. All designs shall meet the design loads and criteria specified in the Plans.

The Fabricator may propose minor alterations to the design of each device from that shown on the Plans to conform to the particular method of fabrication used at that Fabricator's plant. The general design intent of the Plans shall be followed with modifications approved on the Fabrication Drawings, including minor changes to the overall height of the bearing.

If proposed bearing height varies from that shown in the Contract Documents, the Contractor shall propose a method for accommodating the difference in height, which shall be shown in the submittal.

(b) Surface Protection. All bearings, except interior surfaces of pot bearings, shall be galvanized in accordance with Subsection 726.08 or metalized in accordance with Subsection 726.09,.

(c) Tolerances. After fabrication and application of surface protection, bearing devices or components shall be within the following tolerances:

(1) Plain elastomeric pads and steel reinforced elastomeric pads shall be within the tolerances specified in Table 2 of AASHTO M251.

(2) High load mulit-rotational bearings, external load plates, and guides shall be within the tolerances specified in Section 18 of the AASHTO *LRFD Bridge Construction Specifications*.

(d) Sliding Surfaces.

(1) Stainless steel used as a mating surface with PTFE shall conform to the following:

a. The thickness of the stainless steel sheet shall be at least 1.9 mm (14 gauge) when the maximum dimension of the surface is less than or equal to 305 mm (12 inches), and at least 3.0 mm (11 gauge) when the maximum dimension is larger than 305 mm (12 inches).

b. For bonded applications, stainless steel sheets may be affixed to backup plates with a combination of high-temperature resistant epoxy and mechanical attachment by spot welding or other approved procedures. The Fabricator must demonstrate that any proposed alternate procedure for attachment will maintain adhesion between the backup material and stainless steel under loading, movement, and weather conditions anticipated to be encountered during life of the bearing.

c. For welded applications, stainless steel sheets shall be circumferentially seal welded to backup plates. Procedure qualification will be required for any welding process and welding procedures shall be submitted for approval in accordance with Subsections 506.04 and 506.10.

d. Prior to adhesion or attachment of the stainless steel to a backup plate, the contact surface of the backup plate shall meet the sliding surface tolerance specified herein and shall be blast cleaned to an appearance equivalent to SSPC-SP10. The contact surface of stainless steel sheets to be bonded with epoxy shall be mechanically abraded or etched prior to application of adhesive.

(e) High Load Multi-Rotational (Pot or Disc). In addition to the requirements of Section 14 of the AASHTO *LRFD Bridge Design Specifications* and Section 18 of the AASHTO *LRFD Bridge Construction Specifications*, the following shall apply to the design and fabrication of pot bearings:

(1) General. Bearings shall be designed for the vertical and horizontal forces shown on the Plans.

Exposed PTFE material on a guide bar or other component shall be pigmented to prevent penetration of ultraviolet light

The shape characteristics, clearances, and sealing mechanism of the piston and cylinder must be designed to prevent extrusion of the elastomer under load and rotational movement.

Either PTFE sheets or other approved material shall be provided to lubricate compressive surfaces of the elastomer.

The internal floating portion of the bearing must be sealed to prevent the intrusion of foreign material.

The steel housing shall be manufactured by welding or machining from a single piece of plate. The shear restriction mechanism shall be connected to the bearing plate by mechanically fastening, welding, or other means approved by the Engineer.

High load multi-rotational bearings shall be tested in accordance with the AASHTO *LRFD Bridge Design Specifications* and Section 18 of the AASHTO *LRFD Bridge Construction Specifications*, modified as follows:

a. For each structure or pair of structures on a project, one of every ten fixed bearings and one of every ten expansion bearings shall be selected at random from the production lot. Sample or specially made test bearings will not be permitted.

b. Load measuring instruments used in conjunction with the testing equipment should be calibrated yearly and be accompanied by a certificate indicating their date of calibration.

c. Measured static coefficient of friction shall be less than 4 percent.

d. Measured dynamic coefficient of friction shall be less than 4 percent

e. Basis of acceptance:

1. Coefficients of friction are less than 4 percent.

2. Acceptable material certifications.

3. Assembled bearings meet requirements and tolerances of Contract.

4. Inspection of tested bearings show no visual defects, such as extruded or deformed elastomer, polyether urethane, or PTFE, damaged seals or limiting rings, evidence of metal-to-metal contact between the pot wall and the top plate, or cracked steel.

f. Test results and material certifications shall be sent to the Agency's Materials and Research Section with a copy of the test results sent to the Structures Engineer.

g. Acceptable test results are a prerequisite for certification acceptance. Expenses for performing any testing shall be incidental to the work.

531.05 INSTALLATION.

(a) General. Bearings shall be set level and parallel. with full and uniform bearing. Pedestals detailed to be on a slope shall be set at the elevation and position specified.

The concrete under the bearing device shall be level.

Anchor bolts shall be positioned to the alignment and dimensions specified or approved in the Fabrication Drawings. When preset or cast-in anchorages are not specified, the Contractor shall drill holes and set the anchor bolts in a Type IV mortar. Additional aggregates shall not be added to the material during field mixing.

Prior to ordering materials and starting the work, the Contractor shall submit a drilling and mortaring proposal to the Engineer for approval, including a premixed mortar material brand name.

The drilled holes to be mortared shall be thoroughly cleaned, wetted, and free of standing water.

The mortar shall be mixed in a mechanical mixer in accordance the manufacturer's recommendations and shall be readily pourable so that when poured it completely fills the remaining hole cavities. The placement of mortar for each bearing shall be continuous and complete at all hole locations.

All exposed mortar shall be cured for a period of not less than three (3) days by the wetted burlap method in accordance with Section 501. Curing shall commence as soon as practical after mortar placement. The Contractor shall not apply any forces to the anchor bolts during the curing period.

If allowed in the Contract or ordered by the Engineer, a pre-approved adhesive may be used to set the anchor bolts into the concrete. If an adhesive is used, the manufacturer's installation requirements for the adhesive shall be followed during installation. The Engineer shall be provided a copy of the Material Data Safety Sheet (MSDS) and a copy of the manufacturer's installation requirements.

Unless otherwise specified on the Plans, anchor bolts shall have a minimum embedment of 450 mm (18 inches) into the concrete and shall conform to Subsection 714.08.

Anchor bolts to be double nutted shall use the following procedure: install lower nut in contact with top of sole plate, and then back off ½ turn; install upper nut snug tight to prevent lower nuts from loosening.

Whenever a bridge seat is off by 6 mm (1/4 inch) or more from its designed or adjusted elevation, corrective measures shall be required.

If shims are required, they shall be a single thickness plate of AASHTO M 270M/M 270, Grade 250 or 345 (Grade 36 or 50) steel, galvanized in accordance with Subsection 726.08 or metalized in accordance with Subsection 726.09. Details of shims shall be furnished and approved in accordance with Subsection 105.03. The cost of any necessary corrective measures, including any costs due to a delay, shall be borne by the Contractor.

(b) Elastomeric Pad with External Load Plate and High Load Multi-Rotational Bearings. During any welding, surfaces in contact with the elastomer shall be restricted to 93°C (200°F), and surfaces in contact with PTFE shall be restricted to 148°C (300°F). Temperatures shall be determined by temperature indicating wax pencils or other suitable means. No welding current shall be permitted to pass between the pot and piston components.

The welds for the sole plate connection should only be along the longitudinal girder axis. Transverse joints should be sealed with an acceptable caulking material.

Metal bearing plates shall be placed on a 3 mm (1/8 inch) thick bearing pad conforming to Subsection 731.02. The bearing pad shall be the same size as the bearing plate with holes to accommodate the anchor bolts.

PTFE and stainless steel sliding surfaces shall be protected from splatter during welding, grouting, or painting operations if applicable.

High load multi-rotational bearings shall not be disassembled once they have left the manufacturer, since the process could result in damage to the components or malfunction of the device. Pot bearings that have been disassembled shall not be accepted unless recertified by the manufacturer.

531.06 METHOD OF MEASUREMENT. The quantity of Bearing Device Assembly of the type specified to be measured for payment will be the number of units used in the complete and accepted work. All bearing device components and anchor bolt assemblies will be included as part of the measured unit. Anchor bolt assemblies include bolts, threaded rods, nuts, washers, and beveled plates required for attachment of bearing devices to the superstructure and substructure.

The quantity of Remove and Replace Existing Anchor Bolt to be measured for payment will be the number of each anchor bolt removed and replaced in the complete and accepted work.

531.07 BASIS OF PAYMENT. The accepted quantity of Bearing Device Assembly of the type specified will be paid for at the Contract unit price for each. Payment will be full compensation for detailing, furnishing, handling, transporting, and placing the material specified, including surface preparation, protective coating, testing, anchor bolt assemblies, drilling for anchor bolts, mortar, proprietary anchoring systems, bearing device components, and welding, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment for alternate bearing designs and submittals will be considered incidental to the appropriate Section 531 pay item in the Contract.

Payment for Remove and Replace Existing Anchor Bolt will be paid for at the Contract unit price for each. Payment will be full compensation for removing the existing anchor bolt, removing and replacing the existing bearing assembly, welding, drilling for new anchor bolt, mortar, proprietary anchoring systems, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

	Pay Item	Pay Unit
531.15	Bearing Device Assembly, High Load Multi-Rotational	Each
531.16	Bearing Device Assembly, Plain Elastomeric Pad	Each
531.17	Bearing Device Assembly, Steel Reinforced Elastomeric Pad	Each
531.18	Bearing Device Assembly, Elastomeric Pad with External Load Plates	Each
531.19	Remove and Replace Existing Anchor Bolt	Each

SECTION 540 – PRECAST CONCRETE

540.01 DESCRIPTION. This work shall consist of manufacturing, transporting, and erecting precast concrete structure components. This specification also addresses the manufacture of precast concrete mechanically stabilized earth (MSE) wall panels. Hereafter, the phrase "precast concrete" will be used to include both precast concrete structure components and MSE wall panels.

540.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Portland Cement 701.02
High Early Strength Portland Cement 701.04
Blended Silica Fume Cement 701.06
Tar Emulsion 702.05
Fine Aggregate for Concrete 704.01
Coarse Aggregate for Concrete 704.02
Mortar, Type I 707.01
Mortar, Type IV 707.03
Asphalt-Treated Felt 707.08
PVC Waterstop 707.10
Bar Reinforcement 713.01
Mechanical Splices for Bar Reinforcement 713.02
Welded Steel Wire Fabric 713.05
Coated Bar Reinforcement 713.07
Structural Steel 714.01-714.05
Concrete Curing Materials 725.01
Air-Entraining Admixtures ..... 725.02(b)
Retarding Admixtures ..... 725.02(c)
Water-Reducing Admixtures ..... 725.02(f)
Water-Reducing and Retarding Admixtures ..... 725.02(g)
Water-Reducing, High Range Admixtures ..... 725.02(h)
Water-Reducing, High Range, and Retarding Admixtures ..... 725.02(i)
Accelerating Admixtures ..... 725.02(j)
Water-Reducing and Accelerating Admixtures ..... 725.02(k)
Low Shrinkage Admixtures ..... 725.02(l)
Mineral Admixtures 725.03
Silica Fume ..... 725.03(b)
Ground Granulated Blast-Furnace Slag (GGBFS) ..... 725.03(c)
Bearing Pads for Structures 731
Polystyrene Insulation Board 735.01
Blanket Insulation Material 735.02
Pipe Insulation 740.08
Water 745.01
Overhead and Vertical Concrete Repair Material 780.02

540.03 GENERAL FABRICATION REQUIREMENTS.

(a) Qualification. For all Contracts advertised for bids after December 31, 2006, precast concrete shall be manufactured in a plant that has been certified by either the Prestressed Concrete Institute (PCI) under its Plant Certification Program for precast concrete or by the National Precast Concrete Association (NPCA) Plant Certification Program.

Precast concrete shall be manufactured in a plant that maintains a quality control laboratory complete with equipment for measuring the properties of fresh and hardened concrete. As a minimum, the laboratory shall be equipped with a compression testing machine, curing room or chamber, apparati for measuring slump and air entrainment, and a complete set of aggregate sieves. The compression testing machine shall be calibrated yearly by an independent laboratory using equipment that is certified by the National Institute of Standards and Technology. The testing machine shall be power operated and capable of applying the load continuously rather than intermittently, and without shock.

(b) Quality Control. The manufacture of precast concrete shall be in accordance with the latest editions of PCI MNL-116 *Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products* and PCI MNL 135 *Tolerance Manual for Precast and Prestressed Concrete Construction*, except as modified in this Section, or with the *National Precast Concrete Association (NPCA) Quality Control Manual for Precast Plants.*

The Fabricator shall demonstrate a level of quality control testing that satisfies the Agency as to its ability and commitment to produce precast concrete to the requirements of this Section. A satisfactory program of quality control shall include gradation and moisture determinations of the aggregates, as well as slump, air content, and strength determinations of the concrete. These tests shall be performed at regular and suitable intervals and actively used to maintain the quality of the concrete within the specified requirements.

540.04 SUBMITTALS. As soon as practical after award of the Contract, all required information shall be prepared and submitted.

A complete copy of the structural design calculations for the precast concrete shall be submitted as Construction Drawings in accordance with Section 105. The design calculations shall substantiate that the proposed precast concrete satisfies the design parameters of the Contract. The design calculations shall include a load rating for superstructures for the seven standard axle configurations shown in the load rating block in the Contract Plans and any general or construction notes required for the fabrication and construction of the precast concrete. The applicable design code will be the latest edition of the AASHTO *LRFD Bridge Design Specifications* unless indicated otherwise in the Contract Documents.

Fabrication Drawings for the precast concrete shall be submitted in accordance with Section 105, with an additional copy to the Structural Concrete Engineer. In addition to the requirements for Fabrication Drawings in Section 105, the following shall be included:

(a) Dimensions of the precast concrete to be fabricated.

(b) The concrete mix design**,** including but not limited to the following:

(1) Batch weights specifying dry or saturated surface dry.

(2) Material names and sources.

(3) Aggregate properties and date tested.

(4) Chemical and physical properties of cementitious material.

(5) Admixture names and sources.

(6) Lab data that shall include, but not be limited to:

a. Slump.

b. Air Content.

c. Temperature.

d. Ratio of Water/Cementitious Material.

e. Cylinder breaks for 3, 7, and 28 days cured in the same manner as the piece to be fabricated.

f. 56 day Rapid Chloride Ion Permeability – AASHTO T 277 test data. The results shall be the average from testing 3 specimens, but the individual specimen results shall also be included. Testing shall be performed by a CCRL qualified laboratory.

g. Alkali-Silica Reactivity (ASR) – AASHTO T 303 data from testing of both the fine and coarse aggregates**.** Testing shall be performed by a CCRL qualified laboratory.

(7) Alkali-Silica Reactivity (ASR) – If potentially reactive aggregates are to be used in a mix design, then proposed mitigation method(s) and test results must be provided. The AASHTO T 303 test must be run again with the proposed mitigation method(s) and using the proposed job cementitious material proportioning. The proposed mitigation method(s) shall reduce expansion to below 0.10%.

If a mix design, including the testing results, has been submitted and approved within a 12 month period for the manufacture of precast concrete, it may be used in lieu of submitting an additional mix design. However, if any change in the material sources or properties has occurred, then a new mix design with lab test data will be required regardless of previous approval.

The requirements for testing in Subsections 540.04(b)(6)f, 540.04(b)(6)g, and 540.04(b)(7) above shall be waived if the submitted mix design has a minimum proportion of the cementitious material content of 25% ground granulated blast-furnace slag (GGBFS) and 6% silica fume or 20% fly ash and 6% silica fume.

The mix design shall be approved by the Structural Concrete Engineer prior to fabrication.

(c) The sources and properties of the materials proposed for use.

(d) The placement of reinforcing steel, welded wire fabric, mechanical bar connectors, and inserts.

(e) The type of surface finish and how the finish will be obtained. Include details of potential repair procedures.

(f) The curing method, detailing sequence and duration.

(g) The minimum required concrete strength for form removal.

(h) The design of the lifting attachments.

(i) Transportation, handling, and storage details.

(j) The installation procedure including a detailed grouting procedure.

(k) Description of Quality Control procedures.

540.05 CONCRETE.

(a) Batch plant equipment, materials, and batching procedures shall conform to the following provisions of Section 501:

501.04	BATCHING, paragraphs 1 and 3 only.
501.04 (b)	Testing Laboratory.
501.04 (c)	Bins and Scales.
501.04 (d)	Accuracy of Plant Batching.
501.04 (e)	Storage and Proportioning of Materials.
501.05	MIXING AND DELIVERY, for plants not located in the State, the Agency has the option of waiving the requirements of Subsections 501.05(a)(4) and 501.05(c), paragraphs 1 and 3 only.

(b) Concrete for precast concrete shall conform to the following:

(1) The cementitious material content in the mix design shall be between 363 and 475 kg/m³ (611 and 800 pounds per cubic yard) of concrete.

(2) The percent of air entrainment shall be 7 percent with a tolerance of +/- 2 percent, as tested in accordance with AASHTO T 152.

(3) The temperature of the concrete at the time of placement shall be between 10 and 29 ºC (50 and 85 ºF), as tested in accordance with AASHTO T 309.

(4) The maximum water-cementitious material ratio shall be 0.44. When a water-reducing, high range admixture (AASHTO M 194, Type F or Type G) has been included in the approved mix design, the concrete shall not demonstrate segregation at the proposed slump.

(5) The maximum allowed rapid chloride ion coulomb permeability result as tested per AASHTO T 277 is 2000, tested at 56 days from the date specimens were cast.

(6) The maximum allowable mortar bar expansion when tested per AASHTO T 303 (with proposed mitigation method(s), as described previously, if required) shall be 0.10%.

(c) The proposed concrete mix design, including performance history and all requests for variance from the material requirements of these Specifications, shall be submitted for approval as part of Subsection 540.04. The Structural Concrete Engineer may require a minimum of 8 weeks for testing and approval of the mix design.

(d) Any admixture containing calcium chloride shall not be used. Type II, Type III, or Blended Silica Fume portland cement may be used. Only one type of cement and only one source of that type shall be used for the precast concrete units required for any one structure.

(e) Compressive Strength.

(1) Compressive strength for precast concrete structure components at 28 days, as determined in accordance with AASHTO T 22, shall not be less than 35 MPa (5000 psi). When an acceptance test result, as defined in this Section, is below the specified strength, all concrete represented by that test shall be unacceptable for the requirements of this Section. The Engineer shall reject all precast concrete structure components that were manufactured from this concrete. Acceptance of precast concrete structure components, with respect to compressive strength, shall be determined on the basis of representative compression strength tests. The representative samples shall be taken per each piece cast, a single day's production or 75 CM (100 CY) placed, whichever is less or other sampling sequence accepted by the Structural Concrete Engineer.

Specimens shall be standard cylinders made by the Fabricator in accordance with AASHTO T 23. Fabrication of test specimens shall be witnessed by an Agency representative.

Four specimens are required to determine compliance with the 28-day strength requirement. The specimens shall be cured under the same conditions as the piece from the time of casting until the piece is removed from the form. At that time, the specimens shall be moved to storage where curing shall continue under standard conditions in accordance with AASHTO T 23. These specimens shall be retained by the Fabricator for testing.

The average of the compressive strengths of two specimens shall constitute a test result. Specimens shall be tested either at the Agency's Materials and Research Section laboratory, or at the Fabricator's plant laboratory. An Agency representative shall witness all tests.

If the average strength of specimens representing precast concrete structure components does not reach the 28-day design strength within 28 days, the precast concrete structure components shall be rejected.

(2) Acceptance of the MSE wall panels, with respect to compressive strength, shall be determined on the basis of production lots. A production lot is defined as a group of panels that shall be represented by a single set of compressive strength samples and shall consist of not more than 80 panels or a single day's production, whichever is less.

Compressive strength test specimens shall be prepared in accordance with AASHTO T23. During the production of the concrete panels, the manufacturer shall randomly sample the concrete in accordance with AASHTO T141.

A single set of compressive strength samples, consisting of a minimum of four (4) cylinders, shall be made for every production lot.

For every compressive strength sample, a minimum of two cylinders shall be cured in the same manner as the panels and tested at seven (7) days or less. The average compressive strength of these cylinders, when tested in accordance with AASHTO T22, will determine the initial strength of the concrete.

In addition, a minimum of two cylinders shall be cured in accordance with AASHTO T23 and tested at 28 days. The average compressive strength of the cylinders, when tested in accordance with AASHTO T22, will determine the compressive strength of the production lot.

If the initial strength test results indicate a compressive strength greater than or equal to 27.6 MPa (4000 psi), then this test result will be utilized as the compressive strength test result for that production lot, and the requirement for testing at 28 days will be waived for that particular production lot.

A production lot will be accepted if the compressive strength test result is greater than or equal to 27.6 MPa (4000 psi) at 28 days.

If the compressive strength test result is less than 27.6 MPa (4000 psi) at 28 days, the acceptance of the production lot will be based on its meeting each of the following acceptance criteria:

a. Ninety (90) percent of the compressive strength test results for the overall production shall exceed 28.6 MPa (4150 psi).

b. The average of any six (6) consecutive compressive strength test results, including the one in question, shall exceed 29.3 MPa (4250 psi).

c. No individual compressive strength test result shall be below 24.8 MPa (3600 psi).

In the event that a production lot fails to meet the specified compressive strength requirements, the production lot shall be rejected. Such rejection shall prevail unless the manufacturer, at the manufacturer's expense, obtains and submits evidence to the Engineer that the strength and quality of the concrete placed within the panels of the production lot is acceptable. If such evidence consists of tests made on cores taken from the panels within the production lot, then the cores shall be obtained and tested in accordance with AASHTO T24.

540.06 INSPECTION. Materials furnished and the work performed under Section 540 shall be inspected by the Agency. The inspector shall have the authority to reject any material or work that does not meet the requirements of these Specifications. Advance notification of at least two weeks must be provided by the Fabricator to the Agency's Engineer and the Structural Concrete Engineer concerning the proposed intention to commence work. A minimum of five working days notification must be provided to the Structural Concrete Engineer by the Fabricator to confirm the fabrication start date.

Prior to shipment of any precast concrete, the Materials and Research Engineer shall have approved all applicable material certifications required in accordance with Subsection 700.02.

540.07 FABRICATION.

(b) Pre-Production Meeting. Unless the Engineer deems, in writing, that a pre-production meeting is unnecessary, then a pre-production meeting shall be held a minimum of seven (7) calendar days prior to beginning concrete placement. The pre-production meeting shall be attended by, and including but not limited to, the Crew Supervisor, Plant Manager, Inspector or Inspector's Supervisor, and Project Manager and/or Designer.

(b) Forming Members. Any defects or damage due to form work, stripping, or handling may be cause for rejection. Holes or cutouts for anchoring devices, diaphragm connections, openings for connection rods, recesses for grout holes for railing bolts, and any other related details shown on the Plans shall be provided for in the members.

(c) Post Tensioning Strands and Conduits. Each post tensioning strand to be post-tensioned shall be encased in an approved conduit. Unless otherwise shown on the Plans, the ratio of cross-sectional area of the post tensioning strand to be encased to the interior cross-sectional area of the conduit shall not exceed 0.4, except when a steel bar is used as a tendon, the inside diameter of the conduit shall be at least 10 mm (3/8 inch) greater than the diameter of the bar. Conduit that has been crushed or has opened seams shall not be used.

The conduit shall be rigidly constructed, completely sealed, accurately placed, and securely fastened to maintain the desired profile during concreting. No conduit shall be located more than 6 mm (1/4 inch) from the position shown on the Plans. Bundling of conduits will not be permitted.

(d) Bar Reinforcement and Welded Wire Reinforcement. Bar reinforcement and welded wire reinforcement shall be furnished and installed in conformance with Subsections 507.03, 507.04, 507.05, 507.07, and 507.08. The chairs or spacers used to support or locate the reinforcement that bears on the faces of the forms shall be made of, or be coated with a non-corrosive material so that no discoloration will show on the faces of the precast concrete units.

(e) Placing Concrete. Concrete shall not be deposited in the forms until the Agency representative has approved placement of the reinforcement, conduits, and anchorages. The concrete shall be vibrated internally, externally, or a combination thereof to the required consolidation. The vibrating shall be done with care and in such a manner to ensure that:

(1) The concrete is uniformly consolidated.

(2) Displacement of reinforcement, inserts, conduits, and anchorages is avoided.

(3) Acceptable finish surfaces are produced.

(f) Repairs/Patching. Precast concrete structure components that contain minor defects caused by manufacture or handling may be repaired at the manufacturing site. Minor defects are defined as holes, honeycombing, or spalls, which are 150 mm (6 inches) or less in diameter, that do not penetrate deeper than 25 mm (1 inch) into the concrete. Surface voids or "bugholes" that are less than 16 mm (5/8 inch) in diameter and less than 6 mm (1/4 inch) deep need not be repaired. Repairs shall be made using a material from the Approved Products List for overhead and vertical concrete repair. The repair material shall be cured as specified by the manufacturer. Repairs shall be approved by the Engineer.

(g) Cracking. Cracks less than 0.25 mm (0.01 inch) in width shall be sealed by a method approved by the Engineer. Cracks in excess of 0.25 mm (0.01 inch) may be cause for rejection. At the Engineer's discretion, cracked precast concrete structure components shall be repaired or replaced at the Contractor's expense.

(h) Dimensional Tolerances for Precast Concrete Structure Components. All tolerances shall be in accordance with the latest editions of both PCI MNL 116 *Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products* and PCI MNL 135 *Tolerance Manual for Precast and Prestressed Concrete Construction*, or with the *National Precast Concrete Association (NPCA) Quality Control Manual for Precast Concrete*, unless otherwise noted in the Contract Documents or as approved by the Engineer.

(i) Welding. All welding shall conform to the requirements of Subsection 506.10.

(j) Cold Weather. When the concrete is cast in ambient air temperatures of 10˚C (50˚F) or less, the requirements of Subsection 501.07(b) shall apply.

(k) Marking. The date of manufacture, the production lot number and the piece mark shall be clearly marked on each individual piece of precast concrete. The mark shall be in a location that will not be visible in the finished product.

(l) Form Removal. Unless otherwise specified, form removal shall be permitted only after the strength required and approved in Subsection 540.04 (g) is attained on two successive test specimens.

(m) MSE Wall Panel Tolerances and Acceptance/Rejection. MSE wall panels shall have a minimum structural thickness of 140 mm (5 inches) and a minimum cover for steel reinforcement of 40 mm (1 1/2 inches). The concrete surface for the front face shall have a form liner finish as required on the approved Fabrication Drawings. The concrete surface on the rear face shall be an unformed flat finish. The concrete panels shall be constructed using colored concrete. The color shall be as specified in the Plans. A full size test panel shall be produced and approved by the Agency prior to production of the MSE wall panels. The panel shall be available for review a minimum of five working days prior to the start of production. The approved test panel shall be used as a benchmark for the correct color and form liner finish.

All MSE wall panels shall be manufactured within the following tolerances with respect to the dimensions shown on the approved Fabrication Drawings:

(1) Attachment Device Locations and Alignment. Lateral position of reinforcing element attachment devices shall be within 25 mm (1 inch). Embedment measured from the back face of the panel shall be 100 mm (4 inches) within +6 mm (1/4 inch) or -13 mm (1/2 inch).

(2) Panel Dimensions. All panel dimensions shall be within 6 mm. All hardware embedded in the panel with the exception of attachment devices shall be within 6 mm (1/4 inch).

(3) Panel Squareness. Squareness, as determined by the difference between the two diagonals, shall not exceed 13 mm (1/2 inch).

(4) Panel Surface Finish. Surface defects on smooth-formed surfaces, measured on a length of 1.5 m (5 feet), shall not exceed 6 mm (1/4 inch). Surface defects on textured-finished surfaces, measured on a length of 1.5 m (5 feet), shall not exceed 8 mm (5/16 inch).

MSE wall panels shall be accepted for use in wall construction provided the concrete strength meets or exceeds the minimum compressive strength requirement, the soil reinforcement connection devices and the panel dimensions are within tolerances, and any chipping, cracks, honeycombing, or other defects are repaired to the satisfaction of the Structural Concrete Engineer using methods submitted and approved under Subsection 540.04.

The MSE wall panels shall be subject to inspection by the Engineer at the time of unloading and once placed in their final position. MSE wall panels that do not meet the required specifications are subject to rejection. Individual panels may be rejected for any of the following:

(1) Variations in the exposed face that deviate from the approved model as to color and texture in accordance with precast concrete industry standards.

(2) Dimensions not conforming to 540.07 (l), Tolerances.

(3) Honeycombed or open texture not properly repaired.

(4) Defects which would affect the structural integrity of the unit.

540.08 CURING.

(a) General. All curing methods for precast concrete shall be subject to the Structural Concrete Engineer's approval.

Where the Fabricator elects to cure precast concrete structure components by method(s) other than low pressure steam or radiant heat as described below, the Fabricator shall submit with the Fabrication Drawings complete details of the proposed method(s) for approval.

The Fabricator shall provide one automatic temperature recorder for each precast concrete structure component. The recorder shall continuously record curing temperature for the entire curing period. Temperature sensors shall be carefully placed within the curing enclosure to ensure that ambient temperatures are measured at typical locations. Recorder accuracy shall be certified at least once every 12 months, and the certificate displayed with the recorder. Calibration and certification shall be performed by either the manufacturer, the supplier, or an independent laboratory. Random temperature checks of each recorder may be made by an Agency representative. Each recorder chart shall indicate the casting bed, date of casting, time of start and finish of record, and the mark number of the precast concrete structure component being cured. At the completion of the curing period, the recorder charts shall be given to the Agency representative. Temperatures recorded on the charts shall be used to determine whether the precast concrete structure components have been cured in accordance with the specifications and the approved Fabrication Drawings.

Regardless of the curing method chosen the following requirements shall apply:

(1) Except as allowed in Subsection 540.08(b), precast concrete structure components shall be cured by one of the methods specified in Subsection 501.17 until design strength has been achieved.

(2) MSE wall panels shall have an approved curing compound applied to the back face of the panel immediately following finishing.

(3) The precast concrete shall not be subjected to temperatures less than 20 ºC (36 ºF) until the design strength has been achieved.

(4) After the curing period, the temperature of the precast concrete shall be gradually lowered to that of the surrounding atmosphere. The cooling rate shall not exceed 10°C/hr (50°F/hr) and the precast concrete shall not be more than 5°C (40°F) warmer than the ambient air temperature when removed from a curing enclosure.

(b) Curing with Low-Pressure Steam or Radiant Heat.

(1) Immediately upon completing placement of the concrete for each precast concrete structure component, an enclosure shall be placed over the forms. This enclosure shall be suitable for containing the live steam or heat. The Fabricator shall make these covers available for inspection prior to casting.

(2) When low pressure steam methods are used for curing, precautions shall be taken to prevent live steam from being directed on the concrete or forms in such a way as to cause localized high temperatures.

(3) When radiant heat is used for accelerated curing, all exposed precast concrete surfaces shall be covered with plastic sheeting. Radiant heat may be applied by means of a circulation pipe containing steam, hot oil, or hot water, or by electric heating elements.

(4) The precast concrete shall be allowed to attain its initial set before commencing accelerated curing. This waiting period shall not exceed four hours from time of placement for concrete with no retarder added, or eight hours from the time of placement for concrete with retarder. During this initial curing period, while waiting for the initial set to take place, the temperature within the enclosure shall be maintained between 10 and 27ºC (50 and 80ºF).

(5) During the initial application of heat or steam, the ambient air temperature within the enclosure shall increase at a rate not exceeding 20ºC (36ºF) per hour until the maximum curing temperature is reached. The maximum curing temperature shall not exceed 82ºC (180ºF). The selected curing range shall be as approved on the Working Drawings. The maximum temperature shall be held until the concrete has reached a minimum of 80 percent of f'c, unless otherwise specified in the Contract.

540.09 HANDLING, STORAGE, AND SHIPPING. All precast concrete shall be handled, stored, and shipped in such a manner as to minimize chipping, cracks, fractures, discoloration, and excessive bending stresses. Units damaged by handling, storage, or shipping shall be replaced at the Contractor's expense.

MSE wall panels shall be stored and shipped in stacks, front face down. Firm blocking of sufficient thickness to prevent the reinforcement attachments from contacting the adjacent panels shall be used. Lifting inserts shall be installed on the top edge of the MSE wall panels to permit lifting at the project site. Reinforcement connection inserts (tie strips) shall not be used for lifting or handling the panel at the project site.

Precast concrete will not be considered for shipment until it has been accepted. This acceptance shall include verification that the pieces are free from defects and all specification requirements including the compressive strength and tolerance requirements have been achieved. In addition, precast concrete will not be considered for shipment for a minimum of 72 hours following the completion of casting.

540.10 INSTALLATION.

(a) Methods, Equipment and Erection. Cranes, lifting devices, and other equipment for precast concrete structure erection shall be of adequate design and capacity to safely erect, align, and secure all members and components in their final positions without damage. The Contractor is solely responsible for the methods and equipment employed for the erection of the precast concrete structure components.

Construction Drawings for precast concrete structure component erection shall be submitted in accordance with Section 105. The erection plan shall include the necessary computations to indicate the magnitude of stress in the units during erection and to demonstrate that all of the erection equipment has adequate capacity for the work to be performed, and provisions for all stages of construction, including temporary stoppages.

Submittal of the erection plan is for the Agency's documentation only and shall in no way be construed as approval of the proposed method of erection. The Contractor shall follow the erection plan as submitted.

(b) When included in the Contract Documents, the installation of MSE wall panels shall be as specified in the MSE wall specification.

540.11 GROUT.

(a) Grout shall be used to fill shear keys, leveling screw voids, transverse tie anchor recesses, dowel holes, and for fairing joints as detailed in the Contract or as ordered by the Engineer.

Grout shall be Mortar, Type IV. Acceptable grout materials shall be those included on the Approved Products List on file with the Agency's Materials and Research Section. Additional aggregates shall not be added to the material during field mixing.

The Contractor, with written permission from the Engineer, has the option to use ready mixed mortar for the grouting process. The Contractor shall prepare and submit for approval the mix design for the grout. The maximum quantity that can be delivered in a single load is one cubic meter (1.25 cubic yards), which must be delivered and placed within the time limits specified by the manufacturer.

For testing, 6 neat 50 mm (2 inch) cubes shall be molded and cured in accordance with AASHTO T 106 (ASTM C 109). The average compressive strength of 3 cubes shall be a minimum of 7 MPa (1000 psi) at 3 days and a minimum of 35 MPa (5000 psi) at 28 days.

(b) The surface to be grouted shall be thoroughly cleaned, wetted, and free of all standing water.

The grout shall be mixed using a mechanical mixer according to the manufacturer's recommendations and shall be readily pourable so that it completely fills the shape of the shear keys or holes, depending on the product being installed. The placement of the grout shall be continuous. The grouting of each shear key shall be completed in its entirety within a single working day.

(c) Grout shall be placed between precast concrete structure components as required for fairing out any unevenness between adjacent components. Mortar, Type IV shall be used.

The mortar shall be placed to the thickness necessary to eliminate unevenness, forming a smooth surface from the higher beam edges to the lower surface. The finished surface shall be feathered smoothly and be free of depressions or sharp edges.

(d) All exposed grout shall be cured for a period of not less than three days by the wetted burlap method in accordance with Section 501. Curing shall commence as soon as practical after grout placement.

540.12 POST-TENSIONING. Post-tensioning strands shall not be bonded to the concrete. Post-tensioning strands shall be double protected against corrosion as specified in the Contract.

Post-tensioning of strands shall not commence until a minimum compressive strength of 10 MPa (1500 psi) has been attained in the grout and the grout has cured for three days.

540.13 METHOD OF MEASUREMENT. The quantity of Precast Concrete Structure of the type and size specified to be measured for payment shall be on a lump sum basis. The lump sum shall include all of the precast concrete structure components in the complete and accepted work for each location specified in the Contract.

MSE wall panels will not be measured separately for payment, but will be considered in the measurement for the Mechanically Stabilized Earth (MSE) Wall item in the Contract.

540.14 BASIS OF PAYMENT. The accepted quantity of Precast Concrete Structure of the type and size specified will be paid for at the Contract lump sum price. Payment shall be full compensation for designing, detailing, fabricating, repairing, transporting, handling, and erecting the materials specified, for furnishing and implementing the erection plan, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any grouting work, such as fairing out unevenness between adjacent precast concrete structure components and filling leveling screw holes, shear keys, transverse anchor recesses, and dowel holes, is considered incidental to the work for Precast Concrete Structure.

Payment will be made under:

Pay Item	Pay Unit
540.10 Precast Concrete Structure	Lump Sum

SECTION 541 - STRUCTURAL CONCRETE

541.01 DESCRIPTION. This work shall consist of furnishing and placing portland cement concrete for structures and incidental construction.

The portland cement concrete shall consist of a homogeneous mixture of cement, fine aggregate, coarse aggregate, water, admixtures, and pozzolan (when used), proportioned and mixed according to these Specifications.

541.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Portland Cement 701.02
High Early Strength Portland Cement 701.04
Portland-Pozzolan Cement 701.05
Portland Blast-Furnace Slag Cement 701.07
Tar Emulsion 702.05
Fine Aggregate for Concrete 704.01
Coarse Aggregate for Concrete 704.02
Lightweight Coarse Aggregate for Structural Concrete 704.14
Mortar, Type I 707.01
Mortar, Type IV 707.03
Asphalt-Treated Felt 707.08
PVC Waterstop 707.10
Concrete Curing Materials 725.01
Air-Entraining Admixtures ..... 725.02(b)
Retarding Admixtures ..... 725.02(c)
Water-Reducing Admixtures ..... 725.02(f)
Water-Reducing and Retarding Admixtures ..... 725.02(g)
Water-Reducing, High Range Admixtures ..... 725.02(h)
Water-Reducing, High Range, and Retarding Admixtures ..... 725.02(i)
Accelerating Admixtures ..... 725.02(j)
Water-Reducing and Accelerating Admixtures ..... 725.02(k)
Low Shrinkage Admixtures ..... 725.02(l)
Mineral Admixtures 725.03
Ground Granulated Blast-Furnace Slag ..... 725.03(c)
Polystyrene Insulation Board 735.01
Blanket Insulation Material 735.02
Pipe Insulation 740.08
Water 745.01

Precast concrete stay-in-place forms (prestressed deck panels) shall conform to the requirements of Section 510.

541.03 CLASSIFICATION AND PROPORTIONING. The following classes of concrete are included in these Specifications and shall be used as shown on the Plans:

TABLE 541.03A (Metric)

Class	Minimum Cement (kg/m^3)	Max Water-Cement Ratio	Range in Slump (mm)	Air Cont. (%)	Coarse Aggregate Gradation Table	28-Day** Comp. Strength (MPa)	28-Day** Modulus of Rupture (MPa)
AA	418	0.40	25 to 65	7.0 ± 1	704.02A	30	4.48
A*	392	0.44	50 to 100*	6.0 ± 1	704.02B	30	4.48
B	363	0.49	50 to 100	5.0 ± 1	704.02B, C	25	4.14
C	335	0.49	50 to 100	4.5 ± 1	704.02B, C	20	3.79
D	279	0.58	50 to 100	4.5 ± 1	704.02B, C	20	3.10
LW	392	0.44	25 to 75	6.0 ± 1	704.02B	30	---

* When this class of concrete is used for bridge decks, the range in slump shall be 25 to 75 mm.

** The listed 28-day compressive strength or modulus of rupture will serve as the basis of designing or approving the concrete mix.

TABLE 541.03A (English)

Class	Minimum Cement (lbs./cy)	Max Water-Cement Ratio	Range in Slump (in.)	Air Content (%)	Coarse Aggregate Gradation Table	28-Day** Comp. Strength (psi)	28-Day** Modulus of Rupture (psi)
AA	705	0.40	1 to 2 1/2	7.0 ± 1	704.02A	4000	650
A*	660	0.44	2 to 4*	6.0 ± 1	704.02B	4000	650
B	611	0.49	2 to 4	5.0 ± 1	704.02B, C	3500	600
C	564	0.49	2 to 4	4.5 ± 1	704.02B, C	3000	550
D	470	0.58	2 to 4	4.5 ± 1	704.02B, C	2500	450
LW	660	0.44	1 to 3	6.0 ± 1	704.02B	4000	---

* When this class of concrete is used for bridge decks, the range in slump shall be 1 to 3 inches.

** The listed 28-day compressive strength or modulus of rupture will serve as the basis of designing or approving the concrete mix.

The maximum unit density of Class LW concrete shall be:

(a) Plastic: 1922 kg/m^3 (120 pounds per cubic foot).

(b) Dry: 1842 kg/m^3 (115 pounds per cubic foot).

Unless otherwise specified in the Contract, Class B concrete shall be used.

A water-reducing, retarding, or water-reducing-retarding admixture shall be used for all Class AA, Class A, Class B, and Class LW concrete, unless otherwise authorized in writing by the Engineer. These admixtures may be used in Class C and Class D concretes when required or approved by the Engineer. The use of an accelerating or water-reducing-accelerating admixture to alter the setting characteristics of concrete mixtures shall be employed only with the approval of the Engineer. The use of chlorides or admixtures containing chlorides is prohibited. All admixtures will be considered incidental to the work and included in the Contract unit price of the concrete.

The Contractor, following mix design criteria and procedures outlined by the Agency, shall submit the mix design, required data, and test results to the Structural Concrete Engineer for review and acceptance. For initial submittals a minimum of two weeks shall be allowed for evaluation of the submitted mix design, test results and required data. No production of concrete for the project shall commence until the Structural Concrete Engineer has reviewed and accepted the concrete mix design.

The concrete materials shall be proportioned using the absolute volumes method in accordance with the requirements for each class as specified in Table 541.03A. The volumetric proportioning method such as that outlined in ACI Standard 211.1, *Recommended Practice for Selecting Proportions for Normal Weight Concrete*, or other approved volumetric proportioning methods shall be employed in the mix design.

Production activities shall operate so that no intentional deviations are made from the reviewed and accepted mix design. If test results indicate a failure to obtain the 28-day compressive strength as specified in Table 541.03A as tested in accordance with AASHTO T 22 or AASHTO T 97, changes to the mix design shall be made with no extra payment. Changes may include, but are not limited to, using additional cement, changing the source of cement or aggregates, using a water reducer or other additives, or, if necessary obtaining concrete from another supplier.

After the materials to be furnished by the Contractor have been approved, no proposed change in the source, proportions, or characteristics of the materials shall be made without the review and acceptance of the Engineer. No new materials shall be used until such materials and their proportions have been reviewed and accepted by the Engineer. In no case shall concrete from more than one batch plant be permitted on the same structure without prior written approval of the Engineer.

The Engineer may order concrete production and delivery suspended and a new mix or altered mix design submitted if components or final product material characteristics are determined to be out of tolerances, unsatisfactory, or if proposed changes in the source, proportions, or characteristics of the materials are proposed. No production of concrete for the project shall resume until the Engineer has reviewed and accepted the new or altered mix design. For evaluation, new mix design submittals shall be considered as initial mix design submittals.

The various classes of concrete shall have an air content by volume as specified. The entrained air may be obtained by the use of an approved admixture.

The Contractor may substitute fly ash for portland cement. The substitution rate shall be 20 percent of the required portland cement for concrete. The fly ash shall be substituted at a ratio of 1 kg (1 pound) of fly ash for 1 kg (1 pound) of portland cement.

The use of fly ash in high early strength concrete will not be permitted. When any mineral admixture is incorporated into a standard class of concrete, necessary adjustments to the mix design shall be made by the Contractor and reviewed and accepted by the Engineer. Proportioning of the concrete mixtures containing mineral admixture shall be by the absolute volumes method in accordance with the requirements for each class as specified in Table 541.03A except that the listed water-cement ratio shall be based on total cementitious material (portland cement and fly ash).

The Contractor, at its option, may substitute ground granulated blast-furnace slag (GGBFS), Grade 100 or 120 for portland cement. The substitution rate shall be 25.0 percent of the required portland cement for concrete. The GGBFS shall be substituted at a ratio of one unit of GGBFS for one unit of portland cement. Fly ash and GGBFS will not be permitted in the same concrete mixture.

The proportioning of the concrete mixture shall be by the absolute volumes method and in accordance with the requirements for each class of concrete as specified in Table 541.03A, except that the listed water-cement ratio shall be based on the total cementitious material (portland cement plus GGBFS).

Strict adherence to the requirements of Subsection 541.07 is required when using concrete with mineral admixtures. The setting time may be retarded in cool weather. The Resident Engineer, after consultation with the Agency's Structural Concrete Engineer, may require that the curing period, as designated in Table 541.17A, be extended.

541.04 BATCHING. Measuring and batching of materials shall be done at an approved batch plant. The batch plant shall meet the requirements of AASHTO M 157, except as modified and shall be maintained in good repair at all times and shall be subject to a periodic inspection by an authorized representative of the Agency.

All new or relocated concrete batch plants offered for Agency approval shall be equipped for semi-automatic batching and proportioning of all cementitious material, aggregates, water, and fly ash (when used) and for automatic insertion of admixtures. The plants shall be equipped to automatically and accurately record the quantity of all aggregates, cementitious material, and the water incorporated into each batch and shall identify and record the addition of the required admixtures.

Proper facilities shall be provided for the Engineer to inspect ingredients and processes used in the batching and delivery of the concrete. The Contractor shall, without charge, afford the Engineer all reasonable facilities for securing samples to determine whether the concrete is being furnished in accordance with these Specifications.

The Contractor shall give the Engineer 24-hour notice of intent to place concrete so that arrangements can be made for laboratory inspection and control.

(a) Semiautomatic Batch Plants. When actuated by a starting mechanism, the semiautomatic batch controller shall start the mass measuring (weighing) operation of the materials and stop the flow automatically when the designated mass (weight) has been reached. It shall be interlocked to ensure that the discharge mechanism cannot be opened until the mass (weight) is within the tolerance specified in Subsection 541.04(d).

Water and admixtures may be batched in a weigh batcher or by volume in a volumetric device. When actuated, volumetric controls shall start the measuring operation and stop the flow automatically when the designated volume has been reached.

(b) Testing Laboratory. The Contractor shall provide at the plant site a weatherproof building or room for the use of Agency personnel as a testing laboratory. The laboratory shall have a minimum gross internal area of 14 m^2 (150 square feet) with a layout providing a minimum internal width of 2.1 m (7 feet), in which to house and use the equipment specified. Should the Contractor elect to provide additional equipment relevant to testing of portland cement concrete and materials, the gross inside floor area of the laboratory shall be increased in proportion to the area required to house and operate the additional equipment. If the additional equipment is to be operated on a bench, the length of bench sections shall also be proportionally increased. An adequate method of ventilation, lighting, heating, and necessary electrical or gas connections shall be provided. Sanitary toilet facilities with lavatory shall be available for use by Agency personnel at the plant site. A private telephone service shall be provided in the laboratory.

The laboratory shall be equipped with the following:

1 Standard office desk, with lockable drawers or a separate lockable two-drawer file cabinet.
1 Side chair.
1 Bench section(s) at least 600 mm (2 feet) wide providing a minimum of 2.6 m^2 (28 square feet) of working area with undercounter shelving.
1 Standard laboratory stool.
1 Fully automatic electronic calculator with eight digit capacity.
1 Standard laboratory sink and faucet provided with an adequate supply of water meeting the requirements of Subsection 745.01. The sink shall drain to the outside of the laboratory.
1 Bench brush.
1 Floor brush.
1 Motorized 203 mm (8 inch) sieve shaker (with adjustable timer) with sieving operation conducted by means of lateral and vertical motion of the sieve accompanied by jarring action with the following 203 mm (8 inch) diameter sieves: 9.5 mm (3/8 inch), 4.75

mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 600 μm (No. 32), 300 μm (No. 50), 150 μm (No. 100), plus pan and cover.

1 Mechanical aggregate shaker (with adjustable timer) with a 0.0283 m^3 (1 cubic foot) capacity with the following screens: 45 mm (1 3/4 inch), 37.5 mm (1 1/2 inch), 25 mm (1 inch), 19 mm (3/4 inch), 12.5 mm (1/2 inch), 9.5 mm (3/8 inch), 6.3 mm (1/4 inch), 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), and pan. The aggregate shaker may be placed in a separate enclosed area or be shielded for dust and sound. When the aggregate shaker is placed in a separate enclosed area, there shall be a minimum of 1.5 meters (5 feet) of clear space measured from the front frame of the shaker outward. The enclosed area shall be well lighted and ventilated. Also, the shaker shall have an adjacent bench section approximately 900 mm (36 inches) high, 600 mm (24 inches) deep and 1250 mm (50 inches) long.

1 Electronic balance with a minimum capacity of 22 kg (50 pounds) accurate to 0.1 g (0.0002 pound).

1 Double burner hot plate, variable temperature.

5 Metal pans, nominal size, 230 by 230 by 50 mm (9 × 9 × 2 inches).

1 Sample splitter, 63.5 mm (2 1/2 inch) chute.

1 250 mm (10 inch) blunted trowel.

1 1.25 by 1.25 m (4 × 4 feet) minimum heavy canvas for quartering samples.

1 Brass wire bristle brush.

1 Pair, heat resistant gloves.

2 38 mm (1 1/2 inch) soft bristle paint brushes.

3 355 mL (12 ounce) clear graduated glass bottles.

1 Reference color comparison chart with five organic plate number colors. Reagent sodium hydroxide solution (3 percent) in sufficient quantity for the duration of the project.

Acceptable substitutes for the aforementioned equipment may be provided when approved by the Materials and Research Engineer.

Batching operations shall not begin until the testing laboratory has been approved as being in compliance with these Specifications and all requirements of the current VAOT Quality Assurance Program document. Removal of any equipment, except at the direction of the Engineer, will revoke any prior approval and require the termination of batching operations.

The building or room designated as a testing laboratory shall be maintained in a clean condition by the user and kept free of all articles not necessary for the testing of materials. Cleaning supplies shall be furnished by the Contractor.

(c) Bins and Scales. The batch plant shall include bins, weighing hoppers, and scales with adequate separate compartments for fine aggregate and for each required separate size of coarse aggregate. If cement is used in bulk, a bin, hopper, and scale for cement shall be included. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided so that when required, the material may be added slowly in minute quantities and shut off with precision. Means of removing the overload of any one of the several materials shall be provided. Hoppers shall be constructed so as to eliminate accumulations of tare materials and to discharge fully without jarring the scales. Partitions between compartments shall be ample to prevent spilling under any working condition. All batch plant structures shall be properly leveled and maintained in that condition within the tolerance required by the design of the mass measuring (weighing) mechanism.

The scales for determining the mass (weight) of aggregate and cementitious material shall be comprised of a suitable system of levers or load cells. The levers or load cells will determine the mass (weight) consistently within 0.5 percent under operating conditions, with loads indicated either by means of a beam with balance indicator, a full-reading dial, or a digital read-out or display.

Adequate means for checking the accuracy of the scales shall be provided by the Contractor either by the use of 22.68 kg masses (50 pound weights) or by other methods approved by the Engineer. All exposed fulcrums, clevises, and similar working parts of scales shall be kept clean. When beam-type scales are used, provision shall be made for indicating to the operator that the required load in the weighing hopper is being approached. Poises shall be designed to be locked in any position to prevent unauthorized change of position. All mass measuring (weighing) and indicating devices shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls.

The scales shall be serviced and their accuracy verified annually by a hopper scale service person licensed by the Division of Weights and Measures of the Vermont Department of Agriculture. For Vermont plants, an inspector representing the Division of Weights and Measures shall witness all testing conducted by the service person and will attach a seal to each hopper scale, provided it meets the current specifications, tolerances, and regulations adopted by the Division of Weights and Measures. Standard test masses (weights) used to determine the accuracy of hopper scales shall be certified yearly by the Division of Weights and Measures in accordance with their established standards.

The ready-mixed concrete producer shall hire a licensed hopper scale service person for annual checking and service of scales. In addition, Vermont producers shall schedule an inspection with the Division of Weights and Measures between February 15th and April 30th of each year. After April 30th, Vermont plants without current seals affixed to the hopper scales will not be permitted to supply concrete to Agency projects, unless otherwise directed by the Engineer or until the seals are affixed.

Out of state concrete producers shall observe all annual hopper scale mass measurement (weighing) and seal requirements of their respective states of location.

(d) Accuracy of Plant Batching. For weighed ingredients, accuracy of batching is determined by comparison between the desired mass (weight) and the actual scale reading; for volumetric measurement of water and admixtures, accuracy is determined by checking the quantity either by mass (weight) on a scale or by volume in a calibrated container.

Chemical admixture containers or scales shall be calibrated annually by a qualified admixture distributor representative.

Batching shall be conducted to accurately measure the desired quantities within the following tolerances:

Cement:	± 1 percent	Aggregates:	± 2 percent
Water:	± 1 percent	Chemical Admixtures:	± 3 percent
Mineral Admix.:	± 1 percent		

(e) Storage and Proportioning of Materials.

(1) Portland Cement. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed.

All bulk cement shall be weighed on an approved mass measuring (weighing) device. The bulk cement-weighing hopper shall be properly sealed and vented to preclude dusting during operation. Facilities shall be provided for the sampling of cement at the batch plant, either from the storage silo or from the weighing hopper. This device shall be a permanent installation located so as to allow safe and easy access. It shall provide a sample that represents the true nature of the material being used.

(2) Water. Water may be measured either by volume or by mass (weight). When measurement is by meter, the water meter shall be so located that the measurements will not be affected by variable pressure and temperature in the water supply line.

Measuring tanks shall be equipped with an outside tap and valve to provide for checking the setting, unless other means are provided for readily and accurately determining the amount of water in the tanks.

(3) Aggregates. In stockpiling aggregates, the location and preparation of the sites shall be subject to the approval of the Engineer. Stockpiles shall be formed on hard well-drained areas that prevent contamination from underlying material and accumulation of excessive moisture.

Aggregates from different sources or of different gradations shall not be stockpiled together. Only rubber-tired equipment shall be permitted to operate on aggregate stockpiles.

Stockpiles shall be constructed as follows:

a. If the stockpile is to be made using mechanical equipment (front end loader, clam bucket, rock ladder, radial stacker, or other approved equipment), the stockpile shall be made in such a manner that segregation is kept to a minimum.

b. If the stockpile is to be made by dumping from trucks in multiple layers, each layer shall be approximately 1.2 m (4 feet) in depth. Each layer shall be completely in place before commencing the next layer. Care shall be taken that successive layers do not “cone” down over the previous layer.

c. No equipment shall be used to haul aggregate over the stockpiled material except to deposit the material for the layer being placed. It shall be the responsibility of the Contractor that the aggregate be kept free from deleterious material or degradation.

Stockpiles shall be maintained in such a manner that twice the anticipated aggregate requirement for any Agency project placements will be on hand and available for sampling and testing at least 48 hours before mixing operations for the placements are scheduled to begin. The Engineer may modify this requirement when special aggregates are required, such as when lightweight concrete is being produced.

Aggregates shall be handled from stockpiles or other sources to the batch plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. All aggregates produced or handled by hydraulic methods and washed aggregates shall be stockpiled or binned for draining at least 12 hours before being batched. In case the aggregates contain high or non-uniform moisture content, storage or stockpile period in excess of 12 hours may be required by the Engineer.

d. Lightweight aggregate stockpiles shall be presoaked for a minimum period of 48 hours immediately prior to use. Soaking shall be accomplished by continuous sprinkling or other suitable means that will provide a uniform moisture content throughout the stockpile.

(4) Admixtures. The Contractor shall follow an approved procedure for adding the necessary amount(s) of admixture(s) to each batch. Admixture(s) shall be dispensed in such a manner that will ensure uniform distribution of the material throughout the batch within the required mixing period. All admixtures shall be added to the batch at the plant, unless otherwise authorized by the Engineer.

All dispensers shall include visual inspection aids such as graduated transparent cylinders. A separate dispenser shall be provided for each liquid admixture. Storage and dispensing systems for liquid admixtures shall be equipped so as to allow thorough circulation and/or agitation of all liquid in the system. This shall be required prior to the first batching of concrete for Agency projects in any calendar year and periodically thereafter at intervals not to exceed 60 calendar days for the duration of the period the plant is supplying concrete for Agency projects. If the circulation method is used, the admixture shall be circulated until a complete exchange of admixture is achieved. If an agitation method is used, the method shall be subject to approval by the Engineer.

Storage and dispensing systems for liquid admixtures shall be sufficiently protected to prevent freezing of admixtures at all times.

It shall be the responsibility of the Contractor to use the quantity of Agency approved admixtures needed to obtain concrete meeting the requirements of the Contract. All additions of admixtures will be approved by the Engineer prior to incorporation into the mix.

The use of calcium chloride as an admixture or an admixture ingredient will not be permitted.

a. Air-Entraining Admixture. Air-entraining admixture shall be used as required to obtain the specified air content.

b. Water-Reducing, Retarding, and Water-Reducing and Retarding Admixtures. Dosages shall be those recommended by the Manufacturer, unless otherwise approved by the Engineer.

(5) Fly Ash or GBBFS. Fly ash or GBBFS shall be stored at the batch plant in a separate storage or holding bin and shall be protected from rain and moisture.

541.05 MIXING AND DELIVERY.

(a) General. Concrete may be mixed at the site of construction, at a central point, or wholly or in part in transit mixers. The production of concrete shall meet the requirements of AASHTO M 157 with the following additional requirements:

(1) All concrete shall reach its final position in the forms within 1.5 hours after the cement has been added to the aggregates. When retarded concrete or concrete with a water reducer is being used, time in excess of the 1.5-hour limit may be allowed. The Engineer will determine this additional time. When the ambient air temperature is 16 °C (60 °F) or above, the elapsed time may be reduced as necessary as directed by the Engineer or in accordance with Subsection 541.07(a).

(2) The Engineer may authorize the addition of cement and water at or near the site, or the use of admixtures at the Contractor's expense.

(3) The addition of water in excess of the design water-cementitious material ratio for purposes of meeting the slump limits will not be permitted. Concrete that is not within the specified slump limits at time of placement shall not be used.

(4) Each load of concrete delivered at the job site shall be accompanied by a State of Vermont Batch Slip signed by the authorized Agency representative, if present, at the plant. Batch Slips shall contain such information as is deemed necessary by the Engineer.

(5) The Contractor shall provide direct communication service from the site of the work to the batch plant that shall be available to the Engineer at all times during concrete operations. The cost of this service will be considered incidental to the work.

(6) When use of a Water-Reducing, High Range or Water-Reducing, High Range, and Retarding Admixture is specified for deck concrete, the contractor shall submit, for the Engineer's approval, the following information: Admixture manufacturer, admixture addition rate, and when the admixture is to be added to the mixture (i.e., at the plant, on project, or a combination thereof). In order to obtain the required slump, a representative from the concrete producer is required on the project to determine the final admixture dosage for each load of concrete. This representative shall be responsible for adding the Water-Reducing, High Range or Water-Reducing, High Range, and Retarding Admixture to the mixer. The dosage shall be applied by means of a dispenser, or by other means as approved by the Engineer.

(7) Not including initial mixing revolutions, all concrete shall be discharged into the forms before 300 revolutions of the drum or blades. The total revolutions may be increased as directed by the Engineer.

Mortar shall be mixed in an approved mixer at the site of placement or in transit mixers when approved by the Engineer. The Engineer will withdraw approval for use of transit mixers, if necessary, to ensure a quality product or if the rate of delivery cannot be coordinated with finishing requirements.

(b) Stationary Mixers. When a stationary mixer is used for the complete mixing of the concrete, the mixing time for mixers having a capacity of 7.5 m^3 (10 cubic yards) or less shall be not less than 60 seconds. For mixers of more than 7.5 m^3 (10 cubic yards) capacity, the mixing time shall be determined by the Engineer. The time is valid provided mixer efficiency tests prove the concrete is satisfactory for uniformity and strength. The plant shall be equipped with a timing device that will not permit the batch to be discharged before the predetermined mixing time has elapsed. Vehicles used in hauling shall comply with the requirements of Subsection 541.05(c).

(c) Transit Mixers. Transit mixers and agitators shall be subject to a periodic inspection by an authorized representative of the Agency. Such equipment shall bear a currently dated inspection "sticker" supplied by the Agency indicating that the transit mixer or agitator conforms to the Agency's requirements.

Transit mixers shall be equipped with a water-measuring tank with a visible sight gauge for use when the water for the batch is supplied from the transit mixer tank. The gauge shall be clean and legibly graduated. Measuring tanks shall be provided with outside drain valves or other means to check their calibration.

No transit mixer or agitator shall be charged with the ingredients of the concrete unless an authorized Agency representative is present and authorizes it. This requirement may be waived by the Engineer if a batch slip accompanies the delivery vehicle to the site.

Electrically actuated revolution counters shall be required on all transit mixers except on mixers charged at central mix plants and utilized as agitator trucks only.

Transit mixer maximum load size shall be limited to the manufacturer's rated mixing capacity; however legal vehicle load restrictions shall not be exceeded. The mixer shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

Agitators, when loaded, shall also not exceed the manufacturer's rated mixing capacity or legal load restrictions and shall be capable of maintaining the mixed concrete in a thoroughly mixed and uniform mass and of discharging the concrete with a satisfactory degree of uniformity.

The Engineer may make tests for consistency (slump) of individual samples at approximately the beginning, the midpoint and end of the load. If the range of results exceeds 50 mm (2 inches), the mixer or agitator shall not be continued in use unless the condition is corrected.

All mechanical details of the mixer or agitator such as water measuring and discharge apparatus, condition of the blades, speed of rotation of the drum, general mechanical condition of the unit and clearance of the drum shall be checked before a further attempt to use the unit will be permitted.

Mixers and agitators shall be kept free from accumulation of hardened concrete or mortar. The mixing blades shall be rebuilt or replaced when any part or section is worn 19 mm (3/4 inch) or more below the original height of the manufacturer's design. A copy of the manufacturer's design, showing the dimensions and arrangements of blades shall be available to the Engineer at the plant at all times.

When a transit mixer is used for complete mixing, each batch of concrete shall be mixed for at least 70 or more than 100 revolutions of the drum at the rate of rotation designated as mixing speed by the mixer manufacturer. Additional mixing, if any, shall be at the speed designated by the manufacturer as agitating speed. The mixing and agitating speeds shall be found on the metal plate on the mixer.

When a transit mixer or agitator is used for transporting concrete, mixing during transport shall be continuous and at the speed designated by the manufacturer of the equipment as agitating speed. Failure to do so is cause for rejection of the concrete.

Transit mixers and agitators assigned to a project shall not be used for other purposes until the desired work is completed at the site, and shall arrive at the project within the cycle that anticipated placement conditions dictate. The interval between loads shall be controlled in order that concrete in place shall not become partially hardened prior to placing succeeding batches. The plant capacity and transportation facilities shall be sufficient to ensure continuous delivery at the rate required.

Before discharging a transit mixer that has been operating at agitating speed, the drum or blades shall be rotated approximately one minute at mixing speed. The same procedure shall apply to agitators if admixtures, water, or other ingredients are added to the mix in the field.

If additional mixing water is required to maintain the specified slump and is added with the permission of the Engineer, a minimum of 20 revolutions of the transit mixer drum at mixing speed shall be required before discharge of any concrete. At no time shall the total water introduced into any mix exceed the maximum water cement ratio shown in Table 541.03A.

Upon discharge of the concrete from the drum, a sufficient amount of water shall be charged into the drum to properly cleanse the drum. This water shall not be used as a part of the next succeeding batch but shall be discharged from the drum prior to the charging of the drum with the concrete ingredients. The drum shall be completely emptied before receiving materials for the succeeding batch. Retempering of concrete or mortar that has partially hardened, by remixing with or without additional materials, shall not be permitted.

541.06 FIELD TESTS. The Contractor shall provide assistance, equipment, materials, and curing for field sampling and testing as required by the Engineer. All costs shall be included in the Contract unit prices under Section 631. The Engineer shall perform all sampling and testing.

(a) Sampling. Sampling for tests shall be taken in accordance with AASHTO T 141 or other procedures approved by the Agency.

(b) Slump Tests. Slump tests shall be made in accordance with AASHTO T 119.

(c) Air Content Tests. Air content tests shall be made in accordance with the pressure method in AASHTO T 152, for acceptance or rejection. The Chace meter may be used in conjunction with the pressure method of AASHTO T 152 for monitoring other air content tests. A volumetric air meter shall be used for determining the air content of Class LW concrete in accordance with AASHTO T 196.

(d) Strength Tests.

(1) General. Strength tests shall be by test cylinder, except that when specified in the Contract or when authorized in writing by the Engineer, test beams may be used.

A test shall be the average of the strengths of at least two specimens from the same sample of concrete.

The number of strength tests shall be as follows:

a. A minimum of one test shall be required for each project.

b. One test shall be required for each placement of 75 m^3 (100 cubic yards) or fraction thereof except that a test will not be required on placements of less than 7.5 m^3 (10 cubic yards).

c. The Engineer may order additional tests as deemed necessary.

Test Cylinders. Test cylinders shall be made in accordance with AASHTO T 23, and tested for compressive strength in accordance with AASHTO T 22.

Test Beams. Test beams of dimensions 152 by 152 by 508 mm (6 × 6 × 20 inches) shall be made in accordance with AASHTO T 23, and tested for flexural strength in accordance with AASHTO T 97. Beam molds for constructing test beams shall be reusable steel molds conforming to the requirements of AASHTO T 23.

(2) Categories of Testing.

a. Quality acceptance testing utilizes specimens to determine the compliance with strength requirements for the project. All test cylinders used for quality acceptance testing shall be stored in an approved curing box until they are shipped to the central laboratory.

When the Engineer gives written permission to use test beams for quality acceptance testing, the beams will be cured in accordance with a method approved by the Engineer.

Quality acceptance testing shall be performed at 28 days except as follows:

1. When 90 percent of the 28-day design compressive strength requirement is obtained at 14 days, the 28-day testing may be omitted when approved by the Engineer.

2. When high early strength concrete is used, specimens will be tested at seven days at which time 100 percent of 28-day design strength must be obtained.

b. Job control testing utilizes specimens to determine whether adequate curing procedures are being followed and for early form removal or early loading of structure. All job control specimens shall be stored on the structure and shall receive the same curing and protection from the elements as the concrete that they represent up until 24 hours before anticipated testing of specimens.

c. Specimen curing requirements shall be as follows or as directed by the Engineer:

Number of Specimens	Category	Location of Curing
2	Quality Acceptance - 28 days	Curing Box
2	Quality Acceptance - 14 days	Curing Box
4	Quality Acceptance - 7 days (Type III only)	Curing Box
2	Job Control - Applicable Curing Period	On Structure

541.07 WEATHER AND TEMPERATURE LIMITATIONS - PROTECTION OF CONCRETE. The temperature of the concrete just prior to placement in the forms shall not be less than 10 ºC (50 ºF) nor more than 29 ºC (85 ºF), except that Concrete, Class AA mix shall not exceed 27 ºC (80 ºF) just prior to placement. Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits.

Placement and curing procedures shall be approved by the Engineer prior to actual placement.

(a) Hot Weather Concrete. Placement of concrete during hot weather may be limited by the Engineer based on an assessment of temperature, humidity, wind velocity, and sun radiation conditions.

No concrete shall be placed when the ambient air temperature is, or is expected to be, above 32 ºC (90 ºF). However, no Concrete, Class AA mix shall be placed when the ambient air temperature is, or is expected to be, above 29 ºC (85 ºF) during the placement, except by written permission of the Engineer.

(b) Cold Weather Concrete.

(1) General. When it is necessary to place concrete or mortar at or below an ambient air temperature of 5 °C (40 °F), or whenever in the opinion of the Engineer, ambient air temperatures may fall below this limit within the curing period, the mixing water, aggregates, or both, shall be heated and the work protected by adequate housing, covering and heating, or insulated forms.

When using concrete with mineral admixtures, strength gain may be retarded in cool weather. When the ambient air temperature is 10 ºC (50 ºF) or less, the Resident Engineer, after consultation with the Agency's Structural Concrete Engineer, may require special preparation and protection of the concrete and its components and that the curing period, as indicated in Subsection 541.17, be extended.

The Contractor shall have on the job, ready to install prior to starting any placing operation adequate equipment meeting the approval of the Engineer for heating and protecting the materials and freshly placed concrete.

No concrete shall be placed when the temperature of the surrounding atmosphere is lower than -12 °C (10 °F) except by written permission of the Engineer.

No concrete shall be placed in any superstructure or thin section under cold weather conditions (ambient air temperature 5ºC (40ºF) or less) without written permission of the Engineer.

(2) Heating of Materials. The heating equipment shall be capable of heating the materials uniformly. Aggregates shall not be heated over 66 °C (150 °F). If water is heated in excess of 66 °C (150 °F), the water shall be mixed with the aggregate before the cementitious material is added. The materials shall be heated in such a manner, for such a period of time, and in such quantity as to produce concrete having a uniform temperature within the specified temperature range at the time of placing. Materials containing frost or frozen lumps shall not be used. Stockpiled aggregates may be heated by the use of dry heat or steam. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. When aggregates are heated in bins, steam-coil or water-coil heating, or other methods that will not be detrimental to the aggregates, may be used.

(3) Antifreeze Compounds. Salts, chemicals, or other foreign materials shall not be used in the mix to lower the freezing point of the concrete.

(4) Preparation of Forms. Before placing concrete; ice, snow, and frost shall be completely removed from the forms.

Concrete shall not be placed on a surface or in forms that are frozen, have surface temperatures below 0 ºC (32 ºF), or that contain~~s~~ frozen materials. The frozen surface or forms shall be completely thawed the day previous to the placing of the concrete and shall be kept continuously thawed until the concrete is poured.

(5) Housing. The Contractor shall furnish sufficient canvas and framework or other suitable type of housing to enclose and protect the structure. The sidewalls of the housing for protecting abutments and piers shall be completely built before the placing of any concrete. They shall be constructed independent of the forms and bracing and with space large enough to provide for form removal and initial finishing of concrete as required during the heating period. Joists adequately spaced to prevent sagging shall support the top of the housing. The housing shall be completely built and the heat applied before placing any concrete.

Bridge decks, floor slabs, and roof slabs placed when the ambient air temperature is below 5 °C (40° F) shall be protected by a housing which also encloses the space beneath and which extends approximately 300 mm (12 inches) outside the edge of the floor. Alternatively, the deck may be insulated in accordance with part (b)(8)b. below.

When the temperature readings taken on or in the concrete indicate the temperature of the concrete may fall below 10 °C (50 °F), the Contractor shall, without exposing the concrete, immediately build the necessary enclosures around the area involved and supply heat to ensure curing conditions as specified in Subsection 541.17. The enclosure shall be removed when directed by the Engineer.

(6) Heating the Enclosure. The enclosure shall be heated in such a manner that the temperature of the concrete and the enclosed air shall be kept above 10 °C (50 °F) for the designated curing period. During this time, the concrete shall be kept continuously wet to provide proper curing. After the curing period, the temperature shall be gradually lowered to that of the surrounding atmosphere, taking at least 48 hours for the transition but at no time exceeding a 0.5 °C (1 °F) change per hour.

When dry heat is used, a means of maintaining atmospheric moisture shall be supplied. The Contractor shall maintain adequate fire protection and shall provide personnel to keep the heating units in continuous operation. When operations are in locations where water levels may fluctuate, the supports for heating equipment shall be built so that the heating equipment can be raised and steam lines shall be placed above the probable high water level.

(7) Temperature Records. The Contractor shall provide an automatic temperature recorder to continuously record concrete curing temperatures for the entire curing period. Recording thermometers shall be capable of measuring and recording temperatures within the range of -20 to 100 °C (-4 to 212 °F) with maximum graduations of 5 °C (10 °F).

Temperature sensors shall be carefully placed within the curing enclosure or the concrete to ensure that temperatures are measured at typical locations. Recorder accuracy shall be certified once every 12 months, and the certificate displayed with each recorder. The Engineer may make random checks of each recorder. On each recorder chart, the Engineer shall indicate the location of the representative concrete, date of placement, and time of start and finish of the record. At the completion of the curing period, the recorder charts shall be given to the Engineer.

When the Contractor places concrete at more than one location within the specified curing period, additional recorders shall be furnished to provide temperature records at each location.

In addition to concrete curing temperatures, a permanent daily record of ambient air temperatures shall be maintained. Thermometer readings shall be taken twice daily and data recorded showing the date, hour, location of each reading, and any conditions that might have an effect on the temperature.

(8) Insulated Forms.

a. General. When authorized by the Engineer, the concrete forms shall be completely covered with an approved insulating material.

To prevent loss of heat, immediately upon completion of concrete placement, all exposed surfaces shall be covered with a double thickness of burlap or cotton mats. This covering will be designed to prevent loss of moisture from the concrete and then covered with sufficient hay, straw, or insulated mats to prevent loss of heat from the concrete during the curing period. Tarpaulins shall be used as additional cover when directed.

To prevent excessive heat buildup, provisions shall be made for loosening of insulation to provide ventilation and the subsequent cooling of the concrete if the surface temperature of the concrete approaches 38 °C (100 °F). In no case shall this temperature drop below 10 °C (50 °F) during the curing period.

The following table shall be used as a guide in determining the outside temperature at which concrete walls, piers, abutments, or floor slabs above ground shall be protected with blanket insulation.

TABLE 541.07A
MINIMUM AIR TEMPERATURE ALLOWABLE
FOR ALL CLASSES OF CONCRETE

Concrete Thickness		Insulation Rating of R-4		Insulation Rating of R-8	
mm	in.	°C	°F	°C	°F
150	6	5	40	-2	29
300	12	-2	28	-18	0
450	18	-11	13	-34	-29
600	24	-18	0	-48	-55
900	36	-33	-27	---	---
1200	48	-40	-40	---	---
1500	60	-40	-40	---	---

b. Bridge Decks, Floor Slabs, and Roof Slabs. Immediately upon completion of the finishing, the surface shall be protected as specified under part (b)(5) above. When approved in writing by the Engineer, the Contractor may insulate the top and bottom of the slab as specified in Table 541.07A instead of constructing a heated housing. This insulating material shall be installed immediately upon the completion of finishing in such a way that the fresh concrete surface is not marred.

c. Concrete With Water-Reducing , High Range or Water-Reducing, High Range, and Retarding Admixture.

These admixtures are not to be used if the ambient temperature is below 10 ºC (50 ºF) at the time of placement, or if it is forecasted to drop below 10 ºC (50 ºF) and within 24 hours after completion of the placement, unless hot water is used or the concrete temperature is maintained in accordance with Subsection 541.07(b), subparts (5) and (7).

541.08 THIS SUBSECTION RESERVED

541.09 FORMS. Construction Drawings including falsework and form work plans shall be submitted by the Contractor in accordance with Section 105 before being used. In all cases, the Contractor shall be responsible for, and shall make good, any injury arising from inadequate forms. The Engineer shall inspect and accept all forms prior to concrete placement. Unless the Plans specifically call for the use of stay-in-place forms, such forms shall not be used in the construction of any superstructure or bridge deck. Stay-in-place forms will only be allowed in the construction of substructure elements in locations where the Engineer agrees that removable formwork is impossible to use.

(a) Falsework. In general, falsework that cannot be founded upon a solid footing shall be supported by falsework piling.

The Engineer may require the Contractor to employ screw jacks or hardwood wedges to take up any slight settlement in the falsework.

(b) Construction. Forms shall be mortar tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations including vibration. Forms shall be constructed and maintained so as to prevent the opening of joints due to shrinkage of the lumber. Sealer/caulking as approved by the Engineer shall be used where forms abut structural steel members, such as top flanges of beams and girders, etc.

Forms shall be filleted and chamfered at all sharp corners, unless otherwise shown on the Plans or directed by the Engineer, and shall be given a bevel or draft in the case of all projections, such as girders and copings to ensure easy removal.

Falsework and forms for slabs, beams, and girders shall be constructed to provide camber shown on the Plans or ordered by the Engineer.

(c) Form Lumber. All face form lumber for exposed surfaces shall be concrete form exterior grade plywood, not less than five ply and not less than 19 mm (3/4 inch) in thickness. In computing stud spacing, plywood shall be considered 25 mm (1 inch) lumber provided that the grain of three of the plys runs perpendicular to the studs.

Form lumber for unexposed surfaces may be dressed tongue and groove, dressed shiplap, or square edge sized four sides of uniform width and thickness. It shall have a minimum thickness, after finishing, of 19 mm (3/4 inch).

All form lumber shall be sound and free from loose or rotten knots, knotholes, checks, splits, or wanes showing on the surface in contact with the concrete. Used face form lumber, having defects or patches which may produce work inferior to that resulting from new material, shall not be used.

Other form material may be used with permission of the Engineer.

(d) Studs. Studs shall have a minimum nominal size of 50 by 150 mm (2 × 6 inches), except that 50 by 100 mm (2 × 4 inch) nominal size studs may be used for pours not exceeding 1.1 m (3 1/2 feet) in height. Studs shall be spaced center to center not more than 16 times the actual thickness of the form lumber.

Studs shall be capped at the top with a plate of not less than 50 by 150 mm (2 × 6 inches) nominal size, carefully selected as to straightness. All joints in plates shall be scabbed 1.2 m (4 feet) each way to provide continuity.

(e) Wales. All wales shall be at least 100 by 150 mm nominal size (4 × 6 inches, minimum section) or equivalent and shall be scabbed at least 1.2 m (4 feet) each side of joints to provide continuity. A row of wales shall be placed within 150 mm (6 inches) of the bottom of each pour unless studding can be extended below the bottom of the pour and secured by wales fastened to ties in the previous pour. Wales shall have a maximum spacing of 900 mm (36 inches).

(f) Form Ties. Metal ties or anchorages within the forms shall be constructed to permit their removal to a depth of at least 25 mm (1 inch) from the face without injury to the concrete.

Wire ties shall be used only in locations where they will not extend through surfaces exposed in the finished work and then only when authorized.

The cavities shall be filled with cement mortar in accordance with Subsection 541.16.

(g) Walls. Where the bottom of the form is inaccessible, the lower form boards shall be left loose or other provisions made so that extraneous material may be removed from the form immediately before placing the concrete.

(h) Surface Treatment. All forms shall be treated with commercial form oil prior to placing reinforcement and wood forms shall be saturated with water immediately before placing the concrete. Any material that will adhere to or discolor the concrete shall not be used.

(i) Metal Forms. The specifications for forms regarding design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse, and oiling also apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms that do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

(j) Removal of Forms. The forms, or their supports, for any portion of a structure shall not be removed without the approval of the Engineer. Forms under arches, beams, floor slabs, pier caps, or special designs may be removed upon approval of the Engineer after the concrete attains 85 percent of the minimum compressive strength as specified in Table 541.03A.

If field operations are not controlled by beam or cylinder tests, the following periods for removal of forms and supports, exclusive of days when the ambient air temperature is below 5 °C (40 °F), may be used as a guide:

Arch Center	14 Days
Centering under Beams	14 Days
Supports under Flat Slabs	14 Days
Floor Slabs	14 Days
Vertical Wall Surfaces	24 Hours
Columns	24 Hours
Sides of Beams	12 Hours
Top Slabs R.C. Box Culverts	14 Days

If high early strength is obtained with Type III cement or an altered concrete mix design is reviewed and accepted**,** these periods may be reduced as directed by the Engineer.

When field operations are controlled by strength tests, the removal of forms and supports may begin when the concrete is found to have the required strength. In no case shall the number of curing days be less than specified in Table 541.17A.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without approval. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own dead load.

541.10 PLACING CONCRETE.

(a) Workforce. The Contractor shall have sufficient skilled personnel at all times during the concreting operations to properly place, consolidate, and finish the concrete. If, in the opinion of the Engineer, the Contractor does not have sufficient skilled personnel to handle the concrete properly, the Engineer may postpone the start of the concreting operations until such time as the Contractor has remedied this condition.

(b) Pre-placement Meeting. For deck pours, or as required by the Engineer, a pre-placement meeting shall take place at least 7 calendar days before concrete placement. The pre-placement meeting shall be attended by all participating parties, including but not limited to, the Contractor's Project Superintendent, the Engineer, and the concrete producer.

(c) Placement Limitations. All concrete shall be placed in daylight, unless otherwise authorized in writing by the Engineer. Authorization to place concrete at any other time shall not be given unless an adequate lighting system is provided prior to beginning the concreting operation.

Concrete shall not be placed under adverse environmental conditions that the Engineer determines will interfere with acceptable placement and/or finishing operations.

Concrete shall not be placed until the depth and character of the foundation, the apparent adequacy of the forms and falsework and the placing of the reinforcing steel have been approved by the Engineer. The interior of the forms shall be clean of all debris before concrete is placed.

The Contractor shall submit to the Engineer a schedule of batching, delivery, and placement prior to the beginning of the concreting operations. The Contractor shall comply with the requirements of Subsection 541.05.

Equipment and tools necessary for handling materials and performing all parts of the work shall meet the approval of the Engineer as to design, capacity, and mechanical condition and must be on the site before the work is started. Any equipment, in the judgment of the Engineer, that proves inadequate to obtain results prescribed shall be improved or new equipment substituted or added.

For simple spans, concrete should be deposited by beginning at the lower end of the span and working toward the upper end. Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. For continuous spans, where required by design considerations, the concrete placing sequence shall be shown on the Plans or in the Special Provisions.

Concrete shall not be deposited in the forms more than 2 m (6 feet) from its final position.

Concrete shall not be deposited in running water.

The rate of placing the concrete shall be so regulated that no excessive stresses are placed on the forms. Concrete in all slabs, decks, girders, or ribs of arches shall be placed in one continuous operation, unless otherwise specified.

Concrete shall be placed in continuous horizontal layers, the thickness of which shall not exceed 450 mm (18 inches), unless otherwise directed by the Engineer. Each succeeding layer shall be placed before the underlying layer has taken initial set and shall be compacted in a manner that will eliminate any line of separation between the layers. When it is necessary, by reason of any emergency, to place less than a complete horizontal layer at one operation, such layer shall terminate in a vertical bulkhead.

After the concrete has taken its initial set, care shall be exercised to avoid jarring the forms or placing any strain on the ends of projecting reinforcing bars.

(d) Placement of Overlays. Unless otherwise shown on the Plans, existing expansion joints and dams shall be maintained through the overlay. A bulkhead equal in width to that of the joint shall be installed to the required grade and profile prior to placing the overlay material. Expansion dam treatment shall be as shown on the Plans.

Screed rails shall be placed and fastened in position to ensure finishing the new surface to the required profile. Supporting rails shall be anchored in such a manner as to provide horizontal and vertical stability. Screed rails shall not be placed so as to create a recess in the overlay surface and shall not be treated with form oil.

A construction dam or bulkhead shall be installed in case of major delay in placement. During minor delays of one hour or less, the end of the placement shall be protected from drying with several layers of wet burlap.

For a period of at least one hour before the placement of overlay material, the prepared surface shall be flooded with water. After removal of all free water, the overlay material shall be deposited on the damp surface and manipulated so as to coat the horizontal and vertical surfaces to be covered. The rate of progress shall be controlled so as to prevent the drying of previously deposited material.

(e) Use of Chutes. Chutes, troughs, and pipes used in placing concrete shall be arranged so as to avoid segregation of the materials and the displacement of the reinforcement and shall be approved by the Engineer. Aluminum chutes, troughs, or pipes will not be permitted.

All chutes, troughs, and pipes shall be kept clean and free of hardened concrete by thoroughly flushing with water after each run. Open troughs or 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.

Dropping of unconfined concrete more than 1.5 m (5 feet) or depositing a large quantity at any point and running or working it along the forms will not be permitted.

(f) Use of Vibrators. Unless otherwise specified, the concrete shall be consolidated with mechanical vibrators, of an approved type and design, operating within the concrete. When required, vibrating may be supplemented by hand spading with suitable tools to ensure proper and adequate consolidation. Vibrators shall be manipulated to work the concrete thoroughly around the reinforcement and imbedded fixtures and into corners and angles of the forms to produce surfaces free of imperfections. Vibrators shall not be used as a means to cause concrete to flow or run into position instead of placing. The vibration at any point shall be of sufficient duration to accomplish consolidation but shall not be prolonged to the point where segregation occurs.

Vibrators shall be used in concrete with reasonable care and shall not come in contact with structural steel, reinforcing steel, ties, forms, or partially set or hardened concrete at any time. Vibrators used in concrete with epoxy coated reinforcing steel shall have non-metallic or rubber coated heads. Vibrating machines shall at no time be left running unattended in the concrete.

When it is necessary by reason of an emergency to discontinue the placing of a monolithic section, the use of vibrators shall cease. Vibrators shall not again be used until a sufficient depth of fresh concrete is placed to prevent any possibility of the effect of vibration on the concrete already in place and in no case shall this depth be less than 600 mm (2 feet).

The number of vibrators used shall be ample to consolidate the incoming concrete immediately after it is deposited in the form. The Contractor shall have at least one spare vibrator in serviceable condition at the site of the structure in which more than 20 m^3 (25 cubic yards) of concrete are to be placed. The vibrators shall be capable of transmitting vibration to the concrete at frequencies of not less than 4500 impulses per minute under load. The vibration shall be of sufficient intensity and duration to cause plasticity, settlement, and complete consolidation of the concrete without causing segregation. The vibrator shall visibly affect a mass of concrete of 50 mm (2 inch) slump over a radius of at least 450 mm (18 inches).

(g) Blasting Operation. All blasting operations within 60 m (200 feet) of any concrete work shall be completed prior to the placement of the concrete. Regardless of the above limitation on blasting operations, the Contractor shall be responsible for any damage resulting from blasting operations.

541.11 DEPOSITING CONCRETE UNDER WATER.

(a) General. Concrete shall not be deposited under water except as specified by the Contract Documents or upon approval of the Engineer and shall be subject to the following specifications:

(1) The Contractor shall submit for the Engineer's review and acceptance a Portland cement concrete mix per the following requirements:

A minimum of thirty-seven (37) calendar days prior to placement (or prior to pre-placement meeting, if one is required), the Contractor shall submit (for approval) the mix design for the class of concrete specified. The mix design(s) shall be submitted to the Agency's Materials and Research Laboratory, 1716 Barre-Montpelier Rd., Berlin, Vermont 05602, attention Structural Concrete Engineer. No class of concrete shall be placed on a project until the mix design is reviewed and accepted. The mix design must contain the following and state the names and sources of all materials:

Saturated Surface Dry or Dry Weights

Compressive Strength

Cement Content in kg/cubic meter (lbs/cubic yard)

Mineral Admixture Content (each) in kg/cubic meter (lbs/cubic yard)

Air Content

Water/Cementitious Material Ratio

Chemical Admixtures (types and dosages)

Laboratory Test Results (strength, air content, water/cementitious material ratio, slump)

(2) Mix Design Requirements:

a. The mix shall contain a minimum of 356 kg/cubic meter (600 lbs/cubic yard) of cementitious material with: a minimum of 25% GGBFS substitution, or a minimum of 20% Fly Ash substitution, or other approved mineral admixture substitution at an approved rate.

b. Air content shall be 4.5% +/- 1.5% unless any portion of this concrete shall experience freeze-thaw conditions - then the air content shall be 6% +/- 1.5%.

c. The maximum water/cementitious material ratio shall be 0.45. When a water-reducing, high range admixture (AASHTO M 194, Type F or Type G) has been included in the reviewed and accepted mix design, the concrete shall not demonstrate segregation at the proposed slump, as determined by the Engineer, but at no time shall the slump be less than 180 mm (7 inches).

d. If needed for a cofferdam and/or seal design, the concrete shall provide a minimum 28 day design strength of 20 MPa (3000 psi). Otherwise, minimum strength requirements for underwater concrete shall be as specified in the Contract Documents.

(b) Placement. Concrete deposited under water shall be carefully placed in still water by use of a tremie hopper and tube, and shall not be disturbed after being deposited.

In no case shall vibrators be used for underwater concrete**.**

The placement shall be continuous to the elevations shown on the Plans and the resulting concrete shall be monolithic and homogeneous.

Concrete shall not be deposited in water having a temperature of 2 °C (35 °F) or below. When the water temperature is between 2 and 5 °C (35 and 40 °F), the mixing water, the aggregates, or both shall be heated as specified in Subsection 541.07(b).

A tremie shall be constructed of heavy-gauge steel pipe and consist of ~~a~~ watertight joints between the tremie sections with a diameter of not less than 250 mm (10 inches). The tremie hopper shall have a capacity of at least 0.4 m^3 (1/2 cubic yard). When a batch is dumped into the hopper, the flow of the concrete shall be induced by slightly raising the discharge tube, always keeping it in the concrete.

The discharge tubes for tremies shall be equipped with a device that will prevent water from entering the tube while charging the tube with concrete. Such tubes shall be supported to permit free movement of the tubes over the entire work surface and to permit rapid lowering, when necessary to retard or stop the flow of concrete from the tube.

Tubes shall be kept continuously submerged in concrete during discharge. The depth that the tube is submerged in concrete and the height of the concrete in the tube shall be sufficient to prevent water from entering the tube. The Contractor shall continuously monitor the difference in elevation between the top of the concrete and the end of the discharge tube.

Horizontal movement of discharge tubes through the concrete will not be allowed.

If a direct pumping method is to be implemented, then the pipe shall consist of heavy-gauge steel sections.

541.12 PUMPING. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be suitable in kind and adequate in capacity for the work. The pump shall be capable of pumping concrete within the specified slump limits. The use of aluminum pipe as a conveyance for the concrete will not be permitted.

The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. The equipment shall be arranged so that no resulting vibrations may damage freshly placed concrete.

The pumping of Class LW concrete will not be permitted.

541.13 CONSTRUCTION JOINTS.

(a) Location of Construction Joints. Joints shall be formed at the location shown on the Plans. Any variation or new location of joints shall require written permission of the Engineer. Feather edges at construction joints will not be permitted. Joints shall be formed with inset form work so that each layer of concrete will have a thickness of not less than 150 mm (6 inches).

(b) Joining Fresh Concrete to Previously Set Concrete. In joining fresh concrete to concrete that has hardened, the surface shall be roughened in such a manner that will not leave loosened particles or damaged concrete at the surface and be thoroughly cleaned of all laitance, loose, and foreign material. Immediately prior to the placing of the new concrete, the surface shall be saturated with water. When shown on the Plans or ordered by the Engineer, the surface shall be thoroughly coated with a very thin coating of mortar or neat cement grout and all forms drawn tight against the face of the concrete. The neat cement mortar or bonding agent shall not be allowed to dry out before being covered with fresh concrete.

(c) Keys. Suitable keys shall be formed at construction joints. Unless otherwise directed by the Engineer, these keys shall be of the type and detail shown on the Plans.

(d) Filled Construction Joints. Filled construction joints shall contain a preformed cork joint filler or other preformed joint filler that may be shown in the Contract Documents. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joints, that portion of the joint to be filled shall be formed with a separate material (other than the preformed joint filler) that can easily be removed prior to placement of the above indicated filler.

(e) Water Stops. Approved water stops shall be placed at locations shown on the Plans. They shall form continuous watertight joints.

(f) Bond Breakers. Bond breakers shall be one of the following materials as shown on the Plans: asphalt-treated felt, pipe insulation, or tar emulsion.

541.14 EXPANSION JOINTS. All joints shall be constructed according to details shown on the Plans.

(a) Filled Compression and Expansion Joints. Filled compression and expansion joints shall be made with a preformed self-expanding cork joint filler or other preformed joint filler that may be shown in the Contract Documents. Joint filler shall be cut to fit exactly and shall completely fill the space that is shown on the Plans. Where a pour grade or caulking grade filler is indicated to be used in the joint, that portion of the joint to be filled shall be formed with a separate material (other than the expansion joint filler) that can easily be removed prior to placement of the above indicated filler.

(b) Special Types of Expansion Joints. Special types of expansion joints may be used when shown on the Plans or ordered by the Engineer.

541.15 PATCHING. Patching of existing concrete shall be accomplished with the type of material shown on the Plans. Type IV mortar shall be used where a non-shrink or expansive mortar is shown on the Plans. Patching of new concrete shall be as specified in Subsection 541.16(a)(1).

541.16 CONCRETE FINISHING.

(a) General. Unless otherwise specified, the surface of the concrete shall be finished immediately after form removal.

All concrete surfaces shall be given a dressed finish. If further finishing is required, exposed surfaces shall be given a rubbed finish. Other finish classes may be shown on the Plans for designated surfaces.

(1) Dressed Finish. The dressed finish work shall begin within 12 hours after removal of forms and shall continue until completed. All fins and irregular projections shall be removed from all surfaces except from those that are not to be exposed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar composed of the same type of cement and fine aggregate and mixed in the same proportions used in the grade of the concrete being finished. Mortar used in pointing shall be not more than one hour old. The mortar patches shall be cured a minimum of 72 hours in accordance with Subsection 541.17. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint shall be left exposed to its full length with clean and true edges.

All surfaces that cannot be repaired to the satisfaction of the Engineer shall be “rubbed” as specified for a Rubbed Finish.

(2) Rubbed Finish. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of the same type of cement and fine sand mixed in proportions used in the concrete being finished. Rubbing shall be continued until all form

marks, projections, and irregularities have been removed, all voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

(3) Float Finish. This finish for horizontal surfaces shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided. After the concrete has been struck off, the surface shall be made uniform by longitudinal or transverse floating.

When the concrete has hardened sufficiently, the surface shall be given a broom finish, burlap drag finish, or left smooth as determined by the Engineer.

(b) Finishing Bridge Deck.

(1) General. At least one week prior to placing any bridge deck concrete, the Contractor shall review the proposed procedure and details for placing deck concrete with the Engineer. The procedure shall provide for adequate labor, equipment, and material supply to complete placement of concrete on the entire deck or specified portion thereof within an eight-hour period. If, during the placement, unforeseen circumstances make placement within the eight-hour period impossible, the Contractor shall be prepared to place a bulkhead, as directed by the Engineer, to limit the placement to eight hours.

A finishing machine shall be provided on all decks constructed with Class LW concrete regardless of length.

Approval of the method and equipment will not relieve the Contractor of full responsibility for obtaining the required surface finish.

Finishing shall continue until such time as there remains no deviation greater than 3 mm (1/8 inch) when tested for trueness with a metal straightedge at least 3 m (10 feet) in length. The Contractor shall furnish the straightedge. When a bituminous concrete surface is to be placed on a bridge deck, the deviation shall be not greater than 6 mm (1/4 inch). When a sheet membrane is being applied, sharp ridges shall not be allowed. All costs of providing a straightedge to test the trueness of the concrete finishing shall be included in the Contract unit prices under Section 631.

Immediately after finishing has been completed**,** and as soon as all excess moisture has disappeared, the bridge deck shall be textured to a uniform gritty surface using a burlap, felt, or other drag satisfactory to the Engineer. Sidewalks and safety curbs shall receive their final finish with a fine bristled broom.

If the bridge deck concrete does not meet the above smoothness requirements, the Contractor shall remove high spots up to 13 mm (1/2 inch) high by means of grinding. Any other corrections shall be made only with the written approval of the Chief Engineer. The use of bush hammers will not be allowed. No concrete shall be removed that will result in a concrete slab thickness less than that shown on the Plans.

Any deck that cannot be corrected by a method satisfactory to the Chief Engineer shall be removed and replaced at the Contractor's expense.

(2) Overall Length of Bridge Over 18 m (60 feet). Bridge floors over 18 m (60 feet) in length shall be struck off and finished by an approved self-propelled finishing machine. This machine will be supported on suitable rails and equipped with adjustable strike-off or finishing screeds capable of producing the required finish surface for the full width of the bridge from face to face of curbs. Machines shall be kept in true adjustment. Machines shall not be used until proper adjustments

have been made and the adjustments have been checked and approved by the Engineer.

Sufficient time shall be provided prior to beginning concreting operations for the finishing machine to be operated over the full length of the bridge deck segment to be placed. This test run shall be made with the screed adjusted to its finishing position. While operating the finishing machine in this test, the screed rails shall be checked for deflection and proper adjustment, the cover on slab reinforcement measured, and the controlling dimensions of slab reinforcement and forms checked.

After the concrete has been placed, it shall be struck off by a self-propelled finishing machine and the operation repeated as necessary to produce a uniformly consolidated, dense, smooth surface. The final passage of the finishing machine shall result in a uniform surface at the required grade and slope over its entire area.

The Contractor shall furnish a work bridge or bridges of an approved type, capable of spanning the entire width of the deck, supported on the finishing machine rails, and supporting at least a 2.2 kN (500 pound) load without deflection to the concrete slab surface.

(3) Overall Length of Bridge 18 m (60 feet) and Less. Screed rails shall be rigidly set to grade and supported sufficiently on adjustable chairs so as to allow no deflection in the rails under operating conditions. Screed guides or chairs shall be supported on structural members where possible. Sufficient screed rails shall be provided so that all rails necessary for any one continuous pour may be preset and graded before the start of concreting operations. The removal of screed rails and exposed chairs shall be accomplished without walking in the fresh concrete.

The Contractor shall furnish a minimum of one work bridge of an approved type, capable of spanning the entire width of the deck and supporting at least a 2.2 kN (500 pound) load without deflection to the concrete slab surface.

After the concrete is placed, it shall be struck off by one of the following methods:

a. A self-propelled concrete finishing machine used as specified in part (b)(2) above for concrete finishing on bridges longer than 18 m (60 feet);

b. A straight steel roller with a minimum diameter of 100 mm (4 inches), at least 300 mm (12 inches) longer than the distance between screed strips, and equipped with handles at each end, which shall be rolled back and forth until the surface is smooth and even with all holes filled;

c. An approved mechanical vibrating screed exerting a force of not less than 175 N/m (12 pounds per foot), the vibrations of which shall be of not less than 6500 vibrations per minute when checked by a vibration reed-type tester, uniform throughout its entire length and adjusted so as not to drive the aggregate more than 6 mm (1/4 inch) below the surface; or

d. An approved wood, metal shod template fitted with handles. If satisfactory results are not obtained with the type of screed selected, the Engineer may direct the use of another type of screed.

After the preliminary screeding, floats shall be operated with a combined longitudinal and transverse motion, planing off the high areas and floating the material removed into the low areas. Each pass shall lap the previous pass by 50 percent of the length of the float.

541.17 CURING CONCRETE.

(a) General. Water for use in curing concrete shall conform to the provisions of Subsection 745.01.

Effective cure time shall be only the time that the concrete has been maintained in a wet condition with the concrete surface temperature above 10 °C (50 °F). The effective cure time may be extended as directed by the Engineer.

Regardless of the curing medium specified and before any premature drying has set in, the entire surface of the newly placed concrete shall be kept damp. This shall be achieved by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The atomized flow shall be applied continuously until the exposed surface is sufficiently hard so that it can be covered by the specified curing mediums. The moisture shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate in a quantity sufficient to cause a flow or washing of the surface.

The atomized flow shall be applied continuously until the surfaces can be covered by the specified curing mediums. For bridge barriers, curbs and sidewalks the curing method shall be applied within 15 minutes of the completion of the finishing process. For bridge decks the curing method shall promptly follow the screed machine, within a maximum lag time of 10 minutes and without interruption.

TABLE 541.17A
CURING OF CONCRETE COMPONENTS

Type of Construction	Curing Methods	Curing Period Days
Substructure	541.17(b)(1), (2), (3), (5), (7), (8)	7
Superstructure	541.17(b) (2), (8)	10
Retaining Walls	541.17(b)(1), (2), (5), (6), (8)	7
Headwalls	541.17(b)(1), (2), (5), (6), (8)	7
Sidewalks, Curbs, and Gutters	541.17(b)(1), (2), (3), (5), (6), (7), (8)	7

If high early strength (Type III) portland cement is permitted and used, the curing period may be reduced as directed by the Engineer.

Concrete placed after September 30th shall have a drying period of seven (7) days immediately following the end of the cure period. The concrete shall be kept moisture free and above freezing for this period.

(b) Methods of Curing. All exposed surfaces of newly placed concrete shall be cured by one of the following specified methods:

(1) Water Curing. Curing with water shall be by continuously sprinkling or flooding of all exposed surfaces for the entire required curing period.

(2) Burlap Curing. The entire exposed surface of the concrete shall be covered with two layers of approved burlap. The burlap shall be soaked with water and kept wet for the entire curing period. For superstructures the burlap shall then be covered with a lapped layer of white polyethylene sheeting. Once the concrete superstructure has hardened sufficiently, a stream of water (per soaker hose or other device) shall be continuously applied under the polyethylene sheeting until the cure period is complete.

(3) Sand Cover. The entire exposed surface of the concrete shall be covered with at least 75 mm (3 inches) of approved sand that shall be kept wet for the entire curing period.

(4) White Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white polyethylene sheeting, maintained and fastened to provide a nearly airtight condition in contact with the surface where possible. If, in the opinion of the Engineer, this cover is not adequately provided or maintained to ensure the proper conditions for concrete cure, then white polyethlyene sheeting cure shall be terminated and another method substituted.

(5) White Burlap-Polyethylene Sheeting. The entire exposed surface of the concrete shall be covered with a blanket of white burlap-polyethylene sheeting. The burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All joints shall be lapped a minimum of 450 mm (18 inches). The burlap shall be kept damp throughout the curing period.

(6) Membrane Forming Curing Compound. White pigmented or fugitive dye membrane curing solution may be used for curing concrete in minor drainage structures. All other use of curing compound shall be approved in writing by the Engineer. When membrane curing is used, the exposed concrete shall be thoroughly sealed immediately after the free water has left the surface. The concrete inside the forms shall be sealed immediately after the forms are removed and necessary finishing has been done. The solution shall be applied in one or two separate applications. If the solution is applied in two increments, the second application shall follow the first application within 30 minutes. Satisfactory equipment shall be provided, together with means to properly control and ensure the direct application of the curing solution on the concrete surface so as to result in a uniform coverage of the surface area at the rate of 275 mL/m^2 (1 gallon for each 150 square feet).

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the solution shall be applied to the affected portions equal in curing value to that specified above.

Should the surface be subject to continuous injury or the use of curing compound result in a streaked or blotchy appearance, the method shall be stopped and water curing applied.

Only curing compounds approved by the Agency's Materials and Research Section may be used.

(7) White Polyethylene Sheeting with Sand Cover. This method may be used only when approved by the Engineer and shall conform to the requirements of part (b)(4) above. The airtight condition shall be obtained by the addition of a uniform sand cover at a minimum depth of 50 mm (2 inches).

(8) Pre-dampened cotton mats. The entire exposed surface of the concrete shall be covered with a blanket of cotton mats that has been pre-dampened with water. The mats shall be maintained in a damp condition until the curing period is complete

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If, in the opinion of the Engineer, the Contractor's curing procedure is not producing an adequate cure, the Engineer may direct a change in the cure method at no additional cost to the Agency.

541.18 LOADING OF CONCRETE. After the concrete has been placed and the finishing operations concluded, it shall not be walked on or disturbed in any manner, including removal of forms, for a minimum period of 18 hours. If retarder is used as an admixture, this minimum period may be extended as directed by the Engineer.

(a) Substructure. No backfill material shall be placed against a newly completed structure until the concrete has been cured in accordance with Table 541.17A, and until the field cured test cylinders have attained 85 percent of the compressive strength specified in Table 541.03A. However, the Contractor may erect forms for subsequent concrete placement on footings after 18 hours have elapsed from the time that the footing placement was completed, provided the concrete has sufficient strength to allow it to be worked on without damage, and proper cure is maintained.

Static loads, such as forms, reinforcing steel, or other materials necessary for construction, may be placed on any concrete after it has been in place 72 hours, or a compressive strength of 12.4 MPa (1800 pounds per square inch) has been obtained, provided proper curing is maintained. Superimposed loads from subsequent concrete pours will not be allowed on any substructure unit or section in place until the field cured test cylinders have attained 85 percent of the compressive strength specified by Table 541.03A, and provided curing of the supporting section is maintained in accordance with Table 541.17A.

(b) Superstructure. Static loads, such as forms, granite curbing, cast-in-place concrete curb, and other materials necessary for deck construction, may be placed on deck concrete as long as the field cured test cylinders for this concrete have attained 85 percent of the compressive strength specified in Table 541.03A, the proper curing is maintained, and the materials are spread out uniformly to avoid point loading.

The Contractor shall keep bridge floors free of all motor vehicles, transit mixers, and heavy construction equipment until the curing period is satisfactorily completed, the field cured test cylinders for the bridge floor concrete have attained the compressive strength specified in Table 541.03A, and the field cured test cylinders for the curb concrete have attained 85 percent of the compressive strength specified in Table 541.03A.

(c) Vertical Joint. Concrete shall not be placed against a vertical construction joint until the previously placed concrete has been in place a minimum of 72 hours.

The Contractor must not allow loads that are in excess of the legal loads permitted by the laws of the State to travel over the completed structure, except with written permission of the Engineer.

541.19 METHOD OF MEASUREMENT. The quantity of Concrete, Class AA, A, B, C, D, or LW to be measured for payment will be the number of cubic meters (cubic yards) of the class of concrete specified in the complete and accepted work, as determined by the prismoidal method using dimensions shown on the Plans or as directed by the Engineer, including the volume of superstructure precast concrete stay-in-place forms, but excluding the volume of steel or other stay-in-place forms and form filling materials. No deductions will be made for the volume of concrete displaced by steel reinforcement, structural steel, expansion joint material, scuppers, weep holes, conduits, tops of piles, scoring, chamfers or corners, inset panels of 38 mm (1 1/2 inches) or less in depth, or any pipe less than 200 mm (8 inches) in diameter.

The quantity of Mortar, Type I or Type IV to be measured for payment will be the number of cubic meters (cubic yards) of the type of mortar specified in the complete and accepted work. The number of cubic meters (cubic yards) will be based on sack count of cement used. One cubic meter (1 cubic yard) of Type I or Type IV mortar is considered equivalent to 950 kg (1600 pounds) of portland cement.

541.20 BASIS OF PAYMENT. The accepted quantities of the Contract items specified will be paid for at the Contract unit prices. Payment will be full compensation for performing the work specified, including designing the mix, satisfactory finishing and curing, and for furnishing all forms, materials, including joint filler and bond breaker, labor, tools, admixtures, equipment, including automatic temperature recording units, trial batches, and incidentals necessary to complete the work.

The cost of heating materials and protecting the concrete against cold weather, and any additional cost for cement, will not be paid for separately but will be considered incidental to the Contract unit prices for Section 541.

The cost of furnishing testing facilities and supplies at the batch plant and the setting of inserts, bench marks, and bridge plaques furnished by the Agency will not be paid for separately but will be considered incidental to the Contract unit price of structural concrete.

Payment will be made under:

Pay Item	Pay Unit
541.21 Concrete, Class AA	Cubic Meter (Cubic Yard)
541.22 Concrete, Class A	Cubic Meter (Cubic Yard)
541.25 Concrete, Class B	Cubic Meter (Cubic Yard)
541.30 Concrete, Class C	Cubic Meter (Cubic Yard)
541.31 Concrete, Class D	Cubic Meter (Cubic Yard)
541.40 Concrete, Class LW	Cubic Meter (Cubic Yard)
541.55 Mortar, Type I	Cubic Meter (Cubic Yard)
541.58 Mortar, Type IV	Cubic Meter (Cubic Yard)

SECTION 580 - STRUCTURAL CONCRETE REPAIR

580.01 DESCRIPTION. This work shall consist of the removal and disposal of delaminated and unsound concrete from an existing superstructure or substructure and its replacement with new portland cement concrete or an approved patching material.

This Section shall be used in conjunction with Section 501 or Section 541, whichever is applicable to other concrete items in the Contract. Where both specifications are used, Section 501 shall be used for this work. Anything not specifically addressed in this Section relative to concrete shall be governed by Section 501 or Section 541.

580.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Coarse Aggregate for Concrete (TABLE 704.02A) 704.02
Concrete Repair Materials 780
Overhead and Vertical Concrete Repair Material..... 780.02
Rapid Setting Concrete Repair Material..... 780.03
Rapid Setting Concrete Repair Material..... 780.04
with Coarse Aggregate

Concrete, High Performance (Class AA, Class A, and Class B) shall meet the applicable requirements of Subsections 501.02 through 501.19 or Concrete (Class AA, Class A, and Class B) shall meet the applicable requirements of Subsections 541.02 through 541.19. Where further references in this Specification are made to Concrete (Class AA, Class A, or Class B), they shall mean that class or corresponding class of concrete described in the governing concrete specifications.

580.03 PROPORTIONING AND MIXING. All Concrete Repair Materials shall be mixed with a mechanical mixer at the project site in accordance with the manufacturer's recommendations on the project packaging, one bag (unit) at a time. Except for Rapid Setting Concrete Repair Material with Coarse Aggregate, the product shall not be extended with sand or gravel.

At no time shall recommended water content be exceeded nor shall any mixture be retempered by adding water and/or remixing once the material has reached initial set.

Rapid Setting Concrete Repair Material with Coarse Aggregate shall be mixed with approved materials in the proportions designated by the Materials and Research Engineer. When Rapid Setting Concrete Repair Material with Coarse Aggregate is used on a project, the Contractor shall submit three (3) 100 mm (4 inch) diameter test cylinders to the Agency's Materials & Research Section Structural Concrete Unit for information for the first quantity of 25 bags (units) of materials or less used on the project. Thereafter, three (3) more test cylinders shall be submitted for each increment of 100 bags of materials used on the project.

580.04 SURFACE PREPARATION FOR REPAIRS, OVERLAYS AND MEMBRANES. Surfaces to be repaired or overlaid shall be chipped back to sound concrete as directed by the Engineer using approved hand or mechanical methods.

When removing unsound portions of an existing structure in preparation for repair, the edges of all areas to be repaired shall be saw cut in straight lines to a minimum depth of 25 mm (1 inch).

After complete removal of unsound concrete, the entire area to be patched or overlaid and all exposed steel which will have concrete placed against or around it (metal plate expansion joints, scuppers, finger plate expansion joints, reinforcing steel, etc.) shall be blast cleaned to remove contaminants and laitance a maximum of 24 hours prior to placing the new concrete. The area shall be vacuumed or flushed using high pressure air or water to remove all loose particles, dust, and debris.

Air or water used for cleaning shall be free of oil and other contaminants. After blast cleaning, once the concrete is wet, whether from flushing or rain, the concrete must be kept wet until the placing of concrete materials. If the concrete is allowed to dry out or the 24 hour time limit has lapsed, the entire area shall be blast cleaned and vacuumed or flushed again.

Following concrete removal, additional surface preparation for the application of Overhead and Vertical Concrete Repair Material shall be as recommended on the product packaging by the manufacturer.

Where Rapid Setting Concrete Repair Material or Rapid Setting Concrete Repair Material with Coarse Aggregate is to be used, concrete surfaces shall be thoroughly blast cleaned and prepared as recommended by the manufacturer.

Concrete bridge decks or other surfaces designated by the Engineer to be prepared for application of a waterproofing membrane shall be ground to a smooth uniform surface by either a hand held grinder or a wheel mounted grinder unit specifically designed for the purpose. Ridges or areas of unevenness designated by the Engineer shall be ground so that no surface deviation greater than 1.6 mm (1/16 inch) remains.

580.05 FORMS. The forms shall be constructed in such a manner that the final concrete surface has the same architectural score marks and exterior face appearance as the original surface.

For additional requirements for forms see either Subsection 501.09 or 541.09.

580.06 PLACING CONCRETE. The Contractor shall comply with the requirements of Subsection 501.07 or 541.07 as well as Subsection 501.10 or 541.10 for this work.

In addition, the following is applicable to concrete repair:

(a) Portland Cement Concrete. When Epoxy Bonding Compound is not specified on the Plans, the prepared concrete surface shall be flooded with water for at least one hour prior to fresh concrete placement, standing water shall be removed and a neat cement paste shall be brushed into the surface. The cement (AASHTO M 85, Type II) and water shall be mixed to a thick latex paint consistency. The neat cement paste shall not be allowed to dry out before it is covered with fresh concrete.

(b) Concrete Repair Material. The moisture condition of the prepared concrete surface, the use of bonding agents and the placement of Overhead and Vertical Concrete Repair Material, Rapid Setting Concrete Repair Materials or Rapid Setting Concrete Repair Material with Coarse Aggregate shall be as recommended by the manufacturer of the product being placed.

(c) Alternate Methods of Repair. The Contractor may propose an alternate means of repairing vertical and overhead surfaces. The alternate may include, but is not limited to, the use of pneumatically applied materials. Should the Contractor choose an alternate method of repair, the written approval of the Structures Engineer shall be obtained prior to beginning work utilizing the alternate method.

580.07 CURING CONCRETE. In addition to the requirements of Subsection 501.17 or 541.17, the following requirements shall apply to concrete repair:

A membrane-forming curing compound may be used to cure the repairs made with concrete, provided the patched areas are covered with white polyethylene sheeting after the curing compound is applied. White Polyethylene Sheeting shall conform to Subsection 725.01(c). The type of curing compound shall be approved by the Engineer prior to its use. The curing period for patches made with concrete shall be seven (7) days regardless of the curing method chosen.

Concrete patches may be cured in accordance with Subsection 501.17(b) or 541.17(b), Parts 1, 2, 3, 5, or 7 only. If the method used does not produce the desired results, alternate curing procedures may be required by the Engineer. Evidence of improper cure could be a dry surface, a cracked or cracking surface, or a streaked or blotchy appearance of the surface.

Overlay concrete shall be cured in accordance with Subsection 501.17(b) or 541.17(b), Parts 1, 2, 5, or 7 only.

Concrete Repair Materials shall be cured in accordance with the manufacturer's recommendations on the product packaging or specification sheet.

580.08 METHOD OF MEASUREMENT. The quantity to be measured for payment of Repair of Concrete Superstructure Surface, Class I or Class II will be the number of square meters (square yards) of repaired concrete surfaces.

Repair of Concrete Superstructure Surface, Class I, shall include the removal of concrete from the surface of existing concrete to a maximum depth as determined by the top of the top bars of the top mat of existing reinforcing steel.

Repair of Concrete Superstructure Surface, Class II, shall include removal of concrete from the surface of the existing concrete to a maximum depth as determined by the top of the top bars of the bottom mat of reinforcing steel. The minimum depth removed under this item shall be 19 mm (± 6 mm) [¾ of an inch (±¼ inch)] below the bottom bars of the top mat of reinforcing steel.

The quantity to be measured for payment of Concrete Substructure Surfaces, Class I or Class II, will be the number of square meters (square yards) of repaired substructure surfaces, whether they are flat, vertical, or overhead.

Repair of Concrete Substructure Surface, Class I shall include removal of concrete from the plane of the original concrete surface to a maximum depth as determined by the outside face of the first mat of reinforcing steel.

Repair of Concrete Substructure Surface, Class II shall include removal of concrete from the plane of the original concrete surface to a maximum depth of 150 mm (6 inches) measured from the plane of the original surface. The minimum depth removed under this item shall be 19 mm (± 6 mm) [¾ of an inch (±¼ inch)] beyond the inside face of the first mat of reinforcing steel.

The quantity to be measured for payment of Repair of Concrete Superstructure Surface, Class III, will be the number of cubic meters (cubic yards) of concrete removed. Repair of Concrete Superstructure Surface, Class III, shall include removal from the top of the existing concrete surface to the bottom of the concrete deck (i.e. full depth removal).

The quantity to be measured for payment of Repair of Concrete Substructure, Class III, will be the number of cubic meters (cubic yards) of concrete removed. Repair of Concrete Substructure Surface, Class III, shall include removal from the face of the existing concrete surface to a depth greater than 150 mm (6 inches).

The quantity to be measured for payment for Surface Preparation for Membrane will be the number of square meters (square feet) of prepared surface. Payment will be made for surface preparation of existing surfaces and not for new patches, which will be the responsibility of the Contractor.

The quantity to be measured for Rapid Setting Concrete Repair Material, Overhead and Vertical Concrete Repair Material and Rapid Setting Concrete Repair Material with Coarse Aggregate will be the number of cubic meters (cubic feet) of material mixed for use, as approved by the Engineer. The volume will be computed on the basis of the quantity identified as being contained in the product packaging.

The quantity to be measured for payment of Concrete, Class AA Overlay will be the number of square meters (square yards) of finished surface complete in place. The limits of removal shall be as specified for Repair of Concrete Superstructure Surface, Class II or Class III as determined by the Engineer.

580.09 BASIS OF PAYMENT. The accepted quantities will be paid for at the Contract unit prices for the pay items specified, which price shall be full compensation for performing the work specified, including surface preparation as specified, satisfactory completion of curing, and the furnishing of all forms, materials, including joint filler, labor, tools, admixtures, equipment, and incidentals necessary to complete the work.

The cost of heating or cooling materials and protecting the concrete against cold weather and any additional cost for cement shall be included in the Contract unit price for the applicable concrete repair item in the Contract.

The unit price bid for Repair of Concrete Superstructure Surface, Class I, Repair of Concrete Superstructure Surface, Class II and Repair of Concrete Superstructure Surface, Class III will be full compensation for the removal and replacement of concrete. Replacement material shall be Concrete, Class AA or an acceptable alternate as approved by the Engineer.

The unit price bid for Repair of Concrete Substructure Surface, Class I and Repair of Concrete Substructure Surface, Class II will be full compensation for the removal and replacement of concrete. Replacement material shall be Concrete, Class AA or an acceptable alternate as approved by the Engineer, such as pneumatically applied concrete.

The unit price bid for Repair of Concrete Substructure Surface, Class III will be full compensation for the removal and replacement of concrete. Replacement material shall be Concrete, Class AA, Class A, Class B, or an acceptable alternate as approved by the Engineer.

The accepted quantity of Surface Preparation for Membrane will be paid for at the contract unit price per square meter (square foot), which price shall be full compensation for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Rapid Setting Concrete Repair Material, Overhead and Vertical Concrete Repair Material and Rapid Setting Concrete Repair Material with Coarse Aggregate will be paid for at the Contract unit price bid per cubic meter (cubic foot), which price shall be full compensation for furnishing, transporting, storing, handling, and placing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The unit price bid for Concrete, Class AA Overlay will be full compensation for the removal and replacement of concrete. Replacement concrete shall be Concrete, Class AA.

Duplicate payment will not be made for preparation of concrete surfaces in any area. For example, if an area is originally prepared as Class I and the Engineer orders a change to the Class II depth, the area will be paid as Class II.

Payment will be made under:

	Pay Item	Pay Unit
580.10	Repair of Concrete Superstructure Surface, Class I	Square Meter (Square Yard)
580.11	Repair of Concrete Superstructure Surface, Class II	Square Meter (Square Yard)
580.12	Repair of Concrete Superstructure Surface, Class III	Cubic Meter (Cubic Yard)
580.13	Repair of Concrete Substructure Surface, Class I	Square Meter (Square Yard)
580.14	Repair of Concrete Substructure Surface, Class II	Square Meter (Square Yard)
580.15	Repair of Concrete Substructure Surface, Class III	Cubic Meter (Cubic Yard)
580.16	Surface Preparation for Membrane	Square Meter (Square Foot)
580.17	Rapid Setting Concrete Repair Material	Cubic Meter (Cubic Foot)
580.18	Overhead and Vertical Concrete Repair Material	Cubic Meter (Cubic Foot)
580.19	Concrete, Class AA Overlay	Square Meter (Square Yard)
580.20	Rapid Setting Concrete Repair Material with Coarse Aggregate	Cubic Meter (Cubic Foot)

DIVISION 600

INCIDENTAL CONSTRUCTION

SECTION 601 - CULVERTS AND STORM DRAINS

601.01 DESCRIPTION. This work shall consist of the construction, cleaning, and reconditioning or reconstruction of culverts and storm drains, hereinafter referred to as pipe.

601.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type II 707.02
Rubber Gaskets 707.11
Reinforced Concrete Pipe 710.01
Reinforced Concrete Pipe End Sections 710.02
Corrugated Polyethylene Pipe 710.03
Corrugated Steel Pipe, Pipe Arches, and Underdrains 711.01
Corrugated Aluminum Alloy Pipe, Pipe Arches, and Underdrains .. 711.02
Polymeric Coated Corrugated Steel Pipe and Pipe Arches 711.03
Bituminous Paving for Pipe Inverts 711.04
Coal-Tar Based Coating 711.05

Manufacturing plants may be inspected periodically for compliance with specified manufacturing methods.

All units in a given pipe or pipe arch installation, including elbows, end sections, coupling bands, and reducer units, shall be of the same material, except that corrugated steel pipe end sections shall be used with polymeric coated corrugated steel pipe and pipe arches.

All materials will be subject to inspection for acceptance prior to or during incorporation of materials in the work.

When either corrugated steel pipe or pipe arches with 125 by 25 mm (5 × 1 inch) corrugations are shown on the Plans, the Contractor may substitute pipe or pipe arches of the same thickness with 75 by 25 mm (3 × 1 inch) corrugations at no additional compensation.

601.03 GENERAL. Care shall be exercised when unloading pipe from delivery trucks and moving pipe to its final position. If the Engineer rejects damaged pipe, new pipe shall be furnished by the Contractor at no additional cost to the Agency.

Unless otherwise directed by the Engineer, the Contractor shall provide for the temporary diversion of water to permit the installation of the pipe in a reasonably dry trench.

The location of all pipe installation shall be approved by the Engineer.

Where existing pipe is to be retained or relaid and it becomes damaged due to the fault of the Contractor, it shall be replaced with new pipe at the Contractor's expense.

Aluminum, aluminized, or aluminum-zinc alloy coated pipe that is to be in contact with concrete or mortar shall have the contact surfaces thoroughly coated with an approved barrier coating recommended by the pipe manufacturer or approved by the Agency's Materials and Research Section, which shall be allowed to dry before installation.

Where the protective coating has been removed from the metal, either by cutting, burning, welding, placing, or any other means, it shall be repaired by thoroughly cleaning with a wire brush and treating the damaged areas as follows:

(a) in accordance with AASHTO M 36M.

(b) for damaged polymeric coating, application of a coal-tar based or other polymeric coating as recommended by the manufacturer.

601.04 EXCAVATION. Where pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe.

The completed trench bottom shall be firm for its full length and width. The invert grade shall be cambered by an amount to be determined by the Engineer.

If shown on the Plans or directed by the Engineer, unsuitable foundation material encountered below the normal grade of the culvert bed shall be removed and replaced with Granular Backfill for Structures, or other specified or approved material.

Ledge rock, rocky or gravelly soil, hard pan, or other unyielding foundation material encountered at the normal grade of the culvert bed shall be removed and replaced with Granular Backfill for Structures having a width measurement of the inside width of the pipe plus 600 mm (24 inches) and to a minimum depth of 300 mm (12 inches) below the pipe grade, unless otherwise shown on the Plans or directed by the Engineer.

601.05 BEDDING. Unless otherwise specified, the bed shall be shaped and compacted to fit the pipe for a depth of not less than 10 percent of its total height. Recesses to receive the bell shall be formed when applicable.

601.06 PLACEMENT. No pipe shall be placed until the trench and the prepared foundation have been approved by the Engineer.

Placement shall begin at the outlet end. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the outside circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of riveted pipe shall be at the sides.

Pipe with paved inverts shall be laid so that the paved segment is centered at the bottom of the pipe.

The handling holes in concrete pipes shall be filled with a precast plug, sealed, and covered with mastic or mortar.

601.07 JOINING PIPE.

(a) Concrete Pipe. Concrete pipe shall be of bell and spigot or tongue and groove design, or as specified. Pipe sections shall be joined so that the ends are fully entered and the inner surfaces are reasonably flush and even.

Joints shall be made with portland cement mortar, portland cement grout, rubber gaskets, oakum and mortar, oakum and joint compound, a combination of these types, or any one type as specified and approved by the Engineer. Joints in concrete pipe should be thoroughly wetted before mortar or grout is applied.

Mortar joints shall be made with an excess of mortar to form a bead around the outside of the pipe and finished smooth on the inside. For grouted joints, molds or runners shall be used to retain the poured grout. Rubber ring gaskets shall be installed so as to form a flexible watertight seal. Where oakum is used, the joint shall be caulked with this material and then sealed with the specified materials.

When portland cement mixtures are used, the completed joints shall be protected against rapid drying by suitable curing materials, and protected from freezing until adequate set and strength have been reached, as determined by the Engineer.

The first three sections, at ends of culverts that are not restrained by drop inlets or catch basins, shall be connected together at the springline on each side of the pipe to restrain movement of the sections. If an end section is used, it shall be one of the three sections to be connected together.

The connecting devices shall be at least 3.7 m (12 feet) in length when used with 2.3 m (7.5 foot) minimum length sections and at least 3 m (10 feet) in length when used with 1.8 m (6 foot) minimum length sections. Each device shall be securely anchored to the pipe, with minimum slack in the device and the joints. The anchoring points shall be a minimum of 450 mm (18 inches) from the end of the pipe sections and the flared end sections. Each end of the device shall be anchored with an M24 (1 inch) bolt with a nut and washer, or its equivalent, through the section wall.

Each device shall be a steel strap with an effective cross-sectional area of 150 mm^2 (0.23 in^2) for all pipe 1200 mm (48 inches) in diameter or smaller. For pipe larger than 1200 mm (48 inches) in diameter, the required steel area for restraining devices shall be as shown on the Plans.

Alternate designs of restraining devices and anchoring hardware will be considered for approval as long as they provide equivalent restraining properties and durability.

Restraining devices may be placed on either the inside or outside of the pipe. If placed on the inside, the device shall not protrude from the wall to the degree that flow would be obstructed. Any bending of the device for proper installation shall be done by the cold bending method. Holes in the pipe and end sections, required for the anchor bolts, may be drilled in the field.

(b) Metal Pipe. Metal pipes shall be firmly joined by coupling bands.

Pipes with an effective diameter greater than 900 mm (36 inches) shall be joined by coupling bands that fully engage the second full corrugation from the end of each pipe.

Pipes on steep grades (greater than 14 percent) will be joined either by 600 mm (24 inches) wide coupling bands or by bands additionally equipped with silo rods or cables for positive attachment.

In all cases, ends of pipes joined by coupling bands shall be as close together as the corrugations will allow.

(c) Corrugated Polyethylene Pipe. Corrugated Polyethylene pipe shall be joined by a system designed and approved by the pipe manufacturer. Couplings and fittings shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints.

601.08 BACKFILLING. Installed pipe will be inspected and approved before any backfill is placed. Any pipe found to be damaged or out of alignment shall be removed and replaced or re-laid without additional compensation.

Unless otherwise shown on the Plans or directed by the Engineer, the backfill material shall be selected fine compactable soil from excavation when available, or Granular Backfill for Structures. This material shall be placed to a height of 600 mm (24 inches) over the pipe. No stones in excess of 75 mm (3 inches) in diameter shall be placed in contact with the pipe. Rock fill or boulders shall not be placed within 600 mm (24 inches) of the outside of the pipe.

The backfill material shall be placed in 150 mm (6 inch) thick layers and compacted in accordance with Subsection 203.11(d) using air or mechanical tampers. Care shall be exercised to thoroughly compact the material under the haunches of the pipe. The backfill shall be placed evenly on both sides of the pipe for its full length. In embankment sections the fill shall be compacted for a width on each side of the pipe equal to at least twice the horizontal inside diameter of the pipe or 4 m (12 feet), whichever is less. Fill at the sides of the pipe may be compacted by operating compaction equipment longitudinally parallel with the pipe, provided care is taken to avoid displacement or injury to the pipe.

All pipe shall be protected by a 1.2 m (4 foot) cover of fill before heavy equipment or traffic is permitted to cross during construction of the roadway. Whenever this cover extends above the subgrade the Contractor shall temporarily place earth which shall be removed when necessary to complete the work in accordance with the details shown on the Plans or as directed by the Engineer. Any deviation from this practice shall have prior approval by the Engineer. However, compliance with the 1.2 m (4 foot) protective cover requirement shall not relieve the Contractor of any responsibility concerning damage to the pipe.

601.09 CLEANING OF CULVERTS. Pipe culverts at the locations shown on the Plans, or as directed by the Engineer, that contain silt, debris, and other material within the barrel and appurtenances shall have the silt, debris, and other material removed and disposed of by methods that do not damage the pipe.

With the approval of the Engineer, all or part of a pipe designated to be cleaned in place may be removed, cleaned, and relaid in accordance with these specifications. In these cases, the Contractor shall furnish all material required to replace damaged pipes and joints, perform all excavation and backfill, and re-lay the pipe, all at the Contract unit price for the Contract item Cleaning Culvert Pipe, In Place.

However, if the Engineer determines that the pipe must be replaced, through no fault of the Contractor, replacement will be paid for under the appropriate Contract items.

601.10 METHOD OF MEASUREMENT. The quantities of culverts and storm drains to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work, as shown on the Plans or ordered by the Engineer. No allowance will be made for "growth" in length at joints when this increase exceeds the ordered length.

When it is necessary to cut pipe in the field, the quantity of pipe to be measured for payment will be the length necessary, rounded to the next whole meter (2 foot) increment.

The quantity of Re-laying Pipe Culverts to be measured for payment will be the number of meters (linear feet) of re-laid pipe in the complete and accepted work.

The quantities of pipe Elbows, End Sections, and Concentric Reducer Sections to be measured for payment will be the number of each size and type of unit installed in the complete and accepted work.

The quantity of Cleaning Culvert Pipe, In-Place to be measured for payment will be the total length of pipe for each pipe acceptably cleaned, as determined along the flow line of the pipe. The cost to clean material from pipes as the result of on-project construction activities shall be at the Contractor's expense.

601.11 BASIS OF PAYMENT. The accepted quantities of culverts and storm drains of the type and size specified will be paid for at the respective Contract unit price per meter (linear foot).

The accepted quantity of Re-laying Pipe Culverts will be paid for at the Contract unit price per meter (linear foot).

The accepted quantities of pipe Elbows, End Sections, and Concentric Reducer Sections of the type and size specified will be paid for at the respective Contract unit price each.

The cost of vertical risers, when shown on the Plans, shall be included in the Contract unit price per meter (linear foot) for each culvert to which a riser is attached. Each vertical riser pipe shall be bid as a separate unit.

Payment will be full compensation for fabricating, furnishing, transporting, handling, and placing the material specified to include bituminous or other coating, coupling bands, joint material, cutting when necessary, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation, including backfill operations and the disposal of excavated material (excess or unsuitable for backfill), will be paid as follows:

(a) For all pipes, pipe arches, elbows, end sections, or concentric reducers of 1200 mm (48 inches) in diameter and under, at the Contract unit price per cubic meter (cubic yard) for Trench Excavation.

(b) For all pipes, pipe arches, elbows, end sections, or concentric reducers of over 1200 mm (48 inches) in diameter, at the Contract unit price per cubic meter (cubic yard) for Structure Excavation.

(c) When material is required to replace poor foundation material below the normal grade of the culvert, it will be paid for at the Contract unit price per cubic meter (cubic yard) for the type of backfill specified.

(d) When Granular Backfill for Structures is required for backfill material, it will be paid for at the Contract unit price per cubic meter (cubic yard).

Anchor bolts, required in construction of headwalls, will not be paid for separately but will be considered incidental to the Contract unit price for the pipe on which they are required.

The accepted quantity of Cleaning Culvert Pipe, In-Place will be paid for at the Contract unit price per meter (linear foot) for the specified size of pipe. Payment will be full compensation for cleaning the pipe; for excavating, backfilling, and re-laying the pipe, if necessary; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
601.0000 to 601.0199	CSP	Meter (Linear Foot)
601.0200 to 601.0399	CAAP	Meter (Linear Foot)
601.0400 to 601.0599	PCCSP	Meter (Linear Foot)
601.0600 to 601.0799	PCCSP(PI)	Meter (Linear Foot)
601.0800 to 601.0899	RCP	Meter (Linear Foot)
601.0900 to 601.0999	CPEP	Meter (Linear Foot)
601.2000 to 601.2199	CSP(SL)	Meter (Linear Foot)
601.2200 to 601.2399	CAAP(SL)	Meter (Linear Foot)
601.2400 to 601.2599	PCCSP(SL)	Meter (Linear Foot)
601.2600 to 601.2799	CPEP(SL)	Meter (Linear Foot)
601.3000 to 601.3199	CSPA	Meter (Linear Foot)
601.3200 to 601.3399	CAAPA	Meter (Linear Foot)
601.3400 to 601.3599	PCCSPA	Meter (Linear Foot)
601.3600 to 601.3799	PCCSPA(PI)	Meter (Linear Foot)
601.4000 to 601.4199	CSPA(SL)	Meter (Linear Foot)
601.4200 to 601.4399	CAAPA(SL)	Meter (Linear Foot)
601.4400 to 601.4599	PCCSPA(SL)	Meter (Linear Foot)
601.5000 to 601.5199	CSP Elbow	Each
601.5200 to 601.5399	CAAP Elbow	Each
601.5400 to 601.5599	PCCSP Elbow	Each
601.5600 to 601.5799	PCCSP Elbow (PI)	Each
601.5800 to 601.5999	CPEP Elbow	Each
601.6000 to 601.6199	CSPES	Each
601.6200 to 601.6399	CAAPES	Each
601.6800 to 601.6899	RCPES	Each
601.7000 to 601.7099	CPEPES	Each
601.8000 to 601.8199	CSPAES	Each

601.8200 to 601.8399 CAAPAES	Each
601.98 Concentric Reducer Section	Each
601.99 Re-laying Pipe Culverts	Meter (Linear Foot)
601.995 Cleaning Culv. Pipe, In-Place [0 to 600 mm (24 in.), incl.]	Meter (Linear Foot)
601.996 Cleaning Culv. Pipe, In-Place [Greater than 600 mm (24 in.)]	Meter (Linear Foot)

SECTION 602 - MASONRY

602.01 DESCRIPTION. This work shall consist of furnishing materials and constructing walls, and other masonry of the types and sizes specified, or rebuilding, repairing, or repointing of existing masonry.

602.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Stone for Masonry	706.01
Stone for Masonry Facing	706.02
Mortar, Type II	707.02
Dowels and Ties	713.01
Bar Reinforcement	713.01

Materials for Rebuilt and Repairing Stone Masonry shall be approved by the Engineer prior to use. New stone, as required, shall match as closely as practical the existing stone masonry color, texture, and size. If required to match the existing stone masonry, chemical treatment processes to aid in providing stone of similar color shall be investigated by the Contractor.

Concrete for headwalls shall meet the requirements of Section 541 for Concrete, Class B.

Concrete for copings, bridge seats, and backwalls, unless otherwise specified, shall meet the requirements of Section 501 for Concrete, High Performance Class B.

Backfill material shall meet the requirements of Section 204 for Granular Backfill for Structures.

602.03 MIXING OF MORTAR. The fine aggregate and cement shall be mixed in a clean, tight box until a mixture of uniform color is produced, after which clean water shall be added in such quantity as to form a mortar with the consistency of stiff paste. If desired, the Contractor will be permitted to use a batch mixer of an approved size and type. Mortar which has been mixed for more than 45 minutes shall not be used, and retempering of mortar will not be permitted.

602.04 PLACING OF STONE. The placing and shaping of stone shall be the same for dry or cement masonry.

The bed shall be clean and well moistened just prior to the placement of the stone. The stone shall be thoroughly saturated with water, well bedded into the mortar and carefully settled in place before the mortar has set. No spalls will be permitted in the bed. Joints and beds shall not average over 25 mm (1 inch) in thickness.

The masonry shall be laid in full mortar beds to the lines shown on the Plans and in approximately level courses. The bottom or foundation courses shall be composed of large selected stones.

All courses shall be laid with bearing beds parallel to the natural bed of the materials. The larger stone shall be used near the bottom and the smaller stone near the top of the masonry, the latter corresponding, as nearly as possible, to the minimum thickness of the masonry at its top.

The construction of stone masonry will not be permitted in freezing weather or when frost is in the stone, except by written permission of the Engineer and subject to conditions as the Engineer may require.

In walls where the thickness is over 1.2 m (4 feet), the stones used as headers for the purpose of holding in the heart of the wall shall extend not less than 1.2 m (4 feet) into the core and shall occupy not less than 20 percent of the front and back surface area of the wall.

In walls where the thickness is 1.2 m (4 feet) or less, the stones used as headers shall extend entirely through the wall.

The break in joints of the stone shall be at least 150 mm (6 inches) on the exposed faces of the wall and the backing stones shall be laid so that the joints are broken. The rear face of the wall shall present an approximately plane surface.

The stone shall be roughly squared on joints, beds, and faces, and shall be pitched to line, at all angles and ends of walls. All shaping or dressing of stones shall be done before the stone is laid in the wall, and no dressing or hammering that would tend to loosen the stones already set will be permitted after their placement. Any stone around which the bond has become broken shall be removed, the mortar shall be thoroughly cleaned from the bed and joints, and the stone shall be reset in fresh mortar.

602.05 WEEP HOLES. Weep holes shall be constructed as shown on the Plans or as ordered by the Engineer.

602.06 REBUILT AND REPARING STONE MASONRY.

(a) General.

(1) Rebuilt Stone Masonry. The stone masonry of the existing substructure and wingwalls shall be mapped, removed, and rebuilt as indicated and specified in the Contract Documents.

Following backfill excavation, the existing stones, tree stumps, roots, and other foreign matter shall be removed in the areas shown on the Plans or where directed by the Engineer. The existing stones shall be re-set in their original locations, removing any gaps that occurred due to previous damage to the walls. Rebuilt Stone Masonry shall match securely into adjacent masonry.

(2) Repairing Stone Masonry. Earth, minor vegetation, and other foreign matter shall be removed and cavities in the stone substructure and wingwalls filled as indicated and specified in the Contract Documents.

(b) Construction Requirements.

(1) Rebuilt Stone Masonry. The work shall be performed by a stone mason who is highly knowledgeable and experienced in the construction of dry stone masonry walls and fascia. The Contractor's stone mason performing the work must demonstrate at least five years experience in the construction of dry stone masonry walls. Documentation of experience, including a list of previous projects and references, shall be submitted to the Engineer prior to commencement of the work.

The existing stone masonry in the areas of reconstruction shall be mapped out and documented. Each stone size and location shall be noted. The Contractor, prior to stone removal, shall submit documentation to the Engineer for approval.

Special care and precautions shall be taken during removal and storage of the existing stone masonry to ensure that the stone is not damaged.

All stones shall be carefully removed in the areas shown on the Plans. The Contractor shall shore the remaining portions of the walls to ensure that they do not shift during construction.

The existing stones shall be replaced in their original locations, removing any gaps that occurred due to previous damage to the walls. All joints in the reconstructed stone walls shall be no larger than 19 mm (3/4 inch) between stones. Any existing stones that are not suitable for replacement or missing shall be replaced by the Contractor with stones of similar size and appearance.

(2) Repairing Stone Masonry.

a. Examination. The Contractor and Engineer shall jointly examine the abutments and wingwalls to field verify the extent of the work.

All work shall be performed by stonemasons with a minimum of three (3) years experience with similar work.

b. Repair. Gaps between horizontal faces of existing stones less than 25 mm (1 inch) shall not be repaired. The size of these gaps shall equal the approximate diameter of a 22 mm (7/8 inch) diameter steel dowel bar.

Gaps between horizontal faces of existing stones between 25 mm (1 inch) and 150 mm (6 inches) shall have small stone blocks added, with the depth of the blocks as large as possible for good bearing. The minimum width of said blocks shall be 100 mm (4 inches).

Gaps between horizontal faces of existing stones greater than 150 mm (6 inches) shall have crushed gravel and stone blocks added. The crushed gravel shall be placed at the back of the stone and compacted in place up to 300 mm (12 inches) of the exposed wall face. The crushed gravel shall be compacted by tamping rods or other methods acceptable to the Engineer. Stone block(s) shall then be added to achieve a tight fit. New stone blocks shall not extend beyond the face of the stone wall.

602.07 POINTING AND REPOINTING. All joints shall be filled with mortar, well driven in, and finished with an approved pointing tool for a distance of 15 mm (1/2 inch) back from the surface of the stone.

When joints are in old masonry, they shall be cleaned of all loose mortar and dirt for a depth in from the face of the wall of at least twice the width of the joint and moistened.

All mortar shall be cleaned from the face of the stones after the pointing is completed and the work has cured for a period of three days.

602.08 DOWELS AND TIES. Where required, bonding of various portions of the work shall be accomplished with dowels and ties of the shapes and dimensions shown on the Plans or approved by the Engineer. They shall be placed, as shown or required, in the stone so as to clear the bed of the succeeding course.

Dowel holes shall be drilled into each stone, to match dowels already set, before the stone is placed. No drilled holes will be permitted in the exposed top surfaces.

602.09 BACKFILLING. Spaces excavated for masonry structures, but not occupied by these structures, shall be backfilled. The backfill shall be placed in horizontal layers of not more than 150 mm (6 inches) in depth. Each layer shall be thoroughly compacted by means of air or mechanical tampers in a manner approved by the Engineer.

602.10 METHOD OF MEASUREMENT. The quantities of Cement Masonry and Dry Masonry to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, measured in accordance with the dimensions shown on the Plans or ordered by the Engineer.

The quantities of Stone Masonry Facing and Repointing Masonry to be measured for payment will be the number of square meters (square yards) performed in the complete and accepted work, measured as follows:

(a) The quantity of Stone Masonry Facing will be the height of the front face plus the width of the capstones times the length of the stone masonry facing. No deductions will be made for weep holes, drain pipes, or other openings of less than 0.2 m^2 (2 ft^2).

(b) The quantity of Repointing Masonry will be the total surface area of the masonry repointed.

The quantity of Rebuilt Stone Masonry to be measured for payment will be the number of cubic meters (cubic yards) of stone masonry rebuilt in the complete and accepted work, measured in accordance with the dimensions shown on the Plans or as determined by the Engineer.

The quantity of Repairing Stone Masonry to be measured for payment will be the number of square meters (square yards) of stone masonry repaired in the complete and accepted work, measured as the total surface area of the repaired masonry.

602.11 BASIS OF PAYMENT. The accepted quantities of Cement Masonry, Dry Masonry, Stone Masonry Facing, and Repointing Masonry will be paid for at the Contract unit price per cubic meter (cubic yard) or square meter (square yard) for the item specified. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The dowels and ties required for constructing stone masonry facing will not be paid for separately but will be considered incidental to the Contract unit price per square meter (square yard) for Stone Masonry Facing.

Excavation will be paid for as Trench Excavation, unless otherwise shown on the Plans.

The accepted quantity of Rebuilt Stone Masonry will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for mapping, documenting, and removing existing stone masonry; furnishing new stone as needed; furnishing, transporting, handling, and placing the materials specified; backfilling when not paid under a separate Contract item; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation adjacent to Rebuilt Stone Masonry and disposal of excess or unsuitable excavated material will be paid for at the Contract unit price per cubic meter (cubic yard) for Structure Excavation. Excavation shall be backfilled with material acceptable to the Engineer. When Granular Backfill for Structures is required for backfill material, it will be paid for at the Contract unit price per cubic meter (cubic yard).

The accepted quantity of Repairing Stone Masonry will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for removing material specified from the face of stone masonry; filling cavities; furnishing, transporting, handling, and placing the materials specified; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
602.15 Cement Masonry	Cubic Meter (Cubic Yard)
602.20 Dry Masonry	Cubic Meter (Cubic Yard)
602.25 Stone Masonry Facing	Square Meter (Square Yard)
602.30 Repointing Masonry	Square Meter (Square Yard)
602.35 Rebuilt Stone Masonry	Cubic Meter (Cubic Yard)
602.40 Repairing Stone Masonry	Square Meter (Square Yard)

SECTION 604 - DROP INLETS, CATCH BASINS, AND MANHOLES

604.01 DESCRIPTION. This work shall consist of the construction, rehabilitation, or adjustment to grade of drop inlets, catch basins, and manholes; and the furnishing and placing of cast iron or steel grates and cast iron or precast concrete covers.

604.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Clay or Shale Sewer Brick 705.01
Concrete Masonry Blocks 705.02
Precast Drop Inlets, Catch Basins, and Manholes..... 705.04
Mortar, Type II 707.02
Reinforced Concrete Pipe 710.01
Vitrified Clay Pipe 710.04
Bar Reinforcement 713.01
Welded Steel Wire Fabric 713.05
Cast Iron Frame, Grate, and Cover .....715.01(b)
Ductile Iron Frame and Cover .....715.01(c)

Unless otherwise specified, cast-in-place concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Material for steel grates shall meet the requirements of ASTM A36/A36M. For steel grates, a Type D certification shall be furnished in accordance with Subsection 700.02.

Pipe stubs for precast reinforced concrete curb drop inlets shall meet the requirements of Section 601.

The term "cast iron," as used in these Specifications, or in various Contract items, when used in conjunction with covers and frames, shall be understood to mean "cast iron or ductile iron." The Contractor may use ductile iron covers and frames meeting the requirements of Subsection 715.01(c) instead of cast iron covers and frames. Steps or ladder rungs in drop inlets, catch basins, or manholes shall be plastic, complying with all applicable OSHA dimensional and structural requirements. Unless otherwise shown on the Plans, the rungs shall be cast into the fresh concrete, except that for precast units, the rungs may be grouted into preformed voids with a non-shrink grout approved by the Engineer after the concrete has cured.

604.03 GENERAL CONSTRUCTION REQUIREMENTS. The excavation shall be to the depth shown on the Plans or ordered by the Engineer, and carefully shaped and graded.

The footings for drop inlets, catch basins, and manholes may be either precast or cast-in-place concrete.

For construction of drop inlets, catch basins, or manholes, the bricks used on top of the concrete to adjust the top to the correct elevation shall meet the requirements of Subsection 705.01(c).

Unless directed otherwise by the Engineer, when adjusting the elevation of the tops of existing drop inlets, catch basins, sewer manholes, or manholes, the Contractor shall remove all existing bricks and replace them with new bricks meeting the requirements of Subsection 705.01(c) as part of the work and costs included in the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes or the Contract item Changing Elevation of Sewer Manholes.

Channels, inverts, and floor areas for sewer manholes shall be constructed of brick and mortar or Class C concrete conforming to Section 541. Inverts shall have the exact shape of the sewer to which they are connected and any change in size or direction shall be gradual and even. All construction of sewer manholes must be carried out to ensure

watertight work. Any leaks in manholes shall be repaired to the satisfaction of the Engineer, or the entire structure shall be removed and rebuilt. Leakage testing shall be performed in accordance with Subsection 628.08.

In the construction of baffled drop inlets, the angle attaching bolts may be inserted into anchors cast into the fresh concrete, or expansion anchors drilled and set into the concrete after the form work has been removed. Expansion anchors shall not be drilled and placed until a minimum of eight days after the day of the pour has passed.

Prior to rehabilitating or changing the elevation of any drop inlet, catch basin, or manhole, the Contractor shall completely clean out the interior of the unit, including cleaning at least 300 mm (12 inches) but not more than 600 mm (24 inches) into any openings in the walls for inspection to determine the extent of the work that will be required.

Except for components cast using the dry cast process, precast concrete components shall not have the forms removed until a minimum compressive strength of 15 Mpa (2000 psi) has been achieved. Precast components shall not be moved until two hours after they have been cast and until a minimum compressive strength of 15 Mpa (2000 psi) has been achieved. Concrete cylinders shall be made, in accordance with AASHTO T 23, at the last placement of the day.

Reinforced precast sections shall not be shipped from the manufacturing facility until the eighth day from the date of manufacture, except when the supplier provides test results demonstrating that the design strength has been achieved.

604.04 CONSTRUCTION OF DROP INLETS, CATCH BASINS, AND MANHOLES.

(a) Concrete Drop Inlet, Catch Basin, or Manhole. The concrete walls shall be constructed on the approved footing to the lines, grades, and dimensions shown on the Plans or directed by the Engineer.

The required courses of brick shall be placed on top of the concrete to the elevation shown on the Plans or directed by the Engineer. Brick shall be laid in a professional manner by a competent mason. After the bricks are laid, the joints on the inside of the brick masonry shall be neatly pointed. The outside surface of the brick shall be covered with mortar of the same quality as used for laying the bricks so that a reasonably smooth surface is obtained.

The top section may be precast or cast-in-place.

The cast iron frame shall be set in the concrete tops as shown on the Plans. When tops are precast, they shall be placed in a full mortar bed. The grate or cover shall be properly placed in the frame.

(b) Precast Reinforced Drop Inlet, Catch Basin, or Manhole. The precast reinforced concrete risers shall be set reasonably close to line and grade on the previously placed concrete footing. The top section shall be capped with courses of mortared brick.

The cast iron frame shall be placed in a full mortar bed on the brick masonry and the cast iron cover or grate shall be placed on top of the frame.

(c) Precast Reinforced Concrete Pipe Drop Inlet. The precast reinforced concrete pipe sections shall be set on a concrete base as shown on the Plans or as directed by the Engineer.

A precast concrete cover or a cast iron grate shall be placed as shown on the Plans.

(d) Precast Reinforced Concrete Curb Drop Inlet. The precast reinforced concrete curb drop inlet shall be set to the line and grade as shown on the Plans or as directed by the Engineer.

The brick masonry, concrete top, and grate shall conform to the requirements of Subsection 604.04(a).

(e) Changing Elevation of Drop Inlets, Catch Basins, or Manholes. Existing drop inlets, catch basins, and manholes that are to be altered or adjusted in elevation of the existing top shall be reconstructed to the required grade using the existing grates, frames, covers, or tops as specified. If the existing grates, frames, covers, and/or tops are not suitable for reuse, this Contract item shall not be used.

Should any grate, frame, cover, or top become broken through carelessness on the part of the Contractor, it shall be replaced at the Contractor’s expense.

The existing structure shall be dismantled sufficiently to allow elevation adjustment as shown on the Plans or as directed by the Engineer. The existing grates, frames, covers, or tops to be reused shall be thoroughly cleaned of mortar before being reused. Any deteriorated brick, mortar, or missing brick in the structure, including any curb portions of the tops, shall be repaired or replaced by the Contractor.

Granite or concrete curbs, curb board, and bituminous fillet disturbed for this work shall be replaced. New treated timber curb board required shall meet the requirements of Subsection 729.06. Bituminous fillet shall conform to the applicable requirements of Section 406, for the type of mix specified by the Engineer and, after installation, shall be sealed in accordance with Subsection 616.08(d). Concrete curb and granite curb shall conform to the applicable requirements of Section 616. The cost of this curb replacement will not be paid for directly, but will be considered incidental to the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes.

Where the unit is to be raised and the change in elevation is less than 50 mm (2 inches), concentric structural steel rings of nominally 13 mm (1/2 inch) thick material properly welded to the frame may be used.

The Contract unit price bid for the Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes shall include all the work and costs involved in cutting pavements and excavating around the top of the unit and the bricks to provide room to accomplish the work, and shall also include all costs of backfilling around the elevation reset unit up to the bottom of pavement or the upper surface of the unit top, as appropriate to the individual location.

If excavating through paved surfaces is required, the edges of the excavated area shall be saw cut to a minimum depth of 40 mm (1 1/2 inches).

(f) Cast Iron Cover with Frame. The covers with frames shall be properly installed at the locations shown on the Plans or directed by the Engineer.

Covers for sanitary sewer manholes shall have the word “SEWER” cast into the top surface. Covers for storm sewer manholes shall have the word “STORM” cast into the top surface.

(g) Grates. The grates shall be properly installed at the locations shown on the Plans or directed by the Engineer.

(h) Sanitary Sewer Manhole. Sanitary sewer manholes shall be precast sewer manholes of the type and diameter shown on the Plans and shall meet the requirements of Subsection 705.04 except that all barrel joints shall contain an o-ring seal. Steps shall meet OSHA requirements for new construction. The exterior of the entire manhole shall be coated with a bitumastic or other watertight sealant meeting the approval of the sewer line owner. All joints between pipes and the manhole shall be made using an approved watertight boot.

(i) Changing Elevations of Sewer Manholes. Existing sewer manholes that are to be altered or adjusted shall be reconstructed in accordance with Subsection 604.04(e), except that all exterior surfaces disturbed by the necessary reconstruction shall be coated or recoated with a watertight sealant approved by the sewer line owner. Necessary steps, pipe joints, and barrel joints shall conform to the requirements of Subsection 604.04(h).

The Contractor may be required to provide a specific step to match the existing steps as part of the work and costs included in this Contract item.

(j) Rehabilitation of Drop Inlets, Catch Basins, or Manholes. Existing drop inlets, catch basins, and manholes that are to be altered, adjusted, or reconstructed shall be constructed to the required grade using existing grates, frames, covers, or tops, if useable, as specified. If necessary, this work shall include removal of the existing structure and the complete replacement of the drop inlet, catch basin, or manhole with a unit meeting current standards.

This work shall belong to one of three classes. Class I shall include all work down to a depth of 1 m (3 feet). Class II shall include all work greater than 1 m (3 feet) in depth down to a depth of 2 m (6 feet). Class III shall include all work greater than 2 m (6 feet) in depth.

If the existing grates, frames, covers, or tops are suitable for reuse, but the remainder of the top requires replacement, the Contractor shall carefully remove the frame from the existing top and cast a new top utilizing the existing grate, frame, or cover. If the existing grates, frames, covers, or tops are unsuitable for reuse, new ones shall be furnished as required. Unless otherwise specified, the replacement shall match the existing grate, frame, or cover in size and design.

Should any useable, existing grate, frame, cover, or top become broken through carelessness on the part of the Contractor, it shall be replaced at the Contractor's expense.

The existing structure shall be dismantled sufficiently to allow rehabilitation as shown on the Plans for completed drop inlets, catch basins, and manholes. Any existing grate, frame, cover, or top to be reused shall be thoroughly cleaned of mortar before being reused. Any deteriorated brick, concrete, reinforcement, steps, mortar, or missing brick in the structure, including any curb portions of the tops, shall be repaired or replaced by the Contractor as directed by the Engineer.

If the rehabilitation proceeds to a point where the culverts or other pipes entering and/or exiting the unit are within the area of rehabilitation and/or replacement, the necessary pipe stubs and collars, to connect the existing piping to the rehabilitated unit, shall be provided and installed by the Contractor. If the Contract includes a Contract item for the pipe, the pipe stubs will be paid for under the appropriate Section 601 or Section 605 Contract item in the Contract. If the Contract does not include a Contract item for the pipe, the pipe stubs and collar will not be paid for directly, but will be considered incidental to the Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, II, or III, as appropriate.

Granite, bituminous, or concrete curbs, curb board, and bituminous fillet disturbed for this work shall be replaced. New treated timber curb board required shall meet the requirements of Subsection 729.06 Bituminous fillet shall conform to the applicable requirements of Section 406 for the type of mix specified by the Engineer and, after installation, shall be sealed in accordance with Subsection 616.08(d). Concrete, bituminous, and granite curb shall conform to the applicable requirements of Section 616. The costs of this curb replacement will not be paid for directly, but will be considered incidental to Contract items Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I; Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class II; or Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class III, as appropriate.

Where the unit is to be raised and the change in elevation is less than 50 mm (2 inches), concentric structural steel rings of nominally 13 mm (1/2 inch) thick material properly welded to the frame may be used.

The Contract unit price bid for the Contract items Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, II, or III shall include all the work and costs involved in cutting pavements and excavating around the top of the unit and the bricks, to provide room to accomplish the work, and shall also include all costs of backfilling around the rehabilitated unit up to the bottom of pavement or the upper surface of the unit top, as appropriate to the individual location.

Unless otherwise directed by the Engineer, the Contractor shall saw all pavements to a minimum depth of 40 mm (1 1/2 inches).

(k) Rehabilitation of Sewer Manhole. Rehabilitation of sewer manholes shall consist of removing the existing top with cover, with or without frame, and rehabilitation of the existing unit to a safe and useful structure, satisfactory to the Engineer. If necessary, this Contract item shall include the complete reconstruction of the sewer manhole to current standards.

This work shall consist of replacing broken or deteriorated bricks, mortar, concrete, reinforcement, frames, and covers with new materials. New barrel sections shall be precast of the type and diameter existing or as shown on the Plans and shall meet all requirements of Subsection 705.04 except that all barrel joints shall contain an o-ring. Steps, if required, shall meet OSHA requirements for new construction. The exterior of the entire manhole shall be coated with a bitumastic or other water-tight sealant meeting the approval of the sewer line owner. All joints between pipes and the manholes shall be made using an approved watertight boot.

604.05 CURING AND PROTECTION. After the masonry work is completed, it shall be kept moist and protected from the elements in a satisfactory manner for a period of at least 48 hours. Concrete shall be cured in accordance with Subsection 541.17.

Precast concrete shall be cured using membrane curing compound. The curing compound shall be applied to the concrete surface after finishing, as soon as the free water on the surface has disappeared and no water sheen is visible, but not so late that the liquid curing compound will be absorbed into the concrete. When curing compound cannot be applied as specified herein, the manufacturer shall instead immediately begin wet curing the unit until curing compound can be applied. When this method is used in conjunction with the dry cast process, the curing room shall be kept at 100% humidity until a minimum compressive strength of 15 Mpa (2000 psi) has been obtained.

When the forms are removed prior to 7 days, the exposed concrete surfaces shall be wet with water within one half hour of form removal and shall be kept wet until the curing compound is applied. Before application, the concrete shall be allowed to reach a uniformly damp appearance with no free water on the surface, and then the compound shall be applied immediately.

Precast concrete drainage components shall not be subjected to freezing temperatures prior to attaining the specified 28 day compressive strength. Components which are exposed to freezing before reaching the required 28 day compressive strength shall be rejected without further cause. Any additional testing on the rejected components as determined by the Engineer to gain acceptance will be at the expense of the manufacturer.

604.06 BACKFILLING. Backfilling shall not begin until the end of the curing period. Backfill material shall be approved by the Engineer and placed in layers not exceeding 150 mm (6 inches) in depth. Each layer shall be thoroughly tamped using mechanical tampers. Special care shall be taken to ensure adequate compaction around the inlet and outlet pipes.

604.07 METHOD OF MEASUREMENT. The quantities of new structures to be measured for payment will be the number of units of the respective types used in the complete and accepted work. Cast Iron Grates or Cast Iron Cover with Frames, and Cast Iron Grates and Steel Grates, when used and not included in a specific unit, will be measured as the number of each type specified.

The quantity of Changing Elevation or Rehabilitating of Drop Inlets, Catch Basins, or Manholes to be measured for payment will be the number of units modified in the complete and accepted work.

604.08 BASIS OF PAYMENT. The accepted quantities of new Drop Inlets, Catch Basins, or Manholes will be paid at the Contract unit price per unit each for the specified types. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including concrete, concrete risers, top sections, reinforcing steel, steps, vitrified clay tile pipe, mortar, brick, frames, grates, covers, coatings, pipestubs, weep holes, underdrain ends, curb board, and bituminous fillets, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Changing Elevation of Drop Inlets, Catch Basins, or Manholes and Rehabilitating Drop Inlets, Catch Basins, or Manholes will be paid for at the Contract unit price each for the specified unit or class. Payment will be full compensation for all necessary cleaning of the interior of the unit to determine the extent of the work; for excavating, cutting of pavement, and backfilling; for removing deteriorated materials and designated materials; for furnishing all materials, including backfill material, concrete, concrete risers, top sections, reinforcing steel, steps, concrete block, brick, mortar, frames, grates, covers, coatings, pipe stubs, weep holes and underdrain ends required for reconstructing the unit as shown on the Plans or directed by the Engineer; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation for new drop inlets, catch basins, and manholes will be paid for as Trench Excavation of Earth or Trench Excavation of Rock, as appropriate.

Excavation associated with the rehabilitation or changing elevation of existing drop inlets, catch basins, and manholes will not be paid for separately, but will be considered incidental to the appropriate Contract items.

Backfill material for backfilling around elevation adjusted and rehabilitated drop inlets, catch basins, and manholes shall meet the requirements of Subsection 704.08, unless otherwise directed by the Engineer.

The Contract items Sanitary Sewer Manhole, Changing Elevation of Drop Inlets, Catch Basins, or Manholes and Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I, Class II, and Class III are mutually exclusive. Only one of these Contract items will be paid at any designated location.

The Contract item Changing Elevation of Drop Inlets, Catch Basins, or Manholes will include adjusting the elevation of an existing top, including replacement of deteriorated bricks and mortar, only. The Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class I will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit down to a maximum depth of 1 m (3 feet) below the elevation of the upper surface of the unit top. The Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class II will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit extending below a depth of 1 m (3 feet) to a maximum depth of 2 m (6 feet) below the elevation of the upper surface of the unit top. The Contract item Rehabilitating Drop Inlets, Catch Basins, or Manholes, Class III will include adjusting the elevation of the top and all rehabilitation or reconstruction work on an existing unit extending below a depth of 2 m (6 feet) below the elevation of the upper surface of the unit top.

Payment will be made under:

	Pay Item	Pay Unit
604.10	Concrete Catch Basin with Cast Iron Grate	Each
604.11	Concrete Manhole with Cast Iron Cover	Each
604.18	Precast Reinforced Concrete Drop Inlet with Cast Iron Grate	Each
604.20	Precast Reinforced Concrete Catch Basin with Cast Iron Grate	Each
604.21	Precast Reinforced Concrete Manhole with Cast Iron Cover	Each
604.22	Sanitary Sewer Manhole	Each

604.25	Precast Reinforced Concrete Pipe DI with Cast Iron Grate	Each
604.26	Precast Reinforced Concrete Pipe DI with Concrete Cover	Each
604.30	Precast Reinforced Concrete Curb DI with Cast Iron Grate	Each
604.40	Changing Elevation of Drop Inlets, Catch Basins, or Manholes	Each
604.412	Rehab. Drop Inlets, Catch Basins, or Manholes, Class I	Each
604.415	Rehab. Drop Inlets, Catch Basins, or Manholes, Class II	Each
604.418	Rehab. Drop Inlets, Catch Basins, or Manholes, Class III	Each
604.42	Changing Elevation of Sewer Manholes	Each
604.45	Cast Iron Grate with Frame, Type A	Each
604.46	Cast Iron Grate with Frame, Type B	Each
604.47	Cast Iron Grate with Frame, Type D	Each
604.48	Cast Iron Grate with Frame, Type E	Each
604.49	Cast Iron Grate, Type C	Each
604.50	Steel Grate	Each
604.55	Cast Iron Cover with Frame	Each
604.56	Cast Iron Cover with Frame, Sewer	Each

SECTION 605 – UNDERDRAINS

605.01 DESCRIPTION. This work shall consist of constructing drainage systems using underdrains, underdrain outlets, flushing basins, and risers.

605.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Granular Backfill for Structures 704.08
Drainage Aggregate..... 704.16
Corrugated Polyethylene Underdrain 710.03
PVC Plastic Underdrain 710.06
Corrugated Steel Pipe and Underdrains..... 711.01
Corrugated Aluminum Alloy Pipe and Underdrains 711.02
Cast Iron Cover .....715.01(b)
Geotextile for Underdrain Trench Lining..... 720.01

If the Contract does not specify a particular type of underdrain or carrier pipe, the Contractor may furnish underdrain and carrier pipe of the diameter indicated and in any one of the following materials:

(a) Perforated Corrugated Steel

(b) Perforated Corrugated Aluminum Alloy

(c) Perforated Corrugated Polyethylene

(d) Perforated PVC Plastic

Each system of underdrain, carrier pipes, and underdrain risers shall be constructed of the same material.

605.03 PROTECTION OF MATERIALS. Corrugated polyethylene or PVC plastic pipe stored on the job site prior to use shall be protected from prolonged exposure to sunlight. The Engineer may require impact or other strength tests of the pipe prior to installation when ultraviolet light degradation is suspected.

605.04 INSTALLATION.

(a) Excavation. Trenches for underdrain shall be excavated to the dimensions and grade shown on the Plans or as directed by the Engineer. The surface of the trench shall be prepared to a smooth condition free of debris, depressions, or obstructions which may damage the geotextile.

Trenches for carrier pipe shall be excavated to a width 600 mm (24 inches) greater than the inside diameter of the pipe. Proper bedding material shall be provided where excavation is in solid rock or other unyielding material.

(b) Placing Geotextile. The geotextile fabric shall be placed loosely with no wrinkles or folds. Care shall be taken to ensure direct contact with the soil such that there are no voids between the geotextile and the trench. The geotextile shall be overlapped a minimum of 300 mm (12 inches) at the top of the trench. Additional overlap or anchoring may be required as determined by the Engineer. The upstream geotextile shall be overlapped over the downstream. Drainage aggregate shall be placed to a depth of 150mm (6 inches) to provide a bed and uniform slope for underdrain pipe placement.

(c) Placing Underdrain. The underdrain pipe shall be placed in the center of the trench and firmly embedded in the drainage aggregate. Placing shall be started at the outlet end and proceed toward the inlet end. The underdrain shall be placed with the perforations down, unless otherwise directed by the Engineer.

The joints between sections shall be made by fitting the ends as tightly as practical. Corrugated steel or aluminum alloy underdrain shall be joined with an approved coupling. Polyethylene or PVC plastic underdrain shall be joined with approved fittings.

Inlet ends of all underdrain pipe installations shall be closed with suitable plugs to prevent entry of soil material.

Underdrain flushing basins, consisting of corrugated steel or aluminum alloy pipe of the length and diameter shown on the Plans, and cast iron cover shall be installed at locations shown on the Plans or as directed by the Engineer.

Underdrain risers shall be installed as shown on the Plans or as directed by the Engineer.

(d) Placing Carrier Pipes. Carrier pipes used in an underdrain system placed at road crossings, outlets, or as directed by the Engineer shall be placed on a firm bed and joined in the same manner as underdrain. Unless otherwise directed, non-perforated pipe shall be used.

(e) Backfill. After an underdrain pipe installation has been inspected and approved, material meeting the requirements of drainage aggregate shall be placed to a height of 300 mm (12 inches) above the top of the underdrain and the layer compacted. Care shall be taken not to displace the underdrain pipe. The remainder of the backfill material shall be placed in uniform layers of not more than 150 mm (6 inches) in thickness and thoroughly compacted by use of air or mechanical tampers. The geotextile fabric shall be closed over the drainage aggregate as specified in Subsection 605.04(b)

After inspection and approval of a carrier pipe installation, the trench shall be backfilled with suitable material placed in layers not more than 150 mm (6 inches) in thickness and thoroughly compacted. Unless otherwise specified, this material shall be from trench or roadway excavation.

The backfill material shall not be placed directly in the trench by dumping from haul vehicles or by pushing material into trenches by bulldozers, graders, or other equipment. Placing shall be limited to the use of hand shovels, backhoes, front end loaders, or other similar types of equipment as approved by the Engineer.

(f) Flushing. Prior to the acceptance of the project, each underdrain system shall be thoroughly flushed with water to remove any accumulation of silt, sand, or other debris.

605.05 METHOD OF MEASUREMENT. The quantity of the specified size of Underdrain or Carrier Pipe to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work. When it is necessary to cut underdrain or carrier pipe in the field, the quantity of underdrain or carrier pipe to be measured for payment will be the length necessary, rounded to the next whole meter (2 foot) increment.

The quantity of Underdrain Flushing Basin to be measured for payment will be the number of units installed in the complete and accepted work including the corrugated pipe and the cast iron cover.

605.06 BASIS OF PAYMENT. The accepted quantities of each type and size of Underdrain or Carrier Pipe will be paid at the respective Contract unit price per meter (linear foot).

Underdrain Flushing Basins will be paid at the respective Contract unit price for each. Underdrain used for vertical stand pipes at flushing basin locations or risers will be paid as Underdrain Carrier Pipe.

Payment will be full compensation for fabricating, furnishing, transporting, handling, and placing the material specified, including coupling bands and fittings, drainage aggregate, geotextile fabric, and the necessary backfill material to an elevation 2 m (7 feet) above the flowline, and for furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation for all underdrain, carrier pipe, flushing basins, vertical stand pipes, and risers will be paid for as Trench Excavation.

Backfill placed above an elevation of 2 m (7 feet) over the flowline will be paid for as Granular Backfill for Structures as ordered by the Engineer.

Payment will be made under:

	Pay Item	Pay Unit
(a)	Underdrain pipe.	
	605.10 150 mm (6 inches)	Meter (Linear Foot)
	605.11 200 mm (8 inches)	Meter (Linear Foot)
	605.12 250 mm (10 inches)	Meter (Linear Foot)
	605.13 300 mm (12 inches)	Meter (Linear Foot)
(b)	Underdrain Carrier Pipe.	
	605.20 150 mm (6 inches)	Meter (Linear Foot)
	605.21 200 mm (8 inches)	Meter (Linear Foot)
	605.22 250 mm (10 inches)	Meter (Linear Foot)
	605.23 300 mm (12 inches)	Meter (Linear Foot)
	605.95 Underdrain Flushing Basin	Each

SECTION 607 - ROADWAY PATROL MAINTENANCE

607.01 DESCRIPTION. This work shall consist of the maintenance of any section of roadway that is open to public travel and the maintenance of detours in a reasonably smooth and passable condition. The work shall be limited to those roadways within the construction area and any detours shown on the Plans or as directed by the Engineer.

607.02 SCOPE OF WORK. Roadway patrol maintenance shall include only the leveling and smoothing of sections of the roadway or detours within the construction areas that are not subject to the influence of the Contractor's operations.

This work shall be performed by means of a road grader or other approved equipment. Snow shall be removed by use of an approved grader or other approved plowing equipment. The material and equipment required to maintain the roadway and the furnishing and spreading of sand necessary for winter maintenance shall be included in the Contract unit price for roadway patrol maintenance, unless otherwise directed by the Engineer.

607.03 METHOD OF MEASUREMENT. The quantity of Roadway Patrol Maintenance to be measured for payment will be the number of hours actually worked in performing roadway patrol maintenance.

607.04 BASIS OF PAYMENT. The accepted quantity of Roadway Patrol Maintenance will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
607.10 Roadway Patrol Maintenance	Hour

SECTION 608 - EQUIPMENT RENTAL

608.01 DESCRIPTION. This work shall consist of furnishing, operating, and supervising the use of equipment for performance of work shown on the Plans, in accordance with these Specifications or as directed by the Engineer.

608.02 GENERAL REQUIREMENTS. Equipment shall be maintained in good mechanical condition and shall be operated by capable and experienced operators.

Equipment that is to operate on paved surfaces shall be equipped with rubber tires or smooth street plates. Tracked equipment used to draw any other equipment shall be of a type that will not damage the work being done and has sufficient power to operate the drawn equipment effectively.

Equipment used under this Section shall meet the following specific requirements as to type, size, capacity, power, or dimensions.

In determining whether a particular piece of equipment is classified as Type I or Type II in parts (a), (c), (d), or (g) below, the make and model number shall be referenced against an equipment guide book.

Whenever certain size equipment is requested by the Engineer and the Contractor supplies a larger size, payment will be for the size requested.

(a) Bulldozer. The tractor shall be a crawler type furnished with an angle type blade and power operated controls. The machine shall be classified by size as follows:

(1) Type I. Type I bulldozers shall have a net engine or flywheel power rating of less than 112 kW (150 horsepower).

(2) Type II. Type II bulldozers shall have a net engine or flywheel power rating of not less than 112 kW (150 horsepower).

(b) Grader. The power grader shall be self propelled with pneumatic tire wheels, power operated controls, and a wheel base of at least 5.50 m (18 feet).

(c) Dragline. The dragline shall be the full revolving type equipped with a dragline bucket, clamshell bucket, or approved drop ball as required by the Engineer. One set of mats shall be included with each dragline when necessary. The machine shall be classified by size as follows:

(1) Type I. Type I draglines shall have a rated bucket capacity of less than 1.50 m^3 (2 yd^3).

(2) Type II. Type II draglines shall have a rated bucket capacity of not less than 1.50 m^3 (2 $yd^{3)}$

(d) All Purpose Excavator. The machine shall be a hydraulic excavator and may be self propelled, truck mounted, or crawler mounted. It shall include all attachments required by the Engineer to efficiently perform the work for which it is rented. The machine shall be classified by size as follows:

(1) Type I. Type I all purpose excavators shall have a rated bucket capacity of at least 0.40 m^3 (1/2 yd^3) but less than 0.75 m^3 (1 yd^3).

(2) Type II. Type II all purpose excavators shall have a rated bucket capacity of not less than 0.75 m^3 (1 yd^3).

(e) Power Broom. Power Broom shall provide a sweeping path of not less than 2 m (80 inches). It shall be capable of maintaining a speed of 6.50 km/h (4 miles per hour) when sweeping. 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. All hand labor required in connection with a sweeping operation shall be included.

(1) Type I. Type I power brooms shall be self-propelled or a towed type including the tow vehicle.

(2) Type II. Type II power broom shall consist of furnishing a pickup sweeper and accessory equipment and utilizing it for removal of earth and or other dust producing materials from paved surfaces for the purpose of allaying dust conditions. 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.

(f) Truck. The truck may be the highway type or off-highway type with a minimum capacity of 5 m^3 (6 1/2 yd^3). The capacity of the truck shall be determined by three-dimensional measurement of the body.

(g) Loader. The loader may be the wheel or crawler type, straight or articulated, and shall be furnished with a standard bucket. The machine shall be classified by size as follows:

(1) Type I. Type I loaders shall have a rated bucket capacity of at least 0.75 m^3 (1 yd^3) but less than 3.0 m^3 (4 cubic yards).

(2) Type II. Type II loaders shall have a rated bucket capacity of not less than 3.0 m^3 (4 yd^3).

(h) Truck-Mounted Attenuator. Truck-Mounted Attenuator (TMA) is a crash cushion designed to smoothly decelerate an impacting vehicle. The TMA may be mounted on either trailers or trucks; the unit on which the TMA is mounted must weigh at least 45 kN (10 kips) with a heavier unit being preferable. The unit on which the TMA is mounted shall be used as a barrier vehicle as described in the MUTCD. All such attenuators shall meet the requirements of the National Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3. The TMA shall be placed in accordance with the Contract Documents and as directed by the Engineer.

608.03 METHOD OF MEASUREMENT. The Engineer will issue written orders to the Contractor for work to be performed by the specified equipment.

The quantity of equipment to be measured for payment will be the number of hours each piece of equipment actually worked, including necessary travel time within the project limits.

608.04 BASIS OF PAYMENT. The accepted quantity of the specified equipment will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified; for furnishing, operating, and supervising the use of this equipment, including fuel, repairs, attachments, and transportation of the equipment to and from the project; and for furnishing all labor, tools, other equipment, and incidentals necessary to complete the work.

The Contract unit price for the item Truck-Mounted Attenuator shall also include all costs of furnishing the unit on which the attenuator is mounted, solely for the purpose of the attenuator.

Payment will be made under:

Pay Item		Pay Unit
608.10	Bulldozer Rental, Type I	Hour
608.11	Bulldozer Rental, Type II	Hour
608.15	Power Grader Rental	Hour
608.20	Dragline Rental, Type I	Hour
608.21	Dragline Rental, Type II	Hour
608.25	All Purpose Excavator Rental, Type I	Hour
608.26	All Purpose Excavator Rental, Type II	Hour
608.30	Power Broom Rental, Type I	Hour
608.31	Power Broom Rental, Type II	Hour
608.37	Truck Rental	Hour
608.40	Loader Rental, Type I	Hour
608.41	Loader Rental, Type II	Hour
608.45	Truck-Mounted Attenuator	Hour

SECTION 609 - DUST AND ICE CONTROL

609.01 DESCRIPTION. This work shall consist of treating traveled areas to control dust or reduce ice hazard on the project.

609.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Water 745.01
Calcium Chloride 746.01
Sodium Chloride..... 747.01

609.03 DUST CONTROL WITH WATER. Water shall be applied to traveled areas as the Engineer may designate. The number of applications and the amount of water used shall be based upon field and weather conditions and as ordered in writing by the Engineer.

The equipment for water application shall be equipped with an adequate shutoff valve control in the cab and shall be approved by the Engineer. The equipment shall be available at all times in readiness to perform the work at any time, including Sundays and Holidays, upon written order of the Engineer.

609.04 DUST AND ICE CONTROL WITH CALCIUM CHLORIDE. Calcium chloride shall be applied in such a manner and by such devices that uniform distribution is obtained over the entire area on which it is ordered in writing by the Engineer.

Unless otherwise authorized in writing by the Engineer, calcium chloride shall be applied at the rate of 270 g/m^2 (1/2 pound per square yard) for dust and ice control. It shall not be used on surfaces on which bituminous material will be applied, unless directed by the Engineer.

When used on granular surfaces on which bituminous material will be applied, the surface shall be reworked by grading or other means to ensure that the surface is sufficiently free of excess calcium chloride as determined by the Engineer.

Sodium chloride may be substituted for calcium chloride for ice control when approved in writing by the Engineer.

609.05 METHOD OF MEASUREMENT. The quantity of Dust Control with Water to be measured for payment will be the number of cubic meters (1000 gallons) of water actually used in the complete and accepted work. The Contractor shall provide equipment meeting the approval of the Engineer for measuring the quantity of water applied.

The quantity of Dust and Ice Control with Calcium Chloride to be measured for payment will be the number of metric tons (tons) of calcium chloride actually used in the complete and accepted work. When calcium or sodium chloride is delivered in bulk, the quantity will be determined from load tickets.

When sodium chloride is used instead of calcium chloride for ice control, the quantity measured for payment will be the total quantity used multiplied by 0.50.

609.06 BASIS OF PAYMENT. The accepted quantity of Dust Control with Water will be paid for at the Contract unit price per cubic meter (1000 gallons). The accepted quantity of Dust and Ice Control with Calcium Chloride will be paid for at the Contract unit price per metric ton (ton). Payment will be full compensation for furnishing, measuring the load, transporting, handling, and placing the material specified, including any reworking of granular surfaces as specified, and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
609.10 Dust Control with Water	Cubic Meter (Thousand Gallons)
609.15 Dust and Ice Control with Calcium Chloride	Metric Ton (Ton)

SECTION 612

THIS SECTION RESERVED

SECTION 613 - STONE FILL, RIPRAP, AND SLOPE PAVING

613.01 DESCRIPTION. This work shall consist of furnishing and placing protective materials.

613.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Sand Borrow and Cushion 703.03
Gravel Backfill for Slope Stabilization..... 704.07
Concrete Units for Slope Paving 705.03
Stone for Riprap, Heavy Type.....706.03(a)
Stone for Riprap, Light Type.....706.03(b)
Stone for Stone Fill, Type I .....706.04(a)
Stone for Stone Fill, Type II.....706.04(b)
Stone for Stone Fill, Type III.....706.04(c)
Stone for Stone Fill, Type IV .....706.04(d)
Stone for Slope Paving 706.05

613.03 PREPARATION. The areas to be protected shall be constructed and graded to the lines shown on the Plans or as directed by the Engineer and, if a fill area, shall be compacted. All slopes shall be maintained to the neat lines shown on the Plans prior to the placing of filter or bedding material, stone fill, riprap, or slope paving.

Sand borrow shall be placed and graded as bedding material for slope paving.

613.04 PLACING.

(a) Stone Fill. The specified stone fill shall be placed in one course thickness as shown on the Plans in a manner that will result in a reasonably well graded surface. Care shall be taken in the placing to avoid displacing the underlying material.

The stones shall be so placed and distributed that there will be no accumulations of either the larger or smaller sizes of stone.

Rearrangement of the stone fill by hand labor or mechanical equipment may be required to obtain the specified results.

When stone fill and filter blanket are to be placed as part of an embankment, the protective materials shall be placed concurrently with the construction of the embankment, unless otherwise directed by the Engineer.

Where stone fill and filter blanket are to be placed under water, methods shall be used that will minimize segregation and ensure that the required thickness of protective material will be obtained.

(b) Riprap. The stones shall be placed on the prepared slope or filter blanket so that there will be a minimum of space between the stones. The depth of each stone shall be equal to the thickness of the course shown on the Plans. The voids between the stones shall be chinked with smaller stones to produce a relatively smooth and uniform surface.

(c) Slope Paving. The slope paving shall be placed on a minimum 50 mm (2 inch) thick bed of sand borrow in such a manner that the finished paving will present a smooth appearance.

When concrete units are used, the courses shall be laid from the bottom or toe of slope upward, with close joints and with consecutive courses breaking joints. The minimum dimension side of block shall be perpendicular to the slope and the long dimension approximately horizontal. Half blocks shall be used at the edge of the paved area when required.

When field or quarry stone is used, the stones shall be placed from the bottom or toe of slope upward, with close joints approximately perpendicular to the slope. Open joints shall be filled with spalls or gravel so that the entire paved surface will be firmly locked and keyed. Consecutive courses of quarry stone shall break joints and shall be so joined and butted that no part of the joints shall exceed 50 mm (2 inches) in width.

613.05 METHOD OF MEASUREMENT. The quantities of Stone Fill and Riprap to be measured for payment will be the number of cubic meters (cubic yards) of the material specified installed in the complete and accepted work, measured within the limits shown on the Plans or as directed by the Engineer.

The quantity of Slope Paving to be measured for payment will be the number of square meters (square yards) installed in the complete and accepted work, measured using slope measurements.

613.06 BASIS OF PAYMENT. The accepted quantities of Stone Fill and Riprap of the type specified will be paid for at the Contract unit price per cubic meter (cubic yard). The accepted quantities of Slope Paving of the type specified will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing, transporting, and placing the specified material and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation required for placing stone fill, riprap, slope paving, and the filter blanket or bedding material will be paid for at the Contract unit price per cubic meter (cubic yard) for the same type of excavation removed directly above the face of the protective materials, except that when no other type of excavation has been removed, excavation will be paid for under an appropriate excavation Contract item.

Unless otherwise shown on the Plans, the filter blanket will be paid for under the Contract item Gravel Backfill for Slope Stabilization.

Bedding material of sand borrow will not be paid separately, but will be considered incidental to the Contract unit price for Slope Paving, unless otherwise specified.

Payment will be made under:

Pay Item	Pay Unit
613.10 Stone Fill, Type I	Cubic Meter (Cubic Yard)
613.11 Stone Fill, Type II	Cubic Meter (Cubic Yard)
613.12 Stone Fill, Type III	Cubic Meter (Cubic Yard)
613.13 Stone Fill, Type IV	Cubic Meter (Cubic Yard)
613.15 Riprap, Heavy Type	Cubic Meter (Cubic Yard)
613.16 Riprap, Light Type	Cubic Meter (Cubic Yard)
613.20 Slope Paving	Square Meter (Square Yard)

SECTION 616 - CURBS AND GUTTERS

616.01 DESCRIPTION. This work shall consist of the construction, resetting, or removal of curbs and gutters.

616.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Performance-Graded Asphalt Binder (Prepared from Petroleum) 702.02
Emulsified Asphalt 702.04
Tar Emulsion 702.05
Sand Borrow and Cushion 703.03
Mortar, Type I 707.01
Mortar, Type IV 707.03
Joint Sealer, Hot Poured ..... 707.04(a)
Preformed Joint Filler, Cork 707.08
Preformed Joint Filler, Bituminous Type 707.14
Timber Preservative 726.01
Vertical Granite Curb 729.01
Granite Bridge Curb 729.02
Granite Slope Edging 729.03
Precast Reinforced Concrete Curb 729.04
Bituminous Concrete Curb 729.05
Treated Timber Curb 729.06

All cast-in-place concrete for curbing and gutters shall conform to the requirements of Section 541 for Concrete, Class B. There shall be a mineral admixture substitution for portland cement of 20% fly ash or 25% GGBFS.

Bituminous material for curbs, gutters, and traffic islands of the type specified by the Engineer shall meet the requirements of Section 406 or 490.

Concrete, bituminous mixes, and precast concrete curbing materials will be subject to inspection and tests at the plants for compliance with quality requirements.

616.03 GRANITE CURBING AND SLOPE EDGING.

(a) Excavation. Excavation shall be made to the required depth. The base material on which the curb is to be set shall be compacted to a firm, even surface. All soft and unsuitable material shall be removed and replaced with suitable material that shall be thoroughly compacted.

(b) Installation. The curb and slope edging shall be set so that the front top arris line is in close conformity to the line and grade required. All space under the curbing shall be filled and thoroughly tamped with material meeting the requirements of the material for the bed course.

(c) Joints. The curb and slope edging shall be laid and fitted so there will be no open joints exceeding 25 mm (1 inch) between stones. Joints between stones shall be carefully filled with Mortar, Type I and neatly pointed on the top and exposed front portions. After pointing, the stone shall be satisfactorily cleaned of all excess mortar and the joints kept moist until the mortar has set.

(d) Backfilling. After the joints have set, any remaining excavated areas shall be filled and tamped with approved material placed in layers not exceeding 150 mm (6 inches) in depth.

616.04 GRANITE BRIDGE CURB. Prior to beginning work, the Contractor shall receive the Engineer's approval of the proposed fabrication plan. Working Drawings shall be submitted in accordance with Section 105.

Curb stones shall be carefully set and shimmed to the line and grade shown on the Plans. The space under the curb shall be completely filled with concrete or mortar. When shown on the Plans, the mortar shall be removed from the front 50 mm (2 inches) under the curb stone. The curb stones shall be anchored as shown on the Plans with anchors grouted into the curb with Mortar, Type IV or an approved bonding compound. The

curb shall be firmly held in position to prevent sliding or tipping until the concrete has been placed and is sufficiently set.

Long and short lengths of curb stone shall be alternated, unless otherwise directed by the Engineer. The curb shall be set so that joints between curb stones coincide with joints in the concrete deck.

The anchorage and the alignment of the curb shall be approved by the Engineer prior to placing the adjacent concrete.

The joints between the stones shall be raked out to a 50 mm (2 inch) depth and then carefully filled with an approved mortar. The joints shall be neatly pointed on the top and exposed front surfaces with a 5 mm (1/4 inch) recess. The space beneath the stones shall be raked out and filled with an approved mortar as shown on the Plans.

Joints in curb at concrete deck joints shall be treated as shown on the Plans.

The Contractor shall protect curb stones against damage or discoloration of exposed surfaces until completion of the Contract.

616.05 THIS SUBSECTION RESERVED

616.06 CAST-IN-PLACE CEMENT CONCRETE CURB.

(a) Excavation. Excavation and bedding shall conform to the requirements of Subsection 616.03(a).

(b) Forms. Forms shall be of wood or metal, straight or curved as required, free from warp and shall be in accordance with Subsection 541.09. Form construction shall be such that there will be no interference to the inspection of grade or alignment. All forms shall extend for the entire depth of the curb and shall be braced and secured sufficiently so that no deflection from alignment or grade will occur during the placing of the concrete.

(c) Mixing and Placing. Compaction of concrete placed in the forms shall be by spading or other approved methods. Forms shall be left in place for 24 hours or until the concrete has set sufficiently so that they can be removed without injury to the curbing. Upon removal of the forms, the exposed curbing face shall be finished in accordance with Subsection 541.16(a).

(d) Sections. Curbing shall be constructed in sections having a uniform length of 3 m (10 feet), unless otherwise specified.

Sections shall be separated by open joints 3 mm (1/8 inch) wide except at expansion joints.

(e) Expansion Joints. Expansion joints shall be formed at the intervals shown on the Plans using a preformed expansion joint filler having a thickness of 6 mm (1/4 inch). They shall be constructed at 6 m (20 feet) intervals or as directed by the Engineer. When the curb is constructed adjacent to or on concrete pavement, expansion joints shall be located opposite or at expansion joints in the pavement.

(f) Curing. Curbs shall be cured in accordance with Subsection 541.17.

(g) Backfilling. After the concrete has set sufficiently, the spaces in front and back of the curb shall be filled to the required elevation with layers of not more than 150 mm (6 inches) of the same material as the bedding and thoroughly tamped.

(h) Curb Machine. With the approval of the Engineer, the curb may be constructed by a curb forming machine.

616.07 PRECAST CONCRETE CURB.

(a) Excavation. Excavation and bedding shall conform to the requirements of Subsection 616.03(a).

(b) Installation. Precast concrete curb shall be installed in accordance with Subsection 616.03(b).

(c) Joints. Unless otherwise shown on the Plans or directed by the Engineer, expansion joints shall be placed every 6 m (20 feet). The curb sections shall be placed and fitted so that there will be no open joints between them exceeding 3 mm (1/8 inch) in width.

Expansion joints shall be filled with preformed expansion joint filler having a thickness of 6 mm (1/4 inch).

Joints in curb at concrete deck joints shall be treated as shown on the Plans.

The Contractor shall protect the curb against damage or discoloration of the exposed surfaces until completion of the Contract.

(d) Backfilling. The space in front and back of the curb shall be filled and compacted in layers not exceeding 150 mm (6 inches) with the same material as the bedding, unless otherwise specified.

616.08 BITUMINOUS CONCRETE CURB.

(a) General. The plant and equipment necessary for this work shall be in conformance with the requirements of Section 406 or 490.

(b) Preparation of Bed. The bituminous concrete curb shall be placed on bituminous concrete pavement or other hard surface. The surface shall be thoroughly cleaned of all dirt, dust, sand, or other loose material and treated with a tack coat of Type RS-1 emulsified asphalt applied at a rate of from 225 to 450 mL/m^2 (6 to 13 ounces per square yard) prior to placing the curb. All exposed surfaces not to be treated shall be protected against spattering of the bituminous material.

(c) Placing. After the tack coat has cured and become tacky, the mix for the curb shall be placed with an automatic bituminous concrete curb laying machine approved by the Engineer. The machine shall form curbing that is uniform in texture, shape, and density.

The Engineer may permit the construction of curbing by means other than the automatic curber or machine, when short sections or sections with short radii are required, or for such other reasons as may be warranted. The resulting curbing shall conform in all respects to the curbing produced by the use of the machine.

(d) Sealing. After the curb has been in place seven days, the exposed surface shall be treated with two coats of emulsified asphalt or tar emulsion.

616.09 TREATED TIMBER CURB. The treated timber, bituminous fillet, and granular material behind the curb shall be installed as shown on the Plans. The fillet will be sealed as specified in Subsection 616.08(d).

616.10 REMOVING AND RESETTING CURB.

(a) Salvage of Curbing. The Contractor shall carefully remove, store, and clean any curbing specified for resetting. Any existing curbing to be reset that is lost, damaged, or destroyed as a result of the Contractor's operations, or failure to store and protect it in a manner that would prevent its loss or damage, shall be replaced at the Contractor's expense.

(b) Placing. Excavation, setting joints, and backfilling shall be in accordance with specifications for the type of curb being removed and reset.

(c) Cutting and Fitting. Cutting, fitting, or dressing may be necessary in order to install the curbing at the locations directed.

(d) Joints. All sections shall be placed so that the maximum opening between sections is not more than 25 mm (1 inch) wide for the entire top and face. Any dressing of the ends of the curbing necessary to meet this requirement shall be done by the Contractor.

Joints shall be completely filled with mortar and kept moist until the mortar has been set.

(e) Backfilling. After the joints have set, any remaining excavated areas shall be filled and tamped with approved material placed in layers not exceeding 150 mm (6 inches) in depth.

616.11 REMOVAL OF EXISTING CURB. The Contractor shall remove existing curb at locations shown on the Plans or as directed by the Engineer. When shown in the Contract Documents that the curb will remain the property of the State or municipality, the Contractor shall exercise care to avoid damage to the curb during removal. Salvaged curb shall be carefully and neatly stacked with wooden spacers at locations specified in the Contract or as directed by the Engineer.

616.12 PORTLAND CEMENT CONCRETE GUTTER.

(a) Requirements for Forms. Forms shall be of wood or metal, straight or curved as required, free from warp, and shall be in accordance with Subsection 541.09.

(b) Preparation of Bed. The bed shall be prepared and shaped at the proper depth in accordance with the dimensions shown on the Plans. All soft, yielding, or unsuitable material below the subgrade shall be removed and replaced with approved material. The foundation course, when required, shall be placed, compacted thoroughly, and finished to a firm, smooth surface.

(c) Construction of Gutters. The foundation shall be moistened prior to the placing and consolidation of the concrete. The surface shall be smoothly and evenly finished with a wooden float and shaped to conform to the required dimensions of the gutter.

The gutter shall be constructed in alternate sections, each having a uniform length of 4 m (13 feet). The abutting face and adjacent edges of the gutter sections shall be painted with a bituminous material approved by the Engineer. The length of sections may be shortened where necessary for closures but no section less than 1 m (3 feet) in length will be permitted.

During construction, the first alternate sections shall be allowed to set at least 24 hours before the intermediate sections are placed. Forms shall not be removed until 24 hours after the concrete has been placed.

The edges of the gutter shall be finished with an approved edging tool having a radius of not more than 6 mm (1/4 inch).

Immediately upon completion of the finishing of the concrete, it shall be cured in accordance with Subsection 541.17. The method and details of curing shall be subject to the approval of the Engineer.

Expansion joints shall be formed at intervals of 8 m (26 feet) or as shown on the Plans using a preformed expansion joint filler having a thickness of 19 mm (3/4 inch). When the curb is constructed adjacent to or on concrete pavement, expansion joints shall be subject to the approval of the Engineer.

The expansion joints shall be properly sealed with approved joint sealer following completion of the gutter and pavement.

After the forms have been removed, the sides of the gutter shall be backfilled to the required elevation as shown on the Plans or as directed by the Engineer.

616.13 BITUMINOUS CONCRETE GUTTERS AND TRAFFIC ISLANDS.

(a) General. The plant and equipment necessary for this work shall conform to the requirements of Section 406 or 490.

(b) Preparation of Bed. The bed upon which the bituminous concrete surface is to be placed shall be thoroughly compacted to the lines, grades, and shape shown on the Plans or directed by the Engineer. In the case of gutters, all soft, yielding, or unsuitable material below the bed shall be removed and replaced with suitable material and compacted to a firm, smooth surface.

(c) Construction of Gutter. The bituminous concrete shall be laid in two courses. Each course shall be rolled with a roller with a mass of (weighing) at least 68 kg (150 pounds). The finished gutter shall be uniform in appearance, free from irregularities, and present a smooth surface.

All joints adjacent to pavements, curbs, and structures shall be painted with Type RS-1 emulsified asphalt.

616.14 METHOD OF MEASUREMENT. The quantities of Granite Slope Edging; Vertical Granite Curb; Granite Bridge Curb; Granite Bridge Curb, Median Slope Edge; Precast Reinforced Concrete Curb of the type specified; Cast-in-Place Concrete Curb of the type specified; Bituminous Concrete Curb of the type specified (linear measure); Treated Timber Curb; and Removing and Resetting Curb to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, as determined along the face of the finished curb.

The quantities of Bituminous Concrete Curb of the type specified (volume measure) and Bituminous Concrete Gutters and Traffic Islands to be measured for payment will be the number of metric tons (tons) installed in the complete and accepted work, as determined from the load tickets.

The quantity of Removal of Existing Curb to be measured for payment will be the number of meters (linear feet) removed in the complete and accepted work, measured along the face of the curb in its original position.

The quantity of portland Cement Concrete Gutter to be measured for payment will be the number of cubic meters (cubic yards) of Concrete, Class B installed in the complete and accepted work.

616.15 BASIS OF PAYMENT. The accepted quantities of Granite Slope Edging; Vertical Granite Curb; Granite Bridge Curb; Granite Bridge Curb, Median Slope Edge; Precast Reinforced Concrete Curb of the type specified; Cast-in-Place Concrete Curb of the type specified; Bituminous Concrete Curb of the type specified (linear measure); Treated Timber Curb; Removing and Resetting Curb; and Removal of Existing Curb will be paid for at the Contract unit price per meter (linear foot) of curb placed, removed, or removed and reset.

The accepted quantities of Bituminous Concrete Curb of the type specified (volume measure) or of Bituminous Concrete Gutters and Traffic Islands will be paid for at the Contract unit price per metric ton (ton).

The accepted quantity of portland Cement Concrete Gutter will be paid for at the Contract unit price per cubic meter (cubic yard).

Payment will be full compensation for furnishing, transporting, handling, and placing the specified materials, including all excavation, providing, placing and compacting backfill material when not otherwise specified, mortar for the bed and joints of curbs, joint material for curbs and gutters, anchors for bridge curbs, cleaning, cutting, fitting, dressing or stockpiling of curb, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Tack, prime, or seal coats of bituminous material required for the construction of Bituminous Concrete Curb of the type specified and Treated Timber Curb will not be paid for separately, but will be considered incidental to the Contract unit price for the specific item.

The bituminous fillet shown on the Plans to be placed in front of timber curb will not be paid for separately, but will be considered incidental to the Contract unit price for Treated Timber Curb.

The removal of treated timber curbing, including the bituminous concrete fillet, from installations where the existing guardrail is removed will not be paid for separately but will be considered incidental to the Contract item Removing and Resetting Guardrail or Removal and Disposal of Guardrail, as appropriate.

When shown on the Plans, concrete radius curb installed in conjunction with vertical granite curb will be measured and paid for as Vertical Granite Curb.

Foundation materials for Portland Cement Concrete Gutter and Bituminous Concrete Gutters and Traffic Islands will be paid for separately as specified in the Contract.

Payment will be made under:

Pay Item	Pay Unit
616.20 Granite Slope Edging	Meter (Linear Foot)
616.21 Vertical Granite Curb	Meter (Linear Foot)
616.22 Granite Bridge Curb	Meter (Linear Foot)
616.23 Granite Bridge Curb, Median Slope Edge	Meter (Linear Foot)
616.25 Precast Reinforced Concrete Curb, Type A	Meter (Linear Foot)
616.26 Precast Reinforced Concrete Curb, Type B	Meter (Linear Foot)
616.27 Cast-in-Place Concrete Curb, Type A	Meter (Linear Foot)
616.28 Cast-in-Place Concrete Curb, Type B	Meter (Linear Foot)
616.30 Bituminous Concrete Curb, Type A	Metric Ton (Ton)
616.305 Bituminous Concrete Curb, Type A	Meter (Linear Foot)
616.31 Bituminous Concrete Curb, Type B	Metric Ton (Ton)
616.315 Bituminous Concrete Curb, Type B	Meter (Linear Foot)
616.35 Treated Timber Curb	Meter (Linear Foot)
616.40 Removing and Resetting Curb	Meter (Linear Foot)
616.41 Removal of Existing Curb	Meter (Linear Foot)
616.45 Portland Cement Concrete Gutter	Cubic Meter (Cubic Yard)
616.47 Bituminous Concrete Gutters and Traffic Islands	Metric Ton (Ton)

SECTION 617 – MAILBOXES

617.01 DESCRIPTION. This work shall consist of the removal and relocation of existing mailboxes to permanent locations. The work shall include the replacement of any non-conforming boxes, supports, or attachment hardware.

As used in this Section, the term “mailbox” shall include the actual box, post or other support, and attachment hardware.

617.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Timber Preservative, Type IV 726.01
Metal Hand Railing 732.01
Aluminum Posts .....750.01(b)
Wood Posts.....750.01(c)

Steel tubing produced to ASTM A 500, Grade B specifications will be considered acceptable for steel posts.

Brackets and platforms shall be made of pre-galvanized steel sheets. Holes shall be neatly punched or drilled.

Fasteners shall be galvanized and meet the requirements of ASTM A307.

New boxes must meet the approval of the U.S. Postal Service.

Certifications will not be required for materials supplied under this Section.

617.03 GENERAL. Mailboxes designated to be relocated shall be carefully removed and reinstalled as shown on the Plans. Any materials in the existing mailbox installation which do not conform to the Plans or Subsection 617.02 shall be replaced with new, conforming materials. Materials not reused shall remain the property of the owner.

It is the Contractor's responsibility to ensure that each completed relocation has the approval of the mail carrier.

617.04 RELOCATION. Posts may be set in holes or they may be driven as long as the posts or any attached anti-twist devices are not damaged. The installed posts shall be plumb and placed to the depth shown on the Plans. The space around the posts set in holes shall be backfilled with suitable granular material in 150 mm (6 inch) layers. The backfill material shall be thoroughly tamped.

Mailboxes shall be attached to the posts using the mountings and hardware shown on the Plans. All fasteners shall be drawn sufficiently tight so the mailboxes do not pivot or otherwise move.

Existing nameplates shall be attached to any new mailboxes. Names and rural box numbers lettered on existing mailboxes shall be copied onto new mailboxes using good commercial quality stick-on letters acceptable to the Engineer.

617.05 METHOD OF MEASUREMENT. The quantity of Relocate Mailbox to be measured for payment will be the number of each type (Single or Multiple Support) relocated in the complete and accepted work, as determined by the Engineer.

617.06 BASIS OF PAYMENT. The accepted quantity of Relocate Mailbox of the type specified will be paid for at the Contract unit price each. Payment will be full compensation for removing the existing mailbox, installing the mailbox in its permanent location, excavating as necessary, backfill, and furnishing all new materials including mailbox, supports, support hardware, and lettering and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any temporary relocation of mailboxes due to project construction will not be paid under this Section. The costs of this temporary work will be considered incidental to other Contract Items.

Payment will be made under:

Pay Item	Pay Unit
617.10 Relocate Mailbox, Single Support	Each
617.12 Relocate Mailbox, Multiple Support	Each

SECTION 618 – SIDEWALKS

618.01 DESCRIPTION. This work shall consist of the construction of bituminous or portland cement concrete sidewalks and curb ramps.

618.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Emulsified Asphalt 702.04
Preformed Joint Filler, Cork and Asphalt-Treated Felt .. 707.08
Preformed Joint Filler, Bituminous Type 707.14
Detectable Warning Surface 751.08

Concrete for sidewalks shall conform to the requirements of Section 541 for Concrete, Class B. There shall be a mineral admixture substitution for portland cement of 20% fly ash or 25% GGBFS.

The type of bituminous materials for sidewalks shall be specified by the Engineer. The material shall meet the requirements of Section 406.

Portland cement and bituminous mixes will be subject to inspection and tests at the mixing plants for compliance with quality requirements.

Detectable Warning Surfaces shall be either a cast-in-place or surface applied product. Stamping or imprinting systems will not be accepted.

618.03 PORTLAND CEMENT CONCRETE SIDEWALK.

(a) Excavation and Foundation. Excavation shall be made to the required depth and to a width that will permit placing of bed course material and the installation and bracing of the forms. Bed course material shall be placed as shown on the Plans. When the depth of bed course required exceeds 150 mm (6 inches), two layers of approximately equal depth shall be placed, and each layer thoroughly compacted so that it is hard and unyielding. The wetting of bed course material may be necessary to obtain the required compaction.

(b) Forms. Forms shall meet the applicable requirements of Subsection 541.09. Forms shall be wood or metal and shall extend for the full depth of the concrete. All forms shall be straight or curved as required and free from warp.

(c) Placing Concrete. The forms and foundation shall be wetted immediately prior to the placing of the concrete.

The concrete shall be deposited within the forms to such a depth that, after being consolidated and finished, it is of the full thickness required. The concrete shall be consolidated using a method approved by the Engineer.

(d) Finishing. The surface shall be finished with a wooden float. No plastering will be permitted. The edges shall be rounded with an edger having a radius of 6 mm (1/4 inch). Before the concrete has taken its initial set, it shall be tested for waves or irregularities with a straightedge at least 3 m (10 feet) long. Deviations of 6 mm (1/4 inch) or more, either above or below the general contour of the surface, shall be immediately remedied.

The surface of the sidewalk, after the floating and screeding process is completed, shall be finished with a broom of a type approved by the Engineer, drawn over the surface parallel to the transverse joints.

(e) Joints. Unless otherwise shown on the Plans or directed by the Engineer, expansion joints shall be placed every 6 m (20 feet).

Expansion joints shall be formed around all appurtenances such as manholes, utility poles and other obstructions extending into and through the sidewalk. Preformed joint filler with a thickness of 6 mm (1/4 inch) shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete sidewalks and any fixed structure such as a building or bridge. This expansion joint material shall extend for the full depth of the sidewalk.

Between the expansion joints, the sidewalk shall be divided at intervals of 1.5 m (5 feet) by dummy joints formed by a jointing tool or other acceptable means to provide grooves approximately 3 mm (1/8 inch) wide and at least 33 percent of the total sidewalk depth.

When the sidewalk is constructed next to a concrete or granite curb, asphalt treated felt shall be placed between the sidewalk and curb for the total depth of the sidewalk.

(f) Curing. Concrete shall be cured in accordance with Subsection 541.17. During the curing period, all traffic, both pedestrian and vehicular, shall be excluded. Vehicular traffic shall be excluded for such additional time as the Engineer may direct.

(g) Backfilling. After sidewalk construction has been completed, the space on each side shall be backfilled to the required elevation with suitable material as shown on the Plans or as directed by the Engineer.

618.04 BITUMINOUS CONCRETE SIDEWALK.

(a) Excavation and Foundation. Excavation and foundation shall conform to the requirements of Subsection 618.03(a).

(b) Forms. Where no headers, curbing, or other suitable supports are provided, grade control forms shall be installed when hand methods are utilized to assist in obtaining proper alignment and adequate compaction of the sidewalk course. The alignment and grade of all forms set shall be approved by the Engineer immediately prior to placing any material against them. The forms shall be cleaned thoroughly each time they are used. String or wire lines staked to grade will not be accepted as a substitute for grade control forms. When a suitable abutting curb or header is available and is approved by the Engineer as in conformity with the intended grade, it may be utilized as a grade control form.

(c) Placing Bituminous Sidewalk Material. Bituminous sidewalk material shall be placed on the compacted bed course as directed by the Engineer by either mechanical or hand spreading methods in a manner that the required depth will result after rolling. When placing over an existing surface, the surface shall be cleaned and emulsified asphalt applied before the bituminous concrete is placed.

(d) Compaction. Compaction shall be accomplished by means of a hand operated or power roller of a type and mass acceptable to the Engineer. In areas inaccessible to the roller, hand tamping will be permitted. In any case, the bituminous sidewalk material shall be uniformly compacted and shall present a smooth, even surface.

618.05 DETECTABLE WARNING SURFACE

(a) General. Detectable Warning Surfaces shall be furnished and installed as indicated in the Contract and in conformance with ADA Accessibility Guidelines

(b) Surface Treatment. The Detectable Warning Surface shall be a pattern of truncated domes that meets the dimensional and spacing requirements shown in the Contract.

(c) Handling. Detectable Warning Surface materials shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.

(d) Installation. The Detectable Warning Surface shall be installed in accordance with all applicable supplier and manufacturer requirements and recommendations for environmental conditions, surface preparation, installation procedures, curing procedures, and materials compatibility.

The Contractor is responsible for removing any material spatters. The Contractor shall repair any damage to the surface resulting from either installation or clean-up of surface materials. This work shall be performed at no additional cost to the State.

618.06 METHOD OF MEASUREMENT. The quantity of portland Cement Concrete Sidewalk to be measured for payment will be the number of square meters (square yards) of the specified depth of sidewalk installed in the complete and accepted work.

The quantity of Bituminous Concrete Sidewalk to be measured for payment will be the number of metric tons (tons) of material installed in the complete and accepted work, as determined from load tickets.

The quantity of Detectable Warning Surface to be measured for payment will be the number of square meters (square feet) of approved material installed in the complete and accepted work.

618.07 BASIS OF PAYMENT. The accepted quantities of portland Cement Concrete Sidewalk will be paid for at the Contract unit price per square meter (square yard) for the specified depth. The accepted quantity of Bituminous Concrete Sidewalk will be paid for at the Contract unit price per metric ton (ton). The accepted quantity of Detectable Warning Surface will be paid for at the Contract unit price per square meter (square foot). Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including expansion joint material, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The cost of cleaning an existing surface before placing a bituminous concrete sidewalk and the application of emulsified asphalt will not be paid for directly but will be considered incidental to the Contract item Bituminous Concrete Sidewalk.

Bed course material will be paid for under the appropriate Contract item in Section 301.

Excavation, unless otherwise specified, will be paid for under the appropriate Contract item in Section 203.

Payment will be made under:

Pay Item	Pay Unit
618.10 Portland Cement Concrete Sidewalk, 125 mm (5 inch)	Square Meter (Square Yard)
618.11 Portland Cement Concrete Sidewalk, 200 mm (8 inch)	Square Meter (Square Yard)
618.15 Bituminous Concrete Sidewalk	Metric Ton (Ton)
618.30 Detectable Warning Surface	Square Meter (Square Foot)

SECTION 619 – MARKERS

619.01 DESCRIPTION. This work shall consist of furnishing and placing boundary markers, marker posts, and bollards and removing and resetting of existing property markers.

619.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Crushed Gravel for Subbase	704.05
Mortar, Type I	707.01
Paint Materials and Mixed Paints	708.01
Bar Reinforcement	713.01
Wood Posts	728.01(a)
Steel Posts and Post Accessories	728.01(c)
Yielding Marker Posts	751.01(a)

Concrete shall meet the requirements of Section 541 for Concrete, Class B.

619.03 PLACING.

(a) General. Boundary markers, marker posts, and bollards of the dimensions shown in the Contract shall be placed vertically in holes to the depths indicated and shall be backfilled with suitable material placed and compacted in layers not more than 150 mm (6 inches) in depth.

Marker posts and bollards may be driven if suitable caps and driving equipment are used to prevent damage to the post.

Yielding marker posts shall be 2 m (6.5 feet) long and shall be embedded to a depth of 1 m (3 feet) in the ground.

(b) Boundary Markers. When the marker point falls on ledge, a steel rod marker shall be placed in a hole of the diameter and depth shown on the Plans or as directed by the Engineer. The rod shall be securely wedged into the hole and cut off to the required elevation. The space around the rod shall be filled with Type I mortar.

(c) Bollards. Bollards shall be installed as shown on the Plans or as directed by the Engineer.

(d) Removing and Resetting Property Markers. Prior to the removal of any property marker, the Contractor shall verify that the Engineer has located and properly referenced the marker location.

The Contractor shall remove, properly identify, and store the property markers to be reset prior to beginning any other construction in the immediate vicinity.

If the property marker is to be installed at a new location, the hole after removal shall be properly backfilled with suitable material. Each property marker shall be reset at the location directed and shall be 150 mm (6 inches) above the ground, sidewalk, or other surface unless otherwise directed by the Engineer.

When the marker point falls on ledge and the use of a steel rod marker is directed by the Engineer, it shall be set in accordance with Subsection 619.03(b).

619.04 METHOD OF MEASUREMENT. The quantity to be measured for payment will be the number of in-place Markers, Bollards, or Posts and the number of Property Markers removed and reset in the complete and accepted work.

619.05 BASIS OF PAYMENT. The accepted quantity of each type of Marker, Bollard, or Post, and Property Markers removed and reset will be paid for at the Contract unit price each. Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, including object markers, retroreflective sheeting, paint, locking devices, excavation, backfill, mortar, concrete, subbase and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

The Contract unit prices for the items of Wood Marker Posts, Steel Marker Posts, and Yielding Marker Posts will also include the costs of removing the remaining portion of the existing marker post, when the designated new marker post is used as a replacement of an existing marker post.

Payment will be made under:

Pay Item	Pay Unit
619.10 Boundary Markers	Each
619.14 Bollards	Each
619.15 Wood Marker Posts	Each
619.16 Steel Marker Posts	Each
619.17 Yielding Marker Posts	Each
619.20 Removing and Resetting Property Markers	Each

SECTION 620 – FENCES

620.01 DESCRIPTION. This work shall consist of the construction of fences and gates.

620.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type I 707.01
Copper Napthenate Solution..... 726.04
Woven Wire Fence 727.01
Barbed Wire .....727.01(b)
Chain-Link Fence 727.02
Grounding Electrodes 753.05

When chain-link fence is specified in the Plans but the material is not, the Contractor may elect to use galvanized, vinyl coated, or aluminum coated steel fabric for the fence as long as it conforms to the design shown on the Plans.

The materials for snow barrier shall conform to the requirements of this Subsection and the details shown on the Plans.

The wire fabric for the snow barrier shown on the Plans shall be a 25 mm (1 inch) mesh, aluminum-coated, steel chain-link fabric conforming to the requirements of Subsection 727.02.

Hardware for the snow barrier shall be hot-dip galvanized or mechanically galvanized using a mechanically deposited process conforming to the requirements of AASHTO M 298, Class 110.

The fabric shall be installed on the traffic side of the support system.

The Contractor may use preformed 1.6 mm by 9.5 mm (1/16 inch × 3/8 inch) flat aluminum wire bands to attach the chain-link fabric to the galvanized pipe support framework. The bands shall be made of 5052-H32 alloy having a minimum tensile strength of 205 MPa (30 ksi), and an approved closure, as an alternate to the stainless steel clips shown on the Plans.

Concrete shall meet the requirements of Section 541 for Concrete, Class B.

620.03 GENERAL. All trees, brush, and other obstructions which interfere with proper grade, alignment, and construction of fences shall be removed and disposed of as specified in Section 201, unless otherwise directed by the Engineer. Modification of the alignment may be made as directed by the Engineer to preserve valuable trees or other features.

Posts shall be set plumb at the spacing and depth shown on the Plans and, when used for property line fence, shall be erected parallel to and 150 mm (6 inches) inside the right-of-way line. The wire shall be placed on the far side of the posts with respect to the transportation facility.

Existing cross fences shall be connected to the new fences. Corner posts with braces for every direction of strain shall be placed at the junction with existing fences, and the wire in both fences shall be properly fastened to the posts.

At bridges, cattle passes, and large culverts, the fence shall be installed as shown on the Plans or as directed by the Engineer. In no case shall the fence be connected to a structure.

620.04 ERECTION OF WOVEN WIRE FENCE. Where the ground is too soft to hold the post firmly and in depressions where stresses will tend to pull posts from the ground, a second post shall be installed to such depth as necessary and the two posts tied together securely as shown on the Plans.

Wood posts shall be set with the large end down in previously dug holes and backfilled with approved material. When tops of treated posts are cut as shown on the Plans or directed by the Engineer, the cut end shall be treated with two coats of copper napthenate solution.

Steel posts shall be set with anchor plates down, except that when set in rock the anchor plates shall be omitted. When driving posts, the tops shall be protected by driving caps.

When ledge rock is encountered, steel posts shall be used instead of wood posts. The posts shall be set in drilled holes to the depth shown on the Plans and grouted with Mortar, Type I so that they are firmly held in position. When boulders are encountered, they shall be removed, the hole backfilled with suitable materials, thoroughly compacted, and the holes redrilled before installing the posts in the usual manner.

The fence shall be braced as shown on the Plans or directed by the Engineer, with one brace at each end post, including end posts at gates and two braces at each intermediate post, or pull post, and at corner posts where the change in horizontal alignment is in excess of 15 degrees. The maximum distance between braces shall be 180 m (600 feet).

The posts and braces for steel corner, end, and pull posts shall be set in concrete as shown on the Plans. The concrete may be mixed by hand.

The woven wire fence shall be stretched taut and attached to the posts so that the bottom wire is approximately 75 mm (3 inches) above the ground.

When wood posts are used, each horizontal wire shall be fastened to the posts with 3.76 mm (No. 9 gage) galvanized or aluminum coated staples 38 mm (1 1/2 inches) long. When steel posts are used, each horizontal wire shall be fastened to the posts with aluminum bars, galvanized steel bars, or 3.05 mm (No. 11 gage) rust resistant spring wire clips. Instead of the fasteners, posts equipped with fastening studs approximately 13 mm (1/2 inch) high and 57 mm (2 1/4 inches) apart may be used.

Barbed wire shall be installed at river crossings only, as shown on the Plans or as directed by the Engineer. The installation of barbed wire at river crossings will be considered installation of woven wire fence.

620.05 ERECTION OF CHAIN-LINK FENCE. Posts shall be set in concrete bases of the dimensions shown on the Plans.

Where the ground is too soft to firmly hold the line, end, corner, pull, or gate posts, a post of sufficient length shall be used to obtain stability as directed by the Engineer.

Where rock is encountered, the posts shall be set in drilled holes to the depth shown on the Plans and grouted with Mortar, Type I so they are firmly held in position. When boulders are encountered, they shall be removed, the hole backfilled with suitable materials, thoroughly compacted, and the hole redrilled before installing the posts in the usual manner.

The wire fabric shall be properly stretched, without sags or buckles, and attached to the posts as shown on the Plans. Tension wires shall be installed top and bottom as indicated. After erection, any galvanized parts or fittings that have been abraded so that the base metal is exposed shall be painted with two coats of an approved coating.

Any abrasions on aluminum coated steel chain-link fence and the contacting surface of aluminum alloy, or aluminum coated steel chain-link fence with concrete, stone, or masonry shall be thoroughly coated with an approved coating. Abraded areas shall receive a second coat of aluminum paint. The paint shall be allowed to dry thoroughly before installation of the fence.

Where chain-link fence is used in the areas of bicycle paths, the top selvedge shall be knuckled.

620.06 REMOVING AND RESETTING FENCE. Existing fence and posts shall be carefully removed at locations shown on the Plans. Any material damaged while being removed, hauled, or stored and during the process of resetting, due to carelessness on the part of the Contractor as determined by the Engineer, shall be replaced with new materials at the Contractor's expense.

The posts shall be reset in the same manner as posts for new fence and to the same depth and spacing of the fence before removal.

The material used for fencing between posts shall be securely fastened to the posts in their new locations as shown on the Plans for the type of fence being installed.

620.07 REMOVAL OF EXISTING FENCE. Existing fence and posts shall be removed at locations shown on the Plans. When fence is to be salvaged for future use, the Contractor will exercise care during removal to prevent damage and will stockpile the fence at locations indicated in the Contract or as directed by the Engineer. When fence is not to be salvaged, it shall become the property of the Contractor and will be removed from the project area in a manner acceptable to the Engineer.

620.08 GATES. The gates shall be of the design shown on the Plans and shall be completed in a neat and professional manner. The gate hold backs and center stops shall be set in concrete similar to the design and specifications for chain-link fence line posts. The top rail of the gates shall be level along the entire top of the gates.

620.09 METHOD OF MEASUREMENT. The quantity of Fence of the type and size specified and Snow Barrier to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work. Measurement will be along the top of the fence from outside to outside of end posts for each continuous run of fence. Measurement will include fence at bracing assemblies but not at gates.

The length of barbed wire fence installed at a river crossing will be measured for payment as an equal length of Woven Wire Fence.

The quantity of Gate of the type and size specified to be measured for payment will be the number of meters (linear feet) of clear distance between gate posts in the complete and accepted work.

The quantity of Bracing Assembly for Chain-Link Fence of the type and size specified to be measured for payment will be the number of bracing assemblies installed for end, gate, corner, and pull posts in the complete and accepted work.

The quantity of Brace for Woven Wire Fence of the type specified to be measured for payment will be the number of braces installed in the complete and accepted work. If double braces are installed on a post, two units will be measured for payment.

The quantity of Removing and Resetting Fence and Removal of Existing Fence to be measured for payment will be the number of meters (linear feet) of fence in its original position, measured outside of its end posts for each continuous run of fence, including gates.

620.10 BASIS OF PAYMENT. The accepted quantities of Fence, Gate, and Snow Barrier installed or removed and reset, will be paid for at the Contract unit price per meter (linear foot) of the type and size specified.

Barbed wire fence installed at a river crossing will be paid for as Woven Wire Fence.

Bracing Assembly and Braces will be paid for at the Contract unit price for each type specified.

Removing and Resetting Fence will be paid for at the Contract unit price per meter (linear foot).

Removal of Existing Fence will be paid for at the Contract unit price per meter (linear foot). Payment will include compensation for stockpiling or disposal, as appropriate.

Payment will be full compensation for furnishing, transporting, handling, assembling, and placing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The costs of clearing and grubbing, excavation, backfilling, concrete bases, brace plates, anchor plates, electrical grounding, drilling of rock, grouting of holes, extra length posts, and countersunk posts will not be paid for directly but will be considered incidental to the Contract items involved.

Payment will be made under:

Pay Item		Pay Unit
620.11	Chain-Link Fence, 1.2 m (4 feet)	Meter (Linear Foot)
620.12	Chain-Link Fence, 1.8 m (6 feet)	Meter (Linear Foot)
620.13	Chain-Link Fence, 2.4 m (8 feet)	Meter (Linear Foot)
620.15	Gate for Chain-Link Fence, 1.2 m (4 feet)	Meter (Linear Foot)
620.16	Gate for Chain-Link Fence, 1.8 m (6 feet)	Meter (Linear Foot)
620.17	Gate for Chain-Link Fence, 2.4 m (8 feet)	Meter (Linear Foot)
620.20	Bracing Assembly for Chain-Link Fence, 1.2 m (4 feet)	Each
620.21	Bracing Assembly for Chain-Link Fence, 1.8 m (6 feet)	Each
620.22	Bracing Assembly for Chain-Link Fence, 2.4 m (8 feet)	Each
620.25	Woven Wire Fence with Steel Posts	Meter (Linear Foot)
620.26	Woven Wire Fence with Wood Posts	Meter (Linear Foot)
620.30	Drive Gate for Woven Wire Fence	Each
620.40	Steel Brace for Woven Wire Fence	Each
620.41	Wood Brace for Woven Wire Fence	Each
620.50	Removing and Resetting Fence	Meter (Linear Foot)
620.55	Removal of Existing Fence	Meter (Linear Foot)
620.75	Snow Barrier	Meter (Linear Foot)

SECTION 621 - TRAFFIC BARRIERS

621.01 DESCRIPTION. This work shall consist of the furnishing, assembling, removing, and/or resetting of guardrail, median barriers, and guide posts.

621.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Emulsified Asphalt 702.04
Tar Emulsion 702.05
Grease Rustproofing Compound 708.04
Coatings for Wood 708.05
Posts and Post Accessories 728.01
Rail Elements 728.02
Hardware 728.03
Delineation Devices..... 728.04
Concrete Anchors 728.05
Manufactured Terminal Sections..... 728.06
Energy Absorption Attenuators……...728.07

Materials for Terminal Connector for Steel Beam Guardrail shall conform to the requirements shown on the Plans.

Concrete shall meet the requirements of Section 501 for Concrete, High Performance Class A.

Reinforcing steel shall meet the requirements of Section 507.

Materials for Removing and Resetting Guardrail, Replace Guardrail Post Assembly, Replace Guardrail Beam Unit, and Adjust Height of Guardrail shall consist of the acceptable rails, posts, offset blocks, bolts, and other hardware of the existing guardrail together with the necessary new replacement parts. The new replacement parts shall match as close as possible the existing components they replace.

All welding shall conform to the requirements of Subsection 506.10.

621.02A FABRICATION DRAWINGS. The Fabricator of guardrail approach sections furnished under this Section shall submit detailed Fabrication Drawings in accordance with Section 105.

621.03 POSTS AND OFFSET BLOCKS. Posts may be set in holes, or they may be driven if suitable caps and driving equipment are used to prevent damage to the posts. The installed posts shall be plumb, accurately aligned, spaced as shown on the Plans and placed to the full depth indicated. Round posts shall be set or driven with the larger post cross-section facing downward. The space around the posts shall be backfilled with suitable material in 150 mm (6 inch) layers and tamped thoroughly with air or mechanical tampers.

Posts for Steel Backed Timber Guardrail shall be driven into pilot holes that have been punched or drilled. The dimensions of the pilot hole shall not exceed the dimensions of the post by more than 25 mm (1 inch). If impenetrable material is encountered while placing the post, the pilot shall be enlarged to provide not less than 150 mm (6 inches) of clearance on all sides and a minimum depth of 760 mm (2.5 feet). The post shall be set in concrete, the type as approved by the Engineer, to within 150 mm (6 inches) of the top of the hole. The remaining 150 mm (6 inches) shall be backfilled with a suitable material and compacted to the satisfaction of the Engineer.

The guardrail designated to be removed and reset shall be carefully removed, temporarily stored when necessary and reinstalled at the new location. Materials damaged or lost shall be replaced with new material by the Contractor without compensation. The new materials shall be equal to or better than the material of the existing guardrail.

Guardrail posts and anchors shall be installed prior to placing the adjacent top course of pavement unless otherwise directed by the Engineer.

For the guardrail system specified, posts and offset blocks shall be of the type and dimensions shown on the Plans.

621.04 RAIL ELEMENTS.

(a) Beam Rail. Rail elements shall be erected in a manner resulting in a smooth, continuous installation. All bolts, except adjustment bolts, shall be drawn tight. Bolts shall be of sufficient length to extend beyond the nuts.

(b) Cable Rail. Cable guardrail shall be installed as shown on the Plans.

Splicing of cable will be permitted when necessary, but no single piece of cable shall be less than 15 m (50 feet) in length.

(c) Cedar Log Rail. Cedar log guardrail shall be constructed as shown on the Plans. All cuts and notches on rails and posts shall be made in a manner to provide uniform bearing and close joints. The rails shall be attached to posts by steel straps and lag screws.

(d) Steel Backed Timber Rail. Timber rails shall be cut to produce a close fit at all joints. Field cuts shall be treated with an approved material as determined by the Engineer.

621.05 CONCRETE MEDIAN BARRIER (CMB).

(a) General. The Contractor shall notify the Engineer at least three working days prior to the date that casting of the units is to begin, in order that arrangements for plant inspection may be made by Agency personnel.

Once casting has begun, it shall be done on a relatively continuous basis. Casting on a piecemeal basis will not be acceptable.

(b) Fabrication. CMB shall be precast in accordance with Section 540 and shall conform to the shape and size shown on the Plans. The Contractor shall produce units that are uniform in appearance.

The length of individual precast sections shall not exceed 6 m (20 feet), unless otherwise specified. The Contractor may need to cast sections of odd lengths to meet field conditions. However, in no case will sections less than 3 m (10 feet) in length be permitted.

(c) Repair. CMB sections having map or craze cracking or large spalls are not acceptable and shall not be repaired. CMB sections having any cracks that go through the section are not acceptable and shall not be repaired.

(d) Installation. The precast sections shall be installed at the location(s) and in accordance with the details shown on the Plans. The sections shall be firmly butted against each other; any subbase or other material between units shall be removed. Units shall be joined with suitable connectors, where necessary, to prevent differential lateral movements of individual units as a result of vehicle impact.

(e) Sealing. Prior to backfilling and paving, the lower vertical faces of the CMB shall be treated by the Contractor with a uniform protective coat of asphalt or tar emulsion. Care shall be taken to ensure that the bituminous material used is not applied, smeared, or spattered on portions of the barrier other than the vertical faces. The bituminous material and application method shall both be approved in advance by the Engineer.

At some time prior to final project completion, the Contractor shall apply a water repellent/sealant approved by the Engineer to all exposed surfaces of the CMB for its entire length.

(f) Alternate Designs. Instead of the design shown on the Plans, the Contractor may submit an alternate design, including reinforcing details, to the Engineer for approval prior to construction. Ultimate acceptance of a design utilizing less concrete and/or steel may be contingent upon a reduction in the unit bid price, at the discretion of the Engineer.

It is the responsibility of the Contractor to ensure that the time required for submittal, review, and approval of alternate CMB designs does not jeopardize the timely completion of the Contract. A request for a Contract time extension on this basis will be denied.

621.06 ENERGY ABSORPTION ATTENUATOR. Temporary or permanent energy absorption attenuators proposed for use on the project shall receive the approval of the Engineer a minimum of six weeks prior to installing the attenuators on the project.

The Energy Absorption Attenuator(s) proposed by the Contractor shall meet the requirements of the most recent edition of the AASHTO *Roadside Design Guide*.

The installation of the temporary and permanent traffic barrier that the attenuator is to protect shall not begin until complete Energy Absorption Attenuator(s), ready to be installed, are at the project site.

Should an attenuator, or component thereof, in service on the project become damaged and require replacement, as determined by the Engineer, the damaged attenuator, or component thereof, shall be replaced immediately with a backup attenuator, or component thereof, stored on the project in order that there is minimal disruption to incorporating a fully functional attenuator as required by the project traffic control plan.

621.07 TEMPORARY TRAFFIC BARRIER. Temporary traffic barrier shall be one of the barriers included under FHWA's Roadside Hardware Policy and Guidance for crashworthy longitudinal barriers, at the Contractor's discretion, unless otherwise specified. The type of temporary traffic barrier shall be provided to the Engineer prior to use. All temporary traffic barrier and corresponding connections shall meet, unless otherwise specified in the Plans, Test Level 3 (TL-3) criteria as defined in NCHRP Report 350 or the AASHTO *Manual for Assessing Safety Hardware* (MASH). The appropriate resource shall be determined as described in the MASH publication.

Temporary traffic barrier components shall be in a condition satisfactory to the Engineer prior to placement on the project and maintained as such until removed from the project.

The Contractor shall provide to the Engineer verification that the barrier deflection distance is appropriate for the intended use. Where appropriate, temporary traffic barrier shall be adequately anchored to prevent movement if impacted.

Temporary Traffic Barrier shall be erected in accordance with details shown on the Plans or as directed by the Engineer. Unless otherwise specified, Temporary Traffic Barrier shall be removed when no longer needed on the project as determined by the Engineer, and shall remain the property of the Contractor. The area from which the barrier was removed shall be restored to a satisfactory condition where and when no other construction activities are indicated.

621.08 REMOVE AND RESET TEMPORARY TRAFFIC BARRIER. Temporary traffic barrier and required appurtenances shall be removed and reset as shown on the Plans or as ordered in writing by the Engineer.

621.09 TERMINALS. Guardrail and median barrier terminals shall be constructed and installed as shown on the Plans. Concrete anchors associated with terminals shall be constructed in accordance with Subsection 621.10.

621.10 ANCHORS. Anchors for guardrail shall be placed at the locations and depths shown on the Plans. The backfill material shall be placed in layers of not more than 150 mm (6 inches) and shall be thoroughly compacted by use of air or mechanical tampers.

Cable, when required, shall be drawn taut and fastened securely to the anchor assemblies as shown on the Plans and adjusted to equalize the stresses.

621.11 DELINEATION. Delineation devices shall be of the design and materials shown on the Plans and shall be securely fastened to traffic barriers or guide posts as shown on the Plans or as directed by the Engineer.

Delineation devices for use on CMB shall be one of the devices on the Approved Products List on file with the Agency's Materials and Research Section.

621.12 FIELD PAINTING. Galvanized components that have been cut, abraded, or damaged such that base metal is exposed shall be cleaned and painted with two coats of an approved coating.

Wherever guardrail panels are nested, the surfaces on both panels that will be in contact with each other shall be coated with grease rustproof compound.

621.13 REPLACEMENT, ADJUSTMENT, REMOVAL, AND DISPOSAL OF GUARDRAIL OR GUIDE POSTS.

Existing guardrail which is to remain in place on the project shall be inspected by the Engineer for damage, unsuitability, and conformance to present guardrail standards. The Engineer shall mark post assemblies and panel units which are to be replaced. The guardrail shall then be checked for height conformance.

Those sections in which height non-conformance over an extensive portion of the section is greater than 25 mm (1 inch) above or 75 mm (3 inches) below the present height standard shall be adjusted to conform to the current requirements for guardrail height. Sections which in general conform for height but have a large number of variations due to erosion or filling of the shoulder from normal mechanisms shall have the shoulder graded to the proper typical before being checked for height conformance. After adjustment is complete, the existing rail shall conform to current design standards for height as appropriate for the type of guardrail being adjusted.

When guardrail height adjustment is performed in an area of the project where a bituminous pavement overlay is also being placed, suitable allowance shall be made for the pavement thickness remaining to be placed. While adjusting the height of the guardrail, the Contractor shall repair or replace all damaged, broken, or missing components in order that the final adjusted product is a complete, workmanlike, and properly functioning installation conforming to current height requirements. All questions concerning repair or replacement shall be decided by the Engineer.

When post assembly replacement or guardrail beam replacement occur in the same location that guardrail height is being adjusted, the work for all pay items shall be performed by the Contractor as one continuous operation.

The finished appearance of the rehabilitated rail shall be a continuous smooth line without abrupt dips and guardrail shall be adjusted to give a smooth rail line over the entire section meeting the approval of the Engineer.

Unless otherwise specified in the Contract, material to be removed shall become the property of the Contractor. Materials to be salvaged shall be carefully disassembled in a manner to save as much useable material as possible. Materials to be disposed of shall be dismantled in a manner best suited to the Contractor's operations and shall be removed from the project limits and disposed of properly at the end of each work day.

Unless otherwise indicated, anchors which are designated for removal and disposal, not removal and salvage, may have the anchor or anchor block abandoned in place with the anchor rod or anchor cable cut in such a manner that no portion of the anchor assembly is within 300 mm (1 foot) of the ground, shoulder, or roadway surface. The materials resulting from the removal of anchors which are to be removed and disposed of shall be removed from the project limits at the end of each work day.

If posts or anchors are removed from an area where there is no other excavation or embankment work, the resulting holes shall be backfilled with suitable material matching as closely as possible the surface, subbase and other materials in both type and depth. The backfill shall be placed in layers not more than 150 mm (6 inches) in depth and thoroughly compacted using air or mechanical tampers, and the area shall be seeded in accordance with Section 651.

Existing materials to be salvaged shall be protected from damage and/or loss by the Contractor during construction operations. Materials lost or damaged shall be replaced with new materials by the Contractor without compensation. New materials shall be equal to, or better than, the materials in the existing guardrail.

621.14 METHOD OF MEASUREMENT. The quantity of Plank Rail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work measured from end to end of plank rail.

The quantity of Cedar Log Rail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end of log rail.

The quantity of Cable Guardrail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from center to center of end posts. The distance from end posts to the anchors will not be included for payment. The measured quantity of Cable Guardrail will be multiplied by factors as follows:

Post Spacing	Factor
4.9 m (16 ft.)	1.0
3.7 m (12 ft.)	1.1
1.8 m (6 ft.)	1.5
1.2 m (4 ft.)	1.8

The quantity of Steel Backed Timber Guardrail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end along the face of rail, including terminal sections. The measured length will be multiplied by a pay factor of 1.4 for a post spacing of 1.5 m (5 feet).

The quantities of Steel Beam Guardrail, Heavy Duty Steel Beam Guardrail, and Thrie Beam Guardrail to be measured for payment will be the number of meters (linear feet) of each kind specified installed in the complete and accepted work, measured center to center of end posts to which rail is attached. The measured quantity will not include those portions of the installation within the pay limits for Manufactured Terminal Section or Terminal Connector for Steel Beam Guardrail. Where terminal end sections are installed, an additional 600 mm (2 feet) of guardrail will be included for each end section. W-beam to thrie beam transition sections will be paid for as an equal length of thrie beam guardrail. The measured quantities of Steel Beam Guardrail, Heavy Duty Steel Beam Guardrail, and Thrie Beam Guardrail will be multiplied by factors as follows:

Post Spacing	Factor
1.9 m (6 ft., 3 in.)	1.0
1.3 m (4 ft., 2 in.)	1.2
1.0 m (3 ft., 1 1/2 in.)	1.4

The quantity of Box Beam Guardrail to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from center to center of end posts. An additional 300 mm (1 foot) of guardrail will be allowed for each overhang.

The quantities of Steel Beam Median Barrier and Thrie Beam Median Barrier to be measured for payment will be the number of meters (linear feet) of each kind specified installed in the complete and accepted work, measured from center to center of end posts to which rail is attached, excluding terminals.

The quantity of Concrete Median Barrier to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end along the top of the barrier, including depressed or ramped end sections.

The quantities of Terminal Sections, Terminal Connectors, Terminals, Anchors, Approach Sections, and Guide Posts to be measured for payment will be the number of units of each type specified, installed in the complete and accepted work.

The quantity of Energy Absorption Attenuator to be measured for payment will be the number of units, with a unit consisting of a complete attenuator installed when needed and removed when no longer required. Energy Absorption Attenuator will be paid separately and will not be included in the measurement for Temporary Traffic Barrier.

The Contract quantity for Energy Absorption Attenuator includes one backup attenuator to be provided by the Contractor and stored on the project in the event an attenuator, or component thereof, in service is damaged and needs replacement.

The quantity of Remove and Reset Guardrail to be measured for payment will be the number of meters (linear feet) reset in the complete and accepted work, measured in accordance with the type of guardrail specified.

The quantity of Replace Guardrail Post Assembly to be measured for payment will be the number of individual posts replaced.

The quantity of Replace Guardrail Beam Unit to be measured for payment will be the number of 3.81 meter (12.5 foot) rail panels replaced. Those rail panels that are longer or shorter than 3.81 meters (12.5 feet) in length shall be converted to an equivalent number of 3.81 meter (12.5 foot) rail panels. The quantity of Replace Guardrail Beam Unit will not be factored for post spacing.

Minor repairs and replacement of parts for anchorage devices, such as tightening nuts, adjusting turn buckles, replacing nuts and/or bolts, rethreading rod ends, etc. will be considered incidental to the other Section 621 pay items in the Contract.

The quantity of Adjust Height of Guardrail to be measured for payment will be the number of meters (linear feet) of adjusted guardrail complete in place measured from center to center of the end posts to which the rail elements are attached. Payment will not include measurement of any rail element or anchorage which extends beyond the last post to which the rail elements are attached, nor will any factor based on post spacing distances be applied to the measured distance.

The quantity of Removal and Disposal of Guardrail to be measured for payment will be the number of meters (linear feet) removed in the complete and accepted work, measured from end post to end post to which rail was attached.

The quantity of Removal and Disposal of Guide Posts to be measured for payment will be the number of posts removed in the complete and accepted work.

The quantity of Temporary Traffic Barrier to be measured for payment will be the number of meters (linear feet) installed and removed in the complete and accepted work, measured from end to end of each installation, including terminals. Energy Absorption Attenuator(s) will be paid separately and will not be included in the measurement for Temporary Traffic Barrier.

The quantity of Remove and Reset Temporary Traffic Barrier to be measured for payment will be the number of meters (linear feet) removed and reset, measured from end to end of the allowable length as described herein, as shown on the Plans or as directed by the Engineer. Any barrier removed and not reset will not be measured for payment, but will be considered incidental to the original installation of the barrier. No measurement for payment will be made for barrier that is removed and reset for the convenience of the Contractor, for minor adjustments of 600 mm (2 feet) or less in any direction, or for any removal and resetting that was not authorized as described herein.

621.15 BASIS OF PAYMENT. The accepted quantities of Rail, Guardrail, or Median Barrier, new or reset, permanent or temporary, will be paid for at the Contract unit price per meter (linear foot) for the Contract item specified.

The accepted quantity of Manufactured Terminal Section of the type specified will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, detailing, transporting, handling and installing the terminal section(s) used, including but not limited to excavation, backfill, regrading the installation area as necessary, delineation devices, restraining devices, hardware, and preservative treatment, and for furnishing all labor, tools, equipment, and incidentals necessary for installing a complete and properly functioning unit.

The accepted quantities of Terminal Connectors, Terminals, Anchors, Approach Sections, and Guide Posts will be paid for at the Contract unit price for each for the Contract item specified.

The accepted quantity of Removal and Disposal of Guardrail will be paid for at the Contract unit price per meter (linear foot). Removed guardrail that is not reset will be paid for as Removal and Disposal of Guardrail.

The accepted quantity of Removal and Disposal of Guide Posts will be paid for at the Contract unit price for each.

Payment for Removal and Disposal of Guardrail and Removal and Disposal of Guide Posts will include full compensation for removing and disposing of materials, and for restoration of the old installation site when required.

Payment will be full compensation for furnishing, transporting, handling, and placing the materials specified, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. For Steel Backed Timber Guardrail, enlarging holes as necessary for placement of posts, furnishing and placing concrete fill and backfill material, and compacting backfill to the satisfaction of the Engineer will not be paid for separately, but will be considered incidental to the unit price bid for Contract item 621.18.

Payment for CMB will be full compensation for furnishing, transporting, handling, and placing the material specified, including the protective coat of asphalt or tar emulsion and the water repellent/sealant. Excavation and backfill required for installation of CMB will be paid for separately under the appropriate Sections.

The accepted quantity of Energy Absorption Attenuator will be paid for at the Contract unit price for each. Payment will be full compensation for fabricating, furnishing, transporting, handling, and installing the materials required including all hardware, any necessary manufacturer's supervision, the furnishing of all labor, tools, equipment, and incidentals necessary for installing the attenuator complete in place, for maintaining and repairing the attenuator as necessary while it is in place, and for removing and disposing of the attenuator when it is no longer needed.

Payment will be made as follows:

(a) 70 percent of the Contract unit price will be paid when the attenuator is installed and functioning to the satisfaction of the Engineer.

(b) The remaining 30 percent of the Contract unit price will be paid when the Engineer has determined that the attenuator is no longer required for use at the original installed location.

Payment for the backup attenuator will be made as follows:

(a) 50 percent of the Contract unit price will be paid when the backup attenuator is delivered to and placed in storage at the project site to the satisfaction of the Engineer.

(b) The remaining 50 percent of the Contract unit price will be paid when the stored attenuator, or component thereof, is installed on the project and/or removed from the project site, when no longer required, as determined by the Engineer.

Payment for Remove and Reset Guardrail will be full compensation for removing, transporting, storing, reassembling all parts necessary, cutting, furnishing of new parts when necessary, reinstalling at the new locations, furnishing and applying stain, paint, and preservative material and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Payment will also include removing and replacing anchors and terminal ends when required.

The removal of treated timber curbing, including the bituminous concrete fillet, from installations where the existing guardrail is removed will not be paid for directly, but will be considered incidental to Remove and Reset Guardrail and Removal and Disposal of Guardrail.

The accepted quantity of Replace Guardrail Post Assembly (whether for cable, steel beam, box beam, or aluminum rail) will be paid for at the Contract unit price for each. Payment will be full compensation for removing and disposing of the designated post and accessories; for any necessary excavation and backfill, including proper compaction; for furnishing, transporting, handling, and installing the replacement components needed, including new post, offset block and/or backup plate if required; new reflector or other delineation if required; new bolts, nuts and/or washers and any other necessary hardware; steel strapping as necessary; stain, paint, and preservative; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Replace Guardrail Beam Unit (whether for steel beam, box beam, or aluminum rail) will be paid for at the Contract unit price for each. Payment will be full compensation for removing and disposing of the designated beam panel; for furnishing, transporting, handling, and installing the replacement components needed, including new rail beam unit of the required length, replacement backer plate if required and not covered under another Contract item, new reflectors or other delineation if required and not part of the item Replace Guardrail Post Assembly, and new bolts, nuts, and/or washers and any other necessary hardware; for drilling holes as required to complete the installation of the replacement panel; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Adjust Height of Guardrail will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for adjusting the height of the existing guardrail to conform to current standards; for any necessary excavation and backfill, including proper compaction; for furnishing, transporting, handling, and installing necessary cable terminal hardware, turn buckles, tension springs, splicing units, steel strapping, stain, paint, preservatives, and all other components which are necessary to make the adjusted guardrail a complete installation and which are not part of any other pay item in the Contract; for disposing of removed components which are not reused; and for furnishing the labor, tools, equipment, and incidentals necessary to complete the work.

Any post not suitable for reinstallation, as determined by the Engineer, shall be replaced under the item Replace Guardrail Post Assembly.

Payment for Temporary Traffic Barrier will be full compensation for furnishing and installing barrier and any required terminals or protective end devices, and for removal and site restoration where required. Temporary Traffic Barrier on a temporary bridge and its approaches will be considered incidental to the work under Section 528.

Payment will be made as follows:

(a) 50 percent of the accepted quantity upon the satisfactory installation of the barrier.

(b) 50 percent of the accepted quantity upon the final removal of the barrier.

Payment for Remove and Reset Temporary Traffic Barrier will be full compensation for removing, transporting, storing, reassembling all parts necessary, cutting, furnishing of new parts when necessary, reinstalling at the new locations, reinstalling required terminals or protective end devices, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Payment will also include removing and replacing anchors. Partial payment will be made as follows:

(a) 50 percent of the accepted quantity upon the removal of the originally installed barrier.

(b) 50 percent of the accepted quantity upon the satisfactory reinstallation of the barrier.

Payment will be made under:

Pay Item	Pay Unit
621.15 Plank Rail	Meter (Linear Foot)
621.16 Cedar Log Rail	Meter (Linear Foot)
621.17 Cable Guardrail	Meter (Linear Foot)
621.18 Steel Backed Timber Guardrail	Meter (Linear Foot)
621.20 Steel Beam Guardrail, Galvanized	Meter (Linear Foot)
621.205 Steel Beam Guardrail, Galvanized w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.206 Steel Beam Guardrail, Galvanized/Nested	Meter (Linear Foot)
621.207 Steel Beam Guardrail, Galvanized/Nested w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.21 HD Steel Beam Guardrail, Galvanized	Meter (Linear Foot)
621.215 HD Steel Beam Guardrail, Galvanized w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.216 HD Steel Beam Guardrail, Galvanized/Nested	Meter (Linear Foot)
621.217 HD Steel Beam Guardrail, Galvanized/Nested w/2.4 m (8 feet) Posts	Meter (Linear Foot)
621.25 Thrie Beam Guardrail	Meter (Linear Foot)
621.30 Box Beam Guardrail	Meter (Linear Foot)
621.35 Steel Beam Median Barrier	Meter (Linear Foot)

621.40 Thrie Beam Median Barrier	Meter (Linear Foot)
621.45 Concrete Median Barrier	Meter (Linear Foot)
621.50 Manufactured Terminal Section, Flared	Each
621.51 Manufactured Terminal Section, Tangent	Each
621.53 Terminal Connector for Steel Beam Guardrail	Each
621.55 Median Barrier Terminal	Each
621.56 Energy Absorption Attenuator	Each
621.57 Energy Absorption Attenuator, Sand-Filled Plastic Barrel	Each
621.59 Energy Absorption Attenuator, Liquid Filled	Each
621.60 Anchor for Steel Beam Rail	Each
621.61 Anchor for Steel to Box Beam Transition	Each
621.65 Anchor for Cable Rail	Each
621.66 Anchor for Cable Rail at Openings	Each
621.72 Guardrail Approach Section, Galvanized 2 Rail Box Beam	Each
621.725 Guardrail Approach Section, Galvanized 3 Rail Box Beam	Each
621.73 Guardrail Approach Section, Galvanized 4 Rail Box Beam	Each
621.746 Guardrail Approach Section to Concrete Bridge Railing, TL-2	Each
621.747 Guardrail Approach Section to Concrete Bridge Railing, TL-3	Each
621.75 Remove and Reset Guardrail	Meter (Linear Foot)
621.76 Replace Guardrail Post Assembly	Each
621.77 Replace Guardrail Beam Unit	Each
621.79 Adjust Height of Guardrail	Meter (Linear Foot)
621.80 Removal and Disposal of Guardrail	Meter (Linear Foot)
621.81 Removal and Disposal of Guide Posts	Each
621.85 Guide Posts	Each
621.90 Temporary Traffic Barrier	Meter (Linear Foot)
621.95 Remove and Reset Temporary Traffic Barrier	Meter (Linear Foot)

SECTION 622 - INSULATION BOARD

622.01 DESCRIPTION. This work shall consist of furnishing and installing extruded expanded polystyrene insulation board on a prepared surface.

622.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Sand Borrow..... 703.03
Polystyrene Insulation Board..... 735.01

Skewers shall conform to the requirements of the insulation manufacturer.

622.03 PREPARATION OF SURFACE. The surface shall be prepared as follows:

(a) The surface on which insulation board is to be placed shall be shaped as shown on the Plans. Any unsuitable material shall be replaced with satisfactory material. The surface shall be compacted to attain at least 95 percent of the maximum dry density and the in-place moisture content shall be not more than 2 percent above the optimum moisture content, as determined by AASHTO T 99, Method C.

(b) When sand borrow is required, it shall be spread and compacted to a minimum depth of 75 mm (3 inches) just prior to the placement of the insulation board.

(c) Compaction shall be performed in accordance with Subsection 203.11(d).

622.04 PLACEMENT OF INSULATION. The insulation board shall be placed and secured as follows:

(a) The boards shall be placed in such a manner that the transverse joints will be staggered. If two layers of insulation are used, the second shall be placed to cover the joints of the first layer.

(b) Means will be provided to ensure a straight alignment of the boards.

(c) A minimum of two skewers, as approved by the Engineer, shall be used to hold each insulation board in place. The skewers shall be driven at an angle of less than 90 degrees from the horizontal until flush with the surface of the insulation boards.

Skewers shall be used for each layer when more than one layer of material is used.

622.05 PLACEMENT OF MATERIAL ON THE INSULATION BOARD. Special care shall be taken that the equipment used in placing the material does not operate directly upon the installed insulation board.

The first layer of material shall be placed to a minimum depth of 200 mm (8 inches), loose measurement, by dumping in piles and then moving it forward onto the insulation board by approved equipment.

The first layer of material shall be compacted to the satisfaction of the Engineer. The compaction of subsequent layers shall be made with the same construction procedures required for the type of material being placed.

Any insulation board that becomes displaced or damaged prior to or during placing of the material shall be repositioned or removed and replaced with new board at the Contractor's expense.

622.06 METHOD OF MEASUREMENT. The quantity of Insulation Board to be measured for payment will be the number of cubic meters [thousand feet board measure (MFBM)] installed in the complete and accepted work, based on the nominal dimensions of material. No allowance will be made for waste.

622.07 BASIS OF PAYMENT. The accepted quantity of Insulation Board will be paid for at the Contract unit price per cubic meter [thousand feet board measure (MFBM)]. Payment will be full compensation for furnishing, transporting, handling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, except that:

Sand will be paid for at the Contract unit price per cubic meter (cubic yard) for sand borrow under Contract item Sand Borrow.

Payment will be made under:

Pay Item	Pay Unit
622.10 Insulation Board	Cubic Meter (MFBM)

SECTION 625 - SLEEVES FOR UTILITIES

625.01 DESCRIPTION. This work shall consist of the furnishing and installation of sleeves for public or private utilities. Sleeves are hereby defined as encasements for utility lines and are also known as ducts, casings, and conduits.

625.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Emulsified Asphalt, RS-1	702.04
Brick	705.01
Mortar, Type II	707.02
Mortar, Type IV	707.03
Joint Sealer, Hot Poured	707.04(a)
Preformed Joint Filler, Cork and Asphalt-Treated Felt	707.08
Polyvinyl Chloride (PVC) Waterstop	707.10
Asphaltic Plug Bridge Joint	707.15
Reinforced Concrete Pipe	710.01
ABS Plastic Pipe	710.05
PVC Plastic Pipe	710.06
Corrugated Steel Pipe, Pipe Arches, and Underdrains	711.01
Corrugated Aluminum Alloy Pipe, Pipe Arches, and Underdrains	711.02

Bituminous concrete pavement shall conform to the requirements of Section 406.

Steel bar reinforcement shall conform to the requirements of Section 507.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All wood blocks (skids) shall be oak or maple structural lumber #2 Grade or better.

Stainless steel strapping shall meet the requirements of ASTM A 666.

Sleeves for power, telephone, cable TV, and metal pipes shall be nonmetallic.

625.03 INSTALLATION. Sleeves shall be installed using the same methods specified for culverts as in Section 601, unless otherwise specified in the Contract. Nonmetallic pipe shall be positively joined in accordance with standard procedures.

Unless otherwise specified, any sleeve installed for future use is to be fitted with plugs or caps at both ends and shall contain a suitable pull wire or pull cord accessible from both ends.

Carrier pipe (water, sewer, gas) greater than 50 mm (2 inches) in diameter shall be installed in a sleeve of at least 300 mm (12 inches) larger than the diameter of the carrier pipe.

Utilities (power, cable, phone) greater than 50 mm (2 inches) in diameter shall be installed in a conduit of at least 100 mm (4 inches) larger than the diameter of the utility.

For utilities 50 mm (2 inches) and smaller, the inside diameter of sleeves shall be as follows:

Power Lines:	100 mm (4 inches)
Telephone Lines:	100 mm (4 inches)
Cable TV Lines:	100 mm (4 inches)
Water Pipe:	150 mm (6 inches)
Water service lines, DN20-DN25 (¾ inch – 1 inch)	100 mm (4 inches)
Sewer Pipe:	150 mm (6 inches)
Gas Pipe:	150 mm (6 inches)

625.04 METHOD OF MEASUREMENT. The quantity of Sleeves for Utilities to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work.

625.05 BASIS OF PAYMENT. The accepted quantity of Sleeves for Utilities will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for fabricating, furnishing, transporting, handling, saw cutting, and placing all materials, including pull wire and end caps, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Blocking (skids), stainless steel straps, bituminous concrete pavement, portland cement concrete pavement, reinforcing steel, emulsion, subbase materials, brick end walls, and other materials required in conjunction with sleeves will be considered incidental to the Contract item Sleeves for Utilities.

Excavation and backfill of trenches and boring or jacking pits for the placement of sleeves for utilities will be considered incidental to the Contract item Sleeves for Utilities.

Payment will be made under:

Pay Item	Pay Unit
625.10 Sleeves for Utilities	Meter (Linear Foot)

SECTION 626 - WELLS AND CASINGS

626.01 DESCRIPTION. This work shall consist of constructing a well, to the depth required, by driving or drilling using either cable or rotary type machines. This work also includes furnishing and installing the well casing and fittings; sealing and capping the casing, and performing pump or bail tests, or other approved methods of water measurement.

626.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Well Casing 741.01
Chlorine Solution 742.01
Water 745.01

626.03 GENERAL. The Contractor shall notify the Engineer at least two days in advance of the time that work is expected to begin on a specific well drilling site. Unless otherwise specified, the well shall be constructed to a depth necessary to obtain the required rate of flow of water and shall be cased with a well casing of at least 150 mm (6 inches) in diameter. Drilling beyond the estimated depth specified in the Contract shall not be performed unless authorized by the Engineer.

All wells shall be constructed in accordance with these specifications and with the latest edition of the Vermont Water Supply Rule, Chapter 21 of the Environmental Protection Rules published by the Vermont Agency of Natural Resources' Department of Environmental Conservation.

The Contractor shall construct the well with a minimum of disturbance to the property owners and surrounding areas. The well driller shall not use materials or procedures that may adversely affect the public health, the drill site, or groundwater. Wastewater and cuttings shall be disposed of in a manner approved by the Engineer.

The Contractor shall furnish all necessary water for driving or drilling purposes at the site of the well. All water used in drilling, driving, or servicing water wells shall be potable water.

If at any time the Engineer should decide that it is essential to discontinue drilling a particular well for any reason such as excessive depth, insufficient flow of water, or contamination, the Engineer will notify the Contractor in writing.

The well casing shall extend not less than 500 mm (18 inches) above the highest ground surface immediately adjacent to the casing. The Contractor shall take every possible precaution to prevent any foreign material or ground or surface water from entering the well casing.

Upon completion of the well, the top of casing shall be securely capped to prevent the introduction of any foreign material into the well.

All cuttings, waste, and surplus material shall be removed and disposed of; all ruts and damage to lawns, landscaping, or drives shall be repaired, and the site shall be left in a clean and presentable condition.

626.04 DRILLING WELL. The well shall be started with a 200 mm (8 inch) diameter hole, and where bedrock is encountered, extend a minimum of 3 m (10 feet) into competent bedrock, or more when directed by the Engineer. A minimum of 6 m (20 feet) of well casing shall be used in all wells. The 150 mm (6 inch) diameter casing shall be placed and drilling continued with a 150 mm (6 inch) drilling head for approximately 300 mm (12 inches) before seating the casing to provide a proper seal against outside contamination. A standard drive shoe shall be used on the well casing, unless otherwise directed by the Engineer.

After the casing has been sealed, the drilling shall continue until the required well production, as specified in the Contract has been obtained. If the Engineer determines that the well will not be productive, drilling shall be discontinued.

In some instances, such as when the annular space cannot be filled with native materials or drill cuttings, or when additional protection is required due to insufficient isolation distances, the well casing may need to be grouted. The grouting shall be in accordance with the latest edition of the Vermont Water Supply Rule, Chapter 21, Appendix A, Part 12.3.4.

When a rotary drill type machine is used, the water ejection mechanism shall be turned on and shall deliver water through the drill stem at all times when drilling in solid rock.

After the required rate of flow of water has been obtained, drilling shall be continued for approximately 5 m (15 feet) in additional depth, or to the depth directed by the Engineer, to provide a sump for collection of sediment. When this depth has been completed, the well will be considered drilled to its full depth. The well shall be cleaned by continuous blowing or bailing until all fines are removed from the well hole and the water obtained is reasonably clean and clear.

When drilling is proceeding through a water bearing strata of porous material of sufficient depth for development of a well in a gravel formation, the Engineer may order in writing the cessation of further drilling to make preparations for development of the well in the gravel formation.

626.05 DEVELOPMENT OF WELL IN GRAVEL FORMATION. The development of a well in a gravel formation shall be in accordance with the latest edition of the standard specifications of the American Water Works Association, Section A 100-97, and as directed by the Engineer.

The casing shall extend at least 3 m (10 feet) below the anticipated maximum drawdown elevation.

626.06 MEASUREMENT OF FLOW. The Contractor shall determine the flow of water at all water bearing strata encountered while constructing the well and shall perform any additional measuring tests that may be ordered by the Engineer. This work shall not be construed as part of the pump test for yield, but shall be included in the item for a driven or drilled well.

During the time of the well construction, the Contractor shall furnish the Engineer with all tools, equipment, and materials needed to determine the amount of flow and quality of water.

When the flow test shows that the required output of the well has not been obtained, drilling shall resume and continue until sufficient flow has been obtained or the Engineer determines that the well should be abandoned.

626.07 DISINFECTING. The Contractor shall disinfect the well with a chlorine solution after the drilling is completed.

626.08 PUMP TEST FOR YIELD. The Contractor shall perform a pump test for yield on all wells, unless otherwise directed by the Engineer. The Contractor shall install a pump with necessary power and connections capable of pumping the required rate of flow of water for each well.

The test shall be conducted continuously for at least four hours, and up to a maximum of 72 hours, as specified by the Engineer, to determine that the well is capable of continuously producing the required rate of flow of water.

Suitable means shall be provided for determining the water level during the pumping operations.

Readings of the water level in the well and the well output shall be taken and recorded at 30 minute intervals . The Contractor shall furnish a copy of the test records in tabular form to the Engineer.

When the ordered length of pump test for yield is eight hours or less, the pumping shall be started at an hour that will allow completion of the test not later than 5:00 p.m. of the same day, unless otherwise directed by the Engineer prior to beginning the test.

626.09 SAMPLING. In order to determine that the quality of the water obtained from the new well is suitable for domestic use or the intended consumption, the Engineer will submit water samples for analysis to a testing laboratory approved by the Vermont Department of Health. Sample bottles shall be obtained from the same laboratory.

626.10 METHOD OF MEASUREMENT. The quantity of Driven or Drilled Well to be measured for payment will be the number of meters (linear feet) driven or drilled in the complete and accepted work, measured as the difference in elevation between the bottom of the hole and the ground level. However, a minimum depth of 12 m (40 feet) will be measured for each well.

The quantity of Well Casing Pipe to be measured for payment will be the number of meters (linear feet) installed in the complete and accepted work, measured from end to end of casing.

The quantity of Grouting of Well Casing Pipe to be measured for payment will be the number of meters (linear feet) of well casing grouted in place, measured from the bottom of well casing to the top of grout.

The quantity of Development of Well in Gravel Formation to be measured for payment will be the number of hours actually worked.

The quantity of Pump Test for Yield to be measured for payment will be the number of hours actually consumed, while pumping continuously, measured from the time pumping is started, to the completion of the pump test for yield. No allowance will be made for time lost due to breakdown.

626.11 BASIS OF PAYMENT. The accepted quantity of Driven or Drilled Well will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, and handling the equipment; driving or drilling the well; sealing the well casing when required; measuring flow; disinfecting and chlorinating the well; sampling the water; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, including disposal of surplus materials and the cleaning of the site following completion of the construction operations.

The accepted quantity of Well Casing Pipe will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, and installing the casing; for capping the well; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Grouting of Well Casing Pipe will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, and installing the grout mixture, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Development of Well in Gravel Formation will be paid for at the Contract unit price per hour. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Pump Test for Yield will be paid for at the Contract unit price per hour. Payment will be full compensation for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
626.15	Driven or Drilled Well	Meter (Linear Foot)
626.20	Well Casing Pipe	Meter (Linear Foot)
626.22	Grouting of Well Casing Pipe	Meter (Linear Foot)
626.25	Development of Well in Gravel Formation	Hour
626.30	Pump Test for Yield	Hour

SECTION 627 - PUMP AND TANK INSTALLATION

627.01 DESCRIPTION. This work shall consist of furnishing and installing a complete water system of the capacity, size, and type specified.

627.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Flexible Plastic Water Pipe	740.01
Rigid PVC Plastic Water Pipe	740.02
Seamless Copper Water Tube	740.04
Galvanized Steel Water Pipe	740.05
Water Pumps	741.02
Water Storage Tanks	741.03
Chlorine Solution	742.01
Topsoil	755.02
Seed	755.04

The Contractor shall furnish to the owner the manufacturer's warranties for the installed pump, tank, pipe, and necessary fittings and connections.

627.03 INSTALLATION.

(a) Pumps, General. The diameter of the water pipe used shall be that recommended by the manufacturer for the size pump being installed.

All pipes installed between the well and building entrance shall be located below the frost line and in no case shall the depth be less than 1.5 m (5 feet) below ground level, unless otherwise directed by the Engineer.

If the rated capacity of the pump is equal to or greater than the yield of the well, a low pressure cutoff or low-flow switch shall be installed as directed by the Engineer. In the case of a jet pump installation, a flow control valve may be used.

If an overflowing well is encountered, the overflow will be drained using a pitless adapter, check valve, and water pipe sized to contain the flow. The pipe shall be plastic or as approved by the Engineer. The pitless adapter and connections shall be either bronze or brass.

(b) Jet Pump System. Jet pumps shall be installed using flexible plastic pipe of at least 1.1 MPa (160 psi) working pressure, Schedule 80 rigid plastic or galvanized steel pipe between the ejector assembly and the well cap or pitless adapter. The same type of pipe shall be installed between the well and the storage tank, unless otherwise specified in the Contract.

A tailpiece of rigid pipe, 9 m (30 feet) in length, shall be installed with a foot valve of non-corrosive metal.

No splices will be allowed when flexible plastic pipe is installed between the well cap and the injector assembly.

(c) Submersible Pump System. Submersible pumps shall be installed using galvanized steel pipe, rigid plastic pipe, or flexible plastic pipe as specified. The installation will be in accordance with the manufacturer's recommendations.

If rigid plastic pipe is specified, the hanger pipe between the pump and the certified pitless adapter shall have threaded couplings. Schedule 40 plastic pipe may be used to a depth of 60 m (200 feet). For a pump setting between 60 and 120 m (200 and 400 feet) of depth, Schedule 80 plastic pipe shall be used. For a pump setting between 120 and 245 m (400 and 800 feet) of depth, galvanized pipe shall be used. When Schedule 40 or 80 plastic pipe is used, it will have threaded male and female adapters that shall be securely cemented to opposite ends of each length of pipe. A torque arrester shall be attached to the first length of riser pipe at the top of the pump to protect the unit from damage by vibration. The torque arrester shall be expanded to a tight fit of the well diameter and locked in place using stainless steel clamps. The motor leads shall run through the torque arrester so that they will be protected from disturbance. The pump cable shall be firmly taped to the riser pipe at intervals of approximately 3 m (10 feet).

Pipe used between the well head and the pressure tank shall have a pressure rating of at least 1.1 MPa (160 psi). This pipe shall be either galvanized steel, Schedule 40 rigid plastic or flexible plastic.

A 4.5 kN (1000 pound) safety cable shall be furnished and installed when plastic hanger pipe is used.

A pump lightning arrestor shall be furnished and installed.

(d) Shallow Well Pump System. Shallow well pumps shall be installed using galvanized steel pipe, Schedule 40 rigid plastic pipe, or flexible plastic pipe of at least 700 kPa (100 psi) working pressure. The suction line shall extend a minimum of 9 m (30 feet) below the pump intake and shall be fitted with a foot valve of non-corrosive metal. The same type of pipe shall be installed between the pump and storage tank.

627.04 WELL CAP. The well casing shall be capped with a watertight, non-corrodible, vented cap.

627.05 THIS SUBSECTION RESERVED

627.06 CONNECTION TO EXISTING SYSTEM. The connection between the storage tank and existing water system shall be made with seamless copper water tube of adequate size, except that galvanized steel pipe shall be used if the existing plumbing system is galvanized steel pipe.

627.07 STORAGE TANK. The capacity, material, construction requirements, and installation (vertically or horizontally) of the storage tank shall be as specified in the Contract or as ordered by the Engineer.

The tank will be provided with a check valve, pressure relief valve, pressure gauge, and a hose threaded drain cock. A gate/ball valve shall be installed at the tank outlet.

The storage tank shall be supported on stone, brick, concrete blocks, or by use of a tank frame to allow air to circulate freely under the tank. In no case shall the storage tank rest directly in contact with the existing floor or ground.

627.08 ELECTRICAL WORK. This work shall include the furnishing and installation of electric service cables, the pump switch, a fuse or breaker box, the pump control box, a control switch to connect the pump with the power source, and all incidentals required to provide a working pump system. All work shall be completed in a competent and professional manner.

Both the materials and installation methods of all electrical wiring connections, switches, and grounds shall conform to the provisions of the National Electrical Code, and shall be in accordance with all State and local electrical ordinances. Electrical materials approved by the Underwriters' Laboratories, Inc. shall be used wherever standards have been established by that agency.

The electrical feeder circuit shall be sufficient in size to limit the voltage drop to 3 percent or less. A manually operable disconnect switch shall be inserted in the circuit.

Automatic controlling switches and devices as recommended by the manufacturer of the pump unit shall be installed in accordance with the National Electrical Code.

Overcurrent protection for the motor shall be provided to effectively protect the motor against overload or short circuit conditions. The type of fuse or breaker shall be a time lag device which shall allow the passage of momentary starting current but which will open the circuit when exposed to other than normal operating current. The overcurrent protection device shall be located as near the master switch control as possible.

627.09 GROUNDING. Grounding shall be installed remote from the system to prevent the possibility of current feedback.

All water piping, pressure tank and associated metal frames, electrical switches, and control devices shall be effectively grounded by means of a grounding conductor attached thereto and connected to the "ground wire" or "ground buss" at the service entrance switch.

627.10 CELLAR INSTALLATIONS. Unless otherwise required to meet field conditions, storage tanks, jet pumps, shallow well pumps, and electrical control boxes shall be located in the cellar.

627.11 CHLORINATION OF SYSTEM. The Contractor shall disinfect the complete water system by adding an approved chlorine solution at the well head prior to making the water system operative. After the system is operative, the Contractor shall run water through the system for a sufficient time to ensure that all taste, odor, and coloring has been removed and that the water is clear and suitable for use. The owner may assume responsibility of this clearing operation in order to allow the chlorine solution to remain for a longer period in the existing plumbing system for more complete decontamination.

627.12 ALTERATIONS TO PROVIDE ACCEPTABLE WATER. If the water as available from the installation provided under this Section is not potable according to the Vermont Department of Health test results, or is not acceptable because of hardness, iron content, or other unusual conditions as determined from the representative samples taken from the system, the Contractor agrees to furnish adequate conditioning equipment to provide potable and acceptable water. This work shall be done as Extra and Force Account Work, as specified in Section 109. All equipment for water conditioning shall be approved by the Engineer.

627.13 LANDSCAPING. Contingent upon the backfilling operation, the site shall be properly graded to blend with the undisturbed present ground. Topsoil, to a depth of 75 mm (3 inches), shall be placed in area(s) formerly covered with grass and the area seeded in accordance with Section 651. Upon completion of the work, the Contractor shall properly clean up the worksite and leave the area in a neat, presentable condition.

627.14 METHOD OF MEASUREMENT. The quantity to be measured for payment will be on a unit basis for the specified type of Pump System installed in the complete and accepted work.

Acceptance date for completion will be the date of the satisfactory report or reports of the Vermont Department of Health Laboratory's Division of Environmental Health, or other testing laboratory approved by the Vermont Department of Health, indicating potable and acceptable water samples collected after the installation is completed.

627.15 BASIS OF PAYMENT. The accepted quantity will be paid for at the Contract lump sum price for the type of Pump System specified, including a pressure or storage tank, the water pump, water piping, electrical connections, connection to the existing system, and all related fittings. Payment will be full compensation for furnishing; transporting; handling; and placing the material specified including excavation, backfill, gravel, topsoil, or similar materials as needed for grading and seeding; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Any alterations of the pump installation required to provide acceptable water will be paid for as Extra Work and Force Account Work as specified in Section 109.

Payment will be made under:

Pay Item	Pay Unit
627.20 Double Pipe Jet Pump System	Lump Sum
627.25 Submersible Pump System	Lump Sum
627.30 Shallow Well Pump System	Lump Sum

SECTION 628 - SANITARY SEWER SYSTEMS

628.01 DESCRIPTION. This work shall consist of the construction or reconstruction of sanitary sewer lines and appurtenances.

628.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Granular Backfill for Structures	704.08
Rubber Gaskets	707.11
Reinforced Concrete Pipe	710.01
Vitrified Clay Pipe	710.04
ABS Plastic Pipe	710.05
PVC Plastic Pipe	710.06
Ductile Iron Pipe, Cement Lined	740.07

Concrete shall conform to the requirements of Section 541 for Concrete, Class B unless otherwise specified.

Sleeves shall conform to the requirements of Section 625.

628.03 GENERAL. Care shall be exercised by the Contractor to avoid disrupting the operation of existing sanitary sewer facilities without prior written approval of the Engineer.

When existing underground utilities not scheduled for removal or abandonment are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly in accordance with Subsection 107.13 at no additional cost to the Agency.

The Contractor shall be responsible for the unloading, storing, hauling, and distribution of all materials. All materials that are damaged, destroyed, or lost during and after unloading shall be replaced at the Contractor's expense. All pipe, pipe fittings, and accessories shall be handled so as to avoid shock. Pipes having factory applied joint material shall be stacked and blocked to prevent damage to the joint material. Material not needed for immediate use shall be stored in a safe manner at places provided by the Contractor and approved by the Engineer.

The Contractor's attention is called to the fact that sewer pipe and fittings are comparatively brittle. Care shall be taken in handling and laying to avoid damaging the pipe and fittings.

The location of all pipes shall be approved by the Engineer.

628.04 EXCAVATION. Where pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe and compaction of the bedding and backfill material under and around the pipe. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width.

If shown on the Plans or directed by the Engineer, poor foundation material encountered below the normal grade of the pipe bed shall be removed and replaced with granular backfill for structures.

Where ledge rock, rocky or gravelly soil, hardpan, or other unyielding foundation materials are encountered in the trench excavation at the normal grade of the pipe bed, the trench shall be excavated to a width equal to the inside diameter of the pipe plus 600 mm (24 inches), and to a depth of 300 mm (12 inches) below the pipe grade. This area shall be backfilled with granular backfill for structures.

The length of trench to be opened at one time shall be kept within reasonable limits unless otherwise permitted or directed by the Engineer.

No tunneling will be permitted except by written approval of the Engineer. Permission to tunnel will be granted only in short sections where, in the opinion of the Engineer, the pipe can be safely and properly installed and the backfill properly compacted.

During construction, the Contractor shall conduct operations so as to prevent at all times the accumulation of water, ice, and snow in excavations or in the vicinity of excavated areas, and to prevent water from interfering with the progress or quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.

Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health; cause injury to public or private property, work completed or in progress, or public streets; or cause any interference in the use of streets and roads by the public. Pipes under construction shall not be used for drainage of excavations.

Where pipes are to be placed in an embankment, excavation for the pipe shall be made after the embankment has been completed to the specified height above the designed grade for those pipes shown on the Plans.

Sheeting and bracing required for trenches shall be removed to the elevation of the pipe but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.

628.05 BEDDING FOR PIPE. Unless otherwise specified, the bed shall be shaped to fit the pipe for a depth of not less than 10 percent of its total height and shall have recesses to receive the bell.

Concrete cradle bedding shall be installed on approved subgrades when shown on the Plans or directed by the Engineer.

628.06 LAYING PIPE. No pipe shall be placed until the trench and the prepared foundation have been approved by the Engineer.

The laying shall begin at the outlet end and the lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of flexible pipe shall be at the sides.

All pipe and fittings shall be carefully examined for defects and no pipe or fittings shall be laid which are known to be defective. If any defective piece is discovered after laying, it shall be removed and replaced at the Contractor's expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.

The pipe shall be laid to conform to the lines and grades shown on the Plans or as directed by the Engineer. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and to bring the inverts continuously to the required grade.

Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

Before any joint is made, the pipe shall be checked to ensure that a closed joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

The sewers and manholes shall be made as nearly watertight as practicable and leakage measurements shall be made wherever possible.

Concrete reaction blocking shall be provided as detailed at all bends deflecting 22.5 degrees or more. At the Contractor's option, retainer glands may be used at bends instead of concrete blocking. Retainer glands shall also be provided at all joints within three pipe lengths each side of the bends.

628.07 JOINING PIPE. Sewer pipe shall be joined in accordance with the detailed instructions of the manufacturer.

Sewer pipe with premolded gaskets shall be driven completely home and the gasket checked for proper positioning. Where poured joints are used, the pipe shall be properly positioned and the joint completely filled with oakum and joint sealer in accordance with the accepted practice for that type of sewer joint. The sealer shall be allowed to cool completely before the runner is removed.

Where recommended by the manufacturer, the Contractor shall furnish coupling pullers for joining the pipe. Gasket feeler gages shall be available for use by the pipe layer and the Engineer for checking the position of the rubber gaskets in the completed joint, if so directed by the Engineer.

Any fittings showing a crack, and any fitting or pipe that has received a severe blow which may have caused a fracture, even though no fracture can be seen, shall be marked as rejected and removed at once from the work.

Sewer pipe shall be cut by means of a handsaw, "metal-inserted" abrasive wheels, or by pipe cutters with blades, not rollers, doing the cutting. All cut ends shall be examined for possible cracks caused by cutting.

628.08 TESTING OF SYSTEM. The Contractor shall provide all necessary equipment and instrumentation required for proper completion of the flushing and testing. Quality of water, testing procedures, and method of disposal of water shall be approved by the Engineer. Prior to testing, the system shall be flushed with water to remove construction debris.

All tests shall be made in the presence of the Engineer. Preliminary tests made by the Contractor without being observed by the Engineer will not be accepted. The Engineer will be notified at least eight hours before any work is to be inspected or tested.

All defects in the system shall be corrected and retested until acceptable to the Engineer. Repairs shall be made to achieve the standard of quality specified for the entire system.

Sections of the system may be tested separately, but any defect that may develop in a section previously tested and accepted shall be promptly corrected and retested.

Test data shall be recorded on a form acceptable to the Engineer. A copy of all test data shall be submitted to the Engineer at the completion of testing.

All piping shall be tested in accordance with the following test methods, in addition to any test required by State and local codes or building authorities:

(a) Gravity Sewer Testing.

(1) General. The Contractor shall have the option of using the air test or water test for testing sewers. Manholes must be tested by a water test.

The maximum sewer length to be tested at one time shall be that length between any two successive manholes.

Pipe trenches shall be backfilled prior to performing the test.

All service laterals, stubs, and fittings shall be plugged or capped and adequately braced to withstand thrust forces.

The depth of groundwater above the pipe section to be tested shall be determined.

Portions of sewer lines in conflict with water mains shall be tested as ordered by the Engineer.

(2) Air Testing. Low pressure air testing shall be conducted in accordance with the following procedures:

a. Each end of the test section shall be plugged, capped, and braced. Necessary safety precautions shall be taken to prevent blowouts and possible injury.

b. An air hose shall be connected to a tapped plug used for an air inlet. The hose shall be connected to the air control equipment, which shall include valves and pressure gauges.

These shall allow air to enter the sewer test line, monitor air pressure in the sewer, shut off air, and provide pressure reduction and 0 to 70 kPa (0 to 10 psi) relief. The monitoring pressure gauge shall have a range of 0 to 100 kPa (0 to 14.5 psi) with divisions of 1 kPa (0.10 psi), and an accuracy of 0.25 kPa (0.05 psi).

c. The air compressor and air supply shall be connected to the test line and the test section filled slowly until a constant pressure of 25 kPa (3.5 psi) is maintained.

d. A pressure above 20 kPa (3 psi) shall be maintained for at least five minutes to allow the temperature to stabilize. A check for leaks shall be made and if any are found, the pressure shall be released and the fitting replaced or repaired.

e. After the stabilization period, the pressure shall be adjusted to 25 kPa (3.5 psi) and the air supply disconnected.

f. Measure and record the time interval for the test line pressure to drop from 20 to 15 kPa (3 to 2.5 psi).

g. If the groundwater table is above the pipe, increase above test pressures 4 kPa (0.6 psi) for each 300 mm (1 foot) the groundwater is above the invert of the pipe.

h. The minimum time required for a pressure drop of 4 kPa (0.6 psi) using the air test shall be 15 seconds per 5 mm (75 seconds per inch) of diameter of the main sewer being tested.

i. Any line tested that does not hold the minimum specified pressure for the time specified will be considered to have failed the pressure test and shall be repaired and retested. The Contractor may have the option of conducting a water test in accordance with these specifications if the air test has failed.

(3) Exfiltration Test. An exfiltration test measures the amount of water leaking out of the sewer while maintaining a low pressure on the entire sewer being tested.

The exfiltration test procedure shall be as follows:

a. A tapped plumbers plug should be inserted in the downstream manhole inlet sewer. The water supply connection is made at this point, but never directly from a public water supply system or hydrant.

b. A stand pipe shall be tightly connected at the upstream end of the sewer. The height of the stand pipe shall be as directed but in all cases shall be 600 mm (24 inches) higher than any point in the sewer or 600 mm (24 inches) higher than the highest known groundwater table, whichever is higher, and shall be not higher than 7.5 m (25 feet) above the lowest point in the section being tested.

c. Water shall be added at the downstream connection in order to avoid air pockets. The line shall be filled to the elevation designated in the stand pipe. A manhole may be used as a stand pipe. The Engineer may require the manholes to be tested independently in accordance with procedures specified in this Subsection.

d. The line shall be allowed to stand with water for at least four hours in order that air may escape and absorption may take place.

e. The lines shall be filled to the reference mark, and the drop or loss that occurs during a 15-minute period shall be measured. The minimum head shall be maintained throughout the test, adding any volume of water required and including that volume in the leakage measurements. The test shall be repeated as directed.

f. The reading shall be recorded, and the leakage shall be converted to liters per millimeter of pipe diameter per kilometer of sewer per 24-hour day (gallons per inch of pipe diameter per mile of sewer per 24-hour day).

g. Allowable leakage shall be 10 L/mm/km/day (100 gallons/inch/mile/ day).

(4) Infiltration Test. If the groundwater table is at least 600 mm (24 inches) above the entire sewer section to be tested, the Engineer may allow the Contractor to perform an infiltration test.

The infiltration test procedure shall be as follows:

a. The upstream end of the section shall be plugged or taped.

b. The measuring device shall be installed in the downstream end. If a V-notch weir is used, it must be installed so as to maintain a watertight seal between the weir and the interior surface of the pipe. The weir shall meet the approval of the Engineer.

c. Sufficient time shall be allowed for infiltrating water to develop a steady, uniform flow.

d. The reading shall be recorded, and the leakage shall be converted to liters per millimeter of pipe diameter per kilometer of sewer per 24-hour day (gallons per inch of pipe diameter per mile of sewer per 24-hour day).

e. Allowable leakage shall be 10 L/mm/km/day (100 gallons/inch/mile/ day).

(b) Manhole Leakage Test. Each manhole shall be tested by means of a water test. If the water test was used on the sewer line and the manhole was tested with the sewer, and the line passed, the Engineer may not require an independent manhole test. In any case, there shall be no visible leakage into the base or walls of a completed manhole.

All pipes and other openings into the manhole shall be suitably plugged and the plugs braced to prevent blowout.

The manhole shall then be filled with water to the top of the cone section. With the approval of the Engineer, a period of time may be permitted to allow for absorption. At the end of this period, the manhole shall be refilled to the top of the cone, if necessary, and the measuring time of at least four hours begun. At the end of the test period, the manhole shall be refilled to the top of the cone, measuring the volume of water added. This amount shall be converted to liters per vertical meter of depth per 24-hour day (gallons per vertical foot of depth per 24-hour day). The leakage for each manhole shall not exceed 10 L/m/day (1 gallon/foot/day). If leakage exceeds the allowable rate, repairs shall be made as approved by the Engineer and the manhole retested.

If the Contractor elects to backfill prior to testing, the testing shall be at the Contractor's own risk, and it shall be incumbent upon the Contractor to determine the reason for any failure of the test. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc. It will be assumed that all loss of water during the test is a result of leaks through the joints or through the concrete. Furthermore, the Contractor shall take any steps necessary to assure the Engineer that the groundwater table is below the bottom of the manhole throughout the test.

If the groundwater table is above the highest joint in the manhole, and if there is no leakage into the manhole as determined by the Engineer, this test can be used to evaluate the watertightness of the manhole. However, if the Engineer is not satisfied, the Contractor shall lower the groundwater table and carry out the test as described above.

(c) Pressure Pipe Testing.

(1) General. All force mains shall pass the hydrostatic pressure test and leakage test described below.

Prior to testing, all anchors and braces shall be installed. All concrete thrust blocks and restraints shall be in place and cured for at least seven days. All buried pipes shall be backfilled. Suitable test plugs shall be installed and air release valves shall be installed at the high points.

(2) Hydrostatic Test. The following procedure shall be used:

a. All air release valves shall be opened and the pipe shall be filled with water at a rate not to exceed the venting capacity of the air release valves.

b. The water pressure shall be raised to 150 percent of the designed operating pressure and adjusted to the lowest point of the section being tested.

c. The pressure shall be maintained for ten minutes and for an additional period as is required for the Engineer to complete inspection; however, the manufacturer's suggested time duration at the test pressure should not be exceeded.

d. Any defects noted shall be repaired and the test repeated.

e. Upon successful completion of the hydrostatic test, the leakage test will be performed.

(3) Leakage Test. The following procedure shall be used:

a. The water pressure in the section shall be brought up to the designed operating pressure and adjusted to the lowest point of the section. This pressure shall be maintained within a maximum variation of 5 percent for the test duration of two hours minimum.

b. The amount of leakage shall be measured by means of a water meter installed on the supply side of the pump, and the leakage converted to liters per hour (gallons per hour).

c. The allowable leakage is as follows:

1. No leakage will be allowed for exposed piping; buried piping with flanged, threaded, or welded joints; or buried pipe in conflict with potable water lines.

2. Leakage for buried pipe with slip-type or mechanical joints shall not exceed the rate determined by the following formula:

$$L = 0.00102 \times N \times D \times \sqrt{P}$$

where:

L = Maximum allowable leakage in liters per hour (gallons per hour).
N = Number of gasketed joints in the line under test.
D = Nominal internal diameter of the pipe in millimeters (inches).
P = The average test pressure on the line being tested in kilopascals gauge (pounds per square inch gauge).

628.09 BACKFILLING.

(a) General. Immediately prior to backfilling, all debris, forms, and similar materials shall be removed from the excavation. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.

(b) Pipe Bedding Area. Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be sand, gravel, or crushed stone and shall not contain large lumps and stones over 25 mm (1 inch) in diameter. The Engineer may direct the use of material meeting the requirements for Granular Backfill for Structures. As the pipe is laid, bedding material shall be

extended to the spring line of the pipe and leveled along the width of the trench.

The pipe installation is to be inspected and approved by the Engineer before being covered.

(c) Pipe Envelope Area. The pipe envelope consists of selected suitable material placed from the spring line of the pipe to a depth of 300 mm (12 inches) over the top of the pipe. The material shall be carefully placed and spread over the width of the trench and compacted using an approved tamper.

The Contractor shall take all necessary precautions during placement and compaction of the bedding and pipe envelope materials to prevent either damage to or displacement of the pipe.

(d) Above Envelope Area. Unless otherwise shown on the Plans, material used for backfilling trenches above the envelope area shall be suitable material that was removed during excavation or obtained from borrow, and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, masses of roots, individual roots more than 500 mm (18 inches) long or 15 mm (1/2 inch) thick, or stones greater than 20 kg (50 pounds) or larger than 150 mm (6 inches) in the widest dimension.

If additional material is required, it shall be furnished from approved sources.

Backfill material shall be evenly spread and compacted in lifts not more than 300 mm (12 inches) thick or as approved by the Engineer. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction.

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly. If the material is too wet, the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or until other precautions are taken as necessary to obtain proper compaction.

Backfill material shall be compacted to the following percentages of maximum dry density and the in place moisture content shall be not more than 2 percent above the optimum moisture content, as determined by AASHTO T 180, Method C:

Around all structures, under roadway paving, shoulders, and embankments	95 percent
All other areas	90 percent

628.10 HOUSE CONNECTIONS. In general, the Engineer will require new house connections for each existing residential and commercial structure. The actual location of each new house connection shall be determined in the field by the Engineer.

Stub-outs for future connections shall be a minimum of 600 mm (24 inches) long and shall have ends closed with suitable approved plugs specially made for the purpose. All joints and spaces shall be thoroughly filled with mortar. Plugs shall be installed so as to be readily removable without damage to the pipe when future connections are made.

628.11 MANHOLES. Manholes shall conform to the requirements of Section 604.

628.12 TRANSFER OF EXISTING SYSTEM TO NEW SYSTEM. The Contractor shall maintain existing sewage flows during construction of the new sanitary sewer systems and during connection of the new system to the existing system. The Contractor shall submit and receive approval of a detailed construction schedule and procedure for transferring service from the existing system to the new system prior to beginning work on the system.

Prior to making the connection, the Contractor shall notify the owner and the Engineer three days in advance in writing of the date when the Contractor will be ready to complete the work.

After this connection is made, the Contractor shall divert the sewage flow to the new sewer, transfer the house services from the existing system to the new sewer, and abandon the existing system as shown on the Plans or directed by the Engineer.

Where existing manholes and other underground structures are to be abandoned, the Contractor shall remove the frame and cover, remove the top a minimum of 600 mm (24 inches) below subgrade or final slope grade, whichever is greater, plug the pipes with Class C concrete, and

backfill with suitable material. Frames and covers shall remain the property of the owner of the system. Material placed in the manholes and other structures shall be compacted to the requirements of the surrounding subgrade material.

628.13 WATER MAIN - SEWER SEPARATION. Where water mains and sewer lines are in the same area as a result of work under the Contract, parallel installations or crossings of such installations shall conform to the requirements as specified in the "Ten States Standards" for Water and Sewer Works and as specified below.

In addition, all reconstruction or relocation of existing water or sewer facilities shall be as approved by the utility owner. Such approval shall be obtained for scheduling, materials, and configuration of the reconstruction or relocation.

(a) Parallel Installation. Under normal conditions, water mains shall have a separation of at least 3 m (10 feet) horizontally from sewers, storm drains, or manholes whenever possible; the distance shall be measured edge-to-edge.

When local conditions prevent a horizontal separation of 3 m (10 feet), a water main and sewer may be laid closer to each other provided that:

(1) Special written approval is obtained from the Department of Health.

(2) The bottom of the water main is at least 500 mm (18 inches) above the top of the sewer main.

(3) Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to ensure that it is watertight prior to backfilling.

(b) Crossings. Under normal conditions, water mains crossing house sewers, storm sewers, or sanitary sewers shall be laid above the sewer line with a separation of at least 500 mm (18 inches) between the bottom of the water main and the top of the sewer pipe.

When local conditions prevent such a vertical separation, the following construction shall be used:

(1) Sewers passing over or under water mains shall be constructed of materials and joints that are equivalent to water main standards of construction, such as cast or ductile iron pipe with push-on or mechanical joints, or approved equal.

(2) In addition, water mains passing under sewers shall be protected by providing the following:

a. A vertical separation of at least 500 mm (18 inches) between the bottom of the sewer and the top of the water main;

b. Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking of the water mains;

c. The length of water pipe shall be centered at the point of crossing so that the joints will be equivalent and as far as possible from the sewer.

The Contractor shall assume the responsibility of identifying all crossings that may exist. All crossings, whether identified by the Engineer or the Contractor, shall be constructed in accordance with these specifications and as approved by the Engineer.

628.14 METHOD OF MEASUREMENT. The quantity of Sewer Pipe of the type and size specified to be measured for payment will be the number of meters (linear feet) of sewer line installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Relaying Sewer Pipe to be measured for payment will be the number of meters (linear feet) of sewer pipe relayed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Transfer to New System, Sanitary Sewer to be measured for payment will be on a unit basis for each transfer performed in the complete and accepted work.

628.15 BASIS OF PAYMENT. The accepted quantity of Sewer Pipe of the type and size specified will be paid for at the Contract unit price per meter (linear foot). Payment shall be full compensation for furnishing, transporting, handling, installing, and testing the materials specified; for making all necessary connections; and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

The accepted quantity of Relaying Sewer Pipe will be paid for at the Contract unit price per meter (linear foot). Payment shall be full compensation for furnishing all labor, equipment, tools, and incidentals necessary for relaying sewer pipe at the locations specified in the Contract and as directed by the Engineer.

Excavation, including backfill, and disposal of excavated material not suitable for backfill, will be paid for at the Contract unit price per cubic meter (cubic yard) for Trench Excavation of Earth or Trench Excavation of Rock, as specified in Section 204. When material is required to replace poor foundation material below the normal grade of the pipe it will be paid for as Granular Backfill for Structures. Concrete shown on the Plans or directed by the Engineer will be paid for as Concrete, Class B, unless otherwise specified. Sheeting left in place will be paid for as incidental to the appropriate excavation Contract item.

The accepted quantity of Transfer to New System, Sanitary Sewer will be paid for at the Contract lump sum price bid. Payment will be full compensation for furnishing all labor, materials, equipment, tools, and incidentals suitable for effecting the transfer of systems as specified. Items for payment under this lump sum amount include, but are not limited to, maintenance of existing sewage flows, excavation and location of the new connection point, diversion of sewage flow from the connection point, associated pumping/dewatering of connection area, making the physical connection including all fittings and appurtenances, transfer of sewage flow to the new system, abandonment of existing system, and furnishing all labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
628.20	ABS Sewer Pipe Solid Wall	Meter (Linear Foot)
628.21	ABS Sewer Pipe Composite	Meter (Linear Foot)
628.22	Reinforced Concrete Sewer Pipe	Meter (Linear Foot)
628.25	Cast Iron Soil Pipe, Extra Heavy	Meter (Linear Foot)
628.26	Cast Iron Pipe, Cement-Lined	Meter (Linear Foot)
628.27	Vitrified Clay Pipe, Extra Strength	Meter (Linear Foot)
628.28	Ductile Iron Pipe, Cement-Lined	Meter (Linear Foot)
628.30	Relaying Sewer Pipe	Meter (Linear Foot)
628.35	PVC Sewer Pipe	Meter (Linear Foot)
628.42	Transfer to New System, Sanitary Sewer	Lump Sum

SECTION 629 - WATER SYSTEMS

629.01 DESCRIPTION. This work shall consist of the construction or reconstruction of water lines and appurtenances.

629.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Crushed Stone Bedding	704.02
Granular Backfill for Structures	704.08
Plastic Water Pipe, Flexible	740.01
Plastic Water Pipe, Rigid (PVC)	740.02
Copper Water Tube, Seamless	740.04
Steel Water Pipe, Galvanized	740.05
Ductile Iron Pipe, Cement Lined	740.07
Pipe Insulation	740.08
Extension Service Box, Cast Iron	740.09
Curb Stop, Brass	740.10
Gate Valves	740.11
Tapping Sleeve	740.12
Hydrant	740.13
Corporation Stops	740.14
Chlorine Solution	742.01

Concrete shall be Class B, unless otherwise specified, and shall conform to the requirements of Section 541.

Sleeves shall conform to the requirements of Section 625.

Crushed stone used for pipe bedding shall meet the gradation requirements of Table 704.02B.

Ductile iron fittings shall be so-called compact or short-bodied fittings.

The Engineer will approve corporation stops for use on a project after consultation with the utility owner but prior to the stops being ordered by the Contractor.

629.03 GENERAL. Care shall be exercised by the Contractor to avoid disrupting the operation of existing water facilities without prior written approval of the Engineer.

When existing underground utilities, which are not scheduled for removal or abandonment, are encountered in the excavation, they shall be adequately supported and protected from damage. Any damage to utilities shall be repaired promptly in accordance with Subsection 107.13 at no additional cost to the Agency.

Any work associated with existing water lines or appurtenances shown on the Plans to be removed or abandoned in place shall be performed as an incidental item of construction.

The Contractor shall be responsible for the unloading, storing, hauling, and distribution of all materials. All such material that is damaged, destroyed, or lost during and after unloading shall be replaced at the Contractor's expense. All pipe, pipe fittings, and accessories shall be handled so as to avoid shock. Pipe having factory-applied joint material shall be stacked and blocked to prevent damage to the joint material. Material not needed for immediate use shall be stored in a safe manner at locations selected by the Contractor and approved by the Engineer.

The Engineer will approve the location of all pipes.

629.04 EXCAVATION. Where the pipe is to be laid below the existing ground line, a trench shall be excavated to the required depth and to a width sufficient to allow for joining of the pipe. The bedding and backfill material under and around the pipe shall be compacted according to the applicable material specification. Where feasible, trench walls shall be vertical.

The completed trench bottom shall be firm for its full length and width.

If shown on the Plans or directed by the Engineer, poor foundation material encountered below the normal grade of the pipe bed shall be removed and replaced with Granular Backfill for Structures.

Ledge rock, rocky or gravelly soil, hardpan, or other unyielding foundation material encountered at the normal grade of the pipe bed shall be removed and replaced with Granular Backfill for Structures. The width of the pipe bed shall be equal to the inside diameter of the pipe plus 600 mm (24 inches). The minimum depth shall be 300 mm (12 inches) below the pipe grade, unless otherwise shown on the Plans or directed by the Engineer.

No tunneling will be permitted except by written approval of the Engineer. Permission to tunnel will be granted only in short sections where, in the opinion of the Engineer, the pipe can be safely and properly installed and the backfill properly compacted.

The Contractor, at all times, shall conduct operations so as to prevent the accumulation of water, ice, and snow in excavations or in the vicinity of excavated areas, and to prevent water from interfering with the progress or quality of the work. Under no conditions shall water be allowed to rise in open trenches after pipe has been placed.

Accumulated water, ice, and snow shall be promptly removed and disposed of by pumping or other approved means. Disposal shall be carried out in a manner which will not create a hazard to public health; cause injury to public or private property, work completed or in progress, or public streets; or cause any interference in the use of streets and roads by the public. Pipes under construction shall not be used for drainage of excavations.

Where pipes are to be placed in embankment fill, the excavation shall be made after the embankment has been completed to a height of 1 m (3 feet) plus one pipe diameter above the designed grade of the pipe.

Sheeting and bracing required for trenches shall be removed to the elevation of the pipe, but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe.

629.05 BEDDING FOR PIPE. Ductile iron pipe shall be laid on suitable soil and backfilled and compacted to the centerline of the pipe with select material. Select material shall be sand, gravel, or suitable material excavated from the trench free from rocks, foreign materials, and frozen earth.

Concrete cradle bedding shall be installed on approved subgrades when shown on the Plans or directed by the Engineer.

629.06 LAYING PIPE. Installation of all water lines shall be in accordance with ANSI/AWWA C 600, “Ten States Standards,” and as specified.

Pipe laying shall begin at the outlet end. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or grooved ends of rigid pipes and the circumferential laps of flexible pipe shall be placed facing upstream. The longitudinal laps or seams of flexible pipe shall be at the sides.

All pipe and fittings shall be carefully examined for defects, and no pipe or fittings that are known to be defective shall be laid. If any defective piece is discovered after laying, it shall be removed and replaced at the Contractor’s expense. All pipes and fittings shall be cleaned before they are laid and shall be kept clean until accepted in the completed work.

The pipe shall be laid to conform to the lines and grades indicated on the Plans or as directed by the Engineer. Each pipe shall be so laid as to form a closed joint with the next adjoining pipe and to bring the inverts continuously to the required grade.

Each length of pipe shall be driven home against the pipe previously laid and held securely in position. Joints shall not be “pulled” or “cramped.”

Before any joint is made, the pipe shall be checked to ensure that a closed joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

The Contractor shall take all necessary precautions to prevent flotation of the pipe in the trench.

When pipe laying is not in progress, the open ends of the pipe shall be closed with temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until all danger of water entering the pipe is eliminated.

The use of concrete reaction blocking shall be limited to caps, tees, hydrants, and bends of 22.5 degrees and greater. Blocking shall be placed only on the sides of each fitting in the direction of thrust and not underneath for use as a foundation or support. All other bends less than 22.5 degrees shall be restrained by use of retainer glands at each bend and at all joints within three pipe lengths on each side of the bend.

Separation of water mains and sewers shall conform to the requirements of Subsection 628.13.

629.07 JOINING PIPE. Water pipe shall be joined in accordance with the detailed instructions of the manufacturer.

Where recommended by the manufacturer, the Contractor shall furnish coupling pullers for joining the pipe. Gasket feeler gauges shall be available for use by the pipe layer and the Engineer for checking the position of the rubber gaskets in the completed joint, if so directed by the Engineer.

The electrical conductivity of the pipeline and attached services shall be maintained at all joints, couplings, valves, and fittings through the use of three brass wedges at each joint, or with conduction straps. No couplings shall be made at any point on the pipeline or attached services without incorporating provisions to maintain electrical conductivity.

Any fittings showing a crack, and any fitting or pipe which has received a severe blow that may have caused a fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

Water pipe shall be cut by means of a handsaw, “metal-inserted” abrasive wheels, or by pipe cutters with blades, not rollers, doing the cutting. All cut ends shall be examined for possible cracks caused by cutting.

629.08 SETTING OF VALVES AND FITTINGS. Valves, fittings, plugs, and caps shall be set and joined to pipe in the manner specified above for laying and joining pipe.

A valve box or masonry pit shall be provided for every valve.

A valve box shall be provided for every valve that has no gearing or operating mechanism or in which the gearing or operating mechanism is fully protected with a gear case. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve, with the box cover flush with the surface of the finished pavement or other such level as directed by the Engineer.

A masonry valve pit shall be provided for every valve that has exposed gearing or operating mechanisms. The valve nut shall be readily accessible for operation through the opening in the manhole, which shall be set flush with the surface of the finished pavement or such other level as specified by the Engineer. Pits shall be constructed so as to permit minor valve repairs and afford protection to the valve and pipe from impact where they pass through the pit walls.

Mains shall be drained through drainage branches or blowoffs to dry wells from which the water can be pumped. Drainage branches, blowoffs, air vents, and appurtenances shall be provided with valves and shall be located and installed as shown on the Plans.

Drainage branches or blowoffs shall not be connected to any sewer, submerged in any stream, or be installed in any other manner that will permit back siphonage into the distribution system.

All dead ends of new mains shall be closed with plugs or caps; such dead ends shall be equipped with suitable blowoff facilities.

Corporation stops shall, in all instances, be tapped into the main on the side in a horizontal position or in such a position as will provide a minimum of 1.5 m (5 feet) of cover over the connecting service line. The main shall be tapped by skilled workers and the stop installed in

accordance with the manufacturer's recommendations at the locations shown on the Plans or as directed the Engineer. The stops may be installed at a later date, at which time the main may be tapped under pressure. All defective taps shall be repaired or replaced at the Contractor's expense.

Prior to installation, the Contractor shall thoroughly clean all exposed portions of any valves, removing all labels and all traces of foreign substance using only a cleaning solution approved by the manufacturer of the valve and being careful to avoid all damage to surfaces and coatings.

629.09 SETTING OF HYDRANTS. Hydrants shall be located as shown on the Plans or as directed so as to provide complete accessibility and minimize the possibility of damage from vehicles or injury to pedestrians.

When placed behind the curb, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap is less than 150 mm (6 inches) or more than 300 mm (12 inches) from the gutter face of the curb.

When set in the lawn space between the curb and the sidewalk, or between the sidewalk and the property line, no portion of the hydrant or nozzle cap shall be within 150 mm (6 inches) of the sidewalk.

All hydrants shall stand plumb and shall have their nozzles parallel with, or at right angles to, the curb, with the pumper nozzle facing the curb, except that hydrants having two hose nozzles 90 degrees apart shall be set with each nozzle facing the curb at an angle of 45 degrees. Hydrants shall be set to the established grade, with nozzles at least 300 mm (12 inches) above the ground, as shown or as directed by the Engineer.

Each hydrant shall be connected to the main with a 150 mm (6 inches) or larger branch controlled by an independent gate valve, unless otherwise specified.

If, as determined by the Engineer, the waste opening of any hydrant will be below the normal sub-surface water elevation, the waste opening shall be securely plugged and no drainage pit will be required.

Wherever a dry-barrel hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 150 mm (6 inches) above the waste opening in the hydrant, and to a distance of 300 mm (12 inches) around the elbow. No drainage system shall be connected to a sewer.

Wherever a dry-barrel hydrant is set in clay or other impervious soil, a drainage pit 600 by 600 mm by 1 m deep (24 × 24 inches by 3 feet deep) shall be excavated below each hydrant and backfilled with coarse gravel or crushed stone mixed with coarse sand, and compacted under and around the elbow of the hydrant to a level of 150 mm (6 inches) above the waste opening. No drainage pit shall be connected to a sewer.

629.10 ANCHORAGE. The bowl of each hydrant shall be well braced against unexcavated earth at the end of the trench with stone slabs or concrete backing, or the hydrant shall be tied to the pipe with suitable metal tie rods or clamps as shown on the Plans or directed by the Engineer.

All plugs, caps, tees, and bends, unless otherwise specified, shall be provided with a reaction backing, or movement shall be prevented by attaching suitable metal rods or clamps as shown or specified.

Concrete reaction backing shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that shown on the Plans or directed by the Engineer. The backing shall, unless otherwise shown or directed, be placed in such a manner as to contain the resultant thrust forces in such a way that the pipe and fitting joints will be accessible for repair.

A metal harness of tie rods or clamps of adequate strength to prevent movement may be used instead of concrete backing, as directed by the Engineer. Steel rods or clamps shall be galvanized or otherwise rustproofed, or shall be painted as shown or directed by the Engineer.

629.11 PRESSURE AND LEAKAGE TESTS. Except as otherwise directed, all pipelines shall be tested. Pipelines laid in excavation or bedded in concrete shall be tested prior to field painting. Pipe to be insulated shall be tested prior to installing insulation.

The Contractor shall furnish all gauges, testing plugs, caps, and all other necessary equipment and labor to perform leakage and pressure tests in sections of an approved length. Each valved section or a maximum length of 300 m (1000 feet) of pipe shall be tested. The Contractor shall provide and bear the costs of any additional taps to the waterline necessary to perform the pressure and leakage test between valves.

All water required for testing shall be potable. All testing shall be conducted in the presence of the Engineer.

The Contractor shall make the necessary provisions to tap the pipe at the high point to release all air and shall plug the pipe after completing the test. Hydrants or blowoffs located at high points may be used for air release instead of taps if approved by the Engineer.

For the pressure test, the Contractor shall develop and maintain for two hours, 150 percent of the working pressure measured in kilopascals (pounds per square inch). Failure to hold the designated pressure for the two-hour period will constitute a failure of the section tested.

The leakage test shall be performed for a duration of two hours, only after the pressure test has been satisfactorily completed. During the leakage test, the Contractor shall measure the quantity of water required to maintain the maximum operating pressure of the main. Leakage shall not exceed allowable values for leakage presented in Table 6B of ANSI/AWWA C 600 latest revision. All testing shall be conducted in accordance with ANSI/AWWA C 600 latest revision.

Should any section of pipe fail either the pressure or leakage test, the Contractor shall do everything necessary to locate and repair or replace the defective pipe, fittings, or joints at no expense to the Agency.

If for any reason the Engineer should alter the foregoing procedure, the Contractor shall remain responsible for the tightness of the line within the above requirements.

629.12 DISINFECTING. Before being placed in service, the pipeline, valves, hydrants, etc., shall be chlorinated in accordance with ANSI/AWWA C 651, latest revision. The entire procedure of chlorinating the pipes shall be approved by the Engineer two weeks prior to the time the work is to be done. The methods to be employed shall be fully satisfactory to the Engineer before they are applied. The location of chlorination and sampling points is to be determined by the Engineer in the field.

The general procedure for chlorination shall be to first flush out the lines until all dirty or discolored water has disappeared, then to apply the chlorine in approved dosages through a tap at one end of the line while water is being drawn at the other extremity of the line until the entire line contains chlorine solution. The chlorine solution shall remain in the pipeline for a period of 24 hours.

Within 24 hours following the chlorination period, all treated water shall be flushed from the lines or portions thereof at their extremities and replaced with water from the distribution system.

Special disinfecting procedures shall be used as directed by the Engineer where the above outlined method is not practical, and when making connections to existing mains. The Contractor shall provide all necessary apparatus, materials, and labor for disinfecting the mains and shall make the required taps for this purpose. Disinfection of the mains shall be under the immediate direction of the Engineer during all phases of the work.

Prior to being placed in operation for domestic use, all new portions of the system shall be flushed, pressure tested, disinfected, and flushed again. Following this procedure, at least two water samples shall be collected from representative sample points and sent to the Vermont Department of Health Laboratory's Division of Environmental Health, or other testing laboratory approved by the Vermont Department of Health, for bacteriological testing. Passing sample results are required before the system may be placed on line for drinking. Sample bottles shall be obtained from the same laboratory.

629.13 HOUSE CONNECTIONS. Service lines disrupted within the construction limits shall be replaced as ordered by the Engineer. The actual location of each ordered house connection shall be determined in the field by the Engineer.

All service lines shall be seamless copper water tube from the corporation stop to the curb stop. The copper tubing shall be attached to the corporation stop and curb stop in a manner satisfactory to the Engineer. Sufficient slack shall be left adjacent to the corporation stop and curb stop to prevent damage to the copper tubing by movement of the pipeline. Care shall be exercised in the placing and laying of copper tubing to be sure that the pipe does not have kinks or lie directly on sharp stones or ledge which would cause damage to the pipe. The Contractor shall place at least 150 mm (6 inches) of selected material as approved by the Engineer, adjacent to, above, and below the tubing.

In making cuts in copper service pipe, a hacksaw, preferably used with a miter box, shall be used to cut the tubing. A cutter or tool designed for tube cutting may also be used. The tubing shall be reamed, and after placing the coupling nut on the pipe, the pipe shall be flanged, using a flanging tool designed particularly for this purpose.

All services shall be tested for leakage, and in all instances, the corporation stops shall be left in the open position upon completion of the installation.

The Contractor shall install the curb stop and the curb box at the end of the service line, usually at the approximate property line, or as shown on

the Plans and connect the stop to the water main with new copper tubing. The curb box shall be installed vertically and centered over the operating key, with the elevation of the top adjusted to conform to the finished grade. The Contractor shall adequately support the box during backfilling to maintain its vertical alignment. The Contractor shall also ensure that the curb box does not rest on the curb stop owner's services and furnish any adapters and/or special couplings needed for these connections. Any necessary piping from the curb stop to the existing service shall match the existing service line, unless otherwise directed by the Engineer. If no service exists, the Contractor shall furnish a curb stop for connection to a copper service line.

Iron pipe threads shall be supplied under the tube nuts of curb stops and corporation stops.

629.14 BACKFILLING.

(a) General. Immediately prior to backfilling, all debris, forms, and similar materials shall be removed from the excavation. Backfilling shall not be done in freezing weather, with frozen materials, or when materials already placed are frozen.

(b) Pipe Bedding Area. Prior to laying pipe, bedding material shall be placed to the limits of the excavation and to a depth beneath the pipe as specified. This material shall be sand, gravel, or crushed stone and shall not contain large lumps or stones over 25 mm (1 inch) in diameter. The Engineer may direct the use of material meeting the requirements for Granular Backfill for Structures. As the pipe is laid, bedding material shall be extended to the spring line of the pipe and leveled along the width of the trench.

The pipe installation is to be inspected and approved by the Engineer before being covered.

(c) Pipe Envelope Area. The pipe envelope consists of selected suitable material placed from the spring line of the pipe to a depth of 300 mm (12 inches) over the top of the pipe. The material shall be carefully placed and spread over the width of the trench and compacted using an approved tamper.

The Contractor shall take necessary precautions during placement and compaction of the bedding and pipe envelope materials to prevent either damage to or displacement of the pipe.

(d) Above Envelope Area. Unless otherwise shown on the Plans, material used for backfilling trenches above the envelope area shall be suitable material that was removed during excavation, or obtained from borrow, and when compacted shall make a dense stable fill. The material shall not contain vegetation, porous matter, or stones larger than 150 mm (6 inches) in the widest dimension.

If additional material is required, it shall be furnished from approved sources.

Backfill material shall be evenly spread and compacted in lifts not more than 300 mm (12 inches) thick or as approved by the Engineer. Previously placed or new materials shall be moistened by sprinkling, if required, to ensure proper bond and compaction.

Whatever method of compacting backfill is used, care shall be taken that stones and lumps shall not become nested and that all voids between stones shall be completely filled with fine material.

No compacting shall be done when the material is too wet to be compacted properly. If the material is too wet, the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compaction, or until other precautions are taken as necessary to obtain proper compaction.

Around all structures, under roadway paving, shoulders, and embankments	95 percent
All other areas	90 percent

Backfill material shall be compacted to the following percentages of maximum dry density and the in-place moisture content shall be not more than 2 percent above the optimum moisture content as determined in accordance with AASHTO T 180, Method C:

629.15 PIPE INSULATION. Pipe insulation shall be installed on water lines where insufficient cover, less than 1.5 m (5 feet), may exist as a result of vertical alignment conflicts with sanitary sewers, storm sewers, etc., as shown on the Plans or as directed by the Engineer. Insulation shall be at least 50 mm (2 inches) thick and shall conform to Subsection 740.08.

Pipe insulation shall be installed only by a factory approved insulation Contractor. Certification from the insulation manufacturer as to the ability of the Contractor to properly install the insulation in accordance with the manufacturer's specifications shall be required before insulation work begins. In addition, the insulation Contractor shall submit detailed Fabrication Drawings for approval in accordance with Section 105 detailing the methods and materials to be used for the insulation along pipe barrels, couplings, fittings, expansion joints, and sleeves. Variance from the approved methods and materials shall not be allowed without written permission of the Engineer. Insulation shall not be installed until the section of water line to be insulated has passed both pressure and leakage tests, unless otherwise directed by the Engineer.

629.16 WATER SYSTEM TRANSFER. The Contractor shall maintain existing water service during construction of the new water distribution systems and during the connection of the new system to the existing system. The Contractor shall submit to the system owner, and where required, to the Vermont Department of Health, a detailed construction schedule and procedure for transferring service from the existing system to the new system and shall receive approval(s) of the submittal prior to beginning work on the system.

Prior to making the transfer, the Contractor shall notify the owner and the Engineer three days in advance in writing that the system is ready to be transferred.

After the new connection is made, the Contractor shall divert the water to the new water main, disinfect the system, transfer affected individual service lines to the new water main, and abandon the existing system as shown on the Plans or directed by the Engineer.

629.17 METHOD OF MEASUREMENT. The quantity of water Pipe to be measured for payment will be the number of meters (linear feet) of the size, type, and class specified installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Extension Service Box and Curb Stop measured for payment will be the number of units of each installed in the complete and accepted work.

The quantity of Valves, Hydrants, Tapping Sleeves and Valve Pits to be measured for payment will be the number of units of each size and type specified installed in the complete and accepted work.

The quantity of Meter Pit measured for payment will be the number of units of each installed in the complete and accepted work including all interior piping and appurtenances.

The quantity of Corporation Stop to be measured for payment will be the number of units of each size and type specified, installed in the complete and accepted work.

The quantity of Expansion Assembly to be measured for payment will be the number of units of each size and type specified, installed in the complete and accepted work.

The quantity of Transfer to New System, Water System to be measured for payment will be on a lump sum basis for each transfer in the complete and accepted work.

The quantity of Pipe Insulation to be measured for payment will be the number of meters (linear feet) of the size and type installed in the complete and accepted work, as measured along the flow line of the pipe.

The quantity of Crushed Stone Bedding to be measured for payment will be the number of metric tons (tons) of material installed in the complete and accepted work, as determined by load tickets.

629.18 BASIS OF PAYMENT. The accepted quantity of Adjust Elevation of Valve Box, Relocate Hydrant, or Remove Hydrant will be paid for at the Contract unit price per each. Payment will be full compensation for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantities of water Pipe will be paid for at their Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, handling, installing, testing, and disinfecting the materials specified, including fittings and clamps; for making all necessary connections; for furnishing and placing the concrete or other materials for reaction backing or furnishing and installing tie rods, clamps, and restrained joints; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantities of Extension Service Box and Curb Stop units, Valves, Hydrants, Tapping Sleeves, Valve Pits, and Expansion Assembly will be paid for at their respective Contract unit price each. Payment will be full compensation for furnishing, transporting, handling, installing, and testing all materials, including fittings and clamps, for painting hydrants and constructing drainage pits; for furnishing and placing concrete or stone slabs for reaction backing or furnishing and installing tie rods and

clamps; and for all other costs incidental to the work including any cost involved for shipping, rental, or royalty charges, or for manufacturer's supervision in conjunction with the special work of installing valves.

The accepted quantity of Meter Pit will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing all materials, tools, labor, and equipment suitable for installing the meter pit. The unit price includes, but is not limited to, reinforced concrete, concrete fill, wall sleeves and caulking, insulation, control system, hatch and ladder, interior piping and fittings, pipe supports, gate valves, flow meter or other measuring device, and all other costs incidental to the work including any manufacturer's supervision in conjunction with the special work of installing valves and meters.

The accepted quantity of Corporation Stop will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, installing, and connecting the stops and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Transfer to New System, Water System will be paid for at the Contract unit price per lump sum. Payment will be full compensation for performing all work items as directed by the Engineer to abandon existing mains, including but not limited to cutting and capping existing mains and laterals, closing existing valves and curb stops, removing existing valve boxes and curb boxes, and removal of any existing main which conflicts with the construction necessary to complete the transfer to the new system, including disinfection; for providing specialized labor, materials, tools, and equipment for effecting the transfer of systems as specified, and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantity of Pipe Insulation will be paid for at the Contract unit price per meter (linear foot). Payment will be full compensation for furnishing, transporting, handling, and installing the materials specified, including all work at couplings, joints, valves, expansion assemblies, an insulation jacket if shown on the Plans, for providing weatherproof seals at required points, and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work.

The accepted quantity of Crushed Stone Bedding will be paid for at the Contract unit price per metric ton (ton). Payment will be full compensation for furnishing, transporting, handling, placing, and grading the material as specified and for the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation, including backfill and disposal of excavated material not suitable for backfill, will be paid for at the Contract unit price per cubic meter (cubic yard) as Trench Excavation of Earth or Trench Excavation of Rock under Section 204. When material is required to replace poor foundation material below the normal grade of the pipe, it will be paid for as Granular Backfill for Structures.

The utility owner will provide the services of a Professional Engineer to oversee construction of the waterline, to ensure that State requirements are met and to sign and stamp all paperwork required by the Water Supply Division of the Department of Environmental Conservation, Agency of Natural Resources. The Professional Engineer shall advise the Engineer, and the Engineer will provide direction to the Contractor.

Payment will be made under:

Pay Item		Pay Unit
629.20	Adjust Elevation of Valve Box	Each
629.23	Seamless Copper Water Tube	Meter (Linear Foot)
629.24	Ductile Iron Pipe, Cement-Lined	Meter (Linear Foot)
629.25	Extension Service Box and Curb Stop	Each
629.26	Gate Valve	Each
629.27	Gate Valve with Valve Box	Each
629.28	Hydrant	Each
629.29	Relocate Hydrant	Each
629.30	Remove Hydrant	Each
629.31	Meter Pit	Each
629.32	Plastic Water Pipe, Flexible	Meter (Linear Foot)
629.33	Plastic Water Pipe, Rigid	Meter (Linear Foot)
629.34	Steel Water Pipe, Galvanized	Meter (Linear Foot)
629.35	Tapping Sleeve and Valve with Valve Box	Each
629.36	Valve Pit	Each
629.39	Corporation Stop	Each
629.40	Expansion Assembly	Each
629.42	Transfer to New System, Water System	Lump Sum
629.44	Pipe Insulation	Meter (Linear Foot)
629.54	Crushed Stone Bedding	Metric Ton (Ton)

SECTION 630 - UNIFORMED TRAFFIC OFFICERS AND FLAGGERS

630.01 DESCRIPTION. This work shall consist of furnishing qualified uniformed traffic officers (UTOs) and flaggers for the handling of traffic in, around, and through work zones. UTOs and flaggers collectively are also referred to as traffic control personnel. UTOs and flaggers shall be used to control and protect the traveling public and workers during construction operations as directed by the Engineer. All traffic control operations in, around, and through work zones shall conform to the MUTCD.

(a) Definitions.

(1) "Uniformed Traffic Officer" (UTO) means a law enforcement officer who has law enforcement authority at the location where the services are provided.

(2) "Flagger" means a person who has completed an approved, four-hour flagger training course given by a certified instructor.

(b) Certification to Train Flaggers. Certification to train flaggers may be obtained by completing one of the following courses or another course approved by the Agency:

(1) Associated General Contractors of Vermont, Work Zone Traffic Control Technician/Flagger Trainer Course; or

(2) American Traffic Safety Services Association, Worksite Traffic Supervisor Certification Course.

(c) Duties of Uniformed Traffic Officer. UTOs shall perform the following functions as directed by the Engineer in and around work zones:

(1) Promote voluntary compliance by motorists with speed and other rules of the road through an obvious presence. This may include the presence of marked law enforcement vehicles displaying law enforcement signal lamps, the presence of a UTO in or near the highway, and/or signage indicating their presence. This presence is generally stationary (fixed post), with a law enforcement vehicle serving as an advanced warning

signal and the UTO usually positioned outside the vehicle, to direct or control traffic as necessary.

(2) Direct and control traffic. This may include the direction and control of traffic at intersections where signals are not functioning or are malfunctioning.

(3) Serve as a flagger.

(d) Use of Flaggers. A flagger shall be used as directed by the Engineer to stop and release traffic within a designated work zone or where the entrance or exit of construction equipment or other construction activity constitutes a hazard to the traveling public. Flaggers shall not be used to direct traffic.

(e) Use of Railroad Flaggers. Railroad flaggers shall be used within the limits of the project whenever the Contractor's operations are such as to make it necessary as described in the Contract Special Provisions.

Flaggers used in conjunction with railroad operations shall receive approval for use by the operating Railroad. The Contractor may contact the operating Railroad for a listing of approved flaggers.

(f) Responsibility of Contractor to Protect Public and Workers. Direction or lack of direction by the Engineer to use traffic control personnel shall not release the Contractor from its responsibility to protect the traveling public and workers in and around work zones.

630.02 QUALIFICATIONS. The Contractor shall ensure that all flaggers utilized on the project have successfully completed a four-hour flagger training course given by a certified instructor within the last twenty-four months. The Contractor shall provide to the Engineer a list of the names of all trained flaggers currently on the project, including the date of training for each person listed.

630.03 CLOTHING AND EQUIPMENT.

(a) For Uniformed Traffic Officers.

(1) Every UTO shall wear a uniform approved by his/her law enforcement department with an exposed badge that clearly identifies him/her as a law enforcement

officer; when operating outside the vehicle, the UTO shall wear a High-Visibility, Class 2, reflectorized vest as specified in the MUTCD.

(2) When employed on the project during the period from sunset to sunrise, a UTO shall be equipped with hand-held, lighted signals that display a red light suitable for directing traffic and with High-Visibility, Class 2, reflectorized vests as specified in the MUTCD.

(3) Every UTO shall be accompanied by a law enforcement vehicle with operating blue or blue and white, or a combination of these, law enforcement signal lamp(s) conforming in all respects to those permitted under 23 VSA § 1252.

(4) The signal lamp(s) on a UTO's law enforcement vehicle shall be in operation when and where required by project-specific traffic control plans or as directed by the Engineer when, in the Engineer's opinion, the safety of the traveling public and/or project personnel will be enhanced by the operation of the lamp(s).

(b) For Flaggers.

(1) Flaggers shall wear safety apparel (reflectorized vests) meeting the requirements of ISEA "American National Standard for High-Visibility Apparel" that is labeled as meeting the ANSI 107-1999 standard performance for Class 2 risk exposure. The apparel background material color shall be either fluorescent orange-red or fluorescent yellow-green as defined in the standard. The retroreflective material shall be either orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors, and shall be visible at a minimum distance of 300 m (1000 ft). The retroreflective safety apparel shall be designed to clearly identify the wearer as a person.

(2) Flaggers shall wear approved headgear consisting of protective headgear commonly referred to as a "hard hat," a brimmed cap of the type commonly referred to as a "baseball cap," or headgear otherwise required by law, regulation, or governmental policy. The headgear shall be provided in one of the colors designated for high visibility clothing in the MUTCD. Approved

headgear shall have no additions, adornments, or ornamentation, except that on the front of the headgear, above the brim, a small company or governmental logo or name which does not significantly reduce the visibility of the headgear may be displayed.

(3) Flaggers shall be equipped with a STOP/SLOW paddle signaling device as detailed in part 6E.03 of the MUTCD.

(4) Flaggers shall at all times be properly dressed, present a neat appearance, and have all reflectorized gear clean and visible to the traveling public. The Engineer's determination as to the suitability of the appearance of any flagger shall be final. An unsuitable appearance shall constitute ineffectiveness in controlling traffic. Any flagger deemed ineffective in controlling traffic by the Engineer shall be removed.

(c) For Railroad Flaggers.

(1) Railroad flaggers shall be trained, clothed, and equipped in accordance with guidelines, rules, and/or regulations set forth by the operating Railroad.

(d) For All Traffic Control Personnel.

(1) The Contractor shall equip all traffic control personnel on the project with two-way radios capable of maintaining all necessary communication within the work zone. The traffic control personnel shall use these radios to maintain communication and coordination whenever distance, noise, intervening operations, dust, and/or other existing conditions make it difficult or impossible to communicate on a line-of-sight basis and/or whenever the use of two-way radios is ordered by the Engineer. The Contractor shall at all times keep sufficient spare batteries, parts, and complete units on the project so that no individual performing traffic control is without a working two-way radio for a period longer than 10 minutes. Without exception, when two-way radios are required and a person performing traffic control is without a working two-way radio for more than 10 minutes, that person will either be supplied with a working two-way radio or be considered ineffective,

removed in the manner set forth in Subsection 630.04, and replaced with a person with a working two-way radio.

(2) The reflectorized vests worn by traffic control personnel shall have the words "TRAFFIC CONTROL" in 50 mm (2 inch) high black letters on front and back reflective panels. Unless the words and the reflective panels on which they are mounted were placed on the vest by the original manufacturer, the layout, dimensions, proportions, and spacing of the letters in the words shall conform to the requirements for Series B Upper Case Letters in the Standard Sign Alphabets for Highway Signs.

(3) When not actually engaged in traffic control, traffic control personnel shall not wear vests with the traffic control legend.

630.04 STANDARD PROCEDURES. The Contractor or subcontractor supplying uniformed traffic officers and/or flaggers on a project shall designate a person as the responsible person to coordinate the traffic control plan and procedures with the Superintendent and the Engineer.

Any UTO or flagger determined by the Engineer to be ineffective in controlling traffic shall be removed by the Contractor from all traffic control on the project. The Contractor shall immediately comply with the directive from the Engineer and shall suspend operations as necessary until a qualified replacement can be provided. Such a suspension of operations shall not be considered as a basis for a claim or an extension of time.

630.05 METHOD OF MEASUREMENT. The quantities of Uniformed Traffic Officers, Flaggers, and Flaggers, Railroad to be measured for payment will be the number of hours for each as authorized by the Engineer. No additional allowance will be made for premium time (overtime), and no allowance or payment will be allowed for the required four-hour training.

630.06 BASIS OF PAYMENT. The accepted quantities of Uniformed Traffic Officers and Flaggers will be paid for at the Contract unit price per hour. Payment will be full compensation for hiring, training, transporting, and supervising; for furnishing clothing, badges, vehicles, law enforcement signal lamps, signs, lighting devices, reflectorized equipment; for providing all taxes and insurance; and for furnishing all

radios and other equipment, materials, and incidentals necessary to perform this work.

The accepted quantity of Flaggers, Railroad will be paid for at the Contract unit price per hour. Payment will be full compensation for labor hours accrued on the project by a railroad flagger in the employ of the operating Railroad. The unit price shall include the costs of any equipment, clothing, and training required for the railroad flagger(s).

When the Contract item(s) Uniformed Traffic Officers, Flaggers, and/or Flaggers, Railroad is (are) not included in the Contract or when Uniformed Traffic Officers, Flaggers, and/or Flaggers, Railroad are employed by the Contractor without authorization by the Engineer, the cost(s) will not be paid for directly but will be considered incidental to all other Contract items.
Payment will be made under:

Pay Item	Pay Unit
630.10 Uniformed Traffic Officers	Hour
630.15 Flaggers	Hour
630.20 Flaggers, Railroad	Hour

SECTION 631 - FIELD OFFICE

631.01 DESCRIPTION. This work shall consist of furnishing, erecting, equipping, and maintaining field offices and testing equipment. The work shall include cleaning, supplying utility services, office furniture, equipment, and supplies as required for the exclusive use of the Agency engineering staff at locations approved by the Engineer. Upon completion of the project, the field office(s), furniture, accessories, and equipment provided shall remain the property of the Contractor.

The testing equipment and supplies are furnished for the use of the Agency during the term of the Contract and shall be subject to use by Agency personnel to conduct tests of any materials at any location as directed by the Engineer.

The equipment furnished for testing of protective coatings shall be used by the Engineer as required by the Contract.

631.02 FIELD OFFICE, ENGINEERS.

(a) Design.

(1) General. The field office shall be available to the representatives of the State and the Federal Government throughout the duration of the work on the project, shall be independent of other buildings or office space used by the Contractor, and shall be removed when released by the Engineer. The field office, equipment, and supplies shall be maintained in good condition and adequate quantities at all times.

The field office shall be provided with adequate light, heat, potable water, ventilation, and electrical or gas connections as required. The method of heating shall be such that a minimum temperature of 20 °C (68 °F) can be maintained at all times.

The Contractor shall furnish all labor and materials for winterizing field offices.

Sanitary facilities consisting of a flush toilet, chemical or other approved type, including a waterless hand sanitizer, shall be furnished by the Contractor with proper sewage disposal as is necessary to comply with the requirements and regulations of the State and local Boards of Health and VOSHA. Sanitary facilities shall have adequate facilities for washing hands and shall have adequate lighting.

Entrances shall be provided with a 1.2 by 1.2 m (4 × 4 ft) minimum size deck with appropriate steps and railings meeting the requirements of the VOSHA *Safety and Health Standards for Construction*.

Each field office shall be equipped with an exterior security light of 400 W minimum.

(2) Office Type. The office shall be a commercial type field office trailer of standard commercial quality, or a building, in good condition as determined by the Engineer with a minimum width of 3 m (10 feet) and a minimum floor space of 33 m² (360 ft^2). The fully equipped field office shall be available for use from the

day that work on the project is commenced by the Contractor until 30 days after acceptance of the project, unless otherwise directed by the Engineer.

(3) Foundation. The field office shall be constructed on a firm foundation that will remain vibration free and that will not be adversely affected by frost action or water runoff.

(4) Outside Doors. The field office shall have a minimum of two outside doors equipped with dead bolt locks. All keys shall be in the possession of the Engineer or the Engineer's representatives.

(5) Windows. The field office shall have a minimum of four side windows, one front window, and one rear window, all glassed and screened with provisions for opening and locking. All windows shall be equipped with adjustable louvered blinds.

(6) Electrical System. The field office shall be equipped with a 110 V AC, 60 Hz, single-phase electrical system with service entrance equipment suitable for power company attachment and with at least twelve properly positioned interior electrical duplex outlets. The materials and installation methods of all electrical wiring, connections, switches, and grounds shall conform to the provisions of the National Electrical Safety Code and shall be in accordance with all State and local electrical ordinances.

(7) Interior Lights. The field office shall be provided with a minimum of five 1200 mm (48 inch) long fluorescent lighting fixtures, or equivalent, on the ceiling.

(8) Air Conditioner. The field office shall be equipped with an air conditioner of adequate capacity, unless otherwise specified in the Contract.

(9) Fire Extinguishers. The field office shall be equipped with at least two fire extinguishers. Each shall be a Halon fire extinguisher, equal in fire fighting capacity to a 2.27 kg (5 pound) carbon dioxide fire extinguisher.

(b) Office Equipment. Office equipment shall be standard commercial quality office equipment. The minimum required office equipment is as follows. Substitutes may be provided upon approval of the Engineer.

1 Standard office desk with drawers, locks, and keys, 1500 by 750 mm (60 × 30 inches) (minimum dimensions).

2 Adjustable, ergonomic office chairs that provide extra support and comfort to the lower back, have height adjustment to fit chair user, and have rolling casters.

1 Standard drafting table, 1 by 2 m (37 1/2 × 72 inches) (minimum dimensions).

2 Adjustable drafting stools.

1 Fire resistant, four-drawer, legal-size file cabinet, rated to withstand a one-hour fire, with lock and two keys.

1 Storage cabinet, 600 by 600 by 900 mm (2 × 2 × 3 feet) (minimum dimensions).

1 Metal, five-drawer, Plan file, 500 h by 710 d by 1010 w mm (20 h × 28 d × 40 w inches) (minimum dimensions).

1 Plan rack, 600 by 600 by 600 mm (2 × 2 × 2 feet) (minimum dimensions).

1 Locker or closet of sufficient size for storage of surveying equipment.

1 Electronic printing calculator, four-function, ten-column with memory.

1 Telephone, touch tone dial, compatible with the local telephone service available.

The Contractor shall arrange for the connection of the telephone system and pay the installation charge as part of Contract item 631.10. The Contractor shall also pay the monthly service bill. Upon presentation of the paid monthly service bill to the Engineer, the Engineer will pay the Contractor the cost of the service bill under Contract item 631.25. Connected to the telephone shall be a telephone answering device capable of receiving and storing messages.

1 Electric clock having a dial face of at least 200 mm (8 inches) in diameter.

1 Outdoor thermometer with an easy to read weatherproof thermometer having a minimum scale range of -40 to 40 °C (-40 to 100°F) in graduations of 1 or 2 degrees.

2 110 L (30 gallon) trash cans.

1 Potable water system consisting of a sink with faucet within the office, with a continuous supply of pressurized clean potable water for the duration of the project; or (when clean potable water is not available) a commercial bottled drinking water system installed in the office trailer complete with necessary disposable drinking cups (215 ml (8 oz.) size or larger), cup dispenser, and continuous water supply furnished for the duration of the project. The system shall be capable of supplying both hot and cold water. The system and the bottled water shall be furnished by a commercial water service on a regular basis agreeable to the Engineer.

1 First Aid Kit Conforming to ANSI Z308.1-1978

1 Dry copying machine with the capability of copying at least legal size paper full size and a rated capacity of at least 1,000 copies per month. It shall have an automated paper feed system. The Contractor shall supply all the paper and shall provide all other necessary supplies and maintenance to keep the copier working during the life of the Contract.

1 Color Inkjet Printer, furnished, complete and working for use in the Engineer's Field Office for the duration of the Contract. Equipment and supplies shall be provided as follows:

a. A color Inkjet Printer, compatible with Microsoft Windows XP and Microsoft Windows 2000, having 2 MB RAM minimum, 600 by 600 dpi black and white resolution, a tray capacity of at least 50 sheets, a print speed of at least 10 pages per minute, and parallel/USB interface capability.

b. A Bi-directional PC – type parallel printer cable or USB printer cable – 4.5 meters (15 feet) long.

c. A printer stand providing a minimum horizontal space for the printer of 900mm by 600mm (3 feet by 2 feet).

d. An anti-static vinyl dust cover.

e. A good quality commercial surge suppresser to protect against:

a. chronic high and low voltage, and
b. dangerous voltage spikes and radio frequency interference traveling on the AC power circuits.
c. Spare ink cartridges, both color and black.
d. Appropriate software drivers and documentation for the printer.

1 Digital Camera with the following requirements:

a. At least 2 Megapixel resolution
b. Both LCD and Optical viewfinders
c. At least 32 Megabyte storage capacity
d. USB Interface capability
e. Storage case
f. Windows XP/2000 Compatible

1 Plain paper facsimile machine meeting the following requirements:

a. CCITT Group Compatibility - Groups III, II, I
b. Transmission Time - 20 seconds per page, maximum Automatic Feed
c. Minimum 10 Page Stock Capacity
d. Pulse/Tone Dialing
e. Speed Dialing - 50 locations, minimum
f. Single Touch Dialing - 10 locations, minimum
g. Automatic redial - up to 5 times
h. Capacity to distinguish between a fax phone call and a telephone call

A combination Copier/Printer/Fax Machine meeting the requirements of the Copier, Printer and Fax Machine described above may be substituted with the permission of the Engineer.

Paper for the fax machine, copier, and printer shall be furnished by the Contractor, to the Engineer as required during the term of the project.

Three telephone lines shall be provided. Telephone jacks will be located at each end of the field office for both telephone lines. The jacks shall be located above the surface of the desks.

The cost of furnishing these separate telephone lines, including installation and removal, will not be paid for directly, but will be considered incidental to Contract item 631.10. The monthly service charges will be paid under Contract item 631.25.

All furnished equipment shall be maintained in good working order. Replacement equipment shall be provided within 48 hours for all equipment that is damaged, stolen, or becomes inoperative in any way.

The Contractor shall provide training to the Engineer in the use of the furnished equipment.

631.03 FIELD OFFICE, SOILS AND MATERIALS.

(a) Design and Appendages.

(1) General. The field office shall be available to the representatives of the State and the Federal Government throughout the duration of the work on the project, shall be independent of other buildings or office space used by the Contractor, and shall be removed when released by the Engineer. The field office, equipment, and supplies shall be maintained in good condition and adequate quantities at all times.

The field office shall be provided with adequate light, heat, potable water, ventilation, and electrical or gas connections as required. The method of heating shall be such that a minimum temperature of 20 °C (68 °F) can be maintained at all times.

The Contractor shall furnish all labor and materials for winterizing field offices.

Sanitary facilities consisting of flush toilet, chemical or other approved type, including a waterless hand sanitizer, shall be furnished by the Contractor with proper sewage disposal as is necessary to comply with the requirements and regulations of the State and local Boards of Health and VOSHA.

Entrances shall be provided with a 1.2 by 1.2 m (4 × 4 ft) minimum size deck with appropriate steps and railings meeting the requirements of the VOSHA *Safety and Health Standards for Construction*.

Each field office shall be equipped with an exterior security light of 400 W minimum.

(2) Office Type. The field office shall be a commercial type mobile laboratory trailer of standard commercial quality, or a building, in good condition as determined by the Engineer with a minimum floor space of 22 m^2 (240 ft^2). The fully equipped field office shall be available for use from the day that work on the project is commenced by the Contractor until 30 days after acceptance of the project, unless otherwise directed by the Engineer.

(3) Foundation. The field office shall be constructed on a firm foundation that will remain vibration free and that will not be adversely affected by frost action or water runoff.

(4) Outside Doors. The field office shall have a minimum of two outside doors equipped with dead bolt locks. All keys shall be in the possession of the Engineer or the Engineer's representatives.

(5) Windows. The field office shall have a minimum of four side windows, one front window, and one rear window, all glassed and screened with provisions for opening and locking. All windows shall be equipped with adjustable louvered blinds.

(6) Electrical System. The field office shall be equipped with a 110 V AC, 60 Hz, single-phase electrical system with service entrance equipment suitable for power company attachment and with at least twelve properly positioned interior electrical outlets. The materials and installation methods of all electrical wiring, connections, switches, and grounds shall conform to the provisions of the National Electrical Safety Code and shall be in accordance with all State and local electrical ordinances.

(7) Interior Lights. The field office shall be provided with a minimum of five 1200 mm (48 inch) long fluorescent lighting fixtures, or equivalent, on the ceiling.

(8) Air Conditioner. The field office shall be equipped with an air conditioner of adequate capacity, unless otherwise specified in the Contract.

(9) Fire Extinguishers. The field office shall be equipped with at least two fire extinguishers. Each shall have a minimum capacity of 2 kg (5 pounds) and shall be either ABC Dry Chemical or Carbon Dioxide fire extinguishers of standard commercial quality.

(b) Office Equipment. Office equipment shall be standard commercial quality office equipment. The minimum required office equipment is as follows. Substitutes may be provided upon approval of the Engineer.

1 Standard office desk with drawers, locks, and keys, 1500 by 750 mm (60 × 30 inches) (minimum dimensions).
2 Adjustable office chairs.
2 Adjustable drafting stools.
1 Electric printing calculator, four-function, ten-column with memory.
1 Four-drawer legal-size file cabinet with lock and two keys.
1 Bench top cabinet, approximately 900 mm (36 inches) high and 600 mm (24 inches) wide with minimum bench area of 3 m^2 (32 ft^2) and a minimum storage area of 3 m^2 (32 ft^2) using a suitable combination of fully enclosed shelf space and drawers.
1 Sink with gooseneck faucet within the office, with a continuous supply of pressurized, clean, potable water for the duration of the project.
2 110 L (30 gallon) trash cans.

(c) Test Equipment and Supplies. The minimum required testing equipment and supplies are as follows. Substitutes may be provided upon approval of the Engineer.

1 AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Parts 1 and 2, latest edition.
1 Balance of 10 kg (20 pound) minimum capacity accurate to 5.0 g (0.2 ounce).
1 Scale of 1 kg (2 pound) minimum capacity accurate to 100 mg (0.004 ounce).

1 Double burner electric hot plate with variable temperature controls.

1 Electric motorized sieve shaker with either rocking and tapping action or circular and tapping action with a capacity of at least six sieves, cover, and pan of 203 mm (8 inch) diameter, enclosed in a dust retaining enclosure.

1 Set of US Standard, brass 203 mm (8 inch) diameter, full height, woven wire sieves meeting the requirements of AASHTO M 92. The required sieves are as follows:

1 100 mm (4 inch)	1 90 mm (3 1/2 inch)
1 75 mm (3 inch)	1 63 mm (2 1/2 inch)
1 50 mm (2 inch)	1 45 mm (1 3/4 inch)
1 37.5 mm (1 1/2 inch)	1 25.0 mm (1.00inch)
1 19.0 mm (3/4 inch)	1 16.0 mm (5/8 inch)
1 12.5 mm (1/2 inch)	1 9.5 mm (3/8 inch)
2 4.75 mm (No. 4)	2 2.36 mm (No. 8)
2 2.00 mm (No. 10)	2 1.18 mm (No. 16)
2 600 μm (No. 30)	2 425 μm (No. 40)
2 300 μm (No. 50)	2 150 μm (No. 100)
4 75 μm (No. 200)	
3 203 mm (8 inch) sieve covers	
3 203 mm (8 inch) sieve pans	

2 360 mm (14 inch) safety gloves capable of withstanding 600 °C (1110 °F).

1 Brass (wire bristle) brush.

1 Standard floor broom.

1 Round pointed “D” handle shovel.

1 Square pointed “D” handle shovel.

2 1 by 1.2 m (2 1/2 × 4 ft) heavy canvas for quartering samples.

10 Aluminum moisture cans 90 mm (3 1/2 inches) in diameter and 50 mm (2 inches) deep.

2 50 mm (2 inch) soft bristle paint brushes.

4 50 by 200 mm (2 × 8 inch) table brushes.

1 200 mm (8 inch) pointed mason’s trowel.

4 300 by 360 by 130 mm (12 × 14 × 5 inch) plastic dish pans.

8 230 by 230 by 50 mm (9 × 9 × 2 inch) cake pans.

1 150 mm (6 inch) grain scoop.

1 Spatula with a 250 by 30 mm (10 × 1 1/8 inch) blade.

2 300 mm (12 inch) long solid heavy duty plated steel mixing spoons.

1 Microwave oven meeting the following requirements:

(1) A minimum rating of 500 W.

(2) A minimum volume of approximately 0.02 m^3 (0.7 ft^3). The interior dimensions shall be approximately 280 by 280 mm (11 × 11 inches) by an acceptable height. The interior dimensions shall be of adequate size to accept the microwaveable pans listed below.

(3) A minimum of ten adjustable power levels.

(4) A digital display of power level and time.

4 Microwaveable pans with minimum interior dimensions of approximately 200 by 200 by 50 mm (8 × 8 × 2 inches).

1 101.60 mm (4 inch) diameter compaction mold meeting the requirements of AASHTO T 99.

1 2.5 kg (5.5 pound) rammer meeting the requirements of AASHTO T 99.

1 Steel straightedge meeting the requirements of AASHTO T 99.

1 Density apparatus consisting of a sand cone and baseplate and meeting the requirements of AASHTO T 191.

2 4 L (1 gallon) jugs with standard G mason jar top threading with covers.

1 Cushioned carrying box for the two 4 L (1 gallon) mason jugs.

2 4 L (1 gallon) metal cans with moisture proof friction covers and handles, similar to paint cans.

1 Supply of standard Ottawa sand meeting the requirements of ASTM C 778, Section 3.1 (approximately 50 kg (100 pounds) of sand will be used for each 40 000 m^3 (50,000 yd^3) of embankment).

1 Number 2 rubber mallet with 255 mm (10 inch) handle.

1 Box to contain the compaction testing equipment.

When compaction testing in accordance with AASHTO T 180 is required, the following additional equipment shall be supplied by the Contractor:

1 4.54 kg (10 pound) rammer meeting the requirements of AASHTO T 180.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to beginning any construction for which testing is required.

The equipment to be provided for portland cement concrete testing or bituminous concrete testing, when such equipment is also in the Contract, will not be considered common to the equipment for gradation testing or compaction testing and is not to be used as such.

631.04 COMBINED ENGINEERS AND SOILS OFFICE.

(a) Design and Appendages. The Contractor shall provide weatherproofed space in which to store and use testing equipment. This space shall have a floor area equal to or greater than 11 m^2 (120 ft^2). The space shall have a window and a lockable door. Access to the space shall be made available to the Engineer at all times during the construction of the project. If electricity is available at the site, the Contractor shall provide electricity and outlets to run the equipment to be furnished and electric lights for the space. If electricity is not available, the Contractor shall provide a generator having a minimum rating of at least 10 kW and electrical outlets to run the equipment to be furnished and electric lights. The generator shall be maintained ready to go and available to the Engineer at all times. The space shall be provided with a shelf or table approximately 0.6 by 2.0 m (2×7 feet) on which the Engineer can write while performing the necessary tests and other tasks the Engineer is required to perform for the project. Other shelves or bases will be required to support the equipment during use. An ABC Dry Chemical or Carbon Dioxide fire extinguisher having a minimum fire fighting capacity of 2 kg (5 pounds) shall be supplied.

(b) Office Equipment. The minimum required office equipment is as follows:

1 Chair or drafting stool suitable for use with the shelf or table supplied.

1 Telephone, rotary or touch tone dial, compatible with the local telephone service available. The Contractor shall arrange for the connection of the telephone system and pay the installation charge as part of Contract item 631.12. The Contractor shall also pay the monthly service bill. Upon presentation of the paid monthly

service bill to the Engineer, the Engineer will pay the Contractor the cost of the service bill under Contract item 631.25. Connected to the telephone shall be a telephone answering device capable of receiving and storing messages.

1 Elevated clean water tank having a minimum capacity of 400 L (100 gallons) with a hose or pipe leading to a convenient location near the testing and storage space provided. The Contractor shall provide two 20 L (5 gallon) pails to enable the Engineer to use this water source and shall fill the tank on a daily basis. The outlet end of the hose or pipe shall be fitted with a faucet. The faucet shall be fixed at least 600 mm (24 inches) above the ground.

1 110 L (30 gallon) trash can.

(c) Test Equipment and Supplies. The minimum required testing equipment and supplies are as follows. Substitiutes may be provided upon approval of the Engineer.

1 AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Parts 1 and 2, latest edition.

1 Balance of 10 kg (20 pound) minimum capacity accurate to 5.0 g (0.2 ounce).

1 Scale of 1 kg (2 pound) minimum capacity accurate to 100 mg (0.004 ounce).

1 Double burner electric hot plate with variable temperature controls.

1 Electric motorized sieve shaker with either rocking and tapping action or circular and tapping action with a capacity of at least six sieves, cover, and pan of 203 mm (8 inch) diameter, enclosed in a dust retaining enclosure.

1 Set of US Standard, brass, 203 mm (8 inch) diameter, full height, woven wire sieves meeting the requirements of AASHTO M 92. The required sieves are as follows:

1 100 mm (4 inch)	1 90 mm (3 1/2 inch)
1 75 mm (3 inch)	1 63 mm (2 1/2 inch)
1 50 mm (2 inch)	1 45.0 mm (1 3/4 inch)
1 37.5 mm (1 1/2 inch)	1 25.0 mm (1.00 inch)
1 19.0 mm (3/4 inch)	1 16.0 mm (5/8 inch)
1 12.5 mm (1/2 inch)	1 9.5 mm (3/8 inch)

	2 4.75 mm (No. 4)	2 2.36 mm (No. 8)
	2 2.00 mm (No. 10)	2 1.18 mm (No. 16)
	2 600 μm (No. 30)	2 425 μm (No. 40)
	2 300 μm (No. 50)	2 150 μm (No. 100)
	4 75 μm (No. 200)	
	3 203 mm (8 inch) sieve covers	
	3 203 mm (8 inch) sieve pans	

2 360 mm (14 inch) safety gloves capable of withstanding 600 °C (1110 °F).

1 Brass (wire bristle) brush.

1 Standard floor broom.

1 Round pointed “D” handle shovel.

1 Square pointed “D” handle shovel.

2 1 by 1.2 m (2 1/2 × 4 ft) heavy canvas for quartering samples.

10 Aluminum moisture cans 90 mm (3 1/2 inches) in diameter and 50 mm (2 inches) deep.

2 50 mm (2 inch) soft bristle print brushes.

4 50 by 200 mm (2 × 8 inch) table brushes.

1 200 mm (8 inch) pointed mason’s trowel.

4 300 by 360 by 130 mm (12 × 14 × 5 inch) plastic dish pans.

8 230 by 230 by 50 mm (9 × 9 × 2 inch) cake pans.

1 150 mm (6 inch) grain scoop.

1 Spatula with a 250 by 30 mm (10 × 1 1/8 inch) blade.

2 300 mm (12 inch) long solid heavy duty plated steel mixing spoons.

1 Microwave oven meeting the following requirements:

(1) A minimum rating of 500 W.

(2) A minimum volume of approximately 0.02 m^3 (0.7 ft^3). The interior dimensions shall be approximately 280 by 280 mm (11 × 11 inches) by an acceptable height. The interior dimensions shall be of adequate size to accept the microwaveable pans listed below.

(3) A minimum of ten adjustable power levels.

(4) A digital display of power level and time.

4 Microwaveable pans with minimum interior dimensions of approximately 200 by 200 by 50 mm (8 × 8 × 2 inches).

1 101.60 mm (4 inch) diameter compaction mold meeting the requirements of AASHTO T 99.
1 2.5 kg (5.5 pound) rammer meeting the requirements of AASHTO T 99.
1 Steel straightedge meeting the requirements of AASHTO T 99.
1 Density apparatus consisting of a sand cone and baseplate and meeting the requirements of AASHTO T 191.
2 4 L (1 gallon) jugs with standard G mason jar top threading with covers.
1 Cushioned carrying box for the two 4 L (1 gallon) mason jugs.
2 4 L (1 gallon) metal cans with moisture proof friction covers and handles, similar to paint cans.
1 Supply of standard Ottawa sand meeting the requirements of ASTM C 778, Section 3.1 (approximately 50 kg (100 pounds) of sand will be used for each 40 000 m^3 (50,000 yd^3) of embankment).
1 Number 2 rubber mallet with 255 mm (10 inch) handle.
1 Box to contain the compaction testing equipment.

When compaction testing in accordance with AASHTO T 180 is required, the following additional equipment shall be supplied by the Contractor:

1 4.54 kg (10 pound) rammer meeting the requirements of AASHTO T 180.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to beginning any construction for which testing is required.

The equipment to be provided for portland cement concrete testing or bituminous concrete testing, when such equipment is also in the Contract, will not be considered common to the equipment for gradation testing or compaction testing and is not to be used as such.

631.05 TESTING EQUIPMENT, CONCRETE. The following equipment shall be provided to perform concrete field tests:

1 Cylinder test set meeting the requirements of AASHTO T-23.
1 Slump test set meeting the requirements of AASHTO T 119.

1 Platform beam scale sensitive to 5 g (0.01 pound) with a minimum capacity of 50 kg (100 pounds).
1 Steel “Contractors” wheelbarrow.
1 Square pointed “D” handle shovel.

1 Pressure air meter meeting the requirements of AASHTO T 152 and all accessory items required for use with the particular design of apparatus used. Accessory items shall include a flat, rectangular, metal plate at least 6 mm (1/4 inch) thick, a glass or acrylic plate at least 13 mm (1/2 inch) thick, or a wire reinforced glass plate a least 6 mm (1/4 inch) thick with a length and width at least 50 mm (2 inches) greater than the diameter of the measuring bowl of the air meter with which it is to be used.
1 Concrete curing box. The concrete curing box shall be of standard commercial quality. One or more boxes shall be supplied to meet specimen requirements for the project. The curing box shall maintain an internal water temperature of 21 ± 5 °C (70 ± 10 °F) and 100 percent humidity.
1 Straightedge at least 3 m (10 feet) in length.

For testing Class LW concrete, the following additional testing equipment shall be provided:

1 Volumetric air meter meeting the requirements of AASHTO T 196, supplied with a wooden carrying case, syringe, tamping rod, measuring vessel, and baffle.
1 One unit mass (weight) measure meeting the requirements of AASHTO T 121, supplied with a flat, rectangular, metal plate at least 6 mm (1/4 inch) thick, a glass or acrylic plate at least 13 mm (1/2 inch) thick, or a wire reinforced glass plate at least 6 mm (1/4 inch) thick with a length and width at least 50 mm (2 inches) greater than the diameter of the measuring bowl of the air meter with which it is to be used.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placing of any concrete.

When the Contractor places concrete at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

When the equipment to be provided for concrete testing is required by the Contract, it will not be considered common to the equipment for gradation testing, compaction testing, or bituminous concrete testing and is not to be used as such.

631.06 TESTING EQUIPMENT, BITUMINOUS. The following equipment shall be provided:

1 Straightedge at least 4.5 m (16 feet) in length.
1 3 m (10 foot) straightedge.
1 Round pointed "D" handle shovel.
1 Electronic hand-held thermometer having a digital display visible under all lighting conditions.

The thermometer shall be at least capable of measuring temperatures between -50 and 650 °C with a resolution of 1 °C and an accuracy of at least ± 1 °C (-60 and 1200 ºF with a resolution of 2 ºF and an accuracy of at least ± 2 ºF) and shall provide accurate measurements of 1) the ambient air temperature measured at least 1.2 m (4 feet) above the ground and 8 m (26 feet) from any vehicle or other heat source, and 2) the surface temperature of such materials as bituminous pavement and thermoplastic pavement markings in place, or for placement thereof, on the roadway. The final accurate measurement shall be displayed within one second or less.

The unit shall be provided with an instruction manual and shall have internal protection against meter overload, automatic zero adjustment, and low battery indication if battery powered.

The unit shall be completely self-contained and shall not require external probes or other attachments to perform the required functions.

1 Micrometer having a capacity of 0 to 25 mm (0 to 1 inch) and calibrated in micrometers (0.1 mil).

1 48 inch electronic building level.
1 Mechanical measuring wheel.

The electronic building level shall have bubble indicators as well as a digital readout capable of reading in degrees from 0.0 deg to 90.0 deg, in percent slope from 0.0 percent to 100.0 percent, and in pitch in units (inches) of rise per unit (foot) of run. The electronic level shall have the capability of being recalibrated and be accurate to 1/10 of one degree.

The measuring wheel shall have a minimum wheel circumference of 1 m (3 feet) and shall have a sealed counter capable of measuring to a minimum range of 9 999.9 ft or 9 999.9 m specific to the applicable project (Contract) design units.

Black duct tape and tar paper or asphalt treated felt in adequate amounts for the Engineer to perform necessary thickness and moisture testing.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

All equipment and supplies furnished by the Contractor shall be available prior to the placing of any bituminous concrete or pavement markings.

When the Contractor places bituminous concrete or pavement markings at more than one location simultaneously, the necessary testing equipment shall be furnished at each location.

When the equipment to be provided for bituminous concrete testing is required by the Contract, it will not be considered common to equipment for gradation testing, compaction testing, or concrete testing and is not to be used as such.

631.07 TESTING EQUIPMENT, PROTECTIVE COATINGS. The following equipment shall be provided:

1 Psychrometer kit for measuring dew point. The instrument shall meet the requirements of ASTM E337, Method B, with a range from 1 to 43˚C (34 to 110˚F) and an accuracy of ± 1 degree. As a minimum the kit shall include matching thermometers with conversion charts and a thermometer for measuring the surface temperature of the steel object.

1 Dry film electronic thickness probe meeting ASTM D1186, Method B. The probe shall be capable of measuring a range of 0 to 1500 μm (0 to 60 mils) with an accuracy of ± 2%.

1 Adhesion testing kit meeting ASTM D3359 Adhesion By Tape Test, Method A. As a minimum the kit shall include a cutting tool, a cutting guide, tape, rubber eraser, and an illuminated magnifier.

1 Surface profile kit meeting ASTM D4417, Method C. The kit shall include coarse and extra coarse tapes as specified in Section 6.3 and a minimum of one roll (100 pieces) of tape for each range, plus extras as required.

All of the foregoing testing equipment shall be in good condition and shall be replaced or repaired by the Contractor if, during the duration of the project, it becomes unsuitable for testing purposes.

The equipment furnished shall have been calibrated within one year or shall have appropriate means of being calibrated in the field.

631.08 METHOD OF MEASUREMENT. The quantity of each type of Field Office and/or Testing Equipment to be measured for payment will be on a unit basis for each type specified and used on the project. Unless otherwise specified in the Contract Documents, no measurement for payment will be made for protective coatings testing equipment provided by the Contractor.

The quantity of Field Office Telephone to be measured for payment will be to the nearest hundredth of a dollar for all telephone service supplied.

The Agency will include in the proposal a quantity of dollars for all telephone service required. However, the Contractor will be reimbursed the actual costs of providing the telephone service as evidenced by the paid bills submitted to the Engineer. Upon entering the cost of the submitted bill into the next biweekly estimate, the Engineer will forward the original paid bill to the Construction Office to be retained with the project records and will place a copy of the paid bill into the field office records.

631.09 BASIS OF PAYMENT. The accepted quantity of each type of Field Office and/or Testing Equipment will be paid for at the Contract lump sum price for the specified type. Payment will be full compensation for performing the work and furnishing all materials, labor, tools, equipment, and incidentals necessary to provide, construct, install, maintain, and remove the type of office and/or testing equipment specified.

Supplies that become exhausted and equipment that becomes unsuitable for use due to normal wear and tear shall be replaced as necessary by the Contractor as part of the Contract item under which these items are furnished.

Payment for this work will be made as follows:

(a) 25 percent will be paid after each specified office and/or equipment unit has been installed on the project in full working order.

(b) The second payment of 25 percent will be paid when 33 percent of the anticipated construction time has expired.

(c) The third payment of 25 percent will be paid when 67 percent of the anticipated construction time has expired.

(d) The fourth and final payment of the remaining 25 percent will be paid upon final acceptance of the project.

The quantity of Field Office Telephone to be paid will be the total of all paid telephone bills for providing service to all telephones, modems, and fax machines supplied in the project field offices by the Contractor, which total will be limited to the total of the paid telephone bills submitted to the Engineer.

The costs of installing and removing the telephone lines in the field office are part of the costs included in the field office Contract items and are not part of the Contract item Field Office Telephone.

Payment will be made under:

Pay Item		Pay Unit
631.10	Field Office, Engineers	Lump Sum
631.11	Field Office, Soils and Materials	Lump Sum
631.12	Combined Engineers and Soils Office	Lump Sum
631.16	Testing Equipment, Concrete	Lump Sum
631.17	Testing Equipment, Bituminous	Lump Sum
631.18	Testing Equipment, Protective Coatings	Lump Sum
631.26	Field Office Telephone	Dollar

SECTION 634 - EMPLOYEE TRAINEESHIP

634.01 DESCRIPTION. This work shall consist of providing on-the-job training for qualified employees in accordance with applicable approved training programs.

634.02 GENERAL. The training requirements specified herein supersede subparagraph 6b, part II, NONDISCRIMINATION, of the REQUIRED CONTRACT PROVISIONS for FEDERAL-AID CONSTRUCTION CONTRACTS, and implements 23 U.S.C. 140 (a).

The Contractor shall provide on-the-job training aimed at developing full journeyman qualifications in the type of trade, craft, or job classification involved.

The training program shall be carried out in accordance with a training schedule and curriculum devised to give the employee an understanding of the trade, craft, or skill together with instructions in safety operations and performance of the actual specialty covering all aspects of the work involved. The training program shall be one approved by the Agency and the U.S. Department of Transportation.

The required number of employee traineeship hours to be provided by the Contractor is shown in the Contract. In the event that a Contractor subcontracts a portion of the work, the Contractor shall determine how many, if any, of the trainees are to be trained by the subcontractor. However, the Contractor shall retain the primary responsibility for meeting the training requirements specified herein.

634.03 PROCEDURE. The procedures followed in carrying out the training shall be consistent with the approved training program for the particular trade, craft, or skill and the trainee shall be employed insofar as practical in a useful and constructive manner assisting in the work on the project until such time as the Contractor deems the trainee as being qualified to operate independently in the field in which the trainee has been trained. The Contractor shall then give the trainee a certificate of satisfactory completion of apprenticeship training specifying the field of accomplishment.

The Contractor shall maintain payroll records and training records in a manner acceptable to the Engineer as to provide all the information necessary to properly and adequately support progress and final payment for this Contract item, as well as to show the status of training accomplishment.

It is normally expected that a trainee will begin training on the project as soon as feasible after start of work utilizing the skill involved, and remain on the project as long as training opportunities exist in the work classification or until the training program has been completed. It is not required that all trainees be on board for the entire length of the Contract. A Contractor will have fulfilled the requirements of this Contract item if they have provided acceptable training to the number of trainees specified. The number trained shall be determined on the basis of the total number enrolled on the project for a significant period.

634.04 TRAINEES. The number of trainees shall be distributed among the work classifications on the basis of the Contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment. Where feasible, 25 percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training.

Prior to commencing construction, the Contractor shall submit to the Engineer for approval the number of trainees to be trained in each selected classification and training program to be used. Furthermore, the Contractor shall specify the starting time for training in each of the classifications. The Contractor will be credited for each trainee employed on the project that is currently enrolled or becomes enrolled in an approved program and will be reimbursed for such trainees as provided herein.

634.05 RECRUITMENT. Training and upgrading of minorities and women toward journeymen status is a primary objective of this Contract item. Accordingly, the Contractor shall make every effort to enroll minority trainees and women (e.g., by conducting systematic and direct recruitment through public and private sources likely to yield minority and women trainees) to the extent that such persons are available within a reasonable area of recruitment. The Contractor will be responsible for demonstrating the steps taken in pursuance thereof, prior to a determination as to whether the Contractor is in compliance with the requirements of this Contract item. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training, whether a member of a minority group or not.

634.06 TRAINING PROGRAM. The minimum length and type of training for each classification will be as established in the training program selected by the Contractor and approved by the Engineer. The Federal Highway Administration (FHWA) shall approve a program if it is reasonably calculated to meet the equal employment opportunity obligations of the Contractor and to qualify the average trainee for journeyman status in the classification concerned by the end of the training period. Apprenticeship programs registered with the U.S. Department of Labor, Bureau of Apprenticeship and Training, shall also be considered acceptable provided they are being administered in a manner consistent with the equal employment obligations of Federal-Aid highway construction Contracts. Approval or acceptance of a training program shall be obtained from the State prior to commencing work on the classification covered by the program.

It is the intent of these provisions that training is to be provided in the construction crafts rather than clerk-typists or secretarial-type positions. Training is permissible in lower level management positions, such as office engineers, estimators, timekeepers, etc., where the training is oriented toward construction applications. Training in the laborer classification may be permitted provided that significant and meaningful training is provided and approved by the FHWA division office.

Some offsite training is permissible as long as the training is an integral part of an approved training program and does not comprise a significant part of the overall training.

The Contractor may be eligible for reimbursement for training persons in excess of the number of hours specified in the Contract. This reimbursement will be made even though the Contractor receives additional training program funds from other sources, provided such other sources do not specifically prohibit the Contractor from receiving other reimbursement. Reimbursement for offsite training indicated above may only be made to the Contractor where the Contractor does one or more of the following and the trainees are concurrently employed on a Federal-Aid project: contributes to the cost of the training, provides the instruction to the trainee or pays the trainee's wages during the offsite training period.

The Contractor shall furnish the trainee a copy of the program the Contractor will follow in providing the training. The Contractor shall provide each trainee with a certification showing the type and length of training satisfactorily completed.

Trainees will be paid at least 60 percent of the appropriate minimum journeyman's rate specified in the Contract for the first half of the training period, 75 percent for the third quarter of the training period, and 90 percent for the last quarter of the training period, unless apprentices or trainees in an approved existing program are enrolled as trainees on the project. In that case, the appropriate rates approved by the Department of Labor or Transportation in connection with the existing program shall apply to all trainees being trained for the same classification who are covered by these provisions. In no case will the Contractor pay trainees less than the prevailing rate for labor as shown in the Contract wage decision.

634.07 SANCTIONS FOR NON-COMPLIANCE. If the Vermont Agency of Transportation finds the Contractor or subcontractor in non-compliance with the terms of this Contract item it shall:

(a) Issue a "Show Cause Notice" and notify the Contractor in writing that within 30 days a written Plan outlining the steps that will be taken to bring the Contractor into compliance must be submitted to the Vermont Agency of Transportation by the Contractor. In the event the Contractor fails or refuses to submit the Plan within the specified period, or if the Contractor does not exercise the corrective actions outlined in the Plan, the Agency will commence enforcement proceedings under Executive Order 11246, as amended. Such actions could include:

(1) The recovery by the Agency from the Contractor of 1/10 of 1% of the Contract award amount or $1,000.00, whichever sum is greater, as liquidated damages for each week the Contractor fails or refuses to comply. If a subcontractor is in non-compliance, the recovery by the Agency from the Contractor, to be assessed by the Contractor as a back charge against the subcontractor of 1/10 of 1% of the subcontract price, or $500.00, whichever sum is greater, in the nature of liquidated damages, for each week that such party fails or refuses to comply; and/or

(2) The suspension of any payment or part thereof due under the Contract until such time as the Contractor or Subcontractor is able to demonstrate compliance with the terms of the Contract; and/or

(3) The termination or cancellation of the Contract, in whole or in part, unless the Contractor or Subcontractor is able to demonstrate within a specified time compliance with terms of the Contract; and/or

(4) The denial to the Contractor or Subcontractor of the right to participate in any future Contracts awarded by the Agency for a period of up to three years.

(b) If at any time after the imposition of sanctions 1 and 2 above, the Contractor is able to demonstrate compliance with the requirements of this Contract item, the Contractor may request the Agency to suspend the sanctions conditionally, pending a final determination by the Agency as to whether the Contractor is in compliance. Following the final determination the Agency will either lift the sanctions or impose them.

(c) The above sanctions for non-compliance will also apply to the "Standard Federal Equal Employment Opportunity Construction Contract Specifications (Executive Order 11246)".

634.08 METHOD OF MEASUREMENT. The quantity of Employee Traineeship to be measured for payment will be the number of hours completed in the complete and accepted work.

634.09 BASIS OF PAYMENT. The accepted quantity of Employee Traineeship will be paid for at the Contract unit price per hour. Payment will be full compensation for furnishing all tools, equipment, supervision, and incidentals necessary to provide complete training for each trainee.

If, in the judgment of the Contractor, a trainee becomes proficient enough to qualify as a journeyman before the end of the prescribed training period, and the Contractor so employs such trainee, full credit and full payment to the Contractor will be made provided that the period of training given, plus the length of employment as a journeyman in the classification for which trained, are equal to, or in excess of, the training period specified in the approved training program. If the period of training given plus the period employed as a journeyman does not equal or exceed the training period specified in the approved training program, the Contractor will be paid the Contract amount for each hour the trainee was trained and employed as a journeyman by the Contractor.

In the event of partial employee traineeship, the Contractor will be paid for each hour the trainee was trained and employed as a trainee by the Contractor.

Payment will be made under:

Pay Item	Pay Unit
634.10 Employee Traineeship	Hour

SECTION 635 – MOBILIZATION/DEMOBILIZATION

635.01 DESCRIPTION. This work shall consist of preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to and from the project site; for the establishment and removal of all Contractor's field offices, buildings, and other facilities necessary for work on the project; and for all other work and operations that must be performed or costs incurred prior to beginning work and upon completion of Contract items. It shall also include compensation for any costs associated with demobilization, project clean up, establishment of vegetation, and completion of all work that is not associated with acceptance of a specific pay item.

635.02 METHOD OF MEASUREMENT. The quantity of Mobilization/Demobilization to be measured for payment will be on a lump sum basis.

635.03 BASIS OF PAYMENT. The accepted quantity of Mobilization/Demobilization will be paid for at the Contract lump sum price. Payment will be full compensation for performing the work specified and for furnishing all labor, tools, materials, equipment, and incidentals necessary to complete the work.

For the purposes of computing payment under the Contract item Mobilization/Demobilization, the adjusted Contract price will be a summation of all items bid, excluding the amount bid specifically for the Mobilization/Demobilization item.

Partial payments will be made as follows:

(a) The first payment of 50 percent of the lump sum price for Mobilization/Demobilization or 5 percent of the adjusted Contract price, whichever is less, will be made with the first biweekly estimate as determined by work on other Contract items.

(b) The second payment of 40 percent of the lump sum price for Mobilization/Demobilization or 5 percent of the adjusted Contract price, whichever is less, will be made on the first estimate following the completion of 10 percent of the Contract, excluding Mobilization/Demobilization.

(c) Payment of any remaining amount bid for Mobilization/Demobilization will be made after the Acceptance Date.

Payment will be made under:

Pay Item	Pay Unit
635.11 Mobilization/Demobilization	Lump Sum

SECTION 641 - TRAFFIC CONTROL

641.01 DESCRIPTION. This work shall consist of establishing and maintaining traffic control measures to protect the traveling public (including bicyclists and pedestrians) and construction operations.

The requirements for uniformed traffic officers and flaggers used in conjunction with Traffic Control shall be as specified in Section 630.

641.02 GENERAL CONSTRUCTION REQUIREMENTS. The Contractor shall establish traffic controls to divert traffic from the area of construction operations during working hours in accordance with the Contract or as authorized by the Engineer. Working hours shall be as specified in Subsection 104.04. Should the Contractor desire to divert traffic after sunset or before sunrise, a written request shall be submitted to the Engineer. In the request, the Contractor shall justify the request and detail the enhanced safety procedures the Contractor proposes to provide and pay for to protect the safety of the traveling public and project personnel. The request shall be submitted at least three weeks prior to the date the Contractor plans to divert traffic outside of normal working hours as defined in the Contract.

When work is in progress within an interchange area, no more than one ramp at a time may be closed to traffic. Traffic service that would be eliminated by the closing of a ramp shall be maintained elsewhere as specified in the Contract or authorized by the Engineer.

During hours other than working hours, all highway facilities, including sidewalks, shall be open to the unrestricted flow of traffic, unless otherwise specified. Traffic control devices, equipment and materials shall be removed from the traveled way, auxiliary lanes, ramps, and shoulders. Traffic signs relative to traffic control for construction operations shall be removed, covered, or turned so they are not readable from the highway. All equipment and materials shall be stored outside the travel lanes, shoulders, and clear zone for the facility.

When the Plans contain an Agency-designed traffic control plan that includes, but is not limited to, references to standard sheets, the Contractor may submit an alternate traffic control plan for the project. This alternate plan may be for the entire traffic control plan of the project or for revisions to various phases of the Agency's design in the Plans, including the specific location of the lanes where the traffic will be maintained. Any alternate plan submitted shall conform to the latest edition of the MUTCD.

For an alternate traffic control plan, Construction Drawings shall be submitted in accordance with Section 105. The submitted alternative plan shall include complete construction details, including all aspects of traffic control, to the same extent provided in the Agency design. The Contractor shall allow the Agency 30 calendar days to review and accept the proposed alternative plan before it is to be implemented.

641.03 TRAFFIC CONTROL DEVICES. All traffic control devices shall conform to the requirements of the Contract and the latest edition of the MUTCD. Traffic control devices required in the performance of this work may include lane markings, barricades, signs with yielding posts or portable supports, reflectorized drums, traffic cones, delineators, portable flashing arrow boards, portable changeable message sign(s), traffic signal lights, and street lighting. In addition, flashing warning lights may be required by the Engineer for use on signs and barricades to improve visibility.

The location of traffic control devices shall be adjusted in the field as directed by the Engineer to provide for maximum visibility and usefulness. Traffic control devices shall be kept clean so they are clearly visible at all times. All signs shall be composed of the same retroreflective material. The Contractor shall conduct inspections of both daytime and nighttime operations daily in order to ensure proper placement and operation of all traffic control devices.

Unless protected by guardrail or other positive barrier, mounted traffic control devices shall be erected on yielding or breakaway supports.

When protected by guardrail, these devices shall be placed outside the deflection distance of the particular guardrail in use.

Traffic cones shall be orange, at least 700 mm (28 inches) high, and shall be spaced as shown on the Plans. They shall be weighted or nailed for stabilization. Tires may be used to stabilize the cones only if they have been circumferentially sliced to a minimum of 50 percent of their original thickness.

Portable Changeable Message Signs (PCMSs) shall have three (3) lines of eight (8) characters per line and conform to Section 6F.55 of the MUTCD.

Portable Arrow Boards (PABs) shall conform to Type C requirements in Section 6F.56 of the MUTCD.

The Contractor shall operate and maintain the PCMS(s) or PAB(s) as recommended by the manufacturer. The locations of the units and the messages to be used shall be as specified in the traffic control plan shown in the Plans or as directed by the Engineer. The Contractor shall supply the Engineer with the name and telephone number of the Contractor's responsible person in charge of the placement, maintenance and repair of the PCMS(s) or PAB(s) and their components for the duration of the Contract.

If Portable Changeable Message Sign and/or Portable Arrow Board pay items are included in the Contract, the Contractor shall maintain one spare PCMS unit, or a PAB unit if no PCMS unit is being utilized, on site to replace a non-operational unit if necessary. If any unit becomes non-operational during use, and a replacement unit is not available, the Contractor shall provide flaggers or other approved traffic control methods until the unit is repaired or replaced, at no additional cost to the Agency. Non-operational units shall be repaired or replaced as soon as possible, but no later than twenty-four (24) hours after the Engineer determines that repairs or replacement are necessary.

Time lost due to failure to correct deficient traffic control devices will not be considered justifiable cause for granting an extension of time in accordance with Section 108.

641.04 PERSONNEL. Personnel involved with the placement and use of traffic control devices shall receive orientation and explanation of the requirements of the MUTCD and the special project requirements prior to working on the project. The orientation and explanation are the Contractor's responsibility.

641.05 SPEED ZONE ENACTMENT. If the traffic control plan included in the Plans is based on a recommended speed limit reduction, or if a speed limit reduction is requested by the Contractor, the Agency will obtain the necessary permit for this speed reduction. In either case, the Contractor shall provide the Agency with a written plan of work and a detailed sketch of the work zones that will be the basis for the permit application. The Contractor shall allow three weeks for the permit to be processed. The traffic control plan shall not be implemented until the permit is approved.

641.06 METHOD OF MEASUREMENT. The quantity of Traffic Control to be measured for payment will be on a lump sum basis for providing traffic control in the complete and accepted work.

The quantities of Portable Changeable Message Sign and Portable Arrow Board to be measured for payment will be the number of each type of unit specified and used on the project. A unit shall consist of the designated sign panel (or board) complete with controller, power supply, fuel, backup power supply and trailer installed, maintained and removed as indicated on the Plans and directed by the Engineer.

The quantities of Portable Changeable Message Sign Rental and Portable Arrow Board Rental to be measured for payment will be the number of days of the type specified, as authorized in writing by the Engineer.

641.07 BASIS OF PAYMENT. The accepted quantity of Traffic Control will be paid for at the Contract lump sum price. Partial payments will be made as follows:

(a) The first 50% of the Contract lump sum price will be paid upon the complete installation of the traffic control devices and any lane markings associated with the traffic control plan.

(b) The remaining 50% of the Contract lump sum price will be paid on a prorated basis for the estimated duration of the Contract work remaining.

Payment will be full compensation for preparing, implementing, inspecting, maintaining, and removing the applicable traffic control plan and specified traffic control devices, and for furnishing all labor, including traffic patrol vehicle operators if used by the Contractor, tools, materials, equipment, and incidentals necessary to complete the work. Except as otherwise provided below, all other items required to implement the applicable traffic control will not be paid for directly but will be considered incidental to Traffic Control.

Payment for temporary traffic barrier and temporary pavement markings will be made under their respective Contract pay items when included in the Contract.

The accepted quantities of Portable Changeable Message Sign and Portable Arrow Board will be paid for at the Contract unit price for each. There will be no payment for any spare units, as they shall be considered incidental to the unit(s) being utilized and paid for through the Contract.

Partial payment for these items will be made as follows:

(a) The first 50% of quantity payments will be made upon the erection of complete Portable Changeable Message Sign(s) and Portable Arrow Board(s) as specified in Subsection 641.06.

(b) The remaining 50% of quantity payments will be paid on a prorated basis for the estimated duration of the Contract work remaining.

The accepted quantities of Portable Changeable Message Sign Rental and Portable Arrow Board Rental will be paid for at the Contract unit price per day. The minimum quantity for payment shall be 5 days.

Payment for the accepted quantities of Portable Changeable Message Sign, Portable Arrow Board, Portable Changeable Message Sign Rental, and Portable Arrow Board Rental shall be full compensation for furnishing, operating, maintaining, transporting and installing the unit specified, for removing the unit when it is no longer needed, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

When both pay items are in the Contract, a Portable Changeable Message Sign used as a Portable Arrow Board will be paid for at the Contract price for a Portable Arrow Board.

Payment will be made under:

Pay Item		Pay Unit
641.10	Traffic Control	Lump Sum
641.15	Portable Changeable Message Sign	Each
641.16	Portable Arrow Board	Each
641.17	Portable Changeable Message Sign Rental	Day
641.18	Portable Arrow Board Rental	Day

SECTION 643

THIS SECTION RESERVED

SECTION 646 - RETROREFLECTIVE PAVEMENT MARKINGS

646.01 DESCRIPTION. This work shall consist of furnishing and placing retroreflective markings, including temporary markings, and necessary signing on roadway pavement and other surfaces.

Markings shall exhibit adequate intensity to demark the roadway in both daylight and under vehicle headlights at night. Markings shall have adequate contrast to distinguish them from the background material color unless otherwise specified. Minimum retroreflectivity shall be provided as specified in the Plans.

Marking operations shall be conducted in a manner that minimizes traffic disruptions. Adequate safety measures shall be provided for both the construction workers and the traveling public.

Details not shown on the Plans shall be in conformity with the MUTCD.

646.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Polyurea Pavement Markings	708.08(a)
Low VOC Traffic Paint	708.08(b)
Epoxy Paint	708.08(c)
Waterborne Traffic Paint	708.08(d)
Methyl-methacrylate Paint	708.08(e)
Glass Beads	708.09
Thermoplastic Pavement Markings	708.10
Raised Pavement Markers	708.11
Pavement Marking Tape, Type I	708.12(a)
Pavement Marking Tape, Type II	708.12(b)
Pavement Marking Mask	708.12(c)
Preformed Traffic Markings and Symbols	708.13
Line Striping Targets	708.14

Pavement marking materials furnished shall be the ones shown on the Plans, or listed in these specifications as being acceptable for the project. The Contractor may submit alternate materials for approval in accordance with Subsection 646.11.

646.03 CLASSIFICATION. Retroreflective pavement markings are hereby classified as Paint Pavement Markings, Durable Pavement Markings, Temporary Pavement Markings, and Other Related Markings.

646.04 APPLICATION OF MARKINGS, GENERAL.

(a) Placement of Markings. The final pavement markings shall be placed the same day as the wearing course of pavement.

Roadway surfaces shall be clean and dry at the time of application of pavement markings. The Engineer will inspect the pavement to determine if conditions are suitable for the placement of markings. The Engineer will check the pavement for cleanliness, moisture content, and temperature; and will check ambient air conditions. The Engineer will make the final determination as to the suitability of project conditions for the application of pavement markings. Where required, the Contractor shall clean the surface to be marked to the satisfaction of the Engineer so as to provide for an acceptable bond between the marking and the pavement or surface.

Pavement markings shall be applied only during daylight hours, and in accordance with the manufacturer's recommendations. Weather conditions must be sufficient to allow the placement and curing of the pavement marking material without violating the manufacturer's requirements.

All markings shall be applied in a neat and professional 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 marking equipment. Adequate quantities of the material shall be applied to assure constant thickness of marking material. Glass beads shall be delivered at a velocity that is at least 60% of ground speed for the application device. Markings shall be applied parallel to the roadway centerline or as shown on the Plans with no unsightly deviations.

After application, markings shall be protected from crossing vehicles for a time at least equivalent to the drying time of the marking material used. Markings shall be protected from the moment of application until they are sufficiently dry to bear traffic without damage to the marking, tracking, or adhering to vehicle tires.

Any pavement marking materials spilled or tracked on roadway surfaces shall be removed by the Contractor to the satisfaction of the Engineer and at no additional cost to the State. The method of removal shall be such that it is not injurious to the roadway or other surface and is acceptable to the Engineer.

Any pavement marking that is applied on hot pavement and discolors shall be reapplied, at the Engineer's discretion. Payment for each reapplication will be at the Contract unit price for the reapplied item.

All interim pavement markings, including line striping targets when used, shall be applied so that at the end of each working day all centerlines, island markings, gore markings, lane lines, special markings, etc. are in place on all paved surfaces where traffic will be maintained. During paving and cold planing, work shall be scheduled so that the pavement markings are complete immediately after the paving and cold planing operations cease for the day. All required markings shall be completely placed before dusk.

Unless otherwise directed by the Engineer, edgelines shall be applied within three calendar days of the placement of any course of pavement. The Engineer may require edgelines to be applied within a shorter time frame if traffic volume and the safety of the traveling public appear to require an earlier application.

When line striping targets (LSTs) are not shown on the Plans, but are used as a short term substitute for other temporary pavement markings, they shall be placed as directed by the Engineer and will be paid for as the equivalent quantity of temporary pavement marking for which the LSTs are substituted. However, if it becomes necessary to replace those temporary LSTs with either more LSTs or the actual temporary pavement markings designated for that particular location, no further payment for the temporary pavement markings at that particular location will be made.

Failure on the part of the Contractor to comply with the provisions of this part of the specifications may result in all progress payments being withheld until the required work is performed to the satisfaction of the Engineer.

(b) Equipment, General. The pavement marking equipment shall meet the approval of the Engineer and shall be maintained in working condition at all times. It shall be of standard commercial manufacture of the type capable of satisfactorily applying the designated material at required application temperatures, rates, and manufacturer's recommended application practices. For long line markings, each machine shall be capable of applying two separate stripes, either solid or dash, at the same time. Each applicator shall be equipped with satisfactory cutoffs that will apply broken, dashed, or dotted lines automatically. Each applicator shall have a mechanical bead dispenser that will operate simultaneously with the applicator and distribute the beads in a uniform pattern at the rate specified over the entire surface area of the marking. The bead placement device shall maximize bead embedment in the marking material. Each applicator shall also be equipped with suitable line guides.

Equipment for application shall be mobile and maneuverable to the extent that straight lines can be followed and normal curves can be made in a true arc. Equipment shall include adequate process controls to regulate the application of marking materials and maintain required temperatures, pressures, and delivery speed of components in the pavement marking.

The pavement marking equipment shall be operated in accordance with recommendations of the equipment manufacturer, unless otherwise directed by the Engineer. Operating speeds shall be such as to provide uniformity and the specified wet or dry film thicknesses.

Pavement marking vehicles shall operate in the lane for traffic moving in the same direction; they shall not encroach into the lane for opposing traffic flow. Exceptions to this requirement shall be approved in writing by the Engineer.

The application equipment shall be so constructed as to ensure continuous uniformity in the dimensions of stripes. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying dashed and dotted lines. The equipment shall be capable of applying varying widths of traffic markings.

Equipment to be used for determining temperature, moisture, and material thickness including, but not limited to, a thermometer and a micrometer are specified in Subsection 631.06.

(c) Weather Limitations.

(1) At the time of application of painted markings, the temperature of the surface to be painted shall be a minimum of 10 °C (50 °F) and the ambient air temperature shall be 10 °C (50 °F) and rising. Ambient hygrometric conditions required for drying within a twenty minute period shall exist or painting shall be suspended.

(2) At the time of application of durable pavement markings, the pavement surface temperature shall be the greater of: a minimum of 10 °C (50 °F) and the ambient air temperature shall be a minimum of 10 °C (50 °F) and rising or the manufacturer's specified application temperatures.

(3) If weather does not permit the application of durable markings prior to October 15th, paint will be applied in accordance with this Section and Section 708.

(4) When it is in the public interest, the Engineer may authorize the application of pavement markings under conditions that vary from these limitations or the manufacturer's published recommendations.

(d) Layout and Control. The Contractor is responsible for the layout of all markings. The pattern of painted, durable, or temporary markings shall be as follows, unless otherwise shown in the Contract Documents or directed by the Engineer:

(1) Centerline Markings. Centerline markings shall be positioned at the geometric center of the roads. Solid (barrier) lines and dash lines shall start and end at points shown on the Plans or as directed by the Engineer. A dash line shall consist of 3 m ± 300 mm (10 foot ± 12 inch) line segments, and 9 m ± 300 mm (30 foot ± 12 inch) spaces. The spacing between a double barrier line and between a barrier line and a dash line shall be 100 ± 5 mm (4 ± 1/4 inch). The width of the lines shall be as shown on the Plans, ± 5 mm (± 1/4 inch).

Raised pavement markers will not be permitted for solid (barrier) lines. For dashed lines, four raised pavement markers on 1 m (3 foot) centers shall be used for the 3 m (10 foot) line segment. The 9 m (30 foot) space shall remain a space.

(2) Edgeline Markings. Edgeline markings shall be applied along both edges of the road, as shown on the Plans or as directed by the Engineer. Edgelines shall be discontinued through intersections of paved public side roads, unless otherwise shown on the Plans. The width of edgelines shall be as shown on the Plans, ± 5 mm (1/4 inch).

On four-lane roadways, raised pavement markers shall not be used on the right-most lane. Raised pavement markers on the drivers' left side shall be placed on 1.5 m (5 foot) centers.

(3) Dotted Line. Dotted lines shall be positioned as shown on the Plans or as directed by the Engineer. A dotted line shall consist of 600 ± 50 mm (24 ± 2 inch) line segments, and 1200 ± 50 mm (48 ± 2 inch) spaces. The width of the lines shall be as shown on the Plans, ± 5 mm (± 1/4 inch).

Raised pavement markers shall not be used for dotted lines.

(4) Control. The Contractor shall provide the necessary horizontal and longitudinal control to keep all longitudinal lines within 50 mm (2 inches) of their designated locations.

In addition, on tangent, the Contractor shall not allow longitudinal lines to vary from either side of a straight line by more than 25 mm (1 inch) in a distance of 30 m (100 feet).

646.05 ACCOMMODATION AND PROTECTION OF TRAFFIC. The Contractor shall provide adequate warning signs and traffic control measures for the accommodation and protection of traffic, as shown on the Plans or as directed by the Engineer. Placement of pavement markings may be suspended at the discretion of the Engineer during peak traffic hours, or at any time, when in the Engineer's judgment, traffic is being unduly hampered, delayed by the work or when traffic interferes with the quality of work.

All equipment and devices necessary for the application of pavement markings and protection thereof, and for the protection of the traveling public shall be as usually required for work of this type, as shown on the Plans or as directed by the Engineer, and shall be furnished by the Contractor.

646.06 PAINT PAVEMENT MARKINGS. Retroflective paint pavement markings shall be applied by a method in which the liquid paint is applied to the road surface and the glass beads are immediately applied on the paint and firmly embedded therein. The application procedure shall provide a retroreflective marking, with a night visibility satisfactory to the Engineer. The material shall have a dry film thickness of 380 ± 25 μm (15 ± 1 mil) for paint, unless otherwise specified, and shall be applied in a smooth uniform coat, free from thin places or films of excessive thickness.

Liquid tanks on paint application equipment shall be equipped with mechanical agitators. Beads shall be conditioned to provide a smooth uniform rate of release. All materials shall be maintained in the condition recommended by the marking manufacturer prior to and at the time of marking.

Paint shall conform to the requirements of Subsection 708.08 (b) or 708.08 (d). Application shall be in accordance with the manufacturer's requirements.

The paint for permanent markings shall be applied at a rate to create a uniform wet film thickness of 22 mils with an allowable range of +/-2 mils. The application rate shall take into account the surface roughness of the pavement to be marked. Minimum application rates are 70 square feet per gallon (1.9 square meters per liter) with glass beads applied at a rate of 960 grams per liter (8.0 lb per gallon) of paint.

Only painted pavement markings shall be used on portland cement concrete pavement surfaces.

646.07 DURABLE PAVEMENT MARKINGS. Durable pavement markings shall be used at those locations shown on the Plans or directed by the Engineer. Durable pavement markings are classified as pavement marking tape, epoxy paint, thermoplastic markings, polyurea paint, and methyl-methacrylate. Unless otherwise indicated in the Contract, the Contractor may choose any of the following as being acceptable for durable pavement markings:

(a) Pavement Marking Tape, Type I. Type I tape for pavement markings is classified as non-removable. Type I tape shall conform to the requirements of Subsection 708.12(a).

Type I tapes, when used as a final durable marking, shall be applied only by being inlaid in the bituminous pavement during the rolling operation in accordance with the manufacturer's requirements.

(b) Epoxy Paint. Epoxy paint for pavement markings shall conform to the requirements of Subsection 708.08(c). Application shall be in accordance with the manufacturer's requirements. Mixing of the epoxy reagents shall be complete prior to the placement of the marking. Failure to set to a hard condition shall be grounds for rejection. Glass beads shall be AASHTO M247 Type I incorporated at 30% mass of the combined material, unless otherwise specified

(c) Thermoplastic. Thermoplastic pavement markings shall conform to the following requirements and shall meet the requirements of Subsection 708.10.

The thermoplastic pavement marking compound shall be extruded onto the pavement surface in a molten state. The temperature of the material shall not exceed the manufacturer's recommended heating temperature or rate of temperature increase. The surface shall be properly prepared for receipt of the marking material, including surface roughness, cleanliness, and moisture levels. The surface shall be primed when the manufacturer's recommendations require priming.

Following an application of glass beads to the marking surface, and upon cooling to normal pavement temperatures, the resultant marking shall be an adherent retroreflective stripe of the specified thickness and width that is capable of resisting deformation by traffic.

(1) Thermoplastic Application Equipment. Thermoplastic application equipment shall be approved by the Engineer prior to the start of work.

Thermoplastic material shall be applied to the pavement surface by the extrusion method, wherein the bottom of the extrusion shoe is the pavement and the top and other three sides are contained by, or are part of, suitable equipment for maintaining the temperature and controlling the flow of material. The fourth side contains the extrusion opening.

The ribbon extrusion method will not be permitted.

The equipment used for the placement of thermoplastic pavement markings shall be of two general types:

a. Mobile Applicator Equipment. The mobile applicator shall be defined as truck mounted equipment designed to apply thermoplastic by the extrusion method. The unit shall be equipped to apply the thermoplastic material at temperatures exceeding 205 °C (400 °F), and at the widths and thicknesses specified herein. The mobile unit shall be capable of operating continuously and/or installing a minimum of 6.1 km (3.8 miles) of longitudinal markings in an eight-hour day.

The mobile unit shall be equipped with extrusion shoes and shall be capable of simultaneously marking edgeline and/or two centerline stripes. The extrusion shoes shall be closed, heat jacketed or suitably insulated units; shall hold the molten thermoplastic at a temperature from 205 to 225 °C (400 to 435 °F); and shall be capable of extruding a line from 100 to 200 mm (4 to 8 inches) wide, between 2.4 and 2.5 mm (96 and 100 mils) thick, and of generally uniform cross-section. Material temperature gauges shall be affixed, adjacent to or incorporated in the extrusion shoe in such a manner as to be visible and capable of monitoring the composition temperature throughout the marking operation.

The mobile unit shall be equipped with an electronic and programmable line pattern control system, or mechanical system, so as to be capable of applying dashed, dotted, or solid lines in any sequence and through any extrusion shoe in any cycle length.

b. Portable Applicator Equipment. The portable applicator shall be defined as hand operated equipment specifically designed for placing thermoplastic installations such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge, and centerlines. The portable applicator shall be capable of applying thermoplastic markings by the extrusion method. It is intended that the portable applicator will be loaded with hot thermoplastic composition from the melting kettle(s) or that the material will be melted by an integral "melting stack" when so equipped. The portable applicator shall be equipped with all the necessary components, including a material storage reservoir, bead dispenser, extrusion shoe and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature from 205 to 225 °C (400 to 435 °F), and of extruding a line from 100 to 200 mm (4 to 8 inches) wide in 50 mm (2 inch) increments, between 2 and 2.5 mm (80 and 100 mils) thick, and of generally uniform cross-section. Material temperature gauges shall be affixed, adjacent to or incorporated in the extrusion shoe in such a manner as to be visible and capable of monitoring the composition temperature throughout the marking operation. If a machine, as manufactured, cannot be equipped with gauges at the extrusion shoe, the Engineer may approve an alternate method of monitoring the composition temperature at the point of deposition.

(2) Application Requirements.

a. Primer. Primer shall be used under such conditions, at such rates and thicknesses and of a type as is recommended by the manufacturer of the thermoplastic material being applied. Bituminous concrete primer shall be applied to pavements older than two years at the application rates and procedures recommended by the manufacturer of the thermoplastic material.

b. Thermoplastic Composition. Thermoplastic composition shall conform to the requirements of Subsection 708.10.

c. Application Temperature. Thermoplastic composition shall be applied at a temperature range between 205 and 225 °C (400 and 435 °F).

d. Extruded Markings. All extruded markings shall be applied at the specified width and at a thickness between 2.4 and 2.5 mm (96 and 100 mils) exclusive of any drop on glass beads.

e. Beads.

1. Glass beads meeting the requirements of AASHTO M247 Type I incorporated into the thermoplastic composition at a rate of between 28 and 30 percent by mass (weight) of the combined material.

2. Reflective glass spheres (for “drop on”) shall be placed concurrently with application of the thermoplastic. The reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 245 g/m^2 [7 ounces (avoir) per square yard] of composition. The glass spheres shall conform to the requirements of AASHTO M247 Type I.

f. Gaps and Overlaps. When applying durable diagonal pavement markings that are to be enclosed within durable long line borders, the Contractor shall apply the diagonals in such a manner as to allow a maximum of a single overlap and no gaps between the diagonals and the long lines.

Where possible and where applicable, a 50 mm (2 inch) gap should be maintained between thermoplastic pavement markings and parallel joints in bituminous concrete pavement. This requirement is secondary to the alignment controls specified in Subsection 646.04(d).

(d) Polyurea Paint. Approved polyurea marking materials shall be one of the markings listed on the Approved Products List on file with the Agency's Materials and Research Section under Subsection 708.08(a). Glass beads shall be AASHTO M247 Type I incorporated at 30% mass of the combined material, unless otherwise specified.

(e) Methyl-methacrylate Paint. Approved Methyl-methacrylate Paint shall be one of the Methy-methacrylate Paints listed on the Approved Products List on file with the Agency's Materials and Research Section under Subsection 708.08(e). Glass beads shall be AASHTO M247 Type I incorporated at 30% mass of the combined material, unless otherwise specified.

646.08 TEMPORARY PAVEMENT MARKINGS. Temporary pavement markings are classified as Type II tape (removable), Pavement Marking Mask, Type II raised pavement markers, traffic paint with glass beads, and line striping targets. Unless otherwise indicated in the Contract, the Contractor may choose any of the above as being acceptable for temporary pavement markings.

(a) Pavement Marking Tape, Type II. Type II tape for pavement markings is classified as temporary. Type II tape shall conform to the requirements of Subsection 708.12 (b), and shall be installed in accordance with the manufacturer’s requirements.

(b) Pavement Marking Mask. Black or other compatible pavement color Pavement Marking Mask is classified as removable. It shall conform to the requirements of Subsection 708.12 (c), and shall be installed in accordance with the manufacturer's requirements.

(c) Raised Pavement Markers, Type II. Type II raised pavement markers are intended to be temporary markers, usually placed and removed during the period of construction activity.

Type II raised pavement markers, of the color shown on the Plans or directed by the Engineer, shall be installed at the locations shown on the Plans or directed by the Engineer. Unless otherwise shown on the Plans or directed by the Engineer, Type II raised pavement markers shall be installed in accordance with the requirements of the MUTCD.

(d) Line Striping Targets. Line striping targets are intended to be substitutes for planned pavement markings on the wearing course of pavement, and shall be used only in conjunction with "Do Not Pass" signs for not longer than 14 calendar days.

Line striping targets of the color shown on the Plans or directed by the Engineer shall be installed as described below or as directed by the Engineer.

Line striping targets in conjunction with "Do Not Pass" signs shall be used on wearing courses of pavement prior to applying durable markings. Durable markings shall be placed within two weeks of the date the segment of wearing course pavement is placed. Line striping targets shall be placed at 12 m (40 foot) intervals on tangents and curves with a radius of 235 m (771 feet) or greater and at 6 m (20 foot) intervals on curves with a radius less than 235 m (771 feet), or as determined by the Engineer.

"Do Not Pass" signs shall be erected prior to traffic traveling on the wearing course of pavement. "Do Not Pass" signs shall be erected on each side of the road 300 m (985 feet) into the project limits and subsequent signs placed at 800 m (2625 foot) intervals. Additional signs shall be utilized 300 m (985 feet) from significant side roads.

"Do Not Pass" signs shall be 610 by 760 mm (24 × 30 inch) black text on orange Type III retroreflective sheeting as shown on the Plans and shall be mounted as shown on the Plans. The signs shall be turned away from traffic immediately upon placement of the durable markings.

(e) Paint. Temporary paint applied on the base or intermediate courses of pavement shall have a thickness of 200 ± 25 μm (8 ± 1 mil). Beads shall be applied at a rate of 360 g/L (3 pounds per gallon) of paint.

All paint used for temporary markings shall be held to the same alignment and horizontal control standards as specified in Subsection 646.04.

Temporary markings that remain in place for fewer than seven calendar days shall be Type II tape (removable) or Type II raised pavement markers. Paint will not be permitted for use as a temporary marking which remains in place for fewer than seven calendar days on the wearing course of pavement.

646.09 OTHER RELATED MARKINGS.

(a) Pavement Marking Recess. Recessed pavement markings shall be installed as specified for permanent markings. The recess shall be a uniform depth across the width of the marking. The recess shall be controlled such that the depth provided is 125% of the marking material thickness. The recess shall be clean and dry at the time of marking placement.

(b) Raised Pavement Markers, Type I. Type I raised pavement markers are intended to be permanently installed in the pavement surface and are manufactured of a material which will resist destruction by snow plowing equipment.

Type I raised pavement markers shall meet the requirements as specified in Subsection 708.11 and shall be permanently installed in the wearing course of pavement in accordance with the manufacturer's recommendations.

Type I raised pavement markers of the color shown on the Plans or directed by the Engineer shall be installed at the locations shown the Plans or directed by the Engineer. Unless otherwise shown on the Plans or directed by the Engineer, Type I raised pavement markers shall be installed in accordance with the requirements of the MUTCD.

(c) Painted Curbs and Islands. Where painted curb or painted island is called for, the existing curb or island shall be blast cleaned or wire brushed to remove scale, dirt, grass, etc. to the satisfaction of the Engineer, prior to painting. This cleaning work will not be paid for directly, but will be considered incidental to the Contract item Painted Curb or Painted Island.

Paint shall be applied at a rate of 2.5 to 2.8 m^2/L (100 to 115 square feet per gallon) with glass beads applied at a rate of 720 g/L (6 pounds per gallon). All paint shall be applied within the manufacturer's allowable application temperatures.

Retroreflective paint shall be applied by a method in which the liquid material is applied to the curb or island surface and the glass beads are immediately applied to the material and firmly embedded therein, and which shall provide a retroreflective marking, with a night visibility satisfactory to the Engineer. The material shall have a minimum wet film thickness of 380 ± 25 μm (15 ± 1 mil), unless otherwise specified, and shall be applied in a smooth uniform coat, free from thin places or films of excessive thickness.

Beads shall be applied uniformly over the entire painted surface area at the specified rate.

646.10 SUBSTITUTION OF MARKING MATERIALS. If the durable markings can not be placed under suitable environmental conditions, paint shall be applied at the current standards as specified in Subsection 646.06 at no cost to the Agency. Where it can be determined that through no fault of the Contractor the durable markings cannot be applied under suitable environmental conditions, paint may be applied for durable marking of the types indicated on the Plans where appropriate and as directed by the Engineer.

Regardless of the circumstance under which paint is applied after an unsuitable environmental condition determination, durable markings of the types indicated on the Plans shall be applied as soon as suitable environmental conditions permit during the following Spring. These durable markings shall be measured and paid for in accordance with Subsections 646.13 and 646.14.

646.11 ALTERNATE MARKING MATERIALS. If the Contractor wishes to use pavement markings or markers that are not specified in this Section, the Contractor shall submit samples, technical data, installation instructions and, if applicable, removal instructions to the Engineer for approval at least 30 calendar days before the date the markings or markers are to be placed. The Engineer, after consultation with the Materials and Research Engineer, will approve or disapprove the use of the submitted products within the 30 calendar day period. The Contractor should be prepared to place approved markings on the proper date, even if the submittal is disapproved.

646.12 REMOVAL OF EXISTING PAVEMENT MARKINGS. Existing markings shall be obliterated in such a manner and by such means that a minimum of pavement scars are left and all of the existing marking is removed; i.e., grinding a square or rectangle on the pavement to remove a letter or arrow or grinding a large rectangle to remove a word so that the outline of the letter, symbol, or word is not ground into the pavement and therefore still legible even though the marking has been removed. Painting over existing markings is not an acceptable method of removal. The work shall be completed to the satisfaction of the Engineer. Masking of lines in intermediate duration activities shall be completed according to the Plans or as directed by the Engineer.

646.13 METHOD OF MEASUREMENT. The quantity of Pavement Marking edgeline(s) and centerline(s) of the type(s) and size(s) specified to be measured for payment will be the number of meters (linear feet) applied in the complete and accepted work, as measured along the centerline of the pavement stripe. The number of meters (linear feet) of open spaces in a dashed or dotted line will not be measured for payment.

The quantity of Paint Pavement Marking(s) of the type(s) and size(s) specified per Subsection 646.10 through no fault of the Contractor and applied on the project to be measured for payment will be the quantity determined per the measure for the Durable Pavement Marking specified, multiplied by a factor of 1.5 to determine the accepted quantity for payment.

The quantity of Stop Bar of the type specified to be measured for payment will be the number of meters (linear feet) applied in the complete and accepted work, as measured along the centerline of the pavement stripe.

The quantity of Letter or Symbol of the type specified to be measured for payment will be the number of each unit applied in the complete and accepted work. A unit will consist of one letter or one symbol. Example: "SCHOOL" would be measured as six units, a handicapped symbol would be measured as one unit.

The quantity of Crosswalk Marking of the type specified to be measured for payment will be the number of meters (linear feet) applied from curb to curb in the complete and accepted work, as measured along the center of the crosswalk.

The quantity of Railroad Crossing Symbol of the type specified to be measured for payment will be the number of each unit applied in the complete and accepted work. A unit will consist of three "stop bars," two "R's," and one "X" for one traffic lane in one direction of travel.

The quantity of Raised Pavement Markers, Type II to be measured for payment will be the number of individual markers installed in each phase of the traffic control plan and removed when no longer needed.

The quantity of Line Striping Targets to be measured for payment will be the number of individual targets installed on the pavement and removed when no longer needed.

The quantity of Raised Pavement Markers, Type I to be measured for payment will be the number of individual markers installed on/in the pavement in the complete and accepted work.

The quantity of Painted Curb to be measured for payment will be the number of meters (linear feet) applied in the complete and accepted work, as measured along the centerline of the pavement stripe.

The quantity of Painted Island to be measured for payment will be the number of square meters (square feet) of the top of an island painted in the complete and accepted work.

The quantity of Removal of Existing Pavement Markings to be measured for payment will be the number of square meters (square feet) of markings removed or total area in square meters (square feet) of symbol or letter removed in the complete and accepted work, as determined by the Engineer.

The quantity of Pavement Marking Mask to be measured for payment will be the number of square meters (square feet) of existing marking masked in the complete and accepted work.

646.14 BASIS OF PAYMENT. The accepted quantity of Pavement Marking edgeline(s) and centerline(s) of the type(s) and size(s) specified will be paid for at the Contract unit price(s) per meter (linear foot).

The accepted quantity of Paint Pavement Markings of the type(s) and size(s) specified per Subsection 646.10 and measured for payment will be paid for at the corresponding Contract unit price(s) for Temporary Pavement Marking(s).

The accepted quantity of Stop Bar of the type specified will be paid for at the Contract unit price per meter (linear foot).

The accepted quantity of Letter or Symbol of the type specified will be paid for at the Contract unit price per each unit.

The accepted quantity of Crosswalk Marking of the type specified will be paid for at the Contract unit price per meter (linear foot).

The accepted quantity of Railroad Crossing Symbol of the type specified will be paid for at the Contract unit price per each unit.

The accepted quantity of Raised Pavement Markers, Type I will be paid for at the Contract unit price per each unit.

The accepted quantity of Painted Curb will be paid for at the Contract unit price per meter (linear foot).

The accepted quantity of Painted Island will be paid for at the Contract unit price per square meter (square foot).

Payment will be full compensation for furnishing, transporting, handling, assembling, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The Contract unit price for recessed Pavement Marking items will also include all labor, equipment, tools, and incidentals necessary for the placement of the recess and any necessary cleaning, drying, or conditioning of the recess prior to placement of the marking.

The Contract unit price for Pavement Marking items that are used as temporary pavement markings (tape, raised pavement markers, paint, and line striping targets) as specified in Subsection 646.08 will also include all costs of removal of those temporary markings, if removal is required by construction procedures, shown on the Plans or directed by the Engineer.

The accepted quantity of Raised Pavement Markers, Type II will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, and installing the markers as required for each phase of the traffic control plan; for maintaining the installed units during the phase and removing the markers, if necessary, when the phase has been completed; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Adjusting the markers as required by the Engineer during each phase of the traffic control plan, including replacing or resetting improperly placed or poorly oriented markers, will be considered incidental to the Contract item Raised Pavement Markers, Type II.

The accepted quantity of Line Striping Targets will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, installing, removing, and disposing of the targets and the "Do Not Pass" signs, posts, and sleeves (if used); and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. If line striping targets remain in place on the roadway for longer than 14 calendar days, no payment will be made for the Contract item Line Striping Targets.

The accepted quantity of Removal of Existing Pavement Markings will be paid for at the Contract unit price per square meter (square foot). Payment will be full compensation for removing the markings and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. No payment will be made for removal of temporary paint markings installed and removed under the Contract.

The accepted quantity of Pavement Marking Mask will be paid for at the Contract unit price per square meter (square foot). Payment will be full compensation for obliterating existing markings with a masking material, for removing the masking material when it is no longer required as directed by the Engineer, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

"Do Not Pass" signs will not be paid for directly, but will be considered incidental to the Contract item Line Striping Targets.

The Contractor is responsible for supplying necessary materials and equipment recommended by the manufacturer to determine the surface moisture condition of the pavement. The costs for supplying this material and equipment are paid for under the appropriate Contract item specified in Section 631.

Payment will be made under:

Pay Item	Pay Unit
(a) Paint Pavement Markings.	
646.20 100 mm (4 inch) White Line	Meter (Linear Foot)
646.21 100 mm (4 inch) Yellow Line	Meter (Linear Foot)
646.214 150 mm (6 inch) White Line	Meter (Linear Foot)
646.215 150 mm (6 inch) Yellow Line	Meter (Linear Foot)
646.22 200 mm (8 inch) White Line	Meter (Linear Foot)
646.23 200 mm (8 inch) Yellow Line	Meter (Linear Foot)
646.24 300 mm (12 inch) White Line	Meter (Linear Foot)
646.25 300 mm (12 inch) Yellow Line	Meter (Linear Foot)
646.26 600 mm (24 inch) Stop Bar	Meter (Linear Foot)
646.30 Letter or Symbol	Each
646.31 Crosswalk Marking	Meter (Linear Foot)
646.32 Railroad Crossing Symbol	Each
(b) Durable Pavement Markings.	
646.400 to 646.409 Durable 100 mm (4 inch) White Line	Meter (Linear Foot)
646.410 to 646.419 Durable 100 mm (4 inch) Yellow Line	Meter (Linear Foot)
646.420 to 646.429 Durable 150 mm (6 inch) White Line	Meter (Linear Foot)
646.430 to 646.439 Durable 150 mm (6 inch) Yellow Line	Meter (Linear Foot)
646.440 to 646.449 Durable 200 mm (8 inch) White Line	Meter (Linear Foot)
646.450 to 646.459 Durable 200 mm (8 inch) Yellow Line	Meter (Linear Foot)
646.460 to 646.469 Durable 300 mm (12 inch) White Line	Meter (Linear Foot)
646.470 to 646.479 Durable 300 mm (12 inch) Yellow Line	Meter (Linear Foot)
646.480 to 649.489 Durable 600 mm (24 inch) Stop Bar	Meter (Linear Foot)
646.490 to 646.499 Durable Letter or Symbol	Each
646.500 to 649.509 Durable Crosswalk Marking	Meter (Linear Foot)
646.510 to 646.519 Durable Railroad Crossing Symbol	Each

(c) Temporary Pavement Markings.

646.600 to 646.605 Temporary 100 mm (4 inch) White Line	Meter (Linear Foot)
646.610 to 646.615 Temporary 100 mm (4 inch) Yellow Line	Meter (Linear Foot)
646.620 to 646.625 Temporary 150 mm (6 inch) White Line	Meter (Linear Foot)
646.630 to 646.635 Temporary 150 mm (6 inch) Yellow Line	Meter (Linear Foot)
646.640 to 646.645 Temporary 200 mm (8 inch) White Line	Meter (Linear Foot)
646.650 to 646.655 Temporary 200 mm (8 inch) Yellow Line	Meter (Linear Foot)
646.660 to 646.665 Temporary 300 mm (12 inch) White Line	Meter (Linear Foot)
646.670 to 646.675 Temporary 300 mm (12 inch) Yellow Line	Meter (Linear Foot)
646.680 to 646.685 Temporary 600 mm (24 inch) Stop Bar	Meter (Linear Foot)
646.690 to 646.695 Temporary Letter or Symbol	Each
646.700 to 646.705 Temporary Crosswalk Marking	Meter (Linear Foot)
646.710 to 646.715 Temporary Railroad Crossing Symbol	Each
646.75 Raised Pavement Markers, Type II	Each
646.76 Line Striping Targets	Each

(d) Other Related Marking Items.

646.80 Raised Pavement Markers, Type I	Each
646.81 Painted Curb	Meter (Linear Foot)
646.82 Painted Island	Square Meter (Square Foot)

(e) Marking Removal.

646.85 Removal of Existing Pavement Markings	Square Meter (Square Foot)
646.86 Pavement Marking Mask	Square Meter (Square Foot)

SECTION 649 - GEOTEXTILE FABRIC

649.01 DESCRIPTION. This work shall consist of furnishing and placing geotextiles in underdrain trenches, under embankments, for embankment reinforcement, under riprap and stone fill, behind retaining structures, over roadbed subgrades, and beneath pavement overlays.

649.02 MATERIALS. Geotextile terms are defined in Section 720. Materials shall conform to the applicable requirements of Section 720 and the following:

(a) Where sewn seams are used, the Contractor shall furnish the manufacturer's wide strip tensile test results as part of the certification. The results must verify that the seam meets or exceeds the specified average minimum roll values for the grab tensile strength of the geotextiles, or wide strip tensile strength for reinforcement applications.

(b) Where field seams are made, the Contractor shall provide the Engineer with a field-stitched seam test sample in accordance with ASTM D 1683. The Engineer's approval will be required prior to the Contractor beginning production field stitching/seaming.

(c) Where woven wire reinforcement is used, the woven wire shall be 14 gauge minimum with a 150 mm (6 inch) maximum mesh opening.

649.03 GENERAL. The rolls of geotextile shall be protected against damage and deterioration until incorporated into the project. The geotextile shall be dry at the time of installation. The geotextile shall be rejected if, at the time of installation, it has defects, deterioration, or damage as determined by the Engineer.

649.04 INSTALLATION.

(a) General. The surface receiving the geotextile shall be prepared to a smooth condition free of obstructions, depressions and debris, unless otherwise directed by the Engineer. Where angular aggregate or sharp objects will be in contact with the geotextile, increased geotextile strength properties will be required as specified in Section 720. The geotextile shall not be dragged on the ground or mishandled in any way. The geotextile shall be placed loosely and without wrinkles so that placement of the overlying material will not tear the geotextile. The geotextile shall be lapped or sewn as specified at the ends and sides of adjoining sheets. In addition to the above general requirements, the following specific requirements shall be followed for the specified application:

(1) Geotextile Placement on Slopes. The geotextile sheets shall be placed with the machine direction oriented perpendicular to the slope. When the geotextile is placed on slopes steeper than 1:6 (vertical:horizontal), the upper sheets shall lap over the top of the lower sheets. The laps shall be securely anchored to the ground surface with pins or stakes as necessary to prevent slippage and tearing of the geotextile. As specified by the geotextile manufacturer or as directed by the Engineer, placement of fill material on the geotextile shall start at the toe of the slope and proceed upwards.

(2) Geotextile Placement for Stream Bank Protection. Where geotextiles are placed under water, or in an area where water will flow, the geotextile shall be placed with its machine direction parallel to the direction of water flow. Successive geotextile sheets shall be overlapped in such a manner that the upstream sheet is placed over the top of the downstream sheet. The geotextile shall be adequately secured to prevent slippage. As the geotextile is placed under water, the backfill material shall be placed on it to the required thickness. The geotextile placement shall not progress more than 15 m (50 feet) ahead of the backfill placement.

(3) Underdrains. When a geotextile is specified to line an underdrain trench, the geotextile shall be placed to conform loosely to the shape of the trench.

(4) Geotextiles Under Stone Fill. Geotextiles under riprap or stone fill shall be constructed in accordance with the details shown on the Plans and the following requirements. The Contractor shall demonstrate to the satisfaction of the Engineer that the combination of the stone fill drop height and the thickness of any sand cushion, when specified or required, are adequate so as not to puncture or damage the geotextile when placing the riprap or stone fill. Where a sand cushion is used, it shall be a minimum of 150 mm (6 inches) thick, unless otherwise directed by the Engineer. In addition, the following limits apply:

Type of Stone Fill	Maximum Drop Height	
	Onto Geotextile	Onto a Sand Cushion Blanket
Type I	900 mm (36 inches)	900 mm (36 inches)
Type II, III, IV,0 and Riprap		300 mm (12 inches)

After placement of the stone fill or riprap, all voids in the stone face that allow the geotextile to be visible shall be satisfactorily backfilled so that the geotextile is completely covered.

(5) Roadbed Subgrade and Railroad Ballast Separation. The subgrade shall be prepared in accordance with Section 203. Construction vehicles shall be limited in size and mass (weight) such that rutting of the initial lift placed above the geotextile is no greater than 75 mm (3 inches) deep. Ruts shall not be graded off but shall be filled with material specified by the Engineer such that a minimum 200 mm (8 inches) of cover is kept over the geotextile. Turning of vehicles on the first lift of cover material shall not be permitted. The Contractor shall not use vibratory rollers on the first lift if pumping or distortion of the subgrade occurs, as determined by the Engineer.

(6) Silt Fence. The geotextile, and when required woven wire reinforcement, shall be attached on the up-slope side of posts in accordance with the manufacturer's recommendation or as directed by the Engineer. The geotextile at the bottom of the fence shall be buried in a trench a minimum of 150 mm (6 inches) below the ground surface. Where the geotextile elongation is 50 percent as measured in accordance with ASTM D 4632, the post spacing shall not exceed 1.2 m (4 feet); and where the elongation is less than 50 percent, the post spacing shall not exceed 2 m (6 feet).

Either wood or steel posts shall be used. The posts shall have a minimum length of 910 mm (3 feet) and shall be embedded a minimum of 405 mm (16 inches) below the ground surface. The spacing of the posts shall be as shown in the Plans, or as determined by the silt fence manufacturer or the Engineer.

Wood posts shall have minimum dimensions of 25mm by 25 mm (1 inch × 1 inch) and shall be free of defects such as knots, splits, or gouges. Steel posts shall consist of either No. 22 (No. 7) size reinforcing steel or larger, or shall consist of ASTM A 120 steel pipe with a minimum diameter of 20 mm (3/4 inch).

Sediment deposits that accumulate behind the fence shall be removed when the deposit reaches 50 percent of the height of the silt fence above the ground surface.

The Contractor shall repair or replace damaged silt fence as ordered by the Engineer. The silt fence shall be completely removed prior to acceptance of the project, unless otherwise directed by the Engineer.

(7) Filter Curtain. When used to contain sediments or pollutants from a work area that is adjacent to or under water, the fabric shall be installed to completely enclose the portion of the work area that will be under water. The Contractor shall design and construct the curtain to deflect and withstand any existing current or wave action, to be anchored continuously along the bottom, to be effective at any anticipated water level, and to prevent the escape of all sediments or pollutants into the main stream or body of water.

The Contractor shall repair or replace damaged or otherwise ineffective filter curtains as ordered by the Engineer. The Contractor shall remove material accumulated behind the filter curtain as directed by the Engineer.

The Contractor shall remove the filter curtain and all supporting and anchoring material prior to acceptance of the project, unless otherwise directed by the Engineer.

The design, construction, and maintenance plan for the filter curtain installation shall be acceptable to the Engineer before installation of the curtain begins.

(b) Protection of Geotextile. The Contractor shall not permit traffic or construction equipment to travel directly on the geotextile. The geotextile shall be protected at all times during construction from contamination by surface runoff and construction activities. The geotextile shall be covered with the specified cover material as soon as possible; uncovered conditions shall not exceed seven days. Specified cover material shall be placed on the geotextile in such a manner that the geotextile is not torn, punctured, or shifted. The minimum cover layer shall be 200 mm (8 inches) thick or twice the maximum aggregate size, whichever is thicker, before construction equipment is allowed over the area of the geotextile. The Contractor shall not permit end-dumping of aggregates from trucks directly on the geotextile.

(c) Repair of Geotextile. All geotextile that is torn, punctured, or contaminated during construction shall be repaired or replaced by the Contractor. The repair shall consist of a patch of the same type of geotextile placed over the affected area. The patch shall overlap the existing geotextile a minimum of 900 mm (36 inches) from the edge of any part of the rupture. Where geotextile seams are required to be sewn, all damaged sheets shall be repaired by sewing, unless otherwise shown in the Contract Documents or as directed by the Engineer.

(d) Overlaps. The minimum overlap requirements for geotextiles are as follows:

Minimum Overlap Requirements	
Underdrain Trench	300 mm (12 inches)
Under Type I and II Stone Fill	600 mm (24 inches)
Under Riprap and Type III and IV Stone Fill	900 mm (36 inches)
Roadbed Subgrade Stabilization	900 mm (36 inches)
Under Railroad Ballast	900 mm (36 inches)

In the event the Engineer determines that the specified overlap is not sufficient, the overlap shall be increased to provide adequate coverage or the geotextile shall be sewn together in the field. If field sewn, the requirements in part (e) below shall apply.

(e) Field Seams. Field seams shall be sewn with polymeric thread, consisting of polypropylene, polyester, or Kevlar and shall be as resistant to deterioration as the geotextile being sewn. The thread shall be of a contrasting color with the geotextile being sewn, and the seams shall be made such that the stitches are exposed for inspection when the geotextile is placed.

(1) Stitching Equipment. The stitching equipment shall be such that it will provide an acceptable lock-type stitch, as recommended by the geotextile manufacturer and approved by the Engineer.

(2) Stitch Requirements. Two rows of lock-type stitching shall be used to make the seam. The two rows of stitching shall be 13 mm (1/2 inch) apart with a tolerance of ± 6 mm (± 1/4 inch) and shall not cross, except for restitching.

(3) Minimum Seam Allowance. The minimum required seam allowances, i.e., the minimum distances from the geotextile edge to the stitchline nearest to that edge, are as follows:

Seam Type (See Plans)	Minimum Seam Allowance
Flat or Prayer Seam, Type SSa-1	40 mm (1 1/2 inches)
"J" Seam, Type SSa-1	25 mm (1 inch)
Butterfly-Folded Seam, Type SSd-1	25 mm (1 inch)

(4) Seam Type. The Contractor shall obtain the geotextile manufacturer's recommendation for the type of seam and stitch to be used. If the Contractor does not provide the foregoing technical information, then the Contractor shall use a "J" seam with two passes of a lock-type stitch which places at least three stitches per 25 mm (1 inch) of sewn seam. This seam will be tested as required by these Specifications. The prayer seam (flat) may be used for repair of damaged in-place geotextile.

649.05 METHOD OF MEASUREMENT. The quantity of Geotextile of the type specified to be measured for payment will be the number of square meters (square yards) placed in the complete and accepted work. Slope measurements will be used in computing the area. Measurement will not be made for material used for repairs, seams, or overlaps. Measurement will not be made for material used to replace an installation of fabric that has become damaged, destroyed, lost, washed away, or otherwise ineffective unless authorized by the Engineer.

649.06 BASIS OF PAYMENT. The accepted quantity of Geotextile of the type specified will be paid for at the Contract unit price per square meter (square yard). Payment will be full compensation for furnishing, transporting, storing, handling, placing, repairing, and removing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Unless otherwise specified in the Contract, payment for the maintenance of Geotextile of the type specified will not be paid for directly, but will be considered incidental to the specific Contract item.

Payment will be made under:

Pay Item	Pay Unit
649.11 Geotextile For Roadbed Separator	Square Meter (Square Yard)
649.21 Geotextile Under Railroad Ballast	Square Meter (Square Yard)
649.31 Geotextile Under Stone Fill	Square Meter (Square Yard)
649.41 Geotextile For Underdrain Trench Lining	Square Meter
649.51 Geotextile For Silt Fence	Square Meter (Square Yard)
649.515 Geotextile for Silt Fence, Woven Wire Reinforced	Square Meter (Square Yard)
649.61 Geotextile For Filter Curtain	Square Meter (Square Yard)

SECTION 651 - TURF ESTABLISHMENT

651.01 DESCRIPTION. This work shall consist of the preparation of the area and the application of topsoil, grubbing material, sod, seed, soil amendments, and mulch.

651.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Topsoil..... 755.02
Sod..... 755.03
Seed 755.04
Compost 755.05
Fertilizer 755.06
Agricultural Limestone..... 755.08
Liquid Lime 755.09
Hay Mulch.....755.10(a)
Fiber Mulch .....755.10(d)
Hydraulic Matrix .....755.10(e)
Tackifier ..... 755.10(f)
Straw Mulch……755.10(g)
Temporary Erosion Matting .....755.11(a)
Permant Erosion Matting.....755.11(b)

Stakes for holding sod shall be rounded or square wooden stakes at least 200 mm (8 inches) long, having a cross-sectional area of approximately 650 mm^2 (1 in^2). Stakes of other materials or designs may be used when authorized by the Engineer.

Grubbing Material for use on stone fill along streams shall consist of grubbed or stripped earth material containing roots of native stream bank vegetation. Material for use on rock fill slopes shall consist of grubbed or stripped earth material containing roots (not necessarily from native stream bank vegetation) which will promote the growth of vegetation.

Grubbing Material shall not contain any invasive plant material found on the Invasive Species List on file with the Vermont Agency of Agriculture.

651.03 SEASONAL LIMITATIONS. Turf establishment shall occur from May 1st to September 15th unless otherwise authorized under applicable permits and directed by the Engineer. If turf has not been established before October 15th due to the Contractor's neglect, additional stabilization measures as approved by the Engineer shall be implemented at the Contractor's expense.

651.04 GENERAL. The Contractor shall place turf establishment items on all cuts and fills within 48 hours of obtaining final grade, unless otherwise directed by the Engineer.

The Contractor shall be responsible for a vigorous growth of grass until final acceptance of the project. All seeded or sodded areas shall be watered sufficiently to promote continuous growth.

651.05 PREPARATION OF AREA. In areas to be topsoiled and/or sodded, allowance shall be made for the depth of topsoil and/or thickness of sod if not accounted for on the Plans. All breaks in grade shall be well rounded. The surface shall be thoroughly raked, dragged, or otherwise mechanically smoothed. All stones, lumps, roots, or other objectionable materials shall be removed. The soil shall be loosened to a depth of approximately 50 mm (2 inches).

If shown on the Plans or if in the opinion of the Engineer, the area to be seeded or sodded is of such a composition that it is unsuitable for vegetation, it shall be covered with 50 mm (2 inches) of topsoil.

Also, if shown on the Plans or determined necessary by the Engineer to reduce compaction and erosion potential and to increase drainage, nutrient exchange capacity, and moisture retention as well as the speed and total % germination of seed and knitting of roots for sodded areas, compost shall be incorporated into the topsoil such that it comprises 25% of the total prepared soil.

Fertilizer and Agricultural Limestone shall be spread over the area to be sodded. If specified in the Contract Documents or deemed necessary by the Engineer, the Contractor shall conduct a soil test to determine the type and quantity of fertilizer and limestone to be used.

651.06 TOPSOIL. Topsoil shall be obtained from a source shown on the Plans or otherwise approved by the Engineer. Spreading shall not be done when ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work, as determined by the Engineer.

The topsoil shall be spread evenly to a depth of approximately 50 mm (2 inches) or to the depth as shown on the Plans. Topsoil shall be lightly compacted as heavy compaction will reduce the potential for seed-soil contact and germination success.

All large stones and other unsuitable material shall be removed from the area.

Topsoil stockpile areas shall be graded, seeded, and left in a neat and presentable condition. Areas shall be properly drained and all excess or unsuitable materials removed and disposed. This work shall be done to the satisfaction of the Engineer and shall comply with all relevant permits.

Any topsoil stockpiled for more than one year shall be laboratory tested by the Contractor to determine which amendments may need to be incorporated to aid in the establishment of vegetation.

651.07 GRUBBING MATERIAL. Grubbing material shall be placed as shown on the Plans or as directed by the Engineer. Spreading shall not be done when grubbing material is frozen, excessively wet, or otherwise in a condition detrimental to the work, as determined by the Engineer.

The grubbing material shall be spread evenly to a depth of approximately 300 mm (12 inches) or to the depth shown on the Plans. All large stones and other unsuitable material shall be removed from the area.

Grubbing material stockpile areas shall be graded, seeded, and left in a neat and presentable condition. Areas shall be properly drained and all excess or unsuitable materials removed and disposed. This work shall be done to the satisfaction of the Engineer and shall comply with all relevant permits.

Any grubbing material stockpiled for more than one year shall be laboratory tested by the Contractor to determine which amendments may need to be incorporated to aid in the establishment of vegetation.

651.08 SEEDING.

(a) Seed, Limestone and Fertilizer. Seed, limestone, and fertilizer shall be spread uniformly at the rate specified and at the locations shown on the Plans.

Seeding shall not be done when ground is frozen, excessively wet, or otherwise untillable. Seed, limestone, and fertilizer may be applied using a hydraulic application machine (i.e. hydroseeder) or by hand.

Hydroseeding shall consist of mixing and applying seed, lime, commercial fertilizer, stabilizing emulsion, and other materials with water, as specified in the approved Erosion Prevention and Sediment Control Plan.

The quantity of water shall be as needed for application, except that when stabilizing emulsion is specified, the ratio of total water to total stabilizing emulsion in the mixture shall be as recommended by the manufacturer of the emulsion. Mixing of materials for application with hydro-seeding equipment shall be performed in a tank with a built-in continuous agitation system of sufficient operating capacity to produce a homogeneous mixture and a discharge system which will apply the mixture at a continuous and uniform rate. A dispersing agent may be added to the mixture provided the Contractor furnishes evidence that the additive is not harmful. Any material considered harmful, as determined by the Engineer, shall not be used.

When seeding is done by the hydraulic method, liquid lime may be substituted for agricultural limestone at a rate of 4.2 liters (1.1 gallons) of liquid lime to 227 kilograms (500 pounds) of agricultural limestone or at such other rate as recommended by the manufacturer and approved by the Engineer.

Any mixture containing stabilizing emulsion shall not be applied during rainy weather or when soil temperatures are below 5°C (40°F). Pedestrians or equipment shall not be permitted to enter areas where mixtures containing stabilizing emulsion have been applied until vigorous vegetation is established.

Seed sown by hand shall be incorporated into the top ¼ inch of soil by hand raking or other method approved by the Engineer.

Mulching shall occur the same day as the seeding operation.

(b) Mulch. Mulch shall be applied to disturbed areas that have been seeded and require temporary protection until permanent vegetation is established or disturbed areas that must be re-disturbed following an extended period of inactivity.

1. Hay Mulch. Hay mulch shall be applied uniformly, by hand or mechanical blower, over the area at a minimum rate of 4.5 metric tons per hectare (2 tons per acre) or as ordered by the Engineer. Hay mulch shall be anchored by mechanical methods or by applying a tackifier, unless otherwise directed by the Engineer.

   Erosion matting in the form of a biodegradable mesh netting may be applied to reinforce the mulch until turf is established.

   Tackifier may be applied in a liquid or dry powder form using the methods and rates recommended by the manufacturer based on longevitiy and ability to hold fibers in place. To allow tackifier time to cure and bond the hay fibers together and to the soil surface, hay mulch with tackifier shall not be applied during or immediately before rainfall.

2. Hydraulic Mulch Hydraulic mulch consists of applying a fiber mulch or hydraulic matrix with hydro-mulching equipment.

   Fiber mulch shall be mixed in a hydraulic application machine and applied as a liquid slurry in accordance with the manufacturer's specified procedures. Fiber mulch shall be applied from multiple directions and angles to insure complete and proper coverage and only when rainfall is not predicted for at least 12 hours. The resulting coverage must be at least 3 mm (1/8 inch) thick over the entire area.

Hydraulic matrix shall be hydraulically applied to the soil as a viscous mixture, creating a continuous three-dimensional blanket that adheres to the soil surface. Upon drying, the matrix shall form a high-strength, porous, and erosion-resistant mat that shall not inhibit the germination and growth of plants in and beneath the layer. The matrix shall retain its form despite re-wetting. Pedestrians or equipment shall not be permitted to enter areas where mixtures containing stabilizing emulsion have been applied until vigorous vegetation is established.

3. Straw Mulch. Straw mulch shall be applied at the locations and rate indicated in the Plans.

All seeded areas shall be inspected for turf establishment within 14 days of application. Areas not showing signs of sufficient growth shall have seed, limestone, fertilizer, and mulch reapplied at the Contractor's expense.

651.09 SODDING.

(a) Cutting and Transporting. Before cutting sod, the area from which it is to be removed shall be mowed to a height of approximately 50 mm (2 inches) and cleared of excess grass clippings and other foreign material.

The sod shall be cut with an approved sod cutter into strips of uniform width having a minimum dimension of 300 mm (12 inches) in width and 450 mm (18 inches) in length and uniform thickness of approximately 50 mm (2 inches), unless otherwise directed by the Engineer. The sod shall contain the majority of the feeding roots of the grasses.

The sod shall be transported in an unbroken condition to the area to be sodded. Unless otherwise directed by the Engineer, the sod shall be placed in its final position within 48 hours after cutting. When conditions require the sod to be stored, it shall be placed in stacks or piles, grass to grass and roots to roots for not more than five days and shall be protected against drying from sun and wind.

(b) Placing. The sod shall be moist when placed on the prepared surface with the edges in close contact and alternate courses staggered. Any gaps shall be filled with sod plugs or topsoil.

Sod shall be staked (600 mm (2 foot) intervals) on grades greater than 1V:4H and in drainage ditches, unless otherwise directed by the Engineer. In ditches, the sod shall be placed with the longer dimension perpendicular to the flow of water. On slopes, starting at the bottom of the slope, the sod shall be placed with the longer dimension approximately parallel to the bottom of the slope.

The stakes shall be driven center to center in each direction and driven through the sod perpendicular to the surface so that the tops of stakes are flush with the top of the sod.

After installation, sod shall be lightly watered and rolled in order to form tight contact between the sod and the soil grubbings. Sod shall be thoroughly watered within an hour of placing. If any sections of sod turn brown or curl up, these areas are to be carefully cut out and new sod applied and watered, to create a uniform mat and appearance.

651.10 THIS SUBSECTION RESERVED

651.11 CARE DURING CONSTRUCTION. The Contractor shall be responsible for protecting and caring for sodded, seeded, and mulched areas until acceptance of the work. The Contractor shall repair and replace all areas where seed has failed to germinate or sod has failed to grow and any areas damaged by pedestrian or vehicular traffic or other causes at no cost to the Agency, except for conditions covered in Subsection 107.18.

651.12 METHOD OF MEASUREMENT. The quantities of Seed, of the type specified, and Fertilizer to be measured for payment will be the number of kilograms (pounds) for the specified item used in the complete and accepted work, as determined from load tickets furnished to the Engineer. With written permission of the Engineer, the mass (weight) of small quantities may be determined by alternate methods. The Engineer will verify and document such mass (weight) determination.

The quantities of Agricultural Limestone, Hay Mulch, and Straw Mulch to be measured for payment will be the number of metric tons (tons) for the specified item used in the complete and accepted work, as determined from load tickets furnished to the Engineer. When seeding is done by the hydraulic method, liquid lime will be measured for payment in equivalent units of Agricultural Limestone. With written permission of the Engineer, the mass (weight) of small quantities of mulch may be determined by alternate methods. The Engineer will verify and document such mass (weight) determination.

The quantity of Hydraulic Mulch to be measured for payment will be the number of Liters (Gallons) used in the complete and accepted work.

The quantity of Sodding to be measured for payment will be the number of square meters (square yards) of sod used in the complete and accepted work, as determined by using slope measurements.

The quantity of Topsoil to be measured for payment will be the number of cubic meters (cubic yards) including any compost added, used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

The quantity of Grubbing Material to be measured for payment will be the number of square meters (square yards) of grubbing material used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

651.13 BASIS OF PAYMENT. The accepted quantities of Seed, of the type specified, and Fertilizer will be paid for at the Contract unit price per kilogram (pound) for the item specified.

The accepted quantities of Agricultural Limestone, Hay Mulch, and Straw Mulch will be paid for at the Contract unit price per metric ton (ton) for the item specified. Netting and Tackifier shall not be considered for payment and will be considered incidental to the Hay Mulch item.

The accepted quantity of Hydraulic Mulch will be paid for at the Contract unit price per liter (gallon). When hydraulic mulch is not in the Contract hydraulic mulch may be substituted for hay mulch at a rate of 1 unit of hydraulic mulch to 3.1 units of hay mulch or at such other rate as recommended by the manufacturer and approved by the Engineer.

The accepted quantity of Sodding will be paid for at the Contract unit price per square meter (square yard).

The accepted quantity of Topsoil will be paid for at the Contract unit price per cubic meter (cubic yard). Compost will not be paid for separately but will be considered incidental to the Topsoil item.

The accepted quantity of Grubbing Material will be paid for at the Contract unit price per square meter (square yard).

Payment for these items will be full compensation for testing, furnishing, transporting, handling, and placing the material specified, including tackifier when used, and for furnishing all labor, tools, equipment, maintenance, water necessary to promote growth, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
651.15 Seed	Kilogram (Pound)
651.16 Wildflower Seed	Kilogram (Pound)
651.17 Seed, Winter Rye	Kilogram (Pound)
651.18 Fertilizer	Kilogram (Pound)
651.20 Agricultural Limestone	Metric Ton (Ton)
651.25 Hay Mulch	Metric Ton (Ton)
651.28 Hydraulic Mulch	Liter (Gallon)
651.29 Straw Mulch	Metric Ton (Ton)
651.30 Sodding	Square Meter (Square Yard)
651.35 Topsoil	Cubic Meter (Cubic Yard)
651.40 Grubbing Material	Square Meter (Square Yard)

SECTION 653 – EROSION PREVENTION AND SEDIMENT CONTROL MEASURES

653.01 DESCRIPTION. This work shall consist of furnishing, installing, maintaining, removing, and disposing of erosion prevention and sediment control measures in accordance with these Specifications.

653.02 MATERIALS.

Aggregate for Erosion Prevention and Sediment Control	704.17
Vehicle Tracking Pad	704.17(a)
Stone Check Dam, Type I	704.17(b)
Stone Check Dam, Type II	704.17(c)
Inlet Protection Device, Type I	704.17(d)
Geotextile Under Stone Fill	720.02(a)(2)
Prefabricated Check Dam	720.05
Inlet Protection Device, Type II	720.06
Filter Bag	720.07
Topsoil	755.02
Seed	755.04
Fertilizer	755.06
Agricultural Limestone	755.08
Liquid Lime	755.09
Hay Mulch	755.10(a)
Wood Chip Mulch	755.10(b)
Fiber Mulch	755.10(d)
Hydraulic Matrix	755.10(e)
Tackifier	755.10(f)
Temporary Erosion Matting	755.11(a)
Permanent Erosion Matting	755.11(b)
Erosion Logs	755.17
Live Fascines	755.18
Live Stakes	755.19
Brush Layering	755.20

Barrier Fence shall be fluorescent yellow or orange, ultraviolet stabilized, high density polyethylene mesh or grid that will not sag, corrode, rot, or conduct electricity.

Project Demarcation Fence shall be non-adhesive, ultraviolet stabilized, fluorescent yellow or orange vinyl-coated polyester mesh or polyethylene plastic tape that will not sag or tear over time due to natural weather conditions.

653.03 TEMPORARY SOIL STABILIZATION. Temporary soil stabilization methods may include seed, mulch, soil binder, or other methods as approved by the Engineer.

Temporary soil stabilization methods shall be applied to exposed earth within 48 hours of earth disturbance. If vegetation is not established within 21 days seed, mulch, and additional stabilization measures required by the Contract Documents or the Engineer shall be applied at the Contractor's expense.

If vegetation is not established by October 15th, temporary stabilization shall be applied in accordance with the Contract Documents as ordered by the Engineer.

(a) Seed. Seed materials and placement for establishing a temporary vegetative cover on disturbed soil shall be in accordance with Section 651.

(b) Mulch. Mulch materials and placement for establishing a temporary cover on disturbed soil shall be in accordance with Section 651.

(1) Wood Chip Mulch. Wood Chip Mulch consists of applying material generated during tree cutting and clearing operations.

Wood Chip Mulch shall be applied evenly over the disturbed areas to a depth of 25 mm (1 inch).

The Contractor will not be compensated for using wood chip mulch as it is a product of other operations.

(c) Tackifier. Tackifier shall be applied as an ingredient of a dry-applied practice or of a hydraulically-applied practice. Hydraulically applied tackifiers can be used as a stand-alone application of liquid that forms a crust on the soil surface by binding soil particles together; as a tackifying agent over straw or hay mulch as an alternative to crimping; or in combination with hydraulic mulches to create a hydraulic matrix.

Application frequency, rate, and method shall be in accordance with the manufacturer's recommendations based on longevity requirements. Tackifier shall not be applied to saturated soils, frozen soils, areas with standing water, under freezing or rainy conditions, or when the temperature is below 4°C (40° F). The area shall be allowed to cure as recommended by the manufacturer.

Any temporary soil stabilization efforts that are not effectively preventing erosion shall be reapplied or another practice implemented as directed by the Engineer.

653.04 HAY BALES. The Contractor shall install and anchor hay bales as shown in the Contract Documents. Hay bales shall be at least 900 mm (3 feet) in length.

653.05 EROSION MATTING. Temporary erosion matting shall be used to anchor loose mulch and provide temporary erosion control while vegetation is established in those areas where vegetation will provide permanent erosion protection.

Permanent erosion matting shall be used where vegetation will not sustain expected flow conditions or provide sufficient long-term erosion protection. Permanent erosion matting shall provide sufficient thickness and void space to permit soil filling and/or retention to allow for the development of vegetation.

The ground surface shall be shaped to the lines and grades shown on the Plans and shall have a smooth surface free of depressions and eroded areas that would allow water to collect or flow under the matting. The surface shall be cleared of stones, sticks, and other objectionable material that would prevent the matting from maintaining close contact with the ground. Placement of topsoil, fertilizer, seed, and mulch, when required, shall be completed prior to placement of the matting.

After the soil has been properly shaped, fertilized, and seeded the matting shall be placed parallel to the flow of water in channels or vertically on slopes and in direct contact with the soil surface. The Contractor shall not stretch or allow material to bridge over surface inconsistencies. Erosion matting and ground fasteners shall be installed as recommended by the manufacturer for the particular application.

No vehicular traffic of any kind will be permitted over the matting during or after placement. Any torn or damaged material shall be replaced at the Contractor's expense.

The Contractor shall maintain the matted areas until vegetation is established and has been accepted.

653.06 TEMPORARY CHECK DAMS. Temporary check dams shall be constructed and/or installed in the stormwater flow path with the primary purpose of reducing flow velocity and the secondary purpose of allowing sediment to settle out.

(a) Temporary Stone Check Dam, Type I. Temporary Stone Check Dam, Type I shall be designed for placement in a channel. Temporary Stone Check Dam, Type I structures shall be placed on geotextile and shall have a typical height of 600 mm (24 inches). They may vary in height, width, and length depending on site specific conditions. The center shall be at least 150 mm (6 inches) lower than the outside edges and the outside edges shall be a minimum of 150 mm (6 inches) lower than the adjoining banks. The specified configuration will form a spillway or weir at the center for overflow and will prevent water from overflowing onto the roadway or from eroding the banks.

(b) Temporary Stone Check Dam, Type II. Temporary Stone Check Dam, Type II shall be designed for placement along a curb. Temporary Stone Check Dam, Type II structures shall vary in height, width, and length depending on site specific conditions. They shall have a minimum height of 100 mm (4 inches), a minimum width of 150 mm (6 inches) and shall extend 300 mm (1 foot) in a direction perpendicular to the curb and 600 mm (2 feet) up gradient of the curb at an angle ranging from 30 – 60 degrees from the curb face.

(c) Prefabricated Check Dams. Prefabricated check dams shall be installed in accordance with the Contract Documents and the manufacturer's recommendations.

The Contractor shall remove accumulated sediment in accordance with the Contract Documents or as directed by the Engineer, but generally when it reaches half the height of the structure.

653.10 VEHICLE TRACKING PAD. A vehicle tracking pad shall be constructed at each access point between the construction area and all public or private roads. The Contractor shall maintain any existing drainage.

Aggregate for vehicle tracking pad shall be placed on geotextile fabric to reduce the migration of fines through the aggregate.

Vehicle tracking pads shall have a minimum 16 meter (50 foot) length, 3.6 meter (12 foot) width and 200 mm (8 inch) thickness.

Vehicle tracking pads shall be maintained to prevent the aggregate from becoming clogged and resulting in tracking of sediment onto public rights-of-ways. Additional aggregate may be added on top of the existing aggregate only to a point which allows a smooth transition between the road surface and construction area.

When a vehicle tracking pad alone is not capable of preventing tracking of sediment onto the road surface, the Contractor shall take additional steps to remove sediment before vehicles leave the construction area.

653.11 INLET PROTECTION DEVICE. Inlet Protection Devices shall be constructed and installed such that flow is directed through the device and into the inlet.

(a) Inlet Protection Device, Type I. Inlet Protection Device, Type I shall be manufactured in the field as detailed in the Contract Documents. All materials used to construct field manufactured inlet protection devices shall conform to the appropriate Agency material specification or be approved by the Engineer.

(b) Inlet Protection Device, Type II. Inlet Protection Device, Type II shall be pre-fabricated units specifically designed to eliminate sediment from entering a catch basin or drainage inlet. Inlet Protection Device, Type II shall be installed in accordance with the Contract Documents and manufacturer's recommendations.

The Contractor shall remove accumulated sediment from inlet protection devices in accordance with the Contract Documents or as directed by the Engineer.

653.12 FILTER BAG. A filter bag is a device that may be used during dewatering pumping operations. The filter bag shall retain silt, sand, and fines while allowing filtered water to pass through.

Where possible, a filter bag shall be placed a minimum of 50 feet from any waters of the State and on a gradual slope in order that incoming water flows downhill through the bag. To increase the efficiency of filtration the filter bag shall be placed on a coarse aggregate or hay bale bed, unless otherwise directed by the Engineer or specified in the Contract Documents.

The neck of the filter bag shall be strapped tightly to the discharge hose. A filter bag is full when it no longer can efficiently filter sediment or allow water to pass at a reasonable rate. Use of excessive flow rate or overfilling a filter bag with sediment will cause rupture of the bag or failure of the hose attachments.

A filter bag shall be disposed of at an approved location as directed by the Engineer.

653.13 BARRIER FENCE. Barrier Fence shall be installed to enclose archaeologically sensitive areas, existing wetlands or other sensitive resources, for tree protection zones, or as detailed on the Contract Documents as a means for restricting construction activities in these areas and preventing the Contractor and project personnel from entering these areas.

Barrier Fence shall be installed on w-shape steel posts. The fence shall have a minimum height of 1.25 meters (4 feet). The posts shall be embedded a minimum of 600 mm (2 feet) into the ground, shall extend above the fabric, and shall be installed at a 1.5 meter (5 foot) spacing.

The Contractor shall select, inspect, and maintain Barrier Fence in accordance with the Contract Documents or as directed by the Engineer.

653.14 PROJECT DEMARCATION FENCE. Project Demarcation Fence shall be installed as shown on the Contract Documents as a visible barrier beyond which there shall be no construction activity by the Contractor or project personnel.

Project Demarcation Fence shall be installed on hardwood stakes and shall have a minimum width of 75 mm (3 inches). The stakes shall be 25 mm x 25 mm x 1220 mm (1 inch x 1 inch x 4 feet), shall be embedded 300 mm (1 foot) into the ground, shall extend above the fabric, and shall be installed at a 3 meter (10 foot) spacing.

The Contractor shall select, inspect, and maintain Project Demarcation Fence in accordance with the Contract Documents or as directed by the Engineer.

653.15 BIOTECHNICAL SLOPE PROTECTION. Biotechnical slope protection measures shall consist of both structural or mechanical and vegetative elements working together to stabilize a site specific condition. The measures shall be installed to stabilize slopes by slowing water movement down slope, increasing infiltration, trapping sediment, and increasing soil stability with root systems.

(a) Erosion Logs. Erosion logs shall be installed along the toe, top, face, and at grade breaks of exposed and erodible slopes and along stream banks as a base for plantings. Erosion logs may also be used as check dams in unlined ditches and for drain inlet protection where approved.

Erosion logs shall be secured adequately to prevent displacement as a result of normal rain events and such that flow is not allowed under the log. Multiple logs shall be overlapped instead of abutting end to end. Rows shall be spaced as shown on the Contract Documents.

(b) Live Fascines. Live fascines shall be installed on sloping areas such as roadway cuts and fills, slumped areas, and streambanks subject to erosion, seepage, or weathering. Slopes must be 1:1 or flatter.

Live fascines shall be made by forming bundles 2.5 to 4.5 meters (8 to 15 feet) long, 100 mm (4 inches) minimum in diameter, from stems no more than 25 mm (1 inch) in diameter.

Fascines shall be placed in a shallow trench and covered with soil in order that 10% of the fascine is left exposed. Fascines shall be anchored with stakes spaced 600 mm (2 feet) apart. Fascines shall be overlapped a minimum of 300 mm (1 foot) at the tapered ends. Rows shall be spaced as shown on the Contract Documents.

(c) Live Stakes. Live stakes shall be installed for repair of small earth slips and slumps and for stabilizing raw streambanks.

Live stakes shall be 25 to 50 mm (1 to 2 inches) in diameter and 600 mm to 1.8 m (2 to 6 feet) long, depending on site application. If placed in stone fill, at least half the length of the stake shall be inserted into the soil below the stone. A minimum 50 to 100 mm (2 to 4 inches) of the stake and two live buds shall be left exposed.

Live stakes shall be installed using methods described in the Contract Documents and approved by the Engineer.

(d) Brush Layering. Brush layering shall be installed to stabilize slope areas above the flow line of streambanks and cut and fill slopes up to 1:2 (vertical: horizontal) in steepness and 6 meters (20 feet) in height.

Brush layer cuttings shall be from dormant plants and shall be 12 to 50 mm (½ to 2 inches) in diameter. The cuttings shall be long enough to contact the back of the bench on which they are placed with the growing tips protruding out of the slope face.

Benches shall be 600 to 900 mm (2 to 3 feet) deep with the surface angled so the front edge is slightly higher than the back. Cuttings shall be placed on the bench in a crisscross or overlapping configuration in layers 75 to 100 mm (3 to 4 inches) thick. Backfill shall be placed on top of the cuttings and tamped in 150 mm (6 inch) lifts.

Areas between biotechnical slope protection measures shall be stabilized with seed in accordance with Section 651 or as approved by the Engineer.

653.16 METHOD OF MEASURMENT. The quantity of Tackifier to be measured for payment will be the number of liters (gallons) used in the complete and accepted work. When used with mulch, Tackifier shall not be considered for payment and will be considered incidental to the item Hay Mulch.

The quantity of Hay Bales to be measured for payment will be the number of hay bales used in the complete and accepted work.

The quantity of Temporary and Permanent Erosion Matting to be measured for payment will be the number of square meters (square yards) used in the complete and accepted work, as measured in its final position using slope measurements for determining area.

The quantity of Temporary Stone Check Dam of the Type specified to be measured for payment will be the number of cubic meters (cubic yards) of the stone specified used in the complete and accepted work.

The quantity of Prefabricated Check Dam to be measured for payment will be on a per unit basis for each Prefabricated Check Dam used in the complete and accepted work.

The quantity of Vehicle Tracking Pad to be measured for payment will be the number of cubic meters (cubic yards) of stone specified used in the complete and accepted work.

The quantity of Inlet Protection Device of the Type specified to be measured for payment will be on a per unit basis for each Inlet Protection Device used in the complete and accepted work.

The quantity of Filter Bag to be measured for payment will be on a per unit basis for each Filter Bag used in the complete and accepted work.

The quantity of Barrier Fence and Project Demarcation Fence to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work.

The quantity of Erosion Log, Live Fascine, and Brush Layering to be measured for payment will be the number of meters (linear feet) used in the complete and accepted work.

The quantity of Live Stake to be measured for payment will be on a per unit basis for each Live Stake used in the complete and accepted work.

653.17 BASIS OF PAYMENT. The accepted quantities of erosion prevention and sediment control measures will be paid for at the Contract unit price specified for each item. Payment shall be full compensation for furnishing, transporting, handling, placing, and removing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Geotextile, culvert, or any other items necessary to complete the work shall be considered incidental to the appropriate Contract item.

Unless otherwise specified in the Contract, payment for the maintenance of erosion prevention and sediment control measures will be incidental to the specific Contract item.

Pay Item	Pay Unit
653.10 Tackifier	Liter (Gallon)
653.15 Hay Bales	Each
653.20 Temporary Erosion Matting	Square Meter (Square Yard)
653.21 Permanent Erosion Matting	Square Meter (Square Yard)
653.25 Temporary Stone Check Dam, Type I	Cubic Meter (Cubic Yard)
653.26 Temporary Stone Check Dam, Type II	Cubic Meter (Cubic Yard)
653.30 Prefabricated Check Dam	Each
653.35 Vehicle Tracking Pad	Cubic Meter (Cubic Yard)
653.40 Inlet Protection Device, Type I	Each
653.41 Inlet Protection Device, Type II	Each
653.45 Filter Bag	Each
653.50 Barrier Fence	Meter (Linear Foot)
653.55 Project Demarcation Fence	Meter (Linear Foot)
653.60 Erosion Log	Meter (Linear Foot)
653.65 Live Fascine	Meter (Linear Foot)
653.70 Live Stake	Each
653.75 Brush Layering	Meter (Linear Foot)

SECTION 656 - PLANTING TREES, SHRUBS, AND VINES

656.01 DESCRIPTION. This work shall consist of furnishing, transporting, planting, and transplanting various size trees, shrubs, vines, perennials, and ground cover plants.

656.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Barrier Fence	727.03
Water	745.01
Landscape Backfill	755.01
Topsoil	755.02
Compost	755.05
Fertilizer	755.06
Mycorrhizal Fungi Product	755.07
Wood Chip Mulch	755.10(b)
Bark Mulch	755.10(c)
Plant Materials	755.12
Antidesiccant	755.13
Wire Rodent Guards	755.14
Tree Watering Bags	755.16

When weed separator fabrics are required, the separator fabric used shall be one of the separator fabrics and the necessary associated materials on the Approved Products List on file and maintained by the Agency's Materials and Research Section.

656.03 PLANTING SEASON. For best results, the initial planting should be accomplished between April 1st and June 30th. Fall planting will only be allowed between August 15th and October 15th unless otherwise shown on the Plans or directed by the Engineer. Fall planting for deciduous trees is not allowed.

No planting shall be done in frozen ground, when snow covers the ground, or when the soil or weather is determined to be unsatisfactory for planting.

656.04 INSPECTION AND DELIVERY. Plants transported in 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 Engineer will make a preliminary inspection of all plants at the time of delivery on the project. Trees with multiple leaders will be rejected unless otherwise specified in the Contract. Trees with damaged or crooked leaders, bark abrasions, sun scald, disfiguring knots, insect damage, or cuts of limbs over 20 mm (¾ inch) in diameter that are not completely closed will be rejected. Container grown plants that have stem girdling roots will be rejected. Balled and burlapped trees and shrubs with excessive soil on top of the root flare and an otherwise minimal root ball will be rejected.

Substitutions of plant materials will not be permitted unless authorized in writing by the Engineer. Plant substitutions shall be either the nearest available size of that variety or a similar variety with comparable form and function.

A more thorough inspection will be performed just prior to planting. Only those plants that have received this inspection and have been approved for planting shall be planted.

656.05 PROTECTION AND TEMPORARY STORAGE. The Contractor shall keep all plant material moist and protected from drying out. Temporary storage shall be limited to 45 days from the time of delivery. Plants shall be protected when in transit, in temporary storage, or on the project site awaiting planting.

The Contractor shall exercise the utmost care in loading, unloading, and handling of plants to prevent injuries to the branches or to the roots of the plants. The solidity of balled and burlapped plants shall be carefully preserved.

Plants delivered but not scheduled for immediate planting shall be protected as follows:

(a) Bare root materials that are not planted immediately upon receipt shall have the bundles opened, the plants separated and heeled-in in moist soil so as to leave no air spaces and shall be properly maintained until planted.

(b) Balled and burlapped plants which are not scheduled for planting within 48 hours shall be kept in a moist condition and protected adequately by covering the earth balls with topsoil, wood chips, or other suitable material until removed for planting.

Failure to manage the storage of plant material as specified herein may be cause for rejection.

656.06 LAYOUT. Plant material locations and bed outlines shall be staked by the Contractor and approved by the Engineer.

656.07 EXCAVATION. Prior to excavating for plant pits and beds, the area shall conform to the lines and grades shown on the Plans. All sod, weeds, roots, and other objectionable material unsuitable for backfill shall be removed from the site and disposed of by the Contractor in a manner satisfactory to the Engineer.

The size of plant pits shall bear the following relation to the root spread (or diameter of balls) of the plants to be planted in them: The pit diameters shall be three times the root spread diameter. The pit depth shall be the distance from root flare to bottom of root ball. The pits shall be only deep enough to expose the root flare.

Pits for vines and perennials shall be approximately 450 mm (18 inches) in diameter by 300 mm (12 inches) deep.

Bare root, non-containerized seedlings or transplants may be planted in the existing soil. Plant holes shall be deep enough to allow room for the full depth of the root without doubling or folding and wide enough to allow room for its normal spread.

656.08 SETTING PLANTS.

The Contractor shall determine the depth of the main order roots in the rootball before placing the plant in the planting pit by loosening the twine and burlap from the stem and the top one half of the ball. Excess soil on top of the root ball above the root flare or main order roots shall be carefully removed. The depth of the pit shall be adjusted accordingly in order that the main order roots are at or slightly above finish grade. The Contractor shall avoid planting the plant too deep.
All plants shall be moved with the root ball intact, using mechanical methods if needed. If the root ball has been badly cracked or broken, the plant shall be rejected for use.

Plants must be set plumb on all terrain. Soil must be firmly compacted around the roots, leaving no air pockets; a 75 mm (3 inch) diameter and continuous rim for shrubs and 100 mm (4 inch) for trees located at the drip edge of each plant shall form a saucer to retain water.

(a) Bare Root Plants (BR). Bare root plants shall be placed in the center of the plant pit and the roots properly spread out in a natural position. All broken or damaged roots shall be cleanly cut back to sound root growth.

Landscape Backfill shall be carefully worked around and over the roots and be thoroughly and properly tamped. Thorough watering shall accompany backfill around bare root plants.

(b) Balled and Burlapped Plants (B & B). Balled and burlapped plants shall be carefully placed in prepared pits on the required depth of tamped Landscape Backfill so as to rest in a firm, upright position. Plants shall be handled and moved only by the ball. They shall be planted as follows:

(1) Plants Balled in Synthetic Material. Once positioned in the pit, the synthetic covering shall be totally removed. Previously treated burlap shall also be removed.

(2) Plants Balled in Hemp Burlap/Wire Baskets. Once positioned in the pit, all ropes and burlap shall be cut and removed from around the root ball and the stem of the plant. If the plant is balled in a wire basket, once the plant is positioned in the pit, the wire basket shall be cut and the top 2/3 of the basket removed.

Landscape Backfill shall be filled in around the plant ball to 50 percent of the depth of the ball and then tamped. The remainder shall then be placed and tamped.

(c) Containerized Plants. Containerized plants including seedlings, ground covers and vines, perennials, and tubelings shall be planted in accordance with the “American Standard for Nursery Stock” (ANSI Z-60.1 latest edition) published by the American Association of Nurserymen (AAN).

(d) Transplanted Plants. Transplanted plants shall be set in accordance with the requirements of either part (a) or (b) of this Subsection, as appropriate.

(e) Fertilizer and Mycorrhizal Fungi. The use of fertilizer and mycorrhizal fungi shall be as specified in the Contract Documents or as directed by the Engineer. Fertilizer shall be a slow release variety, cultivated into the top 50 mm (2 inches) of the plant pit area or shrub bed within five days after planting. No fertilizer shall be applied to seedlings or during a fall planting. Mycorrhizal fungi shall be applied in accordance with the manufacturer’s specifications.

The rates of fertilizer application shall be approximately as follows:

Trees:	40 g/mm (32 ounces/inch) of caliper
Shrubs and Evergreens:	400 g/m (4 ounces/foot) of height or spread
Vines:	50 g/vine (2 ounces/vine)

(f) Watering. All plant material shall be watered thoroughly at planting. Unless otherwise specified, the minimum interval for watering during the establishment period shall be twice weekly. At each watering, the soil around the plant shall be thoroughly saturated. The time interval between waterings may be increased or decreased by the Engineer to maintain adequate moisture levels. Trees shall receive a minimum of 40 L (10 gallons) at each watering, shrubs a minimum of 20 L (5 gallons) and vines and plants a minimum of 10 L (3 gallons). Natural rainfall of 25 mm (1 inch) per week shall be equivalent to the amount of water specified above.

Tree watering bags may be utilized as approved by the Engineer. The installation and maintenance of the bags shall be in accordance with the manufacturer's recommendations. The bags shall be removed by the Contractor after final inspection. Replacement of watering bags during the establishment period shall be the responsibility of the Contractor.

The Contractor shall provide to the Engineer a weekly log to account for the frequency and amount of watering during the establishment period. When natural rainfall occurs the amount shall be noted in the log as measured on site or noted by the U.S. Weather Service.

(g) Guys and Stakes. Trees shall be guyed and staked as shown on the Plans as soon as planting is completed.

Support posts may be required instead of guys and stakes when ordered by the Engineer.

Stakes, support posts, and deadmen shall be sound new hardwood, treated softwood, or redwood that is free of knots, knot holes, and other defects.

Guys shall prevent lateral deflection of the supported plant. The type of guy shall be approved by the Engineer prior to installation. Guys and stakes shall be removed prior to final acceptance.

The Contractor shall provide rubber or soft plastic hose of a green color to provide protection for guyed trees from the wire. This hose shall be a minimum of 13 mm (1/2 inch) in diameter and long enough to provide full protection. The hose shall be of the same material and the same color for all guyed trees. Guyed trees shall have a minimum of three guys per tree, unless otherwise shown on the Plans or directed by the Engineer.

(h) Antidesiccant Spray. When the Plans indicate the use of antidesiccant spray, it shall be applied in accordance with the manufacturer's recommendations. A second spraying shall be applied prior to winter or as directed by the Engineer.

(i) Pruning. All broken, injured, or damaged branches shall be pruned before or immediately after planting in such a manner as to preserve the natural character of each plant. All pruning shall be performed by experienced personnel with proper equipment and in keeping with accepted horticultural practice.

(j) Mulching. Bark mulch material shall be applied as detailed in the Contract. Wood chip mulch shall not be used. The same type of material shall be used in all areas to provide visual uniformity.

(k) Wire Rodent Guards. Wire rodent guards may be used at the Contractor's option. If used, wire rodent guards shall be removed prior to final acceptance.

(l) Weed Separator Fabric. Weed separator fabric shall be installed on the prepared top surface of the planting bed during the planting procedure as shown on the Plans. The fabric shall extend to the edges of the plant pit and shall be closely fitted around the trunks or stems of the plants, unless otherwise shown on the Plans or directed by the Engineer. Small plants may be inserted through the fabric by making cuts of sufficient size in the fabric to allow planting. Fabric patches may be required over the cuts to ensure coverage.

The fabric shall be covered with a minimum of 100 mm (4 inches) of bark mulch, unless otherwise shown on the Plans or directed by the Engineer.

(m) Restoration and Maintenance. The Contractor shall restore all seeded and grassed areas outside the planting areas that were disturbed by the planting operations at no cost to the State.

All debris, excess excavation, and other objectionable material shall be removed and disposed of as directed by the Engineer.

The Contractor shall actively maintain the plants immediately after planting. Plants shall be pruned and/or cultivated, as appropriate. All mulched areas shall be kept weeded, neat, and maintained to the original layout lines. Stakes, support posts, and deadmen shall be restored or replaced as necessary and guys adjusted as necessary. Weed separator fabric and tree wrappings shall be restored or replaced as necessary and basins and saucers shall be repaired to hold water.

If the Contractor feels that spraying of the plant materials and mulched areas is necessary to prevent damage from insects or plant diseases, the material, application rate, number of applications and any other data pertinent to the spraying shall be submitted to the Engineer for approval. The submittal shall also include a letter from the Vermont Department of Agriculture approving the spraying.

(n) Establishment Period. The Contractor shall properly maintain all planted trees, shrubs, vines, plants, and ground cover until final planting by necessary watering, weeding, fertilizing, spraying with approved insecticides or fungicides, providing protection from rodents and other work necessary to keep plants in living healthy condition. Any plants damaged, dried out, or otherwise in poor condition shall be replaced in kind with healthy stock at the Contractor's expense.

Approximately four to six months following the first planting, the Engineer and Contractor shall inspect the planted material and any dead, dying, or damaged material shall be replaced by the Contractor. This second planting shall be completed within 30 days after inspection or as directed by the Engineer.

The planted material shall be inspected again by the Engineer and Contractor approximately four to six months following the second planting and any dead, dying, or damaged material found at the time shall be replaced by the Contractor. This final planting shall be completed within 30 days of the inspection.

The initial, second, and final plantings shall be in accordance with Subsection 656.03.

656.09 TRANSPLANTING. Transplanting shall be done in accordance with Subsection 656.08 or as ordered by the Engineer.

Transplanted plant materials shall be maintained during establishment in accordance with Subsection 656.08, except that on projects where only transplanting of existing plant materials is performed, the establishment period shall end on the Contract Acceptance Date.

656.10 TREE PROTECTION. The purpose of this item is to prevent damage to branches, stems, and root systems of existing individual trees to remain and to ensure their survival. Provisions under this item include steps to minimize soil and root disturbance and to construct protection measures for trees close to construction areas. The Contractor shall install barrier fence to the drip line of existing trees or shrubs marked either "Save" or "Protect" or shown with a Tree Protection Zone (TPZ) on the Plans prior to any earth disturbance; barrier fence shall not be removed until the final project inspection. There will be no activity within the TPZ or the drip line of the tree except watering or installation of erosion prevention or sediment control measures where required. Tree protection methods and schedule of work shall be approved by the Engineer.

The following protection procedure shall apply when excavation is to be performed near trees or shrubs labeled "Save" or "Protect" or shown with a TPZ on the Plans:

1. Care shall be taken to avoid breaking tree limbs and branches with construction equipment. Prior to construction, tree limbs of trees identified for protection and any other trees identified by the Engineer shall be pruned by a qualified tree service.

2. Roots encountered during excavation work in the vicinity of a TPZ area, shall be cleanly cut with no tearing of roots. Exposed tree roots shall be protected by a double layer of dampened burlap at all times until they can be covered with soil, at which time the dampened burlap shall be removed. Following excavation and during the construction season, water shall be provided to impacted trees at a minimum of 10 liters (2.5 gallons) per week, per 25 mm (1 inch) caliper or as directed by the Engineer. The Contractor shall provide a log to document watering and natural rainfall to the Engineer.

If a tree is damaged due to the Contractor's negligence and determined to be non-repairable by the Engineer, the Contractor shall replace it at no additional cost to the Agency with a tree of equal value, or two or more trees with a total value equal to that of the damaged tree, using the trunk formula method of appraisal established by the International Society of Arboriculture.

656.11 METHOD OF MEASUREMENT. The quantity of Seedlings, Trees, Shrubs, Ground Covers and Vines, Perennials, and Tubelings to be measured for payment will be the number of each of the specified types and sizes furnished and planted or transplanted in the complete and accepted work, with the exception of Transplanting Groundcover, which will be measured by the square meter (square yard). Only living plants in healthy condition at the time of final inspection will be accepted.

The quantity of Landscape Watering to be measured for payment will be the number of cubic meters (1000 gallons) of water used in the complete and accepted work. The Contractor shall provide a written log meeting the approval of the Engineer for measuring the quantity of water applied.

The quantity of Landscape Backfill, Truck Measurement to be measured for payment will be the number of cubic meters (cubic yards) used in the complete and accepted work, as determined by vehicle loads using three-dimensional measurement. All loads designated shall be leveled at the point of delivery when directed by the Engineer. A load ticket shall be furnished to the Engineer with each load delivered to the job site.

The quantity of Tree Protection to be measured for payment will be on a lump sum basis in the complete and accepted work.

656.12 BASIS OF PAYMENT. The accepted quantity of Seedlings, Trees, Shrubs, Ground Covers and Vines, Perennials, and Tubelings will be paid for at the Contract unit price each for the specified types and sizes and kinds for planting or transplanting, with the exception of Transplanting Groundcover, which will be paid for at the Contract unit price per square meter (square yard). All Seedlings, Trees, Shrubs, Ground Covers and Vines, Perennials, and Tubelings that have died, failed to grow, or otherwise have proven unsatisfactory to the Engineer during the establishment period shall be replaced with healthy stock of the same type or approved substitute at the Contractor's expense.

Payment will be made as follows:

(a) 80 percent of the Contract unit price after the first planting;

(b) 10 percent of the Contract unit price after the second planting;

(c) 5 percent of the Contract unit price after the final planting; and

(d) The remaining percentage of the Contract unit price after the Acceptance Date.

Payment for these items will be full compensation for testing, furnishing, transporting, handling, and placing plants, fertilizer, mycorrhizal fungi, mulch, and all incidental materials; for excavation, pruning, guying and staking, mulching, wire rodent guards, water basin formation, cleanup, and plant maintenance establishment work and care including replacement; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work. Weed separator fabric, water bags, or any other item necessary to complete the work will be considered incidental to the appropriate Contract items.

The accepted quantity of Landscape Watering will be paid for at the Contract unit price per cubic meter (1000 gallons). When the Landscape Watering item is not specified as a separate pay item in the Contract, water applied during the plant establishment period will not be paid for directly, but will be considered incidental to the other Section 656 items in the Contract. Water bags, when specified in the Contract, will not be paid for directly but will be considered incidental to Landscape Watering.

The accepted quantity of Landscape Backfill, Truck Measurement will be paid for at the Contract unit price per cubic meter (cubic yard). Payment will be full compensation for furnishing, mixing, testing, transporting, and placing the material specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Tree Protection will be paid for at the Contract lump sum price. Payment will be compensation for all tree protection measures including barrier fence, branch and root pruning, watering, and all incidentals necessary to complete the work.

Partial payments will be made as follows:

(a) The first payment of 25 percent of the lump sum price will be paid upon installation of all required barrier fence;

(b) The second payment of 50 percent of the lump sum price will be paid upon completion of 50 percent of the work under the Contract;

(c) The third payment of 25 percent of the lump sum price will be paid upon removal of all barrier fence.

The project will not be accepted until the replacement of all dead, dying, or poorly growing material has been completed to the satisfaction of the Engineer.

Payment will be made under:

Pay Item	Pay Unit
656.15 Evergreen Seedlings	Each
656.16 Deciduous Seedlings	Each
656.20 Evergreen Trees	Each
656.25 Evergreen Shrubs	Each
656.30 Deciduous Trees	Each
656.35 Deciduous Shrubs	Each
656.40 Ground Covers and Vines	Each
656.41 Perennials	Each
656.42 Tubelings	Each
656.45 Transplanting Trees	Each
656.50 Transplanting Shrubs	Each
656.55 Transplanting Groundcover	Square Meter (Square Yard)
656.65 Landscape Watering	Cubic Meter (Thousand Gallons)
656.80 Landscape Backfill, Truck Measurement	Cubic Meter (Cubic Yard)
656.85 Tree Protection	Lump Sum

SECTION 675 - TRAFFIC SIGNS

675.01 DESCRIPTION. This work shall consist of furnishing and installing traffic signs, removing existing signs, installing salvaged signs, and overlaying existing signs.

675.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Paint for Traffic Signs	708.06
Bar Reinforcement	713.01
Sign Posts	750.01
Extruded Aluminum Panels	750.02
Flat Sheet Aluminum	750.03
High Density Overlaid Plywood	750.06
Acrylic Plastic Reflectors	750.07
Retroreflective Sheeting	750.08
Demountable Characters	750.09
Plastic Lettering Film	750.10
Extruded Aluminum Molding	750.11
Assembly Hardware	750.12

All traffic signs shall conform to the requirements of the Contract and the latest edition of the MUTCD.

If the Contract does not specify a particular type of sign material, the Contractor may furnish any one of the following materials:

(a) Type A sign with an area 2 m^2 (20 ft^2) or less:

(1) Flat sheet aluminum.

(2) Extruded aluminum panels (if attached to a Type B sign).

(b) Type B sign with an area greater than 2 m^2 (20 ft^2):

(1) Extruded aluminum panels.

(2) High density overlaid plywood.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All new signs installed shall be marked on the back with the following information:

Examples	
(State) or (Town)	VAOT Swanton
Month and Year of Sign Fabrication	01/00 09/85
Route Where Sign Installed	US 5 TH 13

The letters and numbers of the text shall be 25 mm (1 inch) high.

Either stick-on letters and numbers or silk-screened letters and numbers will be allowed as long as they are applied in such a way that they remain intact during the life of the sign. If stick-on letters and numbers are used, all letters and numbers to be placed on a sign shall come from the same stick-on sheet. Individual stick-on letters or numbers will not be allowed.

675.03 EXTRUDED ALUMINUM PANELS. Extruded aluminum panels shall be of the butting type, 300 mm (12 inches) wide and of the lengths shown on the Plans. The moment of inertia of a panel shall not be less than 318 500 mm^4 (0.765 $inch^4$), and shall be designed to carry a wind load of 1.44 kPa (30 psf).

All signs fabricated from extruded aluminum panels shall have extruded aluminum molding on the two vertical sides. The color shall be the same as the parent sign.

Fabrication, including punching or drilling holes and cutting to length, shall be completed prior to metal degreasing, treating, and application of the background material. Cut edges shall be true and smooth and free from burrs. Flame cutting will not be permitted. Bolt holes may be drilled to finished size or punched to finished size provided the diameter of the punched hole is at least twice the thickness of the metal being punched. The surface of all panels shall be flat and free of defects. The panels shall be fabricated for horizontal mounting. Each panel shall extend the full width of a sign and shall be bolted at least every 600 mm (24 inches) to each adjacent panel.

If a Type A sign is attached to or part of a Type B sign, it shall be fabricated from extruded aluminum panels.

675.04 FLAT SHEET ALUMINUM. Fabrication of the flat aluminum sheets, including cutting to size, bending, and punching or drilling holes and the welding of reinforcing or stiffening members, if any are required, shall be completed prior to degreasing, etching, or treating, and application of the background material. Material may be sheared, blanked, sawed, or milled. Cut edges shall be true and smooth and free from burrs. No flame cutting will be permitted. The surface of all sign faces shall be flat and free of buckles, warp, dents, burrs, or other defects.

675.05 HIGH DENSITY OVERLAID PLYWOOD. Fabrication of plywood sign blanks, including drilling holes and cutting to size, shall be completed prior to the application of retroreflective sheeting. Plywood sign blanks shall be cut to shape and size using a saw blade that does not tear the plywood grain. Holes shall be 11 mm (7/16 inch) in diameter, clean cut, and uniform. When cut to size and shape, the sign blanks shall be free of warping, open checks, open splits, open joints, open cracks, loose knots, and other defects. The surfaces of all sign blanks shall be flat.

All edges and holes shall be thoroughly sealed with exterior aluminum paint meeting the approval of the Engineer. The paint shall contain at least 30 percent solids (aluminum powder) by volume. After sealing, the edges and interior of the holes shall be painted with one coat of enamel primer followed by one coat of exterior black sign enamel. After a sign has been installed, the edges shall be resealed and repainted if ordered by the Engineer.

The color of the plywood used for the sign base material may be either natural or black. When of natural color, the edges and back of the sign blank shall be painted with one coat of enamel primer followed by one coat of exterior black sign enamel. Before applying the first coat, the surface shall be cleaned with an approved solvent, abraded lightly with fine sandpaper or steel wool and wiped clean.

675.06 THIS SUBSECTION RESERVED

675.07 THIS SUBSECTION RESERVED

675.08 THIS SUBSECTION RESERVED

675.09 APPLICATION OF RETROREFLECTIVE SHEETING. Retroreflective sheeting shall be of the color shown on the Plans. The face of a sign shall be completely covered by the retroreflective sheeting when used as a background. All panels of a multi-panel sign shall be of uniform background color and brilliance both day and night.

Before application of the retroreflective sheeting, the sign face shall be cleaned, degreased, coated, treated, and etched or abraded in accordance with standard commercial processes for the sign base material involved. The faces shall be dried by use of a forced hot-air drier and shall not be handled except by device or clean canvas gloves between all cleaning operations and application of the retroreflective sheeting. There shall be no opportunity for the sign faces to come in contact with greases, oils, or other contaminants prior to the application of the retroreflective sheeting.

Retroreflective sheeting shall be applied to the face of an extruded aluminum panel by a squeeze roller applicator. Retroreflective sheeting shall be applied to flat sheet aluminum, embossed letter frames, and high density overlaid plywood by vacuum heat applicator at 95 ºC (200 ºF), or by squeeze roller applicator. After aging 48 hours at 20 ºC (68 ºF), adhesion of the retroreflective sheeting to the sign surface shall be strong enough to resist stripping when tested with a stiff putty knife.

Retroreflective sheeting having a solvent or heat-activated adhesive shall be completely covered with a clear coating. Retroreflective sheeting with a pressure sensitive adhesive shall be edge sealed with a clear coating. When plastic lettering film or retroreflective sheeting or lettering paint is used for the sign text, the clear coating shall be applied only after the entire text is in place on the retroreflective sheeting.

675.10 TRANSPORTATION AND HANDLING. Sign materials and finished signs shall be handled at all times so as to prevent damage or disfigurement. Damaged signs shall be rejected.

675.11 ERECTION OF SIGN POSTS AND FOUNDATIONS. Signs shall be installed at the locations shown on the Plans or directed by the Engineer. In erecting the sign posts, the materials, methods, and installation procedures shown on the Plans shall be followed, unless otherwise directed by the Engineer.

When a post is set in a concrete footing, the post shall be placed in position and plumbed and braced before the footing is constructed. The type of footing, materials used, and method of construction shall be as shown on the Plans. Care shall be taken during construction of the footing to preserve the setting of the post. When aluminum posts are used, the area to be in contact with concrete shall be treated with one coat of an approved sealer paint. The sealer shall be allowed to dry thoroughly before installing the post.

When a breakaway-type galvanized steel post on a concrete footing is to be used, the post stub section, with or without the upper post section attached, shall be set carefully in the foundation hole and held in place by an approved form or template before the concrete for the footing is placed. The stub post sections shall be so positioned that the projection above finished grade is as shown on the Plans. The shear plates shall be so positioned that when the upper post section is attached, using shims as required, the upper post section shall be vertical and properly oriented with the roadway. The upper post section shall be attached to the stub post section by bolts using procedures as shown on the Plans. With all supporting form work removed from the posts, the bolts shall be tightened as shown on the Plans. Springing or raking of posts to secure proper alignment will not be permitted.

The forms and templates supporting the posts shall not be removed, and a sign shall not be mounted on the posts, until the concrete has cured.

Sign posts shall be installed so that the sign face is oriented as shown on the Plans.

When two or more posts are used to support a single sign, the flanges to which the sign will be fastened shall be in the same plane and the tops of the posts shall be at the same elevation.

When a post does not require a concrete footing, it may either be driven or placed in a hole carefully dug to the depth shown on the Plans. The post shall be plumbed and set so that the sign will face in the proper direction. The hole shall be backfilled with suitable material approved by the Engineer. The backfill shall be placed in layers of not more than 150 mm (6 inches) and thoroughly compacted by the use of an air or mechanical tamper. Care shall be taken in placing and tamping the backfill to preserve the setting of the post.

675.12 MOUNTING OF SIGNS. After the post or posts required for a sign have been erected, the sign shall be mounted as shown on the Plans. A sign shall be mounted tightly to the post or posts, or to the horizontal supporting members if shown on the Plans.

Horizontal and vertical supporting members required to hold together the separate panels forming a multi-panel sign and to attach the sign to the posts, shall be either standard steel or aluminum structural shapes meeting the same requirements as for sign posts and shall conform to the designs shown on the Plans. After a multi-panel sign is mounted, the individual panels shall be joined together as shown on the Plans to ensure a smooth, flat sign face free of deflection.

675.13 REMOVING SIGNS. The Contractor shall remove and salvage signs, posts, and overhead supports and remove foundations and posts, if any, as shown on the Plans or indicated in the Contract. All salvaged signs shall be carefully separated from the posts and/or frames on which they are mounted.

Unless otherwise specified, the signs, supports, mounting frames, and posts shall remain the property of the Agency and shall be carefully removed, separated, transported, and stockpiled at locations specified in the Contract or as ordered by the Engineer. All salvaged mounting hardware shall be placed in separate covered pails and labeled as to contents with a permanent label.

Foundations shall be removed to a depth of at least 300 mm (12 inches) below the ground surface and the unsuitable material disposed of as directed by the Engineer. The resulting holes and post holes from which posts are removed shall be backfilled with suitable material and the area restored to a condition similar to that of the adjacent area.

675.14 ERECTING SALVAGED SIGNS. The specified salvaged signs shall be transported from their stockpiled location and erected on posts at the locations shown on the Plans. The same care in handling, transporting, and erecting new signs shall be exercised for salvaged signs. Attaching devices shall be repositioned or new ones furnished as necessary. Any new material required shall be furnished by the Contractor. Material and erection requirements shall be in accordance with the applicable requirements of this Section.

After erection, the signs shall be washed to remove dirt, grease, and other foreign material to the satisfaction of the Engineer.

675.15 SETTING SALVAGED POSTS. When specified, salvaged sign posts of the type required shall be transported from the stockpiled location and erected on new foundations or placed in holes at the locations shown on the Plans.

The same care in transporting and erecting the new posts shall be exercised for salvaged posts.

The fastening devices, including bolts, nuts, and washers, shall be furnished as necessary for the erection of the posts.

Material and erection requirements shall be in accordance with the applicable requirements of this Section.

675.16 MODIFYING SIGN POSTS. The Contractor shall modify the existing sign posts as shown on the Plans. Posts shall be removed and re-erected where applicable.

675.17 METHOD OF MEASUREMENT. The quantity of Traffic Sign to be measured for payment will be the number of square meters (square feet) of the type specified, installed in the complete and accepted work.

The quantity of Flanged Channel Sign Post to be measured for payment will be the actual measured meters (linear feet) from the tops of the posts to the bottom of the posts, installed in the complete and accepted work. No added measurement will be made for required anchors, sleeves, and overlaps.

The quantity of Square Tube Sign Post and Anchor to be measured for payment will be the actual measured meters (linear feet) from the tops of the posts to the bottom of the anchors, installed in the complete and accepted work. No added measurement will be made for required sleeves and overlaps.

The quantity of other traffic Sign Posts to be measured for payment will be the number of kilograms (pounds) of each type of post installed in the complete and accepted work, as determined by the lengths and the standard mass per meter (weight per linear foot) of the specified material.

The quantity of Foundations, Erecting Salvaged Signs, Setting Salvaged Posts, and Modifying Sign Posts to be measured for payment will be the number of each installed in the complete and accepted work.

The quantity for Removing Signs to be measured for payment will be the number of signs removed in the complete and accepted work.

675.18 BASIS OF PAYMENT. The accepted quantities of the specified Contract items will be paid for at their respective Contract unit prices.

When shown on the Plans, the use of tee-bar auxiliary sign mounting will be considered incidental to the Contract item Traffic Signs.

The concrete, galvanized steel post stub section required for breakaway posts, reinforcing steel, or anchor bolts required for the various types of foundations will not be paid for separately but shall be considered incidental to the Contract unit price of the specified type of foundation.

Removal of sign posts and foundations will be considered incidental to the Contract item Removing Signs.

The cost of attachment hardware, including vandal proof hardware when required, will be considered included in the Contract item for the particular sign being used.

Payment will be full compensation for furnishing and erecting, fabricating, transporting, handling, applying, and installing the materials specified and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Excavation and backfill will not be paid for separately, but will be considered incidental to the Contract unit prices for other items in the Contract.

Signs having an area of 2 m^2 (20 square feet) or less will be paid for as Type A signs without regard for any limitations placed on the choice of the basic panel material by the existence of a parent sign.

Payment will be made under:

Pay Item	Pay Unit
675.20 Traffic Sign, Type A	Square Meter (Square Foot)
675.21 Traffic Sign, Type B	Square Meter (Square Foot)
675.301 Flanged Channel Sign Post	Meter (Linear Foot)
675.31 W-Shape Steel Sign Post	Kilogram (Pound)
675.32 Tubular Aluminum Sign Post	Kilogram (Pound)
675.33 Tubular Steel Sign Post	Kilogram (Pound)
675.341 Square Tube Sign Post and Anchor	Meter (Linear Foot)
675.40 Foundation for W-Shape Steel Post, 450 mm (18 inch) Diameter	Each
675.41 Foundation for W-Shape Steel Post, 600 mm (24 inch) Diameter	Each
675.42 Foundation for W-Shape Steel Post, 750 mm (30 inch) Diameter	Each
675.43 Foundation for Tubular Steel Post	Each
675.50 Removing Signs	Each
675.60 Erecting Salvaged Signs	Each
675.61 Setting Salvaged Posts	Each
675.70 Modifying Sign Posts	Each

SECTION 676 - DELINEATORS

676.01 DESCRIPTION. This work shall consist of removing or furnishing and installing reflector units or delineators consisting of new or salvaged posts, reflectors, and plaques.

676.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Delineator Posts	751.01
Retroreflective Sheeting	751.03
Back Plates and Housing	751.04
Plaques	751.05
Assembly Hardware	751.06

676.03 INSTALLATION. Delineator posts shall be set to the heights and at the locations shown on the Plans. They shall be set vertically facing the direction shown on the Plans or as directed by the Engineer.

Posts set in the ground shall be driven either by hand or by mechanical devices using a suitable driving cap and shall be set in the ground to the satisfaction of the Engineer. Hand tamping will be permitted. Posts set on the roadway surface shall have the base securely fastened to the surface. Delineators to be attached to bridge rail shall be consistent with the design shown on the Plans and securely fastened to the railing as shown on the Plans or as directed by the Engineer. Delineator assemblies and plaques, when required, shall be attached after the posts are set.

The replacement of reflector units on existing posts or guardrail that are to remain shall be as shown on the Plans or as directed by the Engineer.

676.04 METHOD OF MEASUREMENT. The quantity of Delineators or Reflector Units to be measured for payment will be the number removed or installed in the complete and accepted work.

676.05 BASIS OF PAYMENT. The accepted quantity of Delineators or Reflector Units will be paid for at the Contract unit price each. Payment will be full compensation for removing or furnishing, fabricating, transporting, handling, and installing the materials specified, including plaques when required, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
676.10 Delineator with Steel Post	Each
676.12 Removal of Existing Delineator	Each
676.15 Remove and Replace Reflector Unit	Each
676.20 Delineator with Flexible Post	Each

SECTION 677 - OVERHEAD TRAFFIC SIGN SUPPORTS

677.01 DESCRIPTION. This work shall consist of furnishing and installing overhead traffic sign supports, including the concrete footings.

677.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Caulking Compound	707.13
Bar Reinforcement	713.01
Anchor Bolts	714.09
Preformed Fabric Bearing Pads	731.01
Grounding Electrodes	753.05

The sign support shall be of the materials shown on the Plans.

The sign support design may be a cantilever structure or a multi-support structure (tubular beam, tri-chord, or box truss).

Overhead traffic sign support structures, components, and hardware furnished under this Section shall be covered by a Type D Certification. All design details, quality of work, procedure, materials, etc., shall be in accordance with the latest edition of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.*

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

All welding shall be performed in accordance with the provisions of Section 506.

677.03 GENERAL. The overhead traffic sign supports shall be constructed in accordance with the details shown on the Plans.

Prior to installation, the Contractor shall submit Fabrication Drawings in accordance with Section 105, which shall include a complete list of materials.

Concrete footings shall be backfilled by placing and compacting uniform layers of approved material not exceeding 150 mm (6 inches) in depth.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 3.2 mm (1/8 inch) in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

The space between the top of the concrete footing and metal base of the support shall be filled with Mortar, Type IV.

677.04 GROUNDING. All posts used in overhead sign supports shall be grounded. The grounding shall be accomplished by means of a soft drawn, bare copper wire with a cross-sectional area of 13.30 mm^2 (No. 6 AWG) run between the post or pole base and the grounding electrode(s). The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process.

After erection of the structure, the Contractor shall demonstrate, by tests, that the resistance of the entire specified grounding system is not more than 25 ohms.

If lights are to be installed on the overhead sign supports, the lighting work shall be performed in accordance with the applicable requirements of Section 679.

677.05 METHOD OF MEASUREMENT. The quantity of Overhead Traffic Sign Support, of the type specified, to be measured for payment will be the number of each installed in the complete and accepted work.

The quantity of Remove and Reset Overhead Traffic Sign Support to be measured for payment will be the number of each removed and reset in the complete and accepted work.

677.06 BASIS OF PAYMENT. The accepted quantity of Overhead Traffic Sign Support, of the type specified, will be paid for at the Contract unit price for each. Payment will be full compensation for furnishing, transporting, handling, and installing the materials specified, including the concrete footings, excavation, and backfilling and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

The accepted quantity of Remove and Reset Overhead Traffic Sign Support will be paid for at the Contract unit price for each. Payment will be full compensation for removing the existing sign support, including all excavation, removal of the existing base as required, furnishing, placing, and compacting all necessary backfill, all necessary disconnections and modifications to existing wiring, construction of a new base as required, grading all areas disturbed by the work, turf establishment in those areas if turf establishment is not otherwise included in the Contract and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item		Pay Unit
677.12	Overhead Traffic Sign Support, Cantilever	Each
677.13	Overhead Traffic Sign Support, Multi-Support	Each
677.22	Overhead Traffic Sign Support, Cantilever with Lighting	Each
677.23	Overhead Traffic Sign Support, Multi-Support with Lighting	Each
677.25	Remove and Reset Overhead Traffic Sign Support	Each

SECTION 678 - TRAFFIC CONTROL SIGNALS

678.01 DESCRIPTION. This work shall consist of furnishing and installing a traffic control system.

All electrical work performed under the Contract and all materials installed shall be subject to inspection and approval of the State or Municipal Electrical Inspector, whichever position is applicable. As a minimum, all work must meet the requirements of the National Electrical Code.

678.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Paint for Traffic Control Signals	708.07
Electrical Conduit Sleeve	710.06
Anchor Bolts	714.09
Preformed Fabric Bearing Pads	731.01
Pedestal Posts	752.01
Strain Poles	752.02
Traffic Signal Poles with Mast Arms or Bracket Arms	752.03
Span Wire	752.04
Traffic Signal Heads	752.05
Traffic Signal Controllers	752.06
Flashing Beacons	752.07
Electrical Conduit	752.08
Traffic Signal Conductor Cable	752.09
Detectors	752.10
Vehicle Detector Slot Sealant	752.11
Junction Box	752.12
Accessible Pedestrian Signals	752.13
Pedestrian Pushbutton Assemblies	752.14
Grounding Electrodes	753.05

Prior to ordering any traffic control components of the signal system, the Contractor shall submit Fabrication Drawings in accordance with Section 105. The submittal shall contain, as a minimum, the following information:

(a) Traffic Signal Controller. Type of controller, manufacturer, model, number of phases and functions, and assurance of conformance to NEMA standards. Bench testing (minimum of seven calendar days) will be required. Copies of the test results shall be submitted as discussed in Subsection 752.06. The test results shall contain the begin and end time and date of the test, all controller and time-based coordinator settings used, equipment serial numbers, signature of the person performing the test, and signature of a witness who shall be either a registered electrical engineer or a licensed master electrician. The bench test report shall be approved by the Agency prior to the shipping of the controller(s).

(b) Traffic Signal and Pedestrian Heads. Size, manufacturer, model, lamp wattage, wiring, housing (material and color), visors, and back plates, if required. The signal heads shall conform to the requirements of ITE standards.

(c) Controller Cabinet. Size, manufacturer, model, accessories, materials, and finish.

(d) Auxiliary Equipment. Flasher(s), vehicle detector(s), conflict monitor or malfunction management unit, pedestrian audio unit(s), accessible pedestrian signals, manufacturer, model, functions, and assurance of conformance to NEMA standards, where applicable.

(e) Strain Poles, Cantilevers, and Pedestal Posts.

(1) Dimensions for pole/post height, span wire attachment height, pole/post diameter (top and bottom), pole gauge, handhole (size and location), baseplate, bolt circle, and anchor bolt size.

(2) Material specifications for each component.

(3) Welding information for all welded connections.

(4) Special features as shown on the Plans, such as finish or color.

(5) Pole/baseplate stamping detail.

In the above, all information supplied shall match or be equivalent to the details shown on the Plans. If equivalent, the Contractor may be asked to supply proof of equivalency. Copies of catalogue sheets are acceptable if all the appropriate information is included.

Submitted Fabrication Drawings shall indicate by either text in the transmittal letter or by text and signature on the Fabrication Drawings, that the Contractor has reviewed the Fabrication Drawings and that the Fabrication Drawings are in conformance with the Contractor's proposed installation procedures.

Strain pole styles other than that shown on the Plans will be permitted. The poles must be able to carry the design loads with a maximum dead load (span wire and signal head) deflection of 150 mm (6 inches). Bending stress (f_b) is limited to 66 percent of the minimum yield stress (f_y). All design details, quality of work, procedures, materials, etc., shall be in accordance with the latest edition of the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Schedule 80 conduit shall be used for all applications.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Steel bar reinforcement shall conform to the requirements of Section 507.

Pull box frames and covers shall be steel plate and conform to the requirements of ASTM A 36/A 36M. A Type D Certification shall be furnished for the steel frames and convers in accordance with Subsection 700.02. Where the cover is exposed to vehicle or pedestrian traffic, it shall have an approved nonskid surface such as diamond plate. Frames and covers shall be galvanized in accordance with AASHTO M 111M/M 111. Pull boxes shall be designed and constructed to support at least an AASHTO M-18 (H 20) loading.

678.03 EXCAVATION AND BACKFILL.

(a) General. Unless otherwise shown in the Contract Documents, the Contractor shall perform all excavation, backfilling, and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces, and any other materials necessary to complete the work in accordance with the Contract Documents or as directed by the Engineer.

In making excavations in paved surfaces, cuts shall be made with a concrete saw to a minimum depth of 50 mm (2 inches) along the neat lines of the area to be removed.

All landscaping and underground utility systems that have been disturbed by the construction shall be restored to their original condition at the Contractor's expense upon completion of the work.

(b) Excavation. Excavation shall be at the locations and to the dimensions shown on the Plans.

(c) Backfill. Backfill of suitable material shall be placed and compacted in layers not exceeding 150 mm (6 inches). The bottom of pull boxes shall be filled with granular materials approved by the Engineer to within 150 mm (6 inches) of the bottom of conduit.

678.04 ERECTION OF POSTS AND POLES. All posts and poles shall be erected on concrete bases at the locations shown on the Plans.

In the erection of posts and poles, leveling nuts shall be provided for installation between the bases and the concrete foundation to aid in plumbing.

The space between the top of the concrete footing and metal base of the support shall be filled with Type IV mortar.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 3.2 mm (1/8 inch) in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

678.05 PLACING OF CONDUIT, PULL BOXES, AND JUNCTION BOXES. Unless otherwise specified, the conduit for the cable shall be placed not less than 600 mm (24 inches) below the top of curb in the sidewalk areas and not less than 1 m (36 inches) below the finished grade of pavement when passing under roadways. Conduit shall be pitched or graded at not less than 1:400 (vertical:horizontal) and provision shall be made for draining moisture away from pull boxes as directed by the Engineer.

Red plastic marking tape 150 mm (6 inches) wide shall be placed in the excavated trench 150 to 300 mm (6 to 12 inches) below the finished grade for all conduit and sleeve runs except those jacked under the roadway.

High density polyethylene (HDPE) plastic pipe conduit shall be used only for underground installations.

A minimum of 600 mm (24 inches) of cover shall be required over conduit at all times during construction.

Unless otherwise specified, the conduit shall be laid in a straight line with no bends except preformed bends and at the entrance to a pull box or a concrete base.

All joints for PVC or HDPE conduit shall be made with a tapering tool and not an edging tool.

For metal conduit, all couplings shall be tightened until the ends of the conduit are together and provide a good electrical connection. Any cutting of the conduit shall be made squarely so that the resulting ends will butt together over their full area. The ends of conduits shall be reamed and have threaded connections. Slip joints or running threads shall not be used for couplings. The exposed ends for all types of conduits shall be capped with standard conduit caps until wiring starts, at which time they shall be replaced with approved bushings.

Where factory conduit bends are not being used, the conduit shall be bent using the longest radius possible but not less than six times the inside diameter of the conduit and in a manner that will not crimp or flatten the conduit.

No more than three 90-degree bends or equivalent (270 degrees total) shall be used on a continuous conduit line. If more than 270 degrees in total bends are necessary, then a pull box or junction box shall be installed. Either elbows or sweeps may be used for entering concrete bases, but elbows shall be used at the base of a service pole on the street quarter of the pole.

One approved expansion fitting shall be used for each conduit run on a bridge structure at every expansion joint of the bridge. Expansion couplings shall also be used on the power service pole and all conduits entering or leaving the meter or disconnects on a power drop stanchion.

After the conduit lines are completed, the Contractor shall, in the presence of the Engineer, check the installation by pushing a one diameter long mandrel having a diameter of 5 mm (1/4 inch) less than the diameter of the conduit through the length of conduit. Any obstructions, including stone and dirt, shall be removed. Damaged conduit shall be removed and replaced at the Contractor's expense. When conductor cable is not being placed in conduit under the Contract, a pull cord with a 2.2 kN (5 kips) minimum pull strength shall be installed in all conduits. The pull cord shall terminate beyond the end of the conduit in each pull box or just under the cap at concrete bases for poles.

Pull Boxes and Junction Boxes shall be placed at locations shown on the Plans or as directed by the Engineer.

678.06 INSTALLATION OF ELECTRICAL CONDUIT SLEEVES. Electrical Conduit Sleeves shall be installed at the locations shown on the Plans or as directed by the Engineer.

Unless otherwise specified, electrical conduit sleeves placed under roadways or drives shall have a minimum cover depth of 1 m (3 feet) measured from the finished roadway surface. Sleeves shall be pitched or graded at not less than 1:400 (vertical:horizontal) and provision shall be made for draining moisture away from the sleeve location or as directed by the Engineer.

Unless otherwise specified, the Contractor shall install electrical conduit sleeves in a straight line with no bends. The installed sleeve shall terminate a minimum of 1.2 m (4 feet) outside the face of curb or edge of shoulder of the roadway or drive that the sleeve crosses. Electrical Conduit Sleeves may be placed by an open cut or may be directionally bored under roadways or drives.

When conduit is not being placed in a sleeve, prior to backfilling around the sleeve, the Contractor shall install a suitable pull cord with a 2.2 kN (5 kips) minimum pull strength in the sleeve and seal the ends prior to backfilling the sleeve.

678.07 DETECTORS AND CONTROLLERS. Detectors and controllers shall be installed at the locations shown on the Plans and in accordance with directions furnished by the manufacturer. The type of mounting of the controller cabinet shall be as shown on the Plans. Controller cabinets shall be provided with locks as shown on the Plans. Two keys shall be furnished with each lock. All pedestrian activated push buttons shall have an advisory sign attached as shown on the Plans. At locations where Accessible Pedestrian Signals (APS) are installed, the push buttons shall include audible locator tones, raised arrows and vibro-tactile features that comply with the latest editions of the MUTCD and ADA standards as specified in Subsection 752.14.

When applying vehicle detector slot sealant to the slot, it shall be by a pressurized system such as a manual or mechanical caulking gun or in a manner approved by the maufacturer. The loop wires shall be held in place during sealing by nonmetallic strips or tabs approximately 50 mm (2 inches) long located about every 600 mm (24 inches) along the slot.

678.08 ELECTRIC POWER SERVICE. Prior to submitting a proposal, the Contractor shall obtain from the utility company the location of the power source, the amount of power to be supplied, an understanding of the termination of the power company's services and the requirements of the power company for connection of the electrical facilities to be constructed under the Contract.

The Contractor shall furnish and install a service riser at the power control center, a fully enclosed and watertight cabinet with a meter socket, appropriate sized and number of disconnect equipment, and circuit breakers to meet load and/or equipment manufacturer's requirements. All State and local codes shall be adhered to.

Luminaires installed on strain poles shall utilize the same power source as the traffic signal but with a separate disconnect breaker and meter

678.09 WIRING. All wiring shall be performed in accordance with the National Electrical Code. Splices shall be made only at pull boxes, junction boxes, or pole bases. All splices shall be electrically and mechanically secure and shall be insulated for 600 V. The completed splice shall be watertight and shall test electrically equal to or greater than the cable. All splices shall be soldered, using rosin core solder, and then be fully sealed by the application of dual wall heat-shrinkable tubing.

Unless otherwise shown on the Plans, a minimum of 1 m (3 feet) of slack shall be left in each cable in each box or base.

Where shown on the Plans, wired conduit may be either pre-wired before the conduit is installed or the wire may be installed after the conduit is installed. The Contract item Wired Conduit includes both the conduit and the wires contained within the conduit; however, the wires and the conduit shall not be attached to each other and the wires shall be readily pulled from the conduit for replacement without excessive effort.

Except when otherwise shown on the Plans, the minimum size for an installed conduit shall be 50 mm (2 inch) DN inside diameter conduit or shall match the size of the existing conduit to which it attaches, provided that in either case the installed conduit shall be of sufficient inside diameter to contain wiring of a size such that the voltage drop in the secondary circuit(s) will not exceed 3 percent; shall be of sufficient inside diameter that the combined cross-sectional area of the wiring shall not exceed the percentage of conduit fill specified in the National Electrical Code; and shall, in accordance with the other requirements of this Subsection, contain the wires necessary to make the completed system or subsystem function.

Where electrical wiring is shown on the Plans, the Contractor shall remove the existing wiring, if such exists, from the existing conduit, strain pole, streetlight pole or bracket arm and shall install new wiring meeting all code and specification requirements. The wiring shall be of a size such that the voltage drop in the secondary circuit(s) will not exceed 3 percent and the wiring will contain only the number of conductors necessary to make the completed system or subsystem function.

The minimum wire sizes for circuits shall conform to the following requirements:

Service	Area in mm^2	AWG
From supply to Disconnect	13.30	No. 6
Ground	13.30	No. 6
Disconnect to Controller or Flasher	8.37	No. 6
Controller to Signals or Beacons	3.31	No. 12
Controller to Pavement Units	2.08	No. 14
Controller to Push Buttons	2.08	No. 14
Interconnect Figure “8”		
[1 km (1/2 mile) or less]	2.08 (solid)	No. 14 (solid)
[1 to 2 km (1/2 to 1 mile)]	3.31 (solid)	No. 12 (solid)

There shall be a neutral wire for every eight or fewer ungrounded conductors.

Plastic cable rings shall not be permitted for supporting electrical cable from a span wire.

Stranded wire shall be used for all unsupported and span wire supported wiring.

The Contractor shall furnish and install sufficient cable and wire to operate the system properly as shown on the Plans and as specified and shall provide at least two spare conductors in all signal and interconnect cable runs, including fire and railroad preemption cables.

The Contractor shall wire the system in accordance with the following color-coding system where practicable:

Wire Color	Application
Red	Red, Main Street
Orange	Yellow, Main Street
Green*	Green, Main Street
Red with tracer	Red, Side Street
Orange with tracer	Yellow, Side Street
Green with tracer*	Green, Side Street
White	Common ground for all signals and exposed metal parts
Blue	All Steady Burning Arrows
Blue with tracer	Intermittent Arrows
Remaining	Pavement units, push buttons, and spare

* Green wires shall be tagged "NOT GROUNDED WIRES"

678.10 GROUNDING AND TESTING. Each metal pedestal post, strain pole and signal pole, and the common grounding electrode connector of the signal system shall be grounded to the power source and shall be effectively grounded by connection to a grounding electrode driven at each post or pole location. The grounding shall be accomplished by means of a soft drawn, bare, copper wire with a cross-sectional area of 13.30 mm^2 (No. 6 AWG) run between the post or pole base and the grounding electrode or electrodes. The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process.

The "white wire" shall be used for the neutral ground connections and shall be continuously connected to ground.

All exposed metal parts, including service pipe and control box housing shall be connected to ground. On all controllers employing the solid common ground, there shall be installed a visible jumper between the service neutral and the signal common ground. The signal common ground bar shall be jumpered to the bonded grounding electrode.

Upon completion of each signal or beacon system, the Contractor shall demonstrate by tests that all circuits are continuous and free from short circuits; that all circuits are free from unspecified grounds; and that the resistance to ground of non-grounded conductors is at least 100 MΩ for new construction or 5 MΩ for existing wiring at 16 °C (60 °F) when the test is conducted using 500 V DC. The resistances in the entire specified grounding systems shall not be more than 25 Ω

If luminaires are to be installed on strain poles, the lighting work shall be performed in accordance with the applicable requirements of Section 679.

All new traffic and pedestrian signal heads that have been installed but not placed in either flashing or full operation shall be covered. Existing signal heads which are placed out of service in order to perform work on the signal system shall also be covered, except when such work can be completed in a relatively short period of time (several hours) and traffic control has been provided for.

The signal covers shall consist of a one-piece plastic bag having a minimum thickness of 100 μm (4 mils). The bag shall be black or dark brown in color and shall be opaque. The cover shall slip over the entire signal head and shall be securely tied at the opening to secure the cover. An intermediate tie of the same material shall be drawn around the center of the cover to prevent excess flapping in the wind.

A drain hole shall be made at the bottom of the bag to allow the escape of moisture. No tape or adhesive will be allowed to be attached to any surface of the signal housing or lenses. All covers shall be placed in a neat professional manner. Any cover that is torn or missing shall be immediately replaced. Payment for the covers, their placement and removal, and all incidentals for completion of the work will be considered incidental to the installation of the traffic signal.

678.11 INSTALLATION AND COMPLETION. The signals and equipment shall be properly installed, and operating sequences set as shown on the Plans by a competent factory-trained representative of the manufacturer or by workers under the manufacturer's supervision.

All span wire mounted signals shall have disconnect hangers. All fixed mounted signals shall have terminal components.

Traffic signals installed at locations that were previously unsignalized shall be operated in the flash mode for a minimum of 48 hours prior to being put into full operation. Full operation for new installations or switch over for replacement signals shall not be initiated except in the presence of the Roadway, Traffic, and Safety Engineer or a designated representative.

The traffic signals shall not operate without the pavement markings and signal related signing in place.

All work shall conform to the requirements of the National Electrical Code.

After the signal or beacon system has been completely installed, any fixtures with damaged factory applied paint shall be corrected by applying one coat of enamel meeting the requirements of VT 6.01 (Flat Black Enamel) or VT 6.02 (Yellow Enamel) applied to the complete sectional area that is damaged after being lightly sanded to remove gloss. The visors (hoods) and the entire surface of louvers, fins, and the front surface of back plates shall have a dull black finish.

The Contractor shall submit in duplicate to the Engineer the wiring diagrams, signal sequence chart, signal terminal connection diagram, service manual, programming manual (if applicable), and parts list for each signal controller. The foregoing and manufacturer's warranties and guarantees furnished for materials used in the work shall be delivered to the Engineer prior to acceptance of the work. The warranties shall be the manufacturer's customary trade warranties.

There will be a minimum 30-day test control period to adjust and establish timing sequences for the installation. If, during the last 14 days of the control period, the system does not operate correctly, the test period will be extended until the system operates correctly for 14 calendar days.

The Contractor shall correct all deficiencies found in the traffic control signal system as a result of the test control period, and shall repair or replace defective equipment at no additional cost to the Agency. The traffic control system shall not be accepted until successful completion of the test control period.

The Contractor shall make every reasonable effort to have the installation complete and operating, including the test control period, prior to the date specified in the Contract. However, if all other work under the Contract has been completed, any portion of the test control period which extends beyond the completion date may not be considered time charged for liquidated damages.

For new traffic signals or flashing beacons, the Contractor shall be responsible for all utility costs until acceptance of the signal or beacon system. For upgrading of existing signals or beacons, the State or Municipality, whichever is applicable, shall continue to pay for normal monthly power usage while the Contractor shall be responsible for all other utility costs.

When the installation of a telephone line in a traffic signal controller cabinet is included in the Contract, the Contractor shall initiate the installation by the telephone company by contacting the Business Manager for the Agency's Operations Division. The billing for the telephone service will be set up in the name of the Agency's Maintenance District within which the traffic signal controller is located. The Contractor shall reimburse the District for all costs incurred for the installation and for the monthly fees until acceptance of the traffic signal installation. The Contractor shall reimburse the District within 14 days of receiving a copy of the bill. The Final Estimate will not be paid until the Agency's District Transportation Administrator (DTA) certifies that all reimbursements have been received.

The required 30-day test control period for the signal installation shall not begin until all construction of the signal installation is complete and the Engineer has received notice from the responsible Agency parties that all paperwork, including Fabrication Drawings, materials certifications, bench test reports, etc., related to the signal equipment and installation have been completed to the satisfaction of the responsible parties. Once the 30 day test period has been completed, and the project has been declared substantially complete by the Engineer, the Engineer will send a memorandum or an e-mail to the Roadway, Traffic, and Safety Engineer, with a copy to the Traffic Signal Maintenance Technician and the appropriate Agency DTA stating that the above criteria have been met and that the Agency is now responsible for the maintenance of the traffic signal system. The name of the power company and the account number on the power bill shall be included for the DTA's records. If a memorandum is sent, a telephone call will also be made by the Engineer to ensure the transfer of responsibility.

For projects where several signal systems are coordinated, all the individual signal systems must have successfully completed the 30-day test control period before the signal systems can be accepted.

The Contractor shall notify the Engineer and/or the town or city engineer at least 48 hours prior to turning off existing traffic control signals at any location, or when the Contractor is ready to install the traffic control signal system. Notice is required so that a representative may be provided to observe the installation of the equipment in preparation for maintenance and repair of the system and to have a uniformed traffic officer present to maintain traffic.

Removal of existing or reuse of salvaged equipment:

(a) Unwanted equipment must be disposed of by the Contractor. Removal of equipment shall include removal of concrete bases and backfill of the holes, where applicable. Any equipment that is damaged or lost by the Contractor during removal shall be repaired or replaced to the satisfaction of the Engineer, at the Contractor's expense.

(b) All salvaged and reused equipment shall be thoroughly cleaned and painted as required, before reuse.

(c) All reused traffic signal, flashing beacon, or street lighting lenses and reflectors shall be cleaned and all lamps shall be replaced using lamps conforming to the applicable requirements of Subsection 752.05.

678.12 TEMPORARY TRAFFIC CONTROL SIGNALS AND FLASHING BEACONS.

(a) General. Temporary traffic control signals and temporary flashing beacons shall be installed by the Contractor at the locations shown on the Plans or directed by the Engineer.

The temporary traffic control signal system or temporary flashing beacon system installed at the designated location shall include all necessary existing or Contractor provided materials and equipment shown on the Plans, including, but not limited to, controllers, flashers, wiring, conduit, strain poles, associated signs, sign posts, pavement markings, electrical service, vehicle detectors, span wires, interconnect cables, signal heads, warning beacons, and lights. In the case of temporary signals at a temporary bridge location, the signal system shall include all the signals and associated signage to be installed at all approaches to the temporary bridge.

(b) Materials. The traffic signal, flashing beacon, and lighting equipment provided shall conform to the requirements of the latest edition of the MUTCD and NEMA, but are not required to be new. Fabrication Drawings and certification will not be required for the temporary signal, flashing beacon, and lighting materials and equipment.

Materials shall conform to the applicable requirements of Sections 678 and 679.

All associated signing shall conform to the MUTCD and Section 675, except that the materials are not required to be new.

Pavement marking shall conform to the MUTCD and Section 646.

(c) Installation. The components of the temporary traffic signal and flashing beacon systems shall be installed in accordance with the applicable requirements of Sections 646, 675, 677, 678, and 679, with the following modifications:

Concrete bases will not be required for temporary traffic signal installations.

The Contractor shall correct all deficiencies found in the traffic control signal system and shall repair or replace defective equipment at no cost to the State.

During installation of the temporary traffic signal system or flashing beacons for advanced warning signs, no conduit shall be placed under the existing roadway.

The entire signal system including signs, warning beacons, poles, lights, detectors, and other required materials shall be in place and operating correctly prior to the start of the part of the project requiring its operation. Removal of the temporary signal system in its entirety and restoration of the disturbed areas shall constitute completion of the Contract item.

The Contractor shall be responsible for all permits and costs associated with providing electrical power for the traffic signal and warning beacon operation.

The Contractor shall notify the Engineer and/or the town or city officials at least 48 hours prior to turning off the existing traffic control signals, and/or installing temporary signals.

Pavement marking shall meet the requirements for temporary pavement markings, unless otherwise shown on the Plans.

(d) Detectors. Unless shown on the Plans, detectors for temporary traffic signal activation may be of the type and manufacture chosen by the Contractor. However, the furnished detector must function properly and provide the actuation required for the specific installed site. If, in the opinion of the Engineer, the furnished detector either does not function properly or does not perform the required actuation, the Contractor shall replace the detector within 24 hours of receiving notice to do so from the Engineer. The costs of replacement shall be solely at the Contractor's expense.

Unless otherwise shown on the Plans, detectors designed to be installed in the roadway shall be cut and sealed in the pavement in the same manner as permanently installed detectors.

If temporary loop detectors are installed in a gravel roadway, they shall be placed in Schedule 80 PVC or HDPE conduit and buried at least 100 mm (4 inches) below the travel surface. Other detectors installed in gravel roadways shall be installed in accordance with the manufacturer's recommendations.

678.13 METHOD OF MEASUREMENT. The quantity of Traffic Control Signal System, Intersection to be measured for payment will be the number of each signal system installed in the complete and accepted work.

The quantity of Flashing Beacon, Ground Mounted or Flashing Beacon, Aerial Mounted to be measured for payment will be the number of each beacon system installed in the complete and accepted work.

The quantity of Interconnecting Cable to be measured for payment will be the number of meters (linear feet) of the interconnected system installed in the complete and accepted work, as measured between controller units along the alignment shown on the Plans. No allowance will be made for sag between poles or for loops created in making connections.

The quantity of Electrical Conduit and Wired Conduit to be measured for payment will be the number of meters (linear feet) of the specified conduit installed as required by the system being constructed in the complete and accepted work. The measurement will include sweeps into, and out of, bases, pull boxes, and junction boxes.

The quantity of Vehicle Loop Detector to be measured for payment will be the number of meters (linear feet) of pavement cut and sealed, measured from the curb, containing the loop and lead-in wires, in the complete and accepted work.

The quantity of Electrical Wiring to be measured for payment will be the number of meters (linear feet) of specified wiring installed in the complete and accepted work, as measured between connection points along the installed alignment. No allowance will be made for sags or loops for making connections, but including the wiring installed in sweeps into, and out of, bases, pull boxes, and junction boxes.

The quantity of Pull Box, of the type specified, and Junction Box to be measured for payment will be the number of each box installed in the complete and accepted work.

The quantity of Electrical Conduit Sleeve to be measured for payment will be the number of meters (linear feet) of the specified sleeve installed in the complete and accepted work.

The quantity of Temporary Traffic Signal System, Temporary Flashing Beacon, or Temporary Detector to be measured for payment will be the number of each system installed in the complete and accepted work, maintained during construction, and then removed from the project when the Engineer determined it was no longer required.

678.14 BASIS OF PAYMENT. The accepted quantity of Traffic Control Signal System, Intersection will be paid for at the Contract unit price per each at each designated intersection. Payment will include strain poles, signal heads, controller and cabinet, all wiring not included in the Contract items Wired Conduit and Electrical Wiring, and all other materials necessary for a fully operational Traffic Control Signal System not otherwise paid for under other Contract items in this Section. The Contractor shall be responsible for all maintenance costs for new or existing signal(s) and beacons until project acceptance. This period shall include any winter shut downs during the Contract period. Replacement of poles and cabinet/controllers will not be considered maintenance costs unless the loss is due to the Contractor's negligence. At the discretion of the Engineer, the Contractor may be required to replace poles and cabinet/controllers that are lost or damaged due to an accident. If required, such work will be considered Extra Work under Subsection 109.06 and additional payment will be allowed. Any equipment that is defective or damaged prior to the beginning of the Contract shall be maintained in at least as good condition, until it is replaced as part of the Contract.

The accepted quantity of Flashing Beacon, Ground Mounted will be paid for at the Contract unit price per each at each designated location. Payment will include beacon head(s), flasher and cabinet, all wiring not included in the Contract items Wired Conduit and Electrical Wiring, power source, and all other materials necessary for a fully operational Flashing Beacon not otherwise paid for under other Contract items in this Section. Sign post(s) and panel(s) will be paid for under their own Contract items.

The accepted quantity of Flashing Beacon, Aerial Mounted will be paid for at the Contract unit price per each at each designated location. Payment will include strain poles, span wire, attachment hardware, beacon heads, and all other materials necessary for a fully operational flashing beacon system not otherwise paid for under other Contract items in this Section. Sign post(s) and panel(s) will be paid for under their own Contract items.

Payment for Traffic Control Signal System, Intersection; Flashing Beacon, Ground Mounted; and Flashing Beacon, Aerial Mounted will be made as follows:

(a) When applicable, 10 percent of the Contract unit price will be paid for the installation of strain poles.

(b) Upon installation of a functioning system as indicated by a successful continuous 24-hour operation test period, an additional 10 percent of the Contract unit price will be paid. When the installation does not include strain poles, 20 percent of the Contract unit price will be paid upon successful completion of a continuous 24-hour operation test.

(c) Thirty percent of the Contract unit price will be paid upon receipt by the Engineer of notice from all responsible Agency parties that all paperwork related to the signal or beacon installation has been completed to the satisfaction of the Agency.

(d) The remainder, less 20 percent of the Contract unit price, will be paid after successful completion of the 30-day test control period.

(e) The final 20 percent of the Contract unit price will be paid upon acceptance of the project.

(f) The Contractor will not be paid more than 50 percent of the Contract unit price for the traffic signal or flashing beacon installation, whether directly or through stockpile or any other means until the Engineer has been notified that all signal related paperwork has been completed to the satisfaction of the Agency.

The accepted quantities of Interconnecting Cable, Electrical Conduit, and Vehicle Loop Detector will be paid for at the Contract unit price per meter (linear foot). Payment for Electrical Conduit will include installed electrical conduit only.

The accepted quantity of Wired Conduit will be paid for at the Contract unit price per meter (linear foot). Payment will include both the installed conduit and the wiring inside the conduit.

The accepted quantity of Electrical Wiring will be paid for at the Contract unit price per meter (linear foot). Payment will include removing any existing wiring in an existing conduit, strain pole, streetlight pole, or bracket arm; installing new updated wiring including necessary connections; fusing in that existing enclosed location, and providing all the required number of conductors (including grounds, neutrals, and the designated number of spares). No adjustment of the Contract price will be made if a lesser or greater number of conductors becomes necessary to complete the work.

Unless otherwise shown on the Plans, Wired Conduit and Electrical Wiring will not occur in the same location as Electrical Conduit. Furthermore, Electrical Wiring will only occur inside existing and previously installed conduits, strain poles, streetlight poles, or bracket arms.

The accepted quantities of Pull Box, of the type specified, and Junction Box will be paid for at the Contract unit price per each.

The accepted quantity of Electrical Conduit Sleeve will be paid for at the Contract unit price per meter (linear foot). The cost of excavation and backfill will not be included in the costs of the sleeve. When the sleeve is installed for use with one or more conduits, the costs of excavation and backfill will be considered included in the Contract unit price for the conduit(s) installed within the sleeve. When the sleeve is installed without conduit, the pay limits and the excavation and backfill will be paid in the same manner as specified for culverts in Subsection 601.10.

Payment for the above Contract unit prices will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified, including excavation, backfill, concrete, hanger hardware for pole mounting of cable, pole identification, cutting and resealing the pavement, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

Disconnecting existing loop or other detectors will be considered incidental to other Contract items.

The accepted quantity of Temporary Traffic Signal System will be paid for at the Contract unit price per each. Payment will include the installation and removal of strain poles, signal heads, controller and cabinet, luminaires, signs, sign posts, flashing beacons, pavement markings, wiring, conduit, and all other materials necessary for a fully operational Temporary Traffic Signal System complete in place.

When a Temporary Flashing Beacon system is installed on a project that also requires the installation of a temporary traffic signal, the Temporary Flashing Beacon will not be paid for directly, but will be considered incidental to the Contract item Temporary Traffic Signal System.

The accepted quantity of Temporary Flashing Beacon will be paid for at the Contract unit price per each. Payment will include the installation and removal of poles, span wires, signs, sign posts, beacon heads, flasher units and cabinets, conduit, wiring, attachment hardware, and all other materials necessary for a fully operational Temporary Flashing Beacon system complete in place.

The accepted quantity of Temporary Detector will be paid for at the Contract unit price per each. Payment will include the detector and all necessary installation hardware and materials. A detector consists of the "black box" container or the loop and leads within the paved area of the roadway (on unpaved highways, the graveled surface). Wiring from the controller to the detector, including connection to the detector, is included in the Contract item Temporary Traffic Signal System.

Payment of the above Contract unit prices will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified, including excavation, backfill, hanger hardware for cable and signals, span wires, poles, cutting and resealing pavement, providing electrical service and power, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work, to maintain the system while it is required, and then to completely remove it from the project and properly dispose of it when so directed by the Engineer.

All components, materials, and equipment furnished by the Contractor shall remain the property of the Contractor and shall be properly removed from the project and disposed of by the Contractor when the temporary system is removed. Existing components and materials that were utilized for the temporary system shall be disposed of as shown in the Contract Documents.

Payment for Temporary Traffic Signal System and Temporary Flashing Beacon will be made as follows:

(a) When the entire system has been installed at a site (including signing and pavement markings) and working for 24 hours to the satisfaction of the Engineer, 50 percent of the Contract unit price for each will be paid.

(b) When 60 percent of the working days between the date of installation and the original completion date have elapsed, an additional 30 percent of the Contract unit price for each will be paid.

(c) Upon complete removal of the system from the site and restoration of disturbed areas, the remaining 20 percent of the Contract unit price will be paid.

Payment will be made under:

	Pay Item	Pay Unit
678.15	Traffic Control Signal System, Intersection	Each
678.16	Flashing Beacon, Ground Mounted	Each
678.17	Flashing Beacon, Aerial Mounted	Each
678.20	Interconnecting Cable	Meter (Linear Foot)
678.21	Electrical Conduit	Meter (Linear Foot)
678.22	Vehicle Loop Detector	Meter (Linear Foot)
678.23	Wired Conduit	Meter (Linear Foot)
678.24	Electrical Wiring	Meter (Linear Foot)
678.25	Pull Box, Standard	Each
678.26	Junction Box	Each
678.27	Pull Box, Double	Each
678.30	Electrical Conduit Sleeve	Meter (Linear Foot)
678.40	Temporary Traffic Signal System	Each
678.41	Temporary Flashing Beacon	Each
678.42	Temporary Detector	Each

SECTION 679 - STREET LIGHTING

679.01 DESCRIPTION. This work shall consist of furnishing and installing a street lighting system.

All electrical work performed under the Contract and all materials installed shall be subject to inspection and approval of the State or Municipal Electrical Inspector, whichever is applicable. All work must meet the requirements of the National Electrical Code.

679.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Mortar, Type IV	707.03
Bar Reinforcement	713.01
Anchor Bolts	714.09
Preformed Fabric Bearing Pad	731.01
Electrical Conduit	752.08
Aluminum Poles	753.01(b)
Steel Poles	753.01(c)
Luminaires	753.02
Photoelectric Control Devices	753.03
Highway Illumination Conductor Cable	753.04
Grounding Electrodes	753.05

All welding shall be performed in accordance with the provisions of Subsection 506.10. Unless otherwise specified, AWS ER 4043 electrode wire shall be used with Alloy 6063-T6, and AWS ER 5356 electrode wire shall be used with Alloys 6005-T5 and 6061-T6 when welding aluminum.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

Prior to ordering the items, the Contractor shall submit Fabrication Drawings in accordance with Section 105. The submittal shall contain at a minimum the following information:

(a) Luminaires.

(1) Fixture.

a. Voltage rating.

b. Wattage and lamp type.

c. Ballast type.

d. Photo cell.

e. Any other features shown on the Plans, such as finish, special wire access, etc.

(2) Photometric Data.

a. IES Distribution type.

b. Utilization curve.

c. Iso-lux curves.

d. Mounting height factor.

e. Maintenance factor.

(b) Poles.

(1) Dimensions for pole height, mounting height, pole diameter (top and bottom), arm length and diameter(s), handhole (size and location), baseplate, bolt circle, and anchor bolt size.

(2) Material specifications for each component.

(3) Anchor bolts, nuts, and washers. (See Subsection 714.09.)

(4) If frangible bases are shown on the Plans, the submittal shall include type (transformer base, breakaway coupling, or other approved type) and literature to indicate that the base meets the AASHTO standards.

(5) Types of connections and welding information for pole to baseplate, pole to arm and arm components if a truss arm is used. (See Subsection 506.10.)

(6) The welding process and procedures and the materials used to make the two continuous circumferential welds, one attaching the top of the shoe base (anchor base) to the pole shaft and the other attaching the bottom of the pole shaft to the inside of the shoe base.

(7) Special features as shown on the Plans, such as finish or color.

(c) Wiring. Conductor material, insulation type, voltage rating and temperature rating shall conform to the National Electrical Code for use and size and shall be color-coded.

(d) Welding Information. For all welded connections in all of the above, the information supplied shall match or be equivalent to the details shown on the Plans. If equivalent, the Contractor may be asked to supply proof of equivalency. Copies of catalogue sheets are acceptable if all the appropriate information is included.

All design details, quality of work, procedures, materials, etc. shall conform to AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals*, most current section for Aluminum Design.

Pull box frames and covers shall be of steel plate and conform to the requirements of ASTM A 36/A 36M. A Type D Certification shall be furnished in accordance with Subsection 700.02 for the steel frames and covers provided. Where the cover is exposed to vehicle or pedestrian traffic, it shall have an approved nonskid surface such as diamond plate. Frames and covers shall be galvanized in accordance with AASHTO M 111M/M 111. Pull boxes shall be constructed to support an AASHTO M-18 (H 20) loading.

679.03 EXCAVATION AND BACKFILL.

(a) General. Unless otherwise shown in the Contract Documents, the Contractor shall perform all excavation, backfilling, and resurfacing work, including removal and replacement of curbs, sidewalks, paved surfaces, and any other materials necessary to complete the work, in accordance with the Contract Documents or as directed by the Engineer.

In making excavations in paved surfaces, cuts shall be made with a concrete saw to a minimum depth of 50 mm (2 inches) along the neat lines of the area to be removed.

All landscaping and underground utility systems that have been disturbed by the construction shall be restored to their original condition upon completion of the work, at the Contractor's expense.

(b) Excavation. Excavation shall be at the locations and to the dimensions shown on the Plans.

(c) Backfill. Backfill of suitable material shall be placed and compacted in layers not exceeding 150 mm (6 inches). The bottom of pull boxes shall be filled with granular materials approved by the Engineer to within 150 mm (6 inches) of the bottom of conduit.

679.04 PLACING OF CONDUIT, PULL BOXES, AND JUNCTION BOXES. Unless otherwise specified, the conduit for the cable shall be placed not less than 600 mm (24 inches) below the top of curb in the sidewalk areas and not less than 1 m (3 feet) below the finished grade of pavement when passing under roadways. Conduit shall be pitched or graded at not less than 1:400 (vertical:horizontal) and provision shall be made for draining moisture away from pull boxes as directed by the Engineer.

Red plastic marking tape of 150 mm (6 inch) width shall be placed in the excavated trench 150 to 300 mm (6 to 12 inches) below the finished grade for all conduit and sleeve runs except those jacked under the roadway.

HDPE conduit shall be used for underground installations only.

A minimum of 600 mm (24 inches) of cover shall be required over conduit at all times during construction.

Unless otherwise specified, the conduit shall be laid in a straight line with no bends except preformed bends or bends at the entrance to a pull box or a concrete base.

All joints for PVC or HDPE conduit shall be made with a tapering tool and not an edging tool.

For metal conduit, all couplings shall be tightened until the ends of the conduit are together and provide a good electrical connection. Any cutting of the conduit shall be made squarely so that the resulting ends will butt together over their full area. The ends of conduits shall be reamed and have threaded connections. Slip joints or running threads shall not be used for couplings. The exposed ends for all types of conduits shall be capped with standard conduit caps until wiring starts, at which time they shall be replaced with approved bushings.

Where factory conduit bends are not being used, the conduit shall be bent using the longest radius possible but not less than six times the inside diameter of the conduit, and in a manner that will not crimp or flatten the conduit.

No more than three 90 degree bends or equivalent (270 degrees total) shall be used on a continuous conduit line. If more than 270 degrees in total bends are necessary, then a pull box or junction box shall be installed. Either elbows or sweeps may be used for entering concrete bases, but elbows shall be used at the base of a service pole on the street quarter of the pole.

One approved expansion fitting shall be used for each conduit run on a bridge structure at every expansion joint of the bridge. Expansion couplings shall also be used on the power service pole and all conduits entering or leaving the meter or disconnects on a power drop stanchion.

After the conduit lines are completed, the Contractor shall, in the presence of the Engineer, check the installation by pushing a one-diameter long mandrel having a diameter of 5 mm (1/4 inch) less than the diameter of the conduit through the length of conduit. Any obstructions, including stone and dirt, shall be removed. Damaged conduit shall be removed and replaced at the Contractor's expense. When conductor cable is not being placed in conduit under the Contract, a pull cord with a 2.2 kN (5 kip) minimum pull strength shall be installed in all conduits. The pull cord shall terminate beyond the end of the conduit in each pull box or just under the cap at concrete bases for poles.

Pull boxes and junction boxes shall be placed at the locations shown on the Plans or as directed by the Engineer.

679.05 ERECTION OF LIGHT STANDARDS. The light standards shall be erected on concrete bases at the locations shown on the Plans.

If a pole that does not have a breakaway feature needs leveling or plumbing when being erected, metal shims shall not be used. Leveling or plumbing shall be accomplished by the use of leveling nuts installed on the anchor bolts between the pole base and the concrete foundation.

If a pole that has a transformer base needs leveling or plumbing when being erected, metal shims shall be used between the transformer base and the concrete foundation. Leveling nuts shall not be installed on the anchor bolts.

The space between the top of the concrete footing and metal base of the support shall be filled with Mortar, Type IV.

The length of bracket arms and mounting height shall be as shown on the Plans. The bracket arm shall be mounted perpendicular to the centerline of roadway, unless otherwise specified.

Where aluminum alloys come in contact with other materials, the contacting surfaces shall be separated with a fabric pad 3.2 mm (1/8 inch) in thickness or cleaned and thoroughly coated with an aluminum impregnated caulking compound.

Luminaires shall be installed simultaneously with the erection of light standards when aluminum or steel poles are used. Failure to do so may result in damage to the pole due to vibrations that can occur.

Where street lighting is to be installed on existing wood poles, the bracket arms shall be equipped with devices suitable for attachment to wood poles.

679.06 ELECTRIC POWER SERVICE. It shall be the responsibility of the Contractor, prior to submitting a proposal, to have obtained from the utility company, the location of the power source; the amount of power to be supplied; an understanding of the termination of the power company's services; and the requirements of the company for connection of the electrical facilities to be constructed under the Contract.

The Contractor shall furnish and install a service riser at the power control center; a totally enclosed and watertight cabinet with a meter socket; appropriate sized and number of disconnect equipment and circuit breakers to meet load and/or equipment manufacturers' requirements. All State and local codes shall be adhered to.

679.07 WIRING. All wiring shall be done in accordance with the National Electrical Code. Splices shall be made only at pull boxes, junction boxes or pole bases. All splices shall be electrically and mechanically secure and shall be insulated for 600 V. The completed splice shall be watertight and shall test electrically equal to or greater than the cable.

Unless otherwise shown on the Plans, a multiple system of distribution shall be used and the wire sizes shall be such that the voltage drop in the secondary circuit(s) does not exceed 3 percent. Fuses in each light pole base shall be rated three times the maximum current for high intensity discharge ballasts.

Wire connections in the base of each light pole shall be made with a watertight wye or in-line plug-in type connector of a type that will disconnect upon impact to eliminate the shock hazard in a "knock-down"

situation and eliminate damage to the rest of the underground wiring. There shall also be enough slack cable to permit working on the wye-connector outside the pole hand hole.

679.08 GROUNDING AND TESTING. Each metal light standard and the continuous grounded conductor of the distribution circuit shall be effectively grounded at the power source and at each metal light standard with a soft drawn, bare, copper wire with a cross-sectional area of 13.30 mm^2 (No. 6 AWG) run between light standard, power source and grounding electrode(s) at each concrete base location. The grounding electrode conductor shall be attached to the grounding electrode by an exothermic welding process. The neutral wire shall be grounded at the power source. On bridges, the light standards and conduits, if metallic, shall be electrically connected in an approved manner. For bridges that are less than 150 m (500 feet) in length, one end of the conduit, if metallic, shall be connected to a ground electrode and for bridges that are greater than 150 m (500 feet) in length, the conduit shall be grounded in the same manner at both ends.

Upon completion of the system, the Contractor shall demonstrate by tests that all circuits are continuous and free from short circuits; that all circuits are free from unspecified grounds; and that the resistance to ground of non-grounded conductors is at least 100 MΩ for new construction or 5 MΩ for existing wiring at 16 °C (60 °F) when the test is conducted using 500 V DC. The resistances in the entire specified grounding systems shall be not more than 25 Ω.

Voltage readings shall be made at each circuit breaker and distribution transformer with load and without load, and on each side of each circuit breaker and at the end of each circuit with load. Except for no load readings, nighttime and daytime readings shall be taken with the lighting system in normal operation.

Current readings shall be made on the load side of each circuit breaker phase and neutral. Readings shall be made at nighttime and daytime with the lighting system in normal operation.

The lamps shall not be removed or inserted when the power is on.

679.09 ACCEPTANCE. The lighting system shall be completely operable and energized at least 30 days prior to the acceptance of the project and shall be operated each night at the Contractor's expense. The Contractor shall replace all defective parts of the system prior to acceptance of the project. The Contractor shall adjust the luminaire photoelectric switch, if required, so that operation is satisfactory to the Engineer prior to acceptance.

The Contractor shall be responsible for all power costs through project acceptance or the end of the test period, whichever is later.

679.10 METHOD OF MEASUREMENT. The quantity of Direct Burial Cable for Street Lighting to be measured for payment will be the number of meters (linear feet) of cable installed in the complete and accepted work, as measured from pole base to pole base.

The quantity of Light Pole Base to be measured for payment will be the number of each base installed in the complete and accepted work.

The quantity of Extend Light Pole Base to be measured for payment will be the number of each light pole base extended in the complete and accepted work.

The quantity of Breakaway Feature for Light Pole to be measured for payment will be the number of each breakaway feature (approved transformer base, breakaway coupling, etc.) installed in the complete and accepted work.

The quantity of Removing and Resetting Light Pole to be measured for payment will be the number of each light pole completely reset on a new or existing concrete base in the complete and accepted work.

The quantity of Light Pole to be measured for payment will be the number of each light pole, with pole tag and internal wiring, installed on an existing concrete base in the complete and accepted work.

The quantity of Bracket Arm to be measured for payment will be the number of each, with internal wiring, installed in the complete and accepted work.

The quantity of Luminaire to be measured for payment will be the number of each, with photocell, connected both mechanically and electrically in the complete and accepted work.

The accepted quantity of Power Drop Stanchion, Street Lighting to be measured for payment will be the number of each stanchion installed in the complete and accepted work.

679.11 BASIS OF PAYMENT. Street Lighting item prices shall be full compensation for furnishing, transporting, handling, and placing the materials specified. Connections to power source, circuit testing, and the furnishing of all labor, tools, equipment, and incidentals necessary to complete the work will be incidental to other items.

The accepted quantity of Direct Burial Cable for Street Lighting will be paid for at the Contract unit price per meter (linear foot).

The accepted quantities of Light Pole Base, Extend Light Pole Base, Breakaway Feature for Light Pole, Removing and Resetting Light Pole, Light Pole, Bracket Arm, Luminaire, and Power Drop Stanchion, Street Lighting will be paid for at the Contract unit price for each.

Payment will be full compensation for furnishing, transporting, handling, and installing the materials and equipment specified. This includes, but is not limited to, excavation, backfill, concrete, cover plate and frame, anchor bolts, mast, bracket or mast arms, poles, bases, luminaires, ballasts, lamps, transformer enclosures, breakaway devices, wiring, pole identification, necessary fusing, connections to power sources, circuit testing, circuit breakers, photoelectric cells, grounding, hardware, and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

For new construction, fusing in the light pole base, wiring within the pole and base, including within breakaway features, and pole identification are part of the costs included in the Contract item Light Pole. Wiring and fusing within bracket arms are part of the costs included in the Contract item Bracket Arm. Ballasts, lamps, and photoelectric devices are part of the costs included in the Contract item Luminaire.

For rehabilitation work, wiring and fusing within poles, bases, and bracket arms will paid for under the Contract item Electrical Wiring in Section 678.

Circuit testing and connections to power sources will not be paid for separately but will be considered incidental to the Contract items that include the costs of wiring.

The cost of furnishing and installing electrical conduit, wired conduit, electrical wiring, electrical conduit sleeve, pull boxes, and junction boxes will be paid for under the applicable Contract items of Section 678.

Payment will be made under:

Pay Item	Pay Unit
679.16 Direct Burial Cable for Street Lighting	Meter (Linear Foot)
679.21 Light Pole Base	Each
679.22 Extend Light Pole Base	Each
679.23 Breakaway Feature for Light Pole	Each
679.25 Removing and Resetting Light Pole	Each
679.45 Light Pole	Each
679.47 Bracket Arm	Each
679.50 Luminaire	Each
679.55 Power Drop Stanchion, Street Lighting	Each

SECTION 680 - TRAVEL INFORMATION SIGNS

680.01 DESCRIPTION. This work shall consist of furnishing, erecting, and maintaining travel information signs and information plazas.

.680.02 MATERIALS. Materials shall meet the requirements of the following Subsections:

Peastone	704.11
Paint for Traffic Signs	708.06
Structural Timber and Lumber	709.01
Nonstructural Lumber	709.02
Timber Preservative	726.01
Signs Posts	750.01
High Density Overlaid Plywood	750.06
Retroreflective Sheeting	750.08
Plastic Lettering Film	750.10
Assembly Hardware	750.12

All materials shall be in conformance with the State of Vermont Travel Information Council Standards Manual.

The colors used for specific signs, symbols, and plaques shall be as shown on the Plans and shall provide an acceptable match to the appropriate color chip in FED-STD-595B.

Color	Chip Number
Black	Chip No. 17038
White	Chip No. 17875
Magenta	Chip No. 11158
Brown	Chip No. 10100
Orange	Chip No. 12501
Gray	Chip No. 16373

The color of retroreflective material shall be Silver-White #2.

Concrete shall conform to the requirements of Section 541 for Concrete, Class B.

680.03 PLANS. Plans for travel information signs, associated components, and work required will consist of assembly drawings of information plazas, standard drawings, location and site plan, and order forms detailing the work to be performed at each specified location.

680.04 SIGN POSTS. The installation of steel and aluminum sign posts shall conform to the requirements of Section 675. Posts shall be set to the depth shown on the Plans.

When wooden posts are specified, travel information signs shall be mounted on two 100 by 100 mm (4 × 4 inch) nominal wooden posts, S4S. The posts shall be set plumb and true in holes excavated to a minimum depth of 1 m (3 feet). That portion of the post to be in contact with or within 225 mm (9 inches) of the ground shall be pressure treated with an approved preservative.

680.05 SIGNS. Travel and business information signs shall be prepared and installed according to the requirements of Section 675, except as modified by this Subsection. The base material for all signs shall be 16 mm (2/3 inch) nominal thickness acrylic overlaid plywood.

All lettering, mileage numerals, and directional arrows shall be formed from retroreflective sheeting. Basic travel information symbols for use on sign boards carrying only travel information symbols shall be reflectorized either by silk-screening the background color on retroreflective sheeting or by applying reflective symbols on acrylic material of the appropriate color. All other travel information symbols and background material shall be non-reflectorized and shall be of the colors shown on the Plans.

Commercial logos, furnished by others, will be applied to certain signs as shown on the Plans.

680.06 INFORMATION PLAZAS. Information plazas shall be constructed at locations shown on the Plans or directed by the Engineer. The information plaza shall be constructed from materials shown on the Plans and shall be erected as shown on the Plans. The plazas shall also be erected in conformance with the Travel Information Council Standards Manual.

The area in which the information plaza is erected shall be reasonably level and unobstructed in order to provide for easy circulation by pedestrians. In areas subject to vehicular traffic, a 2.5 m (8 feet) length of curbing shall be installed parallel to the axis of the structure for the separation of vehicular and pedestrian traffic. Pedestrian traffic areas shall be excavated and surfaced with 300 mm (12 inches) of peastone.

The relocation of an existing information plaza shall consist of removing the information plaza from its present location and reinstalling it on new posts or concrete bases at the location specified. The reinstallation shall be made as shown on the Plans and shall include the necessary electrical connections, grading, and curb installation if necessary. Removal and disposal of the original mounting posts and curb, if any, and any necessary cleanup of the original site shall also be considered to be included in the relocation item.

An information plaza that is damaged during its removal and resetting due to negligence on the part of the Contractor shall be repaired or components replaced by the Contractor at no additional cost to the Agency.

Information plaza lighting and electrical circuitry shall be as shown on the Plans. The plazas shall be lighted during the hours of darkness under the control of a suitably designed photoelectric device. All electrical materials and installation methods shall conform to the provisions of the National Electrical Safety Code and all electrical work shall be in accordance with State and local regulations.

680.07 MAGNETIC PLAZA INFORMATION PLAQUES. When indicated in the Contract, the Contractor shall furnish magnetic plaques of the sizes and types indicated on the order form, complete with the legend provided on the order form.

Type A plaques shall have space reserved for the application of a commercial logo to be furnished by others. The plaques shall be installed by others.

The graphics shall be white on a square panel of magnetic vinyl in the color specified. Graphics shall be of the nominal sizes indicated below:

Plaque Size	Heading	Text	Type A Logo
150 mm square (6 inches square)	48 point	18 point	38 mm square (1 1/2 inches square)

680.08 SYMBOLS. When called for in the Contract, the Contractor shall furnish travel information symbols as ordered by the Engineer. The symbols shall consist of a self-adhesive acrylic background with the appropriate symbol superimposed, all of the size and color specified. The symbols shall be installed by others.

680.09 METHOD OF MEASUREMENT. The quantity of Travel Information Sign and Business Directional Sign to be measured for payment will be the number of square meters (square feet) of sign(s) installed in the complete and accepted work.

The quantity of Travel Information Plaza or Relocate Information Plaza to be measured for payment will be the number of each plaza installed or relocated in the complete and accepted work.

The quantity of Magnetic Information Plaque, of the type specified, Travel Information Symbol, or Overlay for Travel Information Signs will be measured for payment as the number of plaques, symbols, and overlays furnished in the complete and accepted work.

680.10 BASIS OF PAYMENT. The accepted quantity of Travel Information Sign and Business Directional Sign will be paid for at the Contract unit price per square meter (square foot). Payment will include furnishing the sign complete with letter and symbol text and installing the sign as part of a unit at the location specified.

Sign posts for Travel Information Signs will be paid for at the Contract unit price for the appropriate Contract item for sign posts under Section 675.

The accepted quantity of Travel Information Plaza will be paid for at the Contract unit price per each. Payment will include excavation, preparation, and grading of the area; furnishing and placing backfill material; furnishing and placing protective curb where required; and the information plaza complete with electrical service.

The accepted quantity of Relocate Information Plaza will be paid for at the Contract unit price per each. Payment will include disassembly of the plaza, disposal of the original posts, cleanup of the original area, and reinstallation of the plaza on new posts or base at the location specified, complete with prepared, graded, and curbed area and electrical service.

The accepted quantity of Magnetic Information Plaque, of the type specified, and Travel Information Symbol will be paid for at the Contract unit price per each. Payment will be full compensation for furnishing the materials specified with the required text or symbols superimposed.

The accepted quantity of Overlay for Travel Information Sign will be paid for at the Contract unit price per each. Payment will include furnishing the acrylic background of the color specified, placing the required text on the background, and installation of the overlay on the sign panel at the location specified.

Payment for the above Contract unit prices will be full compensation for performing the work specified and for furnishing all labor, materials, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
680.20 Travel Information Sign	Square Meter (Square Foot)
680.25 Business Directional Sign	Square Meter (Square Foot)
680.30 Travel Information Plaza	Each
680.40 Relocate Information Plaza	Each
680.65 150 mm (6 inch) Magnetic Information Plaque, Type A	Each
680.66 150 mm (6 inch) Magnetic Information Plaque, Type B	Each
680.70 Travel Information Symbol	Each
680.72 Overlay for Travel Information Sign	Each

DIVISION 700

MATERIALS

SECTION 700 GENERAL

700.01 GENERAL STATEMENT. Where the Contract requires that materials conform to AASHTO or ASTM specifications, the latest publications and all modifications thereto in effect on the date of the Invitation for Bids shall apply.

At the Engineer's discretion, testing of any material for which a certification is required may be performed either at the point of manufacture or after delivery to the site of the work. In such cases, the results of the tests shall govern the acceptance or rejection of the material tested

Material certifications are documents submitted pursuant to Subsection 700.02 by the manufacturer, producer, or supplier of a product that assures (or certifies) that products incorporated into Agency projects conform to all applicable requirements of the Agency's Standard Specifications, Standard Drawings, and Contract Documents for the intended project.

The Agency may waive the requirement for submitting a certification for projects with small quantities of material having a cost of less than $5,000 and that are not directly involved with the safety of the structure or the roadway.,. The material must still meet or exceed the specified material requirements.

Materials shall be sampled in accordance with the Agency's Quality Assurance Program and the Material Sampling Manual.

Minor quantities of materials may be accepted without sampling and testing. The acceptance of a minor quantity is at the Engineer's discretion. Sampling and testing of minor quantities will be determined on a project-by-project basis. The Engineer must provide written documentation on form "TA 557 - Minor Quantity Declaration Form". This form shall indicate the basis for declaring a quantity a "minor quantity"," prior to incorporating the material into the project, and be submitted to the Materials and Research Section's Certification and Independent Assurance Unit. For more guidance, see the current edition of the Agency's Material Sampling Manual under Acceptance of Minor Quantities.

Whenever there is a Subsection entitled "General Requirements" within any Division 700 Section, that Subsection is applicable to all other Subsections in Division 700.

700.02 MATERIALS CERTIFICATIONS.

(a) General. When these Specifications require a certification, the certification will be approved prior to the use of the material, unless otherwise directed by the Engineer. In all cases, certifications must be approved prior to payment.

All material used on the basis of a materials certification may be sampled and tested at any time. The fact that a material is used on the basis of a certification shall not relieve the Contractor of responsibility for incorporating material in the work which conforms to the requirements of the Contract and any such material not conforming to such requirements will be subject to rejection whether in place or not.

New materials, previously certified and purchased by the Contractor for use on an Agency contracted project, may be used on another Agency project provided that the Contractor submits a sworn statement identifying the past project which the materials were originally certified for, attests that the material certifications were previously furnished and accepted by the Agency for the past project, and certifies that the new materials were part of the original quantity purchased.

When Agency approval is given for Working Drawings under the requirements of Section 105 and the referenced drawings or project Special Provisions have identified a component of an item by a specific product name and/or number, the Engineer may waive all or part of any certification or testing requirements for that particular product.

The Agency reserves the right to refuse the use of materials where acceptance is based only on certification.

Within each Subsection, materials designated to conform to another Subsection shall require the certification type of the referenced Subsection.

For steel and iron materials, the following requirements shall apply:

(1) To comply with Buy America provisions, a manufacturer must certify that all manufacturing processes have occurred in the United States.

(2) To identify a chain of custody documentation trail that the product meets the Buy America provisions, each supplier or fabricator involved in the manufacturing processes of a product will be required to include in its certification a statement that each process performed by them which alters the physical form or shape or changes its chemical composition was entirely performed in the United States.

(3) All certifications shall be forwarded to the Vermont Agency of Transportation Materials and Research Section.

(b) Required Information. Certifications shall contain the following information, except as waived by the Agency:

(1) Project name, number, and line item to which the material is consigned.

(2) Name of the contractor or distributor to which the material is supplied.

(3) Kind of material supplied.

(4) The quantity of the material to be used on the project.

(5) Means of identifying the consignment, such as a, lot number, heat number, batch number, serial number, etc.

(6) Statement to the effect that the material has been tested and found in conformity with the Specifications. associated to the material pay item..

(7) Results of all tests including the chemical and physical analyses when required by a Type D Certification.

(8) Signature of a person having legal authority to bind the manufacturer. Signatures must be legally notarized.

(c) Types of Certifications. Unless otherwise specified, certifications shall be prepared by the manufacturer for products delivered to the project and shall be one of the following types:

(1) Type A. A Type A Certification shall certify that the component materials and finished products have been tested by means identified in the Manufacturer's Quality Controls and the results conform to all requirements of the Agency, the State, pertinent Plans, Special Provisions, and Specifications for the Contract item or items indicated.

(2) Type B. A Type B Certification shall certify that the material conforms to the requirements as noted in the Type A Certification and is of the same formulation that has a history of satisfactory performance with the Agency.

(3) Type C. This certification type is no longer used and should no longer be specified. However, if any certification requirements incorrectly require a Type C Certification then it shall be interpreted that a Type D Certification is required.

(3) Type D. A Type D Certification shall consist of a Type A Certification accompanied by a Certificate of Analysis (C of A) showing actual chemical and physical analysis of material used in the manufacture of products and a Certificate of Compliance (C of C) indicating that the properties of the finished product meet applicable specifications.

(4) Type E. A Type E Certification shall consist of a lot by lot Type D Certification accompanied by a split sample taken from the lot being certified. The manufacturer's test values may be compared against the Agency's test values of the split sample. The Type E Certification typically follows the Agency's review of the manufacturer's Quality Control Plan. The Type E Certification is the highest level of stringency for acceptance by certificate alone, and is especially appropriate for high cost, high risk materials such as cement for Structural Concrete and performance graded binder for Bituminous Concrete Pavement.

(d) Advance Certification List (ACL). Manufacturers of materials requiring either a Type A or a Type B Certification may submit their certifications annually at the beginning of each calendar year and, if approved, their products will be included on a list of materials with advance certification. Materials that are included on the Advance Certification List will not require separate certification for each project.

The Engineer shall inform the Materials and Research Section of the materials used from the ACL by submitting form "TA 555 - Project Materials Acceptance Report for Advance Certification, to the Materials and Research Section's Certification & Independent Assurance (C & IA) Certifications Unit. The Engineer also uses form TA 555 to notify the C & IA Unit when waiving certification requirements and extending a certified material quantity.

The Agency reserves the right to remove any manufactured product from the Advance Certification List at any time.

700.03 APPROVED PRODUCTS.

The Approved Products List (APL) is a listing of products and materials that have been tested and/or evaluated by the Materials and Research Section and have been deemed satisfactory for use on Agency projects. Materials required to be on the APL do not have certification requirements, therefore material substitutions are not allowed.

Products contained within the APL have undergone a review by the Agency's New Products Committee, an in-place evaluation, and/or an information gathering process in order to determine their viability for successful use on Agency projects.. Should a product not be listed that is desired to be used, the manufacturer or distributer shall submit a New Product Submittal Form, along with materials safety data sheets and any pertinent information necessary to determine acceptable performance. The New Product Submittal Form should be submitted to the Research Engineer in the Materials and Research Section. A determination of its use and/or future testing requirements prior to inclusion on the APL will then be made at a meeting of the New Products Committee.

The Engineer shall inform the C&IA Unit of materials used from the APL by submitting form "TA556 - Project Materials Acceptance Report for Approved Products" to the Certifications Technician.

The Agency reserves the right to remove any product from the Approved Products List at any time.

700.04 DEFINITION OF TERMS.

ADVANCED DECAY - In the case of wood, the older stage of decay in which the disintegration is readily recognized because the wood has become punky, soft, and spongy.

BEDROCK (LEDGE) - Rock of relatively great thickness and extent in its native location; any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

BITUMINOUS MATERIAL - A substance which is characterized by the presence of bitumen, or one from which bitumen can be derived.

BOULDER - A rock fragment, usually rounded by weathering or abrasion, with an average dimension of 300 mm (12 inches) or more.

CAPILLARY ACTION (CAPILLARITY) - The rise or movement of water in the interstices of a soil due to capillary forces.

CHECK - In the case of wood, a separation of the wood grain due to internal stresses caused by severe moisture cycling.

CLAY (CLAY SOIL) - Fine-grained soil or the fine-grained portion of soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dried.

COBBLE (COBBLESTONE) - A rock fragment, usually rounded or semirounded, with an average dimension between 75 and 300 mm (3 and 12 inches).

COHESIONLESS SOIL - A soil that when unconfined has little or no strength when air-dried and that has little or no cohesion when submerged.

COHESIVE SOIL - A soil that when unconfined has considerable strength when air-dried and that has significant cohesion when submerged.

COMPACTION - Densification by means of mechanical manipulation.

COMPACTION CURVE (PROCTOR CURVE) (MOISTURE-DENSITY CURVE) - The curve on a graph that shows the relationship between the dry density and the water content of a soil for a given compactive effort.

COMPACTION TEST (MOISTURE-DENSITY TEST) - A laboratory procedure whereby a soil at a known water content is placed in a specified manner into a mold of given dimensions, subjected to a compactive effort of controlled magnitude, and the resulting unit mass (weight) determined.

COMPRESSIVE STRENGTH - The maximum compressive stress that a material is capable of sustaining.

CONSOLIDATION - Gradual reduction in volume of a soil mass.

CRUSHED GRAVEL - The product resulting from the mechanical crushing of gravel and cobblestones.

CRUSHED STONE - The product resulting from the mechanical crushing of blasted ledge, rocks, boulders, or cobblestones.

DENSITY - The density of a soil is measured in terms of the ratio of its mass (weight) per unit volume and usually expressed as kilograms of wet soil or dry soil per cubic meter (pounds per cubic foot). These ratios are designated as wet density and dry density respectively.

DRYING TIME -

> Set to Touch - Film is "set to touch" when it still exhibits a tacky condition, but none of it adheres to the finger.
>
> Dry to Recoat - Film is "dry to recoat" when the top coat can be applied without the development of film irregularities, such as lifting or loss of adhesion of the undercoat.
>
> Dry Through (Dry to Handle) - Film is "dry through" when there is no loosening, detachment wrinkling, or other distortion of film under condition of test. Test conditions require full thumb pressure with twisting action.

ELONGATED PIECE - One in which the ratio of the length to width of its circumscribing rectangular prism is greater than five.

ELONGATION - The increase in gage length of a tension test specimen, usually expressed as a percentage of the original gage length.

FAMILY OF CURVES - A group of similar moisture-density curves assuming a characteristic shape.

FILTER (PROTECTIVE FILTER) - A layer or combination of layers of pervious materials designed and installed in such a manner as to provide drainage, yet prevent the movement of soil particles due to flowing water.

FINENESS MODULUS - An empirical factor obtained by adding the total percentages of a sample of the aggregate retained on each of a specified series of sieves, and dividing the sum by 100.

FINES - Portion of a material finer than a 75 μm (No. 200) sieve.

FLY ASH - Finely divided residue that results from the combustion of ground or powdered coal.

FRACTURED FACES - Faces on aggregate pieces with sharp and well defined edges.

FREEZING DEGREE-DAYS - The difference between the average temperature each day and 0 °C (32 °F). Freezing degree-days are positive for daily average temperatures above 0 °C (32 °F) and negative for those below.

FREEZING INDEX - The number of freezing degree-days between the highest and lowest points on the cumulative freezing degree-days/time curve for one freezing season.

GAGE LENGTH - The original length of that portion of the specimen over which strain or change of length is determined.

GLACIAL TILL (TILL) - Material deposited by glaciation, usually composed of a wide range of particle sizes, which has not been subjected to the sorting action of water.

GRADATION (GRAIN-SIZE DISTRIBUTION) (SOIL TEXTURE) - Proportion of material of each grain size present in a given material.

GRAIN-SIZE ANALYSIS (MECHANICAL ANALYSIS) - The process of determining gradation.

GRAVEL (AASHTO) - Rounded or semirounded particles of rock that will pass a 75 mm (3 inch) sieve and be retained on a 2.00 mm (No. 10) sieve.

HARDNESS - The resistance of a material to deformation, particularly permanent deformation, indentation, or scratching.

HARDPAN - Extremely dense, cemented soil, which does not soften when wet.

HEAVE - Upward movement of soil caused by expansion or displacement resulting from phenomena such as moisture absorption, removal of overburden, driving of piles, and frost action.

INCIPIENT DECAY - The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of wood.

LIQUID LIMIT - The water content corresponding to the arbitrary limit between the liquid and plastic states of soil.

LOAM - A mixture of sand, silt, or clay, or a combination of any of these, with organic matter. It is sometimes called topsoil in contrast to the subsoils that contain little or no organic matter.

MANUFACTURED SAND - The product resulting from the mechanical processing and crushing of gravel or cobbles in which at least 50 percent of the material passing the 2.36 mm (No. 8) sieve has two fractured faces as determined by ASTM C 295, as modified by the Agency's Materials and Research Section.

MODULUS OF RUPTURE IN BENDING - The value of maximum tensile or compressive stress (whichever causes failure) in the extreme fiber of a beam loaded to failure in bending.

MOISTURE CONTENT (WATER CONTENT) - The ratio, expressed as a percentage, of the mass (weight) of water in a given material to the mass (weight) of solid particles.

MSDS - Material Safety Data Sheet as required by OSHA.

MUCK - A soil of very soft consistency containing greater than 10 percent organic matter.

MUD - A mixture of soil and water in a fluid or weakly solid state.

NATURAL SAND - Any sand that is found to exist in a natural deposit.

OPTIMUM MOISTURE CONTENT (OPTIMUM WATER CONTENT) - The water content at which a soil can be compacted to the maximum dry density by a given compactive effort.

PEAT - A fibrous mass of organic matter in various stages of decomposition, generally dark brown to black in color and of spongy consistency.

PERCENT COMPACTION - The ratio, expressed as a percentage, of dry density of a soil to maximum density obtained in a laboratory compaction test.

PERMEABILITY - The property of a soil allowing it to transmit water; largely dependent upon the size and number of continuous soil pores.

pH - An index of the acidity or alkalinity of a soil where seven is neutral, below seven is acidic and above seven is alkaline.

PLASTICITY INDEX - Numerical difference between the liquid limit and the plastic limit.

PLASTIC LIMIT - The water content corresponding to an arbitrary limit between the plastic and the semisolid states of consistency of soil.

POZZOLANS - Siliceous or siliceous and aluminous materials, which in themselves possess little or no cementitious value, but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

PVC - Polyvinyl chloride, a plastic polymer.

SAMPLING - The process of selecting a fraction of a total material that is similar in all respects to the total material.

SACK - A standard unit of dry powder cement with a mass (weight) of 42.64 kg (94 pounds).

SAND (AASHTO) - Particles of rock that will pass the 2.00 mm (No. 10) sieve and be retained on the 75 µm (No. 200) sieve.

SCREENED SAND - The product resulting from the mechanical screening of natural sands or gravels.

SILICA FUME - An extremely fine product of high amorphous silica content resulting from the condensation of rising vapor given off in the manufacture of ferrosilicon and metallic silicon in high temperature electric arc furnaces. This material is also referred to as Microsilica.

SILT - Material passing the 75 μm (No. 200) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air-dry.

STONE SCREENINGS - The product resulting exclusively from the mechanical crushing of quarried bedrock.

TENSILE STRENGTH - The maximum tensile stress that a material is capable of sustaining.

THIN PIECE - One for which the ratio of the width to thickness of its circumscribing rectangular prism is greater than five to one.

THIN AND ELONGATED PIECES – One in which the ratio of the length to the thickness of its circumscribed rectangular prism is greater than five to one.

WANE - Bark or lack of wood on the surface or edges of lumber.

YIELD STRENGTH - The stress at which a material exhibits a specified limiting deviation from the proportionality of stress to strain.

SECTION 701 - HYDRAULIC CEMENT

701.01 GENERAL REQUIREMENTS.

(a) General. The Contractor shall provide suitable means for storing and protecting the cement against dampness. Cement which, for any reason, has become partially set or which contains lumps or is caked shall be rejected.

The mixing of different brands or types of Portland cement, and the mixing of Portland cement of the same brand or types from different mills, will not be permitted except by written permission of the Engineer.

(b) Certification. A Type E Certification shall be furnished as specified in Subsection 700.02. A delivery slip or bill of lading shall accompany each transport identifying the manufacturer, whom the material was shipped to, date of delivery, and an

identification number traceable to a discrete quantity of material with certified test results.

701.02 PORTLAND CEMENT. Portland cement shall conform to the requirements of AASHTO M 85, Type II, unless otherwise shown on the Plans or directed by the Engineer. Portland cements that fail to meet all parts of AASHTO M 85 due to the dilution of the original cement with added limestone will be acceptable, provided the original Portland cement used in the product met AASHTO M 85 requirements prior to the addition of limestone.

701.03 THIS SUBSECTION RESERVED

701.04 HIGH EARLY STRENGTH PORTLAND CEMENT. High early strength Portland cement shall conform to the requirements of AASHTO M 85, Type III.

701.05 PORTLAND-POZZOLAN CEMENT. Portland-pozzolan cement shall conform to the requirements of AASHTO M 240, Type IP except that the pozzolan constituent shall be not more that 20 percent of the total mass (weight) of the Portland-pozzolan cement.

701.06 BLENDED SILICA FUME CEMENT. Blended silica fume cement shall conform to the requirements of ASTM C 1157.

701.07 PORTLAND BLAST-FURNACE SLAG CEMENT. Portland Blast-furnace Slag Cement, Type IS shall conform to the requirements of AASHTO M 240, except that for concrete mixes complying with Tables 501.03A and 541.03A the slag constituent shall not be more than 25 percent of the total mass (weight) of the Portland Blast-furnace Slag Cement.

A Type D Certification shall accompany each shipment of blended silica fume cement identifying the percent, by mass (weight), of silica fume contained in the blend.

SECTION 702 - BITUMINOUS MATERIALS

702.01 GENERAL REQUIREMENTS.

(a) Sampling. Bituminous materials shall be sampled at the delivery point from vehicle tanks, above ground stationary tanks, or asphalt plant feed lines in a manner that the samples will show the true nature and condition of the materials. Certification under part (e) below shall cover the material until test results are obtained for the material.

(b) Sampling Valves. Sampling valves shall be installed in strategic locations, readily accessible so that representative samples of the required size can be obtained easily and quickly. The sampling valve shall be constructed of materials compatible with the product at the temperatures handled. The valve seat shall be either inside the tank or compartment or inside the insulating jacket. The flow shall be over a route that is as short and direct as practical. Pockets that will retain product will not be allowed. The outlet shall be a 20 mm (3/4 inch) DN pipe size. The outlet shall be provided with a chained cap or plug. The sampling valves shall conform to the requirements of AASHTO T 40.

(c) Location of Sampling Valves. The recommended location and number of sampling valves needed is as follows:

(1) Vehicle Tanks. The sampling valve shall be located below the horizontal mid line of the end head (rear preferred) at least 300 mm (12 inches) from the shell. The inlet to the sampling valve shall be at least 150 mm (6 inches) from walls or other internal surfaces, except that it shall be at least 300 mm (12 inches) from any heating surface.

(2) Horizontal Tanks. The location on horizontal tanks shall be below the horizontal mid line of an end bulkhead. The inlet of the sampling device shall be at least 1 m (3 feet) from the bottom and 300 mm (12 inches) from the shell.

(3) Vertical Tanks. On vertical tanks, where the contents can be agitated, one sampling device shall be required. It shall be located on the side, at least 1060 mm (42 inches) from the bottom.

On vertical tanks, not capable of being agitated, two sampling devices shall be required. They shall be located, with easy and safe access provided, on the side of the tank, as follows: One no closer than 900 mm (36 inches) from the top, and one no closer than 1060 mm (42 inches) from the bottom

(4) Asphalt Plant Feed Lines. The sampling valve should be located downstream of all additive lines and be 600 mm (24 inches) to 900 mm (36 inches) above the surface and preferably on a horizontal feed line.

Note: All sampling valves should be protected from inclement weather as not to spray hot liquid or introduce moisture.

(d) Defective Sampling Valves. When there is an apparent defect in the sampling valve and a sample cannot be obtained as indicated, the following procedure shall be used:

(1) The sample shall be taken directly from the tank, through the inspection access port or an alternate valve.

(2) A defective equipment tag shall be made out and attached to the valve and the plant manager or carrier shall be notified.

(3) A notation shall be made in the plant log or Engineer's daily report giving location of valve, date, storage tank, vehicle tank, or the asphalt plant number. The plant manager or carrier shall make the necessary repairs within 48 hours from the time notification is given.

(4) If, at the end of the repair period, the plant or tank valve is still found to be defective, the plant shall be shut down and not started again until repairs are made and inspected to the satisfaction of the plant engineer.

(5) Should the tanker return on a second trip and the defective tanker valve not be repaired, the load shall not be used but shall be returned to the sender.

(e) Certification. No bituminous material will be used on any project until the required certifications covering the entire shipment have been received.

702.02 PERFORMANCE-GRADED ASPHALT BINDER (PREPARED FROM PETROLEUM).

(a) Properties. Performance-graded asphalt binder shall be homogenous, uniformly mixed and blended liquid bituminous materials that are free of contaminants such as water, fuel oils or other solvents, and shall not foam when heated to 175 °C (350 ºF). Performance-graded asphalt binder shall meet the requirements of AASHTO M 320 and AASHTO R 29.

The performance-graded manufacturer/supplier shall furnish to the Agency a Certificate of Analysis (COA) and bill of lading representing each delivery in accordance with AASHTO R 26. The Certificate of Analysis must also indicate the binder specific gravity, rotational viscosity, and the mixing and compaction viscosity-temperature chart for each shipment..

(b) Pretest. Failure of performance-graded asphalt binder from any one source to meet the Specifications may require placing this source on Pretest Status. This will require that samples from the source be tested in the Agency's Materials and Research Laboratory and accepted prior to being used on a project.

(1) The Pretest Status will remain in effect for three consecutive samples meeting AASHTO M320 specifications or until the Engineer is satisfied there is no longer any reason to continue on a Pretest Status.

(c) Certification. A Type E Certification shall be furnished in accordance with Subsection 700.02.

702.03 THIS SUBSECTION RESERVED

702.04 EMULSIFIED ASPHALT. Emulsified asphalt shall be homogeneous. It shall show no separation of asphalt at the time of use and shall be used within 30 calendar days after delivery from the manufacturer/supplier.

Emulsified asphalt shall not be allowed to freeze.

(a) Properties. Emulsified asphalt shall conform to the requirements of AASHTO M 140 or AASHTO M 208, as appropriate.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

702.05 TAR EMULSION.

(a) Properties. This material shall conform to the requirements of ASTM D 3320 except that paragraph 4.3 shall not apply.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

702.06 APPLICATION TEMPERATURES. Bituminous materials for the applications specified in the Specifications shall be applied within the temperature ranges designated the following table:

TABLE 702.06A - APPLICATION TEMPERATURES

Performance-Graded Asphalt Binder	ºC				ºF			
	Spray		Mix		Spray		Mix	
	Min	Max	Min	Max	Min	Max	Min	Max.
Asphalt Treated Permeable Base, Section 303	---	---	116	138	---	---	240	280
Marshall Bituminous Concrete Pavement, Section 406	---	---	---	*	---	---	---	*
Superpave Bituminous Concrete Pavement, Section 490	---	---	---	*	---	---	---	*
Emulsified Asphalt								
RS-1	21	60	---	---	70	140	---	---
RS-2, CRS-1	49	71	---	---	120	160	---	---
CRS-2	60	79	---	---	140	175	---	---
SS-1h, CSS1h	24	54	10	54	75	130	50	130
MS-2h, CMS-2h	---	---	24	60	---	---	75	140

*As required to achieve a kinematic viscosity of 170 ± 20 centistokes.

702.07 ANTI-STRIP ADDITIVES. Anti-strip additives shall be capable of improving the bonding properties of the cutback asphalt or the performance-graded asphalt binder to the aggregates in the presence of moisture and shall also be capable of reducing film stripping.

(a) Performance-Graded Asphalt Binder. The additive used in performance-graded asphalt binder shall be heat stable for all temperature ranges prescribed for such performance-graded asphalt binder. The additive shall not alter the material properties nor change the grade of the performance-graded asphalt binder when added in the recommended proportions. The additive shall be capable of thorough dispersion in the performance-graded asphalt binder and capable of remaining in the performance-graded asphalt binder, in storage, and at temperatures specified for the mix without losing its effectiveness.

(b) Testing Procedures. Testing of anti-strip additives shall be in accordance with, and meet the requirements of, Vermont Agency of Transportation Test Procedures MRD-1 and MRD-10.

The percentage of anti-strip additive shall be a minimum of 0.5 percent of the asphalt content and shall be adjusted, as required, above this amount to meet testing requirements. Prior to the use of any anti-strip additive, the Contractor shall submit for testing and approval samples of the specific aggregates, the specific asphalt and the specific anti-strip additive proposed for the mix design.

To identify any change in effectiveness, the asphalt and the anti-strip additive being used shall acceptably pass the requirements of the MRD-10 test procedure on a daily basis.

702.08 SILICONE ADDITIVE. Silicone additive shall be a silicone material of the dimethyl polisiloxane type with a viscosity grading of 1000 ± 200 centistokes at 25 °C (77 °F). It shall be added to the liquid performance-graded asphalt binder at hot mix plants in amounts not to exceed five parts per million. After addition of the silicone additive, the performance-graded asphalt binder shall be thoroughly mixed by mechanical means to ensure complete dispersal.

Other types of silicone material, or the addition of amounts in excess of five parts per million, must be approved by the Engineer before being used in the work.

SECTION 703 - SOILS AND BORROW MATERIALS

703.01 CLASSIFICATION OF SOILS. Based upon their field performance, soils shall be classified into seven groups that shall be designated as A-1, A-2, A-3, A-4, A-5, A-6, and A-7. This classification shall be based upon the results of tests made in accordance with AASHTO M 145, as designated in the following table:

TABLE 703.01A - CLASSIFICATION OF SOILS

General Classification	Granular Materials			Silt-Clay Materials								
	A-1			A-2							A-7	
Group Classification	A-1-a	A-1-b	A-3	A-2-4	A-2-5	A-2-6	A-2-7	A-4	A-5	A-6	A-7-5	A-7-6
Sieve Analysis, percent passing:												
2.00 mm (No. 10)	50-	---	---	---	---	---	---	---	---	---	---	---
425 µm (No. 40)	30-	50-	50+	---	---	---	---	---	---	---	---	---
75 µm (No. 200)	15-	25-	10-	35-	35-	35-	35-	36+	36+	36+	36+	36+
Characteristics of fraction passing 425 µm (No. 40) sieve:												
Liquid Limit	---		---	40-	41+	40-	41+	40-	41+	40-	41+	
Plasticity Index	6-		NP	10-	10-	11+	11+	10-	10-	11+	11+	
Usual Types of Soils	Gravel and Sand		Fine Sand	Silty or Clayey Gravel and Sand				Silty Soils		Clay Soils		

\+ indicates that value shown is the minimum allowable.
\- indicates that value shown is the maximum allowable.
NP indicates non-plastic.
Plasticity Index of A-7-5 subgroup is equal to or less than Liquid Limit minus 30.
Plasticity Index of A-7-6 subgroup is greater than Liquid Limit minus 30.

Classification Procedure. With the required data, proceed from left to right on above chart, and the correct group will be found by the process of elimination. The first group from left into which the test data will fit is the correct classification.

Where the Unified Soil Classification System (USCS) is referenced in the Contract, it shall be based on the Soil Classification Chart in ASTM D 2487.

703.02 EARTH BORROW. Earth borrow shall be material of a quality approved by the Agency as meeting the requirements for the particular embankment, backfill, or other use for which the material is intended, and shall show evidence of satisfactory compaction when placed in embankments.

The natural moisture content shall be less than the laboratory optimum moisture content as determined in accordance with AASHTO T 99, Method C.

703.03 SAND BORROW AND CUSHION. Sand borrow and sand cushion shall consist of material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the requirements of the following table as determined in accordance with AASHTO T 27:

TABLE 703.03A - SAND BORROW AND CUSHION

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
50 mm (2 inch)	100
37.5 mm (1 1/2 inch)	90 to 100
12.5 mm (1/2 inch)	70 to 100
4.75 mm (No. 4)	60 to 100
150 µm (No. 100)	0 to 20
75 µm (No. 200)	0 to 8

703.04 GRANULAR BORROW. Granular borrow shall be obtained from approved sources, consisting of stone and sand reasonably free from loam, silt, clay, and organic material and shall meet the requirements of the following table as determined in accordance with AASHTO T 27:

TABLE 703.04A - GRANULAR BORROW

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
4.75 mm (No. 4)	20 to 100
75 μm (No. 200)	0 to 12

The maximum size of stone particles in the granular borrow shall not exceed 67 percent of the thickness of the layer being spread.

703.05 ROCK BORROW. Rock borrow shall consist of blasted rock broken into various sizes that will form a compact embankment with a minimum of voids. The maximum size shall be 900 mm (36 inches) in its widest dimension and that size which may be incorporated in a 600 mm (24 inch) layer of rock embankment.

SECTION 704 – AGGREGATES

704.01 FINE AGGREGATE FOR CONCRETE. Fine aggregate for concrete shall consist of natural sand washed in an approved manner or a combination of washed natural sand and stone screenings. The stone screenings shall not exceed 50 percent by mass (weight) of the combination.

Fine aggregate shall consist of clean, hard, durable grains, uniformly graded from coarse to fine, and shall be free from injurious amounts of organic matter or other harmful substances.

(a) Grading. Fine aggregate for concrete shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27, with the exception that when the material is being tested in a Producer's laboratory the AASHTO T 27 requirement to perform AASHTO T 11 on the material passing the #200 sieve is waived and the material reported as passing the #200 sieve is obtained by dry sieving methods only :

TABLE 704.01A - FINE AGGREGATE FOR CONCRETE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
9.5 mm (3/8 inch)	100
4.75 mm (No. 4)	95 to 100
1.18 mm (No. 16)	50 to 80
600 µm (No. 30)	25 to 60
300 µm (No. 50)	10 to 30
150 µm (No. 100)	2 to 10

The fineness modulus on that portion of material passing the 9.5 mm (3/8 inch) sieve shall be determined by laboratory sieve test(s). This fineness modulus is defined as the summation of the percentages of sand retained on the following sieve sizes: 150 µm (No. 100), 300 µm (No. 50), 600 µm (No. 30), 1.18 mm (No. 16), 2.36 mm (No. 8), and 75 mm (No. 4), divided by 100. The minimum and maximum fineness moduli shall be 2.60 and 3.10, respectively. Fine aggregate from any one source for any one designated mix having a variation in fineness modulus greater than ± 0.20 from the fineness modulus of a representative sample proposed for use may be rejected.

(b) Organic Impurities. Fine aggregate for concrete shall show a color of not greater than two as determined in accordance with AASHTO T 21.

(c) Compressive Strength of Mortar. When sand or a combination of stone screenings and sand is mixed with Portland cement in the proportion of one part of cement to three parts of sand (or of the combination of stone screenings and sand) by mass (weight), according to the standard method of making 50 mm (2 inch) cubes, the resulting mortar at the age of three and seven days shall have a compressive strength of at least 100 percent of that developed in the same time by mortar of the same proportions and flow, made of the same cement and graded Ottawa sand, when tested in accordance with the requirements of AASHTO T 106M/T 106. Only one series of mortar cube compressive strength tests will be required for each fine aggregate source in any one calendar year unless the Engineer deems additional testing necessary.

(d) Soundness. When there is any question of either soft or laminated pieces being detrimental to any aggregate, a soundness test shall be performed on the aggregate in accordance with AASHTO T 104. The weighted average percentage of loss shall be not more than 8 percent by mass (weight) when subjected to five cycles of the sodium sulfate soundness test.

(e) Alkali-Silica Reaction (ASR). Fine aggregate shall be tested for Alkali-Silica Reaction (ASR) in accordance with AASHTO T 303. This test shall be run for initial source testing or as deemed necessary.

704.02 COARSE AGGREGATE FOR CONCRETE. Coarse aggregate for concrete shall consist of clean, hard, crushed stone or washed crushed gravel, uniformly graded. The blending of crushed stone and crushed gravel in the stockpile shall not be permitted. It shall be free from deleterious material and pieces that are structurally weak, and when proportioned in concrete shall not adversely affect the structural integrity or durability of the concrete when subjected to freezing and thawing. It shall also meet the following requirements:

(a) Grading. Coarse aggregate for concrete shall be furnished in the required separate size(s) for the specified class of concrete and shall meet the gradation requirements of the following tables as determined in accordance with AASHTO T 27, with the exception that when the material is being tested in a Producer's laboratory the AASHTO T 27 requirement to perform AASHTO T 11 on the material passing the #200 Sieve is waived and the material reported as passing the #200 sieve is obtained by dry sieving methods only:

TABLE 704.02A - GRADATION REQUIREMENTS
FOR 9.5 MM (3/8 INCH) STONE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
12.5 mm (1/2 inch)	100
9.5 mm (3/8 inch)	85 to 100
4.75 mm (No. 4)	10 to 30
2.36 mm (No. 8)	0 to 10
1.18 mm (No. 16)	0 to 5

TABLE 704.02B - GRADATION REQUIREMENTS
FOR 19.0 MM (3/4 INCH) STONE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
25.0 mm (1 inch)	100
19.0 mm (3/4 inch)	90 to 100
9.5 mm (3/8 inch)	20 to 55
4.75 mm (No. 4)	0 to 10
2.36 mm (No. 8)	0 to 5

TABLE 704.02C - GRADATION REQUIREMENTS
FOR 37.5 MM (1 1/2 INCH) STONE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
50 mm (2inch)	100
37.5 mm (1 1/2 inch)	95 to 100
19 mm (3/4 inch)	35 to 70
9.5 mm (3/8inch)	10 to 30
4.75 mm (No.4)	0 to 5

(b) Percent of Wear. When the coarse aggregate is composed of crushed stone or crushed gravel, the percent of wear of the aggregate shall not be more than 35 percent when tested in accordance with AASHTO T 96. When the coarse aggregate is composed of crushed igneous rock, the percent of wear of the aggregate shall not be more than 50 percent when tested in accordance with AASHTO T 96.

(c) Fractured Faces. When crushed gravel is used as coarse aggregate, at least 50 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve from each stockpile shall have at least one fractured face in accordance with Vermont Standard Test Procedures AOT-MRD 23.

(d) Thin and/or Elongated Pieces. Not more than 10 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve from each stockpile shall consist of thin and/or elongated pieces in accordance with Vermont Standard Test Procedures AOT-MRD 22.

(e) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

(f) Aggregate Failure. Coarse aggregate that fractures when used in a test cylinder, at a compressive strength less than the minimum compressive strength of the class of concrete tested, may be rejected.

(g) Freeze-Thaw. Coarse aggregate shall be tested for freeze-thaw resistance in accordance with AASHTO T 161, except as modified to use 3% sodium chloride solution and excess weight loss of more than 8% to constitute a failure. This test shall be run for initial source testing or as deemed necessary.

(h) Alkali-Silica Reaction (ASR). Coarse aggregate shall be tested for Alkali-Silica Reaction (ASR) in accordance with AASHTO T 303. This test shall be run for initial source testing or as deemed necessary.

704.03 AGGREGATE FOR ASPHALT TREATED PERMEABLE BASE. Aggregate for Asphalt Treated Permeable Base shall consist of clean, hard, crushed stone or crushed gravel. The blending of crushed stone and crushed gravel may be permitted if, in the opinion of the Engineer, the materials to be blended are equal in quality and are compatible. The several aggregate fractions shall be sized, uniformly

graded, and combined in such proportions that the resulting gradation meets the requirements of Subsection 303.02. The aggregate shall be reasonably free from dirt, deleterious material, and pieces that are structurally weak and shall meet the following requirements:

(a) Percent of Wear. When the coarse aggregate is composed of crushed stone or crushed gravel, the percent of wear of the aggregate shall not be more than 35 percent when tested in accordance with AASHTO T 96. When the aggregate is composed of crushed igneous rock, the percent of wear of the aggregate shall not be more than 50 percent when tested in accordance with AASHTO T 96.

(b) Fractured Faces. When crushed gravel is used, at least 75 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve from each stockpile shall have at least two fractured faces in accordance with Vermont Standard Test Procedures AOT-MRD 23.

(c) Thin and/or Elongated Pieces. Not more than 10 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve from each stockpile shall consist of thin and/or elongated pieces in accordance with Vermont Standard Test Procedures AOT-MRD 22.

(d) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

704.04 GRAVEL FOR SUBBASE. Gravel for subbase shall consist of material reasonably free from silt, loam, clay, and organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. Gravel for subbase shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.04A - GRAVEL FOR SUBBASE

Sieve Designation	Percentage By Mass (Weight) Passing Square Mesh Sieves
4.75 mm (No. 4)	20 to 60
150 µm (No. 100)	0 to 12
75 µm (No. 200)	0 to 6

The gravel shall be uniformly graded from coarse to fine. The maximum size stone particles shall not exceed 67 percent of the thickness of the layer being placed.

(b) Percent of Wear. Percent of wear shall not be more than 50 percent when tested in accordance with AASHTO T 96.

704.05 CRUSHED GRAVEL FOR SUBBASE. Crushed gravel for subbase shall be produced from natural gravels or crushed quarried rock and shall be a material reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. Crushed gravel for subbase shall be uniformly graded from coarse to fine and shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.05A - CRUSHED GRAVEL FOR SUBBASE

Grading	Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
Coarse	100 mm (4 inch)	95 to 100
	4.75 mm (No. 4)	25 to 50
	150 µm (No. 100)	0 to 12
	75 µm (No. 200)	0 to 6
Fine	50 mm (2 inch)	100
	37.5 mm (1 1/2 inch)	90 to 100
	4.75 mm (No. 4)	30 to 60
	150 µm (No. 100)	0 to 12
	75 µm (No. 200)	0 to 6

(b) Percent of Wear. Percent of wear shall not be more than 40 percent when tested in accordance with AASHTO T 96.

(c) Fractured Faces. At least 50 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve shall have at least one fractured face in accordance with Vermont Standard Test Procedures AOT-MRD 23.

704.06 DENSE GRADED CRUSHED STONE FOR SUBBASE. Dense graded crushed stone for subbase shall consist of clean, hard, uniformly graded, crushed stone. It shall be sufficiently free from dirt, deleterious material, and pieces that are structurally weak and shall meet the following requirements:

(a) Source. This material shall be obtained from approved sources. The area from which this material is obtained shall be stripped and cleaned before blasting.

(b) Grading. Dense graded crushed stone for subbase shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.06A - DENSE GRADED CRUSHED STONE FOR SUBBASE

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
90 mm (3 1/2 inch)	100
75 mm (3 inch)	90 to 100
50 mm (2 inch)	75 to 100
25.0 mm (1 inch)	50 to 80
12.5 mm (1/2 inch)	30 to 60
4.75 mm (No. 4)	15 to 40
75 µm (No. 200)	0 to 6

(c) Percent of Wear. The percent of wear of the crushed stone shall be not more than 40 percent when tested in accordance with AASHTO T 96. When the aggregate is composed of crushed igneous rock, the percent of wear of the crushed stone shall be not more than 50 percent when tested in accordance with AASHTO T 96.

(d) Thin and/or Elongated Pieces. Not more than 30 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve shall consist of thin and/or elongated pieces in accordance with Vermont Standard Test Procedures AOT-MRD 22.

(e) Filler. Filler shall be obtained from approved sources and shall consist of clean, hard, uniform graded, crushed stone and/or stone screenings produced by the crushing process. The material shall consist of hard, durable particles sufficiently free from dirt, organic material, structurally weak pieces, and other deleterious materials and shall comply with the requirements of parts (a), (c), and (d) above.

Filler material shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.06B - FILLER

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
19.0 mm (¾ inch)	100
12.5 mm (½ inch)	70 to 100
4.75 mm (No. 4)	50 to 90
150 µm (No. 100)	0 to 12
75 µm (No. 200)	0 to 6

704.07 GRAVEL BACKFILL FOR SLOPE STABILIZATION. Gravel backfill for slope stabilization shall meet the requirements of Subsection 704.04(a).

704.08 GRANULAR BACKFILL FOR STRUCTURES. Granular backfill for structures shall be obtained from approved sources. It shall consist of satisfactorily graded, free draining granular material reasonably free from loam, silt, clay, and organic material.

Granular backfill for structures shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.08A –
GRANULAR BACKFILL FOR STRUCTURES

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
75 mm (3 inch)	100
4.75 mm (No. 4)	45 to 75
150 µm (No. 100)	0 to 12
75 µm (No. 200)	0 to 6

704.09 BACKFILL FOR MUCK EXCAVATION. Backfill for muck excavation shall consist of granular material or blasted rock broken into various sizes that will form a compact embankment with a minimum of voids.

When granular material is used, it shall meet the requirements of Subsection 703.04.

704.10 AGGREGATE FOR BITUMINOUS CONCRETE PAVEMENT.

(a) Aggregate for Marshall Bituminous Concrete Pavement. Coarse aggregate for Marshall bituminous concrete pavement shall consist of clean, hard, crushed stone or crushed gravel, and be uniformly graded. The blending of crushed stone and crushed gravel may be permitted only in the binder course if, in the opinion of the Engineer, the materials to be blended are equal in quality and are compatible. All aggregate shall be free from dirt, deleterious material, and pieces that are structurally weak. "Coarse Aggregate" shall mean that portion of material coarser than the 2.36 mm (No. 8) sieve.

Fine aggregate for Marshall bituminous concrete pavement shall consist of stone screenings or a combination of stone screenings, screened natural and/or manufactured sands, and other fine aggregates, such that at least 95 percent of any individual stockpile of the fine aggregate shall pass a 9.5 mm (3/8 inch) sieve. The minimum percentage by mass (weight) of the blended material passing the 2.36 mm (No. 8) sieve that must be stone screenings shall be as shown in Table 406.03B of Subsection 406.03(b), unless otherwise authorized in writing by the Engineer.

Manufactured sand may be substituted for stone screenings when 100 percent of the material passing the 2.36 mm (No. 8) sieve has two or more fractured faces as determined in accordance with ASTM C 295 Modified.

(1) Grading.

a. Coarse Aggregate. Coarse aggregate shall be furnished in at least three nominal sizes for Mix Type I and in at least two nominal sizes for Mix Types II and III.

The gradation of the coarse aggregate shall be such that when combined with the fine aggregate, the composite aggregate meets the gradation requirements for bituminous concrete pavement specified in Subsection 406.03(a). The process of blending coarse and fine aggregates shall be accomplished through the use of separate bins. Blending in the stockpile shall not be permitted.

b. Fine Aggregate. The gradation of the fine aggregate shall be such that, when combined with a coarse aggregate, the composite aggregate meets the gradation requirements for bituminous concrete specified in Subsection 406.03(a). The process of blending fine and coarse aggregates shall be accomplished through the use of separate bins. Blending in the stockpile shall not be permitted.

The percentage of fine aggregate passing the 2.36 mm (No. 8) sieve shall remain uniform within a tolerance of ± 15 percent for any one mix design. Material produced that does not meet this tolerance may be stockpiled separately and used after an appropriate change is made in the mix design.

c. Recycled Asphalt Pavement (RAP). When RAP is used to produce bituminous concrete pavement, the resulting mixture shall meet all specification requirements for the type(s) of mix specified. The percentage of RAP, when

stated as a percentage of the total mix, shall be limited to a maximum of 50.0 percent for both design and production purposes.

The bitumen component of the RAP shall be free of significant contents of solvents, tars, or other contaminating substances that will make the RAP unacceptable for recycling as determined by the Engineer.

Should the characteristics of any proposed material for recycling be such that an acceptable mixture cannot be produced and/or maintained, the recycled mix will not be allowed for use on the project.

The Contractor may blend, crush, or prepare the proposed RAP(s) into one or more homogenous stockpiles.

When a bituminous concrete pavement is proposed using RAP, the Contractor shall submit, with the mix design information, an analysis of the RAP material. The analysis of the RAP material shall include an extracted aggregate gradation, coarse aggregate specific gravity, fine aggregate specific gravity, asphalt content, and recovered binder values. The recovered binder values will be obtained by AASHTO M 320 testing for the designated project PG grade. The recovered RAP binder material shall be graded according to AASHTO R 29 for all samples. AASHTO M 320 testing will consist of Dynamic Shear Rheometer (DSR) values tested under Original, Rolling Thin Film Oven (RTFO) residue and Pressure Aging Vessel (PAV) residue parameters, and Bending Beam Rheometer (BBR) values. The recovered asphalt will be aged with the RTFO and the PAV for this testing. A minimum of four samples shall be analyzed (or tested) to produce design data. The analysis shall be valid for a 12 month period.

The gradation of the RAP shall be such that, when combined with a coarse and fine aggregate, the composite aggregate shall meet the specified gradation requirements for bituminous concrete in Subsection 406.03(a). The process of blending the RAP, fine aggregate, and coarse aggregate shall be accomplished through the use of separate bins. Blending of these materials in the stockpiles shall not be permitted.

(2) Percent of Wear. When the coarse aggregate is composed of crushed stone or crushed gravel, the percent of wear of the aggregate shall not be more than 35 percent when tested in accordance with AASHTO T 96. When the coarse aggregate is composed of crushed igneous rock, the percent of wear of the aggregate shall not be more than 50 percent when tested in accordance with AASHTO T 96.

(3) Fractured Faces. When crushed gravel is used as coarse aggregate, at least 75 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve shall have at least two fractured faces in accordance with Vermont Standard Test Procedures AOT-MRD 23.

(4) Thin and/or Elongated Pieces. Not more than 10 percent by mass (weight) of the blended material coarser than the 4.75 mm (No.4) sieve shall consist of aggregates which have a ratio of maximum to minimum dimensions greater than five (5). Measurement is made using test method ASTM D 4791 "Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregates, Section 8.4." This criterion is used for design and field control to monitor aggregate production in accordance with Vermont Standard Test Procedures AOT-MRD 22.

(5) Mineral Filler. Mineral filler shall consist of approved limestone dust, talc dust, or other approved materials and shall be added to the aggregate if required.

(6) Soundness. Soundness shall meet the requirements of Subsection 704.01(d), except the percentage of loss shall not be more than 12 percent by mass (weight) and shall apply to wearing course aggregates only.

(7) Control of Aggregate Stockpiles. Before the start of bituminous concrete paving operations and throughout the duration of the paving operation, the cold feed aggregate stockpiles shall each contain at least 1000 metric tons (1000 tons) of accepted aggregate, or the amount required for the job when less than 1000 metric tons (1000 tons).

The addition of unacceptable material to an accepted stockpile shall result in the rejection of the entire stockpile.

The stockpiles shall be separated by partitions or otherwise separated to the satisfaction of the Engineer to prevent intermixing.

All stockpiles shall be maintained at the mixing plant site unless otherwise authorized in writing by the Engineer.

The respective sources of all aggregates to be used in the wearing course shall remain the same for the entire project, unless otherwise authorized in writing by the Engineer.

(b) Aggregate for Superpave Bituminous Concrete Pavement. Coarse aggregate for Superpave bituminous concrete pavement shall consist of clean, hard, crushed stone, crushed gravel, or crushed igneous rock, and be uniformly graded. The blending of crushed stone, crushed gravel, and/or crushed igneous rock may be permitted only in the binder course if, in the opinion of the Engineer, the materials to be blended are equal in quality and are compatible. All aggregate shall be free from dirt, deleterious material, and pieces which are structurally weak. "Coarse Aggregate" shall mean that portion of material coarser than the 2.36 mm (No.8) sieve.

Fine aggregate for Superpave bituminous concrete pavement shall consist of stone screenings or a combination of stone screenings, screened natural sand and/or manufactured sands, and other fine aggregates, such that at least 95 percent of any individual stockpile of the fine aggregate shall pass a 9.50 mm (3/8 inch) sieve. "Fine Aggregate" shall mean that portion of material finer than the 2.36 mm (No.8) sieve.

(1) Grading.

a. Coarse Aggregate. Coarse aggregate shall be furnished in at least three nominal sizes for Mix Type IS and in at least two nominal sizes for Mix Types IIS and IIIS.

The gradation of the coarse aggregate shall be such that when combined with the fine aggregate, the composite gradation shall meet the gradation requirements for Superpave bituminous concrete pavement specified in Subsection 490.03(a). The process of blending coarse and fine aggregates shall be accomplished through the use of separate bins. Blending in the stockpile shall not be permitted.

b. Fine Aggregate. The gradation of the fine aggregate shall be such that, when combined with a coarse aggregate, the composite aggregate meets the gradation requirements for Superpave bituminous concrete pavement specified in Subsection 490.03(a). The process of blending fine and coarse aggregates shall be accomplished through the use of separate bins. Blending in the stockpile shall not be permitted.

The percentage of fine aggregate passing the 2.36mm (No.8) sieve shall remain uniform within a tolerance of ± 15 percent for any one mix design. Material produced that does not meet this tolerance may be stockpiled separately and used after an appropriate change is made in the mix design.

c. Recycled Asphalt Pavement (RAP). RAP shall be permitted to be used in Superpave bituminous concrete pavement. The percentage of RAP, when stated as a percentage of the total mix, shall be limited to a maximum of 50.0 percent for both design and production purposes.

When RAP is used to produce Superpave bituminous concrete pavement, the resulting mixture shall meet all specification requirements for the type of mix specified.

The bitumen component of the RAP shall be free of significant contents of solvents, tars, or other contaminating substances that will make the RAP unacceptable for recycling as determined by the Engineer.

Should the characteristics of any proposed material for recycling be such that an acceptable mixture cannot be produced and/or maintained, the recycled mix will not be allowed for use on the project.

The Contractor may blend, crush, or prepare the proposed RAP(s) into one or more homogenous stockpiles.

When a Superpave bituminous concrete pavement is proposed using RAP, the Contractor shall submit, with the mix design information, an analysis of the RAP material. The analysis of the RAP material shall include an extracted aggregate gradation, coarse aggregate specific gravity, fine aggregate specific gravity, asphalt content, and recovered binder values. The recovered binder values will be obtained by AASHTO M 320 testing for the designated project PG grade. The recovered RAP binder material shall be graded according to AASHTO R 29 for all samples. AASHTO M 320 testing will consist of Dynamic Shear Rheometer (DSR) values tested under Original, Rolling Thin Film Oven

(RTFO) residue and Pressure Aging Vessel (PAV) residue parameters, and Bending Beam Rheometer (BBR) values. The recovered asphalt will be aged with the RTFO and the PAV for this testing. A minimum of four samples shall be analyzed (or tested) to produce design data. The analysis shall be valid for a 12 month period.

The gradation of the RAP shall be such that, when combined with a coarse and fine aggregate, the composite aggregate meets the gradation requirements for Superpave bituminous concrete pavement specified in Subsection 490.03(a). The process of blending the RAP, fine aggregate, and coarse aggregate shall be accomplished through the use of separate bins. Blending in the stockpile shall not be permitted.

(2) Percent of Wear. When the coarse aggregate is composed of crushed stone or crushed gravel, the percent of wear of the aggregate shall not be more than 35 percent when tested in accordance with AASHTO T 96. When the coarse aggregate is composed of crushed igneous rock, the percent of wear of the aggregate shall not be more than 50 percent when tested in accordance with AASHTO T 96.

(3) Fractured Faces. For Superpave bituminous concrete pavements the following design criteria must be met:

Angularity.

a. Coarse Aggregate. Coarse aggregate angularity criterion relates to a one or two fractured face count, as a percentage by mass (weight) of material coarser than the 4.75 mm (No. 4) sieve based on traffic (ESALs). A fractured face for this purpose is defined as an angular, rough, or broken surface of an aggregate created by any means. A face is considered a “fractured face” only if it has a projected area at least as large as 25 percent of the maximum projected area when viewed

directly on and the face has sharp and well defined edges. Measurement is made using test method ASTM D 5821 "Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate." Measurement is based on the blended aggregate and is used for design and field control to monitor aggregate production.

TABLE 704.10A – COARSE AGGREGATE ANGULARITY CRITERIA (MINIMUM) - FRACTURED FACE COUNT

Traffic (ESALs)	CA1/CA2
<30,000,000	95/90[(1)]
≥ 30,000,000	100/100

[(1)] 95/90 denotes that 95 percent of the coarse aggregate has one fractured face and 90 percent has two or more fractured faces.

b. Fine Aggregate. Fine aggregate angularity criteria is defined as the percent of air voids in loosely compacted aggregate that passes the 2.36 mm (No.8) sieve based on traffic (ESALs). Measurement is made using AASHTO Standard: "Standard Test Method for Uncompacted Void Content of Fine Aggregate; T 304, Method A", and is based on the blended aggregate. Results are used for design purposes, not as a field control tool.

TABLE 704.10B – FINE AGGREGATE ANGULARITY CRITERIA (MINIMUM) – UNCOMPACTED VOID CONTENT

Traffic (ESALs)	Uncompacted Void Content
All	45

(4) Thin and Elongated Pieces. Not more than 10 percent by mass (weight) of the blended material coarser than the 4.75 mm (No.4) sieve shall consist of aggregates which have a ratio of maximum to minimum dimensions greater than five (5). Measurement is made using test method ASTM D 4791 "Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregates, Section 8.4." This criterion is used for design and field control to monitor aggregate production.

(5) Mineral Filler. Mineral filler shall consist of approved limestone dust, talc dust, or other approved materials and shall be added to the aggregate if required.

(6) Soundness. Soundness shall meet the requirements of Subsection 704.01(d), except the percentage of loss should not be more than 12 percent by mass (weight) and shall apply to wearing course aggregates only.

(7) Control of Aggregate Stockpiles. Before the start of bituminous concrete paving operations and throughout the duration of the paving operation, the cold feed aggregate stockpiles shall each contain at least 1000 metric tons (1000 tons) of accepted aggregate, or the amount required for the job when less than 1000 metric tons (1000 tons).

The addition of unacceptable material to an accepted stockpile shall result in the rejection of the entire stockpile.

The stockpiles shall be separated by partitions or otherwise separated to the satisfaction of the Engineer to prevent intermixing.

All stockpiles shall be maintained at the mixing plant site unless otherwise approved in writing by to Engineer.

The respective sources of all aggregates to be used in the wearing course shall remain the same for the entire project unless otherwise approved in writing by the Engineer.

(8) Clay Content. Clay content criterion is a measure of the amount of clay material in the portion of blended aggregate finer than the 4.75 mm (No. 4) sieve based on traffic (ESALs). Measurement is made using AASHTO T 176. Results are used for design purposes and field control to monitor aggregate production.

TABLE 704.10C – CLAY CONTENT CRITERIA (MINIMUM) – SAND EQUIVALENT

Traffic (ESALs)	Sand Equivalent
≤ 30,000,000	45
> 30,000,000	50

704.11 AGGREGATE FOR BITUMINOUS SURFACE TREATMENT. The peastone and stone grits shall consist of washed crushed gravel or crushed stone and shall be reasonably free from dirt, deleterious material, and pieces that are structurally weak.

The sand shall be washed, natural sand and shall consist of clean, hard, durable grains, reasonably free from dirt and deleterious material.

(a) Grading. The peastone, stone grits, and sand shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.11A - AGGREGATES FOR BITUMINOUS SURFACE TREATMENT

Aggregates	Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
Peastone	19.0 mm (3/4 inch)	100
	16.0 mm (5/8 inch)	90 to 100
	4.75 mm (No. 4)	0 to 5
Stone Grits	12.5 mm (1/2 inch)	100
	9.5 mm (3/8 inch)	90 to 100
	2.36 mm (No. 8)	0 to 10
	75 μm (No. 200)	0 to 3
Sand	16.0 mm (5/8 inch)	100
	4.75 mm (No. 4)	90 to 100
	150 μm (No. 100)	0 to 8

(b) Percent of Wear.

(1) Crushed Gravel. When the aggregate is composed of crushed gravel, the percent of wear shall not be more than 35 percent when tested in accordance with AASHTO T 96. No wear requirements shall apply when grits are used as a shoulder treatment.

(2) Crushed Stone. When the aggregate is composed of crushed stone, the percent of wear of the aggregate shall not be more than 35 percent when tested in accordance with AASHTO T 96. No wear requirements shall apply when grits are used as a shoulder treatment.

(c) Fractured Faces. When crushed gravel is used at least 50 percent by mass (weight), of the material coarser than the 4.75 mm (No. 4) sieve from each stockpile shall have at least one fractured face.

(d) Thin and/or Elongated Pieces. Not more than 15 percent by mass (weight) of the material coarser than the 4.75 mm (No. 4) sieve shall consist of aggregates that have a ratio of maximum to minimum dimensions greater than five (5). Measurement is made using test method ASTM D 4791 "Flat Particles,

Elongated Particles, or Flat and Elongated Particles in Coarse Aggregates, Section 8.4." This criterion is used for design and field control to monitor aggregate production in accordance with Vermont Standard Test Procedures AOT-MRD 22.

704.12 AGGREGATE FOR SURFACE COURSE AND SHOULDERS. Aggregate for surface course and shoulders shall consist of clean, hard gravel, crushed gravel, or crushed stone. It shall be reasonably free from silt, loam, clay, or organic matter. It shall be obtained from approved sources and shall meet the following requirements:

(a) Grading. Aggregate for surface course and shoulders shall be uniformly graded from coarse to fine and shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.12A - AGGREGATE FOR SURFACE COURSE AND SHOULDERS

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
37.5 mm (1 1/2 inch)	100
25.0 mm (1 inch)	90 to 100
4.75 mm (No. 4)	45 to 65
150 µm (No. 100)	0 to 15
75 µm (No. 200)	0 to 12

(b) Percent of Wear. The percent of wear when tested in accordance with AASHTO T 96 shall be not more than 40 percent for material used as aggregate surface course or not more than 50 percent for material used as aggregate shoulders.

704.13 SAND FOR CEMENT MORTAR. Sand for cement mortar shall be a washed natural sand and shall consist of clean, hard, durable grains. It shall be uniformly graded from coarse to fine, and shall be free from injurious amounts of organic matter or other harmful substances.

(a) Grading. Sand for cement mortar shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27 and AASHTO T 11:

TABLE 704.13A - SAND FOR CEMENT MORTAR

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
2.36 mm (No. 8)	100
300 µm (No. 50)	15 to 40
150 µm (No. 100)	0 to 10
75 µm (No. 200)	0 to 5

(b) Organic Impurities. The sand shall show a color of not greater than two when determined in accordance with AASHTO T 21.

704.14 LIGHTWEIGHT COARSE AGGREGATE FOR STRUCTURAL CONCRETE. Lightweight coarse aggregate for structural concrete shall be clean, hard, and uniformly graded. It shall be reasonably free from dirt, deleterious material, and pieces that are structurally weak. It shall meet the following requirements:

(a) General Characteristics. Two general types of lightweight aggregates may be used:

(1) Aggregates prepared by expanding, calcining, or sintering products such as blast furnace slag, clay, shale, or slate. Other raw materials may be used if the resulting prepared aggregates meet the requirements of these specifications.

(2) Aggregates prepared by crushing, screening, and cleaning natural lightweight materials such as pumice, scoria, or tuff.

(b) Grading. Grading shall meet the requirements specified in Table 704.02B as determined in accordance with AASHTO T 27.

(c) Percent of Wear. Percent of wear shall not be more than 50 percent when tested in accordance with AASHTO T 96.

(d) Thin and/or Elongated Pieces. The thin and/or elongated pieces shall conform to the requirements specified in Subsection 704.02(d).

(e) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

(f) Density. The maximum dry loose density of the lightweight coarse aggregate shall not exceed 880 kg/m^3 (55 pounds per cubic foot) when tested in accordance with AASHTO T 19/T 19M. The density of lightweight aggregate shall not differ by more than 10 percent from samples submitted for acceptance tests.

704.15 QUARTZITE OR GRANITE AGGREGATE USED IN PAVEMENTS. The Agency has identified a potential stripping problem with some granite and quartzite aggregates used in the production of bituminous concrete pavement. Until additional research can determine a more finite evaluation of the problem or identify optional corrective alternatives, any material supplied under Sections 303, 406, or 490 that contains aggregates from monomineralic (a rock consisting essentially of one mineral) quartzite sources or granite sources will require the addition of a minimum of 0.5% (by percentage of asphalt weight) of an anti-strip additive. Anti-strip additives shall comply with the requirements of Subsection 702.07. The Agency reserves the option to require the use of an anti-strip additive at any time that a potential stripping problem is observed.

704.16 DRAINAGE AGGREGATE. Rock for drainage applications shall be produced from natural gravels or crushed quarried rock and shall consist of clean, hard, sound, and durable material.

(a) Drainage aggregate shall be uniformly graded from coarse to fine and shall meet the gradation requirements of the following table as determined in accordance with AASHTO T 27:

TABLE 704.16A – DRAINAGE AGGREGATE

Sieve Designation	Percent By Mass (Weight) Passing the Square Mesh Sieves
25.0 mm (1 inch)	100
19.0 mm (¾ inch)	90 to 100
9.5 mm (⅜ inch)	20 to 55
4.75 mm (No. 4)	0 to 10
2.36 mm (No. 8)	0 to 5

(b) Percent of Wear. Percent of wear shall not be more than 40 percent when tested in accordance with AASHTO T 96.

(c) Soundness. Soundness shall conform to the requirements of Subsection 704.01(d).

704.17 AGGREGATE FOR EROSION PREVENTION AND SEDIMENT CONTROL. Aggregate for erosion prevention and sediment control shall consist of clean, hard, crushed stone or crushed gravel. It shall be reasonably free from dirt and deleterious material. It shall be uniformly graded and meet the gradation requirements of the following table as determined in accordance with AASHTO T 27:

TABLE 704.17A – AGGREGATE FOR EROSION PREVENTION AND SEDIMENT CONTROL

Sieve Designation	Percentage by Mass (Weight) Passing Square Mesh Sieves
150 mm (6 inch)	100
100 mm (4 inch)	80 to 100
75 mm (3 inch)	40 to 60
50 mm (2 inch)	0 to 20

(a) Vehicle Tracking Pad. Stone for Vehicle Tracking Pad shall meet the gradation requirements of Table 704.17A.

(b) Stone Check Dam, Type I. Stone for Stone Check Dam, Type I with a drainage area of less than 0.4 hectare (1 acre) shall meet the gradation requirements of Table 704.17A. Stone for Stone Check Dam, Type I with drainage area between 0.4 and 2 hectares (1 and 5 acres) shall meet the requirements of stone for Stone Fill, Type I. If filtering is desired, aggregate meeting the gradation requirements of Table 704.02B can be added to the upstream surface of the check dam.

(c) Stone Check Dam, Type II. Stone for Stone Check Dam, Type II on grades of 3% or less shall meet the gradation requirements of Table 704.02C. Stone for Stone Check Dam, Type II on grades greater than 3% shall meet the gradation requirements of Table 704.17A.

(d) Inlet Protection Device, Type I. Stone for Inlet Protection Device, Type I shall meet the gradation requirements of Table 704.02C.

704.18. Select Backfill for Mechanically Stabilized Earth (MSE) Walls. Select backfill material used in mechanically stabilized earth structures shall be substantially free from organic matter and otherwise deleterious materials. It shall be obtained from approved sources and meet the following requirements:

(a) Grading. Select backfill material used in MSE structures shall conform to the following gradation limits as determined by AASHTO T 27:

TABLE 704.18A – SELECT BACKFILL FOR MSE STRUCTURES

Sieve Designation	Percent By Mass (Weight) Passing the Square Mesh Sieves
100 mm (4 inch)[1]	100
75 mm (3 inch)	75-100
0.425 mm (No. 40)	0-60
75 µm (No. 200)	0-12

Note 1. Maximum size shall be 19 mm (3/4 inch) when geosynthetic reinforcement is used.

(b) Soundness. Select backfill material shall be substantially free of shale or other soft particles with poor durability characteristics. The material shall have a sodium sulfate soundness loss of less than 8 percent after five (5) cycles, as determined by AASHTO T 104.

(c) Plasticity Index. The Plasticity Index (P.I.), as determined by AASHTO T 90, shall not exceed six.

(d) Electrochemical Requirements.

(1) Select backfill material for metallically reinforced systems shall conform to the following requirements:

TABLE 704.18B – BACKFILL FOR METALLICALLY REINFORCED SYSTEMS

Property	Requirement	Test Method
Resistivity at 100% saturation	Minimum 3000 ohm-cm	AASHTO T288
pH	Acceptable Range 5 - 10	AASHTO T289
Sulfates	Maximum 200 ppm	AASHTO T290
Chlorides	Maximum 100 ppm	AASHTO T291
Organic Content	<1%	AASHTO T267

(2) Select backfill material for geosynthetically reinforced systems shall conform to the following requirements:

TABLE 704.18C – BACKFILL FOR GEOSYNTHETICALLY REINFORCED SYSTEMS

Base Polymer	Property	Requirement	Test Method
Polyester (PET)	pH	Acceptable Range 3 - 9	AASHTO T289
Polyolefin (PP & HDPE)	pH	pH > 3	AASHTO T289

(e) Uniformity Coefficient. Select backfill material shall have a minimum uniformity, Cu, of 4.

SECTION 705 - MASONRY UNITS

705.01 BRICK.

(a) Clay or Shale Manhole Brick. Brick used for sewer manhole inverts shall conform to AASHTO M 91, Grade MS.

(b) Clay or Shale Building Brick. Building brick shall be used in masonry construction where a high degree of resistance to frost action is desired and the exposure is such that water permeating the brick may be frozen. It shall conform to the requirements of AASHTO M 114, Grade SW.

(c) Clay or Shale Sewer Brick. Brick used for construction where resistance to the action of sewage is needed shall conform to the requirements of AASHTO M 91, Grade SM.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

705.02 CONCRETE MASONRY BLOCKS.

(a) Properties. Concrete masonry blocks intended for use in the construction of catch basins or manholes shall conform to the requirements of ASTM C 139 (solid, precast units) or ASTM C 90, Grade N, Type I or Type II (hollow, precast units).

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

705.03 CONCRETE UNITS FOR SLOPE PAVING. Concrete units for slope paving shall be solid precast units of uniform quality and appearance, with all faces smooth and flush, reasonably free from surface defects and shall conform to the following requirements:

(a) Size. The concrete units shall conform to the details shown on the Plans as to size, shape, and, if required, placement of bar reinforcement.

(b) Materials. The concrete shall have a minimum compressive strength of 20.7 MPa (3000 psi). Bar reinforcement, when required, shall conform to the requirements of Subsection 713.01.

(c) Curing. The concrete units shall be cured in accordance with the requirements of ASTM C 478M, Section 8, and for a sufficient length of time so that the concrete will develop the specified compressive strength at 28 days or less.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

705.04 PRECAST DROP INLETS, CATCH BASINS, AND MANHOLES. Precast drop inlets, catch basins, and manholes shall conform to the requirements of AASHTO M 199M/M 199 with the following notes or exceptions:

(a) Reinforced Concrete Pipe. Reinforced concrete pipe for drop inlets shall conform to the requirements of Subsection 710.01. It shall be of the tongue and groove type with positive connection between sections.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 706 - STONE FOR MASONRY, RIPRAP, AND OTHER PURPOSES

706.01 STONE FOR MASONRY. Stone for masonry shall be quarry stone, field stone, or rock fragments approximately rectangular in shape and of a hard, sound, and durable quality acceptable to the Engineer. The stone shall be free from structural defects or imperfections that would tend to destroy its resistance to the weather.

At least 80 percent of the individual stones in a unit shall have a thickness of not less than 200 mm (8 inches) and a width of not less than 150 percent of the thickness. The minimum size of the other stones in the unit shall have a thickness of not less than 100 mm (4 inches) and a width of not less than 150 percent of the thickness.

706.02 STONE FOR MASONRY FACING. Stone for masonry facing shall be irregularly shaped or roughly rectangular quarried granite, marble, or other approved quarried stone.

Stone for capping shall conform to the dimensions shown on the Plans unless changes are ordered in writing by the Engineer.

The stone shall be of approved quality, tough, sound, and durable, resistant to weathering action, uniform in color, free from seams, cracks, laminations, pyrite inclusions, and minerals or other structural defects which, by weathering, would cause discoloration or deterioration and shall be thoroughly cleaned of any iron or rust particles. Stone shall be of such character that it can be wrought to such lines and surfaces, whether curved or plane, as required. Any stone having defects that have been repaired with cement or other materials shall be rejected.

The stone shall be kept free from dirt, oil, and any other injurious material that may prevent the proper adhesion of the mortar or detract from the appearance of the exposed surfaces.

The front face of the facial stone, including capstones when required, shall be smooth, quarry-split, free from drill holes in the exposed face, with no projections or depressions greater than 25 mm (1 inch) measured from the vertical plane of the face of the stone.

The capstone shall have a top surface sawed to an approximately true plane. The front and back arris lines of the capstones shall be pitched straight and true.

706.03 STONE FOR RIPRAP. Stone for riprap shall be approved, rough, unhewn quarry stone, as nearly rectangular in section as practical. The stones shall be hard, sound, and resistant to the action of water and weathering. They shall be of a rock type other than serpentine rock containing the fibrous variety chrysotile (asbestos) and suitable in every respect for the purpose intended.

(a) Heavy Type. The individual stones shall have a depth equal to the thickness of the course of riprap. At least 75 percent of the volume of the riprap, complete in place, shall consist of stones that have a minimum volume of 0.5 m^3 (16 ft^3).

(b) Light Type. The individual stones shall have a depth equal to the thickness of the course of riprap. The riprap, complete in place, shall consist of stones that have a minimum volume of 0.015 m^3 (1/2 ft^3).

706.04 STONE FOR STONE FILL. Stone for stone fill shall be approved, hard, blasted, angular rock other than serpentine rock containing the fibrous variety chrysotile (asbestos). The least dimension of the stone shall be greater than 33 percent of the longest dimension. The stone fill shall be reasonably well graded from the smallest to the maximum size stone specified so as to form a compact mass when in place.

(a) Type I. The longest dimension of the stone shall vary from 25 to 300 mm (1 to 12 inches), and at least 50 percent of the volume of the stone in place shall have a least dimension of 100 mm (4 inches).

(b) Type II. The longest dimension of the stone shall vary from 50 to 900 mm (2 to 36 inches), and at least 50 percent of the volume of the stone in place shall have a least dimension of 300 mm (12 inches).

(c) Type III. The longest dimension of the stone shall vary from 75 to 1200 mm (3 to 48 inches), and at least 50 percent of the volume of the stone in place shall have a least dimension of 400 mm (16 inches).

(d) Type IV. The longest dimension of the stone shall vary from 75 to 1500 mm (3 to 60 inches), and at least 50 percent of the volume of the stone in place shall have a least dimension of 500 mm (20 inches).

706.05 STONE FOR SLOPE PAVING. Stone for slope paving shall be approved, rough, unhewn quarry stone or field stone, approximately rectangular in shape and shall be free from structural defects or imperfections.

The individual stones shall have one reasonably flat face for the exposed portion and shall not be less than 130 mm (5 inches) in thickness perpendicular to the exposed face, which thickness shall be the least dimension of the stone.

Seventy-five percent of the stones shall have a minimum volume of 0.055 m^3 (2 ft^3). The minimum volume of other stones shall be 0.015 m^3 (1/2 ft^3).

706.06 ROCK FILL FOR GABIONS. Rock fill for gabions shall be well graded, hard, sound, durable, and free from cracks and other structural defects that may cause it to deteriorate. It shall not contain any material that easily disintegrates or can be easily cleaved into thin elongated pieces (such as phyllite, shale or slate). In addition to the following requirements, the size shall be such that a minimum of two layers of rock can be achieved when filling any gabion.

(a) Grading. The rock size shall be 100 mm (4 inches) minimum to 200 mm (8 inches) maximum when measured in accordance with ASTM D5519. A tolerance of 5% undersize and 5% oversize rock by number of particles shall be allowed. In addition, the rock shall be large enough to prevent individual pieces from passing through the gabion mesh openings.

(b) Soundness. Soundness shall meet the requirements of Subsection 704.01(d).

SECTION 707 - JOINT MATERIALS

707.01 MORTAR, TYPE I. Type I mortar is generally used as a joint filler between curb stones, for stone slope edging, and for the grouting of dowels. It shall be used in small quantities as needed and shall not be retempered or used after it has begun to set.

The mortar shall be composed of one part cement and one part sand, and shall be mixed with sufficient water to form a plastic composition. For grouting, sufficient water shall be added to provide the required consistency.

The cement, sand, and water shall meet the following requirements:

(a) Cement. Cement shall conform to the requirements of Subsection 701.02.

(b) Sand. Sand shall conform to the requirements of Subsection 704.13 or 704.01, as appropriate.

(c) Water. Water shall conform to the requirements of Subsection 745.01.

707.02 MORTAR, TYPE II. Type II mortar is generally used as a joint filler for concrete and clay pipes, stone and brick masonry, and for repointing. It shall be used in small quantities as needed and shall not be retempered or used after it has begun to set.

The mortar shall be composed of one part cement and two parts sand, and shall be mixed with sufficient water to form a plastic composition.

The cement, sand, and water shall meet the requirements of Subsection 707.01.

707.03 MORTAR, TYPE IV. Type IV mortar is used when a non-shrinking cement mortar is required.

(a) Packaging. The manufacturer's name, product designation, and recommendations for surface preparation, mixing, placing, finishing, and curing shall be clearly indicated on the product packaging. Handling precautions and toxicity warnings shall be printed on all containers. The expiration date and lot number shall appear on each package of material delivered to the project site.

(b) Sampling and Testing. Upon request, the Agency's Materials and Research Section will furnish a list (Approved Products List, or APL) of products that have been tested and are considered satisfactory. Should the Contractor wish to use a product not included on the APL, an alternate product may be submitted for consideration. Application for alternate material approval shall be submitted to the Agency's Materials and Research Section accompanied by a 45 kg (100 pound) sample of the product and complete Material Safety Data Sheet (MSDS) information. Upon approval, the product name and manufacturer will be placed on the APL. A minimum period of two months shall be allowed for testing purposes.

(c) Performance Requirements.

(1) Compressive Strength. The neat material shall exhibit a minimum three-day compressive strength of 17.2 MPa (2500 psi), a minimum seven-day compressive strength of 24.1 MPa (3500 psi) and a minimum 28-day compressive strength of 34.5 MPa (5000 psi) when tested in accordance with AASHTO T 106.

(2) Freeze-Thaw Durability. Resistance to rapid freezing and thawing shall be determined in accordance with AASHTO T 161, Procedure A, as modified by the Agency's Materials and Research Section for use of a 3 percent sodium chloride solution. The material shall exhibit no more than an 8 percent loss in mass (weight) after 300 cycles.

(3) Volume Stability. The material shall exhibit a maximum height change of +0.3 percent and a minimum height change of 0.0 percent when tested in accordance with ASTM C 1090.

(d) Other. Instead of a commercially prepared product, the Contractor may produce a non-shrinking cement mortar composed of one part cement, one part sand, and aluminum powder mixed with sufficient water to form a plastic composition as follows:

From 2 to 4 g (0.07 to 0.14 ounces) of the superfine unpolished variety of aluminum powder shall be added for each sack of cement used in the mortar. The exact amount of aluminum powder shall be as directed by the Engineer. The dosage per batch of mortar shall be carefully measured. The aluminum powder shall be blended with pozzolan or pumicite in the proportion of one part aluminum powder to 50 parts pozzolan or pumicite by mass (weight). The blend shall be thoroughly mixed with the cement and sand before water is added to the batch, as it has a tendency to float on water. The amount of the blend used shall vary from 128 g (4.5 ounces) per sack of cement for a placing temperature of 21 °C (70 °F) to 198 g (7 ounces) per sack of cement for a placing temperature of 5 °C (40 °F). After all ingredients are added, the batch shall be mixed for three minutes. Batches of mortar shall be placed within 45 minutes after mixing, as the action of the aluminum powder becomes very weak after this time, and it shall not be retempered or used after it has begun to set.

The cement, sand, and water shall meet the requirements of Subsection 707.01.

707.04 JOINT SEALER, POURABLE.

(a) Joint Sealer, Hot Poured. This material shall consist of a hot applied, single-component, low-modulus, elastic sealant meeting the requirements of AASHTO M 324 (ASTM D 6690) Type II or Type IV as specified in the Contract Documents..

(b) Joint Sealer, Cold Poured. This material shall consist of a cold applied, two-component, low-modulus, elastic sealant capable of 200 percent elongation at -29 °C (-20 °F) when placed in a typical joint configuration.

(c) Backer Rod. Backer rod shall be 100 percent watertight, closed-cell, non-gassing, polyethylene, polyolefin, or other suitable material that does not react chemically with the sealant. It shall be compatible with the sealant applied at temperatures up to 210 °C (410 °F), shall remain stable down to -29 °C (-20 °F), and shall not cause bubbling of the sealant bead. The backer rod shall be approximately 3 mm (1/8 inch) larger in diameter than the width of the joint in which it is used.

(d) Certification. If the formulation of the material has a proven history of satisfactory performance on Agency projects then the Contractor shall submit a Type B Certification, otherwise a Type D Certification shall be furnished. Certifications shall be submitted in accordance with Subsection 700.02.

707.05 JOINT SEALER, POLYURETHANE. Polyurethane joint sealer shall consist of a single or a two-component, cold-applied, polyurethane, elastomeric compound for use in expansion joints in widths up to 150 mm (6 inches). The sealer shall be suitable for installation at temperatures above 7 °C (45 °F) and below 27 °C (80 °F), self-leveling where used in horizontal joints, capable of filling the joint completely without the formation of air holes or other discontinuities, and non-sagging or not subject to flow when placed in vertical or inclined joints.

The sealer shall cure by chemical reaction between the two components or by reaction with moisture from the atmosphere.

(a) Primer. When recommended by the manufacturer, a primer system shall be used to ensure adhesion to steel, concrete, epoxy, epoxy mortar, or granite under all conditions. The primer system shall be furnished by the sealer manufacturer.

(b) Filler Material. A foam spacer (backing) or filler material shall be used where shown on the Plans. The foam spacer shall be a closed-cell polyethylene or PVC foam, recommended by the manufacturer of the joint sealer and acceptable to the Engineer.

(c) Bond Breaker. A suitable bond breaker shall be applied to those surfaces shown on the Plans. The bond breaker shall be polyethylene-coated tape or other substitute acceptable to the Engineer.

(d) Proportioning and Mixing. When required, proportioning and mixing shall be accomplished strictly according to the manufacturer's instructions.

(e) Packaging. The joint sealer materials shall be delivered to the project in suitable containers for handling and shall be sealed or otherwise protected from contamination.

The containers shall be clearly labeled with the following information:

Name and Address of Manufacturer
Name of Product or Component Identification
Batch Number
Date of Manufacture

The manufacturer shall furnish with each shipment complete instructions for its storage, proportioning, mixing, handling, joint preparation, and joint installation procedures and complete MSDS information. A copy of these instructions shall be furnished to the Engineer.

(f) Performance Requirements for Two-Component Materials. The joint sealer system, consisting of sealer and primer, shall meet the requirements of the following:

Sealer system shall meet the performance requirement of Federal Specification TT-S-00227E, Sealing Compound, Elastomeric Type, Class A.

(g) Performance Requirements for Single-Component Materials. The joint sealer system shall meet the requirements of the following:

Sealer system shall meet the performance requirement of Federal Specification TT-S-00230C, Sealing Compound, Type II, Class B.

(h) Certification. If the formulation of the material has a proven history of satisfactory performance on Agency projects then the Contractor shall submit a Type B Certification, otherwise a Type D Certification shall be furnished. Certifications shall be submitted in accordance with Subsection 700.02.

707.06 JOINT SEALER, PREFORMED NEOPRENE.

(a) Properties. Preformed neoprene joint sealer shall conform to the requirements of AASHTO M 220. The lubricant-adhesive shall be of the formulation recommended by the manufacturer for the kind of material adjacent to the joint sealer.

The Contractor shall furnish representative samples of joint sealer, lubricant-adhesive, or other components at no additional cost to the Agency for laboratory testing, when requested by the Engineer.

Any material not conforming to this Subsection at the time of application or which has been improperly stored or which has exceeded the stated shelf life will be rejected.

Lubricant-adhesive shall not be used beyond one year following its date of manufacture or if the container has been previously opened.

(b) Certification. If the formulation of the material has a proven history of satisfactory performance on Agency projects then the Contractor shall submit a Type B Certification, otherwise a Type D Certification shall be furnished. Certifications shall be submitted in accordance with Subsection 700.02.

707.07 PREFORMED FABRIC MATERIAL.

(a) Properties. Preformed fabric material shall be a multi-layered sheet composed of multi-plies of 510 g/m^2 ± 5 percent (15 ounces per square yard ± 5 percent) polyester fabric laminated with butadiene acrylonitrile, vulcanized to form an integral laminate.

Physical properties of the laminate shall meet the material requirements in the following table:

TABLE 707.07A – PREFORMED FABRIC

	Number of Plies		
	2	3	5 to 8
Minimum Mass (Weight) per Unit Area of laminate, kg/m^2 (lbs/ft^2)	3.65 (0.75)	4.15 (0.85)	19.50 (4.0)
Minimum Thickness, mm (in)	3.2 (1/8)	4.0 (5/32)	19.0 (3/4)
Minimum Ultimate Tensile Strength of laminate, kN/m (lbs/in) of width	140 (800)	210 (1200)	350 (2000)
Maximum Elongation at Ultimate Tensile	30%	30%	30%
Maximum Elongation at 10% of Ultimate Tensile	3%	3%	3%

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.08 PREFORMED JOINT FILLER, CORK AND ASPHALT-TREATED FELT.

(a) Properties. Preformed cork joint filler shall conform to the requirements of AASHTO M 153, Type II unless otherwise specified. Asphalt-treated felt shall conform to the requirements of ASTM D 226 unless otherwise specified.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.09 PREFORMED JOINT FILLER, CLOSED-CELL FOAM.

(a) Properties. Preformed joint filler shall be a closed-cell polyethylene or PVC foam, premolded to a semi-rigid consistency.

When tested in accordance with ASTM D 3575, the premolded foam shall meet the material requirements in Table 707.09A.

TABLE 707.09A – PREFORMED JOINT FILLER, CLOSED CELL FOAM

Property	Test Procedure	Minimum	Maximum
Density, kg/m^3 (lbs/ft^3)	Test C	48 (3)	80 (5)
Buoyancy, kg/m^3 (lbs/ft^3)	Test AA	830 (52)	930 (58)
Tensile Strength, kPa (psi)	Test E	240 (35)	---
Water Absorption, % by volume	Test G	---	0.5
Tensile Elongation, %	Test E	65	75
Compressive Strength, kPa (psi)	Test B @ 25%	70 (10)	100 (15)
Compressive Strength, kPa (psi)	Test B @ 50%	140 (20)	170 (25)
Compressive Set Not Recovered, % original thickness	Test A	10	15

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.10 POLYVINYL CHLORIDE (PVC) WATERSTOP. PVC waterstop shall be manufactured from virgin PVC resin with the addition of only those plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, it will meet the requirements of this Subsection. No reclaimed, scrap, or reprocessed PVC shall be used.

(a) Physical Properties. The finished waterstop shall conform to the requirements of the following table:

TABLE 707.10A - PVC WATERSTOP

Property	ASTM Procedure	Minimum	Maximum
Tensile Strength, kPa (psi)	D 638 (Type IV)	9650 (1400)	---
Ultimate Elongation, %	D 638 (Type IV)	250	---
Low Temperature Brittleness	D 746	*	---
Durometer Hardness – Shore Type A	D 2240	60	80
Stiffness in Flexure, kPa (psi)	D 747	2750 (400)	---
Alkali Resistance (10% NaOH) Mass (Weight) Change, %	D 543	-0.10	+0.25
Durometer Hardness Change	---	-5	+5

* No cracking or chipping permitted on three specimens at -29 °C (-20 °F).

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.11 RUBBER GASKETS.

(a) Properties. Rubber gaskets for culvert pipe joints shall conform to the requirements of AASHTO M 198, Type A.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.12 JOINT SEALER, BUTYL RUBBER TAPE.

(a) Properties. Butyl rubber joint sealer tape shall be a flexible plastic gasket conforming to AASHTO M 198, Type B. The sealant shall be in roll form with release paper backing dimensioned to the width and thickness specified.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.13 ALUMINUM IMPREGNATED CAULKING COMPOUND. Aluminum impregnated caulking compound is generally used to protect the surfaces of aluminum alloy in contact with other metals, wood, or Portland cement concrete. The compound shall be impregnated with aluminum flake or powder and shall be of such consistency and properties that it can be readily applied with a trowel, putty knife, or caulking gun without pulling or drawing. The material shall meet the approval of the Engineer.

707.14 PREFORMED JOINT FILLER, BITUMINOUS TYPE.

(a) Properties. Bituminous type preformed joint filler shall conform to the requirements of AASHTO M 33 or AASHTO M 213.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

707.15 ASPHALTIC PLUG BRIDGE JOINT. All components of the Asphaltic Plug Joints shall conform to the requirements of ASTM D 6297. Acceptable Asphaltic Plug Bridge Joint systems shall be those included on the Approved Products List on file with the Agency's Materials and Research Section.

707.16 BONDING AGENTS.

(a) Properties. Acceptable bonding agents shall conform to the requirements of ASTM C 881.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 708 - PAINTS, STAINS, AND TRAFFIC MARKING MATERIALS

708.01 GENERAL REQUIREMENTS.

(a) General. All paints shall be ready-mixed in accordance with the specific formulas from ingredients that meet the requirements described below. The paints shall be free of coarse particles, skins, and water, and other foreign and objectionable matter except where tolerances have been allowed. The paints shall not skin over, thicken, liver, settle out excessively, or cake in the container in storage and shall be readily broken up with a paddle into a smooth, uniform consistency.

No rosin or rosin derivatives shall be added to the paints, but beneficial agents such as antioxidants or wetting aids may be added.

Ready-mixed paints that have hardened on standing or otherwise deteriorated to any extent will not be acceptable.

All paints shall be suitable for use in airless spray equipment.

The paint, when applied by brush or spray to a smooth vertical metal surface at a wet film thickness of 75 μm (3 mils), shall dry without running, streaking, or sagging.

(b) Packaging. Ready-mixed paints shall be shipped in strong, new, airtight containers. All containers of paint shall be clearly labeled with the following information:

Name and Address of Manufacturer
Manufacturer's Batch Number
Date of Manufacture
Vermont Paint Number, Name, and Color
Volume of Contents

Containers shall be clearly marked to indicate any hazards connected with the use of the paint and the protective measures that should be provided to prevent injury to the health of workers.

(c) Sampling, Testing, and Certification. No paint or stain shall be used until it has been tested and approved by the Agency's Materials and Research Section.

(1) Sampling. At least one sample, not less than 1 L (1 quart), shall be taken for each batch of paint or stain to be used regardless of whether or not the quality of the paint is certified by the manufacturer.

(2) Testing. Testing of paints shall be done in accordance with FED-STD-141C or ASTM test methods, at the discretion of the Agency's Materials and Research Section.

(3) Certification.

a. Shop and Field Primers Used on Aluminum and Galvanized Surfaces. Paints used under this Section shall be covered by a Type A Certification in accordance with Subsection 700.02.

b. Paint for Pavement Markings. Pigment and vehicle constituents used in the paints shall be covered by a Type A Certification in accordance with Subsection 700.02.

(d) Identification. To provide a means of identification for all paint, the applicable identification number and name taken from the following list shall be printed on all Test Reports and container labels.

(1) Primer Coatings for Structural Steel and Other Metals. For primer coatings, the identification number and the name for the primer used shall be the manufacturer's name, the manufacturer's name for the primer, and the manufacturer's lot number.

(2) Intermediate Coatings for Structural Steel and Other Metals. For paint coatings, the identification number and the name for the intermediate coat used shall be the manufacturer's name, the manufacturer's name for the coatings, and the manufacturer's lot number.

(3) Finish Coatings for Structural Steel and Other Metals. For paint coatings, the identification number and the name for the finish coat used shall be the manufacturer's name, manufacturer's name for the coating, and the manufacturer's lot number.

(4) Coatings for Wood.

VT 4.01 - Dark Brown Oil Base Stain

(5) Paint For Traffic Signs.

VT 5.01 – Black Enamel
VT 5.02 – Blue Enamel
VT 5.03 – Green Enamel
VT 5.04 – Red Enamel
VT 5.05 – White Enamel
VT 5.06 – Yellow Enamel
VT 5.07 – Brown Enamel
VT 5.08 – Orange Enamel

(6) Paint For Traffic Control Signals.

VT 6.01 – Flat Black Enamel
VT 6.02 – Yellow Enamel

(7) Paint For Pavement Marking.

VT 7.01 – White Traffic Paint
VT 7.02 – Yellow Traffic Paint
VT 7.05 – White Traffic Paint, Fast Dry
VT 7.06 – Yellow Traffic Paint, Fast Dry

(8) Approved Coatings. Acceptable structural coatings shall be the coatings listed on the Qualified Products List on file with the Agency's Materials and Research Section.

(e) Vehicle Constituents. RESERVED

708.02 THIS SUBSECTION RESERVED

708.03 APPROVED STRUCTURAL COATING SYSTEMS. Acceptable structural coating systems shall be the Structural Coating Systems listed on the Qualified Products List on file with the Agency's Materials and Research Section.

Colors shall conform to Federal Standard No. 595:

COLOR	COLOR CHIP NO.
Green	14062
Black	27038
Brown	20059

708.04 GREASE RUSTPROOFING COMPOUND. Grease rustproofing compound shall be a soft film type material made from petroleum combined with special additives to enhance its moisture displacing capabilities. It shall contain effective rust inhibitors and conform to the following table:

TABLE 708.04A - GREASE RUSTPROOFING COMPOUND

Appearance (Color):	Brown Green
Flash, COC, Min.:	66 ºC (150 ºF)
Undist. (D-127):	280 (30 units)
Melting Point, Min.:	63 ºC (145 ºF)
Thinner, Max.	20 % by mass (weight)
Density, Min.	0.839 gm/ml at 16 ºC (7.00 lb./gal at 60 ºF)
Approximate NLGI Grease Grade:	No. 2 before solvent evaporation and No. 5 after solvent evaporation.

708.05 COATINGS FOR WOOD.

(a) VT 4.01 Dark Brown Oil Base Stain. The stain is used as a protective coating for wood surfaces.

The stain shall conform to the requirements of Table 708.05A.

TABLE 708.05A - DARK BROWN OIL BASE STAIN

	Minimum	Maximum
Pigment:		
The pigment shall consist of pure mineral pigments combined in proportions necessary to match the specified color.		
Vehicle:		
Heavy Bodied Linseed Oil, %	15	---
Mineral Spirits, %	---	85
Stain:		
Pigment, %	15	---
Vehicle, %	---	85
Density, g/L (lb./gal)	910 (7.5)	---
Drying Time, hrs., dry to recoat	---	24
Fineness of Grind (Hegman Scale)	4	---
Color:		
Dark Brown to match color standard supplied by the Agency's Materials and Research Section.		

(b) Insecticide/Fungicide. Insecticide/fungicide coatings for interior applications shall be water/glycol-based solutions per the manufacturer's specifications. Acceptable coatings shall be those on the Approved Products List on file with the Agency's Materials and Research Section.

(c) Fire Retardant. Fire retardant coatings for interior and exterior applications shall be non-toxic, non-hazardous, and water-based solutions passing ASTM E 84/NFPA 255/UL 723 "Standard Test Method for Surface Burning Characteristics of Burning Materials." Acceptable coatings shall be those on the Approved Products List on file with the Agency's Materials and Research Section.

708.06 PAINT FOR TRAFFIC SIGNS. Paint for traffic signs shall consist of ready-mixed enamels suitable for exterior use on primed wood and metal surfaces and shall conform to the requirements of CID A-A-2962. The type of cure shall be as shown on the Plans. Porcelain enamels shall conform to the requirements of Porcelain Enamel Institute, Inc. Specification ALS-105.

The Color Tolerance Charts prepared by FHWA shall be used to determine acceptable color match for blue, brown, green, orange, red, and yellow traffic sign paints.

(a) VT 5.01 Black Enamel. The color shall be an acceptable match to Chip No. 17038 in FED-STD-595B.

(b) VT 5.02 Blue Enamel. The color shall be an acceptable match to Chip No. 15090 in FED-STD-595B.

(c) VT 5.03 Green Enamel. The color shall be an acceptable match to Chip No. 14109 in FED-STD-595B.

(d) VT 5.04 Red Enamel. The color shall be an acceptable match to Chip No. 11105 in FED-STD-595B.

(e) VT 5.05 White Enamel. The color shall be an acceptable match to Chip No. 17875 in FED-STD-595B.

(f) VT 5.06 Yellow Enamel. The color shall be an acceptable match to Chip No. 13538 in FED-STD-595B.

(g) VT 5.07 Brown Enamel. The color shall be an acceptable match to a chip provided by the Agency's Materials and Research Section.

(h) VT 5.08 Orange Enamel. The color shall be an acceptable match to a chip provided by the Agency's Materials and Research Section.

708.07 PAINT FOR TRAFFIC CONTROL SIGNALS. Paint for traffic control signals shall consist of ready-mixed enamels suitable for exterior use on primed metal surfaces.

(a) VT 6.01 Flat Black Enamel. The color shall conform to the requirements of Federal Specification TT-E-527. The color shall be an acceptable match to Chip No. 37038 in FED-STD-595B.

(b) VT 6.02 Yellow Enamel. The color shall conform to the requirements of CID A-A-2962. The color shall be an acceptable match to Chip No. 13538 in FED-STD-595B.

708.08 PAINT FOR PAVEMENT MARKINGS. Ready-mixed traffic paint suitable for marking on either bituminous or Portland cement concrete pavements shall conform to the following requirements:

(a) Polyurea Pavement Markings. Approved polyurea marking materials shall be one of the markings listed on the Approved Products List on file with the Agency's Materials and Research Section.

(b) Low VOC Traffic Paint. Ready-mixed Low VOC Traffic Paint shall consist of 100% acrylic type, fast drying traffic paint that shall contain properly formulated pigment and vehicle to give the desired results.

(1) Materials. The paint shall be formulated and processed specifically for service as a binder for reflective beads, in such a manner as to produce maximum adhesion, refraction, and retroreflection. Any capillary action of the paint shall not be such as to cause complete coverage of the beads.

a. The paint shall be well mixed in the manufacturing process and shall be properly ground when incorporating the pigments in order to conform to the requirements as specified.

b. The paint shall not liver, thicken, curdle, gel, settle excessively, or otherwise show any objectionable properties during storage and shall be readily remixed manually to a smooth uniform consistency throughout.

c. The paint shall dry on a road surface to a strongly adherent uniform noncracking film that will not turn dark in sunlight or show considerable discoloration with age. It shall be easily and uniformly applicable with mechanical line-marking equipment and shall meet the opacity (contrast ratio) properties specified herein. The paint shall be suitable for binding glass beads so as to produce a highly weather resistant traffic line.

(2) Composition. The binder shall be tested according to ASTM D2621 (infrared analysis) or other standard ASTM methods designated herein and shall be a 100% acrylic binder. The composition of the paint shall comply with Table 708.08A.

TABLE 708.08A – LOW VOC TRAFFIC PAINT COMPOSITION

PERFORMANCE CHARACTERISTIC	WHITE	YELLOW/BLUE/ GREEN
Pigment Content, % by Mass (Weight) (ASTM D3723)	58% min. 62% max.	58% min 62% max.
Vehicle Content, % by Mass (Weight)	38% min. 42% max.	38% min. 42% max.
VOC Content, Mass (Weight) per Unit Volume (ASTM D3960)	150 g/L (1.25 lb/gal) max.	150 g/L (1.25 lb/gal) max.
Lead Content, %	0.005% max.	0.005% max.
Yellow Pigment	N/A	Yellow #65 or #75
Titanium Dioxide, Rutile Type II, (ASTM D1394)	120 g/L (1.00 lb/gal) max.	25 g/L (0.21 lb/gal) max.
Total Non-Volatile Content, % by Mass (Weight) (ASTM D2369)	42.0% min.	42.0% min.
Density, (ASTM D1475)	1.68 ± 0.04 kg/L (14.0 ± 0.33) lb/gal	1.62 ± 0.04 kg/L (13.5 +/- 0.33 lb/gal)
pH of the Paint	9.6 min.	9.6 min.
Close Cup Flash Point (ASTM D 3278)	60 ^{o}C (140 ^{o}F) min.	60 ^{o}C (140 ^{o}F) min.

(3) Laboratory Tests.

a. Viscosity. The paint viscosity shall not be less than 78 nor more than 95 Krebs units at 25 °C (77 °F) when tested according to ASTM D562.

b. Condition in Container. The paint as received shall show no gelling, skinning, mold growth, putrefaction, or hard settling of the pigment. The paint shall not cause any corrosion of the container. Any settling shall be readily dispersed when stirred by hand with no persistent foaming.

c. Fineness of Grind. The fineness of grind shall not be less than two Hegman units when tested in accordance with ASTM D1210.

d. Drying Time (No Pick Up Time). The paint shall dry in not more than ten minutes at 23 ± 2.0 °C (73.5 ± 3.5 °F) and a relative humidity of 50 ± 5 %, when tested in accordance with ASTM D711 and drawn down to a wet film thickness of 380 microns (15 mils).

e. No Track Time (Field Test). The paint shall dry to a "no track" condition in no more than three minutes when tested by driving a standard passenger vehicle across the line at 65 kilometers per hour (40 miles per hour). The "no tracking" condition shall be determined by actual application on the pavement at a wet film thickness of 508 microns (20 mils) with the paint covered with glass beads at a rate of 960 g/L (8 lb/gal). The paint lines for this test shall be applied with the striping equipment at the manufacturer's recommended temperatures. The "no tracking" time shall be determined by passing over the paint line three (3) minutes after paint application, in a simulated passing maneuver at a constant speed of 50 to 65 kilometers per hour (30 to 40 miles per hour) with a passenger car. A line showing no visual deposition of the paint to the pavement surface when viewed from a

distance of approximately 15.3 meters (50 feet) from the point where the test vehicle has crossed the line shall be considered as showing "no tracking" and conforming to the requirement for field drying conditions. This maximum tracking time shall not be exceeded when the pavement temperature varies from 10 °C (50 °F) to 49 °C (120 °F), and under humidity conditions of 80% or less providing that the pavement is dry and shall be used for production samples only.

(4) Sampling and Testing.

a. Sampling Size. The paint contractor shall submit two 500 ml (1 pint) samples per batch of each type and color of traffic paint to be used under these specifications. The submission shall include a copy of a Material Safety Data Sheet (MSDS).

b. 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, trade name and/or identification number, type of paint, number of liters (gallons), contact number, intended use, directions for application, and formula. Improperly labeled samples will be rejected.

c. Sample Delivery. All samples shall be delivered to the following shipping address: Materials Engineer, Vermont Agency of Transportation, Materials and Research Section, 1716 Barre-Montpelier Road, Berlin, VT 05602.

All samples shall be delivered at least five working days prior to use and at least three working days in advance of subsequent deliveries. Samples adequate for testing shall be furnished free of charge by the Contractor.

d. Batch Sampling and Testing. Each batch of paint furnished under these specifications will be tested by the Vermont Agency of Transportation, Materials and Research Central Laboratory. Random samples at the point of delivery may be subjected to both chemical and physical analysis and if found to be of unsatisfactory quality, the materials they represent may be rejected. If the Engineer observes failure or other conditions during application which lead the Engineer to question whether or not the material meets specification, further tests will be conducted on field samples taken at random.

(c) Epoxy Paint. Epoxy Paint shall be one of the Epoxy Paints on the Approved Products List on file with the Agency's Materials and Research Section.

(d) Waterborne Traffic Paint. Waterborne Traffic Paint shall consist of properly formulated pigment and vehicle to give the desired results. When used with reflecting glass beads it shall bind the beads in such a fashion that it will produce maximum adhesion, refraction, and reflection. The paint shall show the proper capillary action at the bead surface to provide anchorage, refraction, and reflection when beads are applied at the standard rate of 960 g/L (8 lb/gal) of paint.

(1) Materials.

a. Pigments. The pigments used shall be those designated which shall conform to the stated requirements.

b. Titanium Dioxide. Titanium Dioxide shall be of the rutile type and shall meet the requirements specified in ASTM designation D 476 (Latest Revision) Type II, Class II.

c. Vehicle. The vehicle will be water.

(2) Composition. The composition of the waterborne paint shall be a 100% acrylic binder, as determined by infrared analysis according to ASTM D2621 or other standard ASTM methods designated herein. The composition of the paint shall comply with Table 708.08B:

TABLE 708.08B – WATERBORNE TRAFFIC PAINT COMPOSITION

PERFORMANCE CHARACTERISTIC	WHITE	YELLOW/BLUE /GREEN
Pigment Content, by mass (weight) (ASTM D3723)	58% min. 62% max.	58% min. 62% max.
Vehicle Content, by mass (weight)	38% min. 42% max.	38% min. 42% max.
VOC Content, by mass (weight) (ASTM D3960)	150 g/L max. (1.25 lb/gal)	150 g/L max. (1.25 lb/gal)
Lead Content, %	0.005% max.	0.005% max.
Titanium Dioxide Rutile Type II, (ASTM D1394)	120 g/L max. (1.00 lb/gal)	25 g/L max. (0.21 lb/gal)
Total Non-Volatile Content, by mass (weight) (ASTM D2369)	76.0% min.	76.0% min.
Total Volatile Content by mass (weight) (ASTM D2369)	25% max.	25% max.
Total Non-Volatile, by volume (ASTM D2697)	62.0% min.	62.0% min.
Density, (ASTM D1475)	1.68 ± 0.04 kg/L (14.0 lb/gal ± 0.33)	1.63 ± 0.04 kg/L (13.6 lb/gal ±0.33)
pH of the Paint	9.6 min.	9.6 min.
Close Cup Flash Point	60 °C (140 °F) min.	60 °C (140 °F) min.

(3) Laboratory Tests.

a. Viscosity. The paint viscosity shall not be less than 78 nor more than 95 Krebs units at 25 °C (77 °F) when tested according to ASTM D562.

b. Condition in Container. The paint as received shall show no gelling, skinning, mold growth, putrefaction, or hard settling of the pigment. The paint shall not cause any corrosion of the container. Any settling shall be readily dispersed when stirred by hand with no persistent foaming.

c. Fineness of Grind. The fineness of grind shall not be less than two Hegman units when tested in accordance with ASTM D1210.

d. Drying Time (No Pick Up Time). The paint shall dry in not more than 10 minutes at 23°C ± 2°C (71°F ± 6°F) and a relative humidity of 50 ± 5%, when tested according to ASTM D711 and drawn down to a wet film thickness of 380 microns (15 mils).

e. No Track Time (Field Test). The paint shall dry to a "no track" condition in no more than three minutes when tested by driving a standard passenger vehicle across the line at 65 kilometers per hour (40 miles per hour). The "no tracking" condition shall be determined by actual application on the pavement at a wet film thickness of 508 microns (20 mils) with the paint covered with glass beads at a rate of 960 g/L (8 lb/gal). The paint lines for this test shall be applied with the striping equipment at the manufacturer's recommended temperatures. The "no tracking" time shall be determined by passing over the paint line three minutes after paint application, in a simulated passing maneuver at a constant speed of 50 to 65 kilometers per hour (30 to 40 miles per hour) with a passenger car. A line showing no visual deposition of the paint to the pavement surface when viewed from a distance of

approximately 15.3 meters (50 feet) from the point where the test vehicle has crossed the line shall be considered as showing "no tracking" and conforming to the requirement for field drying conditions. This maximum tracking time shall not be exceeded when the pavement temperature varies from 10 °C (50 °F) to 49 °C (120 °F), and under humidity conditions of 80% or less providing that the pavement is dry and shall be used for production samples only.

(4) Sampling and Testing.

a. Sampling Size. The paint Contractor shall submit two 500 ml (1 pint) samples of each traffic paint per batch, to be used under these specifications. The submission shall include a copy of a Material Safety Data Sheet (MSDS).

b. 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, trade name and/or identification number, type of paint, number of liters (gallons), contact number, intended use, directions for application, and formula. Improperly labeled samples will be rejected.

c. Sample Delivery. All samples shall be delivered to the following shipping address: Materials Engineer, Vermont Agency of Transportation, Materials and Research Section, 1716 Barre-Montpelier Road, Berlin, VT 05602.

All samples shall be delivered at least five working days prior to use and at least three working days in advance of subsequent deliveries. Samples adequate for testing shall be furnished free of charge by the Contractor.

d. Batch Sampling and Testing. Each batch of paint furnished under these specifications will be tested by the Vermont Agency of Transportation, Materials and Research Central Laboratory. Random samples at the point of delivery may be subjected to both chemical and physical analysis and, if found to be of unsatisfactory quality, the materials they represent may be rejected. If the Engineer observes failure or other conditions during application which lead the Engineer to question whether or not the material meets specification, further tests will be conducted on field samples taken at random.

(e) Methyl-methacrylate Paint. Approved Methyl-methacrylate Paint shall be one of the Methyl-methacrylate Paints listed on the Approved Products List on file with the Agency's Materials and Research Section.

708.09 GLASS BEADS.

(a) Properties. Glass beads for pavement markings shall conform to the requirements of AASHTO M247, Type 1, unless otherwise specified.

All glass beads shall have a concentration of less than 75 parts per million arsenic and less than 100 parts per million lead as determined by EPA Methods 6010B and 3520.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

708.10 THERMOPLASTIC PAVEMENT MARKINGS. Crushed glass shall be incorporated into the thermoplastic material at a rate of between 9 to 10 percent by mass (weight) of the combined material. The crushed glass will be used as a substitute for an equal amount by mass (weight) of the filler material. The crushed glass shall be produced from cullet of clear glass, with a maximum size of 850 microns (33 mils) [100 percent passing by mass (weight)] and a minimum size of 425 microns (17 mils) [0-2 percent passing by mass (weight)].

Thermoplastic composition shall comply with Table 708.10A.

TABLE 708.10A – THERMOPLASTIC PAVEMENT MARKINGS COMPOSITION

Binder	18% Minimum
Filler	35% Maximum
Crushed Glass	10%
Glass Beads	30%

Acceptable Thermoplastic Pavement Markings shall be one of the Thermoplastic Pavement Markings on the Approved Products List on file with the Agency's Materials and Research Section.

708.11 RAISED PAVEMENT MARKERS. Acceptable Raised Pavement Markers shall be one of the Raised Pavement Markers on the Approved Products List on file with the Agency's Materials and Research Section.

708.12 PAVEMENT MARKING TAPE.

(a) Pavement Marking Tape, Type I. Type I Pavement Marking Tape shall be one of the Non-Removable Pavement Marking Tapes on the Approved Products List on file with the Agency's Materials and Research Section.

(b) Pavement Marking Tape, Type II. Type II Pavement Marking Tape shall be one of the Removable Pavement Marking Tapes on the Approved Products List on file with the Agency's Materials and Research Section.

(c) Pavement Marking Mask. Pavement Marking Mask shall be one of the Masking Marking Tapes on the Approved Products List on file with the Agency's Materials and Research Section.

708.13 PREFORMED TRAFFIC MARKINGS AND SYMBOLS. Preformed traffic markings made of the same material as that of an approved permanent Type I tape will be accepted under a Type B Certification provided by the manufacturer identifying that the material is the same as the approved product.

708.14 LINE STRIPING TARGETS. Line Striping Targets shall be one of the Line Striping Targets on the Approved Products List on file with the Agency's Materials and Research Section.

SECTION 709 - LUMBER AND TIMBER

709.01 STRUCTURAL LUMBER AND TIMBER. Structural lumber and timber shall conform to the species and stress-grades specified in the Contract and shall be acceptable to the Engineer.

(a) Grading. Structural lumber and timber shall be graded in accordance with the requirements of AASHTO M 168. Lumber ordered in multiple lengths shall be graded after having been cut to lengths.

(b) Moisture Content.

(1) Untreated Lumber and Timber. The maximum moisture content of material entering into a finished structure shall be 19 percent.

(2) Treated Lumber and Timber. The maximum moisture content of material prior to treatment shall be 19 percent. Material treated with water-borne preservatives in accordance with AWPA standards shall be dried after treatment to a moisture content not exceeding 19 percent and shall be maintained at a moisture content of 19 percent or less until it is incorporated into the work.

(c) Minimum Stress Requirements. Unless otherwise specified in the Contract, lumber and timber shall meet the following minimum requirements:

(1) Southern and Western Material. The material shall meet the allowable unit stress requirements for "No. 1 Grade" or better material as specified in the AASHTO *LRFD Bridge Design Specifications*.

(2) Eastern (Local) Material. The material shall meet the allowable unit stress requirements for "No. 1 Grade" or better material as specified in the AASHTO *LRFD Bridge Design Specifications*.

(d) Lumber Dimensions.

(1) Full-Sawn. Minimum full-sawn lumber sizes are nominal dimension sawn sizes after seasoning. Pieces shall be sawn to obtain the full nominal dimensions specified with only occasional slight variation permitted. Thickness and width dimensions are somewhat variable depending upon the sawmill equipment used.

(2) Rough-Sawn. Rough-dry sized lumber is minimally 3 mm (1/8 inch) larger in each dimension than standard (seasoned) dressed sized lumber. Thickness and width dimensions are somewhat variable depending upon the sawmill equipment used.

(3) Dressed. Dressed lumber sizes are the finished planed dimensions of material after seasoning. Minimum net finished dimensions for dressed lumber shall be 13 mm (1/2inch) less than nominal dimension, except that the minimum net width of dressed lumber exceeding 152 mm (6 inches) shall be 19 mm (3/4 inch) less than nominal dimension.

(e) Lumber Finish. As specified per AASHTO M 168 for manufacturing classifications: e.g., Rough Lumber or Dressed (Surfaced) Lumber.

(f) Soundness. Material shall be sound and free from any incipient or advanced form of decay.

(g) Preservative Treatment. Preservative treatment of lumber and timber materials shall conform to Subsection 726.01. Unless otherwise specified, the treatment for lumber and timber materials shall conform to Type II preservative.

(h) Miscellaneous Hardware, Shapes, and Fabricated Materials.

(1) Structural steel shapes and metal fabricated materials shall conform to the requirements of the Contract and the specific material requirements as specified in Sections 714 and 715.

(2) Unless otherwise specified, bolts, studs, threaded rods, nuts, and washers shall conform to the requirements of ASTM F 568M, Class 4.6 (ASTM A 307). Carbon steel nuts (unless otherwise specified) shall conform to the requirements of AASHTO M 291M (AASHTO M 291).

(3) Nails and spikes shall conform to the requirements of ASTM F 1667.

(4) Lag screws shall be of low to medium carbon steel and shall be of good commercial quality.

(5) Unless otherwise specified, all steel hardware and fabricated materials shall be galvanized in accordance with AASHTO M 111M/M 111 or AASHTO M 232M/M 232, whichever is applicable. When Alkaline Copper Quat preservative is specified for members per Subsection 726.01, and metal fasteners are required, stainless steel fasteners shall be used for lumber and timber connectors.

(i) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

709.02 NONSTRUCTURAL LUMBER. Material furnished under this Subsection shall be for non load–carrying, structural applications with a maximum nominal thickness of 50 mm (2 inches) (e.g. boarding, siding, trim, etc.). Lumber shall be seasoned or kiln dried Spruce, Eastern White Pine, Eastern Hemlock, Southern Pine, or Western Fir, unless otherwise specified in the Contract.

(a) Grade. The grade classification of Yard Lumber, whether Common or Select, shall be as specified in the Contract. Structural lumber meeting the requirements of Subsection 709.01 and 50 mm (2 inches) thickness may be used for nonstructural lumber applications. Except with the written permission of the Engineer, lumber which has not been grade classified or stress-graded shall not be used for nonstructural lumber.

(b) Moisture Content. The moisture content shall be as specified in Subsection 709.01 (b).

(c) Dimensions.

(1) Full-Sawn. When required in the Contract, lumber shall be furnished to the minimum full-sawn (nominal) dimensions specified. See Subsection 709.01 (d) for a full definition of full-sawn lumber dimensions.

(2) Dressed. Unless otherwise specified, all lumber shall be S4S. See Subsection 709.01 (d) for a full definition of dressed lumber dimensions.

(d) Finish. Rough Lumber or Dressed (Surfaced) Lumber, per AASHTO M 168 manufacturing classifications.

(e) Soundness. Lumber shall be sound and free from any incipient or advance form of decay.

(f) Preservative Treatment. Preservative treatment of lumber shall conform to Subsection 726.01. Unless otherwise specified, the treatment shall conform to Type IV preservative.

(g) Hardware, Shapes, and Fabricated Materials. Hardware, shapes, and fabricated materials shall be as specified in Subsection 709.01 (h).

(h) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

709.03 STRUCTURAL GLUED LAMINATED TIMBER.

(a) Material. Unless otherwise specified, structural glued laminated timber shall be fabricated from Southern Pine, Coastal Douglas Fir, Western Hemlock, or Western Larch and shall meet the requirements of Section 16 of the AASHTO *LRFD Bridge Construction Specifications*.

Adhesives used in the lamination process shall be for wet-use conforming to ASTM D 2559 and shall comply with all other requirements of ANSI/AITC A190.1.

Unless otherwise specified, the appearance grade of the finished glulam products shall be “Industrial.”

(b) Seasoning. Unless otherwise specified, all material shall have a moisture content not exceeding 16 percent at the time of gluing laminations.

(c) Preservative Treatment. Unless otherwise specified, all glued laminated timber shall be treated with Type II pentachlorophenol preservative (heavy oil solvent) conforming to Subsection 726.01. Also, unless otherwise specified, all material shall be shop fabricated prior to treatment. Any field treatment required by the Engineer shall be performed in accordance with AWPA Standard M4.

(d) Miscellaneous Hardware, Shapes, and Fabricated Materials.

(1) Structural steel shapes and metal fabricated materials shall conform to the requirements of the Contract and the specific material requirements as specified in Sections 714 and 715.

(2) Unless otherwise specified, bolts, studs, threaded rods, nuts, and washers shall conform to the requirements of ASTM F 568M, Class 4.6 (ASTM A 307). Stainless steel fasteners shall conform to the requirements of ASTM F 568M, Property Class A1-70, Condition CW, with nuts conforming to ASTM F 836M, Property Class A1-70, Condition CW.

(3) All welding shall conform to the requirements of Subsection 506.10.

(4) Nails and spikes shall conform to the requirements of ASTM F1667.

(5) Lag screws shall be of low to medium carbon steel and shall be of good commercial quality.

(6) Unless otherwise specified, all steel hardware and fabricated materials shall be galvanized in accordance with AASHTO M 111M/M 111 or AASHTO M 232M/M 232, whichever is applicable.

(e) Dimensions. The designated dimensions for glued laminated timber shall be taken as the actual net dimensions.

(f) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

(g) Handling. Glued laminated timber shall be carefully handled to avoid damaging the edges and surfaces. The handling, transit, and erection procedures shall meet the requirements of specification AITC 111-79.

SECTION 710 - CULVERTS, STORM DRAINS, AND SEWER PIPES, NONMETAL

710.01 REINFORCED CONCRETE PIPE. Reinforced concrete pipe shall conform to the requirements of AASHTO M 170M (AASHTO M 170) with the following notes or exceptions:

(a) Design Requirements. The circumferential reinforcement in Table 3 of AASHTO M 170M (AASHTO M 170) for 600 mm (24 inch), Class III, Wall B pipe shall be 210 mm^2/m (0.1 in^2/ft) of pipe wall. Elliptical reinforcement shall not be used in circular pipes.

All pipe 600 mm (24 inches) in diameter or smaller shall be of the bell and spigot type. Pipes larger than 600 mm (24 inches) in diameter may be either of the tongue and groove or bell and spigot type.

In all sizes of bell and spigot pipe, and in tongue and groove pipe 750 mm (30 inches) in diameter and larger, there shall be a line of circumferential reinforcement in the bell or groove, equal in area to that of a single line within the barrel of the pipe.

(b) Marking. The exterior and interior of each length of pipe shall be clearly marked with the following data: pipe class; day, month, and year of manufacture; and name or trademark of the manufacturer. The method shall be by either clear, legible impressions in the pipe, or by clear, legible data stencilled with waterproof paint.

(c) Basis of Acceptance. All pipe shall be accepted on the basis of plant load bearing tests, material tests, and inspection of manufactured pipe for visual defects and imperfections.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02 for the pipe. Certifications for constituent materials shall be furnished in accordance with normal requirements for those types of materials.

710.02 REINFORCED CONCRETE PIPE END SECTIONS. Reinforced concrete pipe end sections shall conform to the requirements of Subsection 710.01. Where two cages of reinforcement are required in accordance with AASHTO M 170M (AASHTO M 170), they shall be placed in the barrel of the end section only. Reinforcement of the apron section shall be equal in area to the inner cage of the barrel reinforcement.

Certification. Certification shall conform to the requirements of Subsection 710.01(d).

710.03 CORRUGATED POLYETHYLENE PIPE. Corrugated polyethylene pipe and fittings shall conform to the latest revisions of AASHTO M 294, Type S or AASHTO M 252, Type SP as appropriate. Acceptable corrugated polyethylene pipe shall be one of the corrugated polyethylene pipe products on the Approved Products List on file with the Agency's Materials and Research Section.

710.04 VITRIFIED CLAY PIPE. Vitrified clay pipe shall conform to the requirements of ASTM C 700.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

710.05 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PLASTIC PIPE. ABS pipe shall conform to the requirements of Table 710.05A.

TABLE 710.05A - ABS PIPE MATERIAL REQUIREMENTS

PIPE TYPE	TEST METHOD
Storm or Sanitary Sewer Pipe (solid wall):	ASTM D 2751
Storm or Sanitary Sewer Pipe (composite wall):	AASHTO M 264

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

710.06 POLYVINYL CHLORIDE (PVC) PLASTIC PIPE. PVC pipe shall conform to the requirements of Table 710.06A.

TABLE 710.06A - PVC PIPE MATERIAL REQUIREMENTS

PIPE TYPE AND DIMENSIONS	TEST METHOD
Smooth wall, perforated or unperforated 100 to 400 mm (4 to 16 inches): 450 to 700 mm (18 to 28 inches):	AASHTO M 278 ASTM F 679*
* Pipe with other cell classifications that meet or exceed the performance requirements of ASTM D 3034 will be permitted provided the wall thickness is not less than 94 percent of that specified in AASHTO M 278	
Corrugated, with smooth interior, all sizes	ASTM F 949 ASTM F 794

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 711 - CULVERTS, STORM DRAINS AND SEWER PIPES, METAL

711.01 CORRUGATED STEEL PIPE, PIPE ARCHES, AND UNDERDRAINS. Corrugated steel pipe, elbows, end sections, reducer units, pipe arches, underdrain, risers, flushing basins, and coupling bands shall conform to the requirements of AASHTO M 36. Material furnished under this Subsection shall be formed from sheet material coated in accordance with AASHTO M 218, M 274, or M 289.

(a) Coupling Bands. Coupling bands shall conform to AASHTO M 36, with the following modifications:

(1) Coupling bands and their connections shall be of such dimensions as required to meet the "Erodible Special Joint" category criteria of Division II of the AASHTO *Standard Specifications for Highway Bridges*. Structural steel for band connections shall conform to ASTM A 36/A 36M.

a. The only approved methods of connection and connection details at the ends of the bands shall be: 51 by 51 by 4.8 mm (2 × 2 × 3/16 inch) galvanized steel angles extending the full width of the band.

b. 2.77 mm (12 gage) die-cast angle with a configuration that provides at least the same section modulus as the 51 by 51 by 4.8 mm (2 × 2 × 3/16 inch) angle, extending the full width of the band.

c. A minimum of two bolts for a 180 mm (7 inch) wide band, three bolts for a 300 mm (12 inch) wide band, and five bolts for a 600 mm (24 inch) wide band, uniformly spaced. Bolts, nuts, and other threaded items used with coupling bands shall be coated by the electroplating process as provided in ASTM B 633, Class Fe/Zn 25, the zinc coating process as provided in AASHTO M 232M/M 232 or the mechanical zinc coating process as provided in AASHTO M 298, Class 25.

d. Angles will be connected to bands by one of the following:

1. spot welds spread over full width of the band,

2. stitch-welded over the full width of the band, or

3. attached by rivets.

(2) Minimum band thickness shall be 1.63 mm (1/16 inch), and bands shall be no more than two nominal sheet thicknesses thinner than the wall thickness of the culvert or unit being connected. Coupling bands and die-cast angles may be formed from any one of the three types of sheet material specified above.

(3) The use of projection pipe coupling (dimpled) bands or preformed channel bands is not allowed.

(4) The Contractor may submit for approval to the Agency alternate coupling bands. The Contractor shall allow 30 days for a testing and evaluation period. Coupling bands shall not be shipped to projects until the Contractor has been notified that the proposed band has been approved by the Agency.

(5) For attaching metal end sections to corrugated steel pipe, the Contractor may supply 25 mm wide by 2.77 mm thick (1 inch by 12 gage) galvanized straps connected by a 12 mm (1/2 inch) galvanized bolt and nut for 300 through 600 mm (12 through 24 inch) diameter round pipes, and for 710 by 510 mm (28 × 20 inch) pipe arches and smaller.

(b) End Sections. Materials used in the manufacture of end sections shall conform to AASHTO M 36, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(c) Reducer Units. Materials used in the manufacture of concentric metal reducer units shall conform to AASHTO M 36, except that the maximum and minimum diameters, dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(d) Underdrain. Perforated underdrain including all lateral and special connections shall conform to AASHTO M 36. Minimum sheet metal thickness required is 1.32 mm (0.052 inch) for 150 mm (6 inch) diameter underdrain and 1.63 mm (0.064 inch) for 200 mm (8 inch) diameter and larger.

(e) Underdrain Risers and Flushing Basins. Underdrain risers and flushing basins, including all connectors, fittings, and covers shall conform to AASHTO M 36, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract, and the pipe shall not be perforated.

(f) Marking. All material furnished under this Subsection shall be clearly marked in an approved manner with the name or trademark of the pipe fabricator and the sheet metal thickness.

(g) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

711.02 CORRUGATED ALUMINUM ALLOY PIPE, PIPE ARCHES, AND UNDERDRAINS. Corrugated aluminum alloy pipe, elbows, end sections, reducer units, pipe arches, underdrain, risers, flushing basins, and coupling bands shall conform to the requirements of AASHTO M 196.

(a) Coupling Bands. Coupling bands shall conform to AASHTO M 196, with the following modifications:

(1) Coupling bands and their connections shall be of such dimensions as required to meet the "Erodible Special Joint" category criteria of Division II of the AASHTO *Standard Specifications for Highway Bridges*.

(2) Coupling band connections:

a. Shall be 51 by 51 by 6.4 mm (2 × 2 × 1/4 inch) aluminum angles (Alloy 6061-T6) extending the full width of the band or 2.77 mm (12 gage) minimum die-cast aluminum angles, extending the full width of the band.

b. Shall have a minimum shear strength capacity of 28.1 kN (6.3 kips).

c. Shall be connected with a minimum of two bolts for a 180 mm (7 inch) wide band, three bolts for a 300 mm (12 inch) wide band and five bolts for a 600 mm (24 inch) wide band. Bolts shall be uniformly spaced across the width of the band. Bolts, nuts, and other threaded items shall be coated in accordance with the requirements of Subsection 711.01(a)(2)c.

d. Shall have angles attached to the bands by stitch welding over the full width of the band or by rivets uniformly spaced across the width of the band.

(3) Minimum band thickness shall be 1.52 mm (0.06 inch), and bands shall be no more than two nominal sheet thicknesses thinner than the wall thickness of the culvert being connected.

(4) Alternate coupling bands may be submitted for approval as specified in Subsection 711.01(a)(5).

(b) End Sections. Materials used in the manufacture of end sections shall conform to the requirements of AASHTO M 196, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(c) Reducer Units. Materials used in the manufacture of concentric reducer units shall conform to the requirements of AASHTO M 196, except that the maximum and minimum diameters, dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(d) Underdrain Risers and Flushing Basins. Underdrain risers and flushing basins including all connectors, fittings, and covers shall conform to the requirements of AASHTO M 196, except that the dimensions, thickness of metal, and fabrication shall be in accordance with the Contract, and the pipe shall not be perforated.

(e) Marking. All material furnished under this Subsection shall be clearly marked in an approved manner with the name or trademark of the pipe fabricator and the sheet metal thickness.

(f) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

711.03 POLYMERIC COATED CORRUGATED STEEL PIPE AND PIPE ARCHES. Polymeric coated corrugated steel pipe, elbows, reducer units, and pipe arches shall conform to AASHTO M 245. Polymeric coating shall conform to AASHTO M 246, Grade 250/250.

(a) Coupling Bands. Coupling bands shall conform to the requirements of Subsection 711.01(a) modified as follows:

(1) Coupling bands and die-cast angles shall be formed from sheet material coated in accordance with AASHTO M 218, M 245, M 274, or M 289.

(2) Coupling bands formed from AASHTO M 274 or M 289 material shall be not more than one nominal sheet thickness thinner than the wall thickness of the culvert or unit being connected.

(3) Coupling bands formed from AASHTO M 245 material shall be not more than two nominal sheet thicknesses thinner than the thickness of the culvert or unit being connected. Angles must be attached to the band by rivets.

(4) Coupling bands formed from AASHTO M 218 material shall be the same nominal sheet thickness as the culvert or units being connected. Angles must be attached to the band with rivets or by stitch-welding over the full width of the band.

(b) End Sections. Materials used in the manufacture of end sections shall conform to Subsection 711.01(b).

(c) Reducer Units. Materials used in the manufacture of concentric reducer units shall conform to AASHTO M 245, except that the maximum and minimum diameters, dimensions, thickness of metal, and fabrication shall be in accordance with the Contract.

(d) Marking. All material furnished under this Subsection shall be clearly marked in an approved manner with the name or trademark of the pipe fabricator and the sheet metal thickness.

(e) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

711.04 BITUMINOUS PAVING FOR PIPE INVERTS. When shown on the Plans, inverts of polymeric coated corrugated steel units shall be paved with bituminous material in accordance with AASHTO M 190, as follows:

Pipe:	Type B Coating
Pipe Arches:	Type B Coating
Reducer Unit:	Type B Coating
Elbows:	Type B Coating
Couplings:	Uncoated
End Sections:	Uncoated

Wherever Type B coating is specified, coating on the exterior of the pipe may be omitted.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

711.05 COAL-TAR BASED COATING. Coal-tar based coating used to repair damaged areas of polymeric coating shall meet the requirements of AASHTO M 243.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

711.06 STRUCTURAL PLATES, BOLTS, AND NUTS. Structural steel plates, bolts, and nuts for pipe, pipe-arches, arches, and box culverts shall conform to the requirements of AASHTO M 167M/M 167.

Structural aluminum alloy plate, bolts, and nuts for pipe, pipe-arches, arches, and box culverts shall conform to the requirements of AASHTO M 219.

(a) Dimensions. The thickness of the plates or sheets and the radius of curvature shall be as specified in the Contract. Each plate or sheet shall be curved to one or more circular arcs.

(b) Fabrication. Plates shall be formed to provide lap joints. The bolt holes shall be punched so that all plates having like dimensions, curvature, and the same number of bolts per meter (foot) of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as specified in the Contract.

Bolt holes along those edges of the plates that form longitudinal seams in the finished structure shall be in two rows. Bolt holes along those edges of the plates that form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 300 mm (12 inches). The minimum distance from center of hole to edge of the plate shall not be less than 1.75 times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than 3 mm (1/8 inch).

Cut edges shall be free from oxide and burrs. Legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

Unless otherwise specified in the Contract, plate pipes shall be elongated so that the finished pipe is elliptical in shape with the vertical diameter approximately 5 percent greater than the nominal diameter of the pipe. Pipe arches shall not be elongated.

(c) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

SECTION 712 - CRIBBING MATERIALS

712.01 METAL BIN-TYPE RETAINING WALL.

(a) Galvanized Metal Units. The various units of metal bin-type retaining wall shall conform to the requirements of AASHTO M 218. The metal sheets used to form the members of the metal wall shall be of the thickness indicated in the Contract.

(b) Bolts and Nuts. Bolts and nuts shall conform to the requirements of Subsection 714.08 and shall be galvanized in accordance with the requirements of AASHTO M 232M/M 232.

(c) Fabrication. All units shall be fabricated so that units of the same nominal size shall be interchangeable. Drilling, punching, or drifting to correct defects in manufacture will not be permitted. Any units improperly manufactured shall be replaced at the Contractor's expense.

Whenever possible in the manufacture of the units, a minimum forming radius of 25 mm (1 inch) shall be maintained. All units that are formed with less than a 25 mm (1 inch) radius shall be hot-dip galvanized after forming.

(d) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

712.02 CONCRETE BIN-TYPE RETAINING WALL. The materials, design details, and dimensions shall be as shown on the Plans and approved Working Drawings.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

712.03 TIMBER CRIBBING.

(a) Material. Dimensional timber furnished for cribbing shall be seasoned Red (Norway) Pine, White Pine, Eastern Hemlock, or Southern Pine, straight, sound, and cut from live timber. Red Pine, White Pine, and Eastern Hemlock shall meet number 1 grade requirements specified by the Northeastern Lumber Manufacturers Association (NELMA). Southern Pine shall meet number 2 grade requirements specified by the Southern Pine Inspection Bureau (SPIB).

Structural timber furnished for glue laminated members shall be seasoned Southern Pine, Coastal Douglas Fir, or Hem-Fir meeting the requirements of Section 16 of the AASHTO *LRFD Bridge Construction Specifications*, with a minimum fiber stress in bending, about either axis, of 8.3 MPa (1200 psi).

Dimensional timber shall be full-sawn S2E (uniformly surfaced two edges to the dimensions specified).

Structural glued laminated timber shall be S4S (uniformly surfaced four sides to the dimensions specified). Surfaces to be exposed in the finished product shall be uniformly rough finish, coarse texture. Maximum unevenness in surface shall be 6 mm (1/4 inch) (process to be performed prior to preservative treatment).

Adhesive used in the lamination process shall be for wet-use conforming to ASTM D 2559 and shall comply with all other requirements of AITC A190.1.

(b) Seasoning. All material shall have a moisture content not exceeding 19 percent prior to preservative treatment.

(c) Preservative Treatment. Timber cribbing shall be pressure treated in accordance with AASHTO M 133 and AWPA Standards using a preservative as specified in Subsection 726.01.

Treatment, inspection, and testing of the treated timber materials shall conform to the requirements of Subsection 728.01.

(d) Miscellaneous Hardware.

(1) Connection and washer plates shall be fabricated from material conforming to Subsection 714.02 and galvanized in accordance with AASHTO M 111M/M 111.

(2) Bolts, nuts, and washers shall conform to Subsection 714.04 and shall be galvanized in accordance with AASHTO M 232M/M 232.

(3) Threaded rods with nuts shall be either material conforming to Subsection 714.04 and be galvanized in accordance with AASHTO M 232M/M 232 or stainless

steel conforming to ASTM F 738M, Property Class A1-70, Condition CW, with nuts conforming to ASTM F 836M, Property Class A1-70, Condition CW.

(4) Bolts and threaded rods shall have a minimum of 100 mm (4 inches) of thread. Threads shall be wrapped with a minimum of two layers of Teflon tape prior to installation. All threads shall be Metric Coarse, 6g (UNC 2).

(5) Sleeve nuts may conform to Subsection 714.04 and be galvanized or may be fabricated from stainless steel rod ASTM A 276, Type 304.

(6) All nuts shall be the heavy hex type.

(e) Certification. A Type D Certification shall be furnished for all treated timber in accordance with Subsection 700.02. A Type A Certification shall be furnished for all miscellaneous hardware in accordance with Subsection 700.

712.04 GABION BASKETS

(a) Wire for Gabion Baskets. Gabion baskets shall be manufactured from woven wire mesh. All steel wire used in the manufacture of gabion baskets shall be galvanized and PVC coated. All tests on the wire mesh shall be performed prior to manufacturing the mesh.

(1) Coating. The steel wire shall be galvanized in accordance with ASTM A 641, Class III soft temper coating. The adhesion of the galvanized coating shall be such that when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with a bare finger in accordance with ASTM A 641.

(2) Tensile Strength. Both the wire used for the manufacture of the gabions and lacing wire shall have a tensile strength of 372 MPa (54,000 psi) minimum and 483 MPa (70,000 psi) maximum when tested in accordance with ASTM A 641.

(3) Elongation. The steel wire shall have a minimum elongation of not less than 12% in accordance with ASTM A 370.

(b) PVC Coating for Gabion Baskets.

(1) Color. The PVC coating shall be gray

(2) Coating Thickness. The nominal thickness shall be 0.51 mm (0.020 inches) with a minimum thickness of 0.38 mm (0.015 inches).

(3) Tensile Strength. The tensile strength of the PVC coating shall not be less than 20.6 MPa (2985 psi) when tested in accordance with ASTM D412.

(4) Abrasion Resistance. Weight loss shall be less than 12% when tested in accordance with ASTM D 1242.

(5) Ultraviolet (UV) Resistance. When subjected to 3000 hours using apparatus Type E in accordance with ASTM D 1499 and ASTM G 23, the coating shall not crack, strip, develop air bubbles or show appreciable variation in color. Variation in the tensile strength of the coating shall not exceed 25% and variation in the abrasion resistance shall not exceed 10%.

(6) Salt Spray Test. When subjected to 3000 hours when tested according to ASTM B 117, the coating shall not crack, strip, develop air bubbles or show appreciable variation in color. Variation in the tensile strength of the coating shall not exceed 25% and variation in the abrasion resistance shall not exceed 10%.

(c) PVC Coated Galvanized Gabion Mesh, 8 x 10 Type.

(1) Mesh Wire. The mesh diameter shall be 2.69 mm (0.106 inches) plus PVC coating.

(2) Selvedge Wire. The selvedge wire shall have a minimum diameter of 3.40 mm (0.134 inches) plus PVC coating.

(3) Mesh Opening. The mesh shall have a nominal opening of 82.55 x 114.30 mm (3.25 x 4.5 inches).

(4) Lacing Wire. Lacing wire and internal stiffener wire shall have a minimum diameter of 2.21 mm (0.087 inches) plus PVC coating.

(5) Tolerances.

a. Wire. In accordance with ASTM A 641, Table 3.

b. Gabion Baskets. ± 5% on the length, width, and height.

c. Mesh Opening. Tolerances on the hexagonal, double twisted wire mesh opening shall not exceed ±10% on the nominal opening.

(d) Certification. A Type D certification shall be furnished in accordance with Subsection 700.02.

SECTION 713 - REINFORCING STEEL, WELDED WIRE REINFORCEMENT, AND REINFORCING STRAND

713.01 BAR REINFORCEMENT. Bar reinforcement for concrete structures shall be Grade 420 (Grade 60) conforming to AASHTO M 31M/M 31, including supplementary requirements.

Samples. Where indicated in the Contract, samples of bar reinforcement at least 1.5 m (60 inches) long shall be submitted to the laboratory for testing.

713.02 MECHANICAL SPLICES FOR BAR REINFORCEMENT. Mechanical splices for bar reinforcement shall develop, in tension or compression, a minimum of 125 percent of the specified yield strength of the bar intended to be spliced. The coating requirement for the mechanical splices shall match the bars that they are intended to splice. Mechanical splices shall be installed in accordance with the manufacturer's recommendations or as ordered by the Engineer.

The Contractor shall make three test splices in the presence of the Engineer for each of the bar sizes to be connected by a mechanical splice. The test splices shall be submitted to the Agency's Materials and Research Section for tensile testing to determine acceptance of the system.

713.03 WIRE ROPE OR CABLE. Wire rope or cable for guardrail shall conform to the requirements of AASHTO M 30, Type I, 19 mm (3/4 inch), Class A coating.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

713.04 COLD DRAWN STEEL WIRE. Cold drawn steel wire shall conform to the requirements of AASHTO M 32M/M 32.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

713.05 WELDED WIRE REINFORCEMENT. Welded steel wire reinforcement for concrete structures shall be Grade 515 (Grade 75) conforming to the requirements of AASHTO M 55M/M 55 or AASHTO M 221M/M 221, including supplementary requirements.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

713.06 PRESTRESSING STRAND. Prestressing elements shall be uncoated, high tensile strength, seven "low relaxation" wire strand of the grade and diameter shown on the Plans and shall conform to the requirements of AASHTO M 203M/M 203. Wire for post tensioning shall conform to the requirements of AASHTO M 204M/M 204.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

713.07 COATED BAR REINFORCEMENT. Coated bar reinforcement shall conform to the applicable requirements of Sections 507 and 713, and to the following requirements:

(a) Galvanizing. Where shown on the Plans, galvanizing shall conform to the requirements of AASHTO M 111M/M 111.

(b) Epoxy Coating. Where shown on the Plans, reinforcing steel shall have an electrostatically applied organic epoxy protective coating, which has been prequalified, fabricated, tested, and installed in accordance with AASHTO M 284M/M 284 or ASTM A 884.

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02 for the coating and coating process.

SECTION 714 - STRUCTURAL STEEL

714.01 GENERAL REQUIREMENTS. Structural steel and other related materials shall conform to the requirements specified in this Section. All main load carrying members and components of rolled or welded sections subject to tensile stress shall meet the longitudinal Charpy V-Notch impact requirements specified in AASHTO M 270M/M 270, Supplementary Requirement tables for nonfracture critical steel and fracture critical steel, for Zone 2. Impact test sampling and testing procedures shall be in accordance with AASHTO T 243.

Main members are tension members and members subject to reversals of stress including stringers, girders, cover plates, rigid frames, floor beams, and curved girder cross frames. Other members may be indicated in the Contract as main load carrying members.

References to AASHTO sections in this Section refer to the AASHTO *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

714.02 STRUCTURAL STEEL. Structural carbon steel shall conform to the requirements of AASHTO M 270M/M 270, Grade 250 (Grade 36).

714.03 HIGH-STRENGTH LOW-ALLOY STRUCTURAL STEEL. High-strength low-alloy structural steel with a 345 MPa (50 ksi) minimum yield point up to 100 mm (4 inches) in thickness shall conform to the requirements of AASHTO M 270M/M 270, Grade 345 (Grade 50) and/or Grade 345W (Grade 50W) as required.

714.04 CARBON STEEL BOLTS AND NUTS. Carbon steel bolts shall conform to the requirements of ASTM F 568M, Class 4.6 (ASTM A 307). Carbon steel nuts shall conform to the requirements of AASHTO M 291M (AASHTO M 291).

714.05 HIGH-STRENGTH BOLTS, NUTS, AND WASHERS. High-strength bolts, nuts, and circular washers shall conform to the requirements/dimensions of ASTM A 325.

Bolts installed in painted structural components shall be Type 1, shall be provided with appropriate nuts and washers, as required, and the combination of bolt, nut, and washer shall be mechanically galvanized in accordance with AASHTO M 298, Class 50, Type I.

Bolts installed in unpainted weathering steel structural components shall be Type 3 and shall be provided with appropriate nuts and washers, as required.

All high-strength bolts, nuts, and washers furnished for Agency projects shall be manufactured in the United States only. All bolts, nuts, and washers furnished for a particular application shall be furnished by a single supplier.

All bolts, nuts, and washers shall have identifiable manufacturer's marking(s) on each piece.

Nuts for galvanized fasteners shall be overtapped a minimum amount to ensure fastener assembly.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye that will provide visual verification of the lubricant during installation. Black bolts must be "oily" to the touch when installed. Bolts and nuts not properly lubricated shall be cleaned and re-lubricated prior to installation.

Certification and Test Requirements. A Type D Certification is required and shall be provided by the manufacturer, the fabricator, or the supplier, or some combination of two or more of these parties. The complete Type D Certification shall cover the entire assembly provided, as well as the individual units.

The Type A Certification(s) provided shall identify the corresponding manufacturer and supplier lot number(s) of the material(s) represented by the shipping invoice(s); the corresponding manufacturer's identification marking(s); and the corresponding Certificate of Analysis (C of A) and Certificate of Compliance (C of C); as well as providing all the information required under Subsection 700.02(b).

Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification. A separate rotational-capacity lot number shall be assigned to each combination of lots tested. The minimum frequency of testing shall be two assemblies per rotational-capacity lot.

All required tests for galvanized bolts, nuts, and washers shall be performed after they have been galvanized.

The supplier shall certify each combination of bolt production lot, nut lot, and washer lot as an assembly. In addition to all the information required under Subsection 700.02(b), the Certificate of Analysis (C of A) and Certificate of Compliance (C of C) provided shall identify the corresponding Type A Certification(s); shall show the name of the entity performing each chemical or physical analysis or test on the supplied material(s) and the place(s) and date(s) of performance; and shall include the results of the following tests, in addition to any other analyses or test results required:

(a) Rockwell Hardness Test. Each lot of bolts shall be tested for hardness. The hardness of high-strength bolts shall be within the limits indicated for Rockwell C Hardness in ASTM 325.

(b) Tensile Strength Test. Each lot of bolts shall be tested for tensile strength. The tensile strength of the furnished bolts shall meet the requirements of ASTM 325.

(c) Rotational-Capacity Test. Except as modified below, each lot of fasteners, black or galvanized, shall be subject to the rotational-capacity test specified in ASTM 325, and shall meet the following requirements:

(1) Each test specimen shall be rotated from a snug tight condition (plies of joint are in firm contact) the following number of turns in a Skidmore-Wilhelm Calibrator or equivalent tensioning device, without stripping or failure:

Bolt Length (Under Head to End of Bolt)	Number of Turns (Snug Tight)	Number of Turns Beyond Snug Tight
0 to 4 diameters	1/3 turn (120°)	2/3 turn (240°)
4 to 8 diameters	1/2 turn (180°)	1 turn (360°)
8 to 12 diameters	2/3 turn (240°)	1 1/3 turns (480°)

(2) At the required test rotation, the maximum recorded tension shall be equal to or greater than the following:

Bolt Diameter (mm)	Tension (kN)	Bolt Diameter (inches)	Tension (kips)
		½	13.8
M16	105	5/8	21.9
M20	163	¾	32.2
M22	202	7/8	44.9
M24	236	1	58.7
M27	307	1 1/8	64.4
M30	375	1 ¼	81.7
		1 3/8	97.8
M36	546	1 ½	118.5

(3) The torque measured to produce the required fastener tension shall not exceed the following values:

Bolt Diameter (mm)	Torque = the measured bolt tension in kilonewtons times the following factor:	Bolt Diameter (inches)	Torque = the measured bolt tension in pounds times the following factor:
		1/2	0.0104
M16	4.0	5/8	0.0130
M20	5.0	3/4	0.0156
M22	5.5	7/8	0.0182
M24	6.0	1	0.0208
M27	6.75	1 1/8	0.0234
M30	7.5	1 1/4	0.0260
		1 3/8	0.0286
M36	9.0	1 1/2	0.0313
	yielding a result expressed in joules (J)		yielding a result expressed in pounds-force foot (lbf•ft)

(d) Proof Load Tests. Proof load tests for bolts are required and shall be performed in accordance with ASTM F 606M (ASTM F 606), Method 1.

(1) Proof load tests for nuts are required and shall be performed in accordance with ASTM F 606M (ASTM F 606). Galvanized nuts shall be tested after the nuts have been overtapped, galvanized, and lubricated.

(e) Wedge Test. Wedge tests for tensile strength of full size bolt specimens are required and shall be performed in accordance with ASTM A 325.

(f) Zinc Thickness Test. Zinc coating thickness shall be measured on all galvanized bolts, nuts, and washers. The measurements shall be made on a minimum of three test specimens randomly selected from each lot supplied. Zinc coating thickness shall conform to the requirements of AASHTO M 232M/M 232 (ASTM A 153).

714.06 HEAT-TREATED STRUCTURAL BOLTS. Heat-treated steel structural bolts, with 1040 MPa (150 ksi) minimum tensile strength, nuts, and washers shall conform to the requirements of ASTM A 490.

Bolts, nuts, and washers shall be Type 3 for all unpainted applications of AASHTO M 270M/M 270, Grade 345W (Grade 50W) steel.

All heat-treated structural steel bolts furnished for Agency projects and nuts and washers furnished with them shall be manufactured in the United States only. All bolts, nuts, and washers furnished for a particular application shall be furnished by a single supplier.

All bolts, nuts, and washers shall have identifiable manufacturer's marking(s) on each piece.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye that will provide visual verification of the lubricant during installation. Black bolts must be "oily" to the touch when installed. Bolts and nuts not properly lubricated shall be cleaned and re-lubricated prior to installation.

Certification and Test Requirements. A Type D Certification is required and shall be provided by the supplier manufacturer, the fabricator, or the supplier, or some combination of two or more of these parties. The complete Type D Certification shall cover the entire assembly provided, as well as the individual units.

The Type A Certification(s) provided shall identify the corresponding manufacturer and supplier lot number(s) of the material(s) represented by the shipping invoice(s); the corresponding manufacturer's identification marking(s); and the corresponding Certificate of Analysis (C of A) and Certificate of Compliance (C of C); as well as providing all the information required under Subsection 700.02(b).

Each combination of bolt production lot, nut lot, and washer lot shall be tested as an assembly. Where washers are not required by the installation procedures, they need not be included in the lot identification. A separate rotational-capacity lot number shall be assigned to each combination of lots tested. The minimum frequency of testing shall be two assemblies per rotational-capacity lot.

All required tests for galvanized bolts, nuts, and washers shall be performed after they have been galvanized.

The supplier shall certify each combination of bolt production lot, nut lot, and washer lot as an assembly. In addition to the information required under Subsection 700.02(b), the Certificate of Analysis (C of A) and Certificate of Compliance (C of C) provided shall identify the corresponding Type A Certification(s); shall show the name of the entity performing each chemical or physical analysis or test on the supplied material(s) and the place(s) and date(s) performed; and shall include the results of the following tests in addition to any other analyses or test results required:

(a) Rockwell Hardness Test. Each lot of bolts shall be tested for hardness. The hardness of heat-treated structural bolts shall be within the limits indicated for Rockwell C Hardness in AASHTO M 253M (AASHTO M 253).

(b) Tensile Strength Test. Each lot of bolts shall be tested for tensile strength. Acceptable bolts shall have a value which is at least 1040 MPa (150 ksi) and which is not greater than 1200 MPa (175 ksi).

(c) Rotational-Capacity Test. Except as modified below, each lot of fasteners, black and galvanized, shall be subject to the rotational-capacity test specified in ASTM A 325, and shall meet the following requirements:

(1) Each test specimen shall be rotated from a snug tight condition (plies of joint are in firm contact) the following number of turns in a Skidmore-Wilhelm Calibrator or equivalent tensioning device, without stripping or failure:

Bolt Length (Under Head to End of Bolt)	Number of Turns (Snug Tight)	Number of Turns Beyond Snug Tight
0 to 4 diameters	1/3 turn (120°)	2/3 turn (240°)
4 to 8 diameters	1/2 turn (180°)	1 turn (360°)
8 to 12 diameters	2/3 turn (240°)	1 1/3 turns (480°)

(2) At the required test rotation, the maximum recorded tension shall be equal to or greater than the following:

Bolt Diameter (mm)	Tension (kN)	Bolt Diameter (inches)	Tension (kips)
		½	17.3
M16	131	5/8	27.6
M20	205	¾	40.3
M22	254	7/8	56.4
M24	295	1	73.6
M27	384	1 1/8	92.0
M30	469	1 ¼	117.3
		1 3/8	139.2
M36	684	1 ½	170.2

(3) The torque measured to produce the required fastener tension shall not exceed the following values:

Bolt Diameter (mm)	Torque = the measured bolt tension in kilonewtons times the following factor:	Bolt Diameter (inches)	Torque = the measured bolt tension in pounds times the following factor:
		1/2	0.0104
M16	4.0	5/8	0.0130
M20	5.0	3/4	0.0156
M22	5.5	7/8	0.0182
M24	6.0	1	0.0208
M27	6.75	1 1/8	0.0234
M30	7.5	1 1/4	0.0260
		1 3/8	0.0286
M36	9.0	1 1/2	0.0313
	yielding a result expressed in joules (J)		yielding a result expressed in pounds-force foot (lbf•ft)

(d) Proof Load Tests. Proof load tests for bolts are required and shall be performed in accordance with ASTM F 606M (ASTM F 606), Section 3.2.1, Method 1. Proof load tests for nuts are required and shall be performed in accordance with ASTM F 606M (ASTM F 606), Section 4.2. Galvanized nuts shall be tested after the nuts have been overtapped, galvanized, and lubricated.

(e) Wedge Test. Wedge tests of full size bolt specimens are required and shall be performed in accordance with ASTM A 490.

(f) Zinc Thickness Test. The thickness of the zinc coating shall be measured on all galvanized bolts, nuts, and washers. The measurements shall be made on a minimum of three test specimens randomly selected from each lot supplied. The thickness of the zinc shall conform to the requirements of AASHTO M 232M/M 232 (ASTM A 153).

714.07 ANCHOR BOLTS, BRIDGE RAILING. Anchor bolts for bridge railing shall conform to the requirements of ASTM A 449, Property Class 8.8. Nuts shall conform to the requirements of ASTM A 563. Washers shall conform to the requirements of ASTM A 436.

All anchor bolts for bridge railing furnished for Agency projects shall be manufactured in the United States only. All bolts, nuts, and washers furnished for a particular application shall be furnished by a single supplier.

All bolts, nuts, and washers shall have identifiable manufacturer's marking(s) on each piece.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye that will provide visual verification of the lubricant during installation. Black bolts must be "oily" to the touch when installed. Bolts and nuts not properly lubricated shall be cleaned and re-lubricated prior to installation.

All bolts, nuts, and washers furnished under this Subsection shall meet all the requirements, including testing and certification, specified in Subsection 714.05.

714.08 ANCHOR BOLTS, BEARING DEVICES. Anchor bolts for bridge bearings shall conform to the requirements of ASTM .F 1554, Grade 36, unless otherwise specified. Nuts shall be heavy hex and conform to the requirements of AASHTO M 291M (AASHTO M 291), and washers shall conform to the requirements of AASHTO M 293., Washers shall be a minimum of 10 mm (3/8 inch) in thickness, unless otherwise noted in the Plans.

All anchor bolts for bearing devices furnished for Agency projects shall be manufactured in the United States only. All bolts, nuts, and washers furnished for a particular application shall be furnished by a single supplier.

All bolts, nuts, and washers shall have identifiable manufacturer's marking(s) on each piece.

All galvanized nuts shall be lubricated with a lubricant containing a visible dye that will provide visual verification of the lubricant during installation. Black bolts must be "oily" to the touch when installed. Bolts and nuts not properly lubricated shall be cleaned and re-lubricated prior to installation.

When the bolts furnished under this Subsection are required to conform to the requirements of ASTM A307 Grade C, or ASTM F 1554 the bolts, nuts, and washers furnished shall be tested and certified as meeting the requirements of the Zinc Thickness Test as specified in Subsection 714.05, in addition to any other test and certification requirements.

Anchor bolts shall be swedged or threaded and shall conform to the shape, length, and diameter specified in the Contract.

714.09 ANCHOR BOLTS, TRAFFIC SIGNALS, LIGHTING, AND OVERHEAD SIGN STRUCTURES. Anchor bolts and washers shall be an austenitic grade of stainless steel conforming to the chemistry of ASTM A 276, Type 304 with the following physical properties:

TABLE 714.09A - ASTM A 276 , TYPE 304 MATERIAL REQUIREMENTS

Tensile Strength, Minimum:	550 MPa (80,000 psi)
Yield Strength, Minimum:	380 MPa (55,000 psi)
Elongation in 50 mm (2 inches), Minimum:	30 percent
Rockwell B Hardness, Minimum:	86
or	
Charpy V-Notch, Minimum: (AASHTO T 243M/T 243 using "H" frequency testing)	20.5 N•m at 5 °C (15 lbf•ft at 40 °F)

Nuts for anchor bolts shall be the heavy hex type conforming to the requirements of AASHTO M 292M/M 292, Grade 8 and dimensions of ANSI B18.2.4.6M.

All anchor bolts for traffic signal, street lighting, and overhead sign installations furnished for Agency projects shall be manufactured in the United States only. All bolts, nuts, and washers furnished for a particular application shall be furnished by a single supplier.

All bolts, nuts, and washers shall have identifiable manufacturer's marking(s) on each piece.

714.10 WELDED STUD SHEAR CONNECTORS. Shear connectors shall conform to the requirements of Section 11 of the AASHTO *LRFD Bridge Construction Specifications* and ANSI/AWS D1.5.

Prior to installation of any shear connectors by a fabricator in a shop or by a Contractor in the field the Engineer shall be furnished:

(a) The stud manufacturer's certification that the studs, as delivered, conform to the applicable requirements of ANSI/AWS D1.5.

(b) Certified copies of the stud manufacturer's test reports of in-plant quality control mechanical tests as specified by ANSI/AWS D1.5.

Studs that do not meet the above requirements will be rejected.

714.11 STEEL TUBING. Steel tubing shall conform to the requirements of ASTM A 500, Grade B.

714.12 DIRECT TENSION INDICATORS. Direct Tension Indicators shall be Compressible-Washer-Type Direct Tension Indicators conforming to the requirements of ASTM F 959M, Type 8.8 (ASTM F 959, Type 325).

714.13 TENSION CONTROL ASSEMBLIES. Tension Control Assemblies shall be "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies conforming to the requirements of ASTM F 1852.

SECTION 715 - MISCELLANEOUS METALS

715.01 IRON CASTINGS.

(a) General Requirements. Castings shall conform to the requirements of AASHTO M 306. Castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blow holes, and other defects in positions affecting their strength and value for the service intended.

Castings shall be boldly filleted at angles and the arises shall be sharp and perfect. The surfaces shall have a blemish free finish.

All castings shall be blast cleaned or otherwise effectively cleaned of scale and sand so as to present a smooth, clean, and uniform surface. The dimensions of the frames and covers shall substantially conform to the dimensions for cast iron covers and frames as shown in the Contract Documents. The covers shall be flush with the upper surface of the frame when seated. The seatings shall be machined or made quiet by the use of a gasket cushioning insert or supported by a three point triangular suspension. The minimum depth of insertion of the cover into the frame shall be no less than 50 mm (2 inches).

As a minimum, the covers and frames shall meet the M-18 (H 20) loading requirements of AASHTO and the proof load requirements of Federal Specification A-A-60005.

Covers shall be identified by the words “STORM SEWER”, “WATER”, “SEWER”, “ELECTRIC”, or other as applicable, in raised cast letters as indicated in the Contract Documents or as directed by the Engineer.

(b) Gray Iron Castings. Gray iron castings shall conform to the requirements of AASHTO M 105, Class No. 35B, unless otherwise specified.

(c) Ductile Iron Castings. Ductile iron castings for frames and covers shall conform to the requirements of ASTM A 536, Grade 80-55-06.

(d) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

715.02 THIS SUBSECTION RESERVED

715.03 CAST IRON PIPE. Cast iron pipe and fittings shall conform to either the requirements of ASTM A 74 or the requirements of ASTM A 377, unless otherwise specified.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

715.04 ALUMINUM ALLOY. Material shall be fabricated from Alloy 6061-T6.

(a) Sheet and Plate. Aluminum alloy sheet and plate shall conform to the requirements of ASTM B 209M (ASTM B 209).

(b) Drawn Seamless Tubes. Aluminum alloy drawn seamless tubes shall conform to the requirements of ASTM B 210M (ASTM B 210).

(c) Bars, Rods, and Wire. Aluminum alloy bars, rods, and wire shall conform to the requirements of ASTM B 211M (ASTM B 211).

(d) Extruded Bars, Rods, Shapes, and Tubes. Aluminum alloy extruded bars, rods, shapes, and tubes shall conform to the requirements of ASTM B 221M (ASTM B 221).

(e) Seamless Pipe and Seamless Extruded Tube. Aluminum alloy seamless pipe and seamless extruded tube shall conform to the requirements of ASTM B 241/B 241M.

(f) Welding Rods and Electrodes. Aluminum and aluminum alloy welding rods and bare electrodes shall conform to the requirements of AWS.

(g) Standard Structural Shapes. Aluminum alloy standard structural shapes, rolled or extruded, shall conform to the requirements of ASTM B 308/B 308M.

(h) Extruded Structural Pipe and Tube. Aluminum alloy extruded structural pipe and tube shall conform to the requirements of ASTM B 429.

(i) Sand Castings. Aluminum alloy sand casting shall conform to the requirements of ASTM B 26/B 26M.

(j) Permanent Mold Castings. Aluminum alloy permanent mold castings shall conform to the requirements of ASTM B 108.

(k) Rivets. Aluminum alloy rivet shall conform to the requirements of ASTM B 316/B 316M.

(l) Bolts, Nuts, and Screws. Aluminum alloy bolts, nuts, and screws shall be made from rod conforming to the requirements of ASTM B 211M (ASTM B 211). Bolt heads shall conform to the American Standard heavy hexagon, ANSI B18.2.3.6M (ANSI B18.2.1), and nuts shall conform to ANSI B18.2.4.6M in accordance with ANSI B18.2M (ANSI B18.2.1 and B18.2.2). Bolt threads shall conform to ANSI B1.13M (ANSI B1.1). Both bolts and nuts shall be given an anodic coating at least 5 μm (0.2 mil) in thickness with dichromate or boiling water seal.

(m) Washers and Shims. Aluminum alloy washers shall be made from aluminum alloy sheet conforming to the requirements of ASTM B 209M (ASTM B 209).

Aluminum alloy shims shall be made from aluminum alloy sheet or plate conforming to the requirements of ASTM B 209M (ASTM B 209) or ASTM B 221M (ASTM B 221).

(n) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

715.05 STAY-IN-PLACE CORRUGATED METAL FORMS (SIPCMF) FOR SUPERSTRUCTURE SLABS

(a) General. Forms and form supports shall be in conformance with ASTM A 653/A 653M, Grades A thru E, Coating Designation G165. Fabrication shall be in conformance with ASTM A 924/A 924M. Prior to the fabrication of forms, the Contractor shall submit to the Engineer certification for conformity of steel and galvanizing to ASTM A 653/A 653M.

(b) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

715.06 METAL ROOFING

(a) Roofing. Metal roofing shall be baked enamel, double lock standing seam metal roofing, galvanized steel ASTM A 653/A 653M Grade CS G90 coating or aluminum, 24 gauge minimum thickness. As approved by the Engineer, an alternate base coating for steel roofing may be allowed. The installer shall provide certificates of compliance for each specification.

The metal roofing system shall meet UL-580, Class 90 (wind uplift) and ASTM E 1646-95(2003) (water penetration). The installer shall provide certificates of compliance for each specification, or computation of an alternate wind load acceptable to the Engineer.

The Contractor shall provide manufacturer's color samples to the Engineer for approval. The Engineer, in consultation with the owner, will determine which, if any, of the samples are acceptable.

(b) Trim. The trim shall be of the type and size recommended by the roofing manufacturer(s).

(c) Fasteners. Fasteners shall be pancake head screws, or other low profile fasteners, with a minimum nominal penetration length of 25 mm (1 inch) into the roof boards. A minimum ultimate pullout strength shall be provided to meet uplift requirements.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 719 - EPOXY RESIN MATERIALS

719.01 THIS SUBSECTION RESERVED

719.02 EPOXY BONDING COMPOUND. Epoxy bonding compound shall meet the requirements of AASHTO M 235M/M 235 for the type, grade, and class corresponding to the application and temperature range for which it is to be used.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 720 - GEOTEXTILES

720.01 GENERAL. The geotextile shall be composed of a polymeric yarn or fiber oriented into a stable network, which retains its relative structure during handling, placement, and design service life. Geotextiles may be rejected by the Engineer if dimensional stability or resistance of the geotextile to ambient temperatures, acid and alkaline conditions, and micro-organisms/insects does not appear to be satisfactory for the intended purpose. The geotextile shall meet or exceed the properties specified below and in the Contract. The geotextile shall be free of any chemical treatment or coating which might significantly reduce permeability. The selvage of geotextiles shall be finished such that the outer fibers are prevented from pulling away from the fabric. The geotextile shall be free of defects or tears. The material shall be protected from damage and deterioration until incorporated into the project.

720.02 DEFINITIONS.

(a) Geotextile. A fabric manufactured specifically for use in civil engineering applications. Fibers used in the manufacture of geotextiles shall consist of long chain synthetic polymers. At least 85 percent by mass (weight) of the long chain polymers shall be polyolephins, polyesters, or polyamides.

(1) Drainage Geotextile. Geotextile for installation in underdrains or other drainage locations as directed by the Engineer.

(2) Stone Fill or Riprap Geotextile. Geotextile for installation behind and beneath stone fill or riprap and other erosion prevention and sediment control applications, rock placed for slope stabilization, and rock shear keys.

(3) Subgrade Geotextile. Geotextile for installation on roadway subgrades, under railroad ballast, and in other material separation applications.

(b) Machine Direction. The long (or warp) direction of the geotextile. The cross-machine (or fill) direction is perpendicular to the machine direction.

(c) Minimum Average Roll Values. The minimum average roll value of any specific geotextile property is the minimum average of the test results from any roll within a lot.

(d) Nonwoven Geotextile. A textile produced by bonding or interlocking of fibers, or both, accomplished by mechanical, heat, or chemical means.

(e) Seam Allowance. The minimum distance from the edge of a geotextile to the stitch line nearest to that edge.

(f) Seam Type. A designation relating to the essential characteristics of geotextile positioning and rows of stitching in a specified sewn seam, as shown on the Plans.

(g) Selvage. The finished edge of a geotextile parallel to the machine direction.

(h) Stitch Type. A designation relating to the essential characteristics of the interlacing of sewing thread(s) in a specified seam, as shown on the Plans.

(i) Woven Geotextiles. A textile comprising two or more sets of filaments or yarns interlaced in such a way that they result in a uniform pattern.

720.03 FACTORY SEAMS. Where factory seams are made, the sheets of geotextile shall be sewn together using a lock-type stitch. The seams shall be sewn with a polymeric thread, i.e., at least 85 percent by mass (weight) of the long chain polymers shall be polyolephins, polyesters, or polyamides, and shall be as resistant to deterioration as the geotextile being sewn. Nylon threads will not be allowed. The strength of the seam shall be determined by the wide strip tensile test method and shall be at least equal to the larger of the minimum required tensile strengths for the intended application.

720.04 SAMPLING, TESTING, AND ACCEPTANCE REQUIREMENTS.

(a) Sampling. The manufacturer shall sample all geotextiles in accordance with ASTM D 4354. The production unit used for sampling shall be a roll.

(b) Testing. Tests shall be performed to determine geotextile properties specified below for the intended application(s). All geotextile property requirements are average minimum roll values. The tensile strengths shall be determined in both machine and cross-machine directions.

(c) Acceptance Requirements. If the average minimum roll value for any lot is less than the average minimum roll value specified for the application, then the lot shall be rejected. All rolls shall be clearly labeled as being part of a lot that has been certified as meeting all applicable requirements below.

(d) Minimum Average Roll Value. Average minimum roll values of each of the geotextiles used shall meet the requirements specified in the following table:

TABLE 720.04A - VAOT MINIMUM AVERAGE ROLL VALUES FOR GEOTEXTILES (METRIC)

Geotextile Property	Test Method	Pay Item 649.11 For Roadbed Separator		Pay Item 649.11 Under Railroad Ballast		Pay Item 649.31 Under Stone Fill		Pay Item 649.41 For Underdrain Trench Lining (Note 3)	Pay Items 649.51 and 649.515 For Silt Fence[5]	Pay Item 649.61 For Filter Curtains
Elongation (Note 2)										
Elongation Criteria at Failure (Note 1)	ASTM D 4632	<50%	≥50%	<50%	≥50%	<50%	≥50%	20% Min.	(Note 4)	20% Max.
1. Grab Tensile Strength (lbs.)	ASTM D 4632	1100	700	1400	900	1400	900	400	550 MD 450 XD	900
2. Static (CBR) Puncture (lbs.)	ASTM D 6241	2200	1375	2750	1925	2750	1925	625	1225	1925
3. Trapezoidal Tear Strength (lbs.)	ASTM D 4533	400	250	500	350	500	350	110	180	225
4. Apparent Opening Size (mils)	ASTM D 4751		0.42 Max. (#40 sieve)	0.21 Max. (#70 sieve)		0.21 Max. (#70 sieve)		0.21 Max. (#70 sieve)	0.60 Max. (#30 sieve)	0.21 Max. (#70 sieve)
5. Permittivity (s^{-1})	ASTM D 4491		0.02	0.3		0.4		0.5	0.05	0.4
6. UV Resistance (% Strength Retained)	ASTM D 4355		50% @ 500 hours	50% @ 500 hours		50% @ 500 hours		50% @ 500 hours	70% @ 500 hours	70% @ 500 hours
7. Other						Woven or Nonwoven; slit film not permitted		Nonwoven only, slit film not permitted	Woven only	Woven only

1. Elongation corresponds to Maximum Grab Tensile Strength as measured in accordance with ASTM D 4632.
2. Only one criteria applies per Pay Item.
3. Where angular aggregate larger than 100 mm size or sharp objects come in contact with the geotextile, or if the trench is deeper than 10 feet, then the minimum Grab Tensile, Burst, Puncture, and Trapezoid Tear Strengths shall be increased to 800 N, 2000 kPa, 360 N, and 225 N, respectively.
4. Where Elongation is ≥50%, post spacing shall not exceed 1.2 m. Where Elongation is <50%, post spacing shall not exceed 2 m.
5. MD = Machine Direction and XD = Cross Machine Direction

TABLE 720.04A - VAOT MINIMUM AVERAGE ROLL VALUES FOR GEOTEXTILES (ENGLISH)

Geotextile Property	Test Method	Pay Item 649.11 For Roadbed Separator		Pay Item 649.21 Under Railroad Ballast		Pay Item 649.31 Under Stone Fill		Pay Item 649.41 For Underdrain Trench Lining (Note 3)	Pay Items 649.51 and 649.515 For Silt Fence[5]	Pay Item 649.61 For Filter Curtains
Elongation (Note 2)										
Elongation Criteria at Failure (Note 1)	ASTM D 4632	<50%	≥50%	<50%	≥50%	<50%	≥50%	20% Min.	(Note 4)	20% Max.
1. Grab Tensile Strength (lbs.)	ASTM D 4632	250	160	315	200	315	200	90	125 MD 100 XD	200
2. Static (CBR) Puncture (lbs.)	ASTM D 6241	500	310	625	435	625	435	140	275	435
3. Trapezoidal Tear Strength (lbs.)	ASTM D 4533	90	55	110	80	110	80	25	40	50
4. Apparent Opening Size (mils)	ASTM D 4751		16.5 Max. (#40 sieve)	8.3 Max. (#70 sieve)		8.3 Max. (#70 sieve)		8.3 Max. (#70 sieve)	23.6 Max. (#30 sieve)	8.3 Max. (#70 sieve)
5. Permittivity (s^{-1})	ASTM D 4491		0.02	0.3		0.4		0.5	0.05	0.4
6. UV Resistance (% Strength Retained)	ASTM D 4355		50% @ 500 hours	50% @ 500 hours		50% @ 500 hours		50% @ 500 hours	70% @ 500 hours	70% @ 500 hours
7. Other						Woven or Nonwoven; slit film not permitted		Nonwoven only, slit film not permitted	Woven only	Woven only

1. Elongation corresponds to Maximum Grab Tensile Strength as measured in accordance with ASTM D 4632.
2. Only one criteria applies per Pay Item.
3. Where angular aggregate larger than 4 inch size or sharp objects come in contact with the geotextile, or if the trench is deeper than 10 feet, then the minimum Grab Tensile, Burst, Puncture, and Trapezoid Tear Strengths shall be increased to 180 lbs, 290 psi, 80 lbs, and 50 lbs, respectively.
4. Where Elongation is ≥50%, post spacing shall not exceed 4 feet. Where Elongation is <50%, post spacing shall not exceed 6 feet.
5. MD = Machine Direction and XD = Cross Machine Direction

(e) Manufacturer's Certification. The Contractor shall furnish the geotextile manufacturer's certified test results attesting that the geotextile and all factory seams meet the requirements stated in these specifications. A Type D Certification shall be furnished that provides the information required under Subsection 700.02, including minimum average roll values for each type of geotextile used.

(f) Additional Information. The supplier shall ensure that the manufacturer's roll or lot numbers are clearly indicated on both the material packaging and the certification. In addition, the Contractor shall provide to the Engineer for verification purposes package information from all of the geotextile rolls used on the project.

720.05 PREFABRICATED CHECK DAM. Acceptable Prefabricated Check Dam(s) shall be one of the Prefabricated Check Dam(s) on the Approved Products List on file at the Agency's Materials and Research Section.

720.06 INLET PROTECTION DEVICE, TYPE II. Acceptable Inlet Protection Device(s) shall be one of the Inlet Protection Device(s) on the Approved Products List on file at the Agency's Materials and Research Section.

720.07 FILTER BAG. Acceptable Filter Bag(s) shall be one of the Filter Bag(s) on the Approved Products List on file at the Agency's Materials and Research Section.

SECTION 725 - CONCRETE CURING MATERIALS AND ADMIXTURES

725.01 CONCRETE CURING MATERIALS.

(a) White Burlap-Polyethylene Sheet. White burlap-polyethylene sheet shall conform to the requirements of AASHTO M 171.

(b) Burlap Cloth. Burlap cloth shall conform to the requirements of AASHTO M 182. Worn burlap cloth with holes, or burlap cloth reclaimed from uses other than that of curing concrete, will not be permitted. The burlap cloth shall be free of any ingredients that may damage or be detrimental to concrete.

(c) White Polyethylene Sheeting. White polyethylene sheeting (film) shall conform to the requirements of AASHTO M 171.

(d) Liquid Membrane-Forming Compounds. Liquid membrane-forming compounds shall conform to the requirements of ASTM C 309, Type 1-D or Type 2, Class B.

(1) Sampling and Testing. Upon request, the Agency will furnish a list of products on the Approved Products List that have been previously evaluated and are considered satisfactory. Should the Contractor wish to use a product other than those included on this list, a 4 L (1 gallon) sample of the product shall be submitted to the Agency's Materials and Research Section for testing purposes. A minimum period of 30 days shall be allowed for testing purposes. Tests for daylight reflectance will not be required.

725.02 CHEMICAL ADMIXTURES.

(a) General

(1) Packaging. The admixture shall be delivered in the manufacturer's original containers that shall be marked with the manufacturer's name and trade name of the material. Bulk deliveries will be allowed provided a copy of the delivery slip accompanies the manufacturer's certification or sample submitted for testing.

(2) Sampling and Testing. Upon request, the Agency will furnish a list of products on the Approved Products List that have been previously tested and are considered satisfactory. Should the Contractor wish to use a product other than those included on this list, a 4 L (1 gallon) sample or the equivalent in powder form shall be submitted to the Materials and Research Section for testing purposes. Tests for bleeding and length change will not be required. A minimum period of 60 days shall be allowed for testing purposes.

(b) Air-Entraining Admixtures. Air-entraining admixtures shall conform to the requirements of AASHTO M 154.

(c) Retarding Admixtures. Retarding admixtures shall conform to the requirements of AASHTO M 194M/M 194, Type B.

(d) Latex Admixture. The formulated latex admixture shall be a homogeneous, nontoxic, film-forming, polymeric emulsion to which all stabilizers have been added at the point of manufacture.

When some degree of flexibility of the composition is considered desirable in the intended use, it shall conform to the requirements of the following table or shall have been approved by the FHWA Fairbank Research Station:

TABLE 725.02A - LATEX ADMIXTURE A

Physical Properties	Min.	Max.
Polymer Type	Styrene butadiene	---
Stabilizers:		
(a) Latex	Nonionic surfactants	---
(b) Portland cement composition	Polydimethyl siloxane	---
Solids, %	46.0	49.0
Density, kg/L at 25 °C (lbs./gal at 77 °F)	1.0 (8.3)	---
Color	White	---

Latex admixture shall be stored in suitable enclosures which will protect it from freezing and from prolonged exposure to temperatures in excess of 30 °C (86 °F). It shall not be used after two years from the date of manufacture.

(e) Silicone Admixture. The formulated admixture shall be of a liquid silicone type that conforms to the following chemical description: N-beta (aminoethyl) gamma-Aminopropyltrimethoxy-silane. Its use is intended to prolong the life of Portland cement concrete by increasing its resistance to deicing chemicals and by reducing spalling, scaling, and surface failure due to freeze-thaw cycling.

Silicone admixture shall be stored in suitable containers that prevent contamination of any kind. It shall not be used after one year from the date of manufacture or if the liquid is cloudy or milky in color.

(f) Water-Reducing Admixtures. Water-reducing admixtures shall conform to the requirements of AASHTO M 194M/M 194, Type A.

(g) Water-Reducing and Retarding Admixtures. Water-reducing and retarding admixtures shall conform to the requirements of AASHTO M 194M/M 194, Type D.

(h) Water-Reducing, High Range Admixtures. Water-reducing, high range admixtures shall conform to the requirements of AASHTO M 194, Type F.

(i) Water-Reducing, High Range, and Retarding Admixtures. Water-reducing, high range, and retarding admixtures shall conform to the requirements of AASHTO M 194M/M 194, Type G.

(j) Accelerating Admixtures. Accelerating admixtures shall conform to the requirements of AASHTO M 194M/M 194, Type C.

(k) Water-Reducing and Accelerating Admixtures. Water-reducing and accelerating admixtures shall conform to the requirements of AASHTO M 194M/M 194, Type E.

(l) Specific Performance Admixtures. Specific performance admixtures that provide desired performance characteristics, including but not limited to shrinkage reduction, alkali-silica reaction mitigation, and viscosity shall conform to the requirements of ASTM C 494M/C 494, Type S.

725.03 MINERAL ADMIXTURES.

(a) Pozzolans. Pozzolans and fly ash shall conform to the requirements of AASHTO M 295. The supplier shall provide the State with the test results of the ten consecutive samples preceding the one submitted for approval to demonstrate compliance with the uniformity requirements shown in Table 2 of AASHTO M 295.

The Contractor shall provide suitable means for storing and protecting the pozzolans from contamination with foreign materials. Fly ash containing oil shall be rejected.

The combining of different types of fly ash or the mixing of the same type of fly ash from different sources will not be permitted.

(b) Silica Fume. Silica fume shall conform to the chemical and physical requirements of Table 725.03A:

TABLE 725.03A – SILICA FUME MATERIAL REQUIREMENTS

Silicon Dioxide (SiO_2), Minimum %:	85.0
Sulfur Trioxide (So_3), Maximum %:	3.0
Moisture Content, Maximum %:	3.0
Loss on Ignition, Maximum %:	6.0
Available Alkalies as Na_2O, Maximum %:	1.5
Specific Surface, Air Permeability, m^2/kg:	6000
Pozzolanic Activity Index:	
With Portland cement, at 28 days when tested in accordance with ASTM C 311, Minimum, % control:	100
Soundness:	
Autoclave expansion or contraction, Maximum %:	0.8
Specific Gravity, Maximum variation from average, %:	5

When silica fume is delivered in packages or drums, the name brand of the manufacturer and the mass (weight) of the silica fume, if dry, or the concentration, if a slurry, shall be clearly marked on the package or drum.

(c) Ground Granulated Blast-Furnace Slag (GGBFS). Ground granulated blast-furnace slag (GGBFS) shall conform to the requirements of AASHTO M 302.

The Contractor shall provide suitable means for storing and protecting the GGBFS from contamination by foreign materials and/or moisture.

(d) Certification. All mineral admixtures shall be certified by submittal of a Type D Certification in accordance with Subsection 700.02 for each shipment of mineral admixture. If the supplier's operations do not permit strict compliance with the above requirements, alternate procedures for certification, if approved, may be established with the Agency Materials and Research Section at the request of the supplier.

SECTION 726 – PROTECTIVE COATINGS AND WATERPROOFING MATERIALS

726.01 TIMBER PRESERVATIVE. Preservatives and pressure treatment processes for lumber and timber shall conform to the requirements of AASHTO M 133. Acceptable preservatives and AWPA Preservative Standards are as given in Table 726.01A.

TABLE 726.01A – TIMBER PRESERVATIVE STANDARDS

Preservative Type	AWPA Standard
I. Creosote	
(a) Creosote	P1
(b) Creosote – Coal Tar Solution	P2
(c) Creosote – Petroleum Solution	P3
II. Pentachlorophenol	P8
Solvent – Heavy Oil Hydrocarbon Solvent, Type A	P9
III. Pentachlorophenol	P8
Solvent – Light Oil Hydrocarbon Solvent, Type C	P9
IV. Chromated Copper Arsenate	P5
V. Alkaline Copper Quat	P5

For wood components, AWPA Product Use and Commodity Specifications shall be as listed in Table 726.01B.

TABLE 726.01B – AWPA PRODUCT USE AND COMMODITY SPECIFICATIONS

Component	AWPA Use Category	AWPA Commodity Spec.
Sawn Guardrail Post	UCB4	6A
Sawn Bollard, Marker Post, Guide Post, and Fence Post	UC4B	6A
Sawn Sign Post	UC4A	6A
Sawn Structural Lumber and Timber	UC4B	6A
Sawn Nonstructural Lumber	UC4B	6A
Sawn Timber Cribbing	UC4B	6A
Structural Glued Laminated Timber	UC4B	6F
Round Fence Post	UC4B	6B
Round Timber Pole	UC4B	6D

Any field treatment required by the Engineer shall be performed in accordance with the provisions of AWPA Miscellaneous Standard M4. Prior to the delivery of preservative material, a copy of the Material Safety Data Sheet for the product shall be provided to the Resident Engineer.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

726.02 BOILED LINSEED OIL. Boiled linseed oil shall conform to the requirements of ASTM D 260.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

726.03 MINERAL SPIRITS. Mineral spirits shall conform to the requirements of ASTM D 235.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

726.04 COPPER NAPHTHENATE SOLUTION. Copper naphthenate solution shall meet the requirements of a good quality commercially available product, as approved by the Engineer.

726.05 WATERPROOFING PITCH. Waterproofing pitch shall conform to the requirements of ASTM D 450. Type II pitch shall be furnished.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

726.06 WOVEN COTTON FABRIC. Bitumen saturated woven cotton fabric shall conform to the requirements of ASTM D 173.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

726.07 WOVEN GLASS FABRIC. Coated woven glass fabric shall conform to the requirements of ASTM D 1668.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

726.08 GALVANIZING. Surfaces to be galvanized shall be zinc coated in conformance with AASHTO M 111M/M 111 or, when applicable, AASHTO M 232M/M 232.

Repair. Galvanizing that has been damaged shall be repaired in accordance with ASTM A 780 “Standard Practice for Repair of Damaged Hot Dipped Galvanized Coatings, Annex A2”. The paint used in the repair shall be organic-rich, containing 92 percent (min.) zinc by mass (weight) in the dry film. The paint shall be applied per manufacturer’s recommendations to a thickness equivalent to the surrounding galvanizing.

726.09 METALIZING. Surfaces to be metalized shall be prepared and coated in accordance with AWS C 2.18 "Guide for the Protection of Steel with Thermal Sprayed Coating of Aluminum and Zinc and Their Alloys and Composites", and the following:

(a) The coating shall be pure zinc (99.9 percent purity minimum).

(b) A minimum thickness of 150 μm (6 mils) shall be applied to all exterior surfaces. Internal surfaces (e.g. pot bearings) shall have a minimum coating of 50 μm (2 mils).

(c) All surfaces to be thermal sprayed shall be blast cleaned to white metal immediately prior to receiving surface protections. The final surface appearances shall be equivalent to preparation grade SSPC-SP5 as defined by SSPC-VIS 1. The first coating shall be applied within one hour of blast cleaning and the surface shall be completely coated to the specified thickness within two hours of blasting.

(d) Exterior surfaces shall be sealed with an approved sealant conforming to the recommendations of the thermal spray supplier and approved by the Engineer. The minimum dry film thickness of the sealant shall be 50 μm (2 mils).

(e) Adherence of the metalized coating to the base metal shall be tested in accordance with AASHTO M 111M/M 111, Section 7.

Repair. Metalizing that has been damaged shall be repaired in accordance with the requirements of 726.08.

SECTION 727 - FENCING MATERIALS

727.01 WOVEN WIRE FENCE.

(a) Woven Wire Fabric for Fencing and Gates. Woven wire fabric shall be rectangular mesh and shall conform to the requirements of AASHTO M 279, Class 3 coating, Design Number 939-6-11. At the option of the Contractor, the woven wire fabric may be aluminum coated and shall conform to the requirements for ASTM A 584, Class 2 coating.

(b) Barbed Wire. Barbed wire shall conform to the requirements of AASHTO M 280, two strand, standard size 2.51 mm (0.099 inch or 12 1/2 gage) diameter, Coating Class 3, with four point, 2.03 mm (0.08 inch or 14 gage) diameter, round barbs spaced at approximately 125 mm (5 inch) intervals.

The Contractor may also elect to furnish aluminum coated barbed wire, which shall conform to the requirements of ASTM A 585, Class 2 aluminum coating.

(c) Wood Posts and Braces. Round wood posts shall be seasoned Red (Norway) Pine or Southern Pine, straight, sound, and cut from live timber.

If round posts are used they shall conform to the diameter and length shown on the Plans. In all cases, they shall be not less than 115 mm (4 1/2 inches) in diameter at the small end after removal of the bark. They shall be shaved to an even surface and be free from bark or skin.

If sawn posts are used, they shall be rough sawn and conform to the requirements of Subsection 728.01. The nominal dimensions shall be at least 100 mm (4 inches) square and of the length shown on the Plans.

The types of wood to be used for bracing shall be similar to those required for the posts. The braces shall conform to the dimensions shown on the Plans.

All wood posts and braces shall be treated full length with a preservative as specified in Subsection 726.01. Any cut portions shall receive a field application of copper naphthenate solution.

Steel Posts and Braces. Intermediate or line posts shall be standard commercial T-Type steel posts conforming to the length shown on the Plans, and shall have a nominal mass (weight) of 2 kg/m (1.3 pounds per linear foot) of post length.

End posts, corner posts, and pull posts shall be standard rolled steel angles, 64 by 64 by 6.4 mm (2 1/2 × 2 1/2 × 1/4 inch). They shall conform to the length shown on the Plans and shall have a nominal mass (weight) of 6.1 kg/m (4.1 pounds per linear foot).

Braces shall be standard rolled steel angles 51 by 51 by 4.8 mm (2 × 2 × 3/16 inch) having a nominal mass (weight) of 3.63 kg/m (2.44 pounds per linear foot).

The nominal masses (weights) stated for the several types of posts do not include anchors, plates, or other metal fittings. Intermediate posts or line posts shall be provided with an anchor plate having a length and/or width of 100 to 130 mm (4 to 5 inches) with a net area of not less than 12 900 mm^2 (20 square inches). The anchor plates shall be securely fastened to the post by welding or by a minimum of two rivets per plate.

All posts, braces, anchors, plates, and other metal fittings shall be zinc coated on all inner and outer surfaces in accordance with the requirements of AASHTO M 111M/M 111 or AASHTO M 232M/M 232, whichever is applicable.

(d) Miscellaneous Hardware. Miscellaneous hardware such as, but not limited to, wire, clips, nails, bolts, nuts, washers, hinges, latches, and staples shall be of low to medium carbon steel, galvanized, and shall be of good commercial quality. Staples shall be at least 38 mm (1 1/2 inches) long of 3.76 mm (0.1483 inch) diameter (9 gage) galvanized wire. Galvanizing shall be in accordance with AASHTO M 232M/M 232, where applicable. Galvanized wire and clips produced from galvanized wire shall have a Class 1 coating in accordance with AASHTO M 279.

(e) Gates. Frames, diagonal tie bars, braces, and hardware for gates shall conform to the design shown on the Plans and shall be zinc coated on all inner and outer surfaces in accordance with ASTM A 53/A 53M, AASHTO M 111M/M 111, or AASHTO M 232M/M 232, whichever is applicable. Woven wire fabric used for gates shall be of the same material used in fences.

(f) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

727.02 CHAIN-LINK FENCE. Chain-link fence shall conform to the requirements of AASHTO M 181. The chain-link fence shall conform to the design, dimensions, and details shown on the Plans.

(a) Chain-Link Fabric. Chain-link fabric shall consist of 3.76 mm (0.1483 inch) diameter (9 gage) wire woven into a 50 mm (2 inch) mesh. The bottom selvage of all chain-link fabric shall be knuckled. When the height of the fabric is 1.2 m (4 feet) or less,

the top edge shall also be knuckled. When vinyl coated fabric is used, the wire shall be 3.76 mm (0.1483 inch) diameter (9 gage) prior to coating with vinyl. Galvanized chain-link fabric shall be Type I, Class D, as specified in AASHTO M 181. When the Contract Documents specify a 3.76 mm (0.1483 inch) diameter (9 gauge) wire woven into a 25 mm (1 inch) mesh, an aluminum-coated steel conforming to the requirements of AASHTO M 181, Type II will be allowed.

(b) Posts, Gate Frames, Rails, Braces, and Miscellaneous Hardware. Posts, gate frames, rails, braces, and miscellaneous hardware furnished for use in conjunction with zinc or vinyl coated steel fabric shall be of zinc coated steel. Zinc coated steel shall conform to the requirements of AASHTO M 181, Grade 1 or Grade 2.

Posts, gate frames, rails, braces, and miscellaneous hardware shall conform to the requirements of Table 727.02A.

TABLE 727.02A - ZINC COATED STEEL MATERIAL (METRIC)

Use and Section		Outside Diameter or Dimensions (mm)	Nominal Mass per Meter (kg)
End, Corner, and Pull Post for fabric heights:			
Less than 1.8 m:	Round, Grade 1	60.3	5.43
	Round, Grade 2	60.3	4.64
	Square	50.8 by 50.8	5.36
	Roll Formed	88.9 by 88.9	7.59
1.8 m and greater:	Round, Grade 1	73.0	8.62
	Round, Grade 2	73.0	6.91
	Square	63.5 by 63.5	8.48
	Roll Formed	88.9 by 88.9	7.59
Line Posts for fabric heights:			
Less than 1.8 m:	Round, Grade 1	48.3	4.05
	Round, Grade 2	48.3	3.39
	Roll Formed	47.6 by 41.3	3.39
	H-Section	57.2 by 43.2	4.85
1.8 m and greater:	Round, Grade 1	73.0	5.43
	Round, Grade 2	48.3	4.64
	Roll Formed	47.6 by 41.3	3.39
	H-Section	57.2 by 43.2	4.85
Gate Posts for nominal width of gate, single gate, or one leaf of double gate:			
1.8 m and less:	Round, Grade 1	73.0	8.62
	Round, Grade 2	73.0	6.91
	Square	63.5 by 63.5	8.48
	Roll Formed	88.9 by 88.9	7.54
Over 1.8 to 4.0 m:	Round, Grade 1	101.6	13.54
	Round, Grade 2	88.9	8.47

TABLE 727.02A - ZINC COATED STEEL MATERIAL (METRIC)
(Continued)

Use and Section		Outside Diameter or Dimensions (mm)	Nominal Mass per Meter (kg)
	Square	76.2 by 76.2	13.54
Over 4.0 to 5.5 m:	Round	168.3	28.23
Over 5.5 m:	Round	219.1	36.76
Gate Frames for fabric heights:			
Less than 1.8 m:	Round, Grade 1	42.2	3.38
	Round, Grade 2	42.2	2.74
	Square	38.1 by 38.1	2.83
1.8 m and greater:	Round, Grade 1	48.3	4.05
	Round, Grade 2	48.3	3.39
	Square	50.8 by 50.8	3.13
Top Rails and Brace Rods:	Round, Grade 1	42.2	3.38
	Round, Grade 2	242.2	2.74
	Roll Formed	41.3 by 31.8	2.00
Truss Rods:	Round with Turnbuckle	9.5	---
Tension Wire:	Wire	3.8	---
Tension Bars:	Bar	6.4 by 19.1	---

TABLE 727.02A - ZINC COATED STEEL MATERIAL (ENGLISH)

Use and Section		Outside Diameter or Dimensions (inches)	Weight Per Foot (pounds)
End, Corner, and Pull Post for fabric heights:			
Less than 6 feet:	Round, Grade 1	2.375	3.65
	Round, Grade 2	2.375	3.12
	Square	2.00 × 2.00	3.60
	Roll Formed	3.50 × 3.50	5.14
6 feet and greater:	Round, Grade 1	2.875	5.79
	Round, Grade 2	2.875	4.64
	Square	2.50 × 2.50	5.70
	Roll Formed	3.50 × 3.50	5.14
Line Posts for fabric heights:			
Less than 6 feet:	Round, Grade 1	1.90	2.72
	Round, Grade 2	1.90	2.28
	Roll Formed	1.875 × 1.625	5.14
	H-Section	1.875 × 1.625 × 0.113	2.70
6 feet and greater:	Round, Grade 1	2.875	3.65
	Round, Grade 2	2.375	3.12
	Roll Formed	1.875 × 1.625	5.14
	H-Section	2.25 × 1.95 × 0.143	4.10
Gate Posts for nominal width of gate, single gate, or one leaf of double gate:			
6 feet and less:	Round, Grade 1	2.875	5.79
	Round, Grade 2	2.875	4.64
	Square	2.50 × 2.50	5.70
	Roll Formed	3.50 × 3.50	5.14
Over 6 to 13 feet:	Round, Grade 1	4.00	9.10
	Round, Grade 2	3.50	5.71
	Square	3.00 × 3.00	9.10

TABLE 727.02A - ZINC COATED STEEL MATERIAL (ENGLISH)
(Continued)

Use and Section		Outside Diameter or Dimensions (mm)	Nominal Mass per Meter (kg)
Over 13 to 18 feet:	Round	6.625	18.97
Over 18 feet:	Round	8.625	24.70
Gate Frames for fabric heights:			
Less than 6 feet:			
	Round, Grade 2	1.660	1.84
	Square	1.50 × 1.50	1.90
6 feet and greater:	Round, Grade 1	1.90	2.72
	Round, Grade 2	1.90	2.28
	Square	2.00 × 2.00	2.10
Top Rails and Brace Rods:	Round, Grade 1	1.660	2.27
	Round, Grade 2	1.660	1.84
	Roll Formed	1.625 × 1.25	1.34
Truss Rods:	Round with Turnbuckle	0.375	---
Tension Wire:	Wire	0.1483	---
Tension Bars:	Bar	1/4 × 3/4	---
Over 13 to 18 feet:	Round	6.625	18.97

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 728 - GUARDRAIL, GUIDE POSTS, AND BARRIERS

728.01 POSTS AND POST ACCESSORIES.

(a) Wood Posts and Offset Blocks for Rail, Guardrail, Barriers, and Guide Posts. Wood posts and offset blocks shall be straight and sound seasoned Red (Norway) Pine or Southern Pine. Red Pine shall meet number 1 stress grade requirements specified by the Northeastern Lumber Manufacturer's Association (NELMA). Southern Pine shall meet number 2 stress grade requirements specified by the Southern Pine Inspection Bureau (SPIB). Preservatives and pressure treatment shall conform to AASHTO M 133 and AWPA Standards C1, C2, and C14. Inspection and care of treated material shall, at a minimum, conform to AWPA Standards M2, M3, and M4.

Material shall be of the proper grade prior to beginning any fabrication operation.

Material shall be fabricated prior to treatment in conformance with the dimensions and details shown on the Plans.

Material shall be treated with a Type IV preservative as specified in Subsection 726.01.

Field repairs shall be made in accordance with AWPA Standard M4. Cuts, holes, and damaged areas shall be treated with copper naphthenate solution. Bored holes shall be plugged with treated tight fitting wooden plugs.

Timber material shall be produced in accordance with the American Softwood Lumber Standard (ASLS) developed by the American Lumber Standards Committee. Acceptable material shall be grade stamped with an appropriate tag or mark identifying conformance with ASLS requirements.

All lumber and timber shall be treated in a plant participating in an independent inspection program designed to provide continuous supervision, testing, and inspection for establishing acceptable quality control. Competency and performance of the inspection agency shall be overviewed by an approved organization, such as the American Wood-Preservers' Association (AWPA). Material meeting compliance with applicable specifications shall bear the quality mark of the authorized inspection agency.

Tags and marks identifying compliance shall, at a minimum, be placed on each post in a location that will be visible after installation.

Each and every charge of treated material shall be inspected in accordance with the applicable requirements specified in AWPA Standards. The treater shall perform laboratory analysis for measured penetration and retention of each charge. A copy of each analysis report shall accompany the certificates covered under Subsection 728.01(e).

It is the responsibility of the producer to arrange for all independent inspection. All inspection costs shall be included in the unit price of the material.

(b) Wood Posts for Cedar Log Rail. Wood posts shall be seasoned Cedar, straight, sound, and cut from live timber. The posts shall conform to the diameter and length shown on the Plans. They shall be shaved to an even surface and shall be free from bark or skin.

(c) Steel Posts and Post Accessories. Steel posts, offset blocks, splice plates, brackets, channel anchors, and other post accessories shall conform to the requirements of AASHTO M 270M/ M 270, Grade 250 (Grade 36). They shall conform to the details shown on the Plans. After fabrication, all posts, post accessories, and channel anchors shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111.

(d) Alternative Blockouts. As an alternative to steel or wood blockouts in part (a) or (c) above, blockouts made of synthetic materials and appearing on the Approved Products List on file at the Agency's Materials and Research Section are allowed.

(e) Certification. For wood posts and accessories, a Type D Certification shall be furnished in accordance with Subsection 700.02. For steel posts and accessories, a Type D Certification shall be furnished.

728.02 RAIL ELEMENTS.

(a) Plank Rail. The plank for rail shall be seasoned Red (Norway) Pine or Southern Pine, planed on four sides, and of the dimensions shown on the Plans. Wood shall be treated full length in accordance with Subsection 726.01, Type I, II, III, or IV.

(b) Log Rail. The log for rail shall be seasoned Cedar, straight, sound, and cut from live timber. The rail shall conform to the diameter and length shown on the Plans. The rail shall be shaved to an even surface and be free from bark or skin.

(c) Cable Rail. Cable shall conform to the requirements of Subsection 713.03.

(d) Steel Beam and Thrie Beam Rail. Steel beam (W-beam) and thrie beam rail elements shall conform to AASHTO M 180, Class A, Type II zinc coated, except that when a heavy duty steel beam is specified, the rail elements shall conform to AASHTO M 180, Class B, Type II.

When corrosion resistant steel is specified, Type IV rail having the corrosion resistance of AASHTO M 270M/M 270, Grade 345W (Grade 50W) shall be used.

(e) Box Beam Rail. Box beam rail shall conform to the requirements of Subsection 714.11. The rail shall conform to the details shown on the Plans as to size and shape and all holes and slots shall be punched, drilled, burned, or cut as indicated. After fabrication, the rail shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111.

(f) Steel Backed Timber Guardrail. Timber for rail shall have a minimum allowable bending stress of 10 Mpa (1450 psi). Steel rails and splice plates shall conform to AASHTO M 270M/M 270 Grade 345 (Grade 50) steel and shall be galvanized in accordance with AASHTO M 111M/M 111.

(g) Certification. For Cedar log and cable rail, a Type A Certification shall be furnished in accordance with Subsection 700.02. For plank rail and steel backed timber guardrail, a Type D Certification shall be furnished. For beam and box beam rail, a Type D Certification shall be furnished.

728.03 HARDWARE.

(a) Hardware for Plank Rail. Miscellaneous hardware such as spikes, lag screws, bolts, nuts, and washers shall conform to the dimensions shown on the Plans. Hardware shall be of low to medium carbon steel, galvanized and shall be of good commercial quality. The metal brackets shall be fabricated from 6 mm (1/4 inch) steel plate and shall be galvanized after fabrication.

(b) Hardware for Cedar Log Rail. Miscellaneous hardware such as lag screws shall be of low to medium carbon steel and shall be of good commercial quality. The metal straps shall be fabricated from 6 mm (1/4 inch) steel plate.

(c) Hardware for Cable, Steel Beam, and Thrie Beam Rail. Miscellaneous hardware and fittings such as bolts, nuts, and washers, cable splices, hook bolts, anchor rod assemblies, and cable end units shall conform to the dimensions shown on the Plans. All cable fittings and anchorages shall be capable of developing the minimum tensile strength shown on the Plans when properly installed.

Bolts, nuts, and washers shall conform to the following:

(1) Steel bolts shall conform to the requirements of ASTM F 568M, Class 4.6 (ASTM A 307, Grade A). Steel nuts shall conform to the requirements of AASHTO M 291M (AASHTO M 291). Steel washers shall conform to the requirements of ASTM F 436M (ASTM F 844).

(2) Steel cast bolts, nuts, and washers shall conform to the requirements of ASTM A 27/A 27M, Grade 65-35 full annealed.

All hardware shall be galvanized in accordance with AASHTO M 232 M/M 232. All bolts, nuts, and washers shall be either hot-dip galvanized in accordance with the requirements of AASHTO M 232M/M 232 or mechanically galvanized using a mechanically deposited process conforming to the requirements of AASHTO M 298, Class 50.

When corrosion resistant steel Type IV rail is specified and galvanized hardware is not desirable, black, ungalvanized bolts shall be used and shall conform to ASTM F 568M, Class 4.6 (ASTM A 307, Grade C); nuts shall conform to AASHTO M 291M (AASHTO M 291); and washers shall conform to ASTM F 436M (ASTM F 844); or bolts, nuts, and washers shall conform to ASTM A 27/A 27M, Grade 65-25, full annealed.

(d) Hardware for Box Beam Rail. Bolts shall conform to the requirements of ASTM F 568M, Class 4.6 (ASTM A 307, Grade A); nuts shall conform to the requirements of AASHTO M 291M (AASHTO M 291); and washers shall conform to the requirements of ASTM F 436M (ASTM F 844). Bolts, nuts, and washers for rail splice connections shall conform to the requirements of ASTM A 325. All bolts, nuts, and washers shall be either hot-dip galvanized in accordance with AASHTO M 232M/M 232 or mechanically galvanized using a mechanically deposited process conforming to the requirements of AASHTO M 298, Class 50.

All bolts, nuts, and washers required to conform to ASTM A 325 shall meet all requirements of Subsection 714.05, except that the rotational capacity tests, the proof load tests, and the wedge tests will not be required.

(e) Hardware for Steel Backed Timber Guardrail. Bolts and lag screws shall conform to ASTM F 568M, Class 4.6 (ASTM A 307 Grade A). Washers shall conform to ASTM F 844. Nuts shall conform to AASHTO M 291M (AASHTO M 291). All fastener hardware shall be galvanized in accordance with AASHTO M 232M/M 232.

(f) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

728.04 DELINEATION DEVICES. Delineators for wood posts shall be an approved reflective sheeting conforming to Subsection 750.08.

Delineators for steel posts or guardrail shall be flat sheet aluminum conforming to Subsection 751.04 and the details shown on the Plans, or high impact polycarbonate thermoplastic conforming to Subsection 751.07 and the details shown on the Plans.

The face of each delineator shall be reflectorized with reflective sheeting conforming to Subsection 750.08 and of the type shown on the Plans.

As an aid to installation, reflectors for use in the valley of W-shaped steel beam guardrail may have a 19 mm (3/4 inch) slot extending horizontally from the bolt hole in the base to the end of the base away from the reflectorized surface or extending vertically down from the bolt hole to the lower edge of the base. The directions indicated are viewed looking at the installed reflector unit from the point on the roadway centerline, which is the intersection of the perpendicular to the centerline that passes through the reflector unit base.

The Contractor may propose other materials as backing for traffic barrier reflectors.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

728.05 CONCRETE ANCHORS. Precast or cast-in-place concrete anchors for guardrail shall conform to the details shown on the Plans as to the size, shape, and placement of the bar reinforcement.

(a) Concrete. Concrete shall conform to Section 541 for Concrete, Class B.

(b) Curing. The concrete anchors shall be subjected to any one of the methods of curing prescribed in AASHTO M 199M/M 199, for a sufficient length of time so that the concrete will develop the specified compressive strength within 28 days.

(c) Bar Reinforcement. Bar reinforcement shall conform to Subsection 713.01.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02 for precast anchors.

728.06 MANUFACTURED TERMINAL SECTIONS. Acceptable Manufactured Terminal Sections shall be one of the Manufactured Terminal Sections on the Approved Products List on file with the Agency's Materials and Research Section.

Unless noted otherwise on the Plans, Manufactured Terminal Sections shall meet as a minimum the requirements of NCHRP 350 for TL-3.

728.07 ENERGY ABSORPTION ATTENUATORS. Acceptable stationary Energy Absorption Attenuators permanently incorporated into the work shall be one of the Energy Absorption Attenuators on the Approved Products List on file with the Agency's Materials and Research Section.

SECTION 729 - CURB MATERIALS

729.01 VERTICAL GRANITE CURB. Vertical granite curb shall consist of hard, durable, quarried granite. It shall be gray in color, free from seams, cracks, or other structural defects, and shall be of a smooth splitting character. The curb may contain natural color variations that are characteristic of the granite source.

(a) Source. The Contractor shall submit for approval the name of the quarry that is the proposed source of the granite for curb materials. 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. Samples of curbing shall be submitted for approval only when requested by the Engineer.

(b) Finish and Surface Dimensions. The individual curb stones shall be of the dimensions shown on the Plans and shall be of uniform thickness in any continuous run. The individual curb stones shall be furnished in minimum lengths of 2 m (6 feet).

The top surface of the curb stones shall be sawed to an approximately true plane and shall have no projection or depression greater than 3 mm (1/8 inch).

The bottom surface may be sawn or split.

The top front arris line shall be rounded to a 13 mm (1/2 inch) radius as shown in the Contract Documents. The exposed arris lines shall be pitched straight and true, with no variations from a straight line greater than 3 mm (1/8 inch).

The front face shall be at right angles to the plane of the top and shall be smooth quarry split or sawn for the full depth. Drill holes in the exposed part of the face shall not be permitted. The front face shall have no projections greater than 25 mm (1 inch) or depressions greater than 13 mm (1/2 inch), measured from the vertical plane of the face through the top arris line for a distance of 200 mm (8 inches) down from the top. For the remaining distance, there shall be no projections or depressions greater than 25 mm (1 inch) measured in the same manner.

The back surface of the curb stones shall have no projection for a distance of 75 mm (3 inches) down from the top which would

fall outside of a plane having a batter of one horizontal to three vertical from the back arris line.

The ends of all curb stones shall be square with the planes of the top and front face, and so finished that when the stones are placed end to end as closely as possible, no space more than 25 mm (1 inch) shall show in the joint for the full width of the top or down on the face for 200 mm (8 inches). The remainder of the end may break back a maximum of 150 mm (6 inches) from the plane of the joint.

Curbing stones to be set on a radius of 25 m (80 feet) or less shall be cut to the curve required, and their ends shall be cut on radial lines.

729.02 GRANITE BRIDGE CURB. Granite bridge curb shall consist of hard, durable, quarried granite. It shall be gray in color, free from seams, cracks, or other structural defects, and shall be of a smooth splitting character. The curb stones in any one structure shall be of uniform color and acceptable to the Engineer. The curb stones shall be thoroughly cleaned of any iron rust or sand particles.

(a) Source. The Contractor shall submit for approval the name of the quarry that is the proposed source of the granite for curb materials. 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. Samples of curbing shall be submitted for approval only when requested by the Engineer.

(b) Finish and Surface Dimensions. The individual curb stones shall be of the dimensions shown on the Plans and shall be of uniform thickness on any one structure or in any continuous run. The individual curb stones shall be furnished in random lengths between 1 and 3 m (3 and 10 feet).

The top surface of the curb stones shall be sawed to an approximately true plane and shall have no projection or depression greater than 3 mm (1/8 inch). The bottom of the curb stones shall be parallel to the top and sawed or dressed to lay with not more than a 25 mm (1 inch) joint at the face for the full length of the stone. The remainder of the bottoms may break back not over 25 mm (1 inch).

The top front arris line shall be rounded to a 13 mm (1/2 inch) radius as shown in the Contract Documents. The exposed arris lines shall be pitched straight and true, with no variations from a straight line greater than 3 mm (1/8 inch).

The front face shall be battered as shown on the Plans and shall be smooth quarry split or sawed for the full depth. Drill holes in the front face shall not be permitted. The front face shall have no projections or depressions greater than 13 mm (1/2 inch), measured from the plane of the face through the top arris line for the full depth of the stone.

The back surface of the curb stones shall have no projections or depressions greater than 25 mm (1 inch), measured from the plane of the face through the top arris line for the full depth of the stone.

The ends of all curb stones shall be square with the planes of the top and front face, and so finished that when the stones are placed end to end as closely as possible, no space more than 10 mm (3/8 inch) shall show in the joint for the full width of the top and full depth of the front face. The remainder of the ends may break back a maximum of 50 mm (2 inches) from the plane of the joint. Where shown on the Plans or where the curb butts metal expansion joints, the ends shall be sawed to an approximately true plane.

Curb stones to be set on a radius of 50 m (160 feet) or less shall be cut to the curve required, and their ends shall be cut on radial lines.

729.03 GRANITE SLOPE EDGING. Granite slope edging shall consist of hard, durable, quarried granite. It shall be gray in color, free from seams, cracks, or other structural defects, and shall be of smooth splitting character. The edging may contain natural color variations that are characteristic of the granite source.

(a) Source. The Contractor shall submit for approval the name of the quarry that is the proposed source of the granite for edging materials. 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. Samples of edging shall be submitted for approval only when requested by the Engineer.

(b) Finish and Surface Dimensions. The individual edging stones shall be of the dimensions shown on the Plans and shall be of uniform thickness in any continuous run. The individual edging stones shall be furnished in minimum lengths of 600 mm (2 feet).

The tops and bottoms shall be not under the square more than 100 mm (4 inches), or over the square at the back more than 25 mm (1 inch), when so tested.

The exposed face shall be smooth quarry split or sawed. Drill holes will be permitted on the exposed face, but only along the bottom edge and then to extend upward from the edge not over 75 mm (3 inches). The exposed face shall have no projections or depressions greater than 25 mm (1 inch), measured from a 600 mm (24 inch) long straightedge placed as closely as possible on any part of the face.

The ends of all edging stones shall be square with the plane of the exposed face and so finished that when the stones are placed end to end as closely as possible, no space more than 25 mm (1 inch) shall show in the joint for the full depth of the face. The arris lines at the ends shall be pitched with no variation from the plane of the face more than 5 mm (1/4 inch).

729.04 PRECAST REINFORCED CONCRETE CURB. Precast reinforced concrete curb shall be solid, precast, reinforced units of uniform quality and appearance. All curb shall be cast in steel or concrete forms which will produce a satisfactory surface requiring no further finishing, rubbing, or patching after the forms are removed, except for the removal of flash or excess material along the edges.

The precast curb shall conform to the following requirements:

(a) Dimensions. The individual precast curb units shall be of the dimensions shown on the Plans and shall be cast in lengths of not less than 1 m (3 feet) or greater than 3 m (10 feet). Random lengths of curb of not less than 1 m (3 feet) in length may be obtained by sawing regular precast curb, if the Engineer determines it is necessary to meet field conditions. All curbs to be set on a radius of 50 m (160 feet) or less shall be precast to fit the curve as required.

(b) Marking. Each pour shall be identified with a registration number cast in the curb showing the name or trademark of the

manufacturer and the manufacturer's date of manufacture by a six digit number indicating in order the year, month, and day of month. A pour shall be considered as one day's production.

(c) Materials. The concrete shall conform to the requirements of Section 540, and when sampled and tested in accordance with AASHTO T 22, shall have a minimum compressive strength of 35 MPa (5000 psi). The manufacturer shall obtain a minimum of one core per pour for testing purposes. The core specimens shall be taken horizontally below the exposed face. The core holes shall be backfilled with Type I mortar conforming to the requirements of Subsection 707.01. Bar reinforcement shall conform to the requirements of Subsection 713.01.

(d) Curing. The precast curb units shall be subjected to any one of the methods of curing prescribed in AASHTO M 199M/M 199, for a sufficient length of time so that the concrete will develop the specified compressive strength at 28 days or less. Liquid membrane-forming compounds will not be allowed.

(e) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

729.05 BITUMINOUS CONCRETE CURB. Bituminous concrete curb shall consist of blended aggregate, polyester fibers, performance-graded asphalt binder, and mineral filler if required, combined in such proportions that the resulting mixture conforms to the requirements of Subsection 406.03(a), Type IV except that the percent of performance-graded asphalt binder shall be between 7.0 and 9.0 percent.

(a) Aggregate. The aggregate shall conform to the requirements of Subsection 704.10.

(b) Performance-Graded Asphalt Binder . The grade of performance-graded asphalt binder shall be as specified on the Plans or in the Contract Documents and shall conform to the requirements of Section 702.

(c) Polyester Fibers. The type of fiber used shall be approved by the Materials and Research Section. The fiber shall be uniformly incorporated into the dry mix. The fiber percent used shall be 0.25 percent per ton of mix. Dry mix times shall be increased to the satisfaction of the Engineer.

729.06 TREATED TIMBER CURB. Treated timber curb and stakes shall be either seasoned Red (Norway) Pine, Eastern (Northern) White Pine, or Southern Pine, straight, sound, and cut from live timber. Material shall be fabricated prior to treatment in conformance with the dimensions and details shown on the Plans. The sides of the planks may be either surfaced or rough-sawn. Treatment shall be performed, inspected, tested, and reported in accordance with the requirements of Subsection 728.01(a).

(a) Miscellaneous Hardware. All spikes, fasteners, U-bolts, nuts, and washers shall conform to the dimensions shown on the Plans. They shall be of low to medium carbon steel, either galvanized or corrosion resistance treated, and shall be of good commercial quality.

(b) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

SECTION 730 – PILING

730.01 STEEL PILING. Steel piling shall be rolled steel sections of the mass (weight) and shape shown on the Plans. Piles, splice plates, and point reinforcement shall be new material conforming to the requirements of ASTM A572/A572M, Grade 345 (Grade 50). When cast steel shoes are used, they shall conform to the requirements of AASHTO M 103M/M 103, Grade 485-275 (Grade 70-40) or ASTM A 148/A 148M, Grade 550-275 (Grade 80-40).

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

730.02 STEEL SHEET PILING. Steel sheet piling shall be rolled steel sections of the type, shape, and mass (weight) shown on the Plans and shall be capable of being interlocked so that a continuous wall is formed when individual pieces are driven side by side. Permanent steel sheet piling shall be new material conforming to the requirements of AASHTO M 202M/M 202. Reconditioned steel sheet piling may be used if authorized by written order by the Engineer.

Certification. Permanent steel sheet piling furnished under this Subsection shall be covered by a Type D Certification in accordance with Subsection 700.02.

SECTION 731 - BEARING PADS FOR STRUCTURES

731.01 PREFORMED FABRIC BEARING PADS. Preformed fabric bearing pads shall be manufactured from all new materials comprised of multiple layers of prestressed duck impregnated and bound with high quality oil resistant rubber vulcanized and cured under pressure to form a resilient pad of uniform thickness. The duck material shall have a mass (weight) of at least 270 g/m^2 (8 ounces per square yard) with a filling of 50 ± 1 warp threads per 25 mm (1 inch) and a filling of 40 ± 2 woof threads per 25 mm (1 inch). The finished product shall have 64 plies per 25 mm (1 inch) of thickness and withstand a compressive load perpendicular to the plane of the laminations of 69 MPa (10,000 pounds per square inch). Load deflection shall not exceed 10 percent at 6.9 MPa (1000 pounds per square inch) and the material shall perform effectively from -54 to 93 °C (-65 to 200 °F). The test sample for measuring load deflection shall be 50 by 50 mm (2 × 2 inches).

Bearing pads over 13 mm (1/2 inch) in thickness may be manufactured by laminating vulcanized sheets together to obtain the designed pad thickness. The number of laminated joints shall not be greater than:

TABLE 731.01A - NUMBER OF LAMINATED JOINTS FOR VARIOUS BEARING PAD THICKNESSES

Bearing Pad Thickness		Number of Laminated
Millimeters	Inches	Joints Permitted
13 to 25	1/2 to 1	1
29 to 38	1 1/8 to 1 1/2	2
41 to 50	1 5/8 to 2	3
Over 50	Over 2	4

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

731.02 BEARING PADS. Bearing pads shall be manufactured from all new materials comprised of high quality elastomer with a random distribution of synthetic fibers in proper proportion to maintain strength and stability. The finished product shall withstand a compressive load perpendicular to the plane of laminations of 48.2 MPa (7000 psi). The surface hardness shall have a Shore A Durometer of 80 ± 10 in accordance with ASTM D 2240.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

731.03 ELASTOMERIC MATERIAL. Elastomeric material shall conform to the specifications contained in the latest edition of the AASHTO *LRFD Bridge Design Specifications* and Section 18 of the AASHTO *LRFD Bridge Construction Specifications*. Unless otherwise shown on the Plans or specified in the Contract, the elastomeric compound shall be virgin crystallization resistant polychloroprene (neoprene) or virgin natural polyisoprene (natural rubber) as the raw polymer, except when using a disc the compound shall be based on polyether urethane, using only virgin materials. The resulting product shall be free of porous areas, weak sections, bubbles, foreign matter, or other defects affecting serviceability. It shall conform to the requirements of AASHTO M 251.

Elastomer was designed using Method A, with a nominal hardness of 50 +/- 5 on the Shore A scale, unless noted otherwise, except for discs which shall have a hardness of 50 +/- 5 on the Shore D scale. It is acceptable to test per AASHTO M 251, Appendix X1.

Elastomer shall meet the requirements for Low-Temperature Zone D, Grade 4.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

731.04 THIS SUBSECTION RESERVED

731.05 STAINLESS STEEL. Stainless steel shall conform to the specifications contained in the latest edition of Section 14 of the AASHTO *LRFD Bridge Design Specifications* and Section 18 of the AASHTO *LRFD Bridge Construction Specifications*.

Stainless steel used as a mating surface with PTFE and incorporated in bearing devices shall conform to the requirements of ASTM A 167, Type 304 or A 240/A 240M, Type 304.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02

731.06 THIS SUBSECTION RESERVED

731.07 BRASS RINGS. Brass sealing rings satisfying Subsections 14.7.4.5.2 and 14.7.4.5.3 of the AASHTO *LRFD Bridge Design Specifications* shall conform to ASTM B 36 (half hard) for rings of rectangular cross-section, and ASTM B 121 for rings of circular cross-section

They shall be in accordance with Section 18 of the AASHTO *LRFD Bridge Construction Specifications*.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

731.08 PTFE MATERIAL. Polytetrafluoroethylene (PTFE) material incorporated in bearing devices shall be all new material consisting of 3 mm (1/8 inch) minimum thickness conforming to the requirements of Subsection 14.7.2 of the AASHTO *LRFD Bridge Design Specifications* and Section 18 of the AASHTO *LRFD Bridge Construction Specifications*.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

SECTION 732 - RAILING MATERIALS

732.01 METAL HAND RAILING. Material for metal hand railing and sleeves shall conform to ASTM A 53/A 53M.

732.02 ALUMINUM BRIDGE RAILING.

(a) Aluminum Alloy. Aluminum alloy for aluminum bridge railing shall conform to the requirements of Subsection 715.04.

(b) Stainless Steel Bolts, Nuts, Washers, and Set Screws. Bolts and washers for post, rail, and offset block connections shall conform to the requirements of ASTM F 738M, Property Class A1-50, Condition AF, Alloy 304 (ASTM F 593, Alloy Group 1, Condition AF, Alloy 304).

Nuts shall conform to the requirements of ASTM F 836M, Property Class A1-50, Condition AF, Alloy 304 (ASTM F 594, Alloy Group 1, Condition AF, Alloy 304).

Stainless steel set screws for use in aluminum bridge railing connections shall conform to the requirements of ASTM F 880M, Property Class A1-70, Condition CW, Alloy 304 (ASTM F 880, Alloy Group 1, Condition CW, Alloy 304).

Stainless steel anchor bolts and washers shall conform to the requirements of ASTM F 738M, Property Class A1-70, Condition CW, Alloy 304 (ASTM F 593, Alloy Group 1, Condition CW, Alloy 304). Heavy hex stainless steel nuts for stainless steel anchor bolts shall conform to the requirements of ASTM F 836M, Property Class A1-70, Condition CW, Alloy 304 (ASTM F 594, Alloy Group 1, Condition CW, Alloy 304).

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02 for any and all stainless steel bolts, nuts, washers, and set screws.

(c) Structural Carbon Steel. Structural carbon steel for anchor channel bars, approach railing posts, offset brackets, and anchor bolt sleeve bases shall conform to the requirements of AASHTO M 270M/M 270, Grade 250 (Grade 36) or ASTM A 36/A 36M.

(d) Steel Pipe. Steel pipe for anchor bolt sleeves shall conform to the requirements of Subsection 740.05.

(e) Anchor Bolts, Nuts, and Washers. Anchor bolts, nuts, and washers shall conform to the requirements of Subsection 714.07.

(f) Fabric Pads. Fabric pads for aluminum posts shall conform to the requirements of Subsection 731.01 or 731.02.

(g) Aluminum Impregnated Caulking Compound. Aluminum impregnated caulking compound shall conform to the requirements of Subsection 707.13.

732.03 GALVANIZED BOX BEAM BRIDGE RAILING.

(a) Structural Steel Tubing. Tubing for posts and rails shall conform to ASTM A 500, Grade B, except as modified below:

(1) General Requirements for Rail and Post Sections.

a. The manufacturer shall test both welded and formed tubular material for the physical properties specified. Results of all tests shall be submitted with material certifications.

b. Longitudinal welds may be made by the resistance, gas shielded arc, submerged arc, or plasma arc process. Welds shall be sound, free from defects, and have no repairs. Transverse mill welds will not be permitted.

c. Longitudinally welded tubing shall have a tensile strength of 400 MPa (58,000 psi) when tested in accordance with AASHTO T 68M (AASHTO T 68).

d. Fabrication welding shall comply with the requirements of Subsection 506.10.

e. A traceable identification number shall be placed on each piece of material in a form that can be read after the galvanizing process.

(2) Post Sections.

a. Post and baseplate material shall meet the requirements of ASTM A 572, Grade 50 and shall be tested for impact properties in accordance with the requirements for Charpy Impact Testing in ASTM A 370, using a Type A specimen.

b. Sampling procedure shall be in accordance with AASHTO T 243M/T 243 using frequency "H" testing.

c. Full size [10 by 10 mm (3/8 × 3/8 inch)] specimens shall be used whenever thickness permits. Subsize specimens may be used when material thickness is less than 10 mm (3/8 inch).

d. To qualify, the average energy absorbed by a full size specimen shall be not less than 33.9 J at 5 °C (25 pounds-force foot at 40 °F). The average energy absorbed by a subsized specimen shall be prorated for the actual thickness of the specimen.

(3) Rail Sections.

a. Material shall be tested in accordance with ASTM E 436. Test samples shall be galvanized in accordance with AASHTO M 111M/M 111 prior to testing.

b. Sampling procedure shall be in accordance with AASHTO T 243M/T 243 with one test (a set of three specimens) for each heat.

c. Tests shall be conducted at -18 °C (0 °F), without removing the galvanizing.

d. Specimens shall be 50 by 230 mm (2 × 9 inches) supported at a span of 180 mm (7 inches).

e. The percent shear area shall be determined from testing nine specimens, three from each of three sides not containing a weld.

f. The final percent shear area shall be an average of the two sides having the highest average shear.

g. The minimum average shear area shall be 50 percent.

h. If any ASTM E 436 test averages between 30 and 50 percent shear, the manufacturer will be permitted to retest the heat. For each original heat test, three sets of nine specimens shall be retested. For the heat to be accepted, each set must show a minimum average shear of 50 percent for the two best sides.

(4) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

(b) Structural Carbon Steel. Structural carbon steel for anchor plates shall conform to the requirements of AASHTO M 270M/M 270, Grade 250 (Grade 36) or ASTM A 36/A 36M. Structural carbon steel for angles and splice plates shall conform to the requirements of AASHTO M 270M/M 270, Grade 345 (Grade 50) or ASTM A 572.

(c) Bolts, Nuts, and Washers. Bolts, nuts, and washers for railing and rail to post connections shall conform to the requirements of Subsection 714.04. Lock washers shall be high-carbon heat-treated spring steel conforming to the requirements of ASME D18.2.

(d) Anchor Bolts, Nuts, and Washers. Anchor bolts, nuts, and washers shall conform to the requirements of Subsection 714.07.

732.04 STEEL BEAM BRIDGE RAILING.

(a) Beam Guardrail. Beam guardrail for bridge railing shall conform to the requirements of Subsection 728.02. The beam rail shall be Class B.

(b) Steel Posts and Components. Posts, baseplates, offset blocks, brackets, washers, and other steel components shall be structural carbon steel conforming to the requirements of AASHTO M 270M/M 270, Grade 345W (Grade 50W); ASTM A 588/A 588M; ASTM A 572/A 572M, Grade 345 (Grade 50); or AASHTO M 270M/M 270, Grade 345 (Grade 50).

(c) Steel Pipe. Steel pipe for anchor bolt sleeves shall conform to the requirements of Subsection 740.05.

(d) Anchor Bolts, Nuts, and Washers. Anchor bolts, nuts, and washers shall conform to the requirements of Subsection 714.07.

(e) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02 for the materials supplied under part (b) above.

SECTION 735 - INSULATING MATERIALS

735.01 POLYSTYRENE INSULATION BOARD. Polystyrene insulation board shall conform to the requirements of AASHTO M 230. It shall be formed by the expansion of polystyrene base resin in an extrusion process and shall be homogeneous and unicellular. It shall be furnished in nominal 600 by 2400 mm (2 × 8 foot) boards and shall be of the thickness shown on the Plans.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

735.02 BLANKET INSULATION MATERIAL. Blanket insulation material shall consist of mats of fiberglass, rock wool, balsam wool, or other approved insulating materials completely enclosed on all sides within weatherproof facings of reinforced, coated, kraft paper or polyethylene sheeting.

The thermal conductivity of the blanket insulation material shall not exceed 0.039 W/[m•ºC] (0.27 BTU inch per hour square foot degree Fahrenheit) at a mean temperature of 24 °C (75 °F).

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 740 - WATER LINES AND APPURTENANCES

740.01 PLASTIC PIPE, FLEXIBLE. Flexible plastic pipe shall be polyethylene plastic pipe suitable for the transportation of potable water and shall conform to the requirements of AWWA C 901. The material grade selected shall be capable of withstanding a minimum sustained water pressure of 1.1 MPa at 23 °C (160 psi at 73 °F). The pipe shall be inside diameter controlled. Fittings may be either nylon, copper, or bronze. Clamps shall be stainless steel.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.02 PLASTIC PIPE, RIGID (PVC). Rigid PVC plastic pipe shall be suitable for the transportation of potable water and shall conform to the requirements of ANSI/AWWA C 900. The material grade selected shall be capable of withstanding a minimum sustained water pressure of 1.1 MPa at 23 °C (160 psi at 73 °F). Fittings shall be PVC plastic conforming to ANSI/AWWA C 110/A 21.10.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.03 THIS SUBSECTION RESERVED

740.04 COPPER TUBE, SEAMLESS. Seamless copper water tube shall conform to ASTM B 88M (ASTM B 88), Type K.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.05 STEEL PIPE, GALVANIZED. Galvanized steel pipe shall be suitable for the transportation of potable water and shall be the standard weight class conforming to ASTM A 53/A 53M.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.06 PLASTIC TUBING, FLEXIBLE. Tubing shall be a flexible transparent PVC material meeting the following requirements:

TABLE 740.06A – FLEXIBLE PLASTIC TUBING MATERIAL REQUIREMENTS

Property	Test Method	Requirement
Inside Diameter	---	13 mm (1/2 inch)
Wall Thickness	---	4 mm (5/32 inch)
Color	---	clear
Durometer Hardness (Shore A)	ASTM D 2240	55 to 65
Tensile Strength	ASTM D 638	11 to 14.5 MPa (1600 to 2100 psi)
Ultimate Elongation	ASTM D 638	450%

The material shall have an operating temperature range between -43 and 65 °C (-45 and 150 °F).

Shop or field splices of tubing will not be permitted when installation lengths are less than 150 m (500 feet). When installation lengths in excess of 150 m (500 feet) are required, one field splice per each 150 m (500 feet) length, or fraction thereof, will be allowed. Splices shall be made with 13 mm (1/2 inch) inside diameter by 75 mm (3 inch) long nipple inserts. Inserts may be stainless steel or copper tubing with a minimum wall thickness of 1.25 mm (0.049 inch). Inserts shall be centered on the splice and fastened each side with stainless steel clamps.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.07 DUCTILE IRON PIPE, CEMENT LINED. Ductile iron pipe shall be cement lined and centrifugally cast in metal or sand-lined molds. It shall conform to the requirements of ANSI/AWWA C 151/A 21.51. The class of pipe shall be as specified in the Contract.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.08 PIPE INSULATION. Thermal insulation for pipes shall be preformed to fit standard pipe sizes and may be supplied as either hollow cylindrical shapes (split in half lengthwise) or as curved segments. Insulation shall include all accessories complete with proper jackets or facings as required by the conditions. Multilayer insulation is acceptable provided the inside and outside diameters of each layer will ensure proper nesting.

The thermal conductivity of the insulation material shall not exceed 0.039 W/[m•°C] (0.27 BTU inch per hour square foot degree Fahrenheit) at a mean temperature of 24 °C (75 °F).

The thickness and jackets shall be as specified in the Contract.

Pipe insulation used as bond breakers for structures shall conform to the requirements of ASTM C 534.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

740.09 EXTENSION SERVICE BOX, CAST IRON. Cast iron extension service boxes shall conform to the dimensions specified in the Contract and shall be a standard commercial type. A suitable key or rod shall be furnished for removing the cover and operating the curb stop.

The type and details of extension service boxes shall be approved by the Engineer prior to purchase.

740.10 CURB STOP, BRASS. Brass curb stops shall be compatible with the pipe being used and be a standard commercial type.

The type and details of curb stops shall be approved by the Engineer prior to purchase.

740.11 GATE VALVES. Gate valves shall conform to the details specified in the Contract.

The type and details of gate valves shall be approved by the Engineer prior to purchase.

740.12 TAPPING SLEEVE. Tapping sleeves shall be compatible with the pipe being used and be a standard commercial type.

The type and details of tapping sleeves shall be approved by the Engineer prior to purchase.

740.13 HYDRANT. Hydrants shall conform to the details specified in the Contract.

The type and details of hydrants shall be approved by the Engineer prior to purchase.

740.14 CORPORATION STOPS. Corporation stops shall be a standard commercial type compatible with the water main and the service line pipes being used.

When used with seamless copper water tube service lines, the outlet shall have a copper compression joint with iron pipe threads under the tube nuts.

The type and details of corporation stops shall be approved by the Engineer after consultation with the utility owner before any purchase is made by the Contractor.

SECTION 741 - WELLS AND PUMPS

741.01 WELL CASING. Well casing shall conform to the requirements of ASTM A 53/A 53M.

Certification. A Type A Certification will be furnished in accordance with Subsection 700.02.

741.02 WATER PUMPS. Water pumps (jet, submersible, or shallow well) shall be of a standard commercial quality. The capacity of the pump shall be such that it will be capable of discharging water at the rate and pressure for the pumping depth specified for the installation.

The motor voltage of the pump shall be compatible with the voltage available at the electrical source.

The Contractor shall submit for approval to the Engineer five days before placing any purchase orders the name of the manufacturer, the specifications for the pump, accessories, and electrical equipment that is proposed to be furnished. .

741.03 WATER STORAGE TANKS. Water storage tanks shall be of steel (galvanized, vinyl or epoxy coated, and lined) or of molded fiber glass and shall be of a standard commercial quality. The tanks shall be capable of withstanding 1.1 MPa (160 psi) test pressure.

The Contractor shall submit for approval to the Engineer five days before placing any purchase orders the name of the manufacturer and the specifications for the water storage tank that is proposed to be furnished.

741.04 PRECAST REINFORCED CONCRETE WELL RINGS AND COVERS. Precast reinforced concrete well rings and covers shall conform to the requirements of Subsection 710.01, Class III pipe, with the following notes or exceptions:

Only one line of circumferential reinforcement will be required with an area of not less than 380 mm^2/m (0.18 in^2/ft) of wall.

Concrete covers shall be reinforced with one line of fabric reinforcement with an area of not less than 2800 mm^2/m^2 (0.40 in^2/ft^2) of cross-sectional area. They shall have hand holes on both sides.

SECTION 742 - DISINFECTANTS

742.01 CHLORINE SOLUTION. Chlorine solution used for disinfecting springs, wells, and other water systems shall consist of a solution of water and liquid chlorine, sodium hypochlorite, calcium hypochlorite, or chloride of lime.

Liquid forms of chlorine or sodium hypochlorite and powder forms of calcium hypochlorite or chloride of lime shall be used according to the instructions supplied by the manufacturer and as recommended by the Vermont Department of Health.

If sodium hypochlorite is already in solution as a laundry bleach containing 5.25 percent sodium hypochlorite, it shall be used at the rate of one part per 12,000 parts of water to be disinfected. The dosage should be sufficient to produce a chlorine taste in the water.

742.02 SPACE DEODORIZER. Space deodorizer shall consist of a commercial liquid concentrate that, when applied at the dilution ratio recommended by the manufacturer, will suppress the obnoxious odors produced by the material to which it is applied. The deodorizer shall be nontoxic and nonirritating. It shall be approved by the Engineer before use.

Upon request, the Agency's Materials and Research Section will furnish a list of products that are considered satisfactory.

SECTION 745 - WATER

745.01 WATER. All water used shall be clear and free of harmful amounts of oil, salt, acids, alkalies, sugar, organic matter, or other substances injurious to the finished product, plant life, or the establishment of vegetation.

Where the source of water is relatively shallow, the intake shall be maintained at such a depth and so enclosed as to exclude silt, mud, grass, and other foreign materials.

No formal tests of water will be made unless the Engineer questions the quality of the water. Water known to be of potable quality may be used without tests.

If the quality of the mixing water for concrete or mortar is questioned, comparative tests will be made with distilled water. Any indication of unsoundness, a marked change in time of setting, or reduction of more than 10 percent in mortar cube compressive strength shall be sufficient cause for rejection of the water under test.

SECTION 746 - CALCIUM CHLORIDE

746.01 CALCIUM CHLORIDE. Calcium chloride shall conform to the requirements of AASHTO M 144. Either regular flake calcium chloride, Type S Grade 1, or concentrated flake, pellet, or other granular calcium chloride, Type S Grade 3, may be used.

SECTION 747 - SODIUM CHLORIDE

747.01 SODIUM CHLORIDE. Sodium chloride shall conform to the requirements of AASHTO M 143. Unless otherwise specified, Type I, Grade 1 shall be used.

(a) Moisture Content. Moisture content shall not exceed 1 percent at the point of delivery.

(b) Anti-Caking Agent. In order to retard caking while in storage, all bulk salt shall be uniformly treated with an approved anti-cake conditioner prior to delivery. The residual amount of anti-cake conditioner should not be less than 50 parts per million. The supplier shall notify the Agency's Materials and Research Section as to the anti-cake agent used and shall furnish the laboratory method for determining the presence of the anti-cake agent.

SECTION 750 - TRAFFIC SIGNS

750.01 SIGN POSTS.

(a) Steel Posts and Anchors. Steel posts and anchors shall conform to the following requirements:

(1) Structural steel tubing shall conform to Subsection 714.11. Steel posts consisting of standard rolled steel structural shapes shall conform to the requirements of AASHTO M 270M/M 270, Grade 250 (Grade 36). After fabrication, these posts shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111.

(2) Steel posts consisting of flanged channels shall conform to the mechanical requirements of ASTM A 499, Grade 60 and the chemical requirements of the 42.2 to 56.6 kg/m (85 to 114 lbs/yard) rail class in ASTM A 1. They shall conform to the details indicated on the plans as to size, shape, weight, hole punching, hole drilling, and other details. After fabrication, these posts shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111.

(3) Steel posts and anchors consisting of welded mechanical square tubes formed from hot rolled carbon steel sheet shall conform to the mechanical and chemical requirements of ASTM A 1011/A 1011M, Grade 380 (Grade 55) or Grade 245 (Grade 40). They shall conform to the details indicated on the Plans as to size, shape, weight, hole punching, hole drilling, strength, and other details. The posts shall be fabricated in accordance with ASTM A 787, Type 2, and shall be galvanized with a G140 coating in accordance with ASTM A 653/A 653M. Alternatively, the posts shall be fabricated in accordance with ASTM A 787, Type 3, and shall be galvanized in accordance with AASHTO M 111M/M 111.

(b) Aluminum Posts. Aluminum posts shall conform to the requirements of ASTM B 308/B 308M, Alloy 6061-T6 for structural shapes, rolled or extruded, and ASTM B 221M (ASTM B 211) extruded tubes. They shall conform to the details shown on the Plans as to size, shape, and mass (weight), and they shall be punched or drilled as shown on the Plans.

(c) Wood Posts. Wood posts shall be seasoned, straight, and sound sawn timber comprised of either Oak, Cedar, Spruce, Western Fir, or other approved wood. The posts shall conform to the dimensions and grade shown on the Plans or requirements specified in the Contract Documents.

All wood posts shall be preservative treated over their full length as specified in Subsection 726.01. All cut ends or notches shall be field treated with copper naphthenate solution. Depending on size and location, wood posts may have to be drilled as shown on the Plans

(d) Sleeves. Sleeves for sign posts consisting of structural tubing shall conform to the requirements of ASTM A 501. They shall conform to the details shown on the Plans as to size, shape, and mass (weight), and they shall be punched or drilled as shown on the Plans. After fabrication, all steel sleeves shall be galvanized in accordance with AASHTO M 111M/M 111.

(e) Certification. A Type D Certification shall be furnished for steel posts and sleeves in accordance with Subsection 700.02. A Type A Certification shall be furnished for all other material.

750.02 EXTRUDED ALUMINUM PANELS. Extruded aluminum panels shall conform to the requirements of ASTM B 221M (ASTM B 221). Alloy 6063-T6 shall be used when reflective sheeting is to be applied to the face of the sign.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.03 FLAT SHEET ALUMINUM. Flat sheet aluminum shall conform to the requirements of ASTM B 209M (ASTM B 209) for either Alloy 6061-T6 or Alloy 5052-H38.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.04 GALVANIZED FLAT SHEET STEEL. Galvanized flat sheet steel shall conform to the requirements of ASTM A 606. Structural steel shapes and welded sections shall conform to the requirements of ASTM A 242/A 242M. The steel shall be galvanized in accordance with AASHTO M 111M/M 111 (ASTM A 123/A 123 M). The galvanized steel shall be given a light and tight phosphate coating by continuous mill process having not less than 1.1 g/m^2 (100 milligrams per square foot) of surface area.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

750.05 FORMED GALVANIZED STEEL PANELS. Formed galvanized steel panels shall conform to the requirements of ASTM A 606 or ASTM A 607, Grade 310 or Grade 340. The panels shall be galvanized in accordance with AASHTO M 111M/M 111. The galvanized panels shall be given a light and tight phosphate coating by continuous mill process having not less than 1.1 g/m^2 (100 milligrams per square foot) of surface area.

Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

750.06 HIGH DENSITY OVERLAID PLYWOOD. High density overlaid plywood shall consist of Douglas Fir plywood, exterior type, grade B or better, with both surfaces overlaid with cellulose fiber sheets or sheet, in which not less than 40 percent by mass (weight) of the laminate shall be a thermosetting resin of the phenol or melamine type. The resin impregnated material shall have not less than 300 g/m^2 (60 pounds per 1000 square feet) of single face before pressing. All materials and construction shall conform to the requirements of Voluntary Product Standard PS-1 published by the National Institute of Standards and Technology. The color of the overlay may be either natural or black.

No press caul, lubricants, release agents, or other contaminants shall be introduced during manufacture or subsequent handling of the high density overlaid plywood, either within or on the surface, which will affect adhesion or cause discoloration or other degradation of retroreflective sheeting or plastic lettering film.

(a) Quality Assurance. The suitability of the plywood for application of retroreflective sheeting shall be verified by laboratory test:

(1) Adhesion Test. Panels of the plywood, approximately 300 by 300 mm (1 × 1 foot) shall be cut from the plywood to be tested. The application surfaces of the panels shall be cleaned as specified in Subsection 675.05. An application of retroreflective sheeting or plastic lettering film shall be made to completely cover the properly prepared, dust-free plywood surface in accordance with the recommendations of the sheeting or film manufacturer. The panels shall be submitted to accelerated conditioning in an oven for one hour at 66 °C (150 °F). Following conditioning, the panels shall be allowed to cool to room temperature. The adhesive bond of the sheeting or plastic lettering film shall resist removal, other than in small pieces, at the point of spatula impact when struck evenly with short, sharp jabs by a test spatula.

(2) Plywood Contamination Test. Panels of the plywood to be tested shall be cut 75 mm (3 inches) long and 50 mm (2 inches) wide. The panels shall be wiped with a tack rag to remove any dust or loose particles. Retroreflective sheeting of the type or types to be used shall be applied to both faces of the test panels. Following conditioning for 24 hours at room temperature, approximately 24 °C (75 °F), the test panels shall be placed in a pressure vessel and held submerged in cold tap water. A vacuum of 610 mm (24 inches) of mercury shall be drawn and maintained for 45 minutes. This shall be followed immediately by the application of 275 to 350 kPa (40 to 50 pounds per square inch) of water pressure for 45 minutes. Proper test procedures are assured if the panel does not float after the above treatment. Test panels shall then be removed and each shall be placed in a glass container (400 mL beaker) filled with approximately 50 mL of water. The container shall be covered with a glass lid such as a petri dish and placed in an oven at 66 °C (150 °F) for 24 hours. The panel shall be removed and the sheeting surface wiped to remove any residue. Upon examination, any evidence of staining, discoloration, or other degradation of the applied sheeting shall constitute failure of the plywood. Some bubbling of the applied sheeting shall be permissible.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.07 ACRYLIC PLASTIC REFLECTORS. Acrylic plastic reflectors shall consist of methyl methacrylate plastic conforming to the requirements of Federal Specification LS-500 A, Type I, Class 3.

They shall consist of a clear and transparent acrylic plastic face, hereinafter referred to as the lens, and an opaque acrylic 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. The reflectors shall be colorless, yellow or amber, red, blue, or green as shown on the Plans, and the colors shall conform to the standards approved by FHWA.

The lens shall consist of a smooth front surface free from projections or indentations other than for identification, and a rear surface bearing a prismatic configuration such that it will effect total internal reflection of light without the aid of any plating or separate reflector.

(a) Optical Performance Requirements. The specific brightness of each colorless reflector shall be equal to or exceed the minimum values of Table 750.07A. All measurements shall be made with the reflectors spinning.

TABLE 750.07A - OPTICAL PERFORMANCE REQUIREMENTS FOR COLORLESS REFLECTORS

Observation Angle (degrees)	Entrance Angle (degrees)	Specific Brightness ($cd/m^2/lux$)	Specific Brightness (candlepower/square inch/footcandle)
0.10	0	2020	14.0
0.10	20	810	5.6
0.17	0	1440	10.0
0.17	20	580	4.0
0.33	0	1010	7.0
0.33	20	400	2.8

Failure to meet the specific brightness minimum shall constitute failure of the reflector being tested; failure of more than two reflectors out of 50 subjected to testing shall constitute failure of the lot.

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 candelas (candlepower) returned at the chosen observation angle by a reflector per each 60 mm^2 (1 square inch) of reflecting surface for each lux (footcandle) of illumination at the reflector.

For yellow or amber reflectors, the specific brightness minimum shall be 60 percent of the value shown for colorless; for either red, blue, or green reflectors, the specific brightness minimum shall be 25 percent of the value shown for colorless.

The brightness of the reflectors totally wet, as by rain, shall be not less than 90 percent of the values specified above.

The reflector to be tested shall be located at a distance of 30 m (100 feet) from a single uniformly bright light source having an effective diameter of 50 mm (2 inches); the light source shall be operated at approximately normal efficiency. The return light from the reflector shall be measured by means of a photoelectric photometer having a minimum sensitivity of 1.08×10^8 lux/mm (1×10^7 footcandles per millimeter) scale division.

The photometer shall have a receiver aperture of 13 mm (1/2 inch) diameter, shielded to eliminate stray light. The distance from light source center to aperture center shall be 53 mm (2.1 inches) for a 0.10 degree observation angle, 89 mm (3.5 inches) for a 0.17 degree observation angle, and 175 mm (6.9 inches) for a 0.33 degree observation angle. During testing, the reflectors shall be spun so as to average orientation effect.

If a test distance other than 30 m (100 feet) is used, the source and aperture dimensions and the distance between source and aperture shall be modified in the same proportion as the test distance.

(b) Physical Test Requirements. The reflectors shall withstand the following physical tests:

(1) Seal Test. Fifty reflectors out of any one shipment shall be selected at random for the following test:

Fifty reflectors shall be submerged in a water bath at room temperature. The submerged samples shall be subjected to a vacuum of 127 mm (5 inch) gage for five minutes. The atmospheric pressure shall then be restored and the samples left submerged for five minutes, after which they shall be examined for water intake. Failure of more than 2 percent of the number tested shall be cause for rejection.

(2) Heat Resistant Test. Three reflectors out of any one shipment shall be selected at random for the following test:

Three reflectors shall be tested for four hours in a circulating air oven at 80 °C (175 °F). The test specimens shall be placed in a horizontal position on a grid or perforated shelf permitting free air circulation. At the conclusion of the test, the samples shall be removed from the oven and permitted to cool in air to room temperature. The samples after exposure to heat shall show no significant change in shape and general appearance when compared with unexposed control standards. No failures will be permitted.

(3) Corrosion Test. Fifty reflectors out of any one shipment shall withstand the corrosion test without any observable effects when tested in accordance with ASTM B 117. The exposure period shall be 48 hours.

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.08 RETROREFLECTIVE SHEETING. Retroreflective sheeting shall conform to the applicable requirements of AASHTO M 268, except as follows:

Silver is an acceptable designation for white.

(a) Packaging Requirements. Retroreflective sheeting shall be furnished in both rolls and sheets. The packaging in which the sheeting is shipped shall protect the sheeting from damage and/or distortion in accordance with commercially acceptable standards and shall be suitable for storing the sheeting until it is used.

When retroreflective sheeting is furnished in continuous rolls, the material shall have a maximum of three splices in any 45 m (50 yards) of length. Splices shall be butted or overlapped and shall be suitable for continuous application.

When stored under normal conditions, the retroreflective sheeting shall be suitable for use for a period of at least one year after purchase.

(b) Classification. Retroreflective sheeting (white or colored) shall meet the requirements of the appropriate AASHTO M 268 (ASTM D 4956) classifications below:

(1) TYPE I. A medium intensity retroreflective sheeting often referred to as "engineering grade."

(2) TYPE II. A medium-high intensity retroreflective sheeting often referred to as "super engineering grade." The product exceeds the minimum requirements for Type I, but does not meet all TYPE III requirements.

(3) TYPE III. A high intensity retroreflective sheeting often referred to as "high intensity."

(4) TYPE IV. A high intensity retroreflective sheeting typically referred to as "micro prismatic retroreflective element material."

(5) TYPE V. A super high intensity retroreflective sheeting.

(6) TYPE VI. An elastomeric high-intensity retroreflective sheeting without adhesive. This is a vinyl material commonly used for traffic cone collars, post bands, etc.

(7) TYPE VII. A super-high-intensity retroreflective sheeting having highest retroreflectivity characteristics at long and medium road distances. This sheeting is typically an unmetallized microprismatic retroreflective element material.

(8) TYPE VIII. A super-high-intensity retroreflective sheeting having highest retroreflectivity characteristics at long and medium road distances.

(9) TYPE IX. A very-high-intensity retroreflective sheeting having highest retroreflectivity characteristics at short road distances.

(c) Retroreflective Requirements. Retroreflective sheeting shall meet or exceed the minimum brightness and color requirements of AASHTO M 268.

(d) Physical Requirements. Retroreflective sheeting shall meet the physical requirements of AASHTO M 268.

(e) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.09 DEMOUNTABLE CHARACTERS. Individual letters, digits, symbols, and borders as shown on the Plans for the text of the sign shall be shaped from 810 μm (0.032 inch) sheet aluminum conforming to the requirements of ASTM B 209M (ASTM B 209), Alloy 3003-H12. The design of the characters or sections listed above shall conform to standards approved by FHWA.

Flat characters shall be reflectorized with white Type III retroreflective sheeting conforming to the requirements of Subsection 750.08. All characters with stroke width 19 mm (3/4 inch) or less shall be supplied with sealed edges.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.10 PLASTIC LETTERING FILM. Plastic lettering film shall consist of a smooth, flexible, pigmented plastic sheeting with a precoated adhesive on one side for application by the heat vacuum method. The plastic film shall be readily cut with scissors, knife blade, or shears without cracking, crazing, checking, or flaking to form the letters, digits, symbols, and borders comprising the text of the various types of signs shown on the Plans. The cutout shapes shall be free from ragged edges, cracks, scales, and blisters. The color of the plastic film shall be as shown on the Plans for the text of each sign involved and shall conform to the standards approved by FHWA. The thickness of the plastic film with adhesive shall not be less than 66 μm (2.6 mils).

The precoated adhesive shall have a mass (weight) of not less than per 68 $\mu g/mm^2$ (1.05 grams per 24 square inches) and shall have a minimum thickness of 50 μm (2.0 mils) when dry. It shall form a durable bond to clean well painted surfaces, unpainted high density overlaid plywood, retroreflective sheeting (flat surface), or unpainted corrosion-proof metals such as galvanized, phosphate coated steel, or aluminum. The precoated adhesive, after 48 hours of aging at 24 °C (75 °F) from the time of application, shall be strong enough to resist peeling the plastic lettering film from the application surface, tough enough to resist scuffing and marring during normal handling, elastic enough at low temperatures to resist shocking off when struck at -7 °C (20 °F), moisture resistant enough to withstand eight hours of soaking in water at 24 °C (75 °F) without appreciable decrease in adhesion, and heat resistant enough to retain adhesion to the application surface after eight hours at 49 °C (120 °F). The precoated adhesive shall have no staining effect on the plastic lettering film and shall be mildew resistant.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.11 EXTRUDED ALUMINUM MOLDING. Extruded aluminum molding to be used with extruded aluminum panel signs shall conform to the requirements of ASTM B 221M (ASTM B 221), Alloy 6063-T6. Moldings shall be finished with baked-on enamel or sheeting of the color shown on the Plans for the background of the sign. The molding shall be extruded in the standard commercial form to fit the type of extruded aluminum panel used.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

750.12 ASSEMBLY HARDWARE. Unless otherwise shown on the Plans, the assembly hardware used to fasten and support traffic sign components shall conform to the designs and sizes used in standard commercial practices for the materials involved.

(a) Bolts, Nuts, and Washers. Bolts and washers shall be stainless steel conforming to the requirements of ASTM F 738M, Property Class A1-70, Condition CW. The alloy shall have a nickel content between 8.0 percent and 10.5 percent.

Nuts shall be stainless steel conforming to the requirements of and its supplementary requirements for S5. The alloy shall be ASTM F 836M, Property Class A1-70, Condition CW, Alloy 304.

(b) Rivets. Rivets shall be of aluminum conforming to the requirements of ASTM B 316/B 316M, Alloy 6053-T61.

(c) Clips. Clips used to fasten extruded aluminum panels to the supporting posts shall be of aluminum conforming to the requirements of ASTM B 108, Alloy 356-T6.

Clips used to fasten formed galvanized steel panels to the supporting posts shall be of aluminum conforming to the requirements of ASTM B 221M (ASTM B 221), Alloy 6063-T6 or of steel conforming to the requirements of ASTM A 242/A 242M that, after fabrication, is galvanized in accordance with the requirements of AASHTO M 232M/M 232 (ASTM A 153/A 153M).

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 751 – DELINEATORS

751.01 DELINEATOR POSTS.

(a) Steel Posts and Anchors. Steel posts and anchors shall conform to the following requirements:

(1) Steel posts consisting of flanged channels shall conform to the mechanical requirements of ASTM A 499, Grade 60 and the chemical requirements of the 42.2 to 56.6 kg/m (85 to 114 lbs/yard) rail class in ASTM A 1. They shall conform to the details indicated on the Plans

as to the size, shape, weight, hole punching, holed drilling, and other details. After fabrication, these posts shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111.

(2) Steel posts and anchors consisting of welded mechanical square tubes formed from hot rolled carbon steel sheet shall conform to the mechanical and chemical requirements of ASTM A 1011/A 1011M, Grade 380 (Grade 55) or Grade 245 (Grade 40). They shall conform to the details indicated on the Plans as to the size, shape, weight, hole punching, holed drilling, strength and other details. The posts shall be fabricated in accordance with ASTM A 787, Type 2, and shall be galvanized with a G140 coating in accordance with ASTM A 653A/ 653M. Alternatively, the posts shall be fabricated in accordance with ASTM A 787, Type 3, and shall be galvanized in accordance with AASHTO M 111M/M 111.

(b) Flexible Posts. Flexible posts shall conform to the type or types shown on the Plans.

(c) Sleeves. Sleeves for sign posts consisting of structural tubing shall conform to the requirements of ASTM A 501. They shall conform to the details indicated on the Plans as to the size, shape, and mass (weight), and they shall be punched or drilled, as shown on the plans. After fabrication, all steel sleeves shall be galvanized in accordance with AASHTO M 111M/M 111.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

751.02 ACRYLIC PLASTIC REFLECTORS. Acrylic plastic reflectors shall conform to the requirements of Subsection 750.07. They shall be mounted in an aluminum housing with a center hole having an aluminum grommet for mounting purposes and shall conform to the details shown on the Plans. The aluminum housing shall conform to the requirements of Subsection 751.04.

751.03 RETROREFLECTIVE SHEETING. Retroreflective sheeting shall conform to the requirements of Subsection 750.08.

751.04 BACK PLATES AND HOUSING. Back plates and housing used for the mounting of retroreflective material shall consist of aluminum conforming to the requirements of ASTM B 209M (ASTM B 209), Alloy 3003-H14. They shall conform to the details shown on the Plans and shall be given a corrosion resistant finish after fabrication in accordance with standard commercial processes. They shall not be painted.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

751.05 PLAQUES. Plaques used for the numbering of delineators between distance markers shall conform to the design shown in the Plans.

The substrate shall be 1.6 mm (0.063 inches) thick aluminum sheet conforming to the requirements of Subsection 750.03 and fabricated in accordance with the requirements of Subsection 675.04.

Retroreflective sheeting shall be Type III or Type IX conforming to the requirements of Subsection 750.08. The text shall be 50 mm (2 inches) Series D Numerals conforming to the Standard Alphabets for Highway Signs and shall be silk screened lettering or plastic lettering film.

Colors shall be white background with green text and shall conform to the Standard Color Tolerance Charts approved by FHWA.

Application of the retroreflective sheeting and text shall conform to the requirements of Subsection 675.09.

Transportation and handling of the plaques after fabrication shall conform to the requirements of Subsection 675.10.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

751.06 ASSEMBLY HARDWARE. Unless otherwise shown on the Plans, the assembly hardware used for connecting the components of the housing, if required, and for fastening reflectors and plaques to posts shall conform to the designs and sizes used in standard commercial practices for the materials involved.

(a) Bolts and Nuts. Bolts and nuts shall consist of aluminum conforming to the requirements of ASTM B 211M (ASTM B 211), Alloy 2024-T4. Both bolts and nuts shall be given another coating at least 5 μm (0.2 mil) in thickness with dichromate or boiling water seal.

(b) Washers. Washers shall consist of aluminum conforming to the requirements of ASTM B 209M (ASTM B 209), Alloy 2024-T4.

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

751.07 POLYCARBONATE SUBSTRATE FOR GUARDRAIL DELINEATORS.

(a) Polycarbonate substrate for guardrail delineators shall conform to the following physical properties when tested as designated:

TABLE 751.07A - POLYCARBONATE SUBSTRATE MATERIAL REQUIREMENTS

Material Property	Material Requirement	Specification
Thickness, Minimum	2 mm (79 mils)	N/A---------
Tensile Strength at Break	65 MPa (9.43 ksi)	ASTM D 638M
Elongation at Break	110%	ASTM D 638M
Tensile Yield Strength	62 MPa (9.0 ksi)	ASTM D 638M
Compressive Strength (Rupture Yield)	86 MPa (12.47 ksi)	ASTM D 695M
Flexural Strength	93 MPa (13.49 ksi)	ASTM D 790M
Tensile Module	2390 MPa (346.6 ksi)	ASTM D 638M
Rockwell Hardness	M 70	ASTM D 785
Specific Gravity	1.2	ASTM D 792

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

751.08 DETECTABLE WARNING SURFACE. Acceptable detectable warning surfaces shall be those detectable warning surface products included on the Approved Products List on file with the Agency's Materials and Research Section.

SECTION 752 - TRAFFIC CONTROL SIGNALS

752.01 PEDESTAL POSTS AND BASES. Steel posts shall utilize cast iron bases; aluminum posts shall utilize cast aluminum bases.

(a) Pedestal Posts.

(1) Steel Posts. Steel posts shall consist of 115 mm (4 1/2 inch) outside diameter galvanized steel pipe conforming to the dimensional requirements of ASTM A 501 or ASTM A 53/A 53M, Type S, Grade B standard weight. The post shall have no taper and shall be threaded at the lower end to fit the base.

(2) Aluminum Posts. Aluminum posts shall consist of 115 mm (4 1/2 inch) outside diameter aluminum structural pipe conforming to the requirements of ASTM B 429, Alloy 6063-T6. Tapered aluminum posts may be used if approved by the Engineer. Posts that have no taper shall be threaded at the lower end to fit the base.

(b) Bases.

(1) Cast Iron Bases. Cast iron bases shall conform to the requirements of AASHTO M 105, Class 20 or higher. Galvanized cast iron bases shall conform to the requirements of ASTM A 126, Class A. Galvanizing shall be in accordance with AASHTO M 111M/M 111 (ASTM A 123/A 123M). Bases shall be galvanized by the same procedure used for steel posts and may be galvanized with the posts.

(2) Cast Aluminum Bases. Cast aluminum bases shall conform to the requirements of ASTM B 26/B 26M or ASTM B 108, Alloy SG70A-T6.

(c) Certification. A Type D Certification shall be furnished for steel posts in accordance with Subsection 700.02. A Type A Certification shall be furnished for all other materials.

752.02 STRAIN POLES.

(a) Wood Poles. Wood poles for span wire mounted signal heads shall be either Douglas Fir or Southern Pine. The poles to be used shall be Class 3 and shall be a minimum of 11 mm (35 feet)

in length, unless otherwise specified. Wood poles shall meet the specification requirements of ANSI 05.1 "Piles and Poles, Wood."

(1) Quality. Outer bark shall be completely removed from all poles. No patch or inner bark more than 25 mm (1 inch) wide and 150 mm (6 inches) long shall be left on the pole surface between the top and 600 mm (24 inches) below the groundline.

All poles shall be neatly sawed at the top and at the butt along a plane which shall not be out of square with the axis of the pole by more than one unit per six units of diameter of the sawed surface. Beveling is permitted at the edge of the sawed butt surface not more than 8.33 percent of the butt diameter in width, or an equivalent area asymmetrically located.

Completely overgrown knots, rising more than 25 mm (1 inch) above the pole surface, branch stubs, and partially overgrown knots shall be trimmed close. Completely overgrown knots less than 25 mm (1 inch) high need not be trimmed. Trimming may be done by a shaving machine or by hand.

(2) Dimensions. The dimensions for the poles required shall be not more than 75 mm (3 inches) shorter or more than 150 mm (6 inches) longer than the nominal length. The lengths shall be measured between the extreme ends of the pole.

The minimum circumference at 2 m (6 feet) from the butt shall be 950 mm (36 inches) for Western Red Cedar and 860 mm (34 inches) for Southern Pine. The minimum circumference at the top of the pole shall be 580 mm (23 inches) for both Western Red Cedar and Southern Pine. The circumference at 2 m (6 feet) from the butt of the pole shall be not more than 180 mm (7 inches) larger than the specified minimum. The top circumference requirements shall remain 580 mm (23 inches) at a point corresponding to the minimum length permitted for the pole.

The true circumference class shall be determined as follows: Measure the circumference at 2 m (6 feet) from the butt. This dimension will determine the true class, provided its top (measured at the minimum length point) is large enough. Otherwise, the circumference at the top will determine the true class, provided the circumference at 2 m (6 feet) from the butt does not exceed the specified minimum by more than 180 mm (7 inches).

(3) Preservative Treatment. All wood posts shall be treated over their full length in accordance with Subsection 726.01, using Type I, II, III, or IV preservatives.

(b) Steel Poles and Baseplates. Steel poles shall consist of tapered tubular shafts or a series of two to three different diameter pipes welded together with baseplates. The pole shall be of such length that the clearance from the pavement to the bottom of the lowest hanging mounted signal head shall be 5.0 m (16.5 feet), when span wire sag is within the allowable range of 5 to 7 percent of the span. The shafts after fabrication shall have at least a minimum yield strength of 330 MPa (48 ksi). The metal thickness shall be not less than 6.4 mm (0.25 inch) for tapered poles and not less than 7.6 mm (0.30 inch) for the bottom section of multiple pipes. The steel poles shall withstand the stringing tension of the span wire with its signal load without exceeding a deflection of 150 mm (6 inches) and a bending stress limit of 66 percent of yield strength.

The tapered shafts shall be formed, welded, and longitudinally cold-rolled under sufficient pressure to flatten the weld and form a smooth tapered tube. A reinforced handhole at least 100 by 150 mm (4 × 6 inches), complete with cover, shall be provided in the pole approximately 450 mm (18 inches) above the base and located at 90 degrees to the span wire on the side away from approaching traffic. A lip shall be provided around the handhole opening to prevent the cover from tipping and falling inside the hole. Stainless steel machine screws shall be provided for attaching the handhole cover. A steel cap shall be provided for the top of each pole with provision for an overhead wire entrance when needed. Stainless steel machine screws shall be provided for securely fastening the cap to the top of the pole. A 50 mm (2 inch) blind half-coupling shall be welded through the side of the shaft 150 to 300 mm (6 to 12 inches) below the span wire

attachment height. A grounding nut shall be located inside the shaft easily accessible from the handhole. Each steel strain pole and the neutral or common grounding electrode conductor shall be bonded to a soft drawn, bare, copper wire with a cross-sectional area of 13.30 mm^2 (No. 6 AWG). The No. 6 AWG soft drawn, bare, copper wire shall be connected to a grounding electrode(s) which will be driven at each strain pole or steel pole with mast arm(s) location.

The baseplate shall be of adequate shape and size to carry the full bending moment of the pole at its yield point. It shall consist of heat treated cast steel conforming to the requirements of ASTM A 27/A 27M or steel plate conforming to the requirements of ASTM A 36/A 36M. The baseplate shall be attached to the shaft by two continuous electric welds, one inside the base at the end of the shaft and the other on the outside at the top of the base. The design shall be such that the welded connection shall develop the full strength of the adjacent shaft section. A four anchor bolt pattern shall be used, unless otherwise shown on the Plans.

After fabrication, the shaft and baseplates shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111 (ASTM A 123/A 123M).

Pole diameter height, yield, strength, and wall thickness shall be stamped on a metal tag attached near the handhole. If stepped poles are used, the stamping shall indicate the equivalent tapered pole.

(c) Certification. A Type D Certification shall be furnished for steel poles and baseplates in accordance with Subsection 700.02. A Type A Certification shall be furnished for wood poles.

752.03 TRAFFIC SIGNAL POLES WITH MAST ARMS OR BRACKET ARMS.

(a) Steel Poles and Baseplates. Steel poles shall consist of tapered tubular shafts or multiple pipe poles with baseplates and shall conform to the requirements of Subsection 752.02(b), except the minimum wall thickness shall be not less than 4.55 mm (0.179 inch or 7 gage).

(b) Cantilever Mast Arms. Material for the mast arms shall conform to the requirements of Subsection 752.02(b) fabricated either as a tapered tube or multi-diameter pipe with a minimum metal thickness of 4.55 mm (0.179 inch or 7 gage). Both types shall have a flange plate welded on the large end for attaching to the vertical pole. A removable cap shall be attached to the far end. Wire outlets with rubber grommets shall be provided for each indicated signal location.

(c) Aluminum Poles, Bases, and Mast Arms. Aluminum poles with anchor bases and mast arms shall conform to the requirements of Subsection 753.01(b).

(d) Luminaire Bracket Arms. Luminaire bracket arms shall be the same type of material as the upright support. Steel brackets shall conform to the requirements of Subsection 753.01(c)(4), and aluminum brackets shall conform to the requirements of Subsection 753.01(b)(4). The bracket arms shall be either truss or tapered tubes as shown on the Plans. The main member of a truss-type arm shall be an oval shaped tapered tube securely joined by means of vertical struts to its companion member.

(e) Identification. Pole diameter, height, yield strength, and wall thickness shall be stamped on a metal tag attached near the handhole. Cantilever arm dimensions, length, and diameter/wall thickness shall also be included on the tag. If stepped poles are used, the stamping shall also indicate the equivalent tapered pole/arm.

(f) Certification. A Type D Certification shall be furnished for steel poles, baseplates, mast arms, and luminaire bracket arms in accordance with Subsection 700.02. A Type A Certification shall be furnished for aluminum poles, baseplates, mast arms, and luminaire bracket arms.

752.04 SPAN WIRE. Span wire shall consist of 10 mm (3/8 inch) diameter galvanized steel cable conforming to the requirements of ASTM A 475, Class A coating, seven wire strand, utilities grade. The signal cable shall be attached to the span wire with a stainless alloy 1.2 mm (18 gage) lashing (spinning) wire.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.05 TRAFFIC SIGNAL HEADS. Traffic signal heads shall be self-contained assemblies that are expandable and adjustable. The signal heads may contain one or more signal faces as shown on the Plans. All traffic signal lenses shall be 305 mm (12 inches) in diameter, unless otherwise shown on the Plans.

Each traffic signal face shall consist of a number of signal sections rigidly fastened together in such a manner as to be watertight and dust proof. It shall be possible to assemble one or more signal faces into a multidirectional traffic signal head.

The components of the signal head; consisting of housings, doors, visors, optical units (lenses, reflectors, lamp sockets, and lamps), wiring, trunnions and brackets; shall conform to the latest requirements of the ITE technical report "Adjustable Face Traffic Control Signal Head Standards." Standard 8000-hour traffic signal lamps shall be used, unless otherwise specified. The Contractor shall use 116 W lamps in 305 mm (12 inch) units, unless otherwise specified. Lamp socket lead wires shall be stranded. The Contractor shall use 135 W lamps with internal reflector and 1750 rated initial lumen output for those faces having arrow lenses.

The components of the signal head shall be rigidly constructed of a diecast aluminum alloy in accordance with ASTM B 85, Alloys S-12A, S-12B, SC-84A, SC-84B, or SG-100B or polycarbonate with a smooth outer surface and shall be capable of holding the optical units securely in place. The polycarbonate material shall be such that it will withstand 95 J (70 pounds-force foot) of impact without fracture or permanent deformation.

(a) Polycarbonate Signal Heads. When a polycarbonate signal head is utilized, it shall conform to the following requirements:

(1) Housing. The housing of each section shall be a one piece polycarbonate resin material with front, sides, top, and bottom integrally molded. The housing shall be of substantial thickness and shall be ribbed so as to produce the strongest possible assembly consistent with low density. Two sets of internal bosses shall be provided in each section for mounting of terminal strip facilities. The terminal bosses shall have threaded inserts sonically welded into each boss.

(2) Housing Door. The housing door of each signal section shall be of the same material as the housing.

(b) Aluminum or Polycarbonate Traffic Signals. For either aluminum or polycarbonate traffic signals, all requirements of the ITE technical report "Adjustable Face Traffic Control Signal Head Standards" shall be met as well as the following:

(1) Optical System. The optical system shall consist of a polycarbonate lens (red, yellow, or green) with a nominal size of 203 or 305 mm (8 or 12 inches).

The lenses and optical system shall be capable of withstanding continuous illumination from a 150 W standard traffic signal lamp without distortion of the lenses. Lens design shall be such that it conforms to American Standards Association #D-10.1-1958UDC 656.057 optical specifications.

(2) Wiring. Terminal blocks shall be placed in the center of a three section signal, unless otherwise specified, and shall be a five-position, ten-terminal, barrier type strip with the following terminal designations clearly marked "R-A-G-RC-AC." Terminal blocks shall be secured on both ends.

(3) Visors. Each signal door shall be equipped with a tunnel or cutaway type polycarbonate resin visor duralocked at four points to the door. The type shall be as shown on the Plans.

(4) Traffic Signal Backplates. All backplates shall be louvered and painted or colored flat black.

(5) Signal Color. Signal color shall be Federal Yellow body, unless otherwise shown on the Plans, with dull black door, visor, and back plate.

(6) Signal Dimmer. When 305 mm (12 inch) diameter signal faces are specified, an integral means shall be provided for gradually regulating the intensity for nighttime operation to approximately 75 percent of that required for daytime operation. This shall apply only to the yellow lens and only when in the flashing mode.

(c) Programmable Traffic Signal Heads. Where applicable, all requirements of ITE technical report "Adjustable Face Traffic Control Signal Head Standards" shall be met as well as those of part (b) above and the following:

When shown on the Plans, programmed visibility traffic signal heads shall be furnished. A signal head may consist of a standard signal head with an optically programmed adapter in place of the lens or may be a commercial assembly designed to provide for programmed visibility. In either case, visibility of the signal indication shall be limited by optical methods and not by hoods or louvers. A rigid mounting attachment or method shall be provided for masked signal assemblies containing programmed visibility signal heads. The visibility of the signal indication shall be adjustable within the signal head to fit the approach to be controlled. During daylight hours the signal indications shall be visible only in those areas designated. During dusk and darkness, a faint glow is permissible when the signal is viewed from outside the designated area. External illumination shall not cause a signal indication, and a signal indication in one signal head shall not cause an indication in another signal head.

When unprogrammed, the indication of each signal head shall be visible from anywhere within 15 degrees of the optical axis.

(d) LED Signals. LED signal units shall be either complete 300 or 200 mm (12 or 8 inch) polycarbonate or aluminum sections for new installation or retrofit module kits for existing signal sections, as shown on the Plans. Each unit shall be a self-contained, sealed, dust and watertight enclosure not requiring on-site assembly prior to installation. New LED signal units shall conform to the Institute of Traffic Engineers Performance Specification: Vehicle Traffic Control Signal Heads – Light Emitting Diode (LED) Circular Signal Supplement (dated June 27, 2005)

The installation of a retrofit replacement LED signal module into an existing signal housing shall require only removing the existing lens and incandescent bulb, fitting the new unit securely in the housing and connecting the module to the existing electrical wiring or a terminal block by means of simple connectors.

The LED signal module shall have a prominent and permanent directional marking(s), such as an UP arrow, for correct indexing and orientation within the housing.

The manufacturer's name, trademark, serial number, and other necessary identification shall be permanently marked on the back of the module. A label shall also be placed on the module certifying compliance with this specification.

(e) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.06 TRAFFIC SIGNAL CONTROLLERS.

(a) General. In order to prevent the State from becoming a testing ground for newly developed traffic signal equipment, it is required that the manufacturer provide certification that the particular type/model of controller to be used shall have been in actual field operation at a minimum of five locations for no less than one year each prior to its introduction in Vermont. This requirement does not apply to minor software updates of an existing unit.

Each controller shall be designated to operate on 115 V AC, 60 Hz, single-phase, and shall be delivered completely wired and enclosed in a weatherproof housing. Controllers shall be of the same type and manufacture conforming to the standard used by the town, city, or village when extensions or improvements of existing traffic control facilities are contracted.

Prior to bench testing, the Contractor shall provide the proposed controller settings for approval. Each controller shall be bench-tested with a NEMA test board that simulates all possible sequencing of signal intervals, corresponding to those for which the controller is to be used, for at least seven continuous calendar days prior to installation. The manufacturer or distributor shall have such bench testing performed by an independent testing company which shall certify that such test has been made and that the controller functions properly. Copies of all test results and descriptions of all changes and repairs shall be submitted with the certification. A copy of the controller settings used for the test shall be included in the bench test results. These settings shall be retained in the controller through shipment and installation. A representative of the manufacturer shall be on the project site for turn-on of the unit(s).

The controller shall be bench tested after it has been completely installed in its cabinet and all wiring internal to the cabinet has been completed. The bench test results shall include actual test results for all functions that the Plans require the controller to be able to perform. Failure to test any required function will result in rejection of the controller without exception. Rejected controllers will not be permitted to remain on the project, and rejected controllers shall not be reworked and subsequently reinstalled on the project. The controller shall not be shipped until the manufacturer has received full written approval of all the bench tests results from the Agency. Shipment of the controller prior to receipt of full written approval for all bench test results will result in the suspension of all payments for the traffic control signal items in the Contract until a fully approved controller is completely installed in place and functioning properly.

Traffic signal equipment design and performance shall meet or exceed all requirements of the latest NEMA standards for traffic control systems. Performance of the equipment shall be consistent with the MUTCD. The controller along with all auxiliary equipment shall be capable of producing the timing plan(s) and coordination shown on the Plans.

(1) Controller/Auxiliary Equipment. All controllers shall be actuated menu driven, keyboard entry and solid state. They shall have a minimum of twelve phases with dual maximum capabilities, and an internal time-based coordinator capable of providing at least four cycle lengths with multiple programs per cycle. The communication modem shall be approved over the same temperature range as the controller, -34 to 74 °C (-30 to 165 °F). All controllers at isolated intersections shall have all necessary hardware/software for the connection of two-way telephone communications. For coordinated systems with hardwire and/or telemetry interconnect, communications capability is required only at the master cabinet. The controllers shall be programmed so as to automatically adjust for daylight savings time changes.

Each installation shall include the following:

a. Twelve-channel conflict monitor or sixteen channel malfunction management unit (MMU) with stop timing function, liquid crystal display and the capability of recording at least nine "events,"

b. Sufficient load switches and flash transfer relays for all twelve phases,

c. LED display load switches (input side) labeled on the cabinet wall,

d. Remote flasher, and

e. Vehicle detector amplifiers. Rack mounted units must be used.

The conflict monitor/MMU and the controller shall be wired to ensure that the "events" logged by the conflict monitor/MMU and the controller indications at the time of failure can be uploaded directly to a computer.

(2) Cabinets. The controller and all auxiliary equipment shall be enclosed within a pre-wired, rainproof NEMA (3R) controller cabinet. The cabinet(s) shall have a polished aluminum alloy natural finish and a police door. The size of the cabinet shall be such as to provide ample space for housing all equipment necessary to provide the timings shown on the Plans.

The cabinet shall have a main door within which an auxiliary door shall be placed. The auxiliary door (police door) shall house a compartment with the following switches: "Flash-Automatic;" "Power, On-Off;" "Signal, On-Off."

A metal plaque listing ownership and emergency telephone numbers shall be attached to the outside of the cabinet. The plaque is as shown in the Plans.

Each cabinet shall have a weatherproof plastic envelope of sufficient size, 450 by 600 mm (18 × 24 inches), to store wiring diagrams, program manuals, etc. The cabinet shall contain a suitably designed vent fan and thermostat [50 to 71 °C (120 to 160 °F)]. The thermostat shall be set initially to 50 °C (120 °F).

The controller cabinet shall contain a strong mounting table, sliding track, hinged adjustable fixed or a folding support of such construction that it will permit the controller or other equipment to be withdrawn from the cabinet for inspection or maintenance without breaking any electrical connection or interrupting normal operation of the controller.

A flexible arm lamp receptacle capable of illuminating all areas of the cabinet, two convenience outlets, ground fault interruption protection, and surge protection shall be provided.

A wiring panel shall be included in each cabinet mounted in such a way so as to provide visibility and accessibility. The lowest row of terminals shall be at least 75 mm (3 inches) from the bottom of the cabinet.

The main door lock of the cabinet shall be a #2 tumbler type lock as recommended by the manufacturer of the equipment. A police type lock shall be provided for the auxiliary door. The cabinet shall also be provided with a Master #3220 padlock. Two keys shall be furnished for each lock. The mounting of the cabinet shall be as shown on the Plans.

An intersection layout drawing to a scale of 1:500 (1:40) shall be taped to the inside of the door, in the proper orientation and covered with plastic. It shall indicate numbers for the vehicle heads, phases, load switches, detectors, loops, and any other pertinent information.

The Contractor shall indicate on the inside of the door, the date and time of signal turn-on for new installations or switch-over for replacement installations. The door marking shall be permanent.

(3) Spare Equipment. In addition to equipment furnished to provide a functional signal system, the Contractor shall supply one of each of the following spare parts in each cabinet:

a. Flasher unit (independent of the controller),

b. Transfer relay,

c. EEPROM, programmed for the project intersection and stored in a protective container,

d. Cabinet lamp bulb,

e. Filter for ventilation system,

f. Relay,

g. Six spare bulbs (for optically programmed heads only), and

h. Loop amplifier with delay call capability.

i. Cabinet surge protector

j. Bus Interface Unit (BIU) in a protected container

This equipment may be used during the construction period to replace malfunctioning equipment but must be replaced and maintained in the cabinet prior to acceptance.

(4) Wiring. All panel wiring shall be neat and firm and UL approved circuit breakers shall be provided

All field terminals shall be suitably identified.

The electrical connections from the controller and other accessory equipment to the outgoing and incoming circuits shall be made either by standard multiple plug or jack.

The outgoing traffic control signal circuits shall be of the same polarity as the line side of the power supply; the common return of the signal circuits shall be of the same polarity as the ground side of the power supply.

The ground side of the power supply shall be grounded to the controller cabinet in an approved manner.

All signals shall be wired such that no more than two through faces (north/south and/or east/west) are wired into one load switch even though the two approaches may time during the same phase.

(5) Contacts. All contacts used in connection with interval indications shall be of pure coin silver or its equivalent and shall be capable of breaking and carrying 10 A at 125 V AC and shall be readily accessible and capable of being replaced in the controller without the use of any tools other than pliers and screwdrivers. Mercury tube contacts will not be accepted.

(6) Relays. Relays shall not be used in connection with any automatic non-flashing red, yellow or green indications without the approval of the Engineer. All relays shall be jack mounted.

(7) Motor and Lamp Leads. All motor and lamp leads shall be moisture and heat resistant type of flexible stranded copper 600 V wire meeting the requirements of the National Electrical Code.

(8) Snap Switch. Each controller shall be equipped with a snap switch that will disconnect the timing mechanism and signal lights from all outside sources of electrical power.

(9) Lightning Arrester. Each controller shall be equipped with a suitable effective lightning arrester that filters lightning or high voltages to ground protecting internal components of the controller.

(10) Radio and Television Interference. Electrical equipment shall be protected against interfering with radio and television reception.

(11) Wiring Diagram. Two internal connection wiring diagrams for all apparatus, and mounting and operating instructions shall be furnished.

(12) Flasher. Each controller shall be equipped with a flashing mechanism capable of providing flashing operation at a rate of not less than 50 or more than 60 flashes per minute, part of which may be yellow and part red, or all red, as directed by the Engineer. The illuminated period of each flash shall be not less than 50 or more than 67 percent of the total cycle. Such flashing mechanism shall be in an encapsulated cube style configuration, shall be adequately housed and protected from the weather and shall be of such design as to be accessible for inspection, cleaning, and adjustment without disconnecting any part. It shall be capable of flashing two inductive or tungsten loads and shall operate within a line voltage range of 95 to 135 V AC. Alternately, a NEMA flasher meeting the same operational requirements may be provided. A mercury tube contact will not be accepted for flashing indications. Flashing operation shall begin automatically if the controller malfunctions and when called for by the timing plan. In addition, flashing shall be capable of being manually controlled by a switch in the police door. The controller itself need not be present to operate the signals in flashing mode.

(13) All controllers, installed in areas where other signalized intersections are nearby and there is likelihood of future coordination, shall be capable of future interconnect either by cable connection, telemetry, spread spectrum radio or the use of time based coordination. Such modifications shall not require return of the controller to the manufacturer.

(14) For semi-actuated controllers, in the absence of actuation, the right-of-way shall return to and remain on the non-actuated approach, or as shown on the Plans.

(15) For fully-actuated controllers, in the absence of actuation, the right-of-way shall remain on the last actuated phase, or as specified.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.07 FLASHING BEACONS.

(a) General Requirements. The applicable portions of Subsection 752.06 shall apply in addition to the specific functional requirements described below.

(b) Flasher. The controller shall be equipped with a flashing mechanism capable of providing flashing operation at a rate of not less than 50 or more than 60 flashes per minute, part of which may be yellow and part red, or all red as directed by the Engineer. The illuminated period of each flash shall be not less than 50 and not more than 67 percent of the total cycle. The flashing mechanism shall be adequately housed and protected from the weather and shall be designed to be accessible for inspection, cleaning, and adjustment without disconnecting any part. A mercury tube contact will not be accepted for flashing indications. Time cycle variations shall not occur due to any change in outside temperature between the limits of -30 to 50 °C (-20 and 120 °F). For temperatures lower than -30°C (-20 °F) (a heater unit may be activated, if required, to keep the unit functioning.

Solid state flasher units shall meet or exceed all requirements of the latest NEMA standards.

The flashing mechanism shall be protected against interfering with radio and television reception by the use of a radio and television interference filter.

(c) Cabinets. The complete flashing mechanism and related interference filters shall be enclosed within a rainproof, NEMA (3R), cast-aluminum cabinet or a glass meter socket housing, whichever is shown on the Plans. The size of the cabinet shall be such as to provide ample space for housing the flashing mechanism, filters, and fuse panel.

The cabinet shall have a main door and lock. The lock shall be a tumbler type lock as recommended by the manufacturer of the equipment. Two keys shall be furnished for the lock.

The cabinet shall contain a suitably designed vent.

The mounting of the cabinet shall be as shown on the Plans.

(d) Flashing Beacon Signal Heads. Flashing beacon signal heads shall be self-contained assemblies that are expandable, adjustable, and may contain one or more signal faces as shown on the Plans.

The components of the signal head consisting of housings, doors, visors, optical units (consisting of lenses, reflectors, lamp sockets, and lamps), wiring, trunnions and brackets shall conform to the latest requirements of the ITE technical report "Adjustable Face Traffic Control Signal Head Standards," and the applicable portions of Subsection 752.05, unless otherwise specified.

(e) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.08 ELECTRICAL CONDUIT. Electrical conduit shall conform to the following:

(a) Rigid Polyvinyl Chloride (PVC) Electrical Conduit. Rigid PVC electrical conduit shall be Schedule 80 and shall meet or exceed the specifications of ASTM D 1784.

(b) Polyethylene Plastic Pipe and Fittings (HDPE) Electrical Conduit. Polyethylene plastic pipe and fittings (HDPE) electrical conduit shall be Schedule 80 and shall meet or exceed the specifications of ASTM D 3350.

(c) Plastic Coated, Galvanized Steel, Rigid Metallic Electrical Conduit. Plastic coated, galvanized steel, rigid metallic electrical conduit shall be hot-dip galvanized and shall have a plastic coating of at least 0.5 mm (20 mils) in thickness intimately bonded to both inside and outside galvanized surfaces. The conduit shall meet the requirements of ASTM A 53/A 53M.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.09 TRAFFIC SIGNAL CONDUCTOR CABLE.

(a) Polyethylene-Insulated, Polyvinyl Chloride (PVC) Jacketed Signal Cable. Polyethylene-insulated, PVC jacketed signal cable for use in underground conduits or as an aerial cable supported by a span wire shall conform to the latest requirements of International Municipal Signal Association, Inc., Specification No. 19-1.

(b) Polyethylene-Insulated, Polyethylene Jacketed Communication Cable. Polyethylene-insulated, polyethylene jacketed communication cable for use in underground conduits or as an aerial cable supported by a span wire shall conform to the latest requirements of International Municipal Signal Association, Inc., Specification No. 20-1.

(c) Polyethylene-Insulated, Polyvinyl Chloride (PVC) Jacketed, Integral Messenger Signal Cable. Polyethylene-insulated, PVC jacketed signal cable with integral supporting span wire for aerial installation shall conform to the latest requirements of International Municipal Signal Association, Inc., Specification No. 19-3.

(d) Polyethylene-Insulated, Polyethylene Jacketed, Integral Messenger Communication Cable. Polyethylene-insulated, polyethylene jacketed communication cable with integral supporting span wire for aerial installation shall conform to the latest requirements of International Municipal Signal Association, Inc., Specification No. 20-3.

(e) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.10 DETECTORS. Vehicle detectors used for actuating traffic signal controllers shall be of the inductive loop type or as shown on the Plans.

(a) Inductive Loop Detectors. Inductive loop detectors shall meet or exceed all requirements of the latest NEMA standards for traffic control systems. Each detector unit shall be capable of serving up to four loops.

The wire loops shall consist of 3.31 mm^2 (No. 12 gage) AWG minimum size, Type TW stranded wire with 600 V insulation. Loop feeder wire shall be in accordance with the loop detector manufacturer's recommendations. Loop feeder length capability shall be at least 230 m (755 feet) for one loop, or a combined total feeder length capability of at least 230 m (755 feet) for multiple loops. Single conductor shall consist of seven-strand tinned copper.

The configurations and installation of the wire loops and loop feeder wires shall be in accordance with the loop detector manufacturer's recommendations and/or as shown on the Plans. The loops shall be located as shown on the Plans.

Vehicle detector feeder wire (lead-ins) shall be enclosed in a nonmetallic conduit for underground travel from the curb to the controller.

752.11 VEHICLE DETECTOR SLOT SEALANT. Vehicle detector slot sealant material shall be a standard of the trade for this purpose, and it shall have the approval of the Engineer prior to being used.

752.12 JUNCTION BOX. Junction boxes shall be constructed of fiberglass, high density polyethylene (HDPE), or acrylonitrile-butadiene-styrene (ABS). They shall be high-impact resistant at temperatures ranging from -35 to 50 °C (-30 to 120 °F), ultraviolet stabilized, and fire retardant. The side wall shall be ribbed for strength. The cover shall be non skid and shall be held down with recessed hex-head bolts. The junction box shall be capable of withstanding a loading of 67 kN (15 kips) over any 250 by 250 mm (10 × 10 inch) area on the cover. The size of the box shall be as specified in the Contract.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.13 ACCESSIBLE PEDESTRIAN SIGNALS. Accessible Pedestrian Signals (APS) shall meet the standards of the American with Disabilities Act (ADA) and the most current edition of the Manual on Uniform Traffic Control Devices (MUTCD).

(a) Wiring. The APS shall interface and be coordinated with the other features of a traffic control signal.

(b) Audible Features. The APS shall include an audible indication of the Walk interval by either tone or voice and shall be audible from the near side of the associated crosswalk. If the tone for the Walk interval is the same as the locator tone of the pushbutton it shall have a faster repetition rate than the associated locator tone. The volume of the audible features shall have automatic volume adjustment based on the ambient noise levels. Audible features shall be no more than 5 dB louder than ambient sound up to a maximum volume of 89 dB measured at 36 inches (900mm) from the device. When voice messages are used, they shall include a clear message that the walk interval is in effect and shall indicate to which crossing it applies. Audible features may be integral to the Pedestrian Pushbutton Assembly (752.14) or through a separate speaker housing.

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

752.14 PEDESTRIAN PUSHBUTTON ASSEMBLIES. Pedestrian pushbutton assemblies shall meet all ADA requirements. The plunger head shall have a minimum diameter of 50 mm (2 inches) and the force required to operate the plunger shall not exceed 22.2 N (5 pounds). The pushbutton shall activate both the Walk interval and the APS (if one is provided).

(a) Color. The color of the pushbutton shall contrast visually with the housing or mounting.

(b) Audible Features. The pushbutton assembly shall include an integral locator tone. The locator tone shall have a duration of 0.15 seconds or less and shall repeat at 1 second intervals. The locator tone shall be 2 dB minimum and 5 dB maximum above ambient noise levels and shall be responsive to ambient noise levels.

(c) Tactile Features. The pushbutton assembly shall incorporate a raised arrow. The arrow shall be raised 0.8 mm (1/32 inch) minimum and shall be 38 mm (1 ½ inches)minimum in length. The arrow color shall contrast with the background. The pushbutton shall vibrate to indicate that the walk interval is in effect.

(d) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 753 - HIGHWAY ILLUMINATION

753.01 LIGHT STANDARDS.

(a) General. The shafts of all light standards shall be designed to withstand an equivalent wind gust load of 160 km/h (100 miles per hour) velocity and when used with the listed bracket arm and luminaire, shall not produce an angular deflection of more than 70 minutes.

The bracket arms shall be able to withstand a vertical load of 450 N (100 pounds) and a horizontal load of 225 N (50 pounds) without fracture or permanent deformation.

The design of light standards shall conform to the latest edition of AASHTO *Standard Specifications for the Structural Supports for Highway Signs, Luminaires and Traffic Signals*.

Breakaway poles shall yield with a change in vehicle momentum of less than 4895 N-s (1100 pound-seconds) when struck by a 1020 kg (2250 pound) vehicle traveling at speeds from 32 to 97 km/h (20 to 60 miles per hour).

(b) Aluminum Poles.

(1) Shafts. Aluminum shafts shall consist of tapered one-piece seamless tubes conforming to the requirements of ASTM B 221M (ASTM B 221), Alloy 6063-T6, 6061-T6, or 6005-T5. Minimum wall thickness shall be 3.2 mm (0.125 inch) for mounting heights of less than 6 m (20 feet) and 4.8 mm (0.188 inch) for mounting heights of 6 m (20 feet) or more.

When transformer bases are not shown on the Plans, a 100 by 150 mm (4 × 6 inch) reinforced handhole, complete with cover plate and stainless steel attachment screws, shall be located approximately 450 mm (18 inches) above the base at 90 degrees from the direction of the bracket arm on the side away from approaching traffic. A lip shall be provided around the handhole opening to prevent the cover from tipping and falling inside the hole. A grounding nut easily accessible from the handhole shall be located inside the shaft at each handhole. Each shaft shall be provided with a

removable, ornamental, cast-aluminum, pole cap held securely in place.

(2) Baseplates. Baseplates shall consist of a one-piece aluminum casting conforming to the requirements of ASTM B 26/B 26M or ASTM B 108, Alloy SG70A-T6, 356-T6. The baseplate shall be attached to the shaft by two continuous welds, one inside the base at the end of the shaft and the other on the outside at the top of the base. The welded connection shall develop the full strength of the adjacent shaft section.

(3) Transformer Bases. Transformer bases shall consist of a one-piece aluminum casting conforming to the requirements of ASTM B 26/B 26M or ASTM B 108, Alloy SG70A-T6, 356-T6. The transformer base shall be approximately 500 mm (20 inches) high, 400 mm (16 inches) square at the bottom, and 330 mm (13 inches) square at the top, unless otherwise specified. Each transformer base shall have an aluminum door attached with stainless steel screws. The bottom plate of the base shall have a grounding nut easily accessible from the door. Stainless steel bolts, nuts, and washers shall be provided to attach the transformer base to the shaft anchor base.

(4) Bracket Arms. Bracket arms shall be a single member elliptical-type or truss-type as shown on the Plans. With the exception of davit-type poles, the main or wire-carrying member shall be ovalized at the shaft end. The shaft end of the arm shall have a cast aluminum fitting welded to it to permit attachment to the shaft. Single bracket arms and the main member of truss-type arms shall be tapered, seamless tube conforming to the requirements of ASTM B 221M (ASTM B 221), Alloy 6063-T6 or Alloy 6061-T6. Other members of truss-type arms shall conform to the requirements of ASTM B 221M (ASTM B 221), Alloy 6063-T6. The bracket arm shall be provided with a 50 mm (2 inch) slip-fit mounting of sufficient length to accommodate the luminaire.

(5) Accessories. All screws, nuts, bolts, and other hardware including anchor bolts shall be stainless steel, unless otherwise specified.

(6) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

(c) Steel Poles.

(1) Steel shafts shall consist of:

a. A tapered one-piece tube fabricated from one length of steel sheet that shall have only one longitudinal automatically electrically welded joint. The shafts shall be formed, welded longitudinally, and cold-rolled under sufficient pressure to flatten the weld and form a smooth tapered tube. The shaft shall be uniformly tapered at a rate of approximately 11.7 mm/m (0.14 inch per foot). The metal thickness shall not be less than 3.0 mm (0.119 inch).

b. A series of two or three different diameter pipes welded together. The metal thickness shall not be less than 4.8 mm (0.188 inch) for the bottom section.

After fabrication, the shafts shall have a minimum yield strength of 330 MPa (48 ksi).

When transformer bases are not shown on the Plans, a 100 by 150 mm (4 × 6 inch) reinforced handhole, complete with cover plate and stainless steel attachment screws, shall be located approximately 450 mm (18 inches) above the base at 90 degrees from the direction of the bracket arm on the side away from approaching traffic. A lip shall be provided around the handhole opening to prevent the cover from tipping and falling inside the hole. A grounding nut shall be located inside the shaft easily accessible from the handhole.

(2) Baseplates. Baseplates shall consist of steel plate conforming to the requirements of ASTM A 36/A 36M or ASTM A 242/A 242M, or of a one-piece steel casting conforming to the requirements of ASTM A 27/A 27M. The baseplate shall be attached to the shaft by two continuous electric welds, one inside the base at the end of the shaft and the other on the outside at the top of the base. The welded connection shall develop

the full strength of the adjacent shaft section. When bolt covers are shown on the Plans, they shall be attached to the upright portion of the base with stainless steel screws.

(3) Transformer Bases. Transformer bases shall consist of a one-piece steel casting conforming to the requirements of ASTM A 27/A 27M or shall be fabricated from steel plate conforming to the requirements of ASTM A 36/A 36M or ASTM A 242/A 242M.

When fabricated, the side plates shall have a minimum thickness of 4.5 mm (0.178 inch). The top and bottom plates shall have a minimum thickness of 19 mm (3/4 inch). The transformer base shall be approximately 500 mm (20 inches) high, 400 mm (16 inches) square at the bottom, and 330 mm (13 inches) square at the top, unless otherwise specified. Stainless steel bolts, nuts, and washers shall be provided to attach the transformer base to the anchor base. Each transformer base shall have a steel door attached with stainless steel screws. The bottom plate of the base shall have a grounding nut easily accessible from the door.

(4) Bracket Arm. Bracket arms shall be fabricated from standard steel pipe, free from burrs and conforming to the requirements of ASTM A 120 or ASTM A 501. Single member arms and individual members of truss-type arms, when required, shall be of one-piece seamless pipe. The bracket arm shall be provided with a 50 mm (2 inch) slip-fit mounting of sufficient length to accommodate the luminaire. Bracket arm connections to the shaft shall be weather resistant.

(5) Finish. After fabrication, shafts, baseplates, transformer bases, and bracket arms shall be galvanized in accordance with the requirements of AASHTO M 111M/M 111.

(6) Certification. A Type D Certification shall be furnished in accordance with Subsection 700.02.

753.02 LUMINAIRES.

(a) General. All luminaires, including lamps, ballasts, photoelectric control devices, and housings, shall include the latest design improvements available at the time the Contract is awarded. They shall include an aluminum housing with easy access to the ballast assembly, photoelectric control, filtered optical assembly, and regulator ballast for the appropriate voltage. The ballast shall be matched to its starting circuit. Wiring shall be neat, bundled, and kept away from excess heat. All light distribution types shown on the Plans shall be in accordance with the latest editions of the *American Standard Practice for Roadway Lighting* by the Illuminating Engineering Society (IES) and *An Informational Guide for Roadway Lighting* (AASHTO).

(b) Mercury, Sodium and Metal Halide Luminaires. Luminaires shall be weatherproof with a detachable reflector gasketed to the refractor and shall be optically sealed to prevent visible light leaks. The refractor shall be of heat-resistant glass or as shown on the Plans. Housings shall be of cast or formed aluminum. The unit shall be provided with a 50 mm (2 inch) slip-fitting for mounting onto a 50 mm (2 inch) bracket, unless otherwise specified. Wattage and type of light distribution to be provided shall be as shown on the Plans.

The ballast shall be of the regulated (constant wattage) type, internally mounted in the luminaire.

For a mercury vapor luminaire, the ballast shall regulate within ± 2 percent variation of the lamp wattage or a ± 13 percent variation in primary voltage. The ballast shall operate within the range of 5 percent voltage drop and have a guaranteed starting characteristic of -30 °C (-20 °F).

For a high-pressure sodium luminaire, the ballast shall regulate within ± 5 percent variation of the lamp wattage or a ± 10 percent variation in primary voltage. The ballast shall operate within the range of 5 percent voltage drop and have a guaranteed starting characteristic of -30 °C (-20 °F).

For a metal halide luminaire, the ballast shall regulate within ± 10 percent variation in primary voltage. The ballast shall operate within the range of 5 percent voltage drop and have a guaranteed starting characteristic of -30 °C (-20 °F).

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

753.03 PHOTOELECTRIC CONTROL DEVICES.

(a) General. Unless otherwise shown on the Plans, a twist-lock type photoelectric control device shall be an integral part of each luminaire and shall operate at a temperature of -30 °C (-20 °F). The photoelectric controls shall be of the cadmium-sulphide type, and the load capacity of the photoelectric cell relays shall be a minimum of 1000 W. They shall be suitable for operating a lighting system through load relays or oil switches when so shown on the Plans. The photoelectric cell circuitry shall be designed to be normally closed at night. The turn-on range shall be adjustable if shown on the Plans and shall be set by the Contractor as recommended by the manufacturer to meet local conditions. The turn-off setting shall be preset by the manufacturer. The relay shall have a time delay to avoid operation due to lightning and transient light. In the event of failure, the relay shall fail safe, that is, the lights are left on in the event of any failure in the electronic circuit. A suitable bracket for mounting, to orient the photoelectric cell window toward the north sky, and a lightning arrester shall be included as part of the unit.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

753.04 HIGHWAY ILLUMINATION CONDUCTOR CABLE.

(a) General. Highway illumination conductor cable shall be single conductors of stranded, soft-drawn copper or single conductors of stranded aluminum with a moisture and heat resistant thermoplastic insulation such as Type THW. It shall be rated for 600 V service at 75 °C (167 °F) for either dry or wet locations. UF cable shall be used in wet areas. Where the UF cable may extend into other conditions it shall be of a type approved for the additional use.

The electrical cable in a conduit shall be single conductors of stranded, soft-drawn copper or single conductors of stranded aluminum with a moisture and heat resistant thermoplastic insulation such as Type XHHW, Type THW, or equivalent. The electrical cable shall be rated for 600 V service at 75 °C (167 °F) for either dry or wet locations.

The cable shall not have any unnecessary kinks or bends put into the cable during installation. Any bends that are necessary shall be made according to the manufacturer's guidelines. End caps, when necessary, of the appropriate size for the service conductors shall be installed at all termination points in pull boxes, junction boxes, and pole bases. When a conduit splice is required near termination (such as at a sweep to a pole base or a pull box), the splice shall be made with a coupling of the same or similar material as directed by the Engineer.

The single conductors shall conform to the National Electrical Code for the intended wire use and existing field conditions. Wire size shall be such that no more than a 3 percent voltage drop will occur anywhere in the secondary circuit. All wiring shall be color-coded.

All conductors within the streetlight pole and bracket arm shall be No. 10 AWG stranded copper wire. Street lighting conductors within strain poles shall also be No. 10 AWG stranded copper wire.

Unless otherwise shown on the Plans, the multiple system of distribution shall be used.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

753.05 GROUNDING ELECTRODES.

(a) General. Grounding electrodes shall be copperclad steel rods 16 mm (5/8 inch) in diameter by 2.4 m (8 feet) long, minimum, and shall conform to UL No. 467 (ANSI C33.8).

Grounding conductor shall be installed throughout the system back to the power source. The earth shall not be used as the sole equipment grounding conductor.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

SECTION 755 – LANDSCAPING MATERIALS

755.01 LANDSCAPE BACKFILL. The landscape backfill material shall be premixed, consisting of approximately 50% topsoil, 25% compost, and 25% native soil as approved by the Engineer. In cases where native soil meets the topsoil specification, the proportions of native soil may be adjusted to up to 75% as approved by the Engineer.

755.02 TOPSOIL. Topsoil shall be a natural, workable soil, free of refuse, roots, stones, brush, weeds, or other material that would be detrimental to the proper development of plant growth. Topsoil shall be screened, loose, and friable, free of subsoil, roots, noxious weeds, stones larger than 25 mm (1 inch), and other debris.

Topsoil shall be reasonably free draining (less than 27% clay), and contain 5-10% organic matter for woody plant materials as determined by the loss of ignition of oven dried samples. Topsoil for lawn areas shall have an organic content of at least 4%. Salinity (electrical conductivity) shall be less than 0.1 S/m as determined by a 1:2 (by volume) soil to water mix. Salt test samples shall not be oven dried. The acidity range of the topsoil shall be ph 5.5 to 7.0.

Topsoil shall be obtained from a source that has been approved by the Engineer and has demonstrated, by a healthy growth of grass, cultivated crops, or wild vegetation that it is of good quality. The Contractor shall provide a 0.5 kg (one pound) sample per each 190 m^3 (250 yd^3) of topsoil.

At least 30 days prior to delivery and use, the topsoil shall be submitted by the Engineer for testing to the University of Vermont Agricultural Extension Service or equivalent approved facility. Testing results shall be sent directly back to the Engineer for approval.

Testing shall be on dry material that has passed the #10 sieve with the following gradation:

SEIVE SIZE	PERCENT PASSING
No. 10	85-100
No. 40	35 – 85
No. 200	10- 35
< 20 um	<5

Soil analysis shall show recommendations for soil additives to correct soil deficiencies and for additives necessary to accomplish particular planting objectives noted.

Soil amendments shall be incorporated thoroughly into the topsoil to meet the specified requirements for topsoil prior to delivering the material on site.

755.03 SOD. Sod shall be live, fresh, and of suitable character for the soil in which it is placed. Sod shall be of a firm, even texture, show good root development, be reasonably free from noxious weeds, and shall have a compact growth of vigorous, dark green grass. Sod shall have a minimum 70 percent Kentucky Bluegrass, improved variety, and a 10 percent Red Fescue (Festuca rubra) improved variety.

Sods shall be 600 mm^2 (2 ft^2) in area and shall be thick enough to contain all natural roots without mutilation. In no case shall sod be under 18 mm (3/4 inches) or over 25 mm (1 inch) thick, unless express written permission of the Engineer is procured.

The sod shall be approved by the Engineer prior to being cut and again before it is laid. Sod stored longer than 36 hours will not be allowed under any circumstances.

Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

755.04 SEED. Seed shall be furnished in new, clean, sealed, and properly labeled containers, either separately or mixed, as appropriate, and shall conform to the seed formula shown on the Plans. Seed that has become wet, moldy, or otherwise damaged shall not be accepted.

(a) Testing. The seed shall conform to all State and Federal regulations.

(b) Labels. Labels shall conform to all State and Federal regulations and shall be clearly marked with the following:

Seed name
Lot number
Percentage of germination
Percentage of purity
Percentage of weed seed content

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

755.05 COMPOST. Compost shall be free of weed seeds and comply with EPA requirements for compost. The compost shall have a loose and granular texture with the following characteristics or properties:

TABLE 755.05A - EPA COMPOST MATERIAL REQUIREMENTS

Physical Property	Material Requirements
Organic Matter Content	30-60%
Total Kjeldahl Nitrogen Content	0.5-2.0%
pH	6.5-7.5
Maximum Particle Size	<25 mm (1inch)
Soluble Salt Content	<5 mmhos/cm
Percentage of Human Inerts, by dry mass (weight)	<1.0%
Moisture Content	35 to 55%

Compost shall generally comprise 25 percent of the back fill material unless otherwise specified. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The compost must meet US EPA Part 503 exceptional quality concentration limits for trace elements/heavy metals.

Certification: A Type A Certification shall be furnished in accordance with Subsection 700.02.

755.06 FERTILIZER. Fertilizer, if specified, shall be a standard commercial grade dry fertilizer and shall conform to the requirements of all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists. Fertilizer shall contain not less than the minimum percentage of nitrogen, phosphoric acid, and potash shown on the Plans.

(a) Packaging. The fertilizer shall be furnished in new, clean, sealed, and properly labeled bags not exceeding 45 kg (100 pounds) each. Caked or otherwise damaged fertilizer shall not be accepted.

Labels shall be clearly marked with the following:

Manufacturer's name
Type
Mass (weight)
Guaranteed analysis

Unless otherwise specified fertilizer shall contain the following percentages by weight:

10 percent available Nitrogen (N)
10 percent available Phosphoric Acid P)
10 percent available Potassium (K)

50% available nitrogen shall be in a slow release form as is found in certain urea form products or natural organic forms or a combination of both.

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

755.07 MYCORRHIZAL FUNGI PRODUCT. Mycorrhizal fungi product, if specified on the Plans and details, shall be of granular form and shall include Mycorrhizae spores to enhance root growth, nutrient uptake, and reduce transplant shock. All Mycorrhizal fungi products shall be administered per manufacturer's recommendations. Mycorrhizal fungi product shall be one of the Mycorrhizal fungi product(s) on the Approved Products List on file with the Agency's Materials and Research Section.

755.08 AGRICULTURAL LIMESTONE. Agricultural limestone shall be a calcitic or dolomitic ground limestone containing not less than 85 percent of total (calcium or magnesium) carbonates. The limestone shall conform to the requirements of all State and Federal regulations and to the standards of the Association of Official Agricultural Chemists.

(a) Packaging. The limestone shall be furnished in new, clean, sealed, and properly labeled bags not exceeding 45 kg (100 pounds) each. Caked or otherwise damaged limestone shall not be accepted.

Labels shall be clearly marked with the following:

Manufacturer's name
Type
Mass (weight)
Guaranteed analysis

(b) Sieve Analysis. Limestone shall meet the following sieve analysis: 100 percent shall pass the 2.00 mm (No. 10) sieve with a minimum of 40 percent passing the 150 μm (No. 100) sieve.

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

755.09 LIQUID LIME. Liquid lime shall be a commercially formulated calcium carbonate lime mixture.

(a) Packaging. Labels shall be clearly marked with the following:

Manufacturer's name
Type
Mass (Weight)
Guaranteed analysis

(b) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

755.10 MULCH MATERIALS. Mulch materials shall conform to the following requirements:

(a) Hay Mulch. Hay mulch shall consist of mowed and properly cured grass or legume mowings, reasonably free from swamp grass, weeds, twigs, debris, or other deleterious material and free from rot or mold. It shall be in an air-dry condition suitable for placing with mulch blower equipment and shall be acceptable to the Engineer.

(b) Wood Chip Mulch. Wood chip mulch shall consist of hardwood chips, 3 to 6 mm (1/8 to 1/4 inch) nominal thickness, with 50 percent having an area of not less than 650 mm^2 (1 in^2) or more than 4000 mm^2 (6 in^2). All wood chip mulch shall be reasonably free from deleterious materials that are injurious to plant growth. Wood chip mulch may be used only for temporary applications for erosion prevention and tree protection during construction. Wood Chip Mulch shall not be used for landscape plantings.

(c) Bark Mulch. Mulch material used for landscape plantings shall consist of well composted shredded Cedar, Pine, or Spruce bark, 3 to 6 mm (⅛ to ¼ inch) nominal thickness, with 50 percent having an area of not less than 650 mm^2 (1 in^2) or more than 4000 mm^2 (6 in^2). All bark mulch shall be reasonably free from leaves, twigs, shavings, insect pests, eggs, larvae, or other deleterious material that is injurious to plant growth, and approved by the Engineer. The same type of material shall be used in all areas to provide visual uniformity. Bark Mulch shall

be applied as detailed in the Contract Plans and on the landscape detail sheets.

(d) Fiber Mulch. Fiber mulch shall be produced from natural or recycled (pulp) fiber, such as wood chips or similar wood materials or from newsprint, chipboard, corrugated cardboard, or a combination of these processed materials. Fiber mulch shall be free of synthetic or plastic materials, weed seed, and growth or germination inhibiting substances and shall be nontoxic to plant or animal life. Fiber mulch shall have a water-holding capacity by mass of not less than 900 percent and shall be of such character that the fiber will disperse into a uniform slurry when mixed with water. Water content of the fiber before mixing into slurry shall not exceed 12 +/- 3 percent of the dry mass of the fiber. Fiber shall have the moisture content of the fiber marked on the package. Fiber mulch shall be colored to contrast with the area on which it is to be applied, and shall not stain concrete or painted surfaces.

Acceptable Fiber Mulch shall be one of the Fiber Mulch(es) on the Approved Products List on file with the Agency's Materials and Research Section.

(e) Hydraulic Matrix. The hydraulic matrix shall consist of a mix of long strand, residual, wood fibers and a high-strength bonding agent. The matrix shall be 100% biodegradable over time, non-toxic to fish and wildlife, and it shall not contain any synthetic fibers. The hydraulic matrix shall be colored to contrast with the area on which it is to be applied, and shall not stain concrete or painted surfaces.

Acceptable Hydraulic Matrix shall be one of the Hydraulic Matrix(ces) on the Approved Products List on file with the Agency's Materials and Research Section.

(f) Tackifier. Tackifier for hay mulch may be guar based organic tackifier, starch based-agricultural tackifier or another type of mulch binder as approved by the Engineer. Tackifier for stabilization of bare soils, without mulch or other fiber incorporated, shall use materials and quantities specified by the manufacturer based on the results of soils, water, and site assessment. Tackifiers shall be nontoxic to plant or animal life and non-staining to concrete or painted surfaces. Tackifiers must be water soluble, "linear", and "non-crosslinked".

Tackifiers shall be non-combustible and shall not change soil pH.

Acceptable Tackifier shall be one of the Tackifier(s) on the Approved Products List on file with the Agency's Materials and Research Section.

(g) Straw Mulch. Straw mulch shall consist of threshed plant residue of oats, wheat, barley, rye, or rice from which the grain has been removed. The material shall be free of noxious weeds, undesirable grasses and plants, and rot or mold, and shall be approved by the Engineer prior to use.

755.11 EROSION MATTING.

(a) Temporary Erosion Matting. Temporary erosion matting shall conform to one of the following specifications and corresponding properties found in Table 755.11A. Temporary erosion matting shall be used in applications where natural vegetation will provide permanent erosion protection.

(1) Mulch Control Netting. A temporary biodegradable rolled erosion control product (RECP) composed of planar woven natural fiber.

(2) Erosion Control Blanket. A temporary all natural biodegradable rolled erosion control product composed of processed fibers mechanically bound together to form a continuous matrix.

(b) Permanent Erosion Matting. Permanent erosion matting shall be a long-term non-degradable rolled erosion control product composed of ultraviolet stabilized, non-degradable, synthetic fibers, filaments, nettings, and/or wire mesh processed into three dimensional reinforcement matrices conforming to one of the specifications and corresponding properties found in Table 755.11B. Permanent erosion matting shall be used in applications where vegetation alone will not provide sufficient long-term erosion protection.

(c) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02 for both temporary and permanent erosion matting.

TABLE 755.11A - STANDARD SPECIFICATION FOR TEMPORARY ROLLED EROSION CONTROL PRODUCTS

(For use where natural vegetation will provide permanent erosion protection)

Product Description	Material Composition	Longevity (months)	Slope Applications*		Channel Applications*	Minimum Tensile Strength[1] kN/m(lbs/ft)
			Maximum Gradient (H:V)	C Factor[2,5]	Maximum Shear Stress[3,4,6] Pa(lbs/ft^2)	
Mulch Control Nets	All natural biodegradable mesh or woven netting.	3	5:1	≤ 0.10	12 (0.25)	0.073 (5)
		12	5:1	≤ 0.10	12 (0.25)	0.073 (5)
		24	5:1	≤ 0.10	12 (0.25)	0.36 (25)
Netless Rolled Erosion Control Blankets	All natural biodegradable fibers mechanically interlocked together to form a continuous matrix.	3	4:1	≤ 0.10	24 (0.5)	0.073 (5)
		12	4:1	≤ 0.10	24 (0.5)	0.073 (5)
Single-net Erosion Control Blankets	All natural processed, biodegradable fibers mechanically bound together by a single net of yarn or twine woven into a continuous matrix.	3	3:1	≤ 0.15	72 (1.5)	0.73 (50)
		12	3:1	≤ 0.15	72 (1.5)	0.73 (50)
Double-net Erosion Control Blankets	All natural processed, biodegradable fibers mechanically bound together between two nets of yarn or twine woven into a continuous matrix.	3	2:1	≤ 0.20	84 (1.75)	1.09 (75)
		12	2:1	≤ 0.20	84 (1.75)	1.09 (75)
		24	1.5:1	≤ 0.25	96 (2.00)	1.45 (100)
		36	1:1	≤ 0.25	108 (2.25)	1.82(125)

Notes:

* "C" factor and shear stress for mulch control nettings must be obtained with netting used in conjunction with pre-applied mulch material.

1 Minimum Average Roll Values, Machine direction using Erosion Control Technology Council (ECTC) Mod. ASTM D 5035.

2 "C" Factor calculated as ratio of soil loss from RECP protected slope (tested at specified or greater gradient, h:v) to ratio of soil loss from unprotected (control) plot in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions using ECTC Test Method # 2.

3 Required minimum shear stress RECP (unvegetated) can sustain without physical damage or excess erosion (> 12.7 mm (0.5 in) soil loss) during a 30-minute flow event in large-scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using ECTC Test Method #3.

4 The permissible shear stress levels established for each performance category are based on historical experience with products characterized by Manning's roughness coefficients in the range of 0.01 - 0.05.

5 Acceptable large-scale test methods may include ASTM D 6459, ECTC Test Method # 2, or other independent testing deemed acceptable by the Engineer.

6 Per the Engineer’s discretion. Recommended acceptable large-scale testing protocol may include ASTM D 6460, ECTC Test Method #3 or other independent testing deemed acceptable by the Engineer.

TABLE 755.11B - STANDARD SPECIFICATION FOR PERMANENT ROLLED EROSION CONTROL PRODUCTS

(For applications where vegetation alone will not provide sufficient long-term erosion protection)

PERMANENT[1]- All categories of Turf Reinforcement Mat (TRM) must have a minimum thickness of 6.35 mm(0.25 inches) per ASTM D 6525 and ultraviolet stability of 80% per ASTM D 4355 (500 hours exposure).

Type	Product Description	Material Composition	Slope Applications	Channel Applications	Minimum Tensile Strength[2,3] kN/m(lbs/ft)
			Maximum. Gradient (H:V)	Maximum Shear Stress[4,5] Pa(lbs/ft^2)	
A	Turf Reinforcement Mat	Non-degradable synthetic fibers, filaments, nets, wire mesh and/or other elements, processed into a permanent, three-dimensional matrix of sufficient thickness.*	0.5:1	288(6.0)	1.82(125)
B	Turf Reinforcement Mat		0.5:1	384(8.0)	2.19(150)
C	Turf Reinforcement Mat		0.5:1	480(10.0)	2.55(175)

Notes:

* TRMs, which may be supplemented with degradable components, are designed to impart immediate erosion protection, enhance vegetation establishment and provide long-term functionality by permanently reinforcing vegetation during and after maturation. Note: TRMs are typically used in hydraulic applications, such as high flow ditches and channels, steep slopes, stream banks, and shorelines, where erosive forces may exceed the limits of natural, unreinforced vegetation or in areas where limited vegetation establishment is anticipated.

1 For TRMs containing degradable components, all property values must be obtained on the non-degradable portion of the matting alone.

2 Minimum Average Roll Values, machine direction only for tensile strength determination using

ASTM D 6818 (Supersedes Mod. ASTM D 5035 for RECPs).

3 Field conditions with high loading and/or high survivability requirements may warrant the use of a TRM with a tensile strength of 44 kN/m(3,000 lb/ft) or greater.

4 Required minimum shear stress TRM (fully vegetated) can sustain without physical damage or excess erosion [>12.7 mm (0.5 in.) soil loss] during a 30-minute flow event in large scale testing. These performance test values should be supported by periodic bench scale testing under similar test conditions and failure criteria using ECTC Test Method #3.

5 Acceptable large-scale testing protocol may include ASTM D 6460, ECTC Test Method #3, or other independent testing deemed acceptable by the Engineer.

755.12 PLANT MATERIALS. Plant materials shall conform to the following requirements:

(a) Quality of Plant Material.. All plants shall be first-class representatives of their normal species or varieties, unless otherwise specified as extra heavy or clump according to the particular exception.

All plant materials shall be nursery grown stock that have been transplanted or root-trimmed two or more times, according to the kind and size of plants. They shall have average or normal, well developed branches, together with vigorous root systems. Plant materials shall be free of insects, disease, sun scald, injuries, abrasions of the bark, knots, dead or dry wood, broken terminal growth, or other objectionable disfigurements. Thin, weak plants shall not be acceptable. Plant materials shall display the appearance of normal health and vigor in strict accordance with these Specifications.

Each shipment shall be accompanied by a description of all the included plant materials or an itemized bill of lading.

All plant materials furnished by the Contractor shall be grown within hardiness Zones 1 through 4 as established by The Arnold Arboretum (in Jamaica Plain, MA) and the plant suppliers shall certify that the stock has been grown under Zone 4 or hardier conditions. Plants that are not certified to have been grown under the designated hardiness zone conditions will not be accepted.

(b) Plant Names. All scientific and common plant names of the items specified shall conform to the latest edition of *Standard Plant Names*, as adopted by the American Joint Committee on Horticultural Nomenclature. All plant materials delivered shall be true to name and legibly tagged with the names and sizes of materials. Should it be necessary to substitute a plant or plants of a different variety than the plant material specified, it will be necessary for the Contractor to secure written approval from the Engineer for the proposed substitution prior to digging the plants. An approved substitute plant shall be of a value at least equal to the specified plant for which the substitution is being made and then only when sufficient evidence is shown that the plant specified cannot be obtained.

(c) Grading Standards. Grading of plant materials shall be accomplished according to ANSI Z60.1-2004 *American Standard for Nursery Stock* as approved by ANSI and published by the American Association of Nurserymen, Inc.

All plant measurements shall be made in conformance with the standard measurement methods in ANSI Z60.1-2004.

If balled and burlapped trees and shrubs are not available, container grown trees and shrubs may be supplied in accordance with the requirements and limitations of ANSI Z60.1-2004; however, all plants supplied shall be of the minimum size listed on the quantity sheet.

Unless designated multi-stemmed, the trunk of each tree shall be a single trunk growing from a single unmutilated crown of roots. The tree trunks shall be free from sunscald, frost cracks, or wounds resulting from abrasions, fire, or other causes. No pruning wounds shall be present having a diameter exceeding 50 mm (2 inches) and all allowable pruning wounds must show vigorous bark on all edges. Trees shall not be pruned prior to delivery. No trees with double-leaders or twin-heads shall be acceptable without the written approval of the Engineer. The

Contractor shall reject such plants at time of delivery by the nursery/supplier unless such plants were previously selected by the Engineer as marked by tags and seals.

The height and spread of each shrub shall correspond to the specifications for Type 0 through Type 3 in ANSI Z60-2004. Single stemmed or thin plants will not be accepted. The side branches shall be generous, well-twigged, and the plant, as a whole, well-branched to the ground. The plants shall be in a moist vigorous condition, free from dead wood, bruises, or other root or branch injuries. Plants shall not be pruned prior to delivery.

Vines and ground cover plants shall be of the size, age, and condition listed in the quantity sheet. Plants shall be healthy and free of insects and diseases. Ground cover plants shall be potted or in soil.

Container grown stock shall have been grown in a container long enough for the root system to have developed sufficiently to hold its soil together, firm and whole. No plants shall be loose in the container. No plants shall be root bound in the container. Such plants shall be rejected at delivery by the Contractor.

Plants delivered by truck and plants requiring storage on-site shall be properly wrapped and covered to prevent wind-drying and desiccation of branches, leaves, or buds. Plant balls shall be firmly bound, unbroken, and reasonably moist to indicate watering prior to delivery and during storage. Tree trunks shall be free from fresh scars and damage in handling. No plant material from cold storage will be accepted.

Evergreens shall be quality evergreens with a well-balanced form complying with the relationship requirements of ANSI Z60.1.

(d) Nursery Inspection and Plant Quarantine. All plant materials shall be free from plant diseases and insect pests. All shipments of plants shall comply with all nursery inspection and plant quarantine regulations of the State of origin and the State of Vermont, as well as with Federal regulations governing interstate movement of nursery stock. A certificate of inspection shall accompany each package, box, bale, or carload of plant materials delivered and shall be provided to the Engineer.

The Contractor shall provide the Engineer with a copy of the installing Landscaper's License from the Vermont Department of Agriculture. Also, the Contractor shall provide the Engineer with a copy of the Nursery License and a copy of the Certificate of Nursery Inspection of each supplying nursery.

Particular attention is directed to the provisions of Title 6 VSA, Chapter 89 - Nursery Inspection, regarding the inspection of nurseries and nursery stock, and Vermont Department of Agriculture regulations regarding dealer's certificates.

(e) Balled and Burlapped Plants (B & B). Balled and burlapped plants shall be dug so as to retain as many fibrous roots as possible, and shall come from soil which will form a firm ball. The soil in the ball shall be the original and undisturbed soil in which the plant has been grown. The plant shall be dug, wrapped, transported, and handled in such manner that the soil in the ball will not be so loosened that it would cause stripping of small and fine feeding roots, or cause the soil to drop away from such roots.

All plants shall be moved with the root systems as solid units with balls of earth firmly wrapped with untreated burlap, Class 2, 248 g/m (8 ounces per yard), firmly held in place by a stout cord or wire. The diameter and depth of the balls of earth shall be sufficient to encompass the fibrous and root feeding system necessary for the healthy development of the plant and in accordance with ANSI Z60.1. No plant shall be accepted when the ball of earth surrounding its roots has been badly cracked or broken preparatory to the process of planting or after the burlap, staves, ropes, or platform required in connection with its transplanting have been removed. The plants and balls shall remain intact during all operations. All plants that cannot be planted at once shall be heeled in by setting in the ground and covering the balls with soil and then watering them.

Any B & B designated plant material arriving at the project with broken or loose balls or balls manufactured on the root will not be acceptable and shall be rejected at delivery by the Contractor.

(f) Certification. A Type A Certification shall be furnished in accordance with Subsection 700.02.

The plants shall be certified to have been grown under Zone 4 or hardier conditions, unless otherwise specified. A copy of this certification shall accompany each shipment of plant material and a copy of each shipment certification shall be attached to the Type A Certification submitted for the project. The certifications shall be identified in such a manner as to be directly traceable to the individual shipments.

755.13 ANTIDESICCANT. Antidesiccant shall be an approved emulsion that will provide a film over plant surfaces permeable enough to permit transpiration. An antidesiccant shall be used only after its use has been approved by the Engineer.

755.14 WIRE RODENT GUARDS. Wire rodent guards shall be galvanized steel wire fabric with 6 mm (1/4 inch) square openings and shall be of good commercial quality.

755.15 PLANT WRAPPING. Plant wrapping material shall be an approved waterproof paper in 100 mm (4 inch) wide rolls or an approved burlap in 150 mm (6 inch) wide rolls.

755.16 TREE WATERING BAGS. Tree watering bags are available in varying sizes and can be used together to accommodate tree trunk diameters. These waterproof bags are made of reinforced, UV treated polyethylene, reinforced with nylon webbing and are secured to the tree using heavy duty zippers located on each side of the bag. The adjustable drip holes at the base allow for water to flow at varying rates for specific needs.

Tree watering bags are on the Approved Products List on file with the Agency's Materials and Research Section.

755.17 EROSION LOGS. Erosion logs shall be composed of woven coir, straw, or excelsior or other biodegradable filtering medium encased in photo degradable and/or biodegradable netting, having varying strengths for differing conditions.

755.18 LIVE FASCINES. Live fascines shall consist of long bundles of live branch cuttings. Live fascines shall be prepared from freshly cut dormant plants. No leaf buds shall have initiated growth beyond 6 mm (1/4 inch) and the cambium layer of each cutting shall be moist, green, and healthy.

755.19 LIVE STAKES. Live stakes consist of branch cuttings from freshly cut dormant plants. Live cuttings shall be 12 to 25 mm (1/2 to 1.0 inch) diameter and 0.3 to 1.2 m (1 to 4 feet) long. Live stakes shall be 26 to 50 mm (1 to 2 inches) or 51 to 100 mm (2 to 4 inches) diameter and 1.5 to 1.8 m (5 to 6 feet) long. No leaf buds shall have initiated growth beyond 6 mm (1/4 inch) and the cambium layer shall be moist, green, and healthy. The live stakes shall have side branches cleanly removed and with the bark intact. The basal ends shall be cut at an angle for easy insertion into the soil and the top cut square.

See contract documents for plant species, size, spacing, and planting season specifications.

Plant material substitutions shall be approved by the Engineer prior to delivery to the project site.

755.20 BRUSH LAYERING. The branch cuttings shall be from freshly cut dormant plants. No leaf buds shall have initiated growth beyond 6 mm (1/4 inch) and the cambium layer shall be moist, green, and healthy. Live branch cuttings shall range from 12 to 50 mm (1/2 to 2 inches) in diameter and be long enough to reach the back of the bench. Side branches shall remain intact for installation.

Plant species, size, and planting season shall be as specified in the Contract Documents.

Plant material substitutions shall be approved by the Engineer prior to delivery or on-site harvesting.

SECTION 780 - CONCRETE REPAIR MATERIALS

780.01 GENERAL REQUIREMENTS.

(a) Packaging. The manufacturer's product designation and recommendations for surface preparation, mixing, placing, finishing, and curing shall be clearly outlined on the product packaging. Handling precautions and toxicity warnings shall be printed on all containers. The expiration date and a lot number shall appear on each package of material delivered to the project site. Liquid components which have been frozen shall not be used.

(b) Sampling and Testing. Upon request, the Materials and Research Section will furnish a list of products that have been tested and are considered satisfactory. Should the Contractor wish to use a product not included on the Approved Products List, he/she may submit an alternate product. Application for material approval shall be submitted to the Materials and Research Section accompanied by a 45 Kg (100 lb.) sample of the product and complete material safety information. Upon approval, the product name and manufacturer will be placed on the Agency's Approved Products List. A minimum period of two months shall be allowed for testing purposes.

780.02 OVERHEAD AND VERTICAL CONCRETE REPAIR MATERIAL. Overhead and vertical concrete repair material shall be a prepackaged material to be used for patching spalled areas of concrete that are either on vertical or overhead surfaces. Its use shall be limited to patches with an average layer thickness of 37.5 mm (1-1/2 inches) on vertical repairs and 25 mm (1 inch) on overhead repairs, as directed by the Engineer.

The product shall meet the following requirements:

(a) Compressive Strength. The neat material shall exhibit a minimum seven day compressive strength of 13.8 MPa (2000 psi) and a minimum twenty-eight day strength of 27.6 MPa (4000 psi) when tested in accordance with AASHTO T 106M/T 106.

(b) Flexural Bond Strength. The material shall exhibit a minimum bond strength of 1 MPa (150 psi) when tested in accordance with Vermont Agency of Transportation MRD-3.

(c) Freeze-Thaw Durability. Resistance to rapid freezing and thawing shall be determined in accordance with AASHTO T 161 using Procedure A (Modified) for use of a 3% Sodium Chloride solution. The material shall exhibit no more than an 8% loss in weight after 300 cycles.

(d) Volume Stability. The material shall exhibit expansion of not more than 0.40% and shrinkage of no more than 0.05% when tested in accordance with ASTM C 1090.

(e) Placement. The material shall be capable of being placed in layers of at least 25 mm (1 inch) for overhead applications without the use of form work or anchoring devices.

(f) Color and Texture. The material shall produce a finished patch of the same color and texture as the existing surface to the satisfaction of the Engineer.

780.03 RAPID SETTING CONCRETE REPAIR MATERIAL. Rapid setting concrete material shall be a prepackaged material to be used for patching horizontal concrete surfaces where rapid return of the structure to service is necessitated.

The product shall meet the following requirements:

(a) Compressive Strength. The neat material shall exhibit a minimum two hour compressive strength of 8.3 MPa (1200 psi) and a seven day compressive strength of 34.5 MPa (5000 psi) when tested in accordance with AASHTO T 106M/T 106.

(b) Time of Setting. When tested in accordance with AASHTO T 131 (Modified), the initial time of set shall not be less than 15 minutes.

(c) Freeze-Thaw Durability. Resistance to rapid freezing and thawing shall be determined in accordance with AASHTO T 161 using Procedure A (Modified) for use of a 3% Sodium Chloride solution. The material shall exhibit no more than an 8% loss in weight after 300 cycles.

(d) Volume Stability. The material shall exhibit expansion of not more than 0.4% and shrinkage of no more than 0.05% when tested in accordance with ASTM C 1090.

(e) Flexural Bond Strength. The material shall exhibit a minimum bond strength of 0.7 MPa (100 psi) without the use of a special bonding agent when tested in accordance with Vermont Agency of Transportation MRD-3.

780.04 RAPID SETTING CONCRETE REPAIR MATERIAL WITH COARSE AGGREGATE. Rapid setting concrete material to contain coarse aggregate shall be a prepackaged material to be used for patching horizontal concrete surfaces where rapid return of the structure to service is necessitated. This material shall be formulated for the optional addition of 9.5 mm (3/8 inch) coarse aggregate to produce a rapid setting concrete mixture.

In addition to the material requirements of Subsection 780.03, the product shall meet the following requirements:

(a) Compressive Strength. The neat material plus coarse aggregate shall exhibit a minimum four hour compressive strength of 13.8 MPa (2000 psi), a one day compressive strength of 20 MPa (2900 psi), and a seven day compressive strength of 34.5 MPa (5000 psi) when tested in accordance with AASHTO T 22.

(b) Time of Workability. Time of workability as observed under laboratory conditions shall not be less than 15 minutes.

(c) Freeze-Thaw Durability (Concrete Specimens). Resistance to rapid freezing and thawing shall be determined in accordance with AASHTO T 161 using Procedure A (Modified) for use of a 3% Sodium Chloride solution. The concrete shall exhibit no more than an 8% loss in weight after 300 cycles.

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