

ITEM 201 CLEARING AND GRUBBING

DESCRIPTION:

This work shall consist of clearing, grubbing, removing and disposing of all trees, brush; stumps, fences, debris, and miscellaneous structures not covered under other contract Items within the construction area and such other areas as specified or directed. The Contractor shall clear such additional areas within the limits of the right-of-way and easement lines as specified or directed. Included in this work shall be the protection, preservation from injury or defacement of vegetation and objects designated to remain.

CONSTRUCTION DETAILS:

Within the excavation lines all trees shall be cut off and stumps removed, unless ordered otherwise by the Engineer.

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

The Contractor shall carefully prune all branches of trees less than sixteen (16) feet above any part of the site including selective trimming of such trees as directed and all branches which have been broken or injured during construction. Fresh scars and wounds shall be painted with approved tree paint.

Whenever trees are felled or trimmed on/or adjacent to travel way, all wood shall be immediately removed from the roadway or any area that would present a hazard to traffic. Grubbed stumps shall be moved immediately at least thirty (30) feet from the edge of pavement.

Trees removed from private property during the course of construction shall be cut into firewood lengths and neatly piled adjacent to the site of removal or as directed by the property owner. Wood remaining after expiration of one week following removal or not required by the property owner shall become the property of the Contractor and properly disposed of off the project site.

All trees, stumps, etc., shall become the property of the Contractor and be removed from the project site and disposed of in a satisfactory manner. All rubbish and refuse shall be removed from the project limits. **NO BURNING** will be allowed on the contract site.

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

All fences, railings, stonewall fences and ornamental and utilitarian domestic accessories, such as but not limited to garden pools, arbors, fireplaces, sheds and incinerators, within the roadway limits shall be removed as directed. However, the removal of materials in stonewalls, that are to be removed and not used in new stonewall fences; will be paid for according to the provisions of Item 202, Excavation and Embankment.

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

MEASUREMENT:

When no price for "Clearing and Grubbing" is asked for on the proposal form, the cost of the work as described above shall be included in the cost of other Items and no direct payment for "Clearing and Grubbing" will be made.

When a price is asked for on the proposal form on a lump sum basis, this shall include all the work as described above which may be necessary to properly complete the project. Should the project be increased in length or the scope of work increased due to construction changes beyond the requirements hereinabove, any additional work required will be paid for as extra work. Should the project be decreased in length, a suitable credit mutually agreed upon and based on the reduction in actual work or scope may be taken by the Authority upon approval of written documentation by the Contractor.

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

PAYMENT:

Payment for this work will be at the contract lump sum price bid for Item 201 - Clearing and Grubbing, except as noted above, and shall include all equipment, tools and labor incidental to the satisfactory completion of this Item. All costs incidental to the disposal of trees, stumps, etc., will be included in the unit price bid for "Clearing and Grubbing".

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
201	Clearing and Grubbing	Lump Sum

ITEM 202 EXCAVATION AND EMBANKMENT

DESCRIPTION:

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

CLASSIFICATION:

Roadway excavation shall be classified for the purpose of payment as "Earth Excavation", "Rock Excavation", or "Unclassified Excavation", in accordance with the following definitions. The classifications applying to any particular project shall be indicated on the list of Items within the bid proposal.

Earth Excavation shall include the removal from existing grade to subgrade as indicated on the Contract Drawings or directed, or all earth, muck, so-called hardpan, loose, disintegrated or decomposed ledge rock, concrete sidewalks, concrete curb, topsoil, sod, pavement (except pavement included under the Items "Rock Excavation"). Earth Excavation includes similar materials which are sufficiently soft to permit removal by normal earth excavation machinery and methods, or which can be loosened by the use of a suitable "ripper". A suitable "ripper" is defined as a hydraulically-controlled steel tooth mounted on mechanical equipment of the proper size, type and power to perform the required excavation. Earth Excavation shall not include water or "Rock Excavation". Earth excavation shall also include the removal of topsoil, as directed, from embankment areas.

Rock Excavation shall include rock in definite ledge formation, severed or fragmented rock and boulders or the portions thereof, one (1) cubic yard, or more, in volume, that cannot be removed by means of a "ripper" as previously defined herein, in good condition and properly operated, without continuous drilling, blasting, barring and/or wedging. It shall also include the removal of concrete and cement masonry structures as may be required. It shall further include concrete pavement and concrete base (excluding any bituminous surfacing material thereon) or over (1) cubic yard in volume. Un-reinforced, fractured concrete pavement with individual sections less than one (1) cubic yard in volume will not be paid for as Rock Excavation.

Excavation of temporary watercourses for stream diversion as required for construction under this contract will not be measured for payment unless specifically indicated on the Contract Drawings or elsewhere within the Contract Documents.

Unclassified Excavation shall include any and all "Earth" and "Rock" as classified herein removed as indicated or directed. When only the Item for "Unclassified Excavation" appears on the proposal form, payment will be made under this Item only; and no compensation will be made under any of the other classifications given hereinabove.

Embankment shall include the construction of embankments with suitable materials obtained from the various proposal items of excavation. The cost of embankment construction shall be included in the unit prices bid for the Excavation Items.

When the amount of usable material excavated within the work contracted for is not sufficient to form the embankments, additional material shall be furnished from borrow/selected borrow pits obtained by and at the expense of the Contractor and located beyond the limits of the project. Prior to utilization of Item 207, Borrow/Selected Borrow by the Contractor, written authorization must be obtained from the Engineer.

CONSTRUCTION DETAILS:

Excavation shall be made in conformity with the requirements of the plans and as ordered by the Engineer. The Contractor shall, when necessary in excavation areas, provide and maintain ditches which are adequate to prevent free water from becoming incorporated in material to be used to form embankments, such ditching to be at the sole expense of the Contractor. Where buildings have been removed to clear the way for construction or where old foundations, concrete or masonry walls exist, they shall be removed to four (4) feet below the directed or finished grading; and all cellar and other holes shall be filled with suitable material.

1. Sod and other organic matter shall be used as "Surplus Excavated Material" or disposed of as "Unsuitable Material" at the discretion of and as directed by the Engineer.
2. Frozen material, otherwise suitable for formation of embankments, shall be placed on embankment slopes or disposed of as directed by the Engineer. The Engineer may direct the removal of any portion of an accepted layer which has become frozen after placement and compaction. This frozen material shall be placed on embankment slopes or disposed of as directed by the Engineer. The removal and placement of frozen material shall be at the sole expense of the Contractor.
3. Topsoil shall be excavated within pavement and shoulder limits at grade points and to an elevation 3 feet below finish grade and elsewhere as directed. The material excavated may be used in the construction of embankments, if permitted by the Engineer, and shall be thus used if the Engineer so directs. In all cases, the use of topsoil in constructing embankments shall be restricted to locations where the surface of

the underlying material is dry, its distance above the free water surface at the time of filling is more than 3 feet, and its distance below finish pavement grade is more than 5 feet.

4. Excavation of Rock: When bedrock is encountered, it shall be excavated to the slope lines and depth indicated on the plans. When rock is encountered within the roadway area it shall be removed to a depth of one foot below the top of subgrade. The Contractor shall presplit bedrock, and all presplitting, hole drilling and blasting shall be performed strictly in accordance with the State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction, Form 816.

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

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

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

5. Placement of Excavated Material: All excavated material shall be used in the formation of embankments, except as provided elsewhere herein or as ordered by the Engineer.

Rock removed from within the roadway area shall be replaced with suitable excavated material, approved by the Engineer, to the subgrade elevation.

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

Embankments shall be constructed of earth, rock, or a mixture of earth and rock. The embankment shall be constructed by depositing successive layers of fill for the full width of the embankment, unless a partial width is permitted by the contract documents or by the Engineer. No embankment layer shall be deposited on surfaces of snow or ice, nor shall it be placed on frozen or unstable surfaces except under the conditions permitted elsewhere herein. If the Contractor is permitted to continue work, any frozen embankment material unless otherwise directed by the Engineer shall be removed, at no cost to the Authority.

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

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

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

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

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

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

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

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

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

Wherever portions of existing bituminous concrete pavement are to be removed they

shall be removed to neat lines. The areas in which such bituminous concrete surfaces are to be removed will be delineated on the plans or by the Engineer before the work is done. The line of delineation shall be cut by a method approved by the Engineer.

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

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

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

No stone over 5 inches in its greatest dimension shall be placed within 12 inches of the elevation of the top of the prepared subbase unless otherwise specifically authorized.

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

The dry density after compaction shall not be less than 95 percent of the dry density for the soil when tested in accordance with AASHTO T 180, Method D, except that the mold used in the test shall be 6.11 inches high. Correction for particles retained on the $\frac{3}{4}$ inch sieve shall be as specified in AASHTO Method T-224.

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

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

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

Any surplus or unsuitable material not required, nor permitted to be used for such purposes, shall be disposed of in accordance with the requirements hereinafter specified for "Disposal of Unsuitable Material".

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

10. Disposal of Unsuitable Material: The Contractor shall dispose of trees, stumps, logs, woody vegetation and unsuitable excavated material by removing such material from within the limits of the project and disposing of such material at point or points as the Contractor shall determine off the project, subject to the approval of the Engineer.

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

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

12. Pavement Removal: Pavement to be removed shall be cut uniformly along the lines shown on the Contract Drawings or as directed by the Engineer.

Concrete pavement and/or bases shall be cut with an approved concrete saw through a minimum of one third of the depth of pavement/base.

Bituminous pavement/base to be removed shall be cut by pneumatic hammer with a clay spade, saw or other approved methods.

After the pavement has been cut, care shall be exercised by the Contractor during breaking and removal of the pavement in order that the adjacent pavement outside the cut will not be damaged.

The Contractor shall remove the excavated pavement from the site and dispose of at a disposal area supplied by the Contractor at no additional cost to the Authority; or the Engineer may direct the Contractor to incorporate this material in other parts of the work.

No sections or pieces of pavement shall be used for trench backfill and all such material shall be kept separate from other excavated materials.

No measurements or separate payment will be made for the work under this section; the costs shall be included in the unit price bid per cubic yard for item 202.01, Excavation and Embankment – Earth.

MEASUREMENT:

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

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

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

Payment lines for rock excavation, where presplitting bedrock is not required by these specifications, shall coincide with the depth shown on the plans or to the depth directed and payment lines for the slopes will be extended to a limit of one foot (1') outside of and parallel to the slope lines shown on the plans, or as directed, to include rock actually removed within this limit

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

Where removal of rock is necessary for reason of safety or due to conditions clearly not attributable to the Contractor's methods of operation, the payment lines for rock excavation where presplitting is required will be fixed to coincide with limits ordered by the Engineer.

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

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

Existing concrete and cement masonry structures over one (1) cubic yard, shall be measured in place before removal. Payment lines for unclassified excavation shall be the same as those outlined above for the type of material encountered.

When rock is encountered, and its removal is to be paid for as "Rock Excavation" the Contractor shall strip or expose the rock to such an extent that in the Engineer's opinion the necessary measurements can be taken. The Contractor shall notify the Engineer at least 2 days prior to distributing any of the rock to allow ample time to obtain the necessary measurements. If the Contractor shall fail to give such notice, or remove any rock prior to the taking of the measurements, the Engineer shall presume that measurements taken at the time they first see the material in question will give a true quantity of excavation.

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

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

The cutting of bituminous concrete pavement will not be measured for payment.

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

PAYMENT:

Roadway excavation will be paid for at the contract unit price per cubic yard for "Earth Excavation", "Rock Excavation", or "Unclassified Excavation", as the case may be, in accordance with the classification given herein and subject to the method of measurement described above. The price shall include all equipment, tools and labor incidental to the completion of the excavation, the formation and compaction of embankment, and the disposal of surplus or unsuitable material in accordance with the provisions of the plans and of these specifications. No direct payment will be made for the formation of embankments under this item.

When the amount of usable material excavated within the work contracted for is not sufficient to form the embankments, additional material shall be furnished by the Contractor from borrow/selected borrow pits obtained by and at the expense of the Contractor and located beyond the limits of the project. Payment will be made for at the contract unit price bid per cubic yard for Item 207, Borrow/Selected Borrow.

The removal of concrete or cement masonry structures over one cubic yard, other than retaining walls or bridge structures, will be paid for at the contract unit price per cubic

yard for “Rock Excavation” or “Unclassified Excavation”, as the case may be.

The removal of drainage structures outside of the limits of Roadway and Structure Excavation will be paid for under the “Trench Excavation” Items.

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

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

The removal of all pavement or pavement bases will be paid for at the contract unit price per cubic yard for “Earth Excavation” unless specified otherwise, or “Unclassified Excavation, as the case may be.

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

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

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
202.01	Earth Excavation	Cubic Yard
202.02	Rock Excavation	Cubic Yard
202.03	Unclassified Excavation	Cubic Yard

ITEM 205 TRENCH EXCAVATION AND BACKFILL

DESCRIPTION:

The Work under this section consists of the removal of all materials, the disposal of all surplus or unsuitable material, dewatering, temporary stream or groundwater diversion, backfilling and compaction necessary for the construction of the Work in the locations and to the dimensions as shown on the Contract Drawings or as directed by the Engineer all in accordance with these specifications for the construction of water mains, sanitary sewers, storm sewers, sanitary force mains, under-drains, service laterals, catch basins, drop inlets, manholes, pipe culverts, service pipes, utilities, conduits and related work. Included also is all Work required for the sealing and removal of underground storm or sanitary sewers, and appurtenant structures (catch basins, manholes, etc.) and utility structures and appurtenances not to be replaced or not removed under other Items of Work. Where required, the Work shall also include the removal of abandoned underground tanks, pipelines, etc.

CLASSIFICATIONS:

- A. Earth - Shall include all earth, muck, mud, swamp, bog, peat, hardpan, ledge rock (loose, disintegrated or decomposed), bituminous and concrete pavements (unless noted otherwise), topsoil, sod and similar materials which are sufficiently soft to permit; removal by normal earth excavation machinery and methods
- B. Rock - Shall include rock in definite ledge formation, and severed or fragmented rock that cannot be removed by means of a shovel or backhoe (min. size $\frac{3}{4}$ cy bucket) suitably powered, in good running condition, and properly operated, without continuous drilling, blasting, barring, wedging, and boulders or portions thereof of one cubic yard or more in volume, and concrete and cement masonry structures (not specified to be removed under other Items of work). A suitable "shovel" or "backhoe" is defined as equipment of the proper type size and power to perform the excavation required.
- C. Unsuitable - Shall include all "Earth" as classified above ordered removed from below the bottom of the trench as defined in the Contract Documents.
- D. Unclassified - Shall include all "Earth", "Rock", and "Unsuitable" material excavation.

CONSTRUCTION DETAILS:

Trench excavations shall be made in conformity with the requirements of the Contract Documents or as ordered. The Contractor shall furnish and employ such support systems, pumps, etc. as described herein under "Trench and Excavation Support Systems" and other items, as may be necessary for the safe and proper completion of work, protection of property and the safety of the public, employees of the Contractor,

the Authority and the Engineer; all in accordance with the current regulations of the applicable Safety Code and pertinent local/state ordinances and regulations and as specified elsewhere within the Contract Documents. The words sewer, pipe, culvert and conduit are used interchangeably herein.

After the excavation is completed, the Contractor shall notify the Engineer. No bedding material, masonry, pipe or any other material shall be placed in the excavated area until the Engineer has approved the depth of excavation and the suitability of the foundation material.

The length of 100 feet shall be the maximum amount of trench opened at one time, or such length as the Engineer considers reasonable and necessary. Rock excavations shall be 20 feet in advance of pipe at all times. All blasting operations shall be conducted in strict accordance with local/state ordinances and regulations, the applicable Safety Code and as specified under "Blasting and Explosives" of the Supplemental General Conditions.

Unless otherwise specified, trenches shall not be wider than the horizontal limits permitted from the elevation of the trench bottom to one (1) foot above the top of the pipe.

Whenever a stub for a proposed sewer, a service lateral, an extension of a sewer or a service chimney is built in rock, the rock shall be excavated not less than five (5) feet beyond the end of the stub, lateral or extension and in the case of a service chimney at right angles to the trench.

The Contractor shall at all times keep the excavation free from water. The water shall be disposed of by the Contractor in accordance with the Contract Documents and applicable permits, laws and regulations.

The Contractor shall provide all necessary pumps, dams, drains, ditches, flumes, well points, cofferdams and other means for excluding water from the trenches, tunnels and other parts of the work, and for preventing the slopes from sliding or caving, and shall satisfactorily remove all water which interferes with the work. The Contractor shall sufficiently dewater all trenches to completely dry out and solidify the foundation below the bottom of the pipe/structure to whatever depth is necessary below the bottom of the pipe/structure to provide a firm, solid, completely dry foundation on which to lay the pipe or construct the structure.

The flow of all sewers, drains, service laterals, utility lines and laterals and water courses shall be maintained and provided for by the Contractor without damage or nuisance to other parties. All connections shall be restored as ordered. Before any bedding material, masonry is placed or any pipe is laid, suitable drains shall be provided as needed and maintained in order that the trench bottom shall be free from water and sufficiently dry at all times. No pipe shall be laid in water. Water shall not be permitted to rise to the level of the bottom of the pipe until such time as it has been inspected as

to acceptability, compaction, bedded and the trench properly backfilled. No masonry of any kind laid in cement mortar shall be placed in water. No water shall be allowed to flow over or rise upon fresh concrete or mortar, and no water shall be allowed to enter the pipe until such time and under such conditions as the Engineer shall approve (never for Water Mains).

It shall be the responsibility of the Contractor to maintain and protect the pipe at all times during the work. Any displacement or damage sustained by the pipe or appurtenant structures as the result of inadequate drainage protection during construction shall be the sole responsibility of the Contractor. The Contractor shall be required to restore any pipe or appurtenant structure so displaced without additional compensation.

Except as otherwise provided, no direct payment shall be made for the work of dewatering as specified above or herein, but compensation for such work and all expenses incidental thereto shall be considered as having been included in the prices submitted for the appropriate Items.

Where the soil in the bottom of the trench is found to be soft or loose or in anyway unsuitable, the Engineer may order it removed and replaced with "Gravel Fill", "Borrow", or any other material that the Engineer considers suitable.

Backfill on both sides of pipe and up to a depth of 1 foot over top of pipe shall be placed carefully in layers, 4 inches to 6 inches thick, and each layer will be tamped and compacted before the next layer is placed. Care must be taken that the fill is made compact and tight under the pipes. No payment will be made for such backfill material or the disposal of the excavated soil.

The Engineer is not under any obligation to order "Borrow" or other suitable material to be used as backfill when in their opinion, the inorganic soils from the excavation can, by utilization of drying or re-handling procedures, be utilized as suitable backfill.

All excavated material shall be so placed as not to endanger the work and to give free access to all flow control devices, hydrants, gates and pipe in the vicinity. All excavated materials shall be kept neatly piled at the side of the trench. Bridges or fences shall be constructed so as to inconvenience the adjoining property owners and the traveling public as little as possible.

Rock excavation, boulders and other excavated material, which, in the opinion of the Engineer, cannot be used as backfill shall be used in other portions of the Work as directed by the Engineer or if not so directed shall be removed from the site and disposed of by the Contractor at a disposal site supplied by the Contractor at no additional cost to the Authority.

The site of the Work will be cleaned of all rubbish and surplus or unsuitable materials and promptly restored as specified elsewhere in the Contract Documents as backfilling

proceeds and work progresses. Pavements adjacent to the site of the work shall be constantly swept so as to prevent scarring of the pavement by scattered stones.

No separate payment shall be made for clean up or removal of unused materials.

TRENCH AND EXCAVATION SUPPORT SYSTEMS:

A. The Contractor shall provide a support system as necessary and in a manner that complies with the applicable Safety Code. The system shall be adequate to support earth and groundwater pressures; accommodate traffic; permit access to adjacent occupied properties; protect adjacent buildings, pavements, structures and all existing utilities; provide an opening of proper depth and width in which to install the proposed pipes and other underground structures; and protect the workmen, subcontractors and employees of the Authority and Engineer, and the public, from death or injury from bank failure, earth collapse or earth movement of any nature.

Generally, all trenches and excavations over 5 feet in depth, any other unstable excavations or excavations in unstable material, shall be protected against the hazard of collapse.

The Contractor shall be entirely and solely responsible for the adequacy and sufficiency of the system and of all steel sheet piling, timber sheet piling, steel plates, bracing, shoring, underpinning, coffer-damming, etc. The Contractor shall assume the entire responsibility for damages due to injury to persons or damage to adjacent pavements and public and private property (including but not limited to the Work under construction, existing buildings, facilities, etc.) if such injury or damage results directly from said Contractor's failure to install an adequate and sufficient support system.

The support system may be left-in-place at the option of the Contractor to serve its own interest, to protect existing facilities, the Work built or to be built under this Contract, or for the safety of the public, etc., at no cost to the Authority.

It is expressly understood and agreed that removing or leaving-in-place the support system, shall not relieve the Contractor from any responsibility for any loss or damage whatever due to omission of or failure of the system.

The Contractor may, with the approval of the Engineer, lay back slopes in accordance with the provisions of the applicable Safety Code in order to avoid the necessity for a support system or limiting the quantity thereof. However, in the case of trenches, the toe of this slope will not be lower than one (1) foot above the top of the pipe to be installed. A level bench of at least two (2) feet in width shall be maintained between the toe of the sloped section and vertical trench excavation for pipes with an outside diameter of six (6) feet, a minimum four (4) foot bench shall be provided.

If the Contractor chooses to lay back slopes to avoid or limit the necessity for a support system, the payment limits for trench excavation will not be increased, and all additional work will be done without added compensation.

Portable trench boxes or sliding trench shields designed solely for the protection of personnel are not acceptable as support systems for utility trenches. The support system must be designed to support the undisturbed face of the trench or excavation.

B. Bracing, shoring, sheeting and other supports, shall be in conformance with the requirements of the applicable Safety Code.

All steel sheet piles shall be continuous and interlocking with materials conforming to the provisions of ASTM Specification A-328 as amended or superseded or equal.

C. Unless expressly authorized by the Engineer, sheeting shall be advanced ahead of the excavation. If it is necessary to excavate below the sheeting to facilitate its advancement, care shall be taken to prevent voids behind the sheeting but if the voids are formed, they shall be promptly filled with approved material and compacted to the satisfaction of the Engineer

Pilot cuts for trenches/excavations shall not exceed five (5) feet at any time.

The Engineer may reduce the depth of the pilot cut should the soil and subsurface conditions warrant such action. Sheet piling must be driven by drop hammer or other methods approved in writing by the Engineer below the area of the pilot cut. Driving of sheet piling above the pilot cut is subject to the directions of the Engineer. The Engineer may direct the Contractor to use other types of equipment, and to revise the procedure during the excavation of the pilot cut and the driving of the sheet piling should it be found necessary to do so

Vibratory driving hammers may NOT be used unless specifically authorized by the Engineer.

If sheeting is to be removed, the backfilling, in accordance with sections "Trench Excavation and Backfill" or "Structure Excavation", shall proceed (1) simultaneously with the withdrawal of sheeting and as each layer is compacted, or (2) up to each set of rangers and braces; the rangers and braces will be removed; the backfilling will proceed up to the next set of rangers and braces, etc. up to the top of the excavation. Alternate sections of sheeting from the left side and right side of the trench/area shall be removed and the cavity remaining there from shall be jetted thoroughly by high pressure water, starting at the toe of the sheeting and being drawn to the surface. Sand shall be inserted with the jetting process. Where the bottom of the excavation is not free draining material

(some areas of organic material or miscellaneous fill) or where granular backfill is not available or ordered by the Engineer, the jetting shall be very carefully done with a minimum amount design revisions, relocations and/or adjustment. No work shall be started within these areas of conflict until authorized by the Engineer.

TEST PITS

Test pit excavation and backfill shall comply with the provisions of Item 205 "Trench Excavation and Backfill".

The Contractor shall measure, record and provide to the Engineer, the size, configuration, exact horizontal and vertical location of all utilities, pipes or other obstacles uncovered in the various pits dug under this section.

The Engineer must be notified well in advance of excavation in order to obtain the necessary measurements to locate all objects within the test pit.

Excavation of test pits shall be accomplished by such means as are required to ensure that any underground utilities or structures as may be encountered are not damaged. It shall be the Contractor's sole responsibility to correct any damages incurred during the excavation operations. Any such damages shall be repaired or replaced by him (if permitted) to the satisfaction of the Utility Owner Responsible Agency or the Engineer at the Contractor's own expense. Where the repair and/or replacement must be done by the Utility Owner/Responsible Agency, any and all costs thereof shall be borne by the Contractor.

Where the test pit is to be excavated within an existing pavement area, the pavement and base shall be removed in accordance with Item 202.01, Earth Excavation.

Where an existing pavement has been removed for the test pit excavation, the surface shall be restored in accordance with Item 407, Temporary Pavement Trench Repair as ordered by the Engineer.

In all other areas, the surface of the test pit area shall be restored to a condition equal or better than prior to excavation as directed by the Engineer.

If, in the opinion of the Authority, the Contractor has failed to maintain a safe trench and work area, Authority forces shall refuse to enter the trench until safety concerns are satisfied. This requirement shall not in any way relieve the Contractor of complete responsibility and liability for maintaining a safe and adequate trench excavation at all times and at any depth.

MEASUREMENT:

Except as noted below, trench excavation will be measured in its original position by taking the difference between the ground surface at the time the trench is excavated and that after the excavations are complete. Before starting any excavation, the Contractor shall notify the Engineer so that elevations and measurements of the work may be obtained.

Any work done prior to such notification will not be paid for.

Trench excavation in roadway cuts shall include only that portion outside of the limits of roadway excavation and will not include open ditches.

Test Pit excavation will be measured for payment under this Item.

Payment limits shall be described hereinafter.

HORIZONTAL PAYMENT LIMITS: Payment lines shall be vertical for pipe culverts, pipe-arches, sewers, service pipes and outlets for under-drains, and shall be the width to which the material is actually removed, except that in no case, even though the actual excavation is wider, shall the width between payment lines be more than the following:

- a.) two (2) feet greater than the nominal inside diameter circular pipe, or nominal inside span of elliptical pipe or pipe-arch for such diameters or spans of less than thirty (30) inches.
- b.) three (3) feet greater than the nominal inside diameter circular pipe, or nominal inside span of elliptical pipe or pipe-arch for such diameters or spans that are thirty (30) inches or greater.

For end-walls, manholes, drop inlets and catch basins, payment lines shall be vertical and two (2) feet outside of the neat lines of the foundations in each direction horizontally.

For under-drains, payment lines shall coincide with the sides and bottoms of the ditch of the dimensions shown on the plans or as ordered.

In case it is necessary to excavate to a greater width than specified above on account of the removal of existing structures, such additional excavation will be considered as trench excavation and will be measured and paid for as such.

For the removal of underground obstructions such as pipelines, tanks, etc., payment lines shall be vertical and two (2) feet outside of the underground item measured horizontally.

If rock is encountered, the Contractor shall strip it of sufficient overlying material to allow

for proper measurement and then shall notify the Engineer that the rock surface is ready for measurement. If the Contractor shall fail to give such notice, the Engineer shall presume that the measurements taken at the time they first saw the material in question will give the true quantity of excavation.

VERTICAL PAYMENT LIMITS: Where pipe bedding is used, the lower vertical payment limit shall be as shown on the plans. There will be no direct payment for the excavation necessitated by the shaping of the bedding, but the cost shall be included in the cost per linear foot for the pipe culvert specified.

VERTICAL PAYMENT LIMITS OTHER THAN IN FILLS: Payment lines will extend vertically from the bottom of the trench to the bottom of the roadway excavation.

If trench excavation is not located within the limits of roadway excavation, payment lines will extend vertically from the bottom of the trench to the existing ground surface.

VERTICAL PAYMENT LIMITS IN FILLS: For the various drainage installations, the vertical payment lines shall extend from the bottom of the completed and accepted trench to the lowest of the following upper limits:

- a. Bottom of subbase.
- b. In the case of culverts, one foot above the top of the pipe.
- c. In case of drainage structure other than culverts, one foot above the top of the uppermost culvert pipe placed in the structure.
- d. In the case of culvert installations transverse to the roadway extending down fill slopes, the vertical payment limit will be the depth below bottom of loam or embankment surface, as the case may be, and measured perpendicular to the bottom of the trench.

Vertical payment limits shall be as described above except that in no case shall the depth measurement used for payment be greater than that actually excavated.

If gravel fill or borrow are used for trench backfill, they will be measured in place within the payment limits described herein.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard for "Trench Excavation-Earth", regardless of depth. When rock, conforming to the description given in this item is encountered within the payment lines for trench excavation, its removal will be classified and paid for at the contract unit price per cubic yard for "Trench Excavation - Rock", regardless of depth.

Those portions of trench excavation classified and paid for as "Trench Excavation - Rock" will be the actual volume of earth excavated within the payment lines. When payment is made for trench excavation in fill, no such excavation will be classified as

“Trench Excavation - Rock”.

For any portion of trench excavation classified and paid for as “Trench Excavation - Unclassified”, no payment will be made under “Trench Excavation - Earth”, “Trench Excavation - Rock” or Trench Excavation - Unsuitable” for the designated project or portion thereof. Excavation necessary for the removal of pipe culverts, test pits, or other installations described herein, will be paid for as trench excavation.

The above prices shall include all materials, tools, equipment and labor necessary to complete the excavation in conformity with the plans or as ordered. They shall also include backfilling where required and the disposal of surplus material. No additional payment will be made for shoring, bracing, sheeting, pumping, bailing or for material or equipment necessary for the satisfactory completion of the work.

No measurement or separate payment will be made for the work under “Trench and Excavation Support Systems,” the cost shall be included in the prices bid for other Items unless an item for permanent and/or temporary sheet piling appears in the proposal.

Test pits will only be measured for payment where the location of the pit is such that said pit will never be incorporated into any excavation being dug for the work, or when the test pit will ultimately be within the limits of an excavation required for the work, but said pit must be backfilled for safety or other reasons, as ordered by the Engineer, prior to the excavation reaching the location of the pit. If any pit is not backfilled and subsequently incorporated into the excavation, said pit will not be measured for payment separately.

Bituminous surface restoration over test pits shall be measured and paid for in accordance with Item 407, Temporary Pavement Trench Repair.

No additional payment will be made for saw cutting bituminous or portland cement concrete pavement, curbs or sidewalks and/or concrete base course according to the requirements of Item 407, Bituminous Concrete Trench Repair.

If gravel fill or borrow are used for trench backfill, payment will be made at their respective contract unit prices, or in the absence of such Items in the contract, as extra work.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
205.01	Trench Excavation - Earth	Cubic Yard
205.02	Trench Excavation - Rock	Cubic Yard
205.03	Trench Excavation - Unsuitable	Cubic Yard
205.04	Trench Excavation - Unclassified	Cubic Yard

ITEM 207 BORROW / SELECTED BORROW

DESCRIPTION:

When the amount of usable material excavated within the work contracted for is not sufficient to form the embankments, backfill trenches or other features of the work, additional material shall be furnished by the Contractor from borrow/selected borrow pits located beyond the limits of the project. This material shall be known as borrow/selected borrow. Borrow/selected borrow shall include the furnishing, removing and satisfactory placing of the additional material necessary to complete the work.

Hydraulically dredged and stockpiled material may be used for part, or all borrow/selected borrow requirements if it meets the requirements under "Materials". Stockpiles shall be placed at locations arranged for and provided by and at the expense of the Contractor will not be allowed within the project area except at locations and under conditions stipulated by the Engineer. All permits, easements, right or other requirements related to dredging and stockpiling shall be the obligation and responsibility of the Contractor.

MATERIALS:

Materials for this work shall conform to the following requirements:

Borrow shall consist of inorganic granular soils and/or rock having not more than 20 percent by weight passing the No. 200 sieve. The maximum stone size shall be 1-1/2 inches for use as trench backfill or 5 inches for construction of embankments and the material shall be well graded throughout the entire size range. Borrow shall be free from garbage, roots, leaves, and other organic or unsuitable materials. Rubbish, garbage or trash in any quantity shall not constitute a part of the borrow. Borrow shall also be free of ice or frost and no aggregations of soil particles shall be frozen. The moisture content of the borrow shall be within +3 percent of its optimum moisture content at the borrow source.

Selected Borrow will be free-draining material consisting of sound, hard, durable stone, run of the bank gravel, sand, or other acceptable granular material, the particles of which shall have a maximum size of 12 inches unless otherwise specified and shall be of such size that, of the portion passing the 4 inches square sieve, not more than 20 percent by weight, shall pass the No. 40 mesh sieve and not more than 10 percent by weight shall pass the No. 200 mesh sieve as determined by washing through the sieve in accordance with ASTM Test Designation D422 as amended or superseded.

Selected Borrow shall include sufficient well-graded material to fill any voids in the embankment/backfill area in its upper strata prior to placing any courses thereon.

CONSTRUCTION DETAILS:

Borrow/Selected Borrow will be permitted only to the extent necessary to complete the embankments, backfill trenches and similar details and only after all usable material from the excavation has been placed. However, with prior written approval of the Engineer, the Contractor may be permitted to place borrow/selected borrow before the excavation is completed. This permission is at the sole discretion of the Engineer and may be revoked at any time if satisfactory progress is not maintained on other operations.

The Contractor shall notify the Engineer at least 15 days prior to obtaining material from any borrow pits so that an examination of the fitness of the material may be made. The limits approved of material from borrow pits shall be given to the Contractor. The Contractor shall be required to clear the borrow pit area of all unsuitable material.

If the Contractor elects to obtain borrow/selected borrow from a, commercial pit, it will be necessary to have a section of the pit set off for its use, unless otherwise directed.

The Contractor shall, at its expense, employ effective dust control measures so that the public will not be adversely affected by dust from stockpiles material or such material in transit. The Contractor shall also provide and maintain at its expense effective and adequate drainage for all dredging and stockpiling operations at all times, and shall be solely responsible for all damages which result from dredging and stockpiling and for the continuing maintenance and final restoration of all drainage facilities affected by the Contractor's operations.

Borrow/selected borrow shall be placed where directed and in accordance with the specifications for the information of embankments under the Item "Roadway Excavation, Formation of Embankment and Disposal of Surplus Materials," the item "Trench Excavation and Backfill" of these Specifications.

MEASUREMENT:

The amount of "Borrow" or "Selected Borrow" to be paid for will be determined by the Engineer in place after compaction and within the payment lines shown on the Contract Drawings or as directed by the Engineer unless otherwise specified.

PAYMENT:

Payment will be made for at the contract unit price per cubic yard for "Borrow" or "Selected Borrow" complete in place, which price shall include furnishing, placing and compacting the material and all other material, equipment, tools, labor and work incidental to or necessary for the completion of the Item.

If no separate Item for "Selected Borrow" has been included in the Bid Proposal, then "Selected Borrow", where required, will be paid for as "Borrow".

No payment will be allowed for "Borrow" or "Selected Borrow" until all suitable excavation has been placed in the embankments or used for trench backfill except with the prior written approval of the Engineer.

The contract unit price for "Borrow" or "Selected Borrow" shall also include the cost, if any, of restoration of the borrow area as required by the Local Regulatory Agency or these Specifications.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
207.01	Borrow	Cubic Yard
207.02	Selected Borrow	Cubic Yard

ITEM 208 FREE DRAINING MATERIAL

DESCRIPTION:

Free-draining material shall consist of material conforming to the requirements stated elsewhere herein. This material shall be furnished and placed in accordance with these specifications and as indicated on the plans, special provisions, or as ordered by the Engineer for the stabilization of embankments, or for fill in free water areas, or wherever specified.

MATERIALS:

Material for this work shall meet the requirements of Article M.02.07.

CONSTRUCTION DETAILS:

The Contractor shall notify the Engineer at least 3 days prior to obtaining free-draining material from any source so that an examination may be made of the material and the necessary measurements may be taken.

The limits of the proposed source shall be shown to the Engineer; and prior to the taking of measurements, the Contractor shall be required to clear the area of all unsuitable material. No payment will be made for any material removed outside of the area measured or which was not used in the contract work. No excavation shall be made within the confines of a source after the Engineer has taken the original measurements, except for material to be used for the purposes hereinbefore indicated, except with the permission of the Engineer.

The Contractor may, with the approval of the Engineer, obtain free-draining material, if available, from within the roadway excavation limits subject to the written approval of the Engineer.

If the Contractor elects to obtain free-draining material from a commercial pit, it will be necessary to have a section of the pit set off for its use solely, so that the amount of material removed may be accurately determined. During the period between the original and the final release by the Engineer, no material shall be taken from a measured pit except by the Contractor and for use only in the work under the contract.

If the Contractor elects to use stone from a quarry or reclaimed miscellaneous aggregate, the Contractor shall use only the materials from stockpiles which have been approved for use.

Free-draining material will be permitted only to the extent necessary to construct embankments to 3 feet above free water, or to promote free drainage in areas specified on the plans, in the special provisions, or as directed by the Engineer.

Free-draining material shall be placed in accordance with the provisions for the formation of embankment of Item 202, Excavation and Embankment.

MEASUREMENT:

The amount of free-draining material to be paid for will be determined by the average end area method based on the results obtained from cross-sectional elevations taken before and after the free-draining material has been excavated.

When material is drawn from a quarry stockpile or stockpile formed from reclaimed miscellaneous aggregate, the material shall be weighed on scales furnished by and at the expense of the Contractor. The scales shall be of a type satisfactory to the Engineer and shall be sealed at the expense of the Contractor as often as the Engineer may require. All weighing (measurements of mass) shall be done in the presence of a representative of the Authority. From the weight (mass) so obtained, the volume shall be computed based on a specific gravity of 2.92 for the aggregate and smaller particles. For material having a different specific gravity, an appropriate correction shall be made.

PAYMENT:

Payment will be made at the contract unit price per cubic yard for "Free-Draining Material," complete in place, which price shall include furnishing and placing the material and all equipment, tools and labor necessary thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
208	Free Draining Material	Cubic Yard

ITEM 209 PREPARATION OF SUBGRADE

DESCRIPTION:

This work shall consist of the forming and compaction of all subgrade surfaces as specified. All trenches shall be backfilled and all other excavation work completed within the immediate vicinity prior to the commencing of subgrade preparation. Base courses shall not be placed until the proper completion of the subgrade surface.

CONSTRUCTION DETAILS:

All soft and yielding material and other portions of the subgrade which will not compact readily when rolled or tamped, shall be removed, as directed, and all loose rock or boulders, over 5 inches in size, found in the earth shall be removed or broken off to a depth of not less than one foot below the subgrade. All holes or depressions made by the removal of material, as described, shall be filled with suitable material and the whole surface compacted uniformly by rolling the entire area with an approved power roller weighing not less than 10 tons. Any portion of the subgrade which is not accessible to a roller shall be compacted thoroughly with hand tampers, weighing not less than 12 pounds, the face of which shall not exceed 50 square inches in area.

The rolling and tamping shall be continued until the entire subgrade is uniformly and thoroughly compacted, true to lines and grades given. In excavation, the ground shall not be disturbed below the elevation of the subgrade.

In handling materials, tools, equipment, etc., the Contractor shall protect the subgrade from damage by exercising such precautions as the Engineer may deem necessary. At all times the subgrade surface shall be kept in such condition that it will drain readily and correctly. The subgrade shall be checked and approved before any foundation or surfacing material is placed thereon.

The subgrade shall be compacted a minimum density of 90 percent of the maximum dry density as determined by the Modified A.A.S.H.T.O. Method T-180-57.

MEASUREMENT:

Preparation of subgrade will be measured coincident with the outside edges of the pavement or its base course construction as approved by the Engineer.

PAYMENT:

This work will be paid for at the contract unit price per square yard for "Preparation of Subgrade" which price shall include all materials, equipment, tools and labor incidental thereto.

When no price for "Preparation of Subgrade" is asked for on the Proposal Form, the

cost of the Work as shown on the Contract Drawings shall be included in the cost of other items and no direct payment for "Preparation of Subgrade" will be made.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
209	Formation of Subgrade	Square Yard

ITEM 210 TEMPORARY SOIL EROSION AND WATER POLLUTION CONTROL

DESCRIPTION:

This work shall consist of temporary control measures as shown in the Contract Documents or as ordered by the Engineer during the life of the contract to control soil erosion and water pollution, through use of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains and other acceptable erosion control devices or methods.

Where appropriate, the temporary control provisions contained herein shall be coordinated with the permanent erosion control features specified elsewhere in the contract to the extent practical to assure economical, effective and continuous erosion control throughout the construction and post construction period.

Work under this specification will not be used and paid for in situations where permanent contract items in the final position in the contract can be practically installed and can provide the necessary control measures.

MATERIALS:

Materials required for this work shall include the following:

Mulches: Mulches may be hay, straw, fiber mats, netting, wood cellulose, bark, wood chips or other suitable material acceptable to the Engineer and reasonably clean and free of noxious weeds and deleterious materials.

Slope Drains: Slope drains may be constructed of pipe, fiber mats, rubble, Portland cement concrete, bituminous concrete, plastic sheet or other material acceptable to the Engineer and adequate for erosion control.

Grass: Grass shall be a quick growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area and as a temporary cover, which will not compete with the grasses sown later for permanent cover.

Fertilizer: Fertilizer and soil conditioners shall be a standard commercial grade acceptable to the Engineer.

CONSTRUCTION DETAILS:

General: In the event of conflict between these specification requirements and pollution control laws, rules or regulations of other Federal or State or local agencies, the more restrictive laws, rules or regulations shall apply.

Authority of Work: The Engineer has the authority to limit the surface area of erodable earth material exposed by excavation, borrow and fill operations and to direct the

Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent land, streams or other watercourses, lakes, ponds or other areas of water impoundment

Schedule of Work: At the pre-construction conference or prior to the start of the applicable construction, the Contractor shall submit to the Engineer for acceptance, the schedules for installing of temporary and permanent erosion control measures, as are applicable for clearing and grubbing; grading; bridges and other structures at watercourses; construction; and paving. In addition, the Contractor shall also submit for acceptance at the same time, the proposed method of erosion control on haul road and borrow pits and the plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the Engineer.

The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the approved schedule. Temporary control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

Where erosion is likely to occur, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise temporary erosion control measures may be required between successive construction stages.

Areas of Work: The Engineer will 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 control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

Under no conditions shall the work area of erodable earth material exposed at one time by clearing and grubbing, excavation, borrow or fill within the right-of-way exceed 75,000 square feet without prior approval by the Engineer. The same limitations shall apply to each borrow or spoil area and erodable haul road outside the right-of-way.

The Engineer may increase or decrease the area of erodable earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by an analysis of project conditions.

Temporary soil erosion and water pollution control may include construction work outside the right-of-way where such work is necessary as a result of highway

construction. Legal rights of access will be provided by the Authority in accordance with **§ 107-11, Furnishing Right- of-Way.**

Where the work to be performed is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, and falls within the specifications for a work item that has a contract price, the units of work shall be computed at the proper contract price for lump sum payment as hereinafter stated. Should the work not be comparable to the project work under the applicable contract Items, the Contractor shall be ordered to perform the work on a force account basis, or by agreed unit prices as approved by the Engineer.

The lump sum of money shown on the estimate and in the itemized proposal for this work will be considered the price bid even though payment will be made only for actual work performed. This lump sum figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded, and the original price will be used to determine the total amount bid for the contract.

The quantity to be paid for will be computed by one or any combination of the following methods:

Temporary Work: Where contract Bid Items cover the temporary work ordered, the amount obtained by the product of the quantity and the unit bid price of the Items.

Agreed Unit Prices: Where no contract Bid Items are available, the amount obtained by the product of the Item quantities and agreed unit prices.

Force Account: By force account records where bid prices do not exist and agreed prices are not available for temporary work Items.

General: The lump sum for this work includes the cost of furnishing all materials, labor and equipment to satisfactorily complete the temporary erosion and pollution control work shown on the plans or ordered to be performed by the Engineer. Monthly payments will be made for this work for the amount of temporary work completed during the Estimate period.

Temporary control measures that are made necessary by the Contractors negligence, carelessness, failure to install permanent controls as a part of the work as scheduled and are ordered by the Engineer, or are made necessary by the Contractor's failure to perform the sequence and scheduling of work as part of the schedule as given in the pre-construction conference or as later amended and approved, shall be ordered by the Engineer to be accomplished and performed by and at the expense of the Contractor.

In case of repeated failures on the part of the Contractor to control emission, pollution and/or siltation, the Engineer reserves the right to employ outside assistance or to use Authority forces to provide the necessary corrective measures. Such incurred direct costs plus project engineering costs will be charged to the Contractor and appropriate

deductions made from the Contractors monthly progress estimate.

On areas off the right-of-way that are selected by the Contractor and which include but are not necessarily limited to borrow pits (other than commercially operated sources), Contractor's haul roads, disposal areas, storage, maintenance, batching areas, etc., temporary control work shall be the responsibility of the Contractor and shall be performed by him at its expense in a manner approved by the Engineer. No direct payment will be made for this work; the cost is to be included in other Items of the contract. Temporary control work on the aforesaid areas which are specifically designated for contractual operations by the Authority shall be paid for under the provisions of this specification.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
210	Temporary Soil Erosion and Water Pollution Control	Allowance

ITEM 213 GRAVEL FILL

DESCRIPTION:

This material shall be used as a foundation for structures, to replace unstable material in slopes, as a foundation for sidewalks and culverts, in shoulders and elsewhere as indicated on the plans, required by the specifications or ordered by the Engineer. It shall consist of gravel conforming to the requirements of these specifications.

MATERIALS:

Gravel fill shall conform to the requirements of Article M.02.01.

CONSTRUCTION DETAILS:

When gravel fill is used for foundation for structures or to replace rock or unsuitable material in trenches, it shall be deposited in layers not over 6 inches in depth, with each layer thoroughly compacted before the addition of other layers.

MEASUREMENT:

Gravel fill will be measured in place after compaction within the payment lines shown or specified by the Engineer.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard for "Gravel Fill", complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
213	Gravel Fill	Cubic Yard

ITEM 216 PERVIOUS STRUCTURE BACKFILL

DESCRIPTION:

Pervious structure backfill shall include the furnishing, placing, and compaction of pervious material adjacent to structures.

MATERIALS:

Pervious structure backfill shall conform to the requirements of Article M.02.05.

CONSTRUCTION METHODS:

Pervious structure backfill shall be placed adjacent to abutments, retaining walls, box culverts, and elsewhere as called for. It shall be placed above a plane extending on a 2 to 1 slope from the upper edge of the footing to the top of the embankment, or as shown on the plans. Where the face of undisturbed material is above or beneath this slope plane, the amount of pervious structure backfill shall be decreased or increased accordingly, if ordered by the Engineer.

In filling behind abutments, retaining walls, box culverts, or other structures, the fill is placed against undisturbed material, or against compacted embankments having a length in a direction at right angles to the abutment wall or culvert not less than twice the height of the structure against which the fill is placed. The slope of the embankment on which the pervious structure backfill is to be placed shall be plowed deeply or cut into steps before and during the placing of pervious structure backfill so both types of material will be thoroughly bonded and compacted.

Each layer of pervious structure backfill shall be spread to a thickness not exceeding 6 inches in depth after compaction and shall be thoroughly compacted as directed by the Engineer by the use of power rollers or other motorized vehicular equipment, by tamping with mechanical rammers or vibrators, or by pneumatic tampers. Any equipment not principally manufactured for compaction purposes and equipment which is not in proper working order in all respects shall not be used within the area described above.

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

The dry density of each layer of pervious structure backfill formed from broken or crushed stone, broken or crushed gravel or reclaimed miscellaneous aggregate free of bituminous concrete shall have a dry density after compaction that is no less than 100 percent of the dry density for that material when tested in accordance with AASHTO T180, Method D. If a layer formed from reclaimed miscellaneous aggregate containing

bituminous concrete is placed as pervious structure backfill, the wet density of this layer after compaction shall not be less than 100 percent of the wet density for that material when tested in accordance with AASHTO T180, Method D.

In this test, material retained on the 3/4 inch sieve shall be replaced with material retained on the number 4 sieve, as noted as an option in the specifications for this test.

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

Where weep holes are installed, bagged stone shall be placed around the inlet end of each weep hole, to prevent movement of the pervious material into the weep hole.

MEASUREMENT:

Payment lines for pervious structure backfill shall coincide with the limits of the compacted pervious structure backfill as actually placed and ordered by the Engineer.

PAYMENT:

Pervious structure backfill will be paid for the contract unit price per cubic yard for "Pervious Structure Backfill," complete in place.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
216	Pervious Structure Backfill	Cubic Yard

ITEM 304 PROCESSED AGGREGATE BASE

DESCRIPTION:

The base shall consist of a two-course foundation constructed on the prepared subbase in accordance with these specifications and in conformity with the lines, grades, compacted thickness and typical cross-section as shown on the plans.

MATERIALS:

All Materials for this work shall conform to the requirements of Articles M.05.01-1, M.05-01-2, and M.05.01-3.

CONSTRUCTION DETAILS:

Coarse aggregate shall be either gravel or broken stone at the option of the Contractor. However, only one type of coarse aggregate shall be used on the project unless otherwise permitted by the Engineer.

Prior to placing the bottom coarse of the processed aggregate base, the prepared subbase shall be maintained true to line and grade, at all times, for a minimum distance of 200 feet in advance of the work. In addition, any of the base aggregate courses shall not be placed more than 500 feet ahead of the compaction and binding operation on that particular course.

The bottom course shall be spread uniformly upon the prepared subbase. Only approved spreaders or stone boxes shall be used. Power graders shall not be used unless otherwise permitted by the Engineer. The thickness of the course shall not be more than 6 inches after compaction, unless otherwise ordered.

After the aggregate is spread, it shall be thoroughly compacted and bound by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 pounds per lineal inch of contact width and shall weigh not less than 10 tons. Vibratory units shall have a static weight of not less than 4 tons. Water may be used during the compaction and binding operation. Water shall be applied from an approved watering device. The direction and intensity of the stream shall be as ordered by the Engineer. The compacting and binding operation shall begin at the outside edges, overlapping the shoulders for a distance of not less than 6 inches and progress towards the middle, parallel with the centerline of the pavement. The work shall cover the entire surface of the course with uniform overlapping of each preceding track or pass. Areas of superelevation and special cross slope shall be compacted by beginning at the lowest edge and proceeding towards the higher edge, unless otherwise directed by the Engineer. The compacting and binding operation shall be continued until the voids in the aggregates have been reduced to provide a firm and uniform surface satisfactory to the Engineer. The amount of compactive effort shall be

as directed by the Engineer, but in no case shall be less than four (4) complete passes of the compacting equipment being used. Any surface lines shall be distributed uniformly by use of brooms during the compacting and binding operations. All aggregate shall be completely compacted and bound at the end of each days work or when traffic is to be permitted to operate on the road.

Should the subbase material become churned up or mixed with the bottom course material at any time, the Contractor shall, without additional compensation, remove the mixture. The Contractor shall add new subbase material, if required, and reshape and compact the subbase in accordance with the requirements of the subbase article in these specifications. New aggregate bottom course material shall be added, compacted and bound as hereinbefore specified, to match the surrounding surface.

When the bottom course has been completed, as specified above, the top course Aggregate shall be spread over it to such thickness than, after final compaction and binding, the total thickness of the two courses will equal that thickness specified for the completed base. The top course shall be spread, compacted and bound exactly as specified above for the bottom.

The final surface of the subbase course shall be fine graded so that, after final compaction and just prior to placement of base or pavement courses, the surface elevation shall not vary more than one-quarter inch above or below the design line and grade at any location. The surface shall be completed to the above tolerance and approved by the Engineer prior to any work at a given location to place an overlying course. If after approval, the course becomes displaced or disturbed in any way for any reason, the Contractor shall repair and regrade the damage to the satisfaction of the Engineer prior to placing the overlying course. All repaired sections shall be recompacted until they meet the requirements as stated herein.

MEASUREMENT:

This material shall be measured for payment by the number of cubic yards of processed aggregate base furnished and complete in place, and the work accepted.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard for "Processed Aggregate Base", complete in place, which price shall include all materials, tools, equipment and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
304	Processed Aggregate Base	Cubic Yard

ITEM 305 BEDDING MATERIAL

DESCRIPTION:

The Work under this section shall consist of furnishing, placing and compacting Bedding Material, to the lines, grades and dimensions for all sewer and water pipes, including services, in accordance with the details on the Contract Drawings, or as ordered, all to the satisfaction of the Engineer.

MATERIALS:

The bedding material shall consist of broken stone or crushed gravel conforming to Article M.01 .01, 3/4" size on the Gradation Table. Material shall be free from soft, disintegrated pieces, mud, dirt, organic and other foreign material. Samples of the material shall be delivered to the site at least 5 days prior to use, so that it may be approved by the Engineer and tested for size and gradation. Periodic Tests will be taken by the Engineer to establish conformity. Stone Quality, soundness and loss due to Abrasion shall conform to Article M.02.04.

CONSTRUCTION DETAILS:

The Bedding Material shall be deposited in layers not over 6 inches thick and each layer shall be thoroughly compacted before the addition of other layers. The surface shall be carefully brought to grade as shown on the Contract Drawings and compacted to 95% of the maximum dry density as determined by AASHTO T-180 Method C. The moisture content of the material shall not vary by more than plus/minus 3% from its optimum moisture content. Approved methods of compaction shall be used.

MEASUREMENT:

This material will be measured for payment by the number of cubic yards of bedding material furnished and complete in place and the work accepted.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard for "Bedding Material", complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
305	Bedding Material	Cubic Yard

ITEM 306 RECLAIMED ASPHALT – GRAVEL BASE

DESCRIPTION:

Work under this item shall consist of establishment of reclaimed asphalt - gravel base utilizing the existing asphalt surface and base material. This work includes, but is not limited to: (a) surveying and staking in conformance with Item 985, Project Survey and Stakeout; (b) scarification and pulverization of the existing asphalt surface; (c) daily dust control by a method approved by the Engineer; and (d) final grading and compaction of the reclaimed asphalt - gravel base to the lines and grades as shown on the plans or as directed by the Engineer which shall provide a suitable base for the placement of a bituminous concrete binder and surface courses.

MATERIALS:

Existing in-place materials only will be used to create a homogenous mixture. If additional material is required to obtain the proper grades and cross-slope, the new aggregate shall conform to Article M.05 for Item 304, Processed Aggregate Base.

**RECLAIMED ASPHALT-GRAVEL BASE
GRADATION TABLE**

<u>SIEVE DESIGNATION</u>	<u>PERCENTAGE BY PASSING WEIGHT</u>
3"	100
1-1/2"	70-100
3/4"	55-90
No.4	40-75
No.40	10-30
No.200	3-10

EQUIPMENT:

The Contractor shall provide a list of the specific equipment to be used in the performance of this work for approval by the Engineer. The equipment shall include, but not be limited to: (a) a pavement and base reclaimer capable of pulverizing material to meet gradation requirements and mixing to a minimum width of six (6) feet and a minimum depth of twelve (12) inches; and (b) a 10-ton (minimum) steel wheel roller or other compaction equipment capable of achieving the specified density. The equipment shall be maintained in satisfactory working condition at all times.

CONSTRUCTION DETAILS:

The existing road pavement shall be pulverized, processed, blended, and compacted to the lines and grades established by the Contractor and approved by the Engineer.

The Contractor shall be responsible for determining the exact location of the utility structures and all obstructions that effect the reclaiming operation (i.e. manholes, water gates, valves, etc.). The Contractor shall be responsible for all maintenance and protection of traffic in accordance with the requirements of Item 971.

Care shall be utilized by the Contractor to insure no damage to curbing, manholes, water boxes, and similar equipment installed in the street, and the Contractor must guarantee repair or replacement of any and all damaged structures when encountered. The Contractor will be responsible for structure adjustments. If additional material is required, it shall be placed over the entire area and uniformly blended with the existing base prior to grading and compacting. The reclamation operation shall be conducted so as not to permit the contamination of the asphalt/gravel material with any shoulder debris, grass, leaves or dirt.

The material shall be uniformly graded to the lines and grades shown on the plans or as directed by the Engineer to establish the reclaimed asphalt gravel base. This material will be thoroughly compacted with a roller(s) to produce 100% compaction and uniform density based on the modified Proctor Test, (AASHTO T-180). Water shall be applied to ensure optimum moisture content during compaction. The maximum compacted lift for reclaimed asphalt gravel bases shall be six (6") inches unless otherwise directed by the Engineer

The compacting and binding operation shall begin at the outside edges, overlapping the shoulders for a distance of not less than 6 inches and progress towards the middle, parallel with the center line of the pavement. The work shall cover the entire surface of the course with uniform overlapping of each preceding track or pass. Areas of super-elevation and special cross slopes shall be compacted by beginning at the lowest edge and proceeding towards the higher edge, unless otherwise directed by the Engineer. The compacting and binding operation shall be continued until the voids in the aggregates have been reduced to provide a firm and uniform surface satisfactory to the Engineer. Any surface lines shall be distributed uniformly by use of brooms during the compacting and binding operations. All aggregates shall be completely compacted and bound at the end of each day of work or when traffic is to be permitted to operate on the road. The Contractor shall also be responsible for supplying dust control on a daily basis with a method acceptable to the Engineer.

Should the subbase material become churned up or mixed with the bottom course material at any time, the Contractor shall, without additional compensation, remove the mixture. The Contractor shall add new subbase material, if required, reshape and recompact the subbase in accordance with the requirements of the subbase article in the standard specifications. New aggregate bottom course material shall be added, compacted and bound as hereinbefore specified, to match the surrounding surface.

The final surface of the reclaimed asphalt-gravel base course shall be fine graded so that, after final compaction and just prior to the placement of pavement courses, the surface elevation shall not vary more than one quarter inch above or below the design

line and grade at any location. The surface shall be completed to the above tolerance and approved by the Engineer prior to the placing of the overlying course. If after approval, the course becomes displaced or disturbed in any way for any reason, the Contractor shall repair and regrade the damage to the satisfaction of the Engineer prior to the placing of the overlying course. All repaired sections shall be recompacted until they the requirements stated herein.

If excess material exists after formation to the specified grades and cross slope, the Contractor shall dispose of the excess material in a manner acceptable to the Engineer.

If excess material exists after additional processed aggregate base was added for the formation to specified grades because of error on the part of the Contractor, the Contractor shall load and weigh the excess material at a certified scale approved by the Engineer. The amount in tons of excess asphalt/gravel base shall be subtracted from the quantity of Item 304, Processed Aggregate Base incorporated in the work.

When rock or unsuitables are encountered within the reclaimed area, the removal of such will be paid for on a time and material basis.

MEASUREMENT:

Work shall be measured by the actual number of square yards of surface area pulverized, blended and compacted in accordance with this specification to a specified depth as shown on the plans or as directed by the Engineer

Additional Aggregate: The costs associated with supplying additional aggregate if ordered, blending, and compacting shall not be included in the unit price bid for reclaimed asphalt – gravel base, but shall be measured by the actual number of square yards of Item 304, Processed Aggregate Base furnished, blended, and compacted in accordance with this specification or as directed by the Engineer.

Dust Control: This work will not be measured for payment, but the cost shall be considered as included in the price bid for reclaimed asphalt – gravel base.

Structure Adjustment: This work will not be measured for payment, but the cost shall be considered as included in the price bid for reclaimed asphalt – gravel base.

PAYMENT:

Payment for accepted quantities as measured will be at the contract unit price per square yard per specified depth, which price shall include full compensation for all labor, equipment, materials, supplies, required within this specification, including, but not limited to, surveying and staking, pulverization, blending, grading, compacting, dust control and structure adjustments.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
306.01	6" Reclaimed Asphalt - Gravel Base	Square Yard
306.02	8" Reclaimed Asphalt - Gravel Base	Square Yard
306.03	10" Reclaimed Asphalt - Gravel Base	Square Yard
306.04	12" Reclaimed Asphalt - Gravel Base	Square Yard

ITEM 405 BITUMINOUS CONCRETE MILLING

DESCRIPTION:

The work under this Item shall consist of removal of bituminous concrete including cold mix, and/or surface treatment pavement by cold milling; hauling of cuttings; cleaning of asphaltic concrete pavement in preparation for an overlay; and may include stockpiling for reuse in a Recycling Program, in conformity with these specifications, and to the lines, grades, and cross sections shown on the plans or ordered by the Engineer. This work includes milling of intersecting streets to the limits shown on the plans or ordered by the Engineer.

All work shall be performed in a manner which prevents the tearing and breaking of underlying and adjacent pavement.

All salvaged pavement shall become the property of the Contractor and shall be removed from the site unless otherwise negotiated by the Authority.

The Contractor shall cold mill within the time limits specified by the municipality in which the project is located. The Engineer may further restrict the time limits when conditions warrant.

EQUIPMENT:

Pavement Profilers - Prior to the start of milling operations, the Contractor shall submit full details concerning the machine to be used, including type, weight, milling width (sixty (60) inch minimum for primary operations), milling depth per pass (two (2) inch minimum), operating speeds, air pollution control, dust suppression, and assurance that no tree damage will occur as a result of the process used, for review by the Engineer.

The Contractor shall furnish one (1) or more machine(s) operated by experienced operators. The equipment for removing the pavement surface shall be a cold planing (milling) machine specifically designed for automatically controlled profiling which has operated successfully for a minimum of one (1) year on similar work, or equipment proven through test results satisfactory to the Engineer.

The equipment shall be maintained in a satisfactory working condition so as not to cause delays and the machine must be equipped with taillights, headlights, and necessary reflectors so that it can be operated in traffic with complete safety.

Pavement profilers shall have a means of loading by an integral loading belt, and it shall have the ability to cold mill concrete patches when encountered in the pavement.

Track-mounted cold milling equipment will be required for primary operations on roadway surfaces in which the pavement is milled down to within three quarters (3/4) of an inch of an unbound base course. Either track or conventional wheel milling machines will be

acceptable on work requiring only partial-depth milling of the bound materials such that sufficient pavement materials exist after removal to support the cold milling operation.

Areas not accessible to the milling machine, such as around and/or adjacent to inlets, manholes, curbs and transverse joints on structures, may be removed by a small milling machine, handwork or other methods approved by the Engineer. Wheel machines of sufficient size will be permitted for trimming operations.

Grade Control - The automatic controls on the milling machine shall provide accurately established profile grades at each edge of the machine by referencing from the existing pavement or an independent grade reference, where required, or be capable of automatically maintaining a designated cross slope from a single reference.

The finished milled surface will be inspected before being accepted, and any deviations in the profile exceeding ½ inch under a 16 foot string line or straightedge placed parallel to the centerline will be corrected to the satisfaction of the Engineer. Any deviations in the cross-slope that exceed 3/8 inch under a 10 foot stringline or straightedge placed transversely to centerline will be corrected to the satisfaction of the Engineer. All corrections will be made with approved methods and materials. Any areas that require corrective measures will be subject to the same acceptance tolerances. Excess material that becomes bonded to the milled surface will be removed to the satisfaction of the Engineer.

The milling machine shall be self-propelled and shall have sufficient power, traction, and stability to maintain an accurate depth of cut.

Sweepers - The surface shall be left clean and dust free by the use of self-propelled power sweepers, vacuums, hand sweepers, or other methods approved by the Engineer.

Pollution Control - All equipment will be operated such that it will effectively control dust generated by cutting, loading, and/or cleaning operations. All equipment must meet or be lower than the current standards set by the Air Quality Act of noise and air pollution.

TRANSPORTATION OF MATERIAL:

Caution shall be taken to insure that any vehicle used to transport milled material intended for use in recycled asphalt concrete will be free from any foreign matter (such as dirt, debris, leaves, solvents, etc.) Disposal of the sweepings or oversized pieces of pavement will not be permitted near the cold milling stockpiles.

CONSTRUCTION DETAILS:

Surface - The milled surface produced by the pavement profilers operation should be characterized by uniform discontinuous longitudinal striations or other patterns which will meet the requirements of the contract documents, and in the opinion of the Engineer, provide a satisfactory riding surface and suitable surface for paving.

Edge Transition Pavement Milling - The tapered cut should consist of a milled depth of up to two (2) inches, as indicated on the plans and as ordered by the Engineer, at the edge of existing pavement, transitioning to a depth of zero (0) inches, seven (7) feet from the edge of pavement.

Structures - Care shall be utilized by the Contractor to insure that no damage occurs to curbing, manholes, water boxes, and/or similar equipment installed in the street, and the Contractor must guarantee repair or replacement of any structures damaged by its negligence.

Intersecting Streets - All streets intersecting the proposed work area shall be milled to a minimum one and one-half (1-1/2) inch depth within the limits shown on the plans or where directed by the Engineer, and shall match the new grade line of said work area. All irregularities shall be eliminated to the satisfaction of the Engineer. At local street intersections classified as "local", where more than a two (2) inch vertical face is anticipated, the butt joint created by the milling operation shall be stepped in such a manner that the rise is no greater than two (2) inches and the run (horizontal distance) is no less than twelve (12) inches. At local street intersections classified as "collector or arterial", the butt joint shall be eliminated, and a temporary transition shall be placed from the milled surface to the adjacent un-milled surface.

Joints - Where the milling area terminates and abuts the existing adjacent pavement, a neat straight line shall be cut with suitable power-driven equipment before commencing the pavement removal with a milling machine. It is the intention of this operation and the obligation of the Contractor to produce a uniform straight line at the joint.

All butt joints created by the milling operation at driveways which are greater than two (2) inches in depth shall be filled with millings or cold patch material and maintained by the Contractor to allow a safe egress and ingress for the traveling public at all times. All butt joints created by the milling operation at intersecting streets which are greater than one and one-half (1-1/2) inches in depth shall be filled with cold patch material and maintained by the Contractor to allow a safe egress and ingress for the traveling public at all times.

Safety - The Contractor will provide all necessary labor, materials, and equipment for protection of motorists and pedestrians from any protruding structures that may result from the milling operation. The Contractor shall be responsible for the protection of motorists and pedestrians from any irregularities and pavement drop-offs that may result from the milling operation.

In the event of rain or inclement weather, the Contractor shall suspend milling operations. The Contractor shall make necessary allowances for drainage of water that may pond in areas where the milling was completed and the paving has not been completed.

Sweeping - The Contractor shall provide sweeping equipment to remove all cuttings from the surface on a daily basis. The Contractor shall sweep and remove loose cuttings, dust

or other objectionable material from the roadway by the end of each working day using power brooms, power vacuums or both; and whatever ancillary equipment, tools and labor necessary to properly prepare the road for subsequent tack coat and paving.

The pavement removal and cleaning operations shall be conducted in such a manner as to effectively minimize the amount of dust being emitted. The operation shall be planned and conducted so as to be safe for persons and property adjacent to the work, including the traveling public.

Bituminous concrete that cannot be removed by cold planing equipment because of physical or geometrical restraints should be removed by other methods acceptable to the Engineer.

Patching - Areas of base exposure caused by the milling Contractor as a direct result of adjusting profiling equipment, over cut beyond specified depths, use of jackhammer around structures, or utilizing equipment not specifically designed to cold plane pavements will be repaired and paid for by the Contractor. These areas of base exposure shall be repaired as a partial depth patch or a full depth patch, as directed by the Engineer. Any patching required shall be repaired before the end of the working day, and in a manner satisfactory to the Engineer.

In areas where the Contractor has held to the specified milling depth, any localized areas of exposed base materials shall be repaired as a partial depth patch by the Contractor and paid by the Engineer under the appropriate bid item.

The Engineer may require re-milling of any area where a non-uniform surface has resulted from the Contractor's operations; these areas will be corrected at no additional cost to the Authority.

SURFACE TEXTURE

Deviation - The milled surface texture deviation produced by pavement profilers should not exceed one quarter (1/4) of an inch in ten (10) feet in any direction in preparation for placing a final wearing surface, or three eighths (3/8) of an inch for an intermediate course.

Milling work shall be of varying depths, as required by the plans and/or specifications, or as directed by the Engineer. The Contractor shall take the necessary steps to prevent the pavement from being torn, gouged, shoved, broken, sooted, oil coated, or otherwise injured by the planing operation.

STOCKPILING MATERIALS

For Recycling - The salvaged material intended for use in the recycled bituminous concrete shall be segregated and stockpiled separately so as not to be contaminated by any foreign matter.

The planing operation shall be conducted so as not to permit the contamination of the salvaged pavement material by any unbound pavement materials, shoulder debris, grass, sweepings, oversized cuttings, leaves, or dirt.

MEASUREMENT:

Work shall be measured by the actual number of square yards of surface area milled to a specified depth in accordance with the specification, as shown on the plans, and accepted by the Engineer.

PAYMENT:

Payment for accepted quantities as measured will be at the contract unit price per square yard per specified depth, which price shall include full compensation for milling, loading, hauling, cleaning the milled pavement surface, temporary transitions, and stockpiling the reclaimed milled material, and for all labor, tools, equipment, materials, supplies, sweeping, and all incidentals necessary to complete the work.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
405.02	Bituminous Concrete Milling 0" – 2"	Square Yard
405.03	Bituminous Concrete Milling 0" – 3"	Square Yard
405.04	Bituminous Concrete Milling 0" – 4"	Square Yard

ITEM 406 BITUMINOUS CONCRETE

DESCRIPTION:

This item shall consist of a base, intermediate, and surface course hot mix asphalt (HMA) composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross sections shown on the plans. Each course shall be constructed to the depth, typical section, or elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

MATERIALS:

AGGREGATE

Aggregates shall consist of crushed stone, or crushed gravel, with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 8 sieve is coarse aggregate. The portion passing the No. 8 sieve and retained on the No. 200 sieve is fine aggregate, and the portion passing the No. 200 sieve is mineral filler, when tested in accordance with AASHTO T27 and AASHTO T11.

- a. Coarse Aggregate - Coarse aggregate shall consist of sound, tough, durable particles of crushed stone or crushed gravel of uniform quality throughout and free from adherent films of matter that would prevent thorough coating and bonding with the bituminous material and be free from organic matter and other deleterious substances. The percentage of wear shall not be greater than 40 percent when tested in accordance with AASHTO T96. The sodium sulfate soundness loss shall not exceed 10 percent, or the magnesium sulfate soundness loss shall not exceed 10 percent, after five cycles, when tested in accordance with AASHTO T104.

The aggregate shall not contain more than 10 percent, by weight, of flat or elongated pieces, when tested in accordance with ASTM D4791 at a 5:1 ratio. ASTM D4791 shall be performed on material coarser than the #4 (4.75mm) sieve and compare the length (longest dimension) to the thickness (smallest dimension) of the aggregate particles.

The aggregate shall contain a minimum coarse aggregate angularity of 75% having at least one fractured face for the base, intermediate, and surface courses, when tested in accordance with ASTM D5821.

The use of steel slag or blast furnace slag shall not be permitted as a coarse aggregate.

- b. Fine Aggregate - Fine aggregate shall consist of clean, sound, durable, angular shaped particles produced by crushing stone, slag, or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter and shall contain no clay balls. The fine aggregate, including any blended material for the fine aggregate, shall have a plasticity index of not more than 6 and a liquid limit of not more than 25 when tested in accordance with AASHTO T89 and AASHTO T90.

Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

The aggregate shall have sand equivalent values of 40 or greater when tested in accordance with AASHTO T176.

The aggregate shall have a fine aggregate angularity value of 40% or greater when tested in accordance with AASHTO T304, Method A. The un-compacted void content shall be evaluated for the combined mix aggregates including both coarse and fine aggregate portions.

- c. Sampling - AASHTO T2 shall be used in sampling coarse and fine aggregate, and AASHTO T127 shall be used in sampling mineral filler.

MINERAL FILLER - If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of AASHTO M17.

The superpave mixtures shall contain a dust-to-effective asphalt ratio by mass between 0.6 and 1.2. Mixtures that pass beneath the boundaries of the aggregate restricted zone shall contain a dust-to-effective asphalt ratio by mass between 0.6 and 1.6.

HOT MIX ASPHALT MATERIAL - Hot mix asphalt material shall conform to the following requirements:

ASPHALT BINDER MATERIAL PERFORMANCE GRADED ASPHALT BINDERS - The Asphalt Binder shall be a Performance Graded Asphalt Binder (PGAB) which meets the specification requirements of AASHTO Provisional Standard MP1 and AASHTO PP-6. Acceptance of the PGAB will be in accordance with AASHTO PP26-96 (June 1996) "Standard Practice For Certifying Suppliers of Performance Graded Asphalt Binders." PGAB shall be provided by an Approved Supplier (AS) under the Approved Supplier Certification (ASC) system.

THE PGAB GRADE SELECTED FOR THIS CONTRACT IS PG 64-28 - The Contractor shall furnish vendor's certified test reports and bill of lading, in accordance with AASHTO PP26, for each lot of asphalt binder material shipped to the project. The performance graded binder shall meet these specification requirements including any anti-strip agent necessary. The vendor's certified test report for the asphalt binder material can be used for acceptance or tested independently by the Engineer.

The blending at the HMA plants of PG binder from different suppliers is strictly prohibited. Contractors may switch to another approved source of PG binder, upon written notification to the Engineer, and by certifying that the tank to be utilized has been drained to an un-pumpable condition. Contractors who blend PG binders will be reclassified as a supplier and required to certify the binder in accordance with AASHTO MP1 and AASHTO PP-26.

A copy of the Material Certificate shall be provided in accordance with the frequency requirements established in the latest version of AASHTO MP-1, and shall include the following:

- a. Flash point
- b. Rotational viscosity at 275°F (135°C) and 329°F (165°C)
- c. Specific gravity at 77°F (25°C)
- d. Original $G^*/\sin\delta$ and phase angle at test temperature
- e. RTFO percent mass loss
- f. RTFO - $G^*/\sin\delta$ and phase angle at test temperature
- g. PAV Residue - $G^*(\sin\delta)$ and phase angle at test temperature
- h. Creep stiffness and m-value at test temperature
- i. Direct tension results (when equipment available)
- j. Strain sweep in accordance with AASHTO TP-5 (optional)
- k. Physical hardening after 24 hours in accordance with AASHTO TP-1 (optional)

ASPHALT ANTI-STRIPPING ADDITIVE - This specification provides for an additive to the asphalt to assist in the coating of wet aggregate and to increase the resistance of the bituminous coating to stripping in the presence of water. The additive shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 400°F (204°C) for extended periods without loss of effectiveness.

Composition: Anti-stripping compound shall be an organic chemical compound free from inorganic mineral salts or inorganic mineral soaps. It shall contain no ingredient harmful to the bituminous material or to the workmen, and shall not appreciably alter the specified characteristics of the bituminous material.

Anti-stripping additive shall be incorporated and thoroughly dispersed in the bituminous material in a minimum amount equal to the percent by weight established by AASHTO T283. The composite mixture shall have a minimum tensile strength ratio (TSR) of not

less than 80, when tested in accordance with AASHTO T283. The specimens for the AASHTO procedure shall be 100mm in diameter, compacted with either the Marshall hammer or the Superpave gyratory compactor to the desired air void level of $7.0 \pm 1.0\%$. If the TSR ratio is less than 80, the aggregates shall be treated with an approved anti-strip agent in sufficient quantity to produce acceptable results. The bituminous mixtures and binder materials that require anti-strip additives (either liquid or mineral) shall continue to meet all requirements specified herein for binder and HMA. The anti-strip agent shall be provided by the Contractor at no additional cost.

PRELIMINARY MATERIAL ACCEPTANCE - Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

- a. Coarse Aggregate.
 - (1) Percent of wear.
 - (2) Soundness.
 - (3) Flat and Elongated.
 - (4) Coarse aggregate angularity.

- b. Fine Aggregate.
 - (1) Liquid limit.
 - (2) Plastic index.
 - (3) Sand equivalent.
 - (4) Fine aggregate angularity.

- c. Mineral Filler.

- d. Performance Graded Asphalt Binder Material. The certification(s) shall show the appropriate AASHTO and/or ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirement.

The Engineer may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

COMPOSITION

COMPOSITION OF MIXTURE - The hot mix asphalt shall be composed of a mixture of well-graded aggregate, filler if required, and asphalt binder material. The several aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

JOB MIX FORMULA - No hot mix asphalt for payment shall be produced until a JMF has been approved by the Engineer. The hot mix asphalt shall be designed in

accordance with AASHTO MP2-00, PP2-00, PP28-00, TP4-00, and the requirements contained herein. For the volumetric mix design, the mixture of asphalt and aggregate shall be oven aged at the mixture's specified compaction temperature in accordance with AASHTO PP2, section 7.1 Mixture Conditioning for Volumetric Mixture Design.

The JMF shall be submitted in writing by the Contractor to the Engineer at least 30 days prior to the start of paving operations and shall include as a minimum:

- a. Percent passing each sieve size.
- b. Percent of asphalt binder.
- c. Performance grading test results and Material Certificate certifying the PG grade.
- d. Number of gyrations for the estimated design ESAL loading.
- e. Mixing temperature.
- f. Compaction temperature.
- g. Temperature of mix when discharged from the mixer.
- h. Plot of the combined gradation on the Federal Highway Administration (FHWA) 45 power gradation curve.
- i. Densification curve for each asphalt content plotting density, %Gmm, versus the logarithm of the number of gyrations.
- j. Percent natural sand.
- k. Percent fractured faces.
- l. Percent flat or elongated particles.
- m. Tensile Strength Ratio (TSR).
- n. Antistrip agent – type and quantity.
- o. Sand equivalent value.
- p. Fine aggregate angularity value.
- q. Percentage of wear.
- r. Sulfate soundness loss.
- s. Combined aggregate specific gravity.
- t. Dust to effective asphalt ratio.
- u. Graphical plot of air voids, voids in mineral aggregate (VMA), voids filled with asphalt (VFA), density at N_{initial} , density at N_{design} , and density at N_{maximum} versus asphalt content.

The Contractor shall submit samples to the Engineer, upon request, for JMF verification testing.

The JMF for each mixture shall be in effect until modified in writing by the ENGINEER. Should a change in sources of materials be made, a new JMF must be approved by the ENGINEER before the new material is used.

TABLE 1 SUPERPAVE DESIGN CRITERIA

Design ESALs (million)	Number of Gyration		
	$N_{initial}$	N_{design}	$N_{maximum}$
0.3 to <3.0	7	75	115

TABLE 2 REQUIRED DENSITY OF Gmm

Design ESALs (million)	Number of Gyration		
	$N_{initial}$	N_{design}	$N_{maximum}$
0.3 to <3.0	$\leq 90.5\%$	96%	$\leq 98.0\%$

TABLE 3 PERCENT VOIDS IN MINERAL AGGREGATE (VMA)

Nominal Maximum Aggregate Size	Percent
9.5 mm.	15.0 – 17.0
12.5 mm.	14.0 – 16.0
25.0 mm.	12.0 – 14.0

TABLE 4 PERCENT VOIDS FILLED WITH ASPHALT (VFA)

Nominal Maximum Aggregate Size	Percent
9.5 mm.	65 – 78
12.5 mm.	65 – 78
25.0 mm.	65 – 78

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 5 when tested in accordance with AASHTO Standards T27 and T11.

The gradations in Table 5 represent the limits which shall determine the suitability of aggregate for use from the sources of supply. The aggregate, as selected (and used in the JMF) and blended, shall have a gradation within the limits designated in Table 5 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine.

Deviations from the final approved mix design for asphalt binder content and gradation of aggregates shall be within the action limits for individual measurements as specified in Table 12. The limits still will apply if they fall outside the master grading band in Table 5.

The maximum size aggregate used shall not be more than one-half of the thickness of the course being constructed on a prepared surface or that which can be placed to achieve specification requirements. The maximum size is defined as one sieve size larger than the nominal maximum size. The nominal maximum size is defined as one sieve size larger than the first sieve to retain more than 10 percent.

The final JMF shall be evaluated in accordance with the Asphalt Institute procedures contained in Chapter III, MARSHALL METHOD OF MIX DESIGN, of the Asphalt Institute's Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete. Three samples of the hot mix asphalt surface course and intermediate course materials shall be compacted with 75 blows on each side with the Marshall compaction hammer in accordance with AASHTO T245. The Contractor shall determine the bulk specific gravity of each of the compacted specimens in accordance with AASHTO T166. The Contractor shall determine and provide the air voids, stability, and flow for each fabricated specimen. The stability and flow shall be determined in accordance with AASHTO T245, paragraph 4. The air voids shall be determined in accordance with AASHTO T269. This information shall be provided for informational purposes only and will not be subject to the requirements of the Asphalt Institute specifications.

TABLE 5 SUPERPAVE HOT MIX ASPHALT MIXTURES												
Percent by Weight Passing Sieves												
Sieve Size in. (mm)	9.5mm Surface				12.5mm Intermediate				25.0mm Base			
	Control Points		Restricted Zone		Control Points		Restricted Zone		Control Points		Restricted Zone	
	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %	Min %	Max %
-1/2" (37.5)	-	-	-	-	-	-	-	-	100.0	-	-	-
1" (25.4)	-	-	-	-	-	-	-	-	90.0	100.0	-	-
3/4" (19.0)	-	-	-	-	100.0	-	-	-	-	90.0	-	-
1/2" (12.5)	100.0	-	-	-	90.0	100.0	-	-	-	-	-	-
3/8" (9.5)	90.0	100.0	-	-	-	90.0	-	-	-	-	-	-
#4 (4.75)	-	90.0	-	-	-	-	-	-	-	-	39.5	39.5
#8 (2.36)	32.0	67.0	47.2	47.2	28.0	58.0	39.1	39.1	19.0	45.0	26.8	30.8
#16 (1.18)	-	-	31.6	37.6	-	-	25.6	31.6	-	-	18.1	24.1
#30 (0.600)	-	-	23.5	27.5	-	-	19.1	23.1	-	-	13.6	17.6
#50 (0.300)	-	-	18.7	18.7	-	-	15.5	15.5	-	-	11.4	11.4
#100 (0.150)	-	-	-	-	-	-	-	-	-	-	-	-
#200 (0.075)	2.0	10.0	-	-	2.0	10.0	-	-	1.0	7.0	-	-
Binder Content:	-	-	-	-	-	-	-	-	-	-	-	-

RECYCLED ASPHALT CONCRETE - The use of recycled asphalt pavement (RAP) will not be allowed in the surface course. All other HMA mixtures may contain a maximum of 25% RAP by mass of the entire mixture. The RAP, incorporated into the HMA mixtures, shall be maintained as a separate captive stockpile and shall not be added to without prior approval. RAP shall consist of asphalt pavement recovered by cold milling or other removal techniques. The RAP shall be crushed so that 100 percent passes the 19mm sieve. The Contractor shall assure that the RAP is free from contaminating substances such as joint seal compound.

The coarse aggregate in the RAP shall be crushed stone, gravel, or a blend of the two and the top-size shall not exceed the maximum aggregate size established by the JMF.

The final HMA mixture containing RAP shall conform to all the specification requirements contained herein.

Superpave mixtures containing RAP shall have the binder tested by laboratory blending to show that the blend conforms to all criteria for the PG grade specified in this contract when tested in accordance with AASHTO PP6 and AASHTO MP1. The contractor or a representative shall submit results from laboratory blending of extracted RAP binder and virgin binder that reflects the blend percentage of RAP proportions selected in the Superpave HMA mixture.

The laboratory RAP-virgin binder blend viscosity value established from the RTFO residue at 140°F (60°C) shall establish the maximum viscosity allowed for the binder after discharge from the HMA plant and/or silo storage, if applicable, when recovered by AASHTO T170 and tested in accordance with AASHTO T202 and AASHTO TP48.

For design purposes, the specific gravity of the combined aggregate blend with RAP used in a HMA mixture shall be determined in accordance with the attached test method for BULK SPECIFIC GRAVITY OF AGGREGATE BLENDS WITH RAP .

TEST SECTION - Prior to full production, the Contractor shall prepare and place a quantity of hot mix asphalt according to the JMF. The amount of mixture should be sufficient to construct a test section 300 feet (90m) long and 20 to 30 feet (6 to 9m) wide placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

Two random samples shall be taken at the plant and tested for VMA and air voids at N_{design} in accordance with the paragraph ACCEPTANCE SAMPLING AND TESTING Plant-Produced Material item (2) Testing. One random sample of mixture shall be taken at the plant and tested for aggregate gradation and asphalt content in accordance with the paragraph ACCEPTANCE SAMPLING AND TESTING Plant-Produced Material item (2) and evaluated in accordance with paragraphs CONTROL CHARTS for Individual Measurements and Range. Three randomly selected cores shall be taken from the finished pavement mat, and three from the longitudinal joint, and tested in accordance with paragraph ACCEPTANCE SAMPLING AND TESTING Field Placed Material item (4) testing. Random sampling shall be in accordance with procedures contained in ASTM D 3665.

Mat density and air voids shall be evaluated in accordance with paragraph ACCEPTANCE CRITERIA item (1) Mat Density and Air Voids. Joint density shall be evaluated in accordance with paragraph ACCEPTANCE CRITERIA item (4) Joint Density.

Voids in the mineral aggregate (VMA), for each plant sample, shall be computed in accordance with procedures contained in Chapter IV, ASPHALT MIXTURE VOLUMETRICS, of the Asphalt Institute's Manual Series No. 2 (SP-2), Superpave Level 1 Mix Design.

The test section shall be considered acceptable if; 1) mat density, air voids at N_{design} , VMA, and joint density are 90 percent or more within limits, and 2) gradation and asphalt content are within the action limits specified in paragraphs CONTROL CHARTS for Individual Measurements and Range.

If the initial test section should prove to be unacceptable, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that are not acceptable shall be removed at the Contractor's expense. Full production shall not begin until an acceptable section has been constructed and accepted by the ENGINEER. The initial test section, whether acceptable or unacceptable, and any subsequent section that meets specification requirements shall be paid for in accordance with the paragraph for PAYMENT.

Job mix control testing shall be performed by the Contractor at the start of plant production and in conjunction with the calibration of the plant for the JMF. It should be recognized that the aggregates produced by the plant may not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens should be prepared and the optimum asphalt binder content determined in the same manner as for the original design tests. A revised JMF will need to be submitted and a test section constructed prior to approval and full production. The test section and JMF submittal shall conform to all the specification requirements contained herein.

CONSTRUCTION DETAILS:

WEATHER LIMITATIONS. The hot mix asphalt shall not be placed when weather conditions of fog or rain prevail or when the pavement surface or base shows signs of free moisture. When the surface temperature of the underlying course is less than 50°F (10°C) the ENGINEER shall determine the time available for compaction. The time available for compaction shall be calculated based on the time, date, air temperature, average wind speed, sky conditions, latitude, mix type, PG grade, lift thickness, mix delivery temperature, existing surface type, existing moisture content of surface, existing state of moisture in surface, and surface temperature. The estimated time available for compaction can be calculated with the computer program called Pave Cool Tool 2.0. This program is available free of charge at the following web location: http://mnroad.dot.state.mn.us/research/mnroad_project/restools/cooltool.asp

The information regarding the air temperature, average wind speed, sky conditions, mix delivery temperature, and existing moisture conditions shall be evaluated by the Engineer and a Contractor's representative located at the paving operation. The estimated time available for compaction shall be provided by the Engineer to the Contractor. The Engineer and the Contractor shall determine if there is an adequate amount of time available to compact the mixture. Options can be explored to extend the time available for compaction. If there is an adequate amount of time available to compact the mixture, the temperature requirements may be waived by the Engineer; however all other requirements including compaction shall be met. The Contractor assumes responsibility for constructing the pavement to meet density and specification requirements.

The Engineer will not permit work to continue when overtaken by sudden storms until the pavement surface shows no signs of free moisture. The material in transit at the time of shutdown will not be placed until the pavement surface shows not signs of free moisture, provided the mixture is within temperature limits as specified.

HOT MIX ASPHALT PLANT. Plants used for the preparation of hot mix asphalt shall conform to the requirements of the current State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction in addition to the following:

(1) Testing Facilities. The Contractor shall provide laboratory facilities at the plant for the use of the Engineer's acceptance testing and the Contractor's quality control testing, in accordance with the paragraph TESTING LABORATORY. All the necessary testing equipment, including the Superpave gyratory compactor, shall be located at the HMA plant supplying material to the project. All the necessary testing equipment shall be provided by the Contractor at no additional cost.

(2) Inspection of Plant. The Engineer, or their authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

(3) Storage Bins and Surge Bins. Use of surge bins or storage bins for temporary storage of hot mix asphalt will be permitted in accordance with the ConnDOT standard specifications section 4.06.03, except mixtures with RAP. Hot mix asphalt mixtures containing RAP shall conform to the following:

- a. For hot mix asphalt containing RAP, the storage period shall be established from the Rolling Thin Film Oven (RTFO) residue at 140°F (60°C), tested in accordance with AASHTO T240. Prior to production the Contractor shall recover, by AASHTO T170, a sufficient quantity of the RAP binder. The RAP binder shall be blended with the virgin binder at the JMF percentages. The laboratory RAP-virgin binder blend shall be

subjected to the RTFO at 140°F (60°C) and the viscosity of the residue shall establish the maximum viscosity allowed for the binder after silo storage. The viscosity of the residue shall be determined in accordance with AASHTO T202 or AASHTO TP48.

HAULING EQUIPMENT. Trucks used for hauling hot mix asphalt shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. If the anti-adhesive agent is sprayed in a heavy amount, the truck bed shall be completely raised and allowed to drain until the excess amount has been removed. Containment of the excess anti-adhesive material may be required for environmental concerns depending on the type of anti-adhesive agent used. Each truck shall have a suitable cover to protect the mixture from adverse weather. During transportation of the hot mix asphalt materials from the plant to the project site, each load shall be fully covered at all times, without exception, to furnish complete protection. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

MATERIAL TRANSFER DEVICE (MTD). A material transfer device is recommended but not required to deliver the mainline hot mix asphalt materials to the paver during the installation of all intermediate lifts, and all surface courses. The MTD system shall consist of the following four major sections:

1. Truck Unloading Hopper and Conveyor. This section shall receive the asphalt mixtures from the trucks and lift the asphalt mixture to the asphalt bin located in the middle of the MTD.
2. Asphalt Bin. This section shall be located in the middle of the MTD and have the capacity for storing a minimum of 15 tons (13.61 MG) of the asphalt mixture. The bin shall have augers located on the bottom of the bin that continuously mix the asphalt mixture as it discharges from the bin.
3. Discharge Conveyor. This section shall deliver the asphalt mixture to the insert paver hopper attached to the paver. The discharge conveyor shall have the capacity to rotate in either direction to allow the MTD to operate on an adjacent lane to the paving operation.
4. Insert Paver Hopper. This section is a separate hopper with a minimum capacity of 18 tons (16.33 MG) that shall be inserted into the regular paver hopper.

The material transfer device shall be capable of remixing plant mix between the hauling vehicles and the hot mix asphalt pavers. Plant mix shall be remixed in the device prior to being laid by the paver or spreader. The plant mix delivered by the material transfer device shall be a homogeneous, non-segregated mixture.

The MTD shall not be weighted or loaded and operated as to cause damage to structures or the roadway or to any other type of construction. Hauling of materials over the base course or surface course under construction shall be limited as directed by the Engineer. No loads will be permitted on a concrete pavement, base or structure before the expiration of the curing period. The Contractor shall be responsible for all damages done by the hauling and placement equipment.

In cases where it is necessary to haul material over a structure, whether old or new, the Contractor will be required to limit the gross loads. Limiting the gross load may be accomplished by adding an additional axle or axles to the MTD, anticipating the bridge crossing and having the MTD empty by the time it reaches the bridge, provide adequate shoring or guides to the bridge structure, and/or any additional method as approved by the Engineer. Load restricted bridges shall not be crossed without prior written approval from the Engineer. Additionally, the MTD shall be the only vehicle allowed on the bridge structures as it traverses the structures. For bridges with posted weight restrictions, the Contractor shall analyze the load situation and provide a recommended course of action to the Engineer.

MTDs exceeding 40 tons unloaded must obtain approval from the Engineer prior to use on bridge structures.

HOT MIX ASPHALT PAVERS. Hot mix asphalt pavers shall be self-contained, heated, power-propelled units with an activated screed or strike-off assembly, and shall be capable of spreading and finishing courses of hot mix asphalt material which will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of hot mix asphalt material in widths shown on the plans.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

The paver shall be equipped with quick and efficient steering devices and shall have reverse as well as forward traveling speeds.

An automatic grade control device shall be used. The paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or

through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent.

The controls shall be capable of working in conjunction with any of the following attachments:

- a. Ski-type device of not less than 30 feet (9.14 m) in length.
- b. Taut stringline (wire) set to grade.
- c. Short ski or shoe.
- d. Laser control.
- e. Sonic control.

ROLLERS. Rollers of the vibratory, steel wheel, and pneumatic-tired type shall be used. They shall be in good condition, capable of reversing direction without backlash, and operating at slow speeds to avoid displacement of the hot mix asphalt. Static rollers shall be operated at speeds not to exceed 3 mph (4.5 km/hr) and vibratory rollers shall be operated at 10 to 12 impacts/ft (32 to 39 impacts/m) in vibratory mode. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition.

The use of equipment which causes excessive crushing of the aggregate will not be permitted.

PREPARATION OF ASPHALT BINDER MATERIAL. The asphalt binder material shall be heated to the specified temperature in a manner that will avoid local overheating and provide a continuous supply of the asphalt binder material to the mixer at a uniform temperature. The temperature of the asphalt binder material delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 330°F (166°C).

PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be heated and dried prior to introduction into the mixer. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

PREPARATION OF HOT MIX ASPHALT. The aggregates and the asphalt binder material shall be weighed or metered and introduced into the mixer in the amount specified by the JMF.

The combined materials shall be mixed until the aggregate obtains a uniform coating of

asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in AASHTO T195, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95 percent of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all hot mix asphalt upon discharge shall not exceed 0.5 percent, when tested in accordance with AASHTO T110.

The temperature of the mixture when discharged from the mixer or silo shall be $\pm 20^{\circ}\text{F}$ (-6°C) from the value stated in the job mix formula. Mixtures exceeding these limits shall be subject to rejection.

PREPARATION OF THE UNDERLYING SURFACE. Immediately before placing the hot mix asphalt, the underlying course shall be cleaned of all dust and debris. A tack coat shall be applied in accordance with the contract documents and conform to the specification requirements for item tack coat. Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin uniform coating of tack material prior to the hot mix asphalt material being placed against them.

TRANSPORTING, PLACING, AND FINISHING. The hot mix asphalt shall be transported from the mixing plant to the site in vehicles conforming to the requirements of the paragraph HAULING EQUIPMENT. Deliveries shall be scheduled so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Trafficking over freshly placed surface course material shall not be permitted until the material has been compacted, and allowed to cool to a temperature of 140°F (60°C) minimum.

Adequate artificial lighting shall be provided during night placements. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to an internal temperature of 140°F (60°C) minimum.

Upon arrival, the mixture shall be placed to the full width by a hot mix asphalt paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the hot mix asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The mixture shall be placed in consecutive adjacent strips having a minimum width of 10 feet (3 m) except where edge lanes require less width to complete the area. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (300 mm). Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. The placement of the material along the longitudinal joint may be performed by setting the

screed to overlap the first mat. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. The overlapped material shall be bumped by the lutes, if necessary, to optimize the density along the longitudinal joint. Under no circumstances should the overlapped material be broadcast across the mat. Excess material should be removed by hand and returned to the screed.

Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m).

Grade control survey shall conform to the specification requirements for GRADE CONTROL. The Contractor shall furnish, set, and maintain all line and grade stakes necessary to guide the automated grade control equipment. Where required these control stakes shall be maintained by the Contractor and used throughout the operations, from the grading of the subbase material up to and including the final layers of the pavement.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the mixture may be spread and luted by hand tools. When hand spreading is permitted, the mixture shall be distributed into place by means of hot shovels and spread with lutes in a loose layer of uniform density and correct depth. The use of rakes to spread the hot mix asphalt shall not be permitted. Loads shall not be dumped any faster than they can be properly handled by the shovelers and the shovelers shall not distribute the dumped load any faster than it can properly be handled by the lutes. The luting shall be carefully and skillfully done to avoid segregation and so that, after the first passage of the roller over the luted mixture, no back patching will be necessary. Compaction must immediately follow hand spreading such that specification density is achieved while the mixture temperature is above 185°F (85°C).

Proper precautions shall be taken to prevent damage by construction operations to edges adjacent to the hot mix asphalt. These edges may be, but are not limited to, gutters, catch basins, curbs, concrete structures, and hot mix asphalt concrete. If damage occurs, repairs shall be made to the satisfaction of the Engineer with no additional payment.

The construction of hot mix asphalt concrete pavements shall terminate on November 15 and shall not be resumed prior to April 1 except as determined and directed in writing by the Engineer.

When the air temperature falls below 50°F (10°C), extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials, and placing and compacting the mixtures.

COMPACTION OF MIXTURE. After placing, the mixture shall be thoroughly and uniformly compacted by rolling. The surface shall be compacted as soon as possible when the mixture has attained sufficient stability so that the rolling does not cause

undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. Rolling shall be initiated with the drive roll or wheel towards the paving machine. When rolling on steep grades, the previous procedure may need to be altered.

The speed of the roller shall, at all times, be sufficiently slow and of uniform speed to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. The number of rollers and passes required shall be governed by the compaction results; however, at least two ten (10) ton (nine (9) Mg) rollers shall be provided for each paver employed on the paving operation. Each roller shall be operated by a competent, experienced roller operator and shall be kept in as nearly continuous operation as practicable while work is underway. A plate shall be attached to each roller showing the ballasted and unballasted weight per length-width of tread.

To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened (and scrapers used), but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers and vibratory plate compactors.

Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade. When paving in echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure.

The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods all contact surfaces shall be given a tack coat of bituminous material before placing any fresh mixture against the joint.

MATERIAL ACCEPTANCE

ACCEPTANCE SAMPLING AND TESTING. All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor. Testing organizations performing these tests shall meet the requirements of ASTM D 3666. All equipment in Contractor furnished laboratories shall be calibrated and verified by a testing organization prior to the start of operations. Such verification/certification shall be furnished to the Engineer prior to production. All testing personnel shall be certified by the New England Transportation Technician Certification Program (NETTCP), as specified below.

a. Plant-Produced Material. Plant-produced material shall be tested for VMA, gradation, asphalt binder content, and air voids at N_{design} , on a lot basis. The ENGINEER's testing personnel shall be certified by the New England Transportation Technician Certification Program (NETTCP), as HMA Plant Technicians. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. A lot will consist of:

- one day's production not to exceed 2000 tons (1,814,000kg), or
- a half day's production where a day's production is expected to consist of between 2000 and 4000 tons (1,814,000 and 3,628,000 kg), or
- similar subdivisions for tonnages over 4000 tons (3,628,000 kg).

Where more than one plant is simultaneously producing material for, the job, the lot sizes shall apply separately for each plant.

(1) Sampling. Each lot will consist of four equal sublots. Sufficient material for analysis and preparation of test specimens will be sampled by the Engineer on a random basis, in accordance with the procedures contained in ASTM D 3665. One set of laboratory compacted specimens will be prepared for each subplot in accordance with AASHTO TP4-00, at the number of gyrations required by Table 1 in the paragraph JOB MIX FORMULA. Each set of laboratory compacted specimens will consist of two test portions prepared from the same sample increment.

The sample of hot mix asphalt may be put in a covered metal tin and placed in an oven for not more than 30 minutes to maintain the heat. The compaction temperature of the specimens should be as specified in the JMF.

In addition to the hot mix asphalt samples, the Contractor shall take one, one quart sample of the PG binder used to produce the hot mix asphalt, per each lot of material produced. The PG samples shall be turned over to the Engineer.

(2) Testing. Sample specimens shall be tested for bulk specific gravity in

accordance with AASHTO T166 or T275, whichever is applicable, for use in computing air voids and density.

The gradation and asphalt binder content of the mixture shall be measured for each subplot in accordance with the following:

a. Asphalt Content. Extraction tests shall be performed once per subplot in accordance with AASHTO T164 or AASHTO T308 for determination of asphalt content. The weight of ash portion of the extraction test, as described in AASHTO T164, shall be determined as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture. If utilizing AASHTO T308 for asphalt content determination, the calibration process and calibration factor, as described in AASHTO T308, shall be determined as stated, prior to acceptance testing. A verification shall be performed as part of every twentieth test performed thereafter or when changes in the mix are apparent

The use of the nuclear method for determining asphalt content in accordance with AASHTO T287 is permitted, provided that it is calibrated for the specific mix being used.

b. Gradation. Aggregate gradations shall be determined once for each subplot from mechanical analysis of extracted aggregate in accordance with AASHTO T 30 and AASHTO T27 (Dry Sieve). When asphalt content is determined by the nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix or continuous mix plants, and tested in accordance with AASHTO T27 (dry sieve) using actual batch weights to determine the combined aggregate gradation of the mixture.

The Dust-to-Effective Asphalt ratio shall be determined once for each subplot from the mechanical analysis of extracted aggregate and the asphalt binder content. The Dust-to-Effective Asphalt ratio shall be determined by the ENGINEER in accordance with AASHTO PP28-00.

The theoretical maximum specific gravity of the mixture shall be measured for each subplot in accordance with AASHTO T209, Type C, D, or E container. Samples shall be taken on a random basis in accordance with ASTM D 3665. The value used in the field placed void computations for each subplot shall be the average of all maximum specific gravity measurements for the lot.

Moisture Content of Aggregate. The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with AASHTO T255.

Moisture Content of Mixture. The moisture content of the mixture shall be determined once per mixture in accordance with AASHTO T110 or at a frequency approved by the Engineer.

Temperatures. Temperatures shall be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the mixture at the plant, and the mixture at the job site.

VMA at N_{design} and air voids at N_{design} , for each plant sample, will be determined by the ENGINEER in accordance with AASHTO PP28-00. The VMA, and air voids at N_{design} for each subplot shall be computed by averaging the results of the two test specimens representing that subplot.

(3) Acceptance. Acceptance of plant produced material for VMA at N_{design} , gradation, asphalt binder content, and air voids at N_{design} , shall be determined by the ENGINEER in accordance with the requirements of ACCEPTANCE CRITERIA.

b. Field Placed Material. Material placed in the field shall be tested for mat and joint density on a lot basis. The ENGINEER'S testing personnel shall be certified by the New England Transportation Technician Certification Program (NETTCP), as HMA Paving Technicians or HMA Plant Technicians. The ENGINEER may conduct any necessary testing to monitor that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

(1) Mat Density. The lot size shall be the same as that indicated in the paragraph ACCEPTANCE SAMPLING AND TESTING, Plant-Produced Material, and shall be divided into four equal sublots. One core of finished, compacted materials shall be taken by the ENGINEER from each subplot. Core locations will be determined by the ENGINEER on a random basis in accordance with procedures contained in ASTM D 3665. Cores shall not be taken closer than 1 foot (0.3 meters) from a longitudinal joint and 10 feet (3.0 meters) from a transverse joint.

(2) Joint Density. The lot size shall be the total length of longitudinal joints constructed by a lot of material as defined in the paragraph ACCEPTANCE SAMPLING AND TESTING, Plant-Produced Material. The lot shall be divided into four equal sublots.

One core of finished, compacted materials shall be taken by the ENGINEER or the Engineer's representative from each subplot. Core locations will be determined by the ENGINEER on a random basis in accordance with procedures contained in ASTM D 3665 and be located directly over the joint, not adjacent to the joint.

(3) Sampling. Samples shall be neatly cut with a core drill. The cutting edge of the core drill bit shall be of hardened steel or other suitable material with diamond chips embedded in the metal cutting edge. The minimum diameter of the sample shall be 3 inches (76.2mm). The minimum diameter of the base samples shall be 6 inches (152.4mm). Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. The Engineer

or the Engineer's representative shall furnish all tools, labor, and materials for cutting samples and filling the cored pavement. Cored holes shall be filled in a manner acceptable to the Engineer and within one day after sampling.

(4) Testing. The bulk specific gravity of each cored sample will be measured by the Engineer's NETTCP certified technician in accordance with AASHTO T166 or T275, whichever is applicable. The theoretical maximum specific gravity shall be measured once for each subplot in accordance with the plant-produced material section. The theoretical value used for the percent density of the core samples shall be the average of the four maximum specific gravity measurements for the lot. The percent density of each sample will be determined in accordance with AASHTO T269, using the bulk specific gravity of each subplot sample and the average theoretical maximum specific gravity for the lot.

(5) Acceptance. Acceptance of field placed material for mat density will be determined by the Engineer in accordance with the requirements of the paragraph ACCEPTANCE CRITERIA, Item (c) Mat Density. Acceptance for joint density will be determined in accordance with the requirements of the paragraph ACCEPTANCE CRITERIA, item d, Joint Density.

c. Partial Lots – Plant-Produced Material. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, the following procedure will be used to adjust the lot size and the number of tests for the lot.

The last batch produced where production is unexpectedly halted will be sampled and its properties shall be considered as representative of the particular subplot from which it was taken. Where three sublots are produced, they shall constitute a lot. Where one or two sublots are produced, they shall be incorporated into the next lot and the total number of sublots shall be used in the acceptance plan calculation, i.e., $n = 5$ or $n = 6$, for example.

d. Partial Lots – Field Placed Material. The lot size for field placed material shall correspond to that of the plant material, except that in no cases less than (3) cored samples shall be obtained, i.e., $n = 3$.

ACCEPTANCE CRITERIA.

a. General. Acceptance will be based on the following characteristics of the hot mix asphalt and completed pavement as well as the implementation of the Contractor's Quality Control plan and test results:

- (1) Voids in Mineral Aggregate (VMA)
- (2) Air voids at N_{design}
- (3) Mat density

- (4) Joint density
- (5) Thickness
- (6) Smoothness
- (7) Grade
- (8) Asphalt Content
- (9) Gradation

VMA and air voids at N_{design} , will be evaluated for acceptance in accordance with item b for VMA and air voids at N_{design} . Mat density will be evaluated for acceptance in accordance with the paragraph Mat Density. Joint density will be evaluated for acceptance in accordance with the paragraph Joint Density.

Acceptance for mat density and air voids will be based on the criteria contained in Item g, Acceptance Criteria for Mat Density and Air Voids. Acceptance for VMA will be based on the criteria contained in Item g, Acceptance Criteria for VMA. Acceptance for joint density will be based on the criteria contained in Item g, Acceptance Criteria for Joint Density. Thickness will be evaluated by the Engineer for compliance in accordance with Item g, Acceptance Criteria for Thickness. Acceptance for smoothness will be based on the criteria contained in Item g, Acceptance Criteria for Smoothness. Acceptance for grade will be based on the criteria contained in Item g, Acceptance Criteria for Grade. Acceptance for asphalt content and gradation will be based on the criteria contained in Item g, Acceptance Criteria for Asphalt Content and Gradation and will be evaluated for compliance in accordance with CONTROL CHARTS and the PERFORMANCE ANALYSIS.

The Engineer may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of hot mix asphalt which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if the Contractor can demonstrate in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

b. VMA and air voids at N_{design} . Acceptance of each lot of plant produced material for VMA and air voids at N_{design} shall be based on the percentage of material within specification limits (PWL). The PWL plan considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results. If a material with high variability is produced, the production must be adjusted to achieve a PWL of 90 or more.

c. Mat Density. Acceptance of each lot of in-place pavement for mat density shall be based on the percentage of material within specification limits (PWL). If a material with high variability is produced, then a higher density must be maintained in order to achieve a PWL of 90 or more.

d. Joint Density. Acceptance of each lot of in-place pavement for joint density shall be based on the percentage of material within specification limits (PWL). If a material with high variability is produced, then a higher density must be maintained in order to achieve a PWL of 90 or more.

e. Asphalt Content and Gradation. Acceptance of each lot of plant produced material for asphalt content and gradation shall be based on the percentage of material within specification limits (PWL). If a material with high variability is produced, then production must be adjusted to achieve a PWL of 90 or more.

f. Percentage of Material Within Specification Limits (PWL). The percentage of material within specification limits (PWL) is determined using standard statistical techniques and involves the average of the test results (X), the standard deviation, (Sn) of the test results, the specification tolerance limit(s) (U for upper and L for lower), and the respective Quality Index(s) (Qu and/or Ql). The specification tolerance limits(L) and (U) are contained in Table 6. The method for calculating the percent within limits shall be in accordance with the section METHOD OF ESTIMATING PERCENTAGE OF MATERIAL WITHIN SPECIFICATION LIMITS (PWL). In the event that a calculated standard deviation is zero for a measured property, the corresponding Quality Index(s) shall be taken as 100.

TABLE 6 ACCEPTANCE LIMITS VMA, AIR VOIDS, AND DENSITY

Test Property	Specification Tolerance	
	L	U
VMA, percent	Target – 1.0	-
Air voids at N_{design} , percent	3.0	5.0
Mat Density, percent	93.0	97.0
Joint Density, Percent	90.0	97.0

g. Acceptance Criteria.

(1) Mat Density. If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. If the PWL is less than 90 percent, the Contractor shall determine the reason and take corrective action. If the PWL is below 80 percent, the Contractor must stop production and make adjustments to the mix and/or the lay down and compaction procedures. A combined material performance analysis will be performed in accordance with the paragraph PERFORMANCE ANALYSIS.

(2) Air Voids at N_{design} . If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. If the PWL is less than 90 percent, the Contractor shall determine the reason and take corrective action. If the PWL is below 80 percent, the Contractor must stop production and make adjustments to

the mix. A combined material performance analysis will be performed in accordance with the paragraph PERFORMANCE ANALYSIS.

(3) VMA. If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. If the PWL is less than 90 percent, the Contractor shall determine the reason and take corrective action. If the PWL is below 80 percent, the Contractor shall stop production and make adjustments to the mix. A combined material performance analysis will be performed in accordance with the paragraph PERFORMANCE ANALYSIS.

(4) Joint Density. If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. If the PWL is less than 90 percent, the Contractor shall evaluate the method of compacting joints and take corrective action. If the PWL is below 80 percent, the Contractor shall stop production until the reason for poor compaction can be determined. A combined material performance analysis will be performed in accordance with the paragraph PERFORMANCE ANALYSIS.

(5) Thickness. The thickness requirements contained herein shall apply only when each pavement layer is specified to be a uniform compacted thickness of 1 inch (25mm) or greater. The compacted thickness of each layer of the hot asphalt mix or mixes will be measured to determine compliance with the acceptance tolerances in Table 7. Thickness shall be evaluated for compliance by the ENGINEER to the requirements shown on the plans. Measurements of thickness shall be made by the ENGINEER using the cores extracted for each subplot for density measurement.

TABLE 7 THICKNESS ACCEPTANCE TOLERANCES

Specified Thickness	Allowable Tolerances (T)
1 inch to 2 inches	+/- 1/4 inch
2 inches+ to 5 inches	+/- 3/8 inch
Over 5 inches	+/- 1/2 inch

Once the thickness measurements have been taken, a thickness index will be calculated. The thickness index is the actual deviation from the target divided by the allowable tolerance in Table 7. This allows a statistical comparison to be made among measurements based on varying specified thickness. If the PWL of the lot equals or exceeds 90 percent, the lot shall be acceptable. If the PWL is less than 90 percent, the Contractor shall determine the reason and take corrective action. If the PWL is below 80 percent, the Contractor must stop production and make adjustments. In addition, if P_l (percent within lower specification limit) is below 80 the thickness of the subsequent layer shall be adjusted to correct for the deficiency and insure the desired thickness of the completed pavement structure is in accordance with the contract requirements. Thickness indexes will be established for analysis in the combined material performance analysis. A combined material performance analysis will be

performed in accordance with the paragraph PERFORMANCE ANALYSIS.

The thickness index shall be calculated under the following equation using the specification limits in Table 8.

$$\text{Thickness Index} = \frac{(M - ST)}{T}$$

Where: M = Core Measurement
 ST = Specified Thickness as shown on the plans
 T = allowable tolerance

TABLE 8 Thickness Index Acceptance Limits

	Target	LSL	USL
Thickness Index	As Specified	- 1	+1

(6) Smoothness. The finished surfaces of the pavement shall be uniform in appearance, free from irregularities in contour and texture and shall present a smooth-riding surface. Smoothness evaluation applies to all hot mix asphalt concrete roadways receiving 1.5" (38mm) or more in plan (compacted) thickness of new or recycled pavement.

The finished surface of the pavement shall not vary more than 1/4 inch (6.2mm) for the surface course and 3/8 inch (9.5mm) for the intermediate course. Each lot shall be evaluated with a 12-foot (3.6m) straightedge. The lot size shall be 2,000 square yards (1,650 square meters). Measurements will be made perpendicular and parallel to the centerline at distances not to exceed 50 feet (15.2m). When more than 15 percent of all measurements within a lot exceed the specified tolerance, the Contractor shall remove the deficient area and replace with new material. Skin patching will not be permitted.

When profile corrections are required, the Contractor shall use one or more of the following corrective methods:

- a. Removing and replacing the entire pavement thickness;
- b. Diamond grinding or micro milling;
- c. Overlaying (not patching) with the specified surface course;
- d. Removing the surface by milling and applying a lift(s) of the specified course(s);
- e. Use of other methods that will provide the desired results;

The corrective method(s) chosen by the Contractor shall be performed at the Contractor's expense, including all necessary equipment and traffic control. Areas of removal and replacement shall be removed the full width of the lane. The removal areas shall begin and end with a transverse butt joint which shall be

constructed with a transverse saw cut perpendicular to the centerline. Replacement materials shall be placed in sufficient quantity so the finished surface will conform to grade and smoothness requirements. The corrective area shall conform to all material and density specification requirements. When the corrective work consists of an overlay, the overlay shall cover the full width of the pavement including shoulders. The area overlaid shall begin and end with a transverse butt joint which shall be constructed with a transverse saw cut and asphalt removal. All materials shall meet contract requirements. The overlay shall be placed so the finished surface will conform to grade and smoothness requirements. The overlaid area shall be compacted to the specified density.

The ENGINEER shall retest any sections where corrections were made to verify that the corrections produced a surface that conforms to the grade and smoothness requirements.

(7) Grade. The finished surface of the pavement shall not vary from the gradeline elevations and cross sections shown on the plans by more than 1/2 inch (12.70 mm). The Contractor shall remove deficient areas and replace with new material. Sufficient material shall be removed to allow at least 1.5 inches (37.5mm) of hot mix asphalt to be placed. Skin patching for correcting low areas shall not be permitted. High points may be ground off.

(8) Asphalt Content and Gradation. The asphalt content and gradation of the hot mix asphalt mixtures will be measured to determine compliance with the acceptance tolerances in Table 9. Asphalt content and gradation shall be evaluated for compliance by the ENGINEER to the target values established in the job mix formula.

TABLE 9 ACCEPTANCE LIMITS FOR ASPHALT CONTENT AND GRADATION

Sieve Size	Specification Tolerance
1-1/2" (38.1 mm)	Target +/-0%
1" (25.4 mm)	Target +/-6%
3/4" (19.0 mm)	Target +/-6%
1/2" (12.5 mm)	Target +/-6%
3/8" (9.5 mm)	Target +/-6%
#4 (4.75 mm)	Target +/-6%
#8 (2.36mm)	Target +/-6%
#16 (1.18 mm)	Target +/-5%
#30(0.600 mm)	Target +/-5%
#50 (0.300 mm)	Target +/-3%
#200 (0.075 mm)	Target +/-2%
Asphalt Binder Content	Target +/-0.45%

When 25.4 mm maximum size aggregate is specified, the 38.1 mm sieves should be deleted from the Acceptance Limits table and the 25.4 mm sieve tolerance should be changed to 0%. When 19.0 mm maximum size aggregate is specified, the 25.4 mm sieves should be deleted from the Acceptance Limits table and the 19.0 mm sieve tolerance should be changed to 0%. When 12.5 mm maximum size aggregate is specified, the 19.0 mm sieves should be deleted from the Acceptance Limits table and the 12.5 mm sieve tolerance should be changed to 0%. When 9.5 mm maximum size aggregate is specified, the 12.5 mm sieves should be deleted from the Acceptance Limits table and the 9.5 mm sieve tolerance should be changed to 0%.

The PWL shall be calculated for the asphalt content and each sieve listed in Table 9 for the lot. If the PWL of the lot equals or exceeds 90 percent for the asphalt content and on each sieve, the lot shall be acceptable. If any of the PWLs are less than 90 percent, the Contractor shall determine the reason and take correction action. If any of the PWLs are below 80 percent, the Contractor shall stop production and make adjustments to the mix. A combined material performance analysis will be performed in accordance with the paragraph PERFORMANCE ANALYSIS.

RESAMPLING PAVEMENT

a. General. Resampling of a lot of pavement for mat or joint density will be allowed if the Contractor requests, in writing, within 48 hours after receiving the written test results from the ENGINEER. A retest will consist of all the sampling and testing procedures contained in paragraphs ACCEPTANCE SAMPLING AND TESTING, (b) Field Placed Material, and ACCEPTANCE CRITERIA, Mat Density and Joint Density. Only one resampling per lot will be permitted.

(1) A redefined PWL shall be calculated for the resampled lot. The number of tests used to calculate the redefined PWL shall include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

b. Payment for Resampled Lots. The redefined PWL for a resampled lot shall be used to determine the acceptance or rejection for that lot in accordance with the paragraph PAYMENT.

c. Outliers. If the tests within a lot include a very large or a very small value which appears to be outside the normal limits of variation, check for an outlier in accordance with ASTM E 178, at a significance level of 5 percent, to determine if this value should be discarded when computing the PWL.

CURBING AND LEVELING COURSE - Any curbing work or any course used for truing

and leveling shall meet the requirements of the conventional Marshall mix design methods and the requirements of the current State of Connecticut Department of Transportation Standard Specifications. Curb work and leveling courses shall not be subject to the density requirements of the paragraphs ACCEPTANCE CRITERIA, for Mat Density and Joint Density (c and d). The leveling course shall be compacted with the same effort used to achieve density of the test section. The truing and leveling course shall not exceed a nominal thickness of 1.5 inches (37.5 mm).

PERFORMANCE ANALYSIS.

Quantities of HMA materials shall be evaluated for acceptance by the Engineer utilizing a Composite Performance Evaluation. The composite performance evaluation shall include an analysis of the combined effect of the material properties and the pavement densities. The composite performance evaluation shall evaluate the HMA on a lot by lot basis. A lot shall be the same as that indicated in the paragraph ACCEPTANCE SAMPLING AND TESTING, Plant-Produced Material.

TABLE 10 PERFORMANCE ADJUSTMENT FACTOR

Percentage of Material Within the Specification Limit (PWL)	Performance Factor (PF)
99+	105
90 – 99	100
80 – 90	PWL + 5.0
65 – 80	2.0 PWL – 65.0
Below 65	0

TABLE 11 MEASURED HMA PROPERTIES AND WEIGHT FACTORS

Performance Factor (PF)	Material Property	Weight Factor
PF1	Asphalt Content	.07
PF2	Percent Passing 0.075mm sieve	.05
PF3	Percent Passing 0.600mm sieve	.02
PF4	Percent Passing 2.36mm sieve	.02
PF5	Percent Passing 12.5mm, 25.4mm sieve ⁽¹⁾	.02
PF6	Air Voids at N _{design}	.15
PF7	VMA	.07
PF8	Pavement Thickness ⁽²⁾	.20
PF9	Mat Density	.30
PF10	Joint Density	.10

⁽¹⁾PF5 shall be the material property corresponding to the nominal maximum aggregate size for a given mixture based on the approved JMF.

⁽²⁾PF8 shall be evaluated on the measured thickness from the pavement core samples.

For all mixtures, the items listed in TABLE 11 shall be used for the composite performance evaluation and acceptance of the mixtures. The PWL, as calculated in accordance with the ACCEPTANCE CRITERIA section, for each of the material properties shall determine the performance factor (PF) as outlined in TABLE 10. The calculated performance factor (PF) shall then be multiplied by the corresponding Weight Factor in TABLE 11 for that material property. The product of the performance factor and the weight factor shall be designated as the Acceptance Factor. All acceptance factors shall be summed to establish the Final AcceValue.

The Final Acceptance Value shall be evaluated as part of the acceptance of the materials. A lot obtaining a Final Acceptance Value of a least 90 shall be considered acceptable. A lot obtaining a Final Acceptance Value of 80 to 90 shall require the Contractor to determine the reason and take corrective action. A lot obtaining a Final Acceptance Value of 70 to 80 shall require the Contractor to stop production and make adjustment to the mix and/or the compaction methods. A lot obtaining a Final Acceptance Value below 70 shall be unacceptable and subject to rejection and corrective actions at no additional cost.

QUALITY ASSURANCE

GENERAL -The Contractor shall establish, provide, and maintain a Quality Control Program (QCP) that will detail the methods and procedures that will be taken to assure

that all materials and completed construction conform to contract plans, technical specifications and other requirements, whether manufactured or processed by the Contractor or procured from subcontractors or vendors. Although guidelines are established and certain requirements are specified, they are minimum and the Contractor shall assume full responsibility for meeting all requirements. The program shall address all elements which effect the quality of the pavement including, but not limited to:

- a. Mix Design
- b. Aggregate Grading
- c. Quality of Materials
- d. Stockpile Management
- e. Proportioning
- f. Mixing and Transportation
- g. Placing and Finishing
- h. Joints
- i. Compaction
- j. Surface smoothness

The Contractor shall be prepared to discuss and present, at the preconstruction conference, its understanding of the quality control requirements. The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the QCP has been completed. No hot mix asphalt for payment shall be produced until the QCP has been reviewed and approved by the Engineer.

The quality control requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the acceptance testing requirements. Acceptance testing requirements are the responsibility of the Engineer.

Independent Assurance (IA) testing is an independent verification of the sampling and testing procedures designed to provide continuity to the QCP and may be performed by an AASHTO Certified Laboratory. The Engineer may periodically evaluate split samples or proficiency samples through an IA program to provide an unbiased and independent evaluation of the sampling and testing procedures used in the acceptance decision.

TESTING LABORATORY -The Contractor shall provide a fully equipped asphalt laboratory located at the plant or job site. It shall be available for joint use by the Contractor for quality control testing and by the ENGINEER for acceptance testing and must have adequate equipment for the performance of the tests required by these specifications and the requirements of NETTCP. The ENGINEER shall have priority in use of the equipment necessary for acceptance testing. All the necessary testing equipment, including the Superpave gyratory compactor, shall be located at the HMA plant supplying material to the project. The Superpave gyratory compactor shall conform to the requirements of AASHTO TP4-00. In addition, all ancillary and miscellaneous equipment needed to perform the testing in accordance with these specifications shall be provided by the Contractor at no additional cost.

The effective working area of the laboratory shall be a minimum of 150 square feet (14 square meters) with a ceiling height of not less than 7.5 feet (2.3 meters). Lighting shall be adequate to illuminate all working areas. It shall be equipped with heating and air conditioning units to maintain a temperature of 70°F \pm 5°F (21°C \pm 2.3°C).

Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

SAMPLING - The sampling and testing of all materials shall be a statistically based procedure of random sampling which provides that all materials being produced have an equal chance of being selected for sampling and testing. 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 deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

QUALITY CONTROL TESTING - The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to these specifications and as set forth in the QCP. The Quality Control Testing shall be performed on a lot to lot basis by only certified NETTCP HMA Plant Technicians and certified NETTCP HMA Paving Technicians. The testing program shall include, but not necessarily limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A Quality Control Testing Plan shall be developed as part of the QCP. The Engineer reserves the right to monitor any or all of the Contractor's testing.

CONTROL CHARTS - The Engineer shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation and asphalt content.

Control charts shall be posted in the testing laboratory and shall be kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Engineer's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the Engineer may suspend production or acceptance of the material.

a. Individual Measurements. Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation and asphalt content. The control charts shall use the JMF target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

TABLE 12 CONTROL CHART LIMITS FOR INDIVIDUAL MEASUREMENTS

Sieve Size	Limits	
	Action	Suspension
1-1/2" (38.1 mm)	0%	0%
1" (25.4 mm)	+/-6%	+/-9%
3/4" (19.0 mm)	+/-6%	+/-9%
1/2" (12.5 mm)	+/-6%	+/-9%
3/8" (9.5 mm)	+/-6%	+/-9%
#4 (4.75 mm)	+/-6%	+/-9%
#8 (2.36 mm)	+/-6%	+/-9%
#16 (1.18 mm)	+/-5%	+/-7.5%
#30 (0.600 mm)	+/-5%	+/-7.5%
#50 (0.300 mm)	+/-3%	+/-4.5
#200 (0.075 mm)	+/-2%	+/-3%
Asphalt Binder Content	+/-0.45%	+/-0.70%

When 25.4 mm maximum size aggregate is specified, the 38.1 mm sieves should be deleted from the Individual Measurements Chart and the 25.4 mm sieve Action and Suspension Limits should be changed to 0%. When 19.0 mm maximum size aggregate is specified, the 25.4 mm sieves should be deleted from the Individual Measurements Chart and the 19.0 mm sieve Action and Suspension Limits should be changed to 0%. When 12.5 mm maximum size aggregate is specified, the 19.0 mm sieves should be deleted from the Individual Measurements Chart and the 12.5 mm sieve Action and Suspension Limits should be changed to 0%. When 9.5 mm maximum size aggregate is specified, the 12.5 mm sieves should be deleted from the Individual Measurements Chart and the 9.5 mm sieve Action and Suspension Limits should be changed to 0%.

b. Range. Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. Should the Engineer elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

CONTROL CHART LIMITS BASED ON RANGE	
(Based on n = 2)	
Sieve	Suspension Limit
1-1/2" (38.1 mm)	11 percent
1" (25.4 mm)	11 percent
3/4" (19.0 mm)	11 percent
1/2" (12.5 mm)	11 percent
3/8" (9.5 mm)	11 percent
#4 (4.75 mm)	11 percent
#8 (2.36 mm)	10 percent
#16 (1.18 mm)	9 percent
#50 (0.30 mm)	6 percent
#200 (0.075 mm)	3.5 percent
Asphalt Binder Content	0.8 percent

c. Corrective Action. The Quality Control Plan shall indicate that appropriate action to be taken when the process is believed to be out of tolerance. The Plan shall contain sets of rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

- (1) One point falls outside the Suspension Limit line for individual measurements or range; or
- (2) Two points in a row fall outside the Action Limit line for individual measurements.
- (3) Three nonconsecutive samples fall outside the Action Limit line for individual measurements.

Failure to stop production and make adjustments when required due to an individual test not meeting the specified requirements shall subject all mix from the stop point tonnage to the point when the next individual test is back on or within the warning limits, or to the tonnage point when production is actually stopped, whichever occurs first, to be considered unacceptable. This material shall be removed and replaced with materials which comply with the specifications.

METHOD OF ROUNDING

ROUNDING - Numbers used in all calculations shall be carried to the correct significant figures and rounded according to the following procedures:

- a. When the first digit after those you want to drop is 4 or less, that digit and all others to the right are dropped. Ex. 62.9437 to 3 significant digits = 62.9
- b. When the first digit after those you want to retain is 5 or greater, that and all others to the right are dropped and the last digit retained is increased by one. Ex. 1.955234 to 3 significant digits = 1.96

MEASUREMENT:

Plant mix hot mix asphalt pavement shall be measured by the number of tons of hot mix asphalt used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.

PAYMENT:

Payment for an accepted lot of hot mix asphalt concrete pavement shall be made at the contract unit price per ton for hot mix asphalt. The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

a. Basis of Payment. Each lot shall be accepted when the Final Acceptance Value equals or exceeds 90 percent. For each accepted lot, payment shall be calculated by multiplying the Final Acceptance Value (as a percent) by the contract unit price per ton for the corresponding tonnage accepted. All final grades and smoothness requirements shall be met.

When the calculation of PWL for mat density, joint density, mix air voids, and/or Final Acceptance Value falls below 65, the lot shall be rejected. However, the Engineer may decide to accept the deficient lot. In that case, if the Engineer and Contractor agree in writing, that the lot shall not be removed, it will be paid for at a reduced percent of the contract price.

When the calculation of the Final Acceptance Value falls between 65 and 90, the lot shall be adjusted for payment. For each deficient lot, payment shall be calculated by multiplying the Final Acceptance Value (as a percent) by the contract unit price per ton for the corresponding tonnage.

TESTING REQUIREMENTS

AASHTO T104	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
AASHTO T11	Materials Finer than 75-um (No.200) Sieve in Mineral Aggregates by Washing
AASHTO T96	Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T127	Sampling and the Amount of Testing of Hydraulic Cement
AASHTO T255	Total Moisture Content of Aggregate by Drying
AASHTO T2	Sampling of Aggregates
AASHTO M17	Mineral Filler for Bituminous Paving Mixtures
AASHTO T170	Recovery of Asphalt from Solution by Abson Method
AASHTO T275	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
AASHTO T110	Moisture or Volatile Distillates in Bituminous Paving Mixtures
AASHTO T245	Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
AASHTO T209	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
AASHTO T164	Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
AASHTO T176	Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
AASHTO T195	Determining Degree of Particle Coating of Bituminous-Aggregate Mixtures
AASHTO T166	Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
AASHTO T269	Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D 2950	Density of Bituminous Concrete in Place by Nuclear Method
ASTM D 3665	Random Sampling of Paving Materials
ASTM D 3666	Inspection and Testing Agencies for Bituminous Paving Materials
AASHTO T287	Asphalt Cement Content of Asphalt Concrete Mixtures by the Nuclear Method
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
ASTM D 4791	Flat or Elongated Particles in Coarse Aggregate
ASTM E 178	Practice for Dealing With Outlying Observations
ASTM D5821	Determining the Percentage of Fractured Particles in Coarse Aggregate
AASHTO T304	Uncompacted Void Content of Fine Aggregate
AASHTO T 30	Mechanical Analysis of Extracted Aggregate
AASHTO T202	Viscosity of Asphalts by Vacuum Capillary Viscometer
AASHTO T240	Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin Film Oven Test)
AASHTO T283	Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
AASHTO T308	Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

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ADDITIONAL REQUIREMENTS

AASHTO MP1	Standard Specification for Performance Graded Asphalt Binder
AASHTO MP2	Standard Specification for Superpave Volumetric Mix Design
AASHTO PP2	Standard Practice for Mixture Conditioning of Hot Mix Asphalt (HMA)
AASHTO PP6	Grading or Verifying the Performance Grade of an Asphalt Binder
AASHTO PP26	Standard Practice for Certifying Suppliers of Performance Graded Asphalt Binders
AASHTO PP28	Standard Practice for Superpave Volumetric Design of Hot Mix Asphalt (HMA)
AASHTO TP4	Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyrotory Compactor
AASHTO TP5	Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
AASHTO TP48	Viscosity Determinations of Unfilled Asphalts Using the Brookfield Thermosel Apparatus

METHOD OF ESTIMATING PERCENTAGE OF MATERIAL WITHIN SPECIFICATION LIMITS (PWL)

GENERAL - When the specifications provide for material to be sampled and tested on a statistical basis, the material will be evaluated for acceptance in accordance with this section. All test results for a lot will be analyzed statistically, using procedures to determine the total estimated percent of the lot that is within specification limits. This concept, termed percent within limits (PWL), is a statistically based evaluation method, whereby the PWL is computed on a lot basis, using the average (\bar{X}) and standard deviation (S_n) of the specified number (n) of subplot tests for the lot and the specification tolerance limits (L for lower and U for upper) for the particular acceptance parameter. From these values, the respective Quality index(s) (QL for Lower Quality Index and/or QU for Upper Quality Index) is computed and the PWL for the specified n is determined from Table 12.

METHOD FOR COMPUTING PWL The computational sequence for computing the PWL is as follows:

- a. Divide the lot into n sublots in accordance with the acceptance requirements of the specification.
- b. Locate the sampling position within the subplot in accordance with the random sampling requirements of the specification.
- c. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.

- d. Average all subplot values within the lot to find X by using the following formula:

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where:

X = Average of all subplot values within a lot

x₁, x₂ = Individual subplot values

n = Number of sublots

- e. Find the standard deviation S_n by use of the following formula:

$$S_n = \text{SQRT}[(d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2) / (n-1)]$$

Where:

S_n = standard deviation of the number of subplot values in the set

d₁, d₂ = deviations of the individual subplot values X₁, X₂ . . . from the average value X

that is: d₁ = (x₁ - X), d₂ = (x₂ - X) . . . d_n = (x_n - X)

n = number of sublots

- f. For single sided specification limits (i.e., L only), compute the Lower Quality Index QL by use of the following formula:

$$QL = (X - L) / S_n$$

Where:

L = specification lower tolerance limit

Estimate the percentage of material within limits (PWL) by entering Table 12 with QL, using the column appropriate to the total number (n) of measurements. If the value of QL falls between values shown on the table, use the next higher value of PWL.

- g. For double sided specification limits (i.e. L and U), compute the Quality Indexes QL and QU by use of the following formulas:

$$QL = (X - L) / S_n \text{ and } QU = (U - X) / S_n$$

Where:

L and U = specification lower and upper tolerance limits

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table 12 separately with QL and QU, using the column appropriate to the total number (n) of measurements, and determining the percent of material above PL and percent of material below PU for each tolerance limit. If the values of QL fall between values shown on the table, use the next higher value of PL or PU. Determine the PWL by use of the following formula:

$$PWL = (PU + PL) - 100$$

Where:

PL = percent above lower specification limit

PU = percent below upper specification limit

EXAMPLE OF PWL CALCULATION

Project: Example Project

Test Item: Heavy Duty Surface, Lot 1.

A. PWL Determination for Mat Density.

1. Density of four random cores taken from Lot A.

A-1 96.60

A-2 97.55

A-3 99.30

A-4 98.35

n = 4

2. Calculate average density for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$$

$$X = 97.95 \text{ percent density}$$

3. Calculate the standard deviation for the lot.

$$S_n = \text{SQRT}[\frac{((96.60 - 97.95)^2 + (97.55 - 97.95)^2 + (99.30 - 97.95)^2 + (98.35 - 97.95)^2)}{(4 - 1)}]$$

$$S_n = \text{SQRT}[(1.82 + 0.16 + 1.82 + 0.16) / 3]$$

$$S_n = 1.15$$

4. Calculate the Lower Quality Index QL for the lot. (L=96.3)

$$QL = (X - L) / S_n$$

$$QL = (97.95 - 96.30) / 1.15$$

$$QL = 1.4384$$

5. Determine PWL by entering Table 12 with QL= 1.44 and n= 4.

$$PWL = 98$$

B. PWL Determination for Air Voids.

1. Air Voids of four random samples taken from Lot A.

A-1 5.00

A-2 3.74

A-3 2.30

A-4 3.25

2. Calculate the average air voids for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$

$$X = 3.57 \text{ percent}$$

3. Calculate the standard deviation S_n for the lot.

$$S_n = \text{SQRT}[\frac{(3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2}{(4 - 1)}]$$

$$S_n = \text{SQRT}[(2.04 + 0.03 + 1.62 + 0.10) / 3]$$

$$S_n = 1.12$$

4. Calculate the Lower Quality Index QL for the lot. (L= 2.0)

$$QL = (X - L) / S_n$$

$$QL = (3.57 - 2.00) / 1.12$$

$$QL = 1.3992$$

5. Determine PL by entering Table 12 with QL = 1.40 and n = 4.

$$PL = 97$$

6. Calculate the Upper Quality Index QU for the lot. (U= 5.0)

$$QU = (U - X) / S_n$$

$$QU = (5.00 - 3.57) / 1.12$$

$$QU = 1.2702$$

7. Determine PU by entering Table 12 with QU = 1.27 and n = 4.

$$PU = 93$$

8. Calculate Air Voids PWL

$$PWL = (PL + PU) - 100$$

$$PWL = (97 + 93) - 100 = 90$$

EXAMPLE OF PERFORMANCE ANALYSIS:

	AC %	#200	#50	#30	#16	#8	#4	3/8	1/2	3/4	1	1-1/2
Tolerances (+ or -)	0.45	2.0	3	5	5	6	6	6	6	6	0	0
Upper Spec Limit	5.45	5.6	12	19	25	40	56	72	82	96	100	100
Target JMF	5.00	3.6	9	14	20	34	50	66	76	90	100	100
Lower Spec Limit	4.55	1.6	6	9	15	28	44	60	70	84	100	100
date/sample #												
10/10/00 #1	5.10	4.2	9	14	23	39	53	68	79	91	100	100
10/10/00 #2	5.30	3.8	8	13	21	36	50	64	75	86	100	100
10/10/00 #3	5.10	3.5	8	13	20	35	49	63	74	86	100	100
10/10/00 #4	5.50	3.4	9	15	20	34	47	61	74	88	100	
Count	4	4	4	4	4	4	4	4	4	4	4	3
Mean	5.25	3.7	8.5	13.8	21.0	36.0	49.8	64.0	75.5	87.8	100	100
Stand Dev	0.19	0.36	0.58	0.96	1.41	2.16	2.50	2.94	2.38	2.36	0.00	0.00
Qu	1.0445	5.217	6.062	5.4834	2.8284	1.8516	2.5000	2.7175	2.7305	3.4915	100.0	100
		1	2								000	
Ql	3.6556	5.912	4.330	4.9612	4.2426	3.7033	2.3000	1.3587	2.3105	1.5870	100.0	100
		7	1								000	
Pu	85	100	100	100	100	100	100	100	100	100	100	
Pl	100	100	100	100	100	100	100	96	100	100	100	
PWL	85	100	100	100	100	100	100	96	100	100	100	-100
Perform. Factor (PF)	90	105	105	105	105	105	105	100	105	105	105	
Weight Factor	.07	.05		.02		.02				.02		
Acceptance Factor	6.3	5.25		2.1		2.1				2.1		

	MAT CORES				JOINT CORES			
Bulk Specific Gravity:	2.387	2.367	2.358	2.387	2.240	2.242	2.300	2.240
Theoretical Maximum Specific Gravity (Gmm):	2.532	2.532	2.532	2.532	2.532	2.532	2.532	2.532
% Compaction of Gmm	94.27	93.48	93.13	94.27	88.47	88.55	90.84	88.47
Percent Voids in Place (Pa):	5.727	6.517	6.872	5.727	11.532	11.453	9.163	11.532
Thickness (inches):	2.50	2.50	3.20	2.60	2.85	2.85	2.80	2.60
Thickness Index:	0.000	0.000	1.867	.267	.933	.800	.800	.267

	voids	vma	mat Thickness	Mat Density	jt density	Joint Thickness	Combined thickness
Tolerances (+ or -)		1.0					
Upper Spec Limit	5.0		1	97.0	97.0	1	1
Target JMF	4.0	13.0	0			0	0
Lower Spec Limit	3.0	12.0	-1	93.0	90.0	-1	-1
date/sample #							
10/10/00 #1	3.60	12.5	0	94.27	88.47	.933	
10/10/00 #2	3.70	13.1	0	93.48	88.55	.8	
10/10/00 #3	4.10	13.3	1.867	93.13	90.84	.8	
10/10/00 #4	3.10	12.2	.267	94.27	88.55	.267	
Count	4	4	4	4	4	4	8
Mean	3.63	12.78	.534	93.79	89.10	.700	.617
Stand Dev	.41	.512	.898	0.577	1.159	.295	.625
Qu	3.3431		.5196	5.5623	6.8160	1.0156	.6131
QI	1.5196	1.5126	1.7079	1.3678	-0.7769	5.7550	2.5862
Pu	100			100	100		73
PI	100	100		96	24		100
PWL	100			96	24		73
Perform. Factor (PF)	105	105		100	0		81
Weight Factor	.15	.07		0.3	0.1		0.2
Acceptance Factor	15.75	7.35	0	31.5	0		16.2

Final Acceptance Value= 88.65

The specified thickness (target) for this layer was 2.5", which results in an allowable tolerance of $\pm 3/8$ ". The thickness index is calculated by the following formula:

$$\text{Thickness Index} = \frac{\text{Measured Core Thickness} - \text{Target Thickness}}{\text{Allowable tolerance}}$$

The Final Acceptance Value is the sum of all the Acceptance Factors. Based on the test results given in this example the contractor would be required to stop production under the Acceptance Criteria section for Joint Density because the PWL was 24. Under the section for Payment, this lot would be subject to a reduced payment in accordance with: Final Acceptance Value (as percent) x contract price per ton. The payment would be equal to 88.65% payment for this lot. The Final Acceptance Value of 88.65 would require the contractor to determine the reason for the deficiencies and take corrective action.

TABLE 13. TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (PWL)

Percent Within Positive Values of Q (QL and QU) Limits

(PL and PU)	n=3	n=4	n=5	n=6	n=7	n=8
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4716
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630
87	1.0597	1.1100	1.1173	1.1191	1.1199	1.1204
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015
83	0.9939	0.9900	0.9785	0.9715	0.9672	0.9643
82	0.9749	0.9600	0.9452	0.9367	0.9325	0.9281
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747
70	0.6787	0.6000	0.5719	0.5583	0.5504	0.5454
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592
66	0.5563	0.4800	0.4545	0.4424	0.4354	0.4310
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4031
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1592
55	0.1806	0.1500	0.1408	0.1363	0.1338	0.1322
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0792
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264
50	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 13. TABLE FOR ESTIMATING PERCENT OF LOT WITHIN LIMITS (PWL)

Percent Within Negative Values of Q (QL and QU) Limits

(PL and PU)	n=3	n=4	n=5	n=6	n=7	n=8
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0792
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057
45	-0.1806	-0.1500	-0.1408	-0.1363	-0.1338	-0.1322
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1592
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4031
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4354	-0.4310
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164
30	-0.6787	-0.6000	-0.5719	-0.5583	-0.5504	-0.5454
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9325	-0.9281
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9672	-0.9643
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794
13	-1.0597	-1.1100	-1.1173	-1.1191	-1.1199	-1.1204
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4716
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520

TEST METHOD FOR BULK SPECIFIC GRAVITY OF AGGREGATE BLENDS WITH RAP

SCOPE

1. This test method covers the procedure to determine the bulk specific gravity (Gsb) of a combined aggregate blend with RAP used in a HMA mixture.
2. This test method may involve hazardous materials, operations, and equipment. This test method does not purport to address all of the safety problems associated with the test method's use. The test method user's responsibility is to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

REFERENCED DOCUMENTS

1. AASHTO Standards
T-2 Sampling Aggregates
T-84 Specific Gravity and Absorption of Fine Aggregates
T-85 Specific Gravity and Absorption of Coarse Aggregate
T-100 Specific Gravity of Soils
T-164 Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
T170 Recovery of Asphalt From Solution by Absorption Method
T-209 Maximum Specific Gravity of Bituminous Paving Mixtures
T-228 Specific Gravity of Semi-Solid Bituminous Materials (Pycnometer Method)
2. Other References
MS-2 Mix Design Methods for Asphalt Concrete by the Asphalt Institute

TERMINOLOGY

Terms and Abbreviations. Definitions for terms and abbreviations shall be in accordance with the Standard Specifications.

SIGNIFICANCE AND USE

1. This test method is used to determine the bulk specific gravity of a combined aggregate blend with RAP used in HMA mixture.
2. The bulk specific gravity (Gsb) of a combined aggregate blend is calculated using an estimate of the bulk specific gravity of the aggregate in the RAP and the actual bulk specific gravity of the other aggregates.
3. The bulk specific gravity of an aggregate blend is used to perform a volumetric analysis on compacted HMA in accordance with the Mix Design Methods for Asphalt Concrete by the Asphalt Institute.

APPARATUS

Apparatus shall be as stated in the referenced test methods.

SAMPLING

Sampling shall be as stated in the referenced test methods.

PROCEDURE

1. Identify the coarse aggregate(s), fine aggregate(s) and RAP selected for use in the mix designs.
2. Identify and record the actual percentages for each of the aggregate components used in the combined aggregate blend of the mix design.
3. Obtain a representative sample of the coarse aggregate, fine aggregate mineral filler and RAP in accordance with the AASHTO procedures.
4. Determine and record the bulk specific gravity of each of the coarse aggregate(s) in accordance with AASHTO T-85.
5. Determine and record the bulk specific gravity of each of the fine aggregate(s) in accordance with AASHTO T-84.
6. Determine and record the maximum specific gravity of the RAP in accordance with AASHTO T-209, Type C, D, or E container.
7. Determine and record the asphalt content of the RAP using AASHTO T164.
8. Calculate and record the effective specific gravity of the RAP aggregate in accordance with the following:

$$G_{se} = (100 - P_{brap}) / ((100/G_{mmrap}) - (P_{brap}/G_{brap}))$$

Where:

G_{se} = Effective specific gravity of the RAP aggregate

P_{brap} = Percent binder of the RAP

G_{mmrap} = Maximum specific gravity of the RAP

G_{brap} = Specific gravity of asphalt in the RAP (AASHTO T228)

9. Calculate and record the effective specific gravity of the combined aggregate blend as follows.

$$G_{sbBlend} = \frac{\%CA1 + \%CA2 + \%FA1 + \%FA2 + \%BHF + \%RAP}{100}$$

$$\frac{\%CA1}{Gsb} + \frac{\%CA2}{Gsb} + \frac{\%FA1}{Gsb} + \frac{\%FA2}{Gsb} + \frac{\%BHF}{Gsb} + \frac{\%RAP}{Gse}$$

Where:

GsbBlend = Bulk specific gravity of the combined aggregate blend.

Gsb = Bulk specific gravity of each respective aggregate.

Gse = Effective specific gravity of the RAP.

%CA1 = Percent of aggregate blend that is course aggregate #1.

%CA2 = Percent of aggregate blend that is course aggregate #2.

%FA1 = Percent of aggregate blend that is fine aggregate #1.

%FA2 = Percent of aggregate blend that is fine aggregate #2.

%BHF = Percent of aggregate blend that is bag house fines.

%RAP = Percent of aggregate blend that is RAP.

REPORT

Report the Gsb of the combined aggregate blend to the nearest 0.001.

ITEM 407 BITUMINOUS CONCRETE TRENCH REPAIR

DESCRIPTION:

The Contractor shall repair pavements which have been damaged or removed during this construction in accordance with these specifications and as ordered by the Engineer. The pavement repair item shall be used only where sewers are proposed with no road reconstruction contemplated, and in other areas as ordered by the Engineer.

MATERIALS:

1. Bituminous Concrete Mixtures shall conform to Article M.04.01.
2. Tack coat shall conform to the requirements of Article M.04.

CONSTRUCTION DETAILS:

Bituminous Concrete Pavement shall conform to Item 405.

The pavement replacement procedure shall be as follows:

Upon completion of the sewer installation the Contractor shall backfill in accordance with the specifications outlined under Item 205.

If the surface settles, additional base materials shall be added by the Contractor as ordered at no additional cost to the Authority. The surface shall be maintained smooth and even.

At a date, determined by the Engineer, dependent mostly upon the date of placement of base and the amount of settlement, the final pavement shall be placed as follows:

The edges of the excavation shall be line cut vertically one foot beyond the undisturbed earth and at no time be less than the trench limit plus two feet. The Contractor shall prepare the excavated area to receive bituminous concrete to the depth and type of pavement material as shown on the plans or as ordered by the Engineer.

The maximum thickness to be placed per course shall be as follows:

Class 1	2 ½" Max. thickness
Class 2	2" Max. thickness
Class 4	4" Max. thickness

The minimum allowable replacement thickness shall be as shown on the standard sheets.

All surfaces, both horizontal and vertical, which will be in contact with the new asphalt mix, must be thoroughly cleaned of all dirt and debris. Vertical faces of existing pavements, curbs, gutters, drainage gratings, manholes, and other contact surfaces shall be painted with a uniform coating of asphalt emulsion tack coat to provide closely bonded watertight joints. This work will be performed in such a manner as to not stain exposed curb or gutter surfaces.

The base course shall be thoroughly compacted to the methods and satisfaction of the Engineer prior to the placement of any pavement materials.

Temporary Pavement

If temporary pavement is ordered it shall be placed upon completion of the sewer installation and backfill. The Contractor shall construct the pavement consisting of a 2" thick rolled Bituminous Concrete Pavement. During the paving season, Class 2 mix shall be used, after November 15th, Class 5 mix shall be used. The Bituminous Concrete shall be placed on an approved base, consisting of trench backfill, gravel fill, or subbase, as ordered by the Engineer.

If the surface settles, additional bituminous material shall be added by the Contractor as ordered by the Engineer at no additional cost to the Authority. The surface shall be maintained smooth and even.

The final pavement will be placed at any time and by methods specified herein.

MEASUREMENT:

The work will be measured for payment by the number of square yards for the Items "Bituminous Concrete Trench Repair" and the number of square yards for "Temporary Pavement - Trench".

There will be no direct measurement for payment for the preparation of the trench for final pavement and coating of asphalt emulsion tack coat. This work and material will be included in other items.

The maximum pay width shall be the trench excavation pay limit plus two feet, as indicated by the Contract Documents, or as specifically ordered by the Engineer.

PAYMENT:

The furnishing and placing of bituminous concrete will be paid for at the contract unit price per square yard for "Bituminous Concrete Trench Repair" of the class and thickness specified in the Proposal Form. No payment will be made for trench repair

beyond the trench excavation pay limit plus two feet. Where alternate construction methods are chosen by the Contractor, additional trench repair will be completed at the sole expense of the Contractor.

The unit price shall include trench preparation and the placing of materials for asphalt emulsion tack coat.

The furnishing and placing of temporary pavement will be paid for at the contract unit price per square yard for "Temporary Pavement, of the thickness and class specified herein.

Payment for the above items will be for the items completed and accepted in place, which price shall include pavement removal as specified elsewhere, any cutting or trimming, any excavation, all materials, equipment, labor and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
407.00	Temporary Pavement, Trench Class _____, Thickness_____	Square Yard
407.10	Bituminous Concrete Trench Repair Class 1, Thickness_____	Square Yard
407.20	Bituminous Concrete Trench Repair Class 2, Thickness_____	Square Yard
407.40	Bituminous Concrete Trench Repair Class 4, Thickness_____	Square Yard

ITEM 507 CATCH BASINS, MANHOLES AND DROP INLETS

DESCRIPTION:

Under this item shall be included the construction of all catch basins, manholes and drop inlets, and the alteration, reconstruction, or conversion of such existing structures, all in conformity with the lines, grades, dimensions and details shown on the plans, or as ordered. All work shall be done in accordance with the provisions of these specifications for the various materials and work which constitute the completed structure.

When it becomes necessary to increase the horizontal dimensions of manholes, catch basins and drop inlets to sizes greater than those shown on the plans in order to provide for multiple pipe installations or large pipes, or for other reasons, the Contractor shall construct such manholes, catch basins and drop inlets to modified dimensions as directed by the Engineer.

MATERIALS:

The materials to be used in the construction shall be those indicated on the plans or ordered by the Engineer and shall conform to Article M.08.02. Protective compound material shall conform to Article M.03.01-11.

No common brick will be allowed, and mortar shall conform to Article M.11.04. Pervious material shall conform to Article M.01.01, 3/4" size on the Gradation Table.

All catch basins and manholes shall be precast reinforced concrete units unless the Contractor receives written permission to do otherwise. All precast tops and frames shall be placed on no less than two courses of brick.

Bedding material shall conform to Item 305.

CONSTRUCTION DETAILS:

All structures shall be precast reinforced concrete units unless the Contractor receives written permission to do otherwise. These structures shall be placed on no less than 6" of compacted Bedding Material.

The surfaces of the tops of all catch basins, and drop inlets shall be coated with protective compound material, applied at the rate of .04 gallons per square yard.

All masonry units shall be laid in full mortar beds.

Precast tops and metal fittings for catch basins, manholes or drop inlets shall be set in full mortar beds or otherwise secured as shown on the plans. All precast tops and frames shall be placed on no less than two courses of brick.

Inlet and outlet pipes shall extend through the walls for a sufficient distance to allow for satisfactory connections, and sealed with mortar to prevent leakage along their outer surfaces. The pipe shall be cut flush with the inside face of the wall, or as shown on the plans. All work shall be performed in a neat and orderly fashion, to the satisfaction of the Engineer.

If permission is granted for use of units other than precast, pervious material shall be used for backfilling in the upper portion of the excavation made for catch basins and drop inlets down to the elevation of the invert of the outlet pipe but in no case to a depth greater than 3 feet below the top of the structure. Drainage openings shall be formed in the four walls of the structure at or immediately above the bottom of the pervious backfill. Depending on the masonry used in the walls, such openings shall be formed by the insertion of 2-inch pipes, omission of a header brick or by leaving two open vertical joints in the masonry.

Frames and strainers or covers which are to be reset shall be removed from their present beds, the walls or sides shall be rebuilt to conform to the requirements of the new construction and the frames and gratings or covers reset. If the frames, gratings or covers are broken or so damaged as to be unfit for further use, they shall be replaced with new, sound material conforming to the above requirements for the material involved.

MEASUREMENT:

New and reconstructed catch basins and manholes shall be measured for payment by the number of linear feet of height measured to the nearest tenth of a foot from the bottom side of the floor slab to the top of the highest point on the grate or cover.

Conversion of catch basins to catch basins of the type specified or to manholes, as the case may be, will be measured for payment as a unit including all necessary alterations to the walls and furnishing and setting the frame and grate or cover.

There will be no measurement or direct payment for the application of the protective compound material. The cost shall be included in the general cost of the Item.

Drop inlets shall be measured for payment as units.

There will be no direct measurement or payment for the required bedding material, frames, gratings, and covers used in the construction on new and reconstructed structures. The cost shall be included in the general cost of the Item.

PAYMENT:

These structures and related Items will be paid for as follows:

1. EXCAVATION - will be paid for in accordance with the provisions of Item 205, "Trench Excavation and Backfill" under the appropriate classification. No measurements or separate payments will be made for furnishing and placing "Bedding Material".
2. CATCH BASINS AND MANHOLES - will be paid for at the contract unit price per linear foot of height measured to the nearest tenth of a foot from the bottom side of the floor slab to the top of the highest point on the grate or cover.
3. DROP INLETS - will be paid for at the contract unit price each for "Drop Inlet", of the type specified, complete in place, which price shall include all materials, equipment, tools, and labor incidental thereto.
4. RESET UNITS - will be paid for at the contract unit price each for "Reset Manhole", "Reset Catch Basin", or "Reset Drop Inlet", of the type specified, respectively, complete in place. The said price shall include all materials, equipment, tools and labor incidental thereto, except that when the work requires reconstruction greater than three feet measured vertically, then the entire cost of resetting the unit will be paid for as extra work unless otherwise provided.
5. FRAMES, GRATINGS AND COVERS - when required in connection with reset units, will be paid for at the contract unit price each for such "Frame, Grate or Cover", complete in place, including all incidental expense; or when no price exists, the furnishing and placing of such material will be paid for as extra work.
6. CONVERSION OF DRAINAGE STRUCTURES - will be paid for at the contract unit price each for "Conversion of Catch Basin to (Type) Catch Basin", "Convert Catch Basin to Manhole", or "Conversion of Manhole to Catch Basin", complete in place, which price shall include all alterations to present catch basin, all materials including catch basin frame and grate of the type specified, or manhole frame and cover, all equipment, tools and labor incidental thereto.

The maximum change in elevation of frame under these Items shall not exceed three feet. Greater changes if required will be paid for as extra work unless otherwise provided.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
507.01	Catch Basin	Linear Feet
507.02	Manhole	Linear Feet
507.03	Drop Inlet	Each
507.04	Reset Manhole	Each
507.05	Reset Catch Basin	Each
507.06	Reset Drop Inlet	Each
507.07	Frame Grate or Cover	Each
507.08	Conversion of Catch Basin to (Type) Catch Basin	Each
507.09	Conversion of Catch Basin to Manhole	Each
507.10	Conversion of Manhole to Catch Basin	Each

ITEM 512

SANITARY SEWER

DESCRIPTION:

The Contractor shall furnish and install complete and ready for use all sanitary sewer pipes, fittings, specials, connections, service laterals, capped outlets and all incidental items as shown on the Contract Drawings, ordered by the Engineer and as specified herein.

The sanitary sewer pipe shall be of size and type as shown on the Contract Drawings and Proposal Form and shall conform to these Specifications.

All excavations trenching supports and backfilling shall conform to applicable sections in these Specifications.

MATERIALS:

All sewer pipes shall be of the sizes and classes as shown on the Contract Drawings. The Contractor shall submit to the Engineer the manufacturer's name with details of pipe, fittings and joints.

The Contractor shall provide all the facilities, labor, materials and equipment for testing pipe when required by the Engineer.

Tests provided by ASTM Specifications will be made in the presence of or by representatives of the Engineer when so required. The manufacturer or the Contractor shall furnish equipment and labor, both skilled and unskilled, for making tests and certificates of each test, without cost to the Authority and so far as applicable, the Authority shall be considered as the "Purchaser" as that word is used in ASTM Specifications.

Preliminary passing of tests or acceptance of pipe at the manufacturer's plant or storage yard shall not constitute final acceptance of the pipe.

Pipe shall be in accordance with the following:

I. Reinforced Concrete Sewer Pipe (RCP) shall conform to ASTM C-76 amended to date.

Each section of pipe delivered to the job site shall be marked with the manufacturer's name, the date of manufacture and the pipe class.

- a. Bituminous Lining - All concrete pipe shall be coated on the inside with a bitumastic coating. The bitumastic coating shall conform to the following requirements:

Weight per gallon, pounds	11-13 weighting cup
Ash, by weight	36-41 ignition

Flash point Degrees Fahrenheit, minimum 95 ASTM D-56

The interior of each pipe shall be given two coats of the above bitumastic coating. It shall be applied with spray equipment in accordance with the manufacturer's recommendations. The first coat shall dry to touch in from three to six hours under normal atmospheric conditions. The second coat shall be applied in not less than 24 hours nor more than 48 hours after the first coat is applied.

The coating shall cover evenly the entire interior of the pipe, the bell or groove and exterior of the spigot or tongue.

- b. Joints shall conform to the requirements of ASTM C-361 for all reinforced concrete sewer pipes as amended.

Each length of pipe shall be provided with bell-and-spigot or tongue and-groove ends formed in the concrete wall which shall enclose the gasket on all surfaces when the joint is in final position. Tongue or spigot ends of pipe shall be a grooved type to hold O-ring compression gasket in place.

The compound used for the O-ring compression gasket shall conform to the requirements for physical properties of rubber gaskets as given in Section 5.9.1 of ASTM C-361 as amended.

The properties enumerated in Section 5.9.1 of ASTM C-361 shall be determined from tests performed on the rubber cord or specimens prepared from the cord. Tests for determination of the physical properties of the rubber cord shall be made in accordance with the test procedures outlined in Section 9.5 of ASTM C-361 as amended.

Prior to acceptance of the pipe, manufacturers must submit certified test reports which show that the rubber cord used meets all requirements for rubber gaskets given above.

- c. Elbows shall be segmented or mitered bends in accordance with the details on the Contract Drawings or as specified elsewhere. The removal of concrete to achieve the bend or miter shall be made while the concrete is still green; the concrete will be cured; the reinforcement will then be cut and welded back together with the halve held at the proper angle and approved epoxy mortar applied to fully fill the gap between pipe halves to a true cylindrical surface. Materials shall conform to those used for main sewer pipe. The angle changes indicated on the Contract Drawings are theoretical and the Contractor shall determine accurately all angle changes in the field prior to manufacture of elbow.
- d. Tees and Wyes - For pipe 33 inches in diameter or smaller, tee and wye branches with bells to take connection shall be integrally formed or cast into the pipe or constructed in a method similar to that for elbows with

rewelded reinforcement and epoxy mortar. Additional steel reinforcement surrounding the tee or wye branch shall be placed in accordance with manufacturer's details subject to the approval of the Engineer. For pipe 36 inches in diameter and larger, inlets for service lateral connection may be cast in the field into the wall of the pipe with a socket for the tongue or spigot of the connection, or an approved flexible service tee seal may be installed into a core drilled hole.

If integral wyes or tees are used, the pipe extension shall be as shown on the Contract Drawings. All joints shall be compatible with the pipe to be used.

- e. Increases-Reducers - Materials shall be in accordance with the Reinforced Concrete Sewer Pipe (RCP) with the exception that the Increases/Reducers shall be eccentric about the horizontal axis and symmetrical about the vertical axis of the pipe, with uniform and gradual varying dimensions to/from the larger diameter pipe from/to the smaller diameter pipe. Joints shall be as those of the main sewer pipe.

II. Asbestos Cement Pipe (ACP) shall conform to the requirements of ASTM Specifications C-428 and 0-644 amended to date.

All pipes shall be Class 3300, Type II, unless otherwise specified on the Contract Drawings.

Lengths and Joints - Pipe lengths shall not exceed 20 feet for 8 inch and larger pipe. Each length of pipe shall have a bell-and-spigot or shall have furnished with it a separate jointing sleeve or coupling with rubber rings compressed into place to make watertight closure. The rubber rings shall consist of a molded and vulcanized rubber compound resistant to common ingredients of groundwater and sewage and which will endure permanently under the conditions likely to be imposed by this use, and shall conform to ASTM Specifications D-1869 amended to date.

Connections to ACP shall conform to manufacturer's recommendations. Each wye or tee branch spur or end of lateral, unless otherwise specified, shall be provided with an asbestos cement bell or special adapter, with bell clearances equal to those of 6-inch pipe service lateral connections.

III. Polyvinyl Chloride Pipe (PVC) shall conform to ASTM Specifications D-3034 for type PSM Polyvinyl Chloride (PVC) sewer and pipe fittings amended to date with the following additions and/or exceptions:

The pipe and fittings shall be made from PVC plastic having a cell classification of 12454-B as described in ASTM Specifications D-1784 for "Rigid Polyvinyl Chloride Compounds and Chlorinated Polyvinyl Chloride Compounds" as amended

Clean rework material, generated from the manufacturer's own pipe or fitting production may be used by the same manufacturer provided the pipe and fittings so produced meet the requirements of this specification.

- A. Lengths and Joints - Pipe lengths shall generally be a minimum of 10' long but shall not exceed 20 feet. Each length of pipe shall have a bell-and-spigot or shall have furnished with it a separate jointing sleeve or coupling with rubber rings compressed into place to make a watertight closure. Joints shall be sealed with a rubber ring gasket and shall be of a composition and texture which is resistant to common ingredients of sewage and groundwater and which will endure permanently under the conditions likely to be imposed by this use, and shall conform to ASTM Specifications C-361 amended to date.

All wyes, tees, bends and adapters and any other fittings required by the Engineer shall be provided. Plans for such fittings showing cross sectional views with dimensions shall be provided by the Contractor to the Engineer for approval and be approved prior to their use. The materials used in the manufacture of fittings shall conform to the requirements for the pipe with which they shall be used and any variation of such requirements shall be subject to the approval of the Engineer.

- B. Markings - Pipe shall be marked along the outside of the barrel in bold style type and shall indicate the manufacturer's name, pipe size, PVC cell classification, type, PVC sewer pipe, and ASTM designation in accordance with ASTM D-3034.

Ratings shall be marked and indicate the manufacturer's name, nominal size, material designation "PVC", type and ASTM designation in accordance with ASTM D-3034.

IV. Cast Iron (CIP) and Ductile Iron (DIP) Sewer Pipe shall conform to the requirements of ANSI Standard A21.6 Class 22 wall for CIP and conform to ANSI Standard A21.51 Class 2 wall for DIP unless otherwise noted on the Contract Drawings or ordered by the Engineer. Nominal laying length shall be 18 feet.

Fitting shall conform to the requirements of ANSI Standard A21.10 with pressure rating of 250 psi.

Joints - All joints shall be push-on design or mechanical, both complying with ANSI Standard A21.11.

Coatings - Except as otherwise specified, all cast iron pipe, ductile iron pipe and fittings shall have a cement lining with a bituminous seal coat inside in accordance with ANSI Standard A21.4. The exterior coating of all pipe and fittings shall be a coal tar pitch varnish, in accordance with Federal Specifications Designation WW-P-421.

Markings - All pipe and fittings shall be marked in accordance with the latest applicable ANSI Specifications for the "Marking of Pipe" and the "Marking of Fittings". Mark number and weight shall be conspicuously painted on each piece.

CONSTRUCTION DETAILS:

1. Pipe Laying - All sewers shall be laid true to line and grade with bells or grooves upgrade. The sections of the pipe shall be so laid and fitted together that, when complete, the sewer will have a smooth and uniform invert. The pipe shall be kept thoroughly clean so that jointing compounds will adhere. Each pipe shall be inspected for defects before being lowered into the trench.

If pipe laying can not start at the downgrade end and progress upgrade, due to restrictions imposed by land acquisition and/or other construction activities, then construction may be done in sections approved by the Engineer.

At the start of each job, when the Contractor is in a position to start laying pipe, the Contractor shall notify the proper representative of the supplying pipe company who will come to the job and thoroughly instruct the Contractor, its men and the Inspector in the proper methods of laying said pipe. The Contractor shall notify its men who are actually doing the laying that this method shall be strictly enforced.

At any time during pipe-laying operations, if the occasion arises, when instruction or advice is required from pipe representatives, they shall be notified and shall come to the site of pipe-laying operations for consultation before any further pipe is laid involving any such problems. Under such conditions the Contractor shall have no claim for delays.

Where the pipe connects with the outside faces of manhole walls or the outside faces of the walls of other structures and approved flexible connections are not used there shall be a short section of pipe (usually 2 feet) placed at the connection to the structure. In order to accomplish this, without cutting pipe and destroying water tight integrity by having other than the normal type joints, minor modifications in manhole locations may be made with the approval of the Engineer.

The Contractor shall furnish materials, tools and men to assist the Inspector and to handle survey equipment, levels, grade poles, plumb poles, plumb bobs, straight edges, laser equipment, and other equipment used for transferring grades, setting strings on profiles or grade slats or aligning pipe. While Inspectors may at times assist or check alignment, the Contractor's crew shall not be dependent upon the Inspector for the performance of such work. The Contractor shall furnish all labor, tools and facilities needed to set or transfer line and grade, to measure pipe beds pipe grade and line, etc.

To oversee pipe laying and other work in general, only one pipe laying crew will be permitted to operate at any time under one Inspector. Thus, the number of

pipe laying crews and the number of locations at which pipe may be laid simultaneously under this Contract may be limited by the number of Inspectors assigned by the Engineer to oversee that type of work on the Contract. If the Contractor wishes to lay pipe at more than one location on a given day, or add additional pipe laying crews, the Contractor must notify the Engineer at least two days in advance so that an adequate number of Inspectors may be assigned to the job.

Not more than 100 feet of trench shall be opened in advance of pipe laying unless permitted by the Engineer.

The excavation of trenches shall be fully completed a sufficient distance in advance of laying of the sewer, and the exposed end of all pipes shall be fully protected with a board or other approved stopper to prevent earth or other substances from entering the pipe.

Any sewer pipe delivered to the job site in a damaged condition shall be removed from the job site immediately. Except for RCP, any other sewer pipe bruised or damaged after delivery to the job site may be repaired and used as specified when permitted by the Engineer.

Any fitting showing a crack and any fitting or pipe which has received a severe blow that may have caused an incipient fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the site.

In any pipe except as specified otherwise, showing a distinct crack and in which it is believed there is no incipient fracture beyond the limits of the visible crack, the cracked portion, if so approved, may be cut off by and at the expense of the Contractor before the pipe is laid so that the pipe used may be perfectly sound. The cut shall be made in the sound barrel at a point at least 12 inches from the visible limits of the crack.

Except as otherwise approved, all cutting of sewer pipe shall be done with an approved power-driven cutter or pipe-cutter. Hammer and chisel shall not be used to cut pipe. All cut ends shall be examined for possible cracks caused by cutting. The use of an oxyacetylene torch for flame cutting CIP/DIP will not be permitted. Any necessary cutting shall be done in a neat and workmanlike manner without damage to the pipe or its lining and so as to leave a smooth end at right angles to the pipe.

Field cutting of RCP will generally not be allowed.

CIP/DIP and fittings shall be subjected to a careful inspection and a hammer test just before being laid or installed.

2. Pipe Jointing - Approved joint materials shall be handled and installed in accordance with the recommendation of the manufacturer. All joints shall be wiped smooth inside the pipe.

- A. RCP Joints shall be made in accordance with the recommendation of the manufacturer. Prior to laying the pipe the spigot of the pipe shall be lubricated with an approved vegetable soap mixture, which will not harm the rubber. The gasket shall then be placed on the spigot end and adjusted to equalize the tension within the gasket around its circumference. After the pipes are aligned in the trench, ready to be jointed, all joint surfaces shall be cleaned and immediately before jointing the pipes together, the bell shall be completely covered with the same vegetable soap mixture. The pipe shall then be carefully pushed home into place without damage to pipe, gasket, bells or bitumastic coating of the pipe. Any interior coatings damaged during installation shall be given two field coats of bitumastic.
- B. ACP/PVC shall be installed in accordance with manufacturer's recommendations. Particular care should be taken to keep fine materials from interfering with proper joint assembly. Mating surfaces of a joint shall be wiped clean. The surfaces shall then be coated with a lubricating material prescribed by the manufacturer to overcome the frictional resistance encountered when shoving the pipe home. Pipe that is not marked with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint.
- C. CIP/DIP shall be joined in accordance with the recommendation of the pipe manufacturer. When joining the pipe with the push-on type joint, the inside of the bell and the outside of the spigot end shall be thoroughly cleaned to remove oil, grit, excess coating and other foreign matter. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the bell socket.

A thin film of gasket lubricant shall be applied to either the inside surface of the gasket or the spigot end of the pipe or both. Gasket lubricant shall be supplied by the pipe manufacturer and approved by the Engineer.

The spigot end of the pipe shall be entered into the socket and care exercised to keep the joint from contacting the ground. The joint shall then be completed by forcing the plain end to the bottom of the socket with a forked or jack-type tool or other device acceptable to the Engineer. Pipe that is not marked with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. Field cut pipe shall be filed or ground to resemble the spigot end of such pipe as manufactured. Assembly instructions from the pipe manufacturer shall be strictly followed as approved by the Engineer.

3. Dewatering - The Contractor shall provide all necessary pumps, dams, drains, ditches, flumes, well points and other means for excluding and removing water from trenches and other parts of the work. Water shall not be allowed to rise around the joint until it has set.

4. Foundations for Sewers - The pipe shall be laid on a foundation and backfilled as shown on the Contract Drawings and as directed by the Engineer. Where the soil in subgrade is found to be soft, loose, freshly-filled earth, unstable or unsuitable as a base for the proposed sewer or appurtenances, the Engineer, may, at their discretion, order it excavated to such additional depth and width as they may deem proper and replace with gravel fill, borrow, Class "A" concrete, or similar materials as directed by the Engineer.

Pipe foundation for each length of pipe shall be as noted on the Contract Drawings and conform to bedding details. The top of the stone shall be brought carefully to the proper grade, well tamped or compacted as directed and shaped for the barrel of the pipe and the pipe laid thereon.

Concrete cradles and encasements where called for on the Contract Drawings or directed by the Engineer shall be of Class "A" concrete. The concrete shall conform to the requirements of Article M.03.01. The cradle or encasement shall be as detailed on the Contract Drawings.

Where pipe is to be encased in concrete or laid in a concrete cradle; the pipe will be laid on wooden cross sills of adequate size and area to support the pipe to grade and line after excavating to required subgrade. Wooden wedges or shims and tie down will be used to secure pipe in place and to proper lines and grades.

5. Caps and/or Plugs - All pipes (e.g. manhole pipe stubs, service laterals, service chimneys, sewer to be abandoned, etc.) shall be either plugged with manufactured units or masonry bulkheads as specified hereafter. All plugs and masonry bulkheads must be installed so that any future removal will not damage the bell of the pipe.
- A. Manufactured Plugs - Whenever possible manufactures watertight plugs shall be used. The material of the plug shall be compatible with the pipe and shall be coated however the pipe is coated externally. Pipe shall be closed with the plug having a gasket set into the bell of the pipe in accordance with the manufacturer's recommended installation procedures and as approved by the Engineer.
- B. Masonry Bulkheads - Where manufactured plugs are not available, the Contractor shall cap manhole stubs and pipes to be abandoned by constructing masonry bulkheads of brick, of a thickness appropriate to the size of the pipe, its depth below surface and other conditions. The outside of brick bulkheads shall be parged with non-shrink mortar. Any sheeting, which is left in place, shall be cut away and removed from in front of plugged manhole stubs and service laterals.

The Contractor shall provide a piece of lumber (2 X 4") to be set vertically and left in place, extending from a point directly in front of but not in contact with the outer end of plugged manhole stubs and service laterals.

Markers shall be set up to a point about 4 feet below the ground surface or finished street grade. In addition, at service laterals when directed by the Engineer a 2" X 4" should be set 3 feet into the ground and 2 feet above grade (unless public safety dictates otherwise) and shall be protected and maintained undisturbed until the Engineer has completed all their measurements, and if so ordered, will thereafter be removed by the Contractor.

6. Service Chimneys - Where ordered by the Engineer, service chimneys shall be contracted to facilitate making connections to the sewer where the sewer is in deep cut, either for connection made under this contract or for future use. Since the location of service chimneys cannot be fully determined in advance, the Engineer shall determine, as the work progresses, where they should be located. Service chimneys will be built as indicated on the Contract Drawings.

All pipe and fittings shall be properly aligned and fitted together. The chimney shall be surrounded with and embedded in, a pier of concrete as shown on the Contract Drawings. When the chimney is complete except for the top plug, a pole or rod shall be run down through the chimney from the top to the invert of the sewer below, in the presence of the Engineer, to make sure the chimney is clean and without obstructions and to measure the actual "as-built" height of the chimney. Thereafter, a watertight plug shall be set in the upper, or straightaway, end of the pipe forming the top of the chimney, and secured into place. Plugs shall be as specified hereinbefore.

7. Service Laterals shall be 6 inches or larger pipe laid on the grade or as ordered by the Engineer. Laterals shall be laid to a point at least 5 feet beyond the edge of pavements, and if an obstruction such as water service, etc., is encountered, the lateral shall be extended beyond same as ordered by the Engineer. Since the location of laterals cannot be fully determined in advance, the Engineer will determine, as the work progresses, where they should be located. They will not be laid on the grade flatter than two percent, and will usually have 7 feet of cover at the curb or street line.

Unless otherwise directed, the entire lateral trench shall be excavated to the required grade before any pipe is laid therein to conform setting of pipes without conflict, or to allow for grade adjustment. The pipe shall be laid closely to line and grade, using a grade line, hand level, or straight edge as may be ordered. Service laterals will generally be laid at right angles to the main sewer, as detailed on the Contract Drawings.

Care shall be taken to make smooth, close-fitting joints at all bends. Pipes shall be trimmed or extra bends used when ordered accomplish this. All requirements for laying as described elsewhere herein, shall be observed in laying service laterals, insofar as those requirements apply. The end shall be closed with watertight plug before being placed in the trench, as described elsewhere for capped outlets, etc.

- A. Connections for Service Laterals to the street sewer shall only be made to a plant manufactured unit set in the line of the sewer with the outlet for the service lateral formed integrally therewith regardless of the sewer pipe material unless otherwise specified or ordered by the Engineer.

For RCP less than 36 inches in diameter, the connection shall be made to a manufactured unit having the outlet formed integrally therewith by the pipe manufacturer or as prefabricated by the Contractor on the job site (not in the trench) at least 2 days prior to its intended use in accordance with the recommendations of the pipe manufacturer, as shown on the plans or directed by the Engineer.

- B. Laterals shall be of the type and size as noted on the Contract Drawings listed in the proposal form or otherwise specified or approved.

8. Inspection and Testing - Upon completion of the installation and backfilling portions of the sanitary sewer, the pipe shall be inspected in accordance with the methods subsequently described. This inspection and testing shall be undertaken as the work progresses. The Engineer shall be notified in advance of such inspection and testing and the Contractor shall provide all facilities, materials, equipment and labor required for such testing. Such inspection and testing shall be a prerequisite for acceptance of all work.

It is the intent of this specification that the completed sanitary sewer pipes of all types, along the manholes and other appurtenances shall be watertight. Each section of sanitary sewer between two successive manholes shall be tested for leakage and/or infiltration. If the leakage and/or infiltration rate as shown by the tests specified herein is greater than the amount specified, the pipe joints shall be repaired or, if necessary, the pipe shall be removed and re-laid by the Contractor at no additional cost to the Authority. The sanitary sewer will not be considered acceptable until the leakage and/or infiltration rate, as determined by test, is less than the allowable.

- A. Visual Inspection - An inspection of the interior of the completed sanitary sewer pipe by direct visual inspection shall be made for all pipe installed from manhole to manhole. Any light, equipment or labor necessary for such inspection shall be provided by the Contractor. Any foreign material found in the interior of the sewer, any dirt, debris or other objects shall be removed by the Contractor. Visible defects such as broken pipe sections, improperly installed gaskets, projecting connections, cracks, visible leaks or other defects shall be noted, corrected and the pipe re-inspected.
- B. Low Pressure Air Testing – Each section of sanitary sewer between two successive manholes shall be tested. The procedure for low pressure air testing shall conform to the following:

ASTM C 024-02, Standard Practice for Testing Concrete Pipe Sewer

Lines by Low-Pressure Air Test Method.

ASTM F 1417-92 (Re-approved 2005), Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

ASTM C 828, Practice for Low-Pressure Air Test for Vitrified Clay Pipe Lines (4 to 12 inches)

- C. Deflection Testing – At least thirty (30) days after construction and flushing, all sanitary sewer systems constructed of PVC pipe shall be tested for vertical ring deflection using a deflectometer, properly sized rigid mandrel (“Go, No-Go”) device cylindrical in shape and constructed with a minimum of 9 evenly spaced arms or prongs. Drawings of the mandrel with complete dimensions shall be submitted to the Engineer for each diameter of pipe to be tested. The mandrel shall be hand pulled through all sanitary sewer lines.

Deflection shall be computed by multiplying the amount of deflection (nominal diameter less minimum diameter when measured) by one hundred (100) and dividing by the nominal diameter of the pipe. Maximum allowable vertical ring deflection is six percent (5%) of the pipe’s diameter.

Any section of sanitary sewer not passing the mandrel shall be uncovered at no additional cost to the Authority and the bedding and backfill replaced to prevent excessive deflection. Repaired sanitary sewer shall be retested. Retested sanitary sewer shall not deflect more than 4 percent (4%).

- D. Inspection by Closed Circuit TV Camera – All sanitary sewers shall be televised in accordance with the provisions of Item 522, Sanitary Sewer Television Inspection. Television inspection shall be made on the completely installed, backfilled and Infiltration/exfiltration tested sanitary sewers, and shall be required for final acceptance.
- E. Major Test by Sections – After any such section has been tested, the Engineer may, at their discretion, permit capped connections to be made with this section of sewers by other parties; said sections may not be put in service until all sewers contemplated under this Contract have been completed and tested unless specifically waived by the Authority.

MEASUREMENT AND PAYMENT:

1. Sanitary Sewers will be measured and paid for at the unit price bid per linear foot under the Item "Sanitary Sewers" of the size, type of pipe as listed in the Proposal Form. The total length of the sewer will be measured along the invert

to the outside face of manholes or other structures.

2. Service Laterals will be measured and paid for at the unit price bid per linear foot under the Item "Sanitary Laterals" of the size and type of pipe, as listed in the Proposal Form. The length shall be measured along the invert from the outside of the wye or tee to the end of the lateral.
3. Service Chimneys will be measured and paid for at the unit price bid per linear foot under the Item "Sanitary Chimneys" of the size and type of pipe as listed in the Proposal Form. The length shall be measured at the chimney vertically from the crown of the sewer to the end of the vertical pipe. The unit price bid shall include the cost of concrete encasement.
4. Cradles and Encasements will be measured and paid for at the unit price bid per cubic yard under the Item "Concrete Cradles and Encasements" as listed in the Proposal Form. The quantity will be the actual cubic yards measured within the payment limits shown on the Contract Drawings or ordered by the Engineer. The volume of the pipe will not be included in the measurement. Concrete encasements for Service Chimneys will not be measured for payment under this Item.
5. Caps. Plugs. Markers will not be measured for payment, but the cost shall be considered as included in the unit price bid for sanitary sewers.
6. Inspection and Testing will not be measured for payment, but the cost shall be considered as include in the unit price bid for sanitary sewers.
7. Wyes and Tees will be measured and paid for at the unit price bid per Each under the Item "Wyes and Tees" of the size and type of pipe, regardless of depth, as listed in the Proposal Form. The cost shall include the cost of furnishing and placing a manufactured plug at the end of the wye or tee.
8. Excavation will be performed in accordance with the Contract Drawings and shall be measured for payment in accordance with Item 205, Trench Excavation and Backfill of the appropriate classification listed in the Proposal Form.
9. Bedding shall be performed and measured for payment in accordance with the details as shown on the Contract Drawings or as ordered by the Engineer. Payment shall be made at the unit price bid for Item 305, Bedding Material.

This work will be paid for at the contract unit prices, complete in place, which price shall include all materials, equipment, tools and labor, testing and inspection of the pipe and all else necessary and incidental to the satisfactory completion of the work in accordance with the Contract Drawings and these specifications or as ordered by the Engineer.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
512.01	Sanitary Sewer Size _____" Type _____	Linear Foot
512.02	Wyes and Tees Size _____" x _____" Type _____	Each
512.03	Sanitary Laterals Size _____" Type _____	Linear Foot
512.04	Service Chimneys	Linear Feet
512.05	Concrete Cradles and Encasement	Cubic Yard

ITEM 516 SANITARY SEWER FLOW CONTROL AND BYPASS PUMPING

DESCRIPTION:

Under this Item, the Contractor shall control flow in sanitary sewers in conjunction with internal television inspections, cleaning operations, manhole rehabilitation, and the installation of cured-in-place pipe lining or other repair/replacement activities. Limited sewage flow is acceptable for television inspection. Complete stoppage of flow is required during sanitary sewer lining and manhole rehabilitation work.

MATERIALS AND EQUIPMENT:

- A. The Contractor shall provide temporary pumps, conduits, and other equipment to bypass sewer flow.
 - 1. Engines must be equipped with mufflers and/or enclosed to keep noise level less than 50 decibels, or 10 decibels above ambient noise levels when measured at the building closest to noise source.
 - 2. Provide pumps and bypass lines of adequate capacity and size to accommodate flows.
- B. The Contractor shall maintain sufficient equipment and materials on site to ensure continuous and successful operation of bypass and dewatering systems.
 - 1. Keep standby pumps fueled and operational at all times.
 - 2. Maintain on site sufficient number of valves, tees, elbows, connections, tools, sewer plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of system as necessary.
- C. The Contractor shall provide piping, joints and accessories designed and installed to withstand at least twice the maximum system pressure, or 50 psi, whichever is greater.
- D. The Contractor is responsible for ensuring that operating equipment is secure and protected and that the safety of the public is maintained at all times.

CONSTRUCTION DETAILS:

Under this item, the Contractor shall furnish, install, operate, maintain, dismantle and completely remove when completed, all necessary pumps, generators, pipelines, fittings and all incidentals necessary for by-passing sanitary sewage flow around work to be performed on the Authority's sanitary sewer system, in accordance with the requirements of these specifications.

A. SUBMITTALS

Prior to the start of work, the Contractor shall submit drawings and complete design data showing methods and equipment to be utilized in sewer bypassing and dewatering for the review of the Engineer. The Contractor shall submit the following information:

1. Indicate location of temporary sewer plugs, by-passed flow discharge points and the routes of proposed bypass discharge lines,
2. Capacities of pumps, prime movers, power requirements and standby equipment,
3. Standby power source,
4. Traffic control and public warning signing plan,
5. An emergency response plan describing the steps to be taken, personnel involved, notifications and documentation required (including Connecticut DEP) , in the event that raw sewage escapes from or as a result of, the by-pass pumping operations,
6. Calculations of static lift friction losses and flow velocity together with pump curves showing pump operating range.

B. PROTECTION

1. In areas where flows are bypassed, the Contractor shall discharge bypass flow to a location in the sanitary sewer system approved by the Engineer. No bypassing to ground, surface receiving waters, storm drains, or any other unauthorized location or bypassing which results in environmental contamination or potential health hazards shall be permitted. The Contractor shall provide additional protection of wetlands, watercourses, etc, when, in the opinion of the Engineer, such protection is appropriate.
2. In the event sewage accidentally escapes from the Contractor's bypass pumping system, the Contractor shall immediately stop the bypass operations, notify the Engineer, implement the emergency response plan and take all necessary actions to clean up the affected area or waterway and disinfect spillage area to the satisfaction of the Engineer.
3. The Contractor shall at all times conduct its operations in such a manner as to protect the health and safety of the Authority's staff , consultants employed by the Authority, the general public and all construction personnel.
4. The Contractor shall provide one hundred percent (100 %) back-up for the bypass pumping system in the event of an equipment failure.
5. The Contractor shall provide secondary containment for diesel pumps and appurtenances.

6. When flow in sanitary sewers is plugged, or partially blocked resulting in insufficient capacity to accept the bypassed flow, sufficient precautions must be taken to protect the sewers from damage that may result from sewer surcharging. Precautions must also be taken to insure that sewer flow control operations do not cause flooding or damage to public or private property.
7. The Contractor shall be allowed to block the flows from building services or house connections only once during the cured-in-place lining process, and/or existing sewer replacement process. The interruption of flow in these connections shall be coordinated with the occupant. Flows shall only be blocked after the occupants and/or residents of the buildings affected by the service disruption have received proper notifications.
8. The Contractor shall notify all property occupants who discharge sewage directly to the sanitary sewer affected by the Authority's work, that their service will be temporarily discontinued while work on the sewer system is taking place and active service connections can be re-established and re-opened. The Contractor shall notify, individual property occupants at least forty-eight (48) hours in advance, providing the date, start time and estimated completion time for the work.
9. High flow conditions may result in a temporary suspension of bypass pumping operations to ensure that spills or back-ups do not occur. No additional payment will be made to the Contractor for temporary suspension of the work due to high flows.

C. PROSECUTION OF THE WORK

1. Flow Control and Bypass Pumping:

Flow Control and Bypass pumping shall be performed in compliance with the following requirements:

- a. Where flow control and bypass pumping is in preparation for television inspection, flow control and bypass pumping shall be in accordance with these specifications and the requirements of Item 522, Sanitary Sewer Television Inspection.
- b. Where flow control and bypass pumping is in preparation for the installation of cured-in-place pipe lining, flow control and bypass pumping shall be in accordance with these specifications and the requirements of Item 520, Sanitary Sewer Cured-in-Place Pipe Lining.
- c. Where flow control and bypass pumping is in preparation for point repairs, flow control and bypass pumping shall be in accordance with these specifications and the requirements of Item 521, Sanitary Sewer Point Repairs.

- d. Where flow control and bypass pumping is in preparation for manhole rehabilitation, flow control and bypass pumping shall be in accordance with these specifications and the requirements of Item 524, Sanitary Sewer Manhole Rehabilitation.
2. Plugging or Blocking:
- a. The Contractor shall insert the sewer line plug into line upstream of section being worked. The plug shall be of appropriate design so as to permit all or any portion of sewage to be released.
3. Pumping and Bypassing:

When pumping and bypassing is required, the Contractor shall provide pumps, conduits, and other equipment to divert flow of sewage around the section of the sanitary sewer system in which work is to be performed. In addition,

- a. The bypass system shall have sufficient capacity to handle the full capacity of the pipe in which flow is blocked.
- b. It shall be constructed of materials, fittings, etc, and shall be assembled in such a manner so as to prevent leakage during pumping operation.
- c. After sewer repairs or other maintenance activities have been completed, the Contractor shall restore flow to normal operation as soon as possible.
- d. When bypass pumping operations are complete, the Contractor shall clean out and drain the piping and pumping equipment into the sanitary sewer prior to disassembly.
- e. The Contractor shall route the bypass lines using shoulders, snow shelves, etc, wherever possible and in such a manner as to accomplish the least affect on vehicular and pedestrian traffic.
- f. When required to do so by the local traffic authority, the Contractor shall install the bypass line across the traveled way in a shallow trench, covered with temporary pavement or steel plating with the permission of the local jurisdiction and with the approval of the Engineer.

D. NOTIFICATIONS

The Contractor is responsible for notifying the appropriate authorities and for securing permission, as required, for all installations within the public right-of-way. Bypass pumping to be carried out over private property will be conducted In accordance with the agreement between the Authority and the property owner. Any damage to private property shall be repaired by the Contractor to the satisfaction of the property owner and the property shall be restored to the condition in which the Contractor first entered the property.

E. LEGAL, SAFETY AND HEALTH REQUIREMENTS

The Contractor shall observe all federal, state and local laws, ordinances, policies, practices and regulations. In addition, the Contractor agrees to promptly procure all necessary approvals, licenses and permits from each jurisdiction, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

The Contractor shall conduct the work at all times in such a manner as to insure the least possible obstruction to traffic. The convenience of the general public and of the residents along and adjacent to the roadway shall be provided for in an adequate and satisfactory manner as the Engineer may direct.

All equipment and materials shall be placed or stored in such locations so as not to be or to create the danger of becoming a hazard to the traveling public. No section of road shall be closed to the public except by permission of the Authority and the local traffic authority.

The safety provisions of applicable laws, building, construction and fire safety codes and the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department", approved by the State Labor Commissioner, shall be complied with at all times.

The Contractor shall obtain the appropriate permits and approvals Perform operations in strict accordance with OSHA and equipment manufacturers' safety requirements. Particular attention is drawn to safety requirements involving entering confined spaces.

F. WATCHMAN SERVICES

The Contractor shall provide watchman service during all non-working hours for the continuous monitoring of the entire work site whenever bypass pumping is in place and operating during non-working hours. The watchmen shall be responsible for insuring that all signs, barricades, flares, and markers are up and that the bypass pumping system is in good working condition.

The watchmen shall maintain daily logs of the patrols and record any incidents relating to the by-pass pumping operations. Copies of these logs shall be made available to the Engineer.

In the event that any unusual or emergency condition arises, the watchmen shall immediately notify the Contractor, the Engineer and the appropriate emergency agency for assistance, in accordance with the emergency response plan.

The Contractor will supply the name and telephone number of the individual that may be contacted in an emergency or at any time, including nights, weekends and holidays during which by-pass pumping activities are undertaken

G. CLEAN UP

The Site shall be cleaned on a daily basis during performance of the work and shall be cleaned upon completion so that the Project Site shall be left in a clean and orderly condition acceptable to the Engineer.

MEASUREMENT AND PAYMENT:

There will be no separate measurement for payment for the cost of flow control and bypass pumping, but the cost thereof shall be included in the contract unit price for the following items when the flow control and bypass pumping is performed in conjunction with work under these items:

- Item 518, Sanitary Sewer Cleaning
- Item 520, Sanitary Sewer Cured-In-Place Pipe Lining
- Item 522, Sanitary Sewer Television Inspection
- Item 521, Sanitary Sewer Point Repairs
- Item 524, Sanitary Sewer Manhole Rehabilitation

ITEM 518 SANITARY SEWER CLEANING

DESCRIPTION:

Sanitary Sewer Cleaning shall consist of removing and disposing of sediment, rocks, debris, roots, grease accumulations and obstructions from sanitary sewer pipes and manholes. In addition, cleaning of sewer and manhole walls in the vicinity of pipe and/or manhole lining operations shall remove grease, scale, encrustation and loose mortar so that no foreign intrusion shall cause imperfections in lining materials (e.g. bumps, folds, dimples).

Sanitary Sewer Hydraulic Cleaning (Light) shall mean up to 3 passes of washing with high pressure water. Removal of roots and grease is included under this item.

Sanitary Sewer Hydraulic Cleaning (Heavy) shall mean more than 3 passes of washing with high pressure water unless alternate means are approved, in writing, by the Engineer. Removal of roots and grease is included under this item.

Sanitary Sewer Bucket Cleaning shall mean the mechanical removal of obstructions using bucket-type equipment followed by Sanitary Sewer Hydraulic Cleaning (Light).

MATERIALS AND EQUIPMENT:

A. HIGH-VELOCITY HYDRAULIC (HYDRO-CLEANING) EQUIPMENT:

Equipment shall be capable of removing dirt, grease rocks, sand, roots, and other materials and obstructions from sewer lines and manholes.

1. Equipment shall have selection of two or more high-velocity nozzles. Nozzles shall be capable of producing scouring action from 15 to 45 degrees in all size lines designated to be cleaned, with nozzles capable of producing flows from fine spray to solid stream. One of the nozzles shall be designed for penetrating blockages.
2. Equipment shall carry its own minimum of 1,000 gallons water tank, auxiliary engines, at least 500 linear feet of high pressure hose, and a high pressure water pump.
3. Combination Unit Pump: Capable of pumping at least 80 gallons per minute at 2,000 psi, measured at beginning of hose reel.
4. Water Pump: Able to run at 2,000 psi while pulling full vacuum, completely independent from vacuum system, with ability to vary vacuum without affecting water pressure.

5. Equipment shall also include attachments for cutting roots and other intrusions into the sanitary sewer flush with the pipe walls.
6. Only trucks and dumpsters suitable for handling semi-liquid waste shall be used to store and/or dispose of debris taken from sanitary sewers. No leakage or dripping from the Contractors equipment will be tolerated.

B. WATER

- 1 When water must be taken from fire hydrants the Contractor shall obtain all permits from the appropriate water utility and local agencies for any use of the potable water source. It shall be the responsibility of the Contractor to contact the appropriate water utility to determine, and comply with, all permit conditions and requirements such as limited hydrant use or other limitations including payment of all fees. All water utility requirements stipulated by the permits for the use of potable water supply shall be strictly enforced.
- 2 The Contractor shall not be allowed to utilize the water source until it has been approved by the appropriate water utility and the Engineer.
- 3 Water supplied from fire hydrants shall be at the expense of the Contractor. The Contractor shall be required to make repair any damages resulting from the improper use of the water supply system. No fire hydrant shall be obstructed in case of a fire in the area served by the hydrant nor shall a hydrant be used for the purpose described unless a back-flow preventer/vacuum break is provided.
- 4 The Contractor shall provide all of the necessary temporary piping, valves, certified reduced pressure backflow preventors, equipment, and other items for handling potable water and wastewater.

CONSTRUCTION DETAILS:

Under this item, the Contractor shall perform sanitary sewer cleaning operations, furnish, install, operate and maintain, and when completed remove, all necessary rodding, bucket-type and other cleaning equipment and all incidentals necessary for sanitary sewer cleaning operations, in accordance with the requirements of this specifications and to the satisfaction of the Engineer.

A. SUBMITTALS

Prior to the start of work, the Contractor shall submit to the Engineer the methods that it will use to remove sediment, debris, grease, scale, encrustations, loose concrete, and roots throughout the section of sanitary sewer to be cleaned. The submittal shall include a detailed explanation of the cleaning process; a schedule of activities; references where the Contractor has used the identified cleaning

method successfully in the past; together with a list of the actions that will be taken to mitigate impact on the collection system during the cleaning operation.

B. PROSECUTION OF THE WORK

- 1 The Authority shall ensure that access to manholes is available. The Authority will provide to the Contractor with the project documents details of any easements over private property within which the cleaning operations are to be conducted. The Contractor shall comply with any restrictions and/or requirements of the subject easement. The Contractor is responsible for providing adequate notice to the property owner prior to entering onto private property. The Contractor shall not enter onto any private property not subject to the appropriate easements without the written permission of the property owner.
- 2 The Contractor shall not be permitted to use chemicals without prior written approval of the Engineer. Chemicals which may be considered by the Engineer to be hazardous or detrimental to organisms or equipment at the wastewater treatment plant shall not be permitted.
- 3 The Contractor shall be aware of flow conditions in the system to be cleaned, and be able to identify potential access problems to sewer access points. The Contractor shall restrict the flow level in the pipe to a maximum of 30% of the pipe diameter.
- 4 Sanitary Sewer Hydraulic Cleaning (Light) and Sanitary Sewer Hydraulic Cleaning (Heavy). The Contractor shall clean designated sewer lines using approved methods and equipment.

Remove internal obstructions such as roots or gaskets by trenchless techniques when obstruction encountered prevents further pipe cleaning.

- a. Provide special attention during cleaning operation to assure almost complete removal of roots from joints.
- b. Procedures to remove internal obstructions may include use of equipment such as rodding machines, root saws,
- c. No roots greater than 1½" shall remain following root removal procedures.

If cleaning of the entire section of sewer cannot be successfully performed from one manhole, equipment shall be dismantled and set up at another manhole and cleaning shall re-commence from this location.

- a. If successful cleaning cannot be performed or equipment fails to traverse entire sewer line section, it will be assumed that a major blockage exists. Temporarily suspend cleaning effort and immediately notify the Engineer.
- b. Upon removal of obstruction by the Contractor, complete cleaning operation.

Employ satisfactory precautions to protect sewer line from damage that might be inflicted by improper use of cleaning equipment.

- a. Immediately notify the Engineer if fresh soil, pieces of pipe, bricks or other visible signs of serious potential damage to the structural integrity of the pipes and/or manholes being cleaned, occurs during cleaning operation.
- b. Insure that water pressure created does not cause damage due to flooding of property being served by sewer section(s) involved.

- 5 When Bucket Cleaning is required, in the opinion of the Engineer, in any particular pipe or section of pipe, bucket machines and winches using root cutters, porcupines, and jet machines equipped with hydraulically driven cutters may be employed.
- 6 When all large obstructions have been removed from pipes or sections of pipe, to the satisfaction of the Engineer, the Contractor shall clean the entire section of pipe according to the requirements for sanitary Sewer Hydraulic Cleaning (Light).
- 7 When manholes are to be cleaned, include entire manhole interior, including manhole benches and walls. Incorporate into line cleaning operation by scouring walls with high velocity nozzle after pipe segment cleaning operation is complete.
- 8 All debris collected and/or loosened during cleaning operations shall be completely removed from the pipes and manholes and transported by the Contractor to the East Shore Water Pollution Control Facility for disposal. At no time shall the Contractor discharge sewage or solids removed from downstream manholes, onto streets, or into ditches, catch basins or storm drains. Removal of any debris that is allowed to escape downstream must be promptly removed from down stream manholes.
- 9 The Contractor shall install screens of adequate aperture in the sewer system, upstream of the cleaning operations in such a way as to prevent debris from entering into the cleaned sections of pipe.

- 10 Any blockage of building laterals resulting from cleaning operations shall be removed by the Contractor including cleaning of the subject lateral if necessary to restore flow.
- 11 The Contractor shall monitor the locations where plugs are introduced into pipes upstream of the cleaning operation to ensure no danger of surcharge or of sewage overflow at manholes or sewage back-up into buildings.

C. LEGAL, SAFETY AND HEALTH REQUIREMENTS

The Contractor shall observe all federal, state and local laws, ordinances, policies, practices and regulations. In addition, the Contractor agrees to promptly procure all necessary approvals, licenses and permits, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

The Contractor shall conduct the work at all times in such a manner as to insure the least possible obstruction to traffic. The convenience of the general public and of the residents along and adjacent to the roadway shall be provided for in an adequate and satisfactory manner as the Engineer may direct.

All equipment and Materials shall be placed or stored in such locations so as not to be or to create the danger of becoming a hazard to the traveling public. No section of road shall be closed to the public except by permission of the Authority.

The safety provisions of applicable laws, building, construction and fire safety codes and the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department", approved by the State Labor Commissioner, shall be complied with at all times.

The Contractor shall perform operations in strict accordance with OSHA and manufacturers' safety requirements. Particular attention is drawn to safety requirements involving entering confined spaces.

D. ACCEPTANCE BY THE ENGINEER

Final Acceptance of the work shall be determined by the Engineer based upon the verification by television inspection that the Sanitary Sewer Cleaning has been successfully completed in accordance with the following requirements:

- 1 Where cleaning is in preparation for television inspection, cleaning shall be in accordance with these specifications and the requirements of Item 522, Sanitary Sewer Television Inspection.
- 2 Where cleaning is in preparation for the installation of cured-in-place pipe lining, cleaning shall be in accordance with these specifications and the requirements of Item 520, Sanitary Sewer Cured-in-Place Pipe Lining.

- 3 Where cleaning is in preparation for manhole rehabilitation, cleaning shall be in accordance with these specifications and the requirements of Item 524, Sanitary Sewer Manhole Rehabilitation.
- 4 Where cleaning is performed for all other operational or maintenance activities performed by the Authority and not listed above, these specifications shall solely apply.

If the Engineer determines that the cleaning has not been completed in accordance with the requirements of these specifications, the Contractor shall continue the cleaning process until final acceptance is obtained.

The Contractor shall notify the Engineer of any sections of pipe that could not be adequately cleaned with up to 3 passes of the washing equipment and the Engineer shall confirm to the Contractor that all such sections of pipe will be paid for at the contract unit price for Sanitary Sewer Hydraulic Cleaning (Heavy).

E. CLEAN UP

The Site shall be cleaned on a continuous, daily basis during performance of the work and shall be cleaned upon completion so that the Project Site shall be left in a neat and orderly condition acceptable to the Engineer.

MEASUREMENT AND PAYMENT:

This work will be measured for payment by the actual number of linear feet of the size and type of sanitary sewer cleaned, measured along the centerline of the sanitary sewer from the center of the manhole to the center of the manhole.

Sanitary Sewer Hydraulic Cleaning (Light)

This work shall be paid for at the contract unit price per linear foot of "Sanitary Sewer Hydraulic Cleaning (Light) (Size) (Type), actually completed, which price shall include all materials, labor, tools, and equipment incidental and necessary for the cleaning of the sanitary sewers and manholes including the collection and transportation of all solids removed in the cleaning process to the disposal area at the East Shore Water Pollution Control Facility.

Sanitary Sewer Hydraulic Cleaning (Heavy)

This work shall be paid for at the contract unit price per linear foot of "Sanitary Sewer Hydraulic Cleaning (Heavy) (Size) (Type), actually completed, which price shall include all materials, labor, tools, and equipment incidental and necessary for the cleaning of the sanitary sewers and manholes including the collection and transportation of all solids removed in the cleaning process to the disposal area at the East Shore Water

Pollution Control Facility.

Sanitary Sewer Bucket Cleaning

This work shall be paid for at the contract unit price per linear foot of “Sanitary Sewer Bucket Cleaning (Size) (Type), actually completed, which price shall include all materials, labor, tools, and equipment incidental and necessary for the cleaning of the sanitary sewers and manholes including the collection and transportation of all solids removed in the cleaning process to the disposal area at the East Shore Water Pollution Control Facility.

The cost for work performed in sanitary sewers in which cleaning had to be terminated because of blockages or obstructions will be paid for at the contract unit price per linear foot for the actual portion of the sanitary sewer cleaned and accepted.

There will be no measurement for payment for the cost of cleaning manholes, but the cost thereof shall be included in the contract unit price per linear foot for the size and type of Sanitary Sewer Hydraulic Cleaning (Light).

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
518.01	Sanitary Sewer Hydraulic Cleaning (Light) (Size) (Type)	Linear Foot
518.02	Sanitary Sewer Hydraulic Cleaning (Heavy) (Size) (Type)	Linear Foot
518.03	Sanitary Sewer Bucket Cleaning (Size) (Type)	Linear Foot

ITEM 520 SANITARY SEWER CURED-IN-PLACE PIPE LINING

DESCRIPTION:

The work to be performed under this Item consists of the installation of a cured-in-place pipe lining in existing sanitary sewers of the type and size shown on the drawings or as directed by the Engineer. The intent is to correct deficiencies in the existing sewers and to extend their service life. The work shall be accomplished through the existing manholes without excavations.

The lining shall be a resin-impregnated, flexible, polyester felt, or equivalent material tube which is inserted into the sewer to be rehabilitated and cured in place by an acceptable curing method. The lining shall have a suitable membrane coating for protection of the interior surface and to provide a uniform, smooth flow surface. The resin shall be a polyester type liquid thermosetting resin and shall be suitable for the design conditions as well as the curing process.

Cured in place pipe lining shall be accomplished by pulling or inverting a resin impregnated, flexible polyester felt or equivalent material tube into the existing sewer. It shall be cured in place by an acceptable curing process until it is tightly and rigidly fitted against the existing pipe. The new liner shall be continuous from manhole to manhole, and shall be designed to carry all superimposed soil, hydrostatic and traffic loads by itself without considering any load relief from the existing sanitary sewer pipe.

Cured-in-Place Pipe Lining shall conform to the following requirements:

REFERENCES:

1. American Society of Testing and Materials (ASTM)

D543	Resistance of Plastics to Chemical Reagents
D638	Tensile Properties of Plastics
D790	Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials
D2412	Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D2990	Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
F1216	Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
F1743	Rehabilitation of Existing Pipelines and Conduit by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)

When reference is made to one of the above Standards, the revision in effect at the time of bid receipt shall apply.

MATERIALS AND EQUIPMENT

A. LINER MATERIAL - GENERAL

1. Light-colored or white liner material to facilitate closed-circuit TV inspection shall be used.
2. The liner material shall conform to the requirements of ASTM D5813 and F1216.
3. Resin-impregnated tube liner material shall consist of one or more layers of flexible needled felt, or equivalent woven or non-woven material.
4. Capable of carrying resin, and withstanding installation pressures and curing temperatures.
5. Able to stretch to fit irregular pipe sections and negotiate bends.
6. Resins shall be styrene-based, thermoset resin and catalyst system, or epoxy resin and hardener system that is compatible with installation process.
7. Outside layer of tube should be plastic-coated with material compatible with resin system used.
8. The felt content of the liner shall be determined by the manufacturer but shall not exceed 25 percent of the total impregnated liner volume.
9. The length of the liner shall be sufficient to effectively carry out installation and seat the liner at the inlet and outlet pipes of each manhole. All lengths shall be verified by the Contractor prior to construction.
10. The Contractor shall be responsible for ensuring that the correct liner is installed in each sewer being rehabilitated.
11. The actual cured liner thickness shall be +5 percent of the approved design thickness and shall not include the thickness of the membrane coating.

B. LINER MATERIAL – PHYSICAL REQUIREMENTS

The CIPP shall provide a service life of 50 years and shall have, as a minimum, the initial and long-term properties listed below. The CIPP lining shall also conform to the applicable provisions and classifications described in EPA Handbook entitled “Sewer System Infrastructure Analysis and Rehabilitation” dated October 1991 or as amended and ASTM F1216 and ADTM F1743. Liners

fabricated from resin-impregnated tubes shall meet the following physical requirements:

PROPERTY	TEST METHOD	MINIMUM VALUE
Corrosion Resistance	ASTM F1216 Section X2	N/A
Flexural Modulus (Initial)	ASTM D790	250,000 psi
Flexural Modulus (Long Term)	ASTM 2990	125,000 psi
Flexural Strength	ASTM D790	4,500 psi
Tensile Strength (Yield)	ASTM D638	3,000 psi
Tensile Modulus (Initial)	ASTM D638	300,000 psi
Tensile Modulus (Long Term)	ASTM D638	150,000 psi

CONSTRUCTION DETAILS:

Under this item the Contractor shall perform cured-in-place pipe lining, furnish, install, operate and maintain, and when completed remove, all necessary equipment, furnish, install impregnate and cure pipe lining materials and provide all incidentals necessary for complete sanitary sewer cured in place pipe lining in accordance with the contract documents and the requirements of these specifications.

A. *SYSTEM DESCRIPTION*

1. LINER DESIGN REQUIREMENTS

- a. The liner shall be designed to have a service life of a minimum of 50 years under continuous hydraulic and structural loading conditions
- b. The thickness of liner system will be designed for a fully deteriorated host pipe condition.
- c. The liner shall be designed by a Professional Engineer Registered in the State of Connecticut.
- d. Design calculations shall be based on a minimum ovality of 2 percent, a soil unit weight of 125 pounds per cubic foot, a soil modulus of 1000 psi and a water table condition at the ground surface. Traffic loads shall be based on H20 highway loading. A

minimum safety factor of 2.0 shall be used.

- e. Manning's "n" value used for the host pipe shall be 0.015, and rehabilitated line shall be 0.013.
- f. Diameter and wall thickness of new liner shall be manufactured to size such that when installed, it will provide minimum wall thickness determined by the use of the standard flexible pipe equations as detailed in ASTM F1216.
- g. The short-term modulus of elasticity shall be reduced by 50 percent in the calculations.
- h. Assume that the completed CIPP shall have complete structural support, without considering structural support from existing pipe except during construction.
- i. The CIPP lining shall also conform to the applicable provisions and classifications described in EPA Handbook entitled, "Sewer System Infrastructure Analysis and Rehabilitation" and dated October 1991 or as amended and ASTM F1216 and ASTM F1743.

2. LINER PERFORMANCE REQUIREMENTS

- a. Liner system shall have minimal effect on the flow-carrying capacity of the existing sewer, but in no case shall system capacity be reduced by more than 16 percent.
- b. Liner material shall be inert to attack by domestic sewage and suitable for use in underground sewer environment.
- c. Liner material shall be manufactured in such manner as to result in tight-fitting liner after installation. There shall be no measurable continuous annular space between outside diameter of new liner and the inside diameter of the existing host pipe.

B. SUBMITTALS

1. SHOP DRAWINGS

The Contractor shall submit a set of design calculations signed and sealed by the designer. These calculations shall include all stresses expected to result from the specified design loading conditions. Calculations shall include thickness calculations, and assumptions used as the basis for the design calculations

The Contractor shall submit shop drawings that identify locations and method of liner insertion.

- a. Shop Drawings shall be submitted for review by the Engineer at least ten (10) working days prior to start of work.
- b. Submit flow control and bypass pumping plans and locations with sufficient detail to assure that Work can be accomplished without service interruption or sewage spill. The by pass pumping plan shall be in accordance with the provisions of Item 516, Sanitary Sewer Flow Control and Bypass Pumping.
- c. Submit an emergency response plan to be followed in event of failure of bypass pumping system.

2. PRODUCT DATA

The Contractor shall provide manufacturer's data for lining materials and resins, and the following documentation:

- a. Manufacturer's certification that liner materials are in compliance with specifications, codes, and standards referenced herein.
- b. Installation instructions and details of component materials and construction details, including complete manufacturer's recommendations for storage and handling procedures and temperature control, and inserting liner, curing details, and trimming, sealing and finishing.
- c. Manufacturer's certification that liner has been properly sized to avoid creation of wrinkles or folds including field measurements, and pipe-sizing calculations.
- d. Resin manufacturer's heating requirements.
- e. A history of successful production of the materials to be used acceptable to the Engineer

3. CONTRACTOR QUALIFICATIONS

The Contractor performing the CIPP lining work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner. The Contractor shall submit the following information to the Engineer for review at the time of the bid opening:

- a. The number of years of experience in performing this type of

specialized work.

- b. The name(s) of the CIPP lining manufacturer(s) and supplier(s) for the work and previous work listed below.
- c. Evidence acceptable to the Engineer, such as certified copy of license or agreement, establishing that the Contractor has authority from patent owner(s) to use and/or install patented equipment, materials and methods.
- d. A list of municipal clients for whom the CIPP Contractor has performed this type of work without defects or performance problems for a period of three years after installation. This list shall include the names and telephone numbers of persons who can be contacted to verify previous satisfactory performance. A description of the actual work performed. The Contractor shall note the type of installation process (inversion or pulled-in-place) that was used for the work. The list of municipal clients shall include the approximate linear footage and sizes of CIPP lining installed.

C. QUALITY CONTROL

TEST CERTIFICATES: The Contractor shall submit certificates of compliance with design and test reports in accordance with applicable ASTM test methods.

D. QUALITY ASSURANCE

1. The Contractor shall comply with the requirements of this specifications and all applicable product manufacturer's recommendations. Any conflict between product manufacturer's recommendations and any portion of these specifications shall be resolved by the Engineer prior to the start of the work.
2. Manufacturer Qualifications: Products used in the work shall be produced by manufacturers regularly engaged in the manufacture of similar items, and with history of successful production acceptable to the Engineer.
3. Installer Qualifications: Licensed by lining system manufacturer, and have the following qualifications:
 - a. Thoroughly trained and experienced in necessary crafts.
 - b. Completely familiar with specified requirements and methods needed for proper performance of Work.
4. All CIPP linings shall be from a single manufacturer. The supplier shall be

responsible for complying with the provisions of all test requirements specified in the respective ASTM standards.

5. Pre-installation inspections of the CIPP lining material may be made by the Engineer or other representative of the Authority after delivery to the site. The CIPP shall be subject to rejection at any time prior to installation for failure to meet any of the specification requirements, even though sample CIPP may have been accepted as satisfactory at the place of the manufacturer. CIPP rejected after delivery shall be marked for identification and shall be immediately removed from the project site.
6. If the Contractor uses any material other than an approved material or a method other than an approved method, the Contractor shall, at its sole expense and with no cost to the Authority, remove the entire section of rehabilitated pipe and replace it with a new pipe as directed by the Engineer.

E. DELIVERY, STORAGE, AND HANDLING

1. The Contractor shall exercise care during transportation, handling, and installation of the liner to ensure that the liner material is not torn, cut, exposed to direct sunlight, or otherwise defective or damaged.
2. If any part of the liner material becomes torn, cut, or otherwise damaged before or during insertion, the Contractor shall repair or replace the affected section at Contractor's expense before proceeding with any additional lining work.
3. The liner shall be adequately supported and protected during delivery storage and handling. The liner shall be stored and handled according to the manufacturer's recommendations.

F. MANUFACTURERS

Subject to compliance with the requirements of the specifications, manufacturers offering products that may be incorporated in the work include the following companies:

- A. Insituform Technologies, Inc. CIPP
- B. InLiner USA
- C. Impreline Technologies
- D. Cure-Line Pipe

G. GUARANTEE

All cured-in-place pipe lining placed shall be guaranteed by the Contractor for a

period of three years from the date of acceptance by the Engineer. During this period, all serious defects discovered in the lining, as determined by the Engineer, shall be repaired in an approved manner or the liner shall be replaced at no cost to the Authority. The Contractor shall perform an internal television inspection prior to the end of the three year period at no cost to the Authority. This inspection shall be performed during night time low flow conditions. Bypass pumping will not be required unless during the inspection it becomes apparent that bypass pumping is necessary.

H LEGAL, SAFETY AND HEALTH REQUIREMENTS

The Contractor shall observe all federal, state and local laws, ordinances, policies, practices and regulations. In addition, the Contractor agrees to promptly procure all necessary approvals, licenses and permits, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

The Contractor shall conduct the work at all times in such a manner as to ensure the safety of the traveling public. The convenience of the general public and of the residents along and adjacent to the site shall be provided for in an adequate and satisfactory manner as the Engineer may direct.

All equipment and materials shall be placed or stored in such locations so as not to be or to create the danger of becoming a hazard to the traveling public. No section of road shall be closed to the public except by permission of the Engineer.

The safety provisions of applicable laws, building, construction and fire safety codes and the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department", approved by the State Labor Commissioner, shall be complied with at all times.

Perform operations in strict accordance with OSHA and manufacturers' safety requirements. Particular attention is drawn to safety requirements involving entering confined spaces, work on elevated platforms, and working with pressurized equipment.

I. PROSECUTION OF THE WORK

1. EXAMINATION

- a. The Contractor shall take field measurements of pipe inside diameter of sewer lines to be rehabilitated.
- b. In conjunction with review of color closed-circuit television (CCTV)

records, provide correct liner diameter and wall thickness to ensure tight fit with existing pipe to be restored.

- c. Confirm lengths of liner to be installed.
- d. Locate live services prior to rehabilitation activities. Each service connection shall be noted by size, position from reference manhole, and orientation with respect to circumference of pipe. For purposes of this specification, live services include inactive service lines to vacant lots, vacant buildings, or to occupied buildings with more than one service line serving property.

2. PREPARATION

The Contractor shall successfully complete the following items before installation of the work.

- a. Control sewer flow.
- b. Clean sewer.
- c. Perform television inspection of sewer.
- d. Take precautions to protect the new liner, and existing pipe and manholes from damage that might result from the liner insertion process.

3. SEQUENCE OF WORK

The Contractor shall perform work in the following sequence:

- a. Divert sewer flow to comply with the requirements of Item 516, Sanitary Sewer Flow Control and Bypass Pumping.
- b. Perform point repairs called out in the project documents or as directed by the Engineer.
- c. Clean sewer in accordance with the requirements of Item 518, Sanitary Sewer Cleaning and perform pre-insertion television inspection to comply with the requirements of Item 522, Sanitary Sewer Television Inspection. Complete cleaning and television inspection a minimum of 4 hours prior to commencement of lining operations.
- d. Install and cure liner and seal ends.
- e. Perform adaptation and sealing of liner at intermediate manhole inverts, as applicable.

- f. Reconnect service connections.
- g. Perform post-insertion television inspection to comply with the requirements of Item 522, Sanitary Sewer Television Inspection.

4. PIPELINE POINT REPAIR

- a. The Contractor shall repair pipeline where point repairs are identified in Contract documents according to the requirements of Item 521, Sanitary Sewer Point Repairs.
- b. Pipe and repair materials shall be as directed by the Engineer, unless otherwise indicated on the contract documents.
- c. Trenching and excavation shall conform to the requirements of Item 205, Trench Excavation and Backfill
- d. Bypassing and Dewatering: When required to maintain sanitary service, bypass sewer flow around work area, in conformance with the requirements of Item 516, Sanitary Sewer Flow Control and Bypass Pumping.
- e. Notify the Engineer, a minimum of forty-eight (48) hours in advance of commencement of pipeline point repair work at each particular location.
- f. Installation and Field Inspection: Installation of replacement pipe and/or repair work shall conform to the requirements of Item 512, Sanitary Sewer. All pipeline point repairs shall be inspected by the Engineer prior to back filling and compaction.

5. LINER INSTALLATION

- a. The Contractor shall install liner for cured-in-place pipe in accordance with ASTM F1216.
- b. *Resin Impregnation:* The Contractor shall designate a location where uncured resin in original containers and un-impregnated liner tube will be impregnated prior to installation. The Contractor shall notify the Engineer where resin impregnation will take place.
 - i. A vacuum impregnation process with roller system or other approved method designed to uniformly distribute resin throughout tube shall be used.
 - ii. The Engineer shall inspect materials and “wet out”

procedure.

- iii. Use resin and catalyst system compatible with requirements of this method.
- c. *Liner Insertion:* The Contractor shall install the liner through existing or new manholes. Ensure that pressure in liner exceeds both pressure due to groundwater head and any pressure due to sewage in laterals or connecting side sewers.
- i. Insert impregnated tube through existing or new manholes by means of installation process, and application of hydrostatic head, compressed air, or other means sufficient to fully extend it to next designated manhole or termination point.
 - a) Inflate and firmly adhere liner to pipe wall.
 - b) Install liner at rate greater than three feet per minute and less than 10 feet per minute.
 - ii. Prior to insertion, mark exterior of manufactured tube along its entire length at regular intervals not to exceed five (5) feet as a gauge to measure elongation during installation.
 - a) During insertion of resin impregnated tube into pipeline, maximum allowable longitudinal elongation or stretch of material shall be 5 percent.
 - b) Longitudinal stretch of tube shall be gauged by comparing markers on fully inserted tube to actual length of pipe being rehabilitated.
- d. *Insertion by Inversion:* Insert wet out liner through existing manhole by means of inversion process, and application of hydrostatic head or air pressure sufficient to fully extend it to next designated manhole.
- i. At lower end of standpipe or guide chute, turn liner inside out and attach to standpipe (or chute) so that a leak proof seal is created.
 - ii. Adjust inversion head or air pressure to be of sufficient magnitude to cause impregnated liner to invert from manhole to manhole, hold tube tight to pipe wall, and produce dimples at service lateral connections and flared ends at manholes.

- iii. Use lubricant if required.
- e. *Insertion by Winching:* The Engineer may accept winched-in applications as an alternate to the inversion process, provided that the liner tube and resin conform to materials and curing requirements of ASTM F1216 and these specifications.
- i. Insert wet out liner through upstream manhole, and pull through section with power winch and steel cable attached to end of liner with appropriate pulling head.
 - ii. Provide monitoring device on cable to measure pulling force. Should the pulling force exceed manufacturer recommendations, tube shall be rejected and replaced.
 - iii. Install rollers in upstream and downstream manholes to guide liner into and out of host pipe, and to guard against chafing of crowns at entry and exit from winch cable.
 - iv. Where indicated on the contract documents, cover sewer invert throughout section to be lined, with polyethylene foil or other suitable material to facilitate threading of liner and reduce risk of damage to liner material.
 - v. Use flexible and impermeable calibration hose to inflate tube. Calibration hose may be allowed to remain in completed installation at the discretion of the Engineer.
 - a) Dry liner or inflation hose material that enters existing pipe that has not been previously vacuum impregnated with resin under controlled conditions cannot be included in structural wall of CIPP. Nominal thickness of this material shall be deducted from field sample thickness measured in order to verify that minimum specified wall thickness is achieved.
 - b) Hose material remaining in installation shall be compatible with resin system used, bond permanently with tube, and be translucent to facilitate post-installation inspection.
 - c) Hose material to be removed after curing shall be non-bondable material.

- vi. Introduce water, air and/or steam into liner. Pressure will inflate and press liner material in tight fit against inner walls of host pipe, producing dimples at lateral and side connections and flared ends at manholes.
 - vii. Excavation for liner insertion shall not be permitted
- f. Curing: After insertion of tube is completed, provide suitable heat source and distribution system to distribute and re-circulate hot water, air, and/or steam throughout pipe as recommended by manufacturer.
- i. Equipment shall be capable of delivering hot water, air, and/or steam throughout section by means of pre-strung hose to uniformly raise temperature above temperature required to affect cure of resin.
 - ii. Temperature shall be determined by manufacturer based on resin/catalyst system employed.
 - iii. Perforate hose in accordance with manufacturer's recommendations, or other methods acceptable to the Engineer
 - iv. Fit heat source piping with suitable continuous monitoring thermocouples to gauge temperature of incoming and outgoing curing medium.
 - v. Temperature of curing medium shall meet requirements of resin manufacturer as measured at heat source inflow and outflow return lines.
 - vi. Place additional continuous monitoring thermocouples between impregnated felt tube and pipe invert at manholes.
 - vii. Curing medium temperature in line during cure period shall be as recommended by resin manufacturer.
 - viii. Ensure that elevated curing temperatures do not over stress liner materials.
 - ix. Initial cure shall be deemed to be complete when, an inspection of the exposed portions of the liner appears to be hard and sound and remote temperature sensor indicates that temperature is of magnitude to realize exothermal curing.

- a) Cure temperature shall be held for period recommended by resin manufacturer, during which time distribution and control of curing medium shall continue.
- b) Curing time required for the resin shall be determined with due consideration for host pipe material, resin/catalyst system, ambient temperature, moisture level, and thermal conductivity of soil.
- x. To ensure proper heat distribution of rehabilitation systems using heat exchange methods, and to prevent creation of flat bottoms in liner profile, the Contractor shall take steps to isolate the new liner system by temporarily stopping inflow and infiltration, and removing standing water, or by using reinforced, flexible pre-liner to isolate new liner.
- xi. Equipment used to supply heat and pressure shall be capable of providing necessary heat and pressure required for installation condition. Heat sources shall be fitted with suitable monitors to gage temperatures and pressures until curing is complete.

6. COOL-DOWN

Cool hardened liner to temperature below 100 degrees F before relieving pressure in section.

- a. Cool-down may be accomplished by introduction of cool water or air into lined pipe to replace water or steam and water being drained.
- b. Drain water from downstream end.
- c. Prevent development of vacuum during release of static head or air pressure that could damage pipe or newly installed lining.
- d. After tube has cured, a sufficient cool-down period shall elapse prior to continuation of the work.

7. SEALING AT MANHOLES

If CIPP fails to make tight seal at manhole walls, apply seal consisting of resin mixture compatible with liner/resin system, in accordance with manufacturer specifications and approved by the Engineer.

- a. All cutting and sealing of lining at manhole connections shall provide watertight pipe and manhole trough seals. All cut edges of the cured liner shall be thoroughly sealed with the same resin as was used in the liner. The catalyst or hardener used shall be compatible with the resin/catalyst used in the liner previously, but shall not require an external heat source to begin the exothermic reaction (curing).
- b. Where the liner has been continuously laid through a manhole during installation, the cured liner shall be neatly saw cut to fit the top of the trough through the width of the manhole base. Any void between the manhole apron and the liner wall shall be cleaned and filled with hydraulic grout. The cut edges of the cured liner shall be sealed with resin as described above.

8. REINSTATEMENT OF SERVICES

- a. Live services shall be reinstated as soon as possible.
- b. Reconnect from interior of sewer line by means of television camera and remote-controlled cutting device.
- c. Excavation for service reinstatement will not be allowed.
- d. Holes cut through rehabilitation liner for service laterals shall be neat and smooth, and shall match the entry invert of the service line.
- e. Service openings shall be reinstated to minimum of 95 percent of service lateral pipe cross section.
- f. New edges shall be smooth with no loose or abraded material.
- g. Seam between host pipe and new liner at reinstated service shall be free of gaps, voids, or cavities. Excessive gaps, voids, or cavities as determined by the Engineer shall be grouted at this joint with packer and grouting system approved by the Engineer.
- h. Provide fully-operational backup device for reinstating service laterals. If for any reason remote cutting device fails during reinstatement of service lateral, standby device shall be immediately deployed to complete reinstatement.

J. FIELD QUALITY CONTROL

1. INSPECTION

- a. Finished liner shall be continuous over entire length of liner insertion run between manholes, and free from visual defects such as foreign inclusions, dry spots, pinholes, and de-lamination.
- b. Wrinkles in finished liner pipe which cause backwater of one inch (25 mm) or more, or reduce hydraulic capacity of pipe (wrinkles which exceed 5 percent of pipe diameter) and wrinkles in finished liner that reduce structural stability of pipe are unacceptable and affected sections of lined pipe will be removed and repaired at no additional cost to the Authority.
- c. In the event that the Engineer has reasonable cause to suspect that annular space exists between liner and host pipe, Contractor will be directed to excavate and expose existing sewer and remove existing host pipe such that confirmation of suspected annular space can be made.
 - i. If annular space is determined to exist, repair in manner approved by the Engineer.
 - ii. If it is determined that no annular space exists, Contractor shall be reimbursed in accordance with **§ 109-04, Extra and Force Account Work.**

2. LEAK TESTING

After completion of liner installation but prior to reinstatement of service lines, pressure-test rehabilitated sewer line for leakage in accordance with Item 512, Sanitary Sewer.

- 3. After completion of liner installation, side sewers, and finish work at manhole, sewer shall be televised according to the requirements of Item 522, Sanitary Sewer Television Inspection. The post-construction CCTV inspection that clearly shows the entire perimeter of each service reconnection shall be performed.
- 4. The layers of the cured lining shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If separation of the layers occurs during testing of field samples, new samples will be cut from the work. Any re-occurrence may cause rejection of the work.

K. TESTING FOR CERTIFICATION

1. The Contractor shall provide sufficient specimens from each length of CIPP Lining installed to allow an independent laboratory to conduct three separate tests for each of the flexural and tensile properties of the liner as specified below. The specimens shall be cut from each installed liner at an intermediate point, the termination point or from the downtube after the liner has been cured and cooled. Each specimen shall be clearly marked to indicate the installed location of the liner, the date of installation, the pipe diameter and the resin used.

The following test shall be performed for each length of CIPP lining installed: Short-Term Flexural (Bending) Properties -The initial tangent flexural modulus of elasticity and flexural yield strength shall be measured in accordance with ASTM D790.

2. Copies of the certified test results shall be sent directly to the Engineer by the laboratory. The certified results shall report the actual test results obtained for all three specimens used for each test, the average of the three results and the standard deviation of the results for each of the properties being tested.
3. Each individual reported value shall meet or exceed the value of that property as specified in this Item or as used in the design calculations, whichever is higher.
4. All the expenses incurred relating to the certified testing of the Cured-in-Place Pipe lining furnished under this Contract, shall be paid for by the Contractor.

L. CLEAN UP

The Site shall be cleaned on a continuous, daily basis during performance of the work and shall be cleaned upon completion so that the Project Site shall be left in a neat and orderly condition acceptable to the Engineer.

MEASUREMENT AND PAYMENT:

Sanitary Sewer Cured-in-Place Pipe Lining

This work will be measured for payment by the actual number of linear feet of each size of sanitary sewer lined with cured-in-place pipe lining, measured along the centerline of the sanitary sewer from the center of the insertion manhole to the center of the last manhole.

This work shall be paid for at the contract unit price per linear foot of "Sanitary Sewer

Cured-in-Place Pipe Lining (Size), completed, which price shall include all materials, labor, tools, and equipment incidental and necessary to furnish and install the resin-impregnated, liner in existing sewers and cutting and sealing of the liner at termination manholes.

Re-establish House Service Connections

This work will be measured for payment by the actual number of house service connections re-established by the Contractor at the unit price bid for each.

This work will be paid for at the contract unit price per each of "Re-Establish House Service Connections," completed, which price shall include all materials, labor, tools, and equipment incidental and necessary to re-establish house service connections.

Cut Protruding Taps

This work will be measured for payment by the actual number of protruding taps cut by the Contractor at the unit price bid for each.

This work will be paid for at the contract unit price per each of "Cut Protruding Taps," completed, which price shall include all materials, labor, tools, and equipment incidental and necessary to cut protruding taps.

Flow Control and Bypass Pumping

There will be no measurement for payment for the cost of flow control and bypass pumping, but the cost thereof shall be included in the contract unit price for Item 520, Sanitary Sewer Cured-in-Place Pipe Lining.

Other Items of Work

Cleaning will be measured and paid for in accordance with the provisions of Item 518, Sanitary Sewer Cleaning.

For Television Inspection in connection with the installation of Sanitary Sewer Cured-In-Place Pipe Lining, the work will be measured for payment by the number of linear feet, measured along the centerline of the sanitary sewer from the center of the manhole to the center of the manhole. The actual number of linear feet shall only be measured and paid for once and the unit price bid shall include the cost of the pre-insertion, post-insertion and final guarantee television inspections of the sanitary sewer lined with cured-in-place pipe lining.

Point Repairs will be measured and paid for in accordance with the provisions of Item 521, Sanitary Sewer Point Repairs.

Maintenance and Protection of Traffic will be measured and paid for in accordance with the provisions of Item 971, Maintenance and Protection of Traffic.

When no price for Items 518, Sanitary Sewer Cleaning; Item 522, Sanitary Sewer Television Inspection; or Item 971, Maintenance and Protection of Traffic, is asked for on the Proposal Form, the cost of the Work as shown on the Contract Documents shall be included in the cost of Item 520.01, Sanitary Sewer Cured-in-Place Pipe Lining and no direct payment for the individual items will be made.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
520.01	(Size) Sanitary Sewer Cured-In-Place Pipe Lining	Linear Foot
520.02	Re-establish House Service Connection	Each
520.03	Cut Protruding Taps	Each

ITEM 521 SANITARY SEWER POINT REPAIRS

DESCRIPTION:

Work under this Item shall include the repairs and/or replacement of existing sanitary sewer pipes and fittings at the locations shown in the contract documents or as directed by the Engineer. Included shall be, but not limited to, sawcutting the existing pavement, excavation, trench support, dewatering, protection of other underground structures and facilities, formation of bedding, bedding material, laying pipe, backfilling, bituminous concrete trench repair and pavement restoration in accordance with the appropriate specifications and as ordered by the Engineer.

MATERIALS AND EQUIPMENT:

The materials and equipment necessary (including the minimum lengths of pipe to be used for point repairs) are those specified under the appropriate Items of the Standard Specifications.

In general, the Contractor shall use PVC pipe in depths 0-15' deep and ductile iron pipe in depths exceeding 15' deep. Materials similar to existing materials shall be used where shown in the contract documents or as directed otherwise or approved by the Engineer.

CONSTRUCTION DETAILS:

Related Technical Specifications:

Item 205	Trench Excavation and Backfill
Item 407	Bituminous Concrete Trench Repair
Item 512	Sanitary Sewers
Item 516	Sanitary Sewer Flow Control and Bypass Pumping
Item 520	Sanitary Sewer Cured-in-Place Pipe Lining

1. The Contractor shall comply with the requirements of the appropriate Standard Specifications for the type of pipe being repaired and/or replaced, as referenced above.
2. All defective pipes shall be excavated and uncovered so that the entire defect is exposed and the repair can be made and that the restored pipe can be aligned into its final position to the correct line and grade as shown in the contract documents. This work shall be accomplished in such a manner that the integrity of the existing pipe beyond the affected section and the joints on either side of the repair/replacement are not displaced.
3. Any joints damaged by the Contractor beyond the section of repairs shown on the contract documents shall be repaired in accordance with the requirements of

these specifications by the Contractor at no additional expense to the Authority.

4. Removal of fences, base material, storm drains, etc., that interfere with the point repair and are necessary to complete the work at the designated locations will be restored or replaced to their original condition at no additional expense to the Authority.
5. Joints: When connecting plain-end spigot pipe, suitable adapters shall be used for joining dissimilar materials or similar materials. The adapters shall be of either the insert type or the shielded coupling type as shown in the contract documents or as directed and approved by the Engineer. The adapter and coupling material shall be of materials which pass the strength and chemical requirements of ASTM Designation: C594, latest revision. All banded maintenance couplings and adapters shall bear the manufacturer's identifying mark and size.
6. Service Connections: Any service connection replaced during a point repair shall conform to these Specifications and applicable ASTM Specifications, for the materials and installation. Materials shall be similar to that of connecting pipe.
7. Cleanouts: Any cleanout replaced during a point repair shall conform to the pipe manufacturer's recommendations and specifications and applicable ASTM Specifications for the cleanout and for installation of such. The material of the cleanout shall be similar to the sewer pipe it is connected to.
8. Cleanout Plugs: All cleanout plugs used to seal an open cleanout shall be a cap similar to the pipe material of the cleanout. All cleanout plugs shall conform to the manufacturer's recommendations and specifications for the cap or plug and for installation of such.

MEASUREMENT AND PAYMENT:

The length of each section of pipe repaired or replaced under this Item shall be measured by the total length of pipe repaired or replaced measured from the centerline of the last upstream joint to the centerline of the last downstream joint, in that section.

Sanitary Sewer Point Repairs measured for payment shall include all labor, materials, equipments, personnel, supervision and all incidentals required for the proper execution of the work including but not limited to, saw-cutting pavement, trench excavation, trench support, protection of other underground structures and facilities, formation of bedding, bedding material, laying pipe, backfilling, trench repair and pavement restoration.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
521	Sanitary Sewer Point Repairs	Linear Foot

ITEM 522 SANITARY SEWER TELEVISION INSPECTION

DESCRIPTION:

Under this item, the Contractor shall inspect sanitary sewer interior using color closed-circuit television (CCTV) camera, and document the record of the inspection in DVD format with audio location and date information, video title information, continuous tape counter and provide paper and digital copies of all inspection logs. Work may be performed in conjunction with sanitary sewer cleaning, installation of cured-in-place pipe lining and/or manhole rehabilitation, independently or in conjunction with other sanitary sewer activities.

MATERIALS AND EQUIPMENT:

- A. Television Inspection Camera(s): Equipped with rotating head, capable of ± 275 -degree rotation from horizontal and 360-degree rotation about its centerline.
 - 1. Minimum Camera Resolution: 400 vertical lines and 460 horizontal lines, picture quality and definition shall be to the satisfaction of the Engineer.
 - 2. Camera Lens: Not less than 140 degree viewing angle, with automatic or remote focus and iris controls.
 - 3. Focal Distance: Adjustable through range of 6 inches to infinity.
 - 4. Camera(s) shall be intrinsically safe and operative in 100 percent humidity conditions.
 - 5. Lighting Intensity: Remote-controlled and adjusted to minimize reflective glare.
 - 6. Lighting and Camera Quality: Provide clear, in-focus picture of entire inside periphery of sewer. A reflector in front of the camera may be required to enhance lighting in large diameter pipe.
 - 7. Height adjustment: Use a camera with camera height adjustment so that the camera lens is always centered at one-half the inside diameter, or higher, in the pipe being.
- B. Footage Counter: Measures distance traveled by camera from the centerline of the starting manhole, accurate to two-tenths of a foot over the entire length of the section being inspected.
- C. Video Titling: Video equipment shall include genlocking capabilities to extent that computer generated data (such as footage, date, and size) as determined by SDR, can be overlaid onto video, and be indicated on television monitor and permanently recorded on inspection videotape.
- D. Recording: All recordings are to be in digital format.
 - 1. Image Capture: Capture color still shots of video recordings for all defects encountered. Digitized picture images shall be stored and be exportable as JPEG formats.

- 2 Video Capture: Full time live video and audio files shall be captured for each pipe segment and lateral inspected. The files shall be stored in industry standard MPEG format viewable from a DVD on an external personal computer that utilizes MicroSoft Media Player, version 9.0 to view the recording. The MPEG video shall be ISO-MPEG Level 1 (MPEG-1) coding with a resolution of 352 pixels (x) by 240 pixels (y) and an encoded frame rate of 29.97 frames per second. System shall perform an automatic disk image/file naming structure to allow saved video/data sections to be "Burned" to DVDR format. It shall have the capability of "burning" a minimum of 120 minutes of recording to the DVDR media. The video recording shall be free of electrical interference and shall produce a clear and stable image. The audio recording shall be sufficiently free of background and electrical noise as to produce an oral report that is clear and discernable. The digital recordings and inspection data shall be cross-referenced to allow instant access to any point of interest within the digital recording.

CONSTRUCTION DETAILS:

The Contractor shall provide qualified and experienced personnel and all necessary equipment, tools and materials and all incidentals required to perform sanitary Sewer Television Inspection according to the requirements of these specifications.

Inspection shall be performed by a NASSCO Pipeline Assessment Certification Program (PACP) certified operator and shall meet the coding and reporting standards and guidelines as set by PACP. All report annotations, pipe conditions and pipe defects shall be identified properly using PACP codes as defined by PACP, and severity ratings shall be calculated according to PACP.

A. SUBMITTALS

1. Quality Assurance: Submit one example DVD of previous sewer inspection work that shows operational and structural defects in sewers, complete with audio commentary and inspection log(s).
2. DVD and inspection logs will be reviewed to determine if quality of CCTV image is acceptable, and if defects were properly identified and documented according to Authority requirements.
3. Modify equipment and/or inspection procedures to achieve report material of acceptable quality.
4. Do not commence Work prior to approval of report material quality by the Engineer. Upon acceptance, report material shall serve as standard for remaining Work.
5. Maintain copy of all inspection documentation (tapes, databases, and logs) for duration of Work and warranty period.

6 Copies of PACP certificate for inspectors completing the work.

B. LEGAL, HEALTH AND SAFETY REQUIREMENTS

The Contractor shall observe all federal, state and local laws, ordinances, policies, practices and regulations. In addition, the Contractor agrees to promptly procure all necessary approvals, licenses and permits, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

The Contractor shall conduct the work at all times in such a manner as to insure the least possible obstruction to traffic. The convenience of the general public and of the residents along and adjacent to the roadway shall be provided for in an adequate and satisfactory manner as the Engineer may direct.

All equipment and Materials shall be placed or stored in such locations so as not to be or to create the danger of becoming a hazard to the traveling public. No section of road shall be closed to the public except by permission of the Authority.

The safety provisions of applicable laws, building, construction and fire safety codes and the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department", approved by the State Labor Commissioner, shall be complied with at all times.

The Contractor shall obtain the appropriate permits and approvals Perform operations in strict accordance with OSHA and equipment manufacturers' safety requirements. Particular attention is drawn to safety requirements involving entering confined spaces.

C. PROSECUTION OF THE WORK

Sewer Flow Requirements

1. Minimal visible sewage flow in the sanitary sewers shall be allowed during inspection. If in the opinion of the Engineer, the amount of sewage flow observed during the television inspection becomes detrimental to the effectiveness of the work, it shall be eliminated by plugging of the sewers in the upstream manhole and/or bypass pumping, if necessary.
2. Plugs for flow control shall be of a design which permits the release of a portion or all of the stored sewage flow in an emergency.
3. Water levels in the manholes upstream of the plugs shall not be allowed to rise to an elevation higher than two (2) feet above the manhole invert. If water levels rise to higher elevations, the plugs shall be removed to release a portion of the stored sewage or bypass pumping shall be utilized. Flows shall be restored to normal after completion of the television inspection.

D. SEQUENCE OF THE WORK

When performed in conjunction with cured-in-place lining, the Contractor shall perform the Work in the following sequence:

1. Clean sewer lines and manholes in accordance with requirements of Item 518, Sanitary Sewer Cleaning.
2. Perform TV inspection to comply with requirements of this specification.
3. Install cured-in-place pipe lining in accordance with requirements of Item 520, Sanitary Sewer Cured-In-Place Pipe Lining.
4. Repeat TV inspection in same direction as previous inspection, after completion of installation of cured-in-place lining.
5. Inspection Requirements
 - a. The entire inspection survey shall be recorded in MPEG-1 format written to DVD and submitted with digital links to the survey. The documentation of the work shall be consistent with the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment Certification Program Second Edition Reference Manual, 2001, including CCTV Reports, unmodified PACP database, logs, electronic reports, etc. noting important features encountered during the inspection.
 - b. Audio portion shall be sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
 - c. Identify each DVD with labels showing Authority's name, Contractor's name, and each manhole-to-manhole pipe segment of sewer line represented on DVD.
 - d. The completed DVD will become the property of the Authority.
6. The speed of travel shall be slow enough to inspect each pipe joint, tee connection, structural deterioration, infiltration and inflow sources, and deposits, but should not, any time, be faster than 30 feet per minute. The camera must be centered in the pipe to provide accurate distance measurements to provide exact locations of important features in the sewer and these footage measurements shall be displayed and documented on the video.
7. Stop at every joint for three seconds and using a pan and tilt view when appropriate, and stopping elsewhere when necessary to ensure proper documentation of the sewer's condition. Stop at every lateral connection. Center the camera so that the lighting and the pan and tilt view can be used to inspect as far into the lateral connection as possible. Recording

all defects found in the service connection. Where lateral flow is observed, observe flows from service connections for approximately two minutes to ascertain if the flow is sanitary or extraneous flow. The video recording may be paused during observation. Record results of the flow observed on video recording and inspection logs.

8. The Engineer shall have access to observe and monitor operations at all times.
9. Every section of sewer (manhole to manhole) shall be identified by audio and alphanumeric on the video display and shall include: Project title, name of Greater New Haven Water Pollution Control Authority, time of day, map number, manhole to manhole pipe section, pipe material, sewer diameter and length, compass direction of viewing, direction of camera's travel, pipe depth, and operator name.

Important features shall be identified by audio and on PACP log to include all manholes, active and inactive service connections, structural defects, maintenance problems, grease, roots, infiltration, obvious inflow sources, etc. All video must be continuously metered from manhole to manhole. In addition to televising the sewer, all manholes shall be panned with the video camera and visually inspected.

E. ACCEPTANCE BY THE ENGINEER

Final Acceptance of the work shall be determined by the Engineer based upon the verification that the Sanitary Sewer Television Inspection has been successfully completed in accordance with the following requirements:

1. Where television inspection is in preparation for the installation of cured-in-place pipe lining, the television inspection shall be in accordance with these specifications and the requirements of Item 520, Sanitary Sewer Cured-in-Place Pipe Lining.
2. Where television inspection is in preparation for manhole rehabilitation, the television inspection shall be in accordance with these specifications and the requirements of Item 524, Sanitary Sewer Manhole Rehabilitation.

If the Engineer determines that the television inspection has not been completed in accordance with the requirements, the Contractor shall repeat the television inspection process until final acceptance is obtained.

F. CLEAN UP

The Site shall be cleaned on a continuous, daily basis during performance of the work and shall be cleaned upon completion so that the Project Site shall be left in a neat and orderly condition acceptable to the Engineer.

MEASUREMENT AND PAYMENT:

This work will be measured for payment by the actual number of linear feet of the size and type of sanitary sewer television inspections, measured along the centerline of the sanitary sewer from the center of the manhole to the center of the manhole.

This work shall be paid for at the contract unit price per linear foot of "Sanitary Sewer Television Inspection (Size) (Type), actually completed, which price shall include all materials, labor, tools, and equipment incidental and necessary for the television inspection.

For Television Inspection in connection with the installation of Sanitary Sewer Cured-In-Place Pipe Lining, the work will be measured for payment by the actual number of linear feet, measured along the centerline of the sanitary sewer from the center of the manhole to the center of the manhole. The actual number of linear feet of the sanitary sewer lined with cured-in-place pipe lining shall only be measured and paid for once and the unit price bid shall include the cost of the pre-insertion and post-insertion television inspections as well as the final television inspection performed at the completion of the three year guarantee period.

There will be no measurement for payment for the cost of television inspection of manholes, but the cost thereof shall be included in the contract unit price per linear foot for the size and type of sanitary sewer television inspection.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
522	Sanitary Sewer Television Inspection (Size) (Type)	Linear Foot

ITEM 523 SANITARY SEWER MANHOLES

DESCRIPTION:

The work under this Item shall consist of the construction, alteration, reconstruction, conversion, or resetting of sanitary manholes and drop manholes. Said structures shall be constructed in conformity with the lines grades, dimensions and details shown on the Contract Drawings or as ordered and in accordance with the provisions of these specifications. In this Contract unless otherwise directed by the Engineer, or shown on the details, all manholes shall be precast.

For the work under this Item the following definitions shall apply:

- A. "Construct" shall mean the work required to construct a new manhole.
- B. "Alter" shall mean that work required on existing manholes in order to make required connections of pipes being installed under other Items of work.
- C. "Reconstruct" shall mean major changes made to an existing manhole in order to adjust the frame and cover or other reconstruction work all as indicated on the Contract Drawings.
- D. "Convert" shall mean the work required in changing an existing unit to a unit of another type.
- E. "Reset" shall mean the minor adjustment of frames and covers of existing units to the proposed grade not involving major reconstruction of the unit. (Examples of resetting are: adding several course of brick/block or use of an approved manufactured manhole extension adapter ring to bring a frame to required grade.; removing some masonry courses for lowering a frame without reconstruction below the required elevation of the bottom of the frame (providing that the frame will be properly seated).

MATERIALS:

The materials to be used in this construction shall be those indicated on the Contract Drawings or ordered by the Engineer and they shall conform to the requirements of these specifications. All units shall be of precast reinforced concrete. Manhole sections and base shall conform to the type and size specified on the Contract Drawings and the requirements of ASTM Specification C-478. Precast manhole sections shall be joined with rubber gaskets in conformance with the provisions of ASTM Specification.

Concrete building brick will conform to the provisions of ASTM C-55, Grade P-II; brick shall conform to the provisions of ASTM C-32, Grade MM. No common brick will be allowed.

Metal for manhole frames, covers and steps shall be cast iron, cast steel, cast or wrought aluminum, structural steel or malleable iron conforming to the requirements of the Contract Drawings. The lower surface of the cover and the corresponding upper surface of the frame shall be machine finished to provide a smooth flat contact or fit, so that covers shall bear uniformly on their supports without tendency for the cover to rock or rattle. Cast iron shall conform to the requirements of AASHTO M 105, Class 25. Cast steel shall conform to the requirements of ASTM 27 and shall be thoroughly annealed. Structural steel shall conform to the requirements of ASTM A36 or A283, grade B or better as to quality and details of fabrication. Malleable iron shall conform to the requirements of specifications of ASTM A47 Grade 32510 (Except for steps which may be graded 35018). Cast aluminum steps shall comply with the provisions of ASTM B-26 for Alloy SG70A-T6. Wrought aluminum shall conform to the provisions of AFTM B209.

Mortar shall conform to the requirements of these Specifications except that the annular rings around the pipe shall be bricked up using concrete brick and an approved non-shrink mortar.

CONSTRUCTION DETAILS:

Excavation for installation of manholes shall be constructed as shown on the Contract Drawings

Precast concrete riser sections shall be carried to below finished grade as shown on the details. The Contractor shall set the casting to grade using not less than two nor more than six courses of brick. Precast concrete sections of manholes will be joined using "O" ring gaskets installed as specified under the Item "Sanitary Sewers" and the joints shall be mortared with non-shrink mortar.

Backfilling and compacting shall be performed in accordance with the provisions of the Item 205, Trench Excavation and Backfill.

Where proposed manholes are indicated on the Contract Drawings to be constructed over, existing sewers, the existing sewer pipe shall be left undisturbed and the flow maintained through it until the manhole has been completed and accepted. Unless otherwise specified, required or ordered, the Contractor shall carefully excavate around and properly support the existing sewer pipe. The base section of the manhole shall be cast-in-place and shall have ring-formed joint cast or formed in the base section which shall be compatible with the corresponding precast manhole riser sections. On completion and acceptance of the manhole, the top portion of the existing sewer pipe shall be carefully removed and the invert formed to the limits and in accordance with the details shown on the Contract Drawings or as directed by the Engineer. Reinforced concrete pipe shall have the reinforcement cut off and mortared over with a minimum of one-half inch of mortar.

TESTING

- A. Vacuum Test (required on all **new** manholes and junction chambers)
1. Vacuum testing shall be performed using an inflatable compression band, vacuum pump, and appurtenances specifically designed for testing manholes. Test procedures shall be in accordance with the equipment manufacturer's recommendations. The Contractor shall be familiar with the vacuum testing equipment and shall provide a minimum of 4 hours of instruction by a factory authorized representative prior to the performance of any vacuum testing.
 2. Each manhole and junction chamber shall be tested immediately after assembly including the connection of pipes and prior to backfilling.
 3. All lift holes shall be plugged with non-shrink grout and all pipes entering the manhole and junction chamber shall be plugged and braced to prevent the plug from being drawn into the manhole or junction chamber.
 4. After the test equipment is in place the test shall be performed at the following rate and test times:
 - a. For 48", 60", 72" or 84" Diameter Manholes.
 - (1) Initial pressure test – 10 inches Hg.
 - (2) Test time - 1inch Hg drop to 9 inch Hg in 1 minute minimum allowable, for 0 -10 ft deep manholes; 1 minute 15 seconds minimum allowable for 10 -15 ft deep manholes; 1 minute 30 seconds minimum allowable for 15 - 25 ft deep manholes.
 - b. If the pressure drop exceeds 1 inch Hg in the specified time the manhole shall be repaired in accordance with approved procedures and retested.
 - c. If a manhole fails to meet a 1 inch Hg drop in the specified time after repairs the unit shall be water exfiltration tested and repaired as necessary.
- B. Water Exfiltration Test (for all manholes and chambers)

1. The Contractor shall assemble the manhole in place; fill and point all lifting holes and exterior joints within six (6) feet of the ground surface with an approved non-shrinking mortar. The test shall be performed prior to the installation of the shelf and invert and before filling and pointing the horizontal joints below six (6) foot of depth. The Contractor shall lower ground water table below the bottom of the manhole for the duration of the test. Plug all pipes and other openings into the manhole and brace to prevent blow out.
 2. The manhole shall be filled with water to the top of the cone section. If the excavation has not been backfilled and no water is observed moving down the surface of the manhole, the manhole is satisfactorily water-tight. If the test, as described above is unsatisfactory as determined by the Engineer, or if the manhole excavation has been backfilled, continue the test. A period of time may be permitted to allow for absorption. Following this period, refill manhole to the top of the cone, if necessary and allow at least eight hours to pass. At the end of the test period, refill the manhole to the top of the cone again, measuring the volume of water added. Extrapolate the refill amount to a 24-hour leakage rate. The leakage for each manhole shall not exceed one gallon per vertical foot for a 24 hour period. If the manhole fails this requirement, but the leakage does not exceed three gallons per vertical foot per day, repairs by approved methods may be made as directed by the Engineer. If leakage due to a defective section of joint exceeds three gallons per vertical foot per day, the manhole shall be rejected. Uncover the rejected manhole as necessary and disassemble, reconstruct or replace it as directed by the Engineer. Retest the manhole and, if satisfactory, fill and point the interior joints.
 3. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorptions, 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.
 4. An infiltration test may be substituted for an exfiltration test if the ground water table is above the highest joint in the manhole. If there is no leakage into the manhole as determined by the Engineer, the manhole will be considered water-tight. If the Engineer is not satisfied, testing shall be performed as described hereinbefore.
- C. If any manhole fails the initial test, the Contractor shall locate the leak and make the necessary repairs. The manhole shall be retested as above. No adjustment in the leakage allowance will be made for unknown causes such as leaking plugs, absorption, etc.

- D. An infiltration test may be substituted for an exfiltration test if the ground water table is above the highest joint in the manhole or where manholes are placed in service immediately and cannot be tested by using the vacuum test or exfiltration test.

MEASUREMENT:

1. Construction of Sanitary Manholes and Sanitary Drop Manholes - shall be measured for payment by the number of linear feet measured vertically. The depth of a unit shall be the total depth, measured to the nearest tenth of a foot from the bottom side of the floor slab to the top of the highest point of the frame.
2. Alterations - of existing manholes necessary to make the required connections to pipes installed under other Items, will not be measured for payment but the cost thereof included in the pipe costs being installed under those Items.
3. Reconstruction - of existing manholes where shown on the Contract Drawings or ordered by the Engineer will be measured for payment by the number of linear feet measured vertically. The depth of a unit shall be the total depth, measured to the nearest tenth of a foot from the bottom side of the floor slab to the top of the highest point of the grate or frame.
4. Conversion - of existing manholes to manholes of another type as specified, will be measured for payment as a unit, including all necessary alterations to the walls and furnishing and setting the frame and cover, whichever applies.
5. Resetting - of existing units where shown on the Contract Drawings will be measured for payment as units.
6. New Frames and Covers - when replacing existing frames and covers will be measured for payment as units and will appear in the proposal form.
7. Dampproofing - will not be measured for payment, but the cost thereof shall be included in the unit price bid for sanitary manholes.
8. Excavation - will be measured for payment as described in Item 205, Trench, Excavation and Backfill.
9. Bedding Material, Borrow/Selected Borrow and Processed Aggregate Base - will be measured and paid under their respective Items.
10. Inspection and Testing will not be measured for payment, but the cost shall be considered as include in the unit price bid for sanitary manholes.

PAYMENT:

1. Construction of "Sanitary Manholes" or "Sanitary Drop" Manholes" - will be paid for at the contract unit price per linear foot of height measured to the nearest tenth of a foot from the bottom side of the floor slab to the top of the highest point on the frame. The price shall include frame, cover, concrete, reinforcing, masonry, castings, parging, dampproofing, and all other materials, equipment, tools labor and work necessary for or incidental to the completion of the Item unless they are specifically called out for separate payment above.
2. Alteration - of existing manholes will not be paid for but included under other Items of work as specified. Alterations shall include the Items "Proposed Connection at Existing Manhole", and "Proposed Drop Connection at Existing Manhole."
3. Reconstruction - of existing manholes will be paid for at the contract unit price per linear foot of height measured to the nearest tenth of a foot from the bottom side of the floor slab to the top of the highest point on the frame, of completed and accepted units. The price shall include dampproofing, materials, equipment, tools, labor and work incidental to or necessary for the completion of the Item.
4. Conversion - of existing manholes to the type specified shall be paid for at the contract unit price per each, completed and accepted, which price shall include all necessary, alterations, dampproofing, and all other materials equipment tools, labor and work incidental to or necessary for the completion of the Item.
5. Resetting - of existing units shall be paid for at the contract unit price per each as specified, completed and accepted. Said price shall include dampproofing and all other materials, equipment, tools, labor and work incidental to or necessary for the completion of the Item, except that when the work requires reconstruction greater than three feet measured vertically, then the entire cost of resetting the unit will be paid for as extra work unless otherwise provided.
6. New Frames and Covers - except where included in the other contract unit prices, will be paid for at the contract unit price per each if an Item appears in the Proposal Form.
7. Dampproofing – this work will not be measured for payment, but the cost shall be included in the unit price bid for sanitary manholes.
8. Excavation and Backfill - will be paid for in accordance with the provisions of Item 205, "Trench Excavation and Backfill" under the appropriate classifications.

The unit prices bid shall include all materials, equipment, tools, testing, labor and all else necessary and incidental to the satisfactory completion of the work.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
523.01	Sanitary Sewer Manhole	Linear Foot
523.02	Sanitary Drop Manhole	Linear Foot
523.03	Reconstruct Sanitary Sewer Manhole	Linear Foot
523.04	Conversion – Sanitary Sewer Manhole	Each
523.05	Reset - Sanitary Sewer Manhole	Each
523.06	Proposed Connection at Existing Manhole	Each
523.07	Proposed Drop Connection at Existing Manhole	Each

ITEM 524 SANITARY SEWER MANHOLE REHABILITATION

DESCRIPTION:

Work under this Item consists of sanitary sewer manhole rehabilitation necessary to provide for the waterproofing, sealing, structural enhancement and corrosion protection of and the non-disruptive structural replacement of existing sewer manholes.

1. Sanitary sewer manhole rehabilitation work for all manholes except precast concrete shall be completed in accordance with following methods as shown within the Contract Documents and as ordered by the Engineer.
 - a. Structurally stable manholes: Spray on application of a uniform and densely compacted cementitious layer. Some manholes shall receive an additional layer of epoxy for corrosion protection. The manholes with cementitious layer and epoxy will be as shown within the Contract Documents or as ordered by the Engineer.
 - b. Unstable or structurally deficient manholes: Installation of a formed-in-place, thick-wall, seamless concrete manhole within the existing manhole extending from bench to frame. The manholes with the formed-in-place concrete with embedded plastic liner will be as shown on the Contract Documents or as ordered by the Engineer.
2. Sanitary sewer manhole rehabilitation work for precast concrete manholes includes the following as shown on the drawings:
 - a. Injection Grout Manhole Base: Work includes injection of chemical grout and application of joint sealing compound to the manhole base to make a structurally sound, watertight manhole base.
 - b. Injection Grout Manhole Wall Joint: Work includes injection of chemical grout and application of joint sealing compound to wall joints to make a structurally sound watertight manhole.
 - c. Injection Grout Pipe Penetration: Work includes injection of chemical grout and application of joint sealing compound to the joint of the penetrating pipe to make a structurally sound watertight pipe connection.
3. Sanitary sewer manhole rehabilitation work for all manholes selected for rehabilitation shall include the replacement of all manhole frames and covers and the structure adjusted to grade, if required.:

4. Flex Coat Chimney Seal: Work includes applying alkylamine epoxy or urethane based flexible coating to chimney section of manhole. Work also includes chimney rehabilitation including replacement of any loose or broken bricks or block.

MATERIALS:

1. GENERAL

- A. Handling, formulation, and storage of the sealing compounds and grouts shall be in strict conformance with the manufacturer's recommendations. The uncured compound and grouts shall be delivered to the site in unopened containers, with the date of manufacture clearly indicated. Any uncured compound determined to be more than six months old shall be immediately removed from the site. Once a container of uncured compound or grout has been opened it shall be used within 24 hours of being opened.
- B. Mixing and handling of the compounds and grouts and the constituents producing it, which may be toxic on contact or inhalation, shall be as recommended by the manufacturer and Contractor shall minimize hazard to personnel. The Contractor is responsible for providing appropriate protective measures to ensure that the components and the chemicals produced in mixing are under the control of the Contractor at all times and are not available to unauthorized personnel or others. Excess material resulting from rehabilitation operations shall be disposed of in a safe manner. All equipment and material shall be subject to the review of the Engineer.
- C. All chemical materials used shall meet the following minimum application requirements:
 - i. All component materials shall be easily transportable by common carriers.
 - ii. Packing of component materials shall be compatible with field storage requirements.
 - iii. Components shall be packed in such a fashion as to provide for maximum worker safety when handling the materials and minimize spillage when preparing for use.
 - iv. Mixing of the components shall be compatible with field applications, not require precise measurements, and be within the limits recommended by the manufacturer.

- v. Catalyzation shall take place at the point of injection/repair.
- vi. Cleanup shall be done without inordinate use of flammable or hazardous chemicals.
- vii. Residual sealing materials shall be removed from the sewer after injection to ensure no flow reductions, restrictions or blockages of sewer flows.

2. *SPRAY-ON CEMENTITIOUS LINER*

- A. Provide the following as manufactured by AP/M Permacast of Johnston, IA or equal:

Plugging holes and stopping active hydrostatic infiltration at points in concrete and masonry manholes includes underdrains: A premixed Portland cement-based hydraulic cement consisting of Portland cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsums, plasters, iron particles, or gas forming agents or promote the corrosion of steel it may come in contact with. Set time shall be approximately 50 seconds. The ten (10) minute compressive strength shall be approximately 500 psi.

- B. A silicate-based liquid accelerator field mixed with neat Portland cement. Set time approximately 50 seconds.

A premixed Portland cement-based hydraulic cement consisting of Portland cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsums, plasters, iron particles, or gas-forming agents or promote the corrosion of steel it may come in contact with. Set time approximately 3 minutes or 15 minutes to suit application. One-hour compressive strength shall be approximately 600 psi.

- C. Cementitious Liner

Provide the following MS-10,000 lining mortar as manufactured by AP/M Permaform of Johnson, IA or equal

1) Ultra high strength, high build, corrosion resistant mortar, based on Portland cement fortified with micro silica. The mortar, when mixed with the appropriate amount of water, shall be able to be sprayed, cast, pumped or gravity-flowed into any area 1/2 inch and larger. The mortar shall harden quickly without any need for special curing and shall develop (80%) eighty percent of its ultimate flexural strength in the first 24 hours.

2) The hardened binder shall be dense and highly impermeable. Graded quartz sands shall be added to enhance particle packing and further improve the fluidity and hardened density. The mortar shall possess excellent thin-section toughness, high modulus of elasticity and be self-bonding. Fibers shall be added as an aid to casting, for increased cohesion and to enhance flexural strength.

3) The water content shall be adjusted to achieve the desired consistency. Despite its high fluidity, the mortar shall have good wet adhesion and shall not sag or run after placement. The mortar shall be able to be cast against soil, metals (including aluminum and lead), wood, plastic, cardboard and other normal construction material.

4) Physical properties

Unit weight	125 pcf
Set Time at 70o F ASTM C-403	
Initial Set	244 minutes
Final Set	440 minutes
Modulus of Elasticity ASTM C-469	
24 hours	180,000 psi
28 days	1,150,000 psi
Flexural Strength ASTM C-293	
24 hours	650 psi
28 days	800 psi
Compressive Strength ASTM C-307	
24 hours	3,000 psi
28 days	10,000 psi
Tensile Strength ASTM C-307	600 psi
Shear Bond ASTM C-882	>1,000 psi
Shrinkage ASTM C-157	None
Chloride Permeability ASTM C-1202	<550Coulombs

D. Chemical protective coating

For the manholes where an additional layer of epoxy is specified provide the following COR+GARD Composite as manufactured by AP/M Permaform of Johnson, IA or equal

1) The chemical protective coating shall be a two-component 100% solids epoxy design formulated for use in sewer systems. It shall be white in color for enhanced visibility and shall be applied uniformly over the entire interior surface. Application shall avoid air bubble entrapment. The chemical protective coating shall cure quickly, even when immersed in fresh or salt water and rapidly form a tenacious bond to freshly applied mortars. The chemical protective coating shall produce a smooth, glossy

and homogenous protective layer that is impervious to biological corrosion, water, oils and chemicals.

2) The chemical protective coating shall be applied at a minimum thickness of 0.065 inches (1.65 mm) to provide a complete and uniform vapor barrier against attack by sewer gases and corrosion causing bacteria. The surface shall be free of entrapped air bubbles or holidays.

3) Physical properties

Dry Time	4-6 hours @ 75° F
Compressive Strength ASTM D-695	16,800 psi
Flexural Strength ASTM D-790	13,900 psi
Tensile Strength ASTM D-638	12,400 psi
Hardness ASTM D-2240	68-72 Shore D
Heat Distortion ASTM D-648	220 ° F
Ultimate Elongation ASTM D-638	4.5 %
Adhesive Shear ASTM C-882	1,000 psi

3. FORMED-IN-PLACE CONCRETE WITH EMBEDDED PLASTIC LINER

Provide the following as manufactured by AP/M Permaform of Johnston, IA or equal:

1) Concrete: The concrete shall be Type I/II Portland cement concrete with 5/8 inch minus coarse aggregate with fiber reinforcement and plasticizers producing an average compressive strength of 4,000 psi at full cure.

2) Plastic Liner: A ribbed or studded plastic liner shall be anchored into the new interior wall during the procedure to create an impermeable barrier. The plastic liner shall be PVC and shall be able to resist corrosion.

4 MANHOLE GROUT INJECTION

A. Acrylamide base grout shall have the following characteristics:

1) A minimum of 10% acrylamide base material by weight in the total grout mix. A higher concentration (%) of acrylamide base material may be used to increase strength or offset dilution during injection.

2) The ability to tolerate some dilution and react in moving water during injection.

3) A viscosity of approximately 2 centipoise, which can be increased with additives.

- 4) A constant viscosity during the reaction period.
- 5) A controllable reaction time from 10 seconds to 1 hour.
- 6) A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, firm, flexible gel.
- 7) The ability to increase mix viscosity, density and gel strength by the use of additives.
- 8) Product Manufacturer: Avanti AV-100; or equal.

B. Acrylic base grout shall have the following characteristics:

- 1) A minimum of 10% acrylic base material by weight in the total grout mix. A higher concentration (%) of acrylic base material may be used to increase strength of set dilution during injection.
- 2) The ability to tolerate some dilution and react in moving water during injection.
- 3) A viscosity of approximately 2 centipoise, which can be increased with additives.
- 4) A constant viscosity during the reaction period.
- 5) A controllable reaction time from 5 seconds to 6 hours.
- 6) A reaction (curing) that produces a homogenous, chemically stable, non-biodegradable, flexible gel.
- 7) The ability to increase mix viscosity, density and gel strength by the use of additives.
- 8) Product Manufacturer: Avanti AV-118; or equal.

C. Additives

1. Latex additive (or equal) shall be added to strengthen the grout. The quantity of latex additive will be according to the manufacturer recommendation. The grout admixture shall be adjusted to meet specified viscosity and reaction time. Strictly follow manufacturer's recommendations for product handling and start. Latex additive shall have the following characteristics.

- a. Solids Content 49% minimum ASTM D-1010

- b. pH 7.5-8.5, 8.0 Average
- c. Viscosity 130 cps @ 77oF ASTM D-1638
- d. Density 8.52 lbs / gal. ASTM D-1564W
- e. Solvent Water
- f. Shall provide protection against shrinkage and improve the strength of the gel.
- g. Shall not contain organic solvents.

2. A root deterrent chemical such as dichlobenil shall be added to the grout in proportions as recommended by the manufacturer.

3. A shrink control agent that is a water-based emulsion shall be used with the grout. The shrink control agent shall reduce shrinkage and improve strength of the grout providing the resultant cured material with both improved hydrostatic pressure resistance and flexibility. The agent shall be added in proportions as recommended by the manufacturer.

5 FLEX COAT CHIMNEY SEAL MATERIAL

A. Coating shall be 100% solids, solvent-free flexible epoxy or urethane coating having the following characteristics:

- 1. Tensile Strength (ASTM-D 412): 1,100 psi.
- 2. Tensile Ultimate Elongation (ASTM-D 412): 400%
- 3. Hardness, Shore D (ASTM-D 2240): 65
- 4. Adhesion Strength (ASTM-D 412): 175 lb/in
- 5. Initial Tear Resistance (ASTM-D1004): 150 lb/in
- 6. Minimum Application Thickness: 170 mil.

B. Acceptable Manufacturer: Flex-Seal Utility Sealant by Sealing Systems, Inc. or Equal.

6. WALL PATCH

A quick setting fiber reinforced calcium aluminate cementitious shall be used as a patching mix, mixed and applied according to manufacturer's recommendations, and having the following minimum physical properties:

- 1. Compressive Strength (ASTM C109B): 1,400 psi, 1 hrs
2000 psi, 24 hours
- 2. Shrinkage (ASTM C596): <0.06% at 90% R.H.
- 3. Bond Strength (ASTM C321): 900 psi, 24 hour
- 4. Flexural Strength 500 psi, 24 hour
900 psi, 28 days
- 5. Cement: sulfate resistant
- 6. Density, when applied: 105 +/- 5 pcf

7. HYDRAULIC CEMENT

A rapid setting cementitious product specifically formulated for leak control shall be used to stop minor water infiltration, mixed and applied according to manufacturer's recommendations, and having the following minimum physical properties:

- | | |
|---------------------------------------|--|
| 1. Compressive Strength (ASTM C109B): | 600 psi, 6 hours
2000 psi, 24 hours |
| 2. Shrinkage (ASTM C596): | <0.06% at 90% R.H. |
| 3. Bond Strength (ASTM C321): | 40 psi, 1 hour
80 psi, 24 hours |

CONSTRUCTION DETAILS:

A. REFERENCES:

1. ASTM C-39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
2. ASTM C-94 - Standard Test Method for Ready-Mix Concrete
3. ASTM C-143 - Standard Test Method for Slump of Hydraulic Cement Concrete
4. ASTM D-149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
5. NACE RP0274 - High Voltage Electrical Inspection of Pipeline Coating Prior to Installation
6. ASTM C-109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
7. ASTM C-293 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
8. ASTM C-307 – Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
9. ASTM C-469 – Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete Compression
10. AASTM C-882 – Standard Test Method for Bond Strength of Epoxy Systems Used with Concrete by Slant Shear
11. ASTM C-157 – Modified Standard Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete
12. ASTM C-1202 – (AASHTO T 277 Equivalent) Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
13. ASTM C150 – Specifications for Portland Cement
14. ASTM C321 – Standard Test Method for Bond Strength of Chemical Resistant Mortars
15. ASTM C495 – Standard Test Method for Compressive Strength of

- Lightweight Insulating Concrete
16. ASTM C496 - Test Method of Splitting Tensile Strength of Cylindrical Concrete Specimens
 17. ASTM C579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing.
 18. ASTM C596, Test Method for Drying Shrinkage of Mortar Containing Portland Cement.
 19. ASTM WK4521, Standard Practice for Sealing Sewer Manholes using Chemical Grouting.
 20. Standards of American Water Works Association, AWWA.
 21. Standards of American National Standards Institute, ANSI.
 22. International Concrete Repair Institute (ICRI) Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

B. SUBMITTALS:

1. The Contractor shall submit manufacturer's technical data, details, and specifications showing complete information on surface preparation and application procedures, material composition, physical properties and installation equipment in accordance with the requirements of **§ 106, Control of Materials**.
2. The Contractor shall submit manufacturer's certification of applicator's successful completion of training in use of the application equipment, rehabilitation products, and rehabilitation procedures.
3. The Contractor shall submit warranty information.

C. MANUFACTURER'S PRODUCT SUPPORT

The Contractor shall provide a representative employed by the manufacturer having technical training in admixture and manhole wall liner design and construction available for consultation on site during the repair work.

D. QUALIFICATIONS:

1. Contractor shall be licensed and certified by the manufacturer of the manhole lining process. Contractor shall have completed spray on cementitious manhole rehabilitation of at least 100 manholes and shall have completed manhole grout injection for at least 100 manholes.
2. All work must be supervised by a foreman responsible for rehabilitating a minimum of 50 manholes using the proposed manufacturer's manhole lining process for spray-on cementitious manhole rehabilitation and a minimum of 50 manholes using the proposed manufacturer's manhole lining process for manhole grout injection.

E. GUARANTEE:

1. Contractor shall re-inspect all manholes in the presence of the Owner or the Engineer 12 to 18 months after Conditional Acceptance of the work during high groundwater conditions.
2. All manhole repairs shall be guaranteed by the Contractor against infiltration, spalling, or loss of adhesion for a period of 5 years from the date of Conditional Acceptance. During this period, all defects shall be repaired by Contractor in a manner satisfactory to the Engineer at no additional compensation.

F. LEGAL, SAFETY AND HEALTH REQUIREMENTS

The Contractor shall observe all federal, state and local laws, ordinances, policies, practices and regulations. In addition, the Contractor agrees to promptly procure all necessary approvals, licenses and permits, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work.

The Contractor shall conduct the work at all times in such a manner as to insure the least possible obstruction to traffic. The convenience of the general public and of the residents along and adjacent to the roadway shall be provided for in an adequate and satisfactory manner as the Engineer may direct.

All equipment and Materials shall be placed or stored in such locations so as not to be or to create the danger of becoming a hazard to the traveling public. No section of road shall be closed to the public except by permission of the Authority.

The safety provisions of applicable laws, building, construction and fire safety codes and the latest edition of the "Construction Safety Code, State of Connecticut, Labor Department", approved by the State Labor Commissioner, shall be complied with at all times.

The Contractor shall perform operations in strict accordance with OSHA and manufacturers' safety requirements. Particular attention is drawn to safety requirements involving entering confined spaces.

G. WORK IN CONFINED SPACES

All work in existing manholes shall be performed in accordance with OSHA 29CFR 1910.146, "Permit Required Confined Spaced."

H. MANHOLE CLEANING / PREPARATION

1. Clean bench/invert floor and interior walls of manholes by removing deleterious material, including dirt, grease, and other debris. Use high-

pressure water, at a minimum force of 3,500 psi. If required, use approved cleaners to remove grease, oil, and other matter, which would prevent a good bond between existing manhole wall and the approved repair materials. Cleaning can also be accomplished by applying a 10 percent solution of muriatic acid or hydrochloric acid over surfaces. If an acid solution is used, the surface shall be thoroughly rinsed and neutralized prior to the application of mortars and coatings.

2. Preparation of the interior surfaces shall conform to requirements of the wall liner material manufacturer. Loose and protruding brick, mortar and concrete shall be removed using a mason's hammer and chisel and/or scraper. No debris shall be disposed of into the sewer system.
3. Ensure all sub-surfaces are clean and free of laitance or loose material.
4. Ensure that overhead sub-surfaces have been prepared to a minimum degree of roughness designated as CSP 4 by the International Concrete Repair Institute (ICRI) Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
5. Ensure that sub-surfaces other than overhead have been prepared to a minimum degree of roughness designated as CSP 3 by the International Concrete Repair Institute (ICRI) Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
6. Inset plywood mats or sheeting over the existing flow channel and bench to prevent debris from falling into the sewer and to collect debris from manhole bench.
7. Contractor shall remove existing manhole rings for the installation of the formed-in-place concrete with the embedded plastic liner. Rungs shall not be replaced.

I. GENERAL APPLICATION

Materials shall be applied in accordance with the material manufacturer's specifications. Plugging leaks and patching surfaces shall be performed where indicated or required. Coatings and sealants shall be applied to all surfaces from the manhole base to the manhole frame.

J. SPRAY ON CEMENTITIOUS LINER

1. Plug any active leaks with hydraulic cement includes underdrains as specified in Part 2 above. Fill voids and overhangs with patching material.

2. Equipment: Mortar mixers, compressors and pumps shall be standard commercial models.
3. Avoid overly windy and arid curing conditions.
4. Application of the Cementitious Liner
 - a) Material shall be applied evenly around the entire circumference of the manhole. Multiple passes shall be made until the desired thickness has been obtained. Thickness shall be verified at any point with a wet gage as directed by the Engineer.
 - b). Total thickness of cementitious product to be spray applied shall be ½" minimum. The liner shall start in the manhole invert and stop at the bottom of the manhole frame. All inverts shall be included in the manhole lining.
5. Application of the protective coating if required. These manholes will be identified by the Engineer during the course of the work if required.
 - a) The epoxy shall be uniformly cast onto the fresh mortar lining before re-exposure to the chemicals can contaminate the underlying mortar.
 - b) If application is delayed beyond 24 hours, or if the mortar liner is exposed to foreign matter, it shall be rinsed to neutralize its surface and the epoxy shall then be applied.
 - c) The epoxy corrosion protection coating shall be applied at a thickness of 0.065 inches and shall include the invert up the walls and overlap the bottom of the manhole frame by a minimum of 2 inches.

K. FORMED IN PLACE CONCRETE WITH EMBEDDED PLASTIC LINER

1. Infiltration which may adversely affect placement of the concrete shall be eliminated. Plug active leaks with hydraulic cement as specified in Part 2 above.
2. Equipment: Segmented, stackable steel forms shall be bolted together in cylindrical and conical sections with either eccentric or concentric cones or flat top ceilings and conform generally to the interior slope of the existing manhole.
3. Installation procedure:

- a) Pipe extensions shall be placed through the new concrete wall at the base and at higher points of entry, such as drop inlets, to maintain flows during the procedure.
- b) The form shall be sized and erected to conform to the existing interior dimensions and shape. The space between the forms and the existing wall shall be of a sufficient thickness, a minimum of 3 inches. The finished opening shall have a minimum diameter of 20 inches.
- c) The form shall be positioned, sealed and finished at the manhole base to ensure concrete does not enter the sewer.
- d) The concrete shall be carefully placed from the bottom up in such a manner as to prevent segregation of the cement and aggregate. The concrete shall be consolidated to fill all pockets, seams and cracks within the existing wall.
- e) When the concrete has sufficiently cured to preclude slump or damage, the form shall be disassembled and removed.
- f) The plastic liner shall be fitted securely to the exterior of the steel forms during their erection within the manhole. When the forms are removed, all joints in the liner shall be welded and tested.
- g) The bench shall receive an overlay of cementitious liner with a chemical protective coating for corrosion resistance as directed by the Engineer at a thickness of three inches at the wall tapering to 1/2" at the edge of the invert channel. Prior to the overlay, a hydrophyllic sealing strip shall be placed around the circumference of the bench where it meets the vertical wall and around all pipe penetrations to form a water stop.
- h) The plastic liner shall extend 2" above the finished concrete at which time the chemical protective coating is poured into the annular space against the plastic liner to seal any exposed concrete.
- i) Sealing at all pipe penetrations shall be accomplished using one of the following procedures:
 - 1) If the penetrating pipe is PVC, a fusion or extrude weld shall be made at their jointure with the new plastic lined wall.
 - 2) If the penetrating pipe is clay (VCP), cast iron, ductile iron or other material, a flat square section of the plastic liner approximately 1.5 times the pipe diameter shall be fitted over the penetrating pipe and fastened with a stainless steel hose clamp.

Then it shall be folded back over the hose clamp and flush with the plastic liner embedded into the wall. A weld strip or an extrude bead shall be welded along each edge of this flashing.

- j) Finish: The resultant concrete interior wall shall be smooth and free of honeycomb and areas of segregated aggregate.

L. JOINT SEALING BY GROUT INJECTION

1. Sealing of the manhole base and wall joints, and of penetrating pipe joints shall be by the grout injection method as shown on the drawings and summary tables.
2. Where indicated by field conditions or directed by the Engineer, grout wall joints as follows.

The wall joints shall have the drill holes at 4, 8, and 12 o'clock positions one foot above the joint to be sealed and drill holes with grout sleeves inserted into the walls at 2, 6, and 10 o'clock positions one foot below the joint to be sealed. For each wall joint, pump grout into the lower holes until grout comes out of the upper holes.

3. Where indicated by field conditions or directed by the Engineer, grout base and/or bench by drilling one hole on one side of the defect with grout sleeves inserted into the bench or base, whichever is lower. Pump grout into drill hole.
4. For each penetrating pipe joint, drill one hole on each side of the pipe with grout sleeves inserted into the walls at the spring line or top of manhole bench, whichever is lower. Pump grout into both drill holes.
5. Into each insert sleeve, grout shall be pumped at controlled pressures which are in excess of groundwater pressures. The Contractor shall install additional insert sleeves and grout as necessary, due to type and size of leak encountered, type of soil and type of voids being filled.
6. Leaks, which are determined to be too large to be effectively eliminated by the grout injection method, shall be plugged with hydraulic cement prior to initiating the injection of grout. The hydraulic cement shall require no additives, shall set in 45 – 90 seconds, and shall be dimensionally stable, freeze/thaw resistant and sulfate resistant.
7. The Contractor shall allow one day for the grout to cure, after which each sealed joint shall be inspected. If leaks are observed in the sealed area, the Contractor shall place new gel insert sleeves and apply more sealant as necessary to stop the leak. The process shall be repeated as necessary to stop the leaks.

8. All holes created by the grouting process shall be repaired with hydraulic cement. Manholes shall be cleaned, as specified, after chemical sealing operation. Any large voids shall be filled with wall patch mix.

M. FLEX COAT CHIMNEY SEAL

1. All manholes identified for rehabilitation shall receive a flex coat chimney seal.
2. If inflow or infiltration is observed within the structure after surface preparation is complete, grout/seal leaks by grout injection method first. Hydraulic cement may also be used upon approval by the Engineer. No infiltration leaks may be evident in the manhole prior to installing chimney seal.
3. Prepare all chimney surfaces in accordance with manufacturer's recommendations.
4. After surface preparation, apply flexible coating to prepared surfaces in accordance with manufacturer's recommendations.

The chimney seal shall be applied from a point 2-inches above the joint between the manhole frame and chimney to a depth as required to rehabilitate the chimney. The minimal coverage shall be 12-inches, unless otherwise directed by the Engineer.

N. INSPECTION AND TESTING

1. Quality Assurance and Acceptance:
 - a) Two test cubes of the cementitious liner with chemical protective coating and two test cubes of the formed-in-place concrete with embedded plastic liner shall be taken randomly for every fifth manhole as directed by the Engineer at the Contractor's expense to verify strengths using ASTM C-109. Testing shall be done by an independent testing laboratory acceptable to the Engineer and paid for by the Contractor.
 - b) After completion of manhole rehabilitation, Contractor shall verify the minimum coating thickness of the manhole liner with a wet gauge. Test several points on the manhole wall, four minimum. Repair verification points. Any areas found to be thinner than minimum tolerances shall immediately receive additional material.
 - c) Spark testing shall be performed by an independent testing laboratory for each manhole to verify the thickness, continuity and

thoroughness of the chemical protective coating and the embedded plastic liner. NACE RP0274 testing standard will detect bubble or blister type voids, cracks, thin spots, and foreign inclusions or contaminants in the coating. All areas of each manhole shall be inspected with a spark-testing device. Any area found to be a defect shall immediately receive additional material. All costs associated with testing shall be paid for by the Contractor.

d) All work shall be performed in accordance with T&R testing voltage. The dielectric strength of the chemical protective coating requires testing at 100 volts per each mil of thickness.

2. After the manhole rehabilitation work has been completed, the manhole shall be visually inspected by the Engineer in the presence of the Contractor and the work shall be found satisfactory to the Engineer. Any work that has been found to be defective shall be redone by the Contractor at no additional expense to the Owner.
3. All manholes rehabilitated by spray on cementitious liner or formed-in-place concrete with embedded plastic liner shall be free of visible leakage. All such manholes shall be tested for leaks and inspected. Manhole testing may be accomplished by vacuum testing instead of spark testing:
 - a) Testing for water tightness shall be accomplished by vacuum testing in accordance with ASTM C 1244-93 or latest edition.
 - b) Manholes shall be vacuum tested and shall have a minimum of 8-inches of mercury applied to the manhole. Pressure drop shall not exceed 1 inch of mercury in a 1-minute test.
 - c) If the tested manhole meets the required test pressure and duration, full payment for the manhole will be made. If the time duration measured to drop 1 inch of mercury is less than the required time as noted above, the manhole will have failed the vacuum test, and payment will be reduced as described below.
 - i. If the tested manhole achieves the required initial vacuum pressure, but holds the required pressure for less than the required time duration, half payment for the applicable manhole pay Item will be made for that manhole.
 - ii. If the tested manhole fails to achieve the initial specified pressure, no payment will be made for the applicable manhole pay Item for that manhole.

4. Contractor may repair and re-test manholes which fail the vacuum test. If the manhole passes the subsequent vacuum test, the Contractor shall be entitled to the commensurate payment for the manhole Work.
5. Vacuum equipment shall be approved by the Engineer prior to its use.
6. Written verification of every manhole test must be provided to the Engineer. The following minimum information shall be recorded and provided:
 1. Manhole Number.
 2. Beginning test pressure, end test pressure, and test duration (minimum 60 seconds).
 3. Repeat test number.
 4. Repairs made.

O. CLEAN UP

The Site shall be cleaned on a continuous, daily basis during performance of the work and shall be cleaned upon completion so that the Project Site shall be left in a neat and orderly condition acceptable to the Engineer.

MEASUREMENT AND PAYMENT

This work will be measured for payment by the actual number of vertical linear feet of manhole rehabilitated, of each size, and each type of manhole, in accordance with these specifications. Measurement shall be made from the invert of the out flowing pipe to the geometric center of the top of the frame and cover and rounded to the nearest whole number of feet.

This work shall be paid for at the unit price bid per vertical foot for Sanitary Sewer Manhole Rehabilitation completed and accepted, which price shall include all materials, labor, tools, and equipment necessary and incidental to complete the work in accordance with these specifications including plugging holes and under drains, stopping active hydrostatic infiltration, patching, filling and repairing non-infiltrating holes, cracks and breaks, surface preparation, installation and/or application of spray-on lining system, installation and/or application of a flex coat chimney seal, installation and/or application of an injection grout system, testing, sealing pipe connections, lift holes, riser joining sections, bench/trough and corbel sections, frames and covers, and clean up of the site.

No measurement will be made for partially completed manhole rehabilitation.

New Frames and Covers will not be measured for payment, but the cost shall be included in the unit price bid for sanitary sewer manhole rehabilitation.

There will be no separate measurement for payment for the cost of flow control and bypass pumping, but the cost thereof shall be included in the contract unit price for sanitary sewer manhole rehabilitation.

Maintenance and Protection of Traffic will be measured and paid for in accordance with the provisions of Item 971, "Maintenance and Protection of Traffic." When no price for Item 971, Maintenance and Protection of Traffic, is asked for on the Proposal Form, this work will not be measured for payment, but the cost shall be included in the unit price bid for sanitary sewer manhole rehabilitation.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
524.01	Sanitary Sewer Manhole Rehabilitation Spray on Cementitious Liner (Size), Cast in Place	Vertical Foot
524.02	Sanitary Sewer Manhole Rehabilitation Spray on Cementitious Liner with Chemical Protective Coating (Epoxy) (Size), Cast in Place	Vertical Foot
524.03	Sanitary Sewer Manhole Rehabilitation Formed-in-Place Concrete with Embedded Plastic Liner (Size), Cast in Place	Vertical Foot
524.04	Sanitary Sewer Manhole Rehabilitation (Size), Pre-Cast	Vertical Foot
524.05	Sanitary Sewer Manhole Rehabilitation Flex Coat Chimney Seal (Size), Pre-Cast	Vertical Foot

ITEM 601 CONCRETE FOR STRUCTURES

DESCRIPTION:

This item shall include concrete for use in bridges and culverts, walls, catch basins, drop inlets and other miscellaneous construction as required. The concrete shall be composed of portland cement, fine and coarse aggregate, admixtures if ordered, and water, prepared and constructed in accordance with these specifications, at the locations and of the form dimensions and class shown on the plans, or as directed by the Engineer.

The concrete shall be of three classes, Class "A," "C" and "F". The class to be used shall be as shown on the plans or designated herein, or as directed.

The use of truck-mixed or transit-mixed concrete is permitted for all Class "A," "C" and "F" concrete.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.03.01.

CONSTRUCTION DETAILS:

1. **(a) Equipment:** All equipment and tools used in the handling of materials, trucks used for transporting the batched material, the batching equipment, and concrete mixers used for the mixing of concrete shall comply with the following requirements:

Batching Plant and Equipment: Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly and approved. After approval, the Contractor shall maintain all equipment and tools in a satisfactory working condition until the completion of the work.

1. **General:** The batching plant shall include storage bins, weighing (mass determining) hoppers, scales, and metering equipment as required. A separate scale for cementitious materials shall be used.
2. **Scales:** Scales for measuring concrete ingredients may be horizontal beam-type, springless scales or electronic devices and shall conform to the applicable requirements of the NIST Handbook 44 except as otherwise specified herein.

Weight (mass)-indicating devices shall be in full view and near enough to be read accurately by the operator while charging the hoppers. The operator shall have convenient access to all controls.

When beam-type scales are used, a "tell-tale" dial shall be provided for indicating to the operator that the required load in the weighing (measuring) hopper is being approached. A device on measuring beams shall indicate critical positions clearly. The dial faces of springless dial scales shall be of a material not affected by moisture. The graduated dial scale shall be provided with the required number of suitable markers in front of the dial face which may be set at the required positions of the indicator for predetermined weights (masses).

Methods for weighing (measuring) (electric, hydraulic, load cells, etc.) other than the methods noted above, which meet the required weighing (measuring) tolerances may be approved by the Engineer.

3. Ten certified standard 50-pound weights (22.7-kilogram masses) shall be available at the batching plant for checking the accuracy of the scales. Weights (masses) shall be certified by the Department of Consumer Protection.
4. The Contractor shall notify the Engineer 2 days in advance that the scales are in proper adjustment and ready to be sealed. The bins shall be filled sufficiently to perform the tests required, and the Contractor shall have available a man skilled in making any adjustments necessary to seal the scales. The Engineer may request that the scales, after checking with a 500-pound weight (227-kilogram mass), be resealed at any time, if in their opinion the scales are out of adjustment. Scales shall be "sealed" at the expense of the Contractor by the "Sealer of Weights and Measures." Scales shall be inspected and sealed at least once every 12 months.
5. Automation: All plants shall be equipped with an approved automatic cycling and monitoring system installed as part of the batching equipment, unless otherwise indicated in the plans or specifications or in the opinion of the Engineer, job conditions warrant otherwise. The system shall include equipment for accurately proportioning the various components of the mixture by weight (mass).

Admixtures and water may be measured volumetrically. The automatic proportioning system shall be capable of consistently delivering each constituent within the tolerances specified.

There shall be auxiliary interlock cutoff circuits to interrupt and stop the automatic batching operations whenever an error exceeding the acceptable tolerance occurs in proportioning for all material components

except water. Zero return tolerance shall be equal to that of the delivery tolerances for the minimum batch size.

When the aggregate sizes are weighed (When the masses of the aggregate sizes are taken) cumulatively, the tolerance for each bin draw weight (mass) shall be based on the total aggregate batch weight (mass). If aggregate sizes are weighed (measured) separately, the percentage shall apply to each scale weight (mass). When the other approved cementitious material is weighed (measured) cumulatively with the cement, the other approved cementitious material shall be last in the weighing (measuring) sequence, and the batching delivery tolerance for each material draw weight (mass) shall be based upon the total weight (mass) of cement plus other approved cementitious material.

The electrical circuits used to check delivery tolerances may be set at any span within the full allowable tolerance for any approved batch size. For plants not equipped to automatically adjust tolerances, the tolerance span shall be set for the minimum approved batch size whenever varying batch sizes are being produced.

Batching Delivery Tolerances:

Cementitious materials $\pm 1\%$ (by weight (mass))

Aggregate $\pm 2\%$ (by weight (mass))

Water $\pm 1\%$ (by weight (mass) or volume—applies at central mix plants only)

Admixtures $\pm 3\%$ (by weight (mass) or volume—or ± 1 ounce (30 milliliters), whichever is greater)

The automatic proportioning system shall be capable of rapidly selecting and proportioning at least 3 classes of concrete. In addition, the system shall have the capability of batching materials in at least 2 batch sizes. These provisions will not be required for project-site plants batching only 1 class of concrete for a project. The system shall be interlocked during the batching of cement and aggregates so that:

No inlet gate can be opened while the weigh (measuring) hopper discharge gate is open.

No weigh (measuring) hopper discharge gates can be opened

- (a) While the hopper is being filled.
- (b) Until the full batch weight (mass) is within the delivery tolerance.

No new batch can be measured until the hopper is entirely empty of the previous batch and the scale has returned to "zero."

When the manual batching is permitted, the constituents shall be batched

within the indicated delivery tolerances for the automatic proportioning system.

6. Slump Control: Controls shall be provided so that the batch plant operator can produce concrete of the slump required by the paving operation. Included shall be a moisture compensation system, a slump-meter, and a slump-adjust control. The moisture compensation control can be automatically or manually set for the amount of moisture in the fine aggregate. A moisture compensation system shall compute the adjustment to the water and the fine aggregate components of the concrete to be measured by the automatic batching plant. The actual amounts of each material batched shall be recorded in the manner required elsewhere in these specifications.
7. Batch Recording Instruments: All concrete batching plants shall be equipped with digital or graphical recording instruments approved by the Engineer. The recording instruments shall be designed to record the quantities of each aggregate component, cement, other approved cementitious materials (when used), water (at central mix batch plants), and the presence of admixture for each batch of concrete produced. All records of batches shall show the batch number, the day, the month, the year, and the time of day to the nearest minute for each batch. This information shall be imprinted on the record so that each batch may be permanently identified. The Authority shall be provided with a clear and legible copy of all batch records for concrete supplied to the Authority.

Cement, other approved cementitious material, and aggregate component weights (masses) shall be recorded separately. Water at central mix plants may be recorded by weight (mass) or volume.

When a digital tape or ticket recorder is used, weights (masses) shall be recorded as indicated on the batching scale or meter within an accuracy of ± 1 scale or meter graduation. The minimum resolution of digital recorders shall be equivalent to the minimum graduation on the scale meter, unless otherwise approved by the Engineer.

If graphical recorders or multiple recorders, either digital or graphical, are used, they shall be subject to the approval of the Engineer.

The control system shall include a mixer timer which is interlocked with the mixer discharge control, such that the concrete will be mixed for the approved time.

If any of the above equipment fails to operate satisfactorily, the Engineer shall be notified immediately, and the Engineer will assign an inspector to the plant to monitor plant operation. Only if job conditions warrant, the

Engineer may allow concrete to be delivered to the project without an inspector at the plant to monitor plant operation. When the plant is permitted to operate by manual control during periods of automatic equipment failure, a manually written ticket providing all the specified batch information required from the automatic "batch recording instrument" will be required for each batch supplied to the Authority.

The plant shall be returned to compliance with these specifications within 2 working days of the equipment failure. After that period, concrete will not be accepted by the Authority. No costs will be incurred by the Authority for any production loss, or delays due to the enforcement of this requirement.

Mixing Equipment:

1. General: Concrete may be mixed at the site of construction or at a central point. Truck-mixed or transit-mixed concrete may be used with the permission of the Engineer for limited amounts of pavement and for other exceptional cases. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.
2. Mixers at site of construction or at a central point: Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period, and of discharging the mixture without segregation.
3. Mixing time: The mixing time requirements shall be in accordance with the recommendations of the manufacturer of the mixer. If a mixing time of less than 60 seconds is recommended, the Contractor shall furnish test data acceptable to the Engineer, verifying that the reduced mixing time will produce uniform concrete conforming to the provisions of AASHTO M157.

The mixer shall be operated at a drum speed as shown on the manufacturer's name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by and at the expense of the Contractor. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet (meters), as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

Hauling Units:

1. Truck mixers and truck agitators: Truck mixers used for mixing and

hauling concrete, and truck agitators used for hauling central-mixed concrete, shall conform to the requirements of "Truck-Mixed and Transit-Mixed Concrete," specified herein.

2. Nonagitator trucks: Bodies of non-agitating hauling equipment for concrete shall be smooth, mortar-tight, non-aluminum metal containers and shall be capable of discharging the concrete at a satisfactory controlled rate without segregation. Covers shall be provided when needed for protection.
3. Hauling central mix concrete: Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The time elapsing from the time water is added to the mix until the concrete is deposited in place at the site of the work shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 60 minutes when hauled in truck mixers or truck agitators, except that in hot weather or under other conditions contributing to quick stiffening of concrete, the maximum allowable time may be reduced by the Engineer.
4. Addition of water in truck mixers: When mixed concrete is transported in approved truck mixers, water may be added to the concrete at the delivery site, with the permission of the Engineer, to achieve the required slump, provided the specified water-cement ratio for the concrete is not exceeded and the concrete is mixed for at least thirty additional revolutions at mixing speed to ensure thorough mixing of the water into the concrete. Further addition of water to the concrete after the initial slump adjustment will not be permitted.

When permitted by the Engineer, mixers of the batch type design with a minimum rated capacity of a 2-bag batch, may be used.

(b) Truck Mixed and Transit Mixed Concrete:

Definitions: Truck mixed concrete shall be construed to mean concrete mixed completely in a truck mixer after its arrival at the point of placement. Transit mixed concrete shall be construed to mean concrete mixed completely in a truck mixer while en route to the point of placement.

General Requirements: The location and capacity of the batch plant and complement of truck mixers for truck or transit mixed concrete shall be adequate for continuous placement of concrete in the forms.

If in the opinion of the Engineer, undue delay in deliveries do occur, and concrete already in place takes initial set, all such material in place may be rejected.

The batch plant, truck mixers and related equipment will be inspected by the

Engineer; and these, as well as all methods of operation related thereto, shall be approved before the concrete is batched.

The concrete shall be discharged within one and one-half hours from the time the dry aggregates are loaded into the truck mixer; otherwise the concrete shall be disposed of by and at the expense of the Contractor.

With each delivery of concrete, the Contractor shall furnish a ticket indicating the proportionment of the batch and stamped by an approved time clock indicating the time the batch is placed in the truck mixer. This ticket shall be presented to the Engineer or an authorized representative before discharge of the concrete will be permitted.

After each time the drum of any mobile mixer is washed, the Contractor shall, at its own expense, add one-half cubic foot mixture of sand and cement for each cubic yard (cubic meter) of concrete being placed in the drum of the mixer. The same proportions as specified for the concrete shall be used, and the mixture shall be introduced immediately before or at the time of batching.

Truck Mixers: The capacity of truck mixers shall be in accordance with the manufacturer's ratings, except that the maximum permissible capacities, expressed as percentages of the total volume of the drum or container, shall not exceed 63.25%.

Each truck mixer shall have an attached metal standard rating plate on which are stated the capacities, in terms of volume, of mixed concrete, for the various uses applicable to the equipment. When the manufacturer's ratings of capacity are less than the limit indicated above, the manufacturer's ratings shall govern. Further, truck mixers shall be equipped with a suitable means by which the number of revolutions of the drum or blades may be readily verified.

Truck mixers shall be of standard type, size and manufacture and shall be either of the horizontal axis revolving-drum type, the inclined axis revolving-drum type, or the open-top revolving blade or paddle type.

Truck mixers must be inspected and approved by the Engineer.

Loading, Water and Transportation: The mix shall be in the proportions required for the work and placed in the drum of the mixer. Water shall be added to the mix, and the mixing conditions shall be in accordance with one of the following methods:

Truck-Mixed Concrete: Water shall be introduced into the mixing drum only after arrival at a level area on the site where the concrete is to be placed and under the supervision of the Engineer. The water shall be measured accurately by volume or mass by an approved adjustable measuring device which shall

measure the required quantity under all operating conditions within a tolerance of 1 quart or 1%, whichever is greater. The device shall be such that the flow of water shall be stopped automatically when the required quantity has been delivered. The mixer shall be equipped with an approved device which shall record the number of revolutions of the drum or blades during mixing. The mixing procedures shall be carried out at the site as hereinafter specified.

Transit-Mixed Concrete: Water shall be introduced into the mixing drum while the mixer is at the batch plant. The water shall be measured and controlled as specified above. The mixing procedure shall be carried out during transportation as hereinafter specified. Each truck mixer shall be equipped with a readily visible device that will record accurately the number of revolutions of the drum or blades at mixing speed from the moment of batching. This equipment shall be set into operation only at the batch plant by the inspector and shall be so constructed as to show evidence of any tampering or misoperation.

Any one of the following shall be sufficient cause for the rejection of any load of truck-mixed or transit-mixed concrete: when the elapsed time exceeds that which is permitted, when the mixing revolutions exceed 100, when the recording device has been tampered with or misoperated after the batching, when, at the time of placing, the air content or slump are not within specified ranges, when there is evidence of segregation or when initial set has taken place.

Mixing Procedure and Delivery: When the truck mixer is loaded in excess of 50% of the gross volume of the drum or container, the mixing period shall consist of not less than 60 revolutions of the drum or blades at mixing speed, after the water is added; if loaded to not more than 50%, the mixing period shall consist of not less than 40 revolutions of the drum or blades at mixing speed.

For the revolving drum type mixers the mixing speed shall be not less than 4 revolutions per minute of the drum, nor greater than a speed which will produce a peripheral velocity of the drum of 225 feet per minute. For the revolving blade type mixers the mixing speed shall be not less than 4, nor more than 16, revolutions per minute of the mixing blades.

Agitating speed for both the revolving drum and revolving blade type of mixers shall be not less than 2, nor more than 6, revolutions per minute of the drum or the blades.

In no case shall mixing exceed 100 revolutions at mixing speed. Mixing beyond 100 revolutions shall be done at agitating speed.

In discharging truck mixers, the direction of rotation of drum or blades shall be manipulated so as to avoid segregation.

Slump: When the slump does not meet the specification requirements,

modification of the concrete mix may be permitted if, in the opinion of the Engineer, no harmful effect upon the structural qualities or appearance of the concrete will result. If permitted by the Engineer, modifications shall be limited to the addition of not more than 50 pounds of portland cement per cubic yard of concrete to decrease the slump or to the addition of water to increase the slump. The amount of water or cement added shall be further limited to the minimum needed to meet slump requirements. The cost of additional material and the work connected with each modification shall be borne by the Contractor. The addition of cement or water, or both, for the purpose of re-tempering concrete will not be permitted.

(c) Vibrators: Not less than two vibrating units, including source of power, shall be available on the work and shall be of the mechanical immersion type, in good operating condition at each pouring of concrete in order to insure satisfactory and uninterrupted vibration during placing. They shall be capable of transmitting vibrations to the concrete at frequencies of not less than 4,500 impulses per minute. Vibrators shall be used only when directed by the Engineer.

(d) Trucking Equipment: Trucks used for the transporting of the batched material from the batcher plant to the mixer shall conform to the requirements for Hauling Units specified herein.

2. **Falsework and Centering:** All falsework and centering required shall be adequate for the type of construction involved. Details of this construction shall be proposed by the Contractor and unless otherwise authorized shall be submitted to the Engineer for their information before construction is started. Approval of the plans or methods proposed for such construction shall not serve to relieve the Contractor of any responsibility for the successful completion of the project.

Suitable provision shall be made to secure the permanent camber required in the superstructure, and means of adjustment shall be provided so as to correct any possible settlement or deflection during construction. The method of adjustment shall be such as to permit the gradual lowering of the falsework or centering when these are to be removed. Falsework and centering shall remain in place for a period as required within this specification. No falsework or centering shall be removed without the permission of the Engineer.

3. **Forms:** Forms shall be built true to lines and grades designated, shall be strong, stable, firm, mortar-tight and adequately braced or tied, or both. They shall be designed and constructed to withstand all loads and pressures including those imposed by plastic concrete, taking full account of the stresses due to the rate of pour, effect of vibration and conditions brought about by construction methods. Where necessary, forms shall be constructed to compensate for variations in camber of supporting members and allow for deflections.

Internal voids may be formed by the use of heavy paper or fiber forms especially made for this purpose, or with an alternate acceptable to the Engineer. These forms must be of substantial construction and adequately waterproofed in order to maintain their shape during the entire construction cycle. The end caps shall also be of similar construction. These forms shall be held in place against uplift or lateral displacement during the pouring and vibrating of the concrete by substantial wire ties or other satisfactory means. Before incorporating the forms in the work, a sample 4 feet in length with end caps shall be furnished the Engineer for approval. These forms shall not be incorporated in the work until the Engineer has approved the sample submitted.

If requested, form work plans shall be submitted to the Engineer by the Contractor before form work is started. The furnishing of such plans, however, shall not serve to relieve the Contractor of any responsibility for the successful completion of the work.

Forms shall be filleted at all sharp corners, unless otherwise ordered or permitted, and shall be given a slight bevel or draft in the case of projections to insure satisfactory removal.

Materials for forms and their supports, ties and bracing, shall be of the type, quality and strength to achieve the foregoing requirements without impairment to the structural qualities or appearance of the concrete structure. Form material in contact with concrete shall be of a quality to provide the hereinafter required concrete surface smoothness; and, unless otherwise authorized, the contact surface shall be oiled with a light, clear paraffin base oil which will not damage, discolor or adhere to the concrete; or, as an alternate, the form may be lined with an approved composition form lining.

Materials and workmanship for forms for concrete to remain exposed in the finished work shall be such as to provide a smooth concrete surface of good appearance and texture, free of voids, indentations, protrusions or bulges and within tolerances consistent with good trade practices. If panels are used, they shall be evenly placed in columns or rows if their positioning is to be visible after the concrete is finished. These same requirements shall apply to forms for concrete not to remain exposed in the finished work except that minor irregularities where form boards or panels join and variations in form pattern will be acceptable.

Metal ties and anchors to hold the forms in alignment and location shall be so constructed that the metal work can be removed to a depth of at least 2 inches from the concrete surface without damage to the concrete. All cavities resulting from the removal of metal ties shall be filled with cement mortar of the same proportions used in the body of the work and the surface finished smooth and even, and if exposed in the finished work, shall conform to the texture and color of adjacent surfaces. With permission of the Engineer, the Contractor need not

remove from the underneath side of bridge decks portions of metal devices used to support reinforcing steel providing such devices are of material, or are adequately coated with material, that will not rust or corrode.

Date of Completion: The year in which each structure is completed shall be shown in at least two places on each concrete superstructure unless otherwise ordered by the Engineer. Usually the date shall be placed in diagonally opposite ends of the bridge parapets adjacent to traffic. The numerals will be furnished by the Contractor. They shall be carefully set by the Contractor; and their subsequent removal after the concrete is placed and the finishing shall be carefully done so that the impression of the numerals in the concrete is clear and sharp, with no broken edges or other imperfections.

Ornament or Reverse Moulds: Ornamental work, when so noted on the plans, shall be formed by the use of reverse moulds. These moulds shall be produced by a qualified manufacturer approved by the Engineer. They shall be carefully built by the most approved modern methods and in accordance with the general dimensions shown on the plans. Additional details necessary to construct the moulds shall be worked out by the manufacturer and shall be such as to produce ornaments having the appearance indicated on the plans. The manufacturer shall prepare all detailed drawings that may be required for guidance, and all such drawings as well as all models or carvings that may be prepared shall be approved by the Engineer before the moulds are made.

Moulds shall be carefully handled, shipped and stored so as to prevent all damage to the ornaments. They shall be delivered at the site of the work completely assembled and of the required size and shape in order to facilitate their proper placing. The Contractor shall be responsible for their condition at all times, and will be required to remove and replace any damaged or defective moulds at its own expense.

The moulds shall be fitted into the surrounding form work so that they will act as a substitute for the ordinary forms which would be required in the area.

The surfaces of the moulds shall be given a coating of grease or lubricant to prevent the adherence of concrete. Any material which will adhere to or discolor the concrete shall not be used.

Utility Installations: On any structure where it becomes necessary to install any public utility, i.e., telephone, electric light or power conduits; gas, water or sewer pipes; pneumatic, oil or any other lines, the utilities concerned will furnish, delivered at the site, all material necessary for such installation.

Unless specifically otherwise ordered, the Contractor shall erect or install such equipment or material as shown on the plans; or if not shown thereon, the Contractor shall comply with the Engineer's instructions.

Whether or not the presence of any public utilities is mentioned on the plans or in the special provisions, the Contractor shall, by any means at its disposal, apprise himself of the location of any and all of them. The Contractor shall use every effort to protect them from damage of any nature whatsoever, which might result from carelessness or negligence in any of its operations. The Contractor shall be held solely and strictly responsible for any damage resulting from such negligence or carelessness.

In cases where any utilities are to be installed on, under or within the construction limits of any structure—and the Contractor does not participate actively in the work—the Contractor shall arrange its operations as to cause no inconveniences or interruption to the progress of such installation. The Contractor shall extend full cooperation to the construction forces of any utility company which may be operating within the limits of the contract.

4. Handling Material: The following requirements shall apply:

Each cementitious material shall be stored in a separate, weatherproof compartment clearly identified.

Sites for aggregate stockpiles shall be reasonably smooth, hard, well-drained areas. Aggregates from different sources and of different gradation shall not be stockpiled together.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner as to minimize segregation of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used.

5. Composition: The following requirements shall apply:

The composition of the concrete shall be in accordance with the requirements set forth in Article M.03.01—General Composition of Concrete Mixes, as well as the applicable sections of ACI 211 and ACI 318. The Contractor shall submit all concrete mix designs to the Engineer for review and approval prior to production of the design. At the option of the Contractor, other approved cementitious material may be used to replace a portion of the required portland cement in accordance with the requirements of Section M.03.

Since the yield is theoretical, the Authority will not be responsible for any variation in yield as actually obtained on the job. Consistency of the concrete shall be uniformly maintained within the allowable range of slump. The slump shall be measured in accordance with AASHTO Method T119.

The concrete shall be air-entrained and shall contain an air content of $6\% \pm 1\frac{1}{2}\%$ at the time the concrete is deposited on the grade. Air entrainment shall be

obtained by use of an approved air-entraining admixture added to the concrete at the time of mixing.

The air content of the plastic concrete shall be determined in accordance with AASHTO Method T152, Pressure Method. No alternative method will be accepted.

No change in the source or character of the materials shall be made without due notice to the Engineer, and no new material shall be used until the Engineer has accepted such materials and has designated new proportions based upon tests of new trial mixes as provided hereinbefore.

For pumped concrete, the percentage of entrained air shall be determined at the placement end of the pump line.

On any one structure, the admixture for a specific purpose shall be the particular product of one manufacturer only. When admixtures for different purposes are used together, the Contractor shall submit proof of their compatibility prior to use.

6. **Consistency:** The consistency shall be determined by the AASHTO Method T 119. A uniform consistency shall be continuously maintained. When Class "A" and Class "C" concrete is not to be vibrated, the allowable range of slump shall ordinarily be not less than 2 nor more than 4 inches. When Class "A" and Class "C" concrete is to be consolidated by vibration, the slump shall be not more than 2 1/2 inches; and for Class "F" concrete, the slump shall be not more than 3 inches. Slumps outside these limits shall be used when, in the opinion of the Engineer, conditions are such that satisfactory workability cannot be obtained within such limits. Concrete mixes designed by the Contractor so as to be pumpable, shall not be subject to the above conditions. The desired slump shall be indicated on the mix design submitted for approval. The slump shall be determined at the placement end of the pump line.

7. **Mixing Concrete:** Mixing shall be in an approved mixer capable of combining the aggregates, cement, and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Each mixer shall have attached in a prominent place a manufacturer's plate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

The mixing time requirements shall be in accordance with the recommendations of the manufacturer of the mixer. If a mixing time of less than 60 seconds is recommended, the Contractor shall furnish test data acceptable to the Engineer, verifying that the reduced mixing time will produce uniform concrete conforming to the provisions of AASHTO M157.

The mixer shall be operated at a drum speed as shown on the manufacturer's

name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by and at the expense of the Contractor. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet, as shown on the manufacturer's standard rating plate on the mixer, except that an overload up to 10% above the mixer's nominal capacity may be permitted provided concrete test data for strength and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

Failure of the water measuring device or of the timing device shall result in suspension of mixing until correction has been made, except that, with prior approval of the Engineer, operations may be allowed to continue for the balance of the day if secondary controls can be demonstrated.

Truck mixed or transit mixed concrete may be used with the written permission of the Engineer for limited amounts or other exceptional cases. If its use is so allowed, the provision of the specification relating to truck mixers and truck mixed and transit mixed concrete shall fully apply.

The first batch of concrete materials placed in the mixer shall contain an additional quantity of sand, cement, and water sufficient to coat the inside surface of the drum without diminishing the mortar content of the mix. Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

Hand mixing shall not be permitted except in cases of emergency and with the permission of the Engineer. When permitted, it shall be done only on watertight platforms. The sand shall be spread evenly over the platform, and the cement spread upon it. The sand and cement shall then be thoroughly mixed while dry by means of shovels until the mixture is of a uniform color, after which it shall be formed into a "crater" and water added in an amount necessary to produce mortar of the proper consistency. The material upon the outer portion of the "crater" ring shall then be shoveled to the center and the entire mass turned and sliced until a uniform consistency is produced. The coarse aggregate shall then be thoroughly wetted and added to the mortar and the entire mass turned and returned at least 6 times and until all of the stone particles are thoroughly covered with mortar and the mixture is of a uniform color and appearance. Hand mixed batches shall not exceed 1/2 cubic yard in volume. Hand mixing will not be permitted for concrete to be placed under water.

8. **Placing Concrete:** Concrete, except for central plant-mix, truck or transit-mixed, shall be placed in the forms immediately after mixing; and in no case shall concrete be used which does not reach its final position in the forms within 60 minutes after the time that water is first added to the mix, except that the Engineer reserves the right to alter this time by as much as one-half when necessary to achieve the requirements related to set and plasticity.

The use of long chutes and troughs for conveying concrete from the mixing plant to the forms will be permitted only on authority from the Engineer. If such conveyors are allowed and the quality of concrete as it reaches the forms or the method of placing or working it therein are not satisfactory, the Engineer may order their use discontinued and the substitution of a satisfactory method of placing. Where steep slopes are required, chutes and troughs shall be equipped with baffle boards or be in short lengths that reverse the direction of movement. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete. Open troughs and chutes shall be either of metal or metal lined and shall extend as nearly as possible to the point of deposit. When the discharge must be intermittent, a hopper or other device for regulating the discharge shall be provided.

During placing operations, the concrete shall not come in contact with any aluminum.

Unless permission is obtained from the Engineer, concrete shall not be dropped a distance of more than 5 feet; and special care shall be taken to fill each part of the forms by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and the concrete forced around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred; and no strain shall be placed on the ends of projecting reinforcement.

Concrete shall be placed in horizontal layers. When less than a complete layer is placed in one operation, it shall be terminated in a vertical bulkhead. Each layer shall be placed and compacted before the preceding layer has taken initial set, to prevent injury to the green concrete and to avoid surfaces of separation between the layers.

Concrete shall be compacted by continuous working with suitable tools or by vibrating as ordered by Engineer. The number and type of vibrators required, the length of the vibrating period, and the location of the vibrators shall be as required by the Engineer.

Special care shall be taken in placing and compacting concrete around ornamental moulds, and vibrating equipment shall be used with caution. The vibrator shall not touch the moulds at any time. A gentle vibration shall be used, sufficient to assure the proper flow of the materials and to bring the mortar into complete contact so that all contours of the ornaments will be sharp. Tarpaulins or heavy paper shall be hung over the moulds, the bottom of which shall be kept constantly immersed in the fresh concrete, in order to prevent splashing the surfaces of the moulds.

When the placing of concrete is temporarily discontinued, the necessary keys or joints shall be formed as shown on the plans or as ordered, and the concrete

after becoming firm enough to retain its form, shall be cleaned of laitance and other objectionable material to a sufficient depth to expose sound concrete.

Joints shall be formed only in the locations shown on the plans or as permitted by the Engineer. Featheredges at construction joints will not be permitted.

Immediately following the discontinuance of the placing of concrete, all accumulations of mortar splashed upon reinforcing steel and the surface of the forms shall be removed. Dried mortar chips and dust shall not be puddled into the unset concrete. If accumulations are not removed prior to the concrete becoming set, care shall be taken not to injure or break the concrete-steel bond, at and near the surface of the concrete, while cleaning the reinforcing steel.

- 9. Concrete for Bridge Decks:** Unless otherwise indicated on the plans or in the Special Provisions, concrete for use in bridge decks, including curbs, safety curbs, sidewalks, parapets and concrete railings placed thereon or attached thereto, shall be Class "F" concrete.

At least 15 days before the erection of the screed rails, the Contractor shall submit the screed erection plans, grades and sequence of concrete pours and proposed rate of placing concrete for review by the Engineer. These plans shall include details of equipment to be used in the placement and finishing of the concrete, including the number and type of personnel who will be engaged in placing the deck concrete. The personnel shall consist exclusively of persons with skill and experience appropriate to their working assignments.

When setting screed rails for mechanical finishing, the Contractor shall take into consideration and make proper allowances for the deflection of the bridge superstructure due to all operations.

(a) Composition: The composition shall be as specified within this specification.

(b) Placing Concrete: Bridge decks shall be finished using a mechanical finisher or other method as approved by the Engineer.

The completed surface shall be constructed in accordance with grades and cross slopes shown on the plans. When tested with a 10-foot straightedge, the surface shall not vary more than 1/8 inch in 10 feet. Variances greater than this, which, in the opinion of the Engineer, may adversely affect the riding qualities of the surface shall be corrected; and this shall be done at the expense of the Contractor.

The Contractor shall notify the Engineer at least 24 hours in advance of the intention to place concrete.

All concrete shall be placed during daylight, and the placing of concrete shall not

be started unless the intended pour can be completed and finished during daylight hours; except that when an adequate and approved lighting system is provided beforehand, the Engineer may waive this requirement.

Concrete shall be deposited in such a manner that the total deflection or settlement of supporting members, and the final finishing of the surface, shall have occurred before the initial set of the concrete takes place.

When construction joints are shown on the plans, or approved by the Engineer, all concrete between consecutive joints shall be placed in a continuous operation.

In order to allow for shrinkage, concrete shall not be placed against the second side of the construction joints for at least 12 hours after that on the first side has been placed, unless otherwise authorized or ordered by the Engineer.

Workmen will not be permitted to walk in the fresh concrete after it has been screeded. All finishing work, including the application of the fog spray and placement of the curing mats, shall be performed from bridges supported above the deck surface. A minimum of 2 bridges shall be available for the various operations.

Concrete shall be placed in a uniform manner across the entire width being poured, and only 2 passes of the transverse screed will be allowed over a given deck area, except as otherwise permitted by the Engineer.

After the concrete has been consolidated and brought to the proper elevation by the screed machine, it shall be further smoothed by use of a longitudinal float of suitable and approved design. The float shall be worked from a bridge with a dragging motion while held in position parallel to the centerline and passed gradually from one side of the deck to the other.

During finishing operations, water shall not be applied to the concrete surface for purposes of re-tempering.

(c) Finishing: The deck shall be given a final transverse-tined texture in cases where the membrane waterproofing is omitted.

The texturing shall be applied to the plastic surface of the concrete using a mechanical self-propelled device designed to ride the screed rails. The texturing operation shall be performed in two stages:

(1) Dragging with Burlap. The burlap shall be at least 3 feet wide and of a length 2 feet greater than the distance between rails. The burlap shall not have frayed edges and shall be kept wet and clean of accumulations of dried concrete particles or other foreign materials, which might leave distinctive undesirable

marks. The burlap shall be drawn longitudinally along the surface in a slow manner so as to leave an even texture. When not in use, the burlap shall not be allowed to rest on the pavement.

(2) Texturing with Metal Tines. As soon as possible, after the pavement surface has been dragged with burlap, mechanical equipment shall be used to texture the surface with deep transverse grooves. The equipment shall consist of a self-propelled mechanical rig capable of applying a textured finish transverse to the centerline of the bridge. The texturing shall be accomplished with metal tines 0.03 inch thick, 0.08 inch wide and 4 inches to 6 inches in length with an average spacing of 1/2 inch (12.0 millimeters) on centers.

The transverse grooving shall be performed when the condition of the concrete is optimum. This condition will prevail when the grooves can be formed to a maximum depth of 3/16 inch with relative ease and without the walls of the grooves closing in on each other.

The tined grooving shall extend across the pavement to within 1 foot of the edge of the pavement on each side. The tining mechanism shall be aligned so as to prevent overlapping of grooves in any two successive transverse passes. The depth of the grooves formed in the surface by the tines shall be checked randomly with a tire tread depth-measuring gage furnished by the Contractor to ensure compliance with the required limits of 1/8 to 3/16 inch. The original surface of the concrete before tining shall serve as the datum for the depth measurements.

Prior to starting work, the Contractor shall submit for approval a plan to protect the concrete in case of adverse weather. All materials required by the approved plan must be on hand at the time of concrete placement.

After completion of the placing and finishing operation—and for at least 12 hours after the concrete has set—the Contractor shall not operate any equipment in the immediate vicinity of the freshly placed concrete if the tare weight (mass) of the equipment exceeds 2,500 pounds. The immediate vicinity is defined as any distance within which the operation of equipment would, in the opinion of the Engineer, cause excessive vibration, movement or deflection of the forms.

(d) Curing: All concrete shall be kept constantly moist and protected against any drying action and cured for no less than 7 days after the placing of the concrete, and shall be accomplished in the following manner:

(1) Fog Spray: Curing of the concrete shall begin by the application of a water fog spray immediately after the initial set. Fog spraying shall continue until such time as the moist cotton mats are placed. The amount of fog spray shall be strictly controlled so that accumulations of standing or flowing water on the surface of the concrete shall not occur. There shall be a sufficient amount of

spray to keep up with the placing operations.

Should atmospheric conditions render the use of fog spray impractical, the Contractor shall use plastic covers of suitable thickness and securely fastened down, but not directly in contact with the deck concrete. The covers shall be used only until the initial set has taken place, whereupon moist cotton mats shall be placed immediately thereafter and kept wet for the duration of the curing period.

On the windward side of the panel being cured, the Contractor shall erect barriers of suitable height, when necessary, to protect the curing concrete from the direct force of the wind.

(2) Moist Curing: When the concrete has set sufficiently, moist curing conforming to the following shall be substituted for the fog spray: After the surface of the concrete has been given its final finish, it shall be protected by covering it with moist mats of the size and quality specified in Article M.03.01-10. These mats shall be laid longitudinally over the surface of the finished pavement by unrolling from the supported roll so as not to bring an excessive weight (mass) upon or to mar the new surface of the pavement. After placing, these mats shall be saturated and kept saturated for a period of 7 days, at the end of which time they may be removed, and no further wetting or artificial curing will be required. The concrete shall be immediately covered with the moist cotton mats upon discontinuance of the fog spray. The mats shall be kept saturated by means of soaker hoses, garden spray, or other approved methods and remain in place for the required curing period.

Particular attentions shall be given to horizontal construction joints in parapet, curb, sidewalks and median areas to assure that the moist mats are in contact with the concrete surface.

- 10. Depositing Underwater Concrete:** Concrete shall not be exposed to the action of water before setting, or deposited in water, except with the approval of the Engineer and under their immediate supervision. When concrete is so deposited, the method and manner of placing shall be as hereinafter designated.

The Contractor shall design and submit to the Engineer the proposed concrete mix to be used. The mix shall be designed in accordance with the applicable sections of ACI 211 and ACI 318.

During placing operations, the concrete shall not come in contact with any aluminum.

Concrete deposited under water shall be carefully placed in a compacted mass in its final position by means of a tremie, a bottom dump bucket or other approved method and shall not be disturbed after being deposited. Special care must be

exercised to maintain still water at the point of deposit. No concrete shall be placed in running water, and all form work designed to retain concrete under water shall be watertight. The consistency of the concrete shall be carefully regulated, and special care shall be exercised to prevent segregation of the materials. The method of depositing concrete shall be so regulated as to produce approximately horizontal surfaces. Concrete deposited under water shall be placed continuously from start to finish whenever possible, and each succeeding layer shall be placed before the preceding layer has taken initial set.

When a tremie is used, it shall consist of a suitable hopper and a tube having a diameter of not less than 10 inches. If the tube is constructed in sections, it shall have watertight couplings. The means of supporting the tremie shall be such as to permit the free movement of the discharge end over the area of the work and shall be such as to permit it to be rapidly lowered when necessary to choke off or retard the flow. The discharge end shall be plugged at the start of the work to prevent water from entering the tube. It shall be entirely sealed at all times, and the tremie tube kept full of concrete to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The flow shall be continuous until the work is complete.

When concrete is placed by means of a bottom dump bucket, the bucket shall have a capacity of not less than one cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised very slowly as the concrete is discharged, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

Before placing substructure concrete, all laitance or other unsound material shall be removed from the surface of the underwater concrete.

11. **Concrete Exposed to Sea Water:** Concrete structures so located as to be subject to the action of sea water shall be constructed to provide a maximum resistance to its disintegrating action.

The concrete shall be mixed not less than 2 minutes. The water content shall be carefully controlled and so regulated as to produce concrete of maximum impermeability. In placing concrete, care shall be exercised to avoid the formation of stone pockets; and the concrete shall be thoroughly compacted to the satisfaction of the Engineer. The original surface of the concrete shall be left undisturbed. In order to secure a thick and dense surface film, the surfaces of the forms shall be heavily coated with shellac or an approved form oil.

The range of possible disintegration of the concrete from an elevation below that of extreme low tide to an elevation above that of extreme high tide shall be

determined by the Engineer; and except with their special permission, no construction joints shall be located within this range. In the determination of this range, due consideration shall be given to wave action, ice formation and other conditions affecting the extreme limits of possible deterioration and disintegration.

- 12. Concreting in Cold Weather:** During the period from October 15 to April 15 of the subsequent year, cold-weather concreting procedures shall be employed by the Contractor, unless otherwise directed by the Engineer. Cold-weather concreting practices shall include taking measures to ensure that the temperature surrounding the structure is kept above 60° F for a period of 5 days after placing the concrete, and above 40° F for an additional nine days. The temperature shall then be gradually lowered to that of the surrounding atmosphere. Concrete test specimens prepared during the period noted shall be cured in the same manner as the structure that they represent, in accordance with ASTM C 31 (AASHTO T 23). If tests performed on the specimens indicate that sufficient strength has been achieved, the Engineer may reduce the amount of time that the structure must be protected and heated.

Sufficient heating apparatus of the kind approved by the Engineer, such as stoves, salamanders, or preferably steam equipment, and fuel to furnish all required heat, shall be supplied. All water used for mixing concrete shall be heated, but shall not exceed a temperature of 150° F.

The temperature of the mixed concrete shall not be less than 60° F at the time of placing in the forms.

If aggregates are heated either by steam or by dry heat, the temperature of the aggregate shall be not less than 50° F, or more than 100° F. The heating apparatus shall be such as to heat the mass uniformly and preclude the possibility of the occurrence of hot spots which will burn the material. There will be no additional compensation for the use of such heating equipment, but the cost thereof must be included in the cost of the concrete.

In case of extreme weather conditions, the Engineer may at their discretion vary the temperature limitations for water, aggregate and mixed concrete.

Except for deck slabs and thin wall sections, form insulation may be substituted for a heated enclosure, provided it can be demonstrated to the satisfaction of the Engineer that the insulation material proposed for use will keep the concrete within the above specified temperature limits for the specified periods of time. When the use of form insulation is permitted, sufficient provision shall be made by the Contractor so that the surface and interior temperature of the concrete may be determined. If the thermometric readings indicate that the required temperature is not being maintained, the structure shall be promptly enclosed and heat furnished as provided hereinabove.

When form insulation is substituted for a heated enclosure, forms shall not be stripped until permission is granted by the Engineer.

- 13. Anchorages:** Anchor bolts and similar materials which are to be placed either at the time the substructure is built, or during the erection of the superstructure, shall be carefully and accurately set to the requirements of the plans or as ordered at such time as the Engineer may approve or direct.

(a) Setting Anchorages at time of Placing Substructure Concrete: When noted on the plans or ordered by the Engineer, the anchor bolts and similar materials shall be accurately set prior to placing concrete for the bridge seat.

(b) Setting Anchorages in Formed Holes: When indicated on the plans, the anchor bolts and similar materials shall be accurately set in formed holes in accordance with details and dimensions shown.

The space around the anchorage material shall be completely filled with non-shrink, non-staining grout conforming to the requirements of Subarticle M.03.01-12.

(c) Setting Anchorages in Drilled Holes: When the Contractor is not required to set anchorages at the time of constructing the substructure, the Contractor may set the anchorages as in (a) and (b) above, or may drill holes having a diameter of 4 inches and a depth suitable to receive the bolts in the correct locations perpendicular to the plane of the bridge seat. Anchor bolts shall be grouted into clean drilled holes in accordance with the requirements of "Setting Anchorages in Formed Holes." When anchorage material is to be furnished by the Contractor for the superstructure and placed by the Contractor of the substructure, the necessary material shall be fabricated and delivered to the site of the work at such times as it may be required for proper inclusion in the substructure construction.

In locating anchor bolts in relation to slotted holes in expansion shoes, due consideration shall be given to the temperature at the time of erection.

Anchor bolt holes shall be clean and free of dirt, moisture or other foreign materials at the time of setting anchor bolts. Precaution shall be taken to prevent damage to concrete due to freezing of water in anchor bolt holes.

- 14. Preparation of Bearing Areas:** The areas of masonry upon which the bases, pedestals or shoes are to rest shall be carefully finished by grinding if necessary to a smooth, even surface of the required elevation, and shall show no variations from a true plane greater than 1/16 inch over the entire area upon which the shoes are to rest.

15. **Placing Superstructure:** No superstructure load shall be placed upon any finished pier or abutment without the approval of the Engineer.
16. **Placing Pipes and Conduits:** Pipes and conduits which are to be carried by the structure as shown on plans or as ordered shall be placed by the Contractor during construction. Such pipe and conduits will be delivered to the Contractor, unless otherwise noted on plans or in the Special Provision, at the site of the work, by the Authority or by others for whose use they are intended.
17. **Construction Joints:** Construction joints other than those shown on the plans will not be permitted without prior approval of the Engineer. When the placing of concrete is to be interrupted and a construction joint formed, provision shall be made for interlocking with the succeeding layer by roughening the surface and providing keyways, dowels or similar construction shown on the plans or as ordered.

In joining fresh concrete to concrete that has already set, the work already in place shall have its surface cut over thoroughly with a suitable tool to remove all loose and foreign material. This surface shall then be washed and scrubbed with wire brooms and thoroughly drenched with water until saturated. It shall remain saturated until the new concrete is placed. Immediately prior to the placing of the new concrete, all forms shall be drawn tight against the concrete already in place.

In construction joints exposed to view or in other construction joints where seepage of water is particularly objectionable, a baffle strip of copper, zinc, sheet lead or other approved materials shall be inserted. This strip shall be placed not less than 3 inches from the face of the concrete and shall extend into each section of the concrete a distance of not less than 2 inches.

18. **Expansion Joints:** Expansion joints shall be built in the locations and to the dimensions and details shown on the plans.

Sliding surfaces of metal shall be planed true and smooth, the marks of the plane paralleling the movement of the joint. Expansion plates shall be well anchored as shown on the plans. All sliding surfaces of expansion plates shall be thoroughly coated with graphite or other approved lubricant just before being placed in position and special care taken to avoid placing concrete in such manner as to interfere with their free action.

Open joints shall be placed at locations designated on the plans and shall be formed by the insertion and subsequent removal of templates of wood, metal or other suitable material. The templates shall be so constructed that their removal may be readily accomplished without injury to the work.

Filled joints shall be made with joint filler, the materials for which shall conform to

the requirements of the plans and of these specifications.

Mortise joints shall be as shown on the plans and, in general, shall consist of a tenon of concrete or metal sliding in a suitable concrete or metal socket or mortise. The construction shall be such as to permit freedom of movement and such as to be, as far as possible, watertight and rust proof. Metal flashing shall be used as shown on the plans or when ordered by the Engineer.

Special types of expansion joints shall conform to the dimensions and details shown on the plans.

- 19. Curing Concrete:** Concrete surfaces exposed to conditions causing premature drying shall be protected by covering, within 2 hours of placing. Concrete shall be cured as follows except Liquid Membrane-Forming Curing shall not be used.

Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the methods below. Moist curing and cover sheet curing must be approved by the Engineer prior to paving operations. In all cases in which curing requires the use of water, the curing shall have prior right to all water supply or supplies. Failure to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 30 minutes between stages of curing or during the curing period.

When concrete is being placed and the air temperature may be expected to drop below 35°F (2° C) a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided along the work and any time the temperature may be expected to reach the freezing point during the day or night, the material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. During the period of time such protection, the Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

Moist Curing: After the surface of the concrete has been given its final finish, it shall be protected by covering it with moist mats of the size and quality specified in Article M.03.01-10. These mats shall be laid longitudinally over the surface of the finished pavement by unrolling from the supported roll so as not to bring an excessive weight (mass) upon or to mar the new surface of the pavement. After placing, these mats shall be saturated and kept saturated for a period of 7 days, at the end of which time they may be removed, and no further wetting or artificial curing will be required.

Cover Sheet Curing: As soon as practicable after the finishing operations, paper or polyethylene cover sheets conforming to Article M.03.01-10 shall be placed in such a manner that the surface of the concrete shall not be marred. The adjoining covers shall overlap at least 18 inches, and the lap shall be securely fastened down to form a closed joint. On removal of the forms, the edges shall be covered down to the bottom of the pavement. The cover sheets shall remain in place for a period of 7 days.

In the event that hair-checking develops before the cover can be placed, the procedure set forth shall be modified at the direction of the Engineer. Moist curing mats shall then be used for the initial 24 hours of the curing period, and the cover sheets placed for the remainder of the curing period.

Before reusing paper or polyethylene covers, they shall be checked for holes or tears, and any such perforations shall be repaired. Covers which have become unserviceable will be rejected by the Engineer.

Other means of curing may be used provided that by either field or laboratory demonstration it can be shown that the material, or method used, sufficiently supplies necessary moisture to the concrete or causes the concrete to retain moisture, is not injurious to concrete and is not toxic.

Other precautions to insure the development of strength or to prevent injury shall be taken as the Engineer may direct.

- 20. Removal of Forms:** The forms for any portion of the structure shall not be removed until the concrete is strong enough to avoid possible injury from such removal. Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to take up the stresses due to its own mass uniformly and gradually.

If field operations are controlled by flexural-strength tests, the flexural strength of the concrete in the structure shall be monitored by the penetration-resistance tests, except in cases where the Engineer directs the use of third-point loading of test beams or splitting-tensile tests of cylinders. In this case, the Engineer shall be guided by the following considerations: penetration-resistance tests will be valid only for concretes containing coarse trap rock aggregate with a top size to 1 1/2 inches; beam tests will be valid for concrete containing all types and sizes of coarse aggregates; and, splitting-tensile tests will be valid for concrete containing any size of trap rock aggregate.

If field operations are controlled by cylinder tests, the removal of forms, supports and housing and the discontinuance of heating and curing may be begun when the strengths reach the values which shall be fixed by the Engineer.

If field operations are not controlled by one of the above tests, the following

period, exclusive of days when the temperature is below 40° F, may be used as a guide for the removal of forms:

Arch Centers	14 to 28 days
Centering Under Beams	14 to 28 days
Floor Slabs	7 to 14 days
Walls	24 hours to 4 days
Columns	2 to 7 days

To facilitate finishing, side forms carrying no load may be removed after 24 hours with the permission of the Engineer, but the curing process must be continued for seven days.

Ornament moulds shall be removed in the same manner as the usual form work. In case a portion of the plaster work remains in the concrete after the mold is removed, this material shall be carefully removed with a wood chisel, wood mallet or wire brush, using a chipping action wherever possible, and taking care that no damage is done to the concrete. No work of this nature shall be started until at least ten days after the forms have been removed.

- 21. Surface Finish:** The external surface of all concrete shall be thoroughly worked during the operation of placing by means of tools of an approved type. The working shall be such as to force all coarse aggregate from the surface and thoroughly work the mortar against the forms to produce a smooth finish free from water and air pockets, segregated materials, or honeycomb. Unless otherwise authorized by the Engineer, the surface of the hardened concrete shall be finished immediately after the removal of the forms. All voids and honeycomb on the surface shall be filled and finished to conform to the surrounding concrete surface immediately after the forms are removed and before the finishing process is started. The finish shall be governed by the "Table of Finishes" shown elsewhere herein.

Float Finish: This finish shall be formed by placing an excess of material in the form and removing or striking off of such excess with a template, forcing the coarse aggregate below the mortar surface. There shall be created no concave surfaces in which water will be retained. After the concrete has been struck off as above described, the surface shall be thoroughly worked and floated with a wooden, canvas or cork float, the operation to be performed by skilled and experienced concrete finishers. Before this last finish has set, the surface shall be lightly stripped with a fine brush to remove the surface cement film, leaving a fine grained smooth, but sanded texture. Curing, as specified elsewhere, shall follow.

Grout Clean-Down Finish: As soon as all cavities have been filled as required elsewhere and the cement mortar has set sufficiently, grout clean-down shall be performed as follows:

(1) All burrs, unevenness, laitance, including that in air holes, and any other material which will adversely affect the bond of the grout to the concrete, shall be removed by approved methods. This cleaning shall be done from the top or uppermost part of the surface to be finished to the bottom.

(2) A mixture of a fine aggregate and portland cement shall be thoroughly blended while dry. The proportions shall be such that when mixed with the proper amount of water, the color will match that of the concrete to be finished. The proportions shall be determined by trial panels. Water shall be added to this mixture in an amount which will bring the grout to a workable thick paint-like consistency.

(3) The surface to be treated shall be thoroughly wetted with a sufficient amount of water to prevent the absorption of water from the grout. Grout shall then be applied to the wetted surface before setting of the grout occurs. Grout which has set, shall not be re-tempered and shall be disposed of by and at the expense of the Contractor

The grout shall be uniformly applied by brushes, spray gun, or sponge rubber float over the entire surface, completely filling all air bubbles and holes. Immediately after applying the grout, the surface shall be floated with a cork, or other suitable float, scouring the surface vigorously. While the grout is still plastic, the surface shall be finished with a sponge rubber float, removing all excess grout but without removing grout from holes or depressions.

(4) The surface shall be allowed to dry thoroughly, and shall then be rubbed vigorously with burlap to remove completely any dried grout. No visible film of grout shall remain after this rubbing. Operations (3) and (4) shall be completed in one and the same day for the area treated.

(5) Curing of the concrete so treated shall then be resumed as specified elsewhere or, if completed, for at least 1 more day.

Rubbed Finish: The entire surface shall be thoroughly wet with a brush and rubbed with a No. 16 carborundum stone or an abrasive of equal quality, bringing the surface to a paste. The rubbing shall be continued sufficiently to remove all form marks and projections, producing a smooth, dense surface without pits or irregularities. The paste formed by the rubbing as above described may be finished by carefully stripping with a clean brush, or it may be spread uniformly over the surface and allowed to reset. After the concrete has set for 7 days or such period as the Engineer may direct, the surface shall be rubbed again, with a carborundum stone, until a uniform even color is obtained. No mortar shall be

used during this second rubbing. Curing, as specified elsewhere, shall be completed in all cases.

TABLE OF FINISHES						
STRUCTURE TYPE OF FINISH						
	PART	AREA	FLOAT	GROUT CLEAN DOWN	RUBBED	
BRIDGE	Abutment	Exposed		X		
	Wings	Top	X			
		Exp. Sides			X	
	Piers	Top	X			
		Exp. Sides			X	
	Parapets & Fascia	Top	X			
		Sides				X
	Median		X			
	Seat		X			
	Bearing Areas *		X			
	Sidewalks	Top	X			
	Curbs	Top	X			
		Sides				X
	BOX CULVERT	Wings	Top	X		
Exp. Sides				X		
Curbs		Top	X			
		Sides				X
Ends		Exp.		X		
Median			X			
Parapets & Fascia		Top	X			
	Sides				X	
CATCH BASINS **		Exp.			X	
CURBING			X			
DROP INLETS **		Exp.			X	
ENDWALLS		Top	X			
		Exp.		X		
GUTTERS		Exp.	X			
PRECAST PILES ***		Exp.			X	
RETAINING WALLS		Top	X			
		Exp.		X		
SHOTCRETE		Exp.	X			
SLOPE PAVING		Exp.	X			
STEPS & COPING		Top	X			
		Exp. Sides			X	

* See Subarticle 6.01.03-14 for finish following floating. *** When required by special provisions.

** Precast units excepted; See Subarticle M.08.02-4.

22. Testing Apparatus and Test Specimens:

(a) The flexural strength of the concrete for structures shall be monitored by the evaluation of compressive strength cylinders. The compressive strength specimens shall be cast and cured in the field in accordance with AASHTO T 23. After proper curing, these cylinders shall be transported to the Division of Materials Testing for strength evaluation.

(b) Cylinders for 28-Day Compressive Strength: The concrete necessary to cast several cylinders for 28-day compressive-strength determinations shall be furnished by the Contractor from each day's pour. The necessary personnel and forms for casting these specimens will be furnished by the Authority and the number of specimens required will be specified by the Engineer. These cylinders shall be cured in an approved concrete cylinder box, or boxes.

23. Opening to Traffic: Vehicular traffic shall be excluded from the structure until the concrete has developed a compressive strength of 4,000 psi, or until the Engineer authorizes its opening to traffic. Use of equipment applying loads greater than the design capacity of the bridge or structure shall not be allowed.

24. Joint Seal: The Contractor shall seal joints where shown on the plans and elsewhere where directed by the Engineer.

Before placement of the sealing material, the joints shall be thoroughly cleaned of all scale, loose concrete, dirt, dust or other foreign matter. Projections of concrete into the joint space shall be removed. The joint shall be clean and dry before the sealing compound is applied.

The joint sealant shall be prepared and placed in accordance with the manufacturer's directions and with the equipment prescribed by the manufacturer. Any material improperly mixed or likely to set up before placement into the joints will be rejected and shall be replaced at the Contractor's expense.

The joints shall be sealed in a neat and workmanlike manner, free from all dust and foreign matter.

When the work is completed, the joints shall effectively seal against infiltration of moisture and water.

The sealing compound shall be flush with, or not more than 1/8 inch above the adjacent surface of concrete. Where directed by the Engineer, the joint shall be smoothed and leveled to the adjacent surface by cutting off all excess compound after the application. Any joint material which does not adhere or bond with the concrete surface of the joint shall be immediately removed and replaced at the Contractor's expense.

MEASUREMENT: This work will be measured for payment as follows:

1. **Concrete:** The quantity of concrete shall be the actual volume in cubic yards of the several classes, with the exception of underwater concrete, completed and accepted within the neat lines as shown on the plans or as ordered by the Engineer.

When a concrete footing is to be constructed on bedrock, that quantity of concrete actually placed down to—but not exceeding 6 inches below the plan or revised plan footing grade—will be included for payment.

No deduction will be made for panels less than 1 1/2 inches in depth, nor for the volume of reinforcing bars or structural steel shapes when used as reinforcing, nor for pileheads. Also there will be no deduction made for the volume occupied by culvert and drainage pipes, scuppers, weep holes, public utility structures or any other opening, unless the surface area of any such single opening is 9 square feet or more.

Concrete for bridge decks, including curbs, sidewalks, railings, placed thereon or attached thereto, will be classified as Class "F" Concrete unless otherwise indicated on the plans.

In the case of culverts or drainage pipes, the computation of the surface area shall be based on the nominal diameter of the pipe, disregarding the thickness of the shell.

Underwater concrete when specified will be measured by the volume in cubic yards, completed and accepted within the horizontal limits of the cofferdam shown on the plans in which it is placed, and between the elevations established by the Engineer. When underwater concrete is not originally specified but is required, it will be measured by the volume in cubic yards, completed and accepted within the actual horizontal limits of the cofferdam in which it is placed and between the elevations established by the Engineer.

2. **Joint Filler:** This material will not be measured for payment, but the cost shall be considered as included in the unit price bid for concrete.
3. **Miscellaneous Material:** Miscellaneous material such as metal flashing and metal used in expansion joints and bearings shall not be measured for payment, but the cost shall be considered as include in the unit price bid for concrete.

PAYMENT: Payment for this work will be made as follows:

1. **Concrete:** This material will be paid for at the contract unit price per cubic yard for "Class A," "Class C" and "Class F Concrete," respectively, complete in place, which price shall include all materials, equipment, tools, labor and work incidental

thereto, including heating, all admixtures and joint sealer.

2. **Underwater Concrete:** When this class of concrete is constructed, it will be paid for at the contract unit price per cubic yard "Underwater Concrete," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

When no item for "Underwater Concrete" appears in the proposal, and is required, it will be paid for at 80% of the contract unit price for "Class A Concrete," which price shall include all materials, equipment, tools, labor, and work incidental thereto.

No direct payment will be made for the work of testing the concrete in structures, any testing equipment, the instruction of its use, or for the concrete in or curing of the required test beams and cylinders as specified, or for completion dates set in the forms; but, the cost of this work shall be considered as included in the general cost of the work. The work of transporting and testing these beams and cylinders will be done by the Authority without expense to the Contractor.

There shall be no direct payment for the cost of forming keys or construction joints, but the cost thereof shall be considered as included in the cost of the concrete items. Where steel dowels are used, this material will be paid for under the reinforcement item.

There shall be no direct payment for forming weep holes through the wall or for the pipe necessary for this purpose, but the cost thereof shall be considered as included in the general cost of the work.

There shall be no direct payment for the work of placing anchor bolts and similar material that is furnished to the Contractor at the site of the work.

Unless covered by specific contract items, any work performed by the Contractor in connection with utilities installations will be paid for as extra work.

The above provision shall not apply where the installation of equipment for the construction or support of utilities is included in the contract items.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
601.01	Concrete (Class A)	Cubic Yard
601.02	Concrete (Class C)	Cubic Yard
601.03	Concrete (Class F)	Cubic Yard
601.04	Underwater Concrete	Cubic Yard

ITEM 602 REINFORCING STEEL

DESCRIPTION:

Work under this item shall consist of furnishing and placing reinforcing steel and splicing materials, of the type and size designated, as shown on the plans, as directed by the Engineer and in accordance with these specifications.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.06.01.

CONSTRUCTION METHODS:

1. Shop Drawings: Prior to fabricating any materials, the Contractor shall submit shop drawings of the reinforcing steel and splicing materials, with material lists, material designations, placement diagrams, bending diagrams and manufacturer's literature for mechanical connections, for review and approval, in accordance with **§ 106-7, Shop Drawings**. Any expenses incidental to the revision of materials furnished in accordance with shop drawing and order lists to make them comply with the requirements of the plans, specifications or special provisions shall be borne by the Contractor.

2. Fabrication:

(a) Cuffing and Bending:

Bar reinforcement shall be cut and bent to the shapes shown on the plans. Fabrication tolerances shall be in accordance with the requirements of the American Concrete Institute publication, ACI 315. All bars shall be bent cold, unless otherwise permitted.

Coated bars shall not be field cut, unless permitted by the Engineer. Field cutting of coated bars should be performed using hydraulic-powered cutters or friction cutting tools to minimize coating damage and field touch-up. Flame cutting of coated bars will not be permitted. Field cut coated bars shall be repaired immediately.

Bars partially embedded in concrete shall not be field bent, except as shown on the plans or permitted by the Engineer.

(b) Hooks and Bend Dimensions:

The dimensions of hooks and the diameters of bends measured on the inside of the bar shall be as shown on the plans. When the dimensions of hooks or the diameter of bends are not shown, they shall be in

accordance with the ACI, "Building Code Requirements for Reinforced Concrete (ACI 318)" as amended by ASTM A767M for galvanized bars.

(c) Identification:

Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the CR51 "Manual of Standard Practice".

3. Handling, Storing and Surface Condition of Reinforcement:

Steel reinforcement shall be stored above the surface of the ground on platforms, skids, or other supports and shall be protected as far as practical from mechanical injury and surface deterioration caused by exposure to conditions producing rust.

Epoxy-coated and galvanized reinforcing steel shall be handled and stored by methods that will not damage the coating. All systems for handling coated reinforcement shall have adequately padded contact areas wherever possible. All bundling bands shall be padded and all bundles shall be lifted with a strong back, multiple supports, or platform bridge so as to prevent bar-to-bar abrasion from sags in the bar bundle. Bars or bundles shall not be dropped or dragged. Coated reinforcing steel shall be transported and stored on wooden or padded supports. Epoxy-coated reinforcing steel, stored at the jobsite, shall be protected by covering with opaque polyethylene or other suitable protective material. Provisions shall be made for adequate ventilation to prevent condensation under the covering. Since the epoxy coating is flammable, the epoxy coated reinforcing shall not be exposed to any fire or flame.

Prior to placement of concrete, all reinforcement shall be free from dirt, loose rust or scale, mortar, paint, grease, oil, or other materials that would reduce bond. Reinforcement shall be free from injurious defects such as cracks and laminations. Bonded rust, surface seams, surface irregularities, or mill scale will not be cause for rejection, provided the minimum dimensions, cross section area, and tensile properties of a hand wire brushed specimen meet the physical requirements for the size and grade of steel specified.

4. Placing and Fastening:

(a) General:

Steel reinforcement shall be accurately placed as shown on the plans and firmly held in position during the placing and setting of concrete. Bars shall be tied at all intersections except where the spacing is less than 12 inches in each direction when alternate intersections shall be tied. Bars shall be tied at all intersections around the perimeter of each mat.

Bundled bars shall be tied together at not more than 6 foot centers. Lap splices shall have a minimum of two ties or be tied 12 inches apart for the length of the splice; whichever requires the greater number of ties. For epoxy-coated reinforcement, tie wires and metal clips shall be epoxy, plastic or nylon coated. For galvanized reinforcement, tie wires and metal clips shall be plastic coated or galvanized.

With the exception of tie down bars, welding (tack welding) will not be permitted for assembly of reinforcement, unless shown on the plans. Tie down bars shall be placed as shown on the plans and a top longitudinal reinforcing bar tied to these bars. When welding coated bars an appropriate protective mask must be worn, safety equipment used and suitable ventilation provided.

If wire fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

(b) Support Systems:

Reinforcing steel shall be supported in its proper position by use of precast mortar blocks, wire bar supports, supplementary bars (tie-down bars), side form spacers or other approved devices. Such devices shall be sufficiently strong and properly placed at frequent intervals so as to maintain the cover between the reinforcing and the surface of the concrete. The reinforcing steel cover shall be no less than that shown on the plans and no greater than that shown plus 1/4 inch.

Platforms for the support of workers and equipment during concrete placement shall be supported directly on the forms and not on the reinforcing steel.

(c) Precast Mortar Blocks:

Precast mortar blocks shall have a compressive strength not less than that of the concrete in which they are to be embedded. The face of the blocks in contact with forms for exposed surfaces shall not exceed 2 inches x 2 inches in size and shall have a color and texture that will match the concrete surface. Precast mortar blocks shall not be used on exposed surfaces of precast concrete members. When used on vertical or sloping surfaces, such blocks shall have an embedded wire for securing the block to the reinforcing. When used in slabs, either such a tie wire or, when the weight of the reinforcing is sufficient to firmly hold the blocks in place, a groove in the top of the block may be used. For epoxy-coated bars, such tie wires shall be epoxy, plastic or nylon coated. For galvanized bars, such tie wires shall be plastic coated or galvanized.

(d) Wire Supports:

Wire bar supports, such as ferrous metal chairs and bolsters, shall conform to industry practice as described in the CRSI "Manual of Standard Practice of the Concrete Reinforcing Steel Institute." All bolsters or chairs which bear against the forms for exposed surfaces shall be equipped with snug fitting, high density, polyethylene tips which provide 1/2 inch minimum clearance between the metal and any exposed surface. For epoxy-coated reinforcement, all wire bar supports and bar clips shall be epoxy or plastic coated. For galvanized reinforcement, chair and bar supports shall be hot-dip galvanized, after fabrication, in accordance with ASTM A123.

The maximum spacing of slab bolster rows and high chair rows for concrete deck slabs shall be 4 feet unless otherwise directed by the Engineer.

(e) Repair of Coated Reinforcing Steel:

Epoxy-coated Reinforcing Steel - In addition to the requirements of ASTM D3963M, all damage (i.e. scratches, nicks, cracks) to the epoxy coating of the bar reinforcement, visible to the unaided eye with corrective vision, caused during shipment, storage or placement shall be repaired by the Contractor at the jobsite with approved patching material. Ends of bars that have been sheared, saw cut or cut by other means shall be coated with approved patching material. The areas on the bars and tie down bars damaged by welding shall be repaired with approved patching material.

Patching of damaged areas shall be performed in accordance with the patching material manufacturer's recommendations. Any singular damaged surface area (prior to repair with approved patching material), shall not exceed 2% of the total surface area of the bar. The total bar surface area covered by patching material shall not exceed 5% of the total surface area of the bar. Should either of these limits be exceeded the bar shall be removed from the work and replaced with an acceptable bar. All patching material shall be fully cured prior to placing concrete.

The patching material shall be compatible with the epoxy coating, inert in concrete, and suitable for repairs in the field. The patching material shall be pre-qualified, as required for the coating material, and shall be either identified on the container as meeting the requirements of Annex AI of ASTM D3963M or shall be accompanied by a Materials Certificate certifying that the material meets the requirements of said Annex AI.

Galvanized Reinforcing Steel - All damage (i.e. scratches, nicks, cracks)

to the galvanized coating on bar reinforcement, visible to the unaided eye with corrective vision, caused during shipment, storage or placement shall be repaired by the Contractor at the jobsite in accordance with ASTM A780, Annex A2 - "Repair using Zinc-Rich Paints". Ends of bars that have been sheared, saw cut or cut by other means shall be coated with zinc-rich paint. The area on the bars and tie down bars damaged by welding shall be repaired with zinc-rich paint.

Field coating of damaged areas shall be performed in accordance with the zinc-rich paint manufacturer's recommendations. The zinc-rich paint shall conform to Federal Specification TT-P-641, Type 1 and shall be brush applied to achieve a dry film thickness from 3-6 mils. All touchup paint shall be fully cured prior to placing concrete.

5. Splicing of Bars:

(a) General:

All reinforcement shall be furnished in the full lengths indicated on the plans unless otherwise permitted. Except for splices shown on the plans, splicing of bars will not be permitted without written approval of the Engineer. Splices shall be staggered as far as possible.

(b) Lapped Splices:

Lapped splices shall be of the lengths shown on the plans.

In contact lap splices, the bars shall be placed in contact and tied together in such a manner as to maintain the minimum distance to the surface of the concrete shown on the plans.

In non-contact lap splices, the bars shall be placed as shown on the plans and tied to adjacent bars in such a manner as to maintain the minimum distance to the surface of the concrete shown on the plans.

(c) Welded Splices:

Welded splices shall be used at the locations shown on the plans. Welding shall conform to the American Welding Society publication "Structural Welding Code, Reinforcing Steel, AWS D1.4" and applicable special provisions.

Welded splices shall not be used on epoxy-coated or galvanized bars. No welding shall be performed close enough to epoxy-coated or galvanized bars to cause any heating of the coating.

6. Splicing of Welded Wire Fabric: Welded wire fabric reinforcement shall be lap spliced as shown on the plans.
7. Substitutions: Substitution of different size bars will be permitted only when authorized by the Engineer. The substituted bars shall have an area equivalent to or larger than the area shown on the plans.
8. Inspection: Reinforcement in any member or component shall be placed, inspected and approved by the Engineer before placing of concrete begins. Concrete placed prior to approval of the reinforcement may be rejected and its removal required.

MEASUREMENT:

1. General: No measurement will be made for payment for any clips, wire, separators, wire chairs, precast mortar blocks and other material used for fastening and supporting the reinforcement in the correct position.
2. Bar Reinforcement: Uncoated, epoxy coated, galvanized and weldable bar reinforcement shall be classified as “Deformed Steel Bars”, “Deformed Steel Bars - Epoxy Coated”, “Deformed Steel Bars - Galvanized” and “Deformed Steel Bars - Weldable” respectively.

This work will be measured for payment by the number of pounds of bar reinforcement installed and accepted.

The weight of reinforcing steel shall be computed using the unit weights tabulated in Subarticle M.06.01.02. No allowance shall be made for the weight of the epoxy or galvanized coatings.

Tie down bars will not be measured for payment.

In case short bars are used when full length bars might reasonably be required, only the amount which would be obtained if full length bars were used will be measured for payment. No allowance will be made for lap splices not contemplated by the plans unless approved by the Engineer.

If bars are substituted upon the Contractors request and as a result more reinforcing steel is used than specified, only the amount specified will be included.

3. Welded Wire Fabric: This work will be measured for payment by the number of pounds of welded wire fabric installed and accepted.

The weight of welded wire fabric will be computed from the values published in the CRSI "Manual of Standard Practice".

PAYMENT:

Payment for this work will be made as follows:

1. Bar Reinforcement: This work will be paid for at the contract unit price per pound for "Deformed Steel Bars", "Deformed Steel Bars - Epoxy Coated" or "Deformed Steel Bars -Galvanized" and "Deformed Steel Bars - Weldable" complete in-place and accepted, including shop drawings, furnishing, fabricating and placing reinforcing steel, welding splices and all materials, equipment, tools, labor and work incidental thereto.
2. Welded Wire Fabric: This work will be paid for at the contract unit price per pound for "Welded Wire Fabric", complete in-place and accepted, including shop drawings, furnishing, fabricating and placing welded wire fabric and all materials, equipment, tools, labor and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
602.01	Deformed Steel Bars	Pounds
602.02	Deformed Steel Bars – Epoxy Coated	Pounds
602.03	Deformed Steel Bars – Galvanized	Pounds
602.04	Deformed Steel Bars – Weldable	Pounds
602.05	Welded Wire Fabric	Pounds

ITEM 604 SIMULATED STONE MASONRY

DESCRIPTION:

This shall consist of furnishing and installation of textured and colored formed concrete surfaces using simulated stone molds (form liners) and color stain system designed to duplicate closely the appearance of a stone wall.

MATERIALS:

Simulated Stone Molds (form liners) - reusable, made of high strength urethane and cutable, made of lower grade urethane, easily attached to forms. Form liners shall not compress more than ¼ inch when concrete is poured at a rate of 10 vertical feet per hour. Form liners shall be removable without causing deterioration of surface or underlying concrete. Form liner together with texture and color staining system shall be manufactured by Custom Rock International and distributed by Connecticut Bomanite Systems, Inc., Newtown, Connecticut (203-426-9536) or an approved substitute.

Release Agent - compatible with simulated stone masonry and with color stain system to be applied to surface, as recommended by the manufacturer.

Form Ties - designed to separate at least one inch back from finished surface, leaving only a neat hole that can be plugged with patching material.

Color Stain - special penetrating stain mix as provided by the manufacturer, shall achieve color variations (such as oxidation and flecking) present in the natural stone being simulated for this project, as approved by the Engineer. Stain shall create a surface finish that is breathable (allowing water vapor transmission), and resists deterioration from water, acid, alkali, fungi, sunlight or weathering. Stain mix shall be a water borne, low V.O.C. material, less than 180 grams/liter, and shall meet requirements for weathering resistance of 2000 hours accelerated exposure measured by weather-o-meter in accordance with ASTM G23 with B-bulb. Scrub test 1000 revolutions. Abrasive resistance (Tabor-CF- 10) 500 cycles. Adhesion ASTM D33 59 1.00 mm cross cuts on glass pass 3 or higher on a scale of 1 to 5. Supply information pertaining to chemical resistance ASTM D1308.

CONSTRUCTION DETAILS:

1. Quality of work

The process of form lining, texturing and color staining of the hardened concrete shall be performed in strict accordance with the manufacturer's recommendations and as approved by the Engineer.

Design and pattern of form lined concrete surfaces shall follow the manufacturer's standard drawing. Prior to the start of work, the Contractor shall submit a 24" X 24"

sample of the simulated stone masonry finished to demonstrate the pattern, texture and finish. The completed colored and formed concrete surface shall match the color and texture of both the sample panel and the Color Stained Concrete Mock-up. Final coloration of cast stone concrete surface shall accurately simulate the appearance of real stone. It shall also demonstrate the colors that may be apparent from aging, such as staining from oxidation, rusting and/or organic staining from soil and/or vegetation.

2. Quality Assurance

Manufacturer of Simulated Stone Molds and Custom Coloring Systems shall possess a minimum of eight years experience making custom simulated stone molds and color stains to create formed concrete surfaces to match natural stone shapes, surface textures and colors.

Contractor/Subcontractor (installer) shall possess a minimum of eight years experience pouring vertically formed architectural concrete. The Contractor shall be trained in manufacturer's special techniques in order to achieve realistic surfaces.

Color Stain System Application - by manufacturer or manufacturer's authorized representative.

Pre-installation Meeting - Contractor to schedule meeting with manufacturer's representative, installer, and the Engineer to assure understanding of simulated stone masonry use, color staining application, requirements for construction of mockup, and to coordinate the work.

3. Submittals

Catalog cuts, manufacturer's literature, sample panel, and technical data for the materials specified herein, including but not limited to simulated stone mold pattern, form liner, release agent, concrete patching material and color charts for staining of hardened concrete shall be submitted to the Engineer for approval.

Photographs - color photographs of three (3) similar past projects of the manufacturer.

Samples - form ties, sample and description, showing method of separation when forms are removed.

Plan, elevation and details to show overall pattern, joint locations, form tie locations, and end, edge and other special conditions.

Form lined and Color Stained Concrete Mockup - build on site before cast-in-place concrete work to be textured and colored, using same materials, methods and work force that will be used for the Project. Location on site for construction of mockup shall be as approved by the Engineer. Concrete shall be placed in the mockup, texture constructed and construction procedure adjusted until a final texture and color is

produced that complies with the color and texture of the Sample Panel.

- A. Size – 50 square feet, or larger if needed to adequately illustrate the pattern and texture selected.
 - B. Included an area to demonstrate simulated stone masonry butt joint, if appropriate, continuation of pattern through expansion joint, around a corner, and a cap detail if it is applicable to the job requirements.
 - C. If design includes stone texture across top of wall, include in mockup.
 - D. After concrete work on mockup has cured sufficiently, prepare the surface for color staining. After the Engineer has approved of the prepared surface of the cast simulated stone masonry mockup for color staining, the work of form lined cast-in-place concrete for permanent work may proceed using mockup as quality standard, except that color staining for permanent work is not yet authorized.
 - E. After a 30 day cure of mockup and last pour of form lined concrete wall to be color stained, mockup shall be color stained. After coloring is determined to be acceptable by the Engineer, construction of the remaining work under this Item may proceed, using mockup as quality standard.
 - F. Remove mockup as directed by the Engineer.
4. Scheduling - schedule color stain application after adjacent earthwork is to rough grade, to avoid contaminating or damaging the surface. Place topsoil and establish turf after staining application is completed. Coordinate the work to prevent interference with other Items of work.
5. Contractor responsibilities:
- 1. Install liners
 - 2. Apply manufacturer release agent
 - 3. Install concrete in accordance with Plans and Specifications.
 - 4. Hand carving of top exposed textured surfaces.
 - 5. Remove form liners.
 - 6. Patching, grinding, and bush hammering of form liner seams as required.
 - 7. Provide scaffolding and heat, as required, and clean water for power washing of the hardened concrete prior to the staining process.
 - 8. Power washing and patching of form liners. (Rental liners only)
 - 9. Return of form liners to manufacturer. (Rental liners only)

Manufacturer responsibilities:

- A. Supply form liners (Rental liners only)
- B. Supply release agent
- C. Supply shop drawings.
- D. Provide technical information.

- E. Train finishers to carve and texture top exposed surfaces.
 - F. Power wash wall (for staining only)
 - G. Apply the grouting process (for staining only)
6. Liner to Form Attachment System - securely attach form liners to forms with wood or sheet metal screws; threaded inserts added to the back of the form liner for bolts to fasten the form liner through the forms, or; bolted through the face of the form liner with flat head bolts inserted in a pattern joint and through the form liner and forming system. Construction adhesives may be used, but not on reusable forms. Place adjacent form liners with less than ¼ inch separation between form liners.
7. Release of Form Liners From Hardened Concrete - only manufacturer recommend form release agents (Lark V, Orna Con, or Crete-Lease) shall be utilized and shall be applied to the form liners before the concrete is poured. Release agents shall be applied in strict accordance with release agent manufacturer recommendations. Hand-charged sprayers will only be allowed if a thin uniform coating of release agent is obtained on the form liner.
- Remove the form liner from the wall within 24 hours of pouring the concrete. The form liners may be detached from the forms and then removed from the concrete, or they may remain attached to the forms and the entire forming system removed from the concrete. Remove the form liners from the top, down. Curing of concrete shall proceed in accordance with the Specifications, after the initial detachment. Curing compounds shall not be used, as they are incompatible with the color staining material.
8. Care and Cleaning of Form Liner - form liners shall be cleaned the same day they are removed from the wall with a power wash and mild detergent. Synthetic brushes with stiff bristles may be used on stubborn areas. Mild acid washes may also be used. Solvents shall not be used. If necessary, patching of holes shall be performed with 100% clear silicone caulk. Form liners shall be stored inside or under a protective, non-transparent cover, in a vertical position.
9. Wall Patching and Preparation - after form liners are removed from the hardened concrete, the textured uncolored surface shall be prepared for color staining. All holes larger than 3/8 inch in greatest principle dimension shall be filled with concrete patching material such as Tamms Speed-crete or equal mixed with latex and acrylic bonder, as approved by the manufacturer and the Engineer. All honeycombed areas shall be filled and textured to match surrounding areas. Seam lines and other unnatural protrusions shall be ground down to match adjacent areas with a hand-held power grinder using discs made of concrete.
10. Grinding of seams shall be performed immediately after removal of form liners. Perform final bush hammering to blend defects and ground areas into the final rock texture. In particular, the process of wall patching and preparation shall be subject to approval of the manufacturer and Engineer.

11. Color Staining (by manufacturer) - the hardened concrete shall be a minimum of 30 days old before color staining is applied. Power wash the wall to free it from latex, dirt, oil and other objectionable materials. After the wall has dried, the color staining process shall be applied using colors approved by the Engineer. Color staining shall be applied in such way that the stones shall have individual colorations from one to another. Water-based stains shall be used in air temperatures ranging from 50 degrees F to 100 degrees F. Solvent-based stains shall be used in air temperatures of 50 degrees F and below, but in no case when the temperature of hardened concrete is 40 degrees F and falling.
12. Special Techniques for Forming Textured Concrete (Simulated Stone Molds Preparation) - clean and make free of buildup prior to each pour. Inspect for blemishes or tears. Repair if needed following manufacturer's recommendations.

MEASUREMENT:

This work will be measured for payment by the number of square yards of the pattern called for in the proposal form of the simulated stone masonry actually installed and accepted.

PAYMENT:

This work shall be paid for at the contract unit price per square yard for "Simulated Stone Masonry" which price shall include sample, mockup, form lining, hand carving, color staining, specific responsibilities of the Contractor specified herein, and all materials, supplies, labor, tools, and equipment incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
604	Simulated Stone Masonry Pattern _____	Square Yard

ITEM 605 MASONRY FACING

DESCRIPTION:

This item shall consist of a surface course or facing of masonry of the hereinafter specified quality, applied to the exposed surfaces of the concrete structures as a protection or ornamentation. It shall be constructed to the dimensions indicated on the plans or as ordered and in accordance with these specifications.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.11.01 for masonry facing stone and lead, Article M.11.04 for mortar and Article M.06.01 for metal dowels and ties.

CONSTRUCTION METHODS:

Each grade of masonry facing stone shall be constructed in the location and to the dimensions shown on the plans or as ordered and shall be built in conjunction with concrete backing. The backing shall not be placed until the masonry facing and any required dowels or ties have been properly placed. The work shall be carried on in successive layers or lifts as permitted by the Engineer. Care must be taken to prevent any movement of the masonry already in place while placing and compacting the concrete. When required by the Engineer, the facing stone shall be supported by such bracing and framework as may be necessary to prevent movement.

All stone shall be set by competent and experienced masons.

1. Dressing Stone: All stones shall be dressed to the required size and shape before being laid and, except in the case of granite, shall be cut to lie on their natural beds. The bottom bed shall be the full size of the stone, and no stone shall have an overhanging top. In rock-faced work the exposed surface of any stone shall not present an excessively undercut contour adjacent to its bottom arris giving a top-heavy, unstable appearance when laid.

Bed joints of dimensioned masonry stone, except for rock-faced surface finish stone, shall be fine finished a full 2 inches from the pitch line of the face from which point the bottom bed may fall under the square 1 inch in 12 inches, the top bed 1 ½ inches in 12 inches; and the joints 2 inches in 12 inches; but all beds must have a reasonable area of bearing spots back of the face. They shall be free from large depressions which might impair the stability of the work. On rock-faced stone, the beds shall be sawn or dressed full for at least the specified minimum width of the stone; beyond that the beds may fall under the square not in excess of 3 inches in 12 inches. The joints shall be cut full and square for at least 12 inches back of the pitch lines from which point they may fall away not over 3 inches in 12 inches. Headers, if called for, shall have a back dimension

not less than 2/3 of the corresponding face dimension unless otherwise shown on the plans.

Beds and joints of ashlar stone shall be rough finished for a depth of not less than 2 inches in from the arris lines, and the balance of the stone shall not fall off more than ¼ of the minimum dimension of the piece.

Holes for dowels or ties or for handling stone shall not be permitted to show in exposed surfaces.

2. Mixing Mortar: The mortar shall be hand or machine mixed as may be directed by the Engineer. In the preparation of hand mixed mortar, the fine aggregate, cement and lime, if used, shall be thoroughly mixed together in a clean, tight mortar box until the mixture is of uniform color, after which water shall be added in such quantity as to form a stiff paste. Machine mixed mortar shall be prepared in an approved mixer and shall be mixed not less than 1½ minutes.

Mortar shall be used before obtaining initial set. Re-tempering of mortar will not be permitted.

3. Laying Stone: Stone shall not be laid when air temperature in the shade and away from heat is 40°F or below and falling, except with the permission of the Engineer and subject to such conditions as may be imposed.

Dimensioned stone masonry shall be carefully and accurately constructed in accordance with the provisions of the approved plans.

Ashlar stone masonry shall be so constructed as to produce the general effect shown on the plans. As an aid in determining the required appearance, the Contractor shall lay up a sample section of wall, under the direction of the Engineer, which when approved, shall be accepted as representing the appearance to be obtained in the construction.

Each stone shall be cleaned and thoroughly saturated with water before being set. Stone shall not be dropped on or slid over the wall, but shall be carefully set without jarring stone already laid and shall be handled with a lewis or other appliance which shall not cause disfigurement. All stones shall be well bedded in freshly made mortar and settled in place with a suitable wooden maul before the setting of the mortar. Whenever possible, the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing by raking them out to a depth of about 2 inches before mortar has set. The face surfaces of stone shall not be smeared with the mortar forced out of joints or that used in pointing. No hammering, rolling, or turning of stones will be allowed on the wall. Precautions shall be taken to prevent seepage of moisture, through or from the beds or joints, which may cause discoloration of the exposed surfaces.

For rock-faced stone, the course heights may vary from 2 feet to 3 feet 2 inches with the higher courses at the bottom. Face bond shall be not less than 12 inches.

Headers shall be placed in the masonry only if so specified. They shall then be placed in each course and shall have a face length of not less than the rise of the stone. They shall bond with the core or backing not less than 12 inches. A minimum face bond of not less than 12 inches shall be maintained. In no case shall a joint occur over or under a header. Approximately $\frac{1}{5}$ of the area of the wall shall consist of headers.

Beds and joints in dimensioned stone masonry, unless otherwise specified, shall be not less than $\frac{3}{8}$ inch nor more than $\frac{3}{4}$ inch in thickness and shall present a uniform appearance. Abrupt changes in the thickness of beds and joints will not be permitted.

Beds and joints in ashlar masonry shall have an average thickness of not more than 1 inch.

4. Dowels and Ties: Metal dowels and ties of the type called for on the plans or as ordered shall be installed during the placing of the stone and before the backing is placed.
5. Resetting: In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.
6. Concrete Backing: Before concrete backing is poured, the backs of all beds and joints shall be pargebed with not less than $\frac{1}{2}$ inch of setting mortar. No concrete shall be poured until the pargebed mortar has set. In general, horizontal construction joints produced by successive pours of the backing concrete shall be located not less than 6 inches below the top or above the bottom bed of any course of masonry.
7. Joints: Joints shall be pointed or raked as called for on the plans or in the special provisions.
8. Pointing: Pointing shall not be done in freezing weather or when the stone contains frost.

Joints not pointed at the time the stone is laid shall be thoroughly cleaned out, wet with water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool to produce the type of joint shown on the plans or required by the Engineer. The wall shall be kept wet while pointing is being done; and in hot and dry weather, the pointed masonry shall be

protected from the sun and kept wet for a period of at least 3 days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workmanlike condition. The use of acid for cleaning will not be permitted.

MEASUREMENT:

This work will be measured for payment as follows:

1. Masonry Facing: The quantity of masonry facing shall be the actual number of square yards of the face area of accepted masonry facing, completed within the neat lines as shown on the plans, or as ordered by the Engineer.

When the masonry facing is backed with concrete, the quantity to be paid under the concrete item shall be determined by assuming that the facing has the average thickness stated on the plans.

2. Metal Dowels or Ties: Metal dowels or ties will NOT be measured for payment; the cost of the work shall be included within the unit price bid for Masonry Facing.
3. Pointing: Unless otherwise specified, all pointing shall be included in the cost of the masonry facing.

PAYMENT:

This work will be paid for as follows:

Masonry Facing will be paid for at the contract unit price per square yard for “Dimension Stone Masonry” or “Ashlar Stone Masonry,” as the case may be, complete in place, which price shall include all equipment, metal dowels or ties, tools, pointing and labor incidental thereto and all materials. The cost of drilling holes for dowels or ties shall be considered as included in the general cost of the work.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
605.01	Dimension Stone Masonry	Square Yard
605.02	Ashlar Stone Masonry	Square Yard

ITEM 606 CEMENT RUBBLE MASONRY

DESCRIPTION:

This item shall consist of approved stone, laid in full mortar beds, constructed in such shapes and at such places as indicated on the plans or where directed, and in accordance with these specifications.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.11.02 for rubble masonry stone and Article M.11.04 for mortar.

CONSTRUCTION DETAILS:

The masonry shall be constructed in the location and to the dimensions shown on the plans or as ordered.

1. Dressing Stone: All necessary dressing or shaping shall be done before the stone is laid in the wall. No dressing or hammering which will loosen the stone will be permitted after it is placed. Stone at angles or at ends of walls shall be roughly squared and dressed to the required lines.
2. Laying Stone: Stone shall not be laid when the air temperature in the shade and away from artificial heat is 40° F or below and falling, except with the approval of the Engineer and subject to such conditions as he may impose.

The masonry shall be laid to line and in courses roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones; and all courses shall be laid with bearing beds parallel to the natural bed of the material.

Each stone shall be cleaned and thoroughly saturated with water before being set. Stone shall not be dropped or slid over the wall but shall be carefully set without jarring stone already laid. All stone shall be well bedded in freshly made mortar. The mortar joints shall be full and the stones carefully settled in place before the mortar has set. No spalls will be permitted in the beds. Joints and beds shall have an average thickness of not more than 1 1/2 inches.

Headers shall be placed in each course and shall have a width of not less than 1 1/2 times their thickness. They shall bond with the core or backing not less than 12 inches; and in walls 2 feet or less in thickness; they shall extend entirely through the wall. Headers shall occupy not less than 1/5 of the face area of the wall and shall be evenly distributed.

Whenever possible the face joints shall be properly pointed before the mortar becomes set. Joints which cannot be so pointed shall be prepared for pointing

by raking them out to a depth of about 2 inches before the mortar has set. The face surfaces of stones shall not be smeared with the mortar forced out of the joints or that used in pointing.

The vertical joints in each course shall break joints with those in adjoining courses at least 6 inches. In no case shall vertical joints be so located as to occur directly above or below a header.

In case any stone is moved or the joint broken, the stone shall be taken up, the mortar thoroughly cleaned from bed and joints, and the stone reset in fresh mortar.

3. Pointing: Pointing shall not be done in freezing weather or when the stones contain frost.

Joints not pointed at the time the stones are laid shall be thoroughly wet with water and filled with mortar. The mortar shall be well driven into the joints and finished with an approved pointing tool. The wall shall be kept wet while pointing is being done; and in hot or dry weather, the pointed masonry shall be protected from the sun and kept wet for a period of at least three days after completion.

After the pointing is completed and the mortar set, the wall shall be thoroughly cleaned and left in a neat and workman-like condition.

Cofferdams shall be so maintained that the masonry is not exposed to the action of running water until such time as the mortar has attained strength sufficient, in the opinion of the Engineer, to prevent injury to the work from such exposure.

MEASUREMENT:

This work will be measured for payment by the actual number of cubic yards of "Cement Rubble Masonry" completed and accepted, within the neat lines as shown on the plans or as ordered by the Engineer. No deduction will be made for the volume occupied by culvert or drainage pipes having an exposed surface area of less than 9 square feet for each opening. The computation of the surface area shall be based on the nominal diameter of the pipe, disregarding the thickness of the shell.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard of "Cement Rubble Masonry", complete in place which price shall include all materials, equipment, tools and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
606	Cement Rubble Masonry	Cubic Yard

ITEM 607 DRY RUBBLE MASONRY

DESCRIPTION:

This item shall consist of approved stone, laid without the aid of mortar, so as to fit neatly and firmly, constructed in such shapes and at such places as indicated on the plans or where directed, and in accordance with these specifications.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.11.02 for rubble masonry stone.

CONSTRUCTION DETAILS:

The masonry shall be constructed in the location and to the dimensions shown on the plans or as ordered.

1. Dressing Stone: All necessary dressing or shaping of stone shall be done before the stone is laid in the wall. No dressing or hammering which will loosen the stone will be permitted after it is placed. Stones at angles or at ends of walls shall be roughly squared and dressed to the required lines.

2. Laying Stones: The masonry shall be laid to line in courses, roughly leveled up. The bottom or foundation courses shall be composed of large, selected stones, and all courses shall be laid with bearing beds parallel to the natural bed of the material. Face joints shall have a width of not more than 1 1/2 inches.

In laying rubble masonry, care shall be taken that each stone takes a firm bearing at not less than three separate points upon the underlying course. Open joints, both front and rear, shall be chinked with spalls, fitted to take firm bearing upon their top and bottom surfaces, for the purpose of securing firm bearing throughout the length of the stone.

MEASUREMENT:

The quantity of dry rubble masonry shall be the actual number of cubic yards, completed and accepted, within the neat lines of the structure as shown on the plans or as ordered by the Engineer. No deduction will be made for the volume occupied by culvert or drainage pipes having an exposed surface area of less than 9 square feet for each opening. The computation of the surface area shall be based on the nominal diameter of the pipe, disregarding the thickness of the shell.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard for "Dry Rubble Masonry," complete in place, which price shall include all materials, equipment, tools, labor and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
607	Dry Rubble Masonry	Cubic Yard

ITEM 651 CULVERTS

DESCRIPTION:

This item shall consist of furnishing and installing new pipe culverts, new pipe-arch culverts and relaying existing pipe and pipe-arch culverts of the type, size and length called for on the plans or as ordered, at the locations and to the lines and grades designated on the plans, or as directed by the Engineer, and in conformity with these specifications.

MATERIALS:

The materials for this work shall conform to the following:

Pipes of the type indicated on the plans, joint sealant and shall conform to the requirements of Article M.08.01.

Bedding material shall conform to the requirements of Item 305, Bedding Materials.

CONSTRUCTION DETAILS:

Unless otherwise directed by the Engineer, all new or relaid pipe culverts shall be installed in pipe bedding in accordance with the details as shown on the plans and in conformance with these specifications.

Pipe with an internal diameter of less than 48 inches and pipe-arch of an equivalent horizontal span shall be installed in a Type I installation, and pipe of 48 inches internal diameter or more, including pipe-arch of equivalent horizontal span shall be installed in a Type II installation.

Type I installation shall consist of installing the pipe, or pipe-arch in bedding material with a thickness directly under the pipe of 4 inches and preshaped to a height of 10 percent of the total height of the pipe. After the pipe has been installed, the trench shall be backfilled with bedding material to a height 25 percent of the total height of the pipe.

Type II installation shall consist of installing the pipe or pipe-arch in bedding material, with a thickness directly under the pipe of 4 inches and preshaped to a height of 10 percent of the total height of the pipe. After the pipe has been installed, the trench shall be backfilled with bedding material to a height of 12 inches above the top of the pipe.

Methods of backfilling shall be in conformance with the pertinent sections of Item 205.

Where pipe is to be laid below the ground lines, a trench shall be excavated to the required depth, the bottom of which shall be graded to the elevation of the bottom of the bedding material or to afford a uniform firm bearing for the pipe throughout its entire length, whichever the case may be. When rock is encountered, it shall be excavated to

not less than 12 inches below the bottom of the pipe, and this depth shall be refilled with bedding material which shall be thoroughly tamped.

Where pipe is to be laid in a fill area, the embankment shall be placed and compacted to an elevation 12 inches above the top of the proposed pipe, whereupon the trench excavation shall be made and the pipe installed.

Where the nature of the foundation is poor, the culvert shall be relocated in firm material if possible. Where this cannot be done, the poor material shall be removed and replaced with a layer of bedding of such depth as the Engineer may direct; or special construction of the character shown on the plans special provisions or as ordered by the Engineer, may be employed.

Normally, the placement of pipe shall start at the downstream end and progress upstream. All pipe shall be carefully laid, true to the lines and grades given, hubs upgrade and with the spigot ends fully entered into the adjacent hubs.

Joints in concrete and vitrified clay pipe shall be sealed with either cold applied bituminous sealer, preformed plastic gaskets or flexible, watertight rubber-type gaskets conforming to the requirements of Article M.08.01. Portland cement mortar shall not be used for sealing pipe joints except by permission of the Engineer, and if permitted shall conform to the requirements of Article M.11.04.

When cold-applied bituminous sealer is used, the bell and spigot or tongue and groove pipe shall be wiped clean and dry before applying the bituminous sealer to the pipe joint. Before the pipes are placed in contact with each other, the spigot or tongue end shall be completely covered with an excess of bituminous sealer; then the pipe shall be laid to line and grade so the inside surface of the abutting pipes are flush. The joints shall be completely filled with bituminous sealer. All excess joint sealant shall be removed from inside of the pipe.

Where shown on the plans or directed by the Engineer, the Contractor shall connect the proposed drainage system(s) with existing drainage structures or pipes. This work shall be performed in a workmanlike manner.

Where shown on the plans or directed by the Engineer, the Contractor shall plug existing pipes with cement masonry.

MEASUREMENT:

This work will be measured for payment as follows:

1. New and Re-laid Pipe Culverts and Pipe-Arch Culverts will be measured for payment by the actual number of linear feet of pipe or pipe-arch of the various sizes and types, completed and accepted and measured in place along the invert to the outside face of manholes or other structures. Coupling bands and fittings

for culvert pipe and pipe-arches will not be measured for payment.

2. Trench Excavation and Backfill will be measured for payment in accordance with Item 205.
3. Bedding Material will be measured for payment by the actual number of cubic yards completed and accepted, measured within the payment lines as shown on the plans or as ordered by the Engineer. The volume of the pipe will not be included in the measurement.
4. There will be no measurement for payment for the cost of connecting proposed drainage systems with existing systems, but the cost thereof shall be included in the contract unit price per linear foot for the size and type of pipe being installed.

Excavation necessary for such work will be considered as trench excavation and will be measured for as such.

5. There will be no measurement for payment for the cost of plugging existing pipes.

PAYMENT:

This work will be paid for as follows:

1. New Pipe Culverts and Pipe-Arch Culverts will be paid for at the contract unit price per linear foot for pipe or pipe-arch of the type and size specified, complete in place, including all materials, equipment, tools and labor incidental thereto.
2. Re-Laid Pipe Culverts and Pipe-Arch Culverts will be paid for at the contract unit price per linear foot for relaid pipe and pipe-arch of the type and size actually relaid, complete in place, including all materials, equipment, tools, labor and work incidental thereto.
3. Trench Excavation and Backfill will be paid for in accordance with Item 205 at the contract unit price per cubic yard for "Trench Excavation and Backfill" of the type indicated in the bid schedule.
4. Bedding Material will be paid for at the contract unit price per cubic yard for "Bedding Material", complete in place, which price shall include all materials, tools equipment and labor incidental thereto.
5. There will be no direct payment for the plugging of existing pipes, but the cost thereof shall be included in the contract unit prices of the drainage and excavation Items.

Item Number

Pay Item

Pay Unit

651

Culvert
Size____, Type____

Linear Feet

ITEM 652 CULVERT ENDS

DESCRIPTION:

This item shall consist of furnishing and installing reinforced concrete culvert ends conforming to the details shown on the plans or to commercial details providing equal lengths and a similar shape, and having generally comparable hydraulic characteristics. These reinforced concrete culvert ends shall be placed where and as shown on the plans, or as directed by the Engineer.

This item shall also include furnishing and installing new metal culvert ends at the locations shown on the plans or as directed by the Engineer. These culvert ends shall be of the size, gage and general shape shown on the plans.

MATERIALS:

The materials for this work shall conform to Subarticle M.08.01-22 for Reinforced Concrete Culvert End, Subarticle M.08.01-23 for Metal Culvert End, Article M.11.04 for Mortar and Article M.02.01 for Gravel Fill.

CONSTRUCTION DETAILS:

Reinforced concrete culvert ends shall be placed on a prepared bed of the existing ground, or if so directed by the Engineer, on gravel fill and accurately aligned as shown on the plans. The joints shall be sealed as specified in Item, 651, Culverts.

Metal culvert ends shall be placed on a prepared bed of the existing ground, or if so directed by the Engineer, on gravel fill. After the attachment of the culvert end to the culvert, backfill shall be placed around both sides of the unit up to the prescribed surface, exercising caution to avoid displacement or deformation of the unit.

MEASUREMENT:

Construction of the culvert ends will be measured as units.

Trench Excavation and Backfill necessary to place the culvert end will be measured for payment in accordance with Item 205.

Gravel Fill will be measured for payment in accordance with Item 213.

PAYMENT:

Reinforced Concrete Culvert Ends and Metal Culvert Ends will be paid for at the contract unit price each for the culvert end of the type and size specified, complete in place, including all materials, equipment, tools and labor incidental thereto. Necessary trench excavation will be paid for in accordance with Item 205 at the contract unit price per cubic yard for "Trench Excavation and Backfill."

Gravel Fill will be paid for in accordance with Item 213.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
652.01	(Size-type) Reinforced Concrete Culvert Ends	Each
652.02	(Size-type) Metal Culvert Ends	Each

ITEM 703 RIPRAP

DESCRIPTION:

Riprap shall consist of angular shaped stones used to protect foundations of piers, abutments, walls, slopes of embankments and waterways from water damage.

MATERIALS:

1. **Stone:** The stone for this work shall be the type called for on the plans and shall conform to the requirements of Article M.12.02.
2. **Bedding:** The bedding material for riprap shall conform to the specifications of the material indicated on the plans.

CONSTRUCTION DETAILS:

The area to be protected by riprap shall be accurately shaped prior to placing of any bedding material or riprap. Where bedding material is called for, it shall be placed on the prepared area and compacted to the depth, lines and grades indicated on the plans.

The riprap shall be placed to its full course thickness in one operation in such a manner as to produce a reasonably well-graded mass of rock without causing displacement of the underlying material. The finished surface shall be free from pockets of small stones and clusters of larger stones. Placing this material by methods likely to cause segregation of the various sizes of stone will not be permitted. Rearranging of individual stones by mechanical or hand methods will be required to the extent necessary to obtain a reasonably well-graded distribution of the specified stone sizes. The completed course shall be of the specified thickness and to the lines and grades as shown on the plans or as ordered by the Engineer.

MEASUREMENT:

The quantity of riprap and level spreader measured for payment shall be the number of square yards measured in place as accepted. The thickness shall be no less than the smallest dimension of the type of riprap specified.

PAYMENT:

This work will be paid for at the contract unit price per square yard for the type of riprap and level spreader indicated, complete in place, including all materials, equipment, tools and labor incidental thereto.

Excavation, backfilling, and disposal of surplus material will not be measured for payment, but the cost shall be considered as included in the unit price bid for the riprap.

Bedding, where called for, will not be measured for payment, but the cost shall be considered as included in the unit price bid for the riprap.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
703	Riprap (Type)	Square Yard

ITEM 708 DAMPPROOFING

DESCRIPTION:

Dampproofing of concrete or masonry work shall consist of a coating of asphalt as indicated on the plans and in accordance with these specifications.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.12.05.

CONSTRUCTION DETAILS:

The surface to which the dampproofing coating is to be applied shall be cleaned of all loose and foreign material and dirt and shall be dry. Where necessary, the Engineer may require the surface to be scrubbed with water and a stiff brush, after which the surface shall be allowed to dry before the application of the primer.

Concrete, brick or other surfaces which are to be protected by dampproofing shall be thoroughly clean and dry before the primer is applied. One (1) coat of primer and one (1) coat of sealer shall be applied using methods, application rates and temperature constraints as recommended by the manufacturer of each product.

Care shall be taken to confine all applied material to the areas to be dampproofed and to prevent disfigurement of any other parts of the structure by dipping or spreading.

MEASUREMENT:

This work will be measured for payment by the number of square yards of dampproofing, consisting of primer and seal coat, completed and accepted within the neat lines shown on the plans or as ordered by the Engineer.

PAYMENT:

This work will be paid for at the contract unit price per square yard for "Dampproofing," complete in place, including all material, equipment, tools, labor and incidental expense.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
708	Dampproofing	Square Yard

ITEM 713 PERMANENT STEEL SHEET PILING

DESCRIPTION:

This specification covers only steel sheet piling shown on the plans to be left in place so that it becomes a part of the finished structure. For purposes of this specification, steel sheet piling shall be any type of adequately braced sheet pile wall which the Contractor elects to build to satisfy, and which does satisfy, the condition that existing facilities be properly retained during excavation for the placement of substructure or other facilities.

MATERIALS:

Materials for steel sheet piling shall conform to the requirements of ASTM A 328.

CONSTRUCTION DETAILS:

The sheet piling shall be safely designed and braced as necessary for proper performance of the work. Construction shall be such as to permit excavation as required. Interior dimensions shall be such as to give sufficient clearance for construction of forms and their inspection and for batter pile clearance when necessary. Movements of steel sheet piling or bracing which prevent the proper completion of the substructure shall be corrected at the sole expense of the Contractor. No part of the steel sheet piling or bracing shall be allowed to extend into the substructure without written permission of the Engineer.

Prior to the commencement of any excavation work, the Contractor shall submit to the Engineer the proposed methods of sheeting and bracing of excavations, size and type of materials, methods of installation and removal. All sheeting shall be designed and sealed by a Professional Engineer licensed to practice in the State of Connecticut. The furnishing and/or approval of such plans shall not serve to relieve the Contractor of any responsibility for the protection of the public, property and workmen, nor the obligation to conform with Local, Federal and State Regulations.

The Contractor shall submit to the Engineer for approval plans showing the proposed method of construction prior to the start of such construction. The furnishing of such plans shall not serve to relieve the Contractor of any responsibility for the safety of the work or for the successful completion of the project.

The steel sheet piling shall be cut off at the elevation shown on the plans or as ordered by the Engineer. All material cut off shall remain the property of the Contractor and shall be disposed of by him.

MEASUREMENT:

Permanent steel sheet piling will be measured for payment by the square foot. This area will be measured or computed from the horizontal and vertical payment limits shown on the plans or as ordered.

PAYMENT:

This work will be paid for at the contract unit price per square foot for "Permanent Steel Sheet Piling," which price shall include the cost of designing, furnishing, driving, cutting off, and all incidental expenses, including all materials, equipment, tools and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
713	Permanent Steel Sheet Piling	Square Foot

ITEM 714 TEMPORARY SHEET PILING

DESCRIPTION:

Under this Item, the Contractor shall, with the approval of the Engineer, install temporary sheet piling. This sheet piling shall be removed upon completion of the permanent work. For purposes of this specification, temporary sheet piling shall be any type of adequately braced sheet pile wall which the Contractor elects to build to satisfy, and which does satisfy, the condition that existing facilities be properly retained during excavation for the placement of substructure or other facilities.

MATERIALS:

Materials of steel sheet piling shall conform to the requirements of ASTM A 328. Timber sheet piling shall conform to the requirements of Subarticle M.09.01-1. Materials other than steel or timber, or a combination of these may be used provided they are properly designed for the purpose intended.

CONSTRUCTION DETAILS:

Temporary sheet piling shall be safely designed and shall be carried to adequate depths and braced as necessary or proper performance of the work. Construction shall be such as to permit excavation as required. Interior dimensions shall be such as to give sufficient clearance for construction of forms and their inspection and for better pile clearance when necessary. Movements of sheet piling or bracing which prevent the proper completion of the substructure shall be corrected at the sole expense of the Contractor.

Prior to the commencement of any excavation work, the Contractor shall submit to the Engineer the proposed methods of sheeting and bracing of excavations, size and type of materials, methods of installation and removal. All sheeting shall be designed and sealed by a Professional Engineer licensed to practice in the State of Connecticut. The furnishing and/or approval of such plans shall not serve to relieve the Contractor of any responsibility for the protection of the public, property and workmen, nor the obligation to conform with Local, Federal and State Regulations.

Unless otherwise ordered by the Engineer, all parts of the temporary sheet piling shall be removed upon completion of the work for which it was provided. The excavation shall be backfilled and properly compacted, prior to removal of piling unless otherwise permitted by the Engineer. Sheet piling may be left in place at the option of the Contractor if so permitted by the Engineer, provided that it is cut off at an elevation as directed by the Engineer and the cutoffs removed from the site.

MEASUREMENT:

Temporary sheet piling, timber and/or steel, will be measured for payment by the number of square feet of temporary sheet piling completed and accepted, as computed from the horizontal and vertical payment limits shown on the plans or as ordered.

Trench shields or any other temporary sheeting used to protect workmen or adjacent utilities on the remainder of the project shall not be measured for payment, but the cost of which should be included in the unit price bid for the appropriate trench excavation items.

PAYMENT:

Payment for this work will be made at the contract unit price per square foot for "Temporary Sheet Piling", measured as described above, which price shall include all design, materials, equipment and labor incidental to the construction and removal of the temporary sheet piling required at the locations specified on the plans; including removal of obstructions, repair and correction, adjustments or reconstruction required by the plans. Any common sheet piling wall required for staged construction will be measured for payment only once.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
714	Temporary Sheet Piling	Square Foot

ITEM 751 UNDERDRAIN AND OUTLETS

DESCRIPTION:

Underdrains shall consist of pipe pervious to water, laid in a trench refilled with pervious material. They shall be of the dimensions and details as indicated on the plans. They shall be classed as "Underdrains", "Foundation Underdrains", "Slope Underdrains" or "Structure Underdrains."

Outlets for underdrains shall consist of pipe laid in a trench and refilled with earth. The size and type of outlet pipe shall be the same as that of the underdrain to which it is connected, except that it shall not be pervious to water.

MATERIALS:

Pipe: The pipe for underdrains and outlets shall conform to the requirements of Article M.08.01. The kind of pipe to be installed shall be at the option of the contractor unless a specific type of pipe is indicated on the plans or in the special provisions.

Aggregates: The aggregates specified for filling the trench shall meet the requirements of Article M.08.03 or as specified herein.

Joint Sealant: The materials for sealing and coupling of joints shall conform to the requirements of Article M.08.01.

Geotextile: Geotextile shall conform to Subarticle M.08.01-26 or as specified herein.

CONSTRUCTION:

The trench for the underdrains shall be excavated in conformity with the requirements of Item 651, Culverts. The dimensions of the trench shall be as indicated on the plans or as ordered. Where the bottom of the trench is unstable or in rock, the trench shall be excavated 6" deeper and an additional 6" layer of gravel fill or aggregate similar to that used to fill the trench shall be placed and compacted in the trench.

Where the perforations are to be at the bottom of the pipe, the aggregate for filling the trench shall then be placed to a depth of 3" and tamped true to grade. The pipe shall be placed and firmly bedded on the aggregate. This aggregate shall be placed whether the pipe is encased with geotextile or not.

When the pipe used has a bell, the pipe shall be installed with the bell end upgrade with the spigot end entered fully into the adjacent bell.

When clay or concrete pipe is used, the joints will not have to be filled with a joint

sealant or fitted with a gasket.

When metal, bituminized fiber, plastic, polyethylene or asbestos cement pipe is used, the pipe shall be carefully butted together and held by hands, or other approved means so as to prevent any displacement of the joint.

After the pipe has been installed as described above, the aggregate shall be placed carefully around and over the pipe to a height of 12" above the top of the pipe. The remainder of the trench shall be filled with aggregate and tamped in layers as shown on the plans. When the underdrain pipe is used with the holes in an upward position, and in all cases where sand is used instead of the aggregate described hereinbefore, a protective 3" minimum layer of 3/8" aggregate shall be placed over the pipe and around all of the holes. Geotextile may be substituted for the 3" layer of aggregate. When filter fabric is used, the entire length of each drain pipe shall be wrapped with the geotextile and the seams lapped and welded or bonded. Where the seams of the geotextile are not welded or bonded, they shall be lapped to a minimum width equal to the diameter of the pipe for 6" pipe and larger and a minimum of 6" for smaller pipe.

In all cases where subbase material or gravel is to be placed over the underdrains, a layer of at least 6" of subbase material or gravel shall be placed over the underdrain immediately after its completion.

For outlets, the trench shall be excavated and the pipe installed in conformity with the requirements of Item 651, Culverts.

Where shown on the plans or directed by the Engineer, the contractor shall connect underdrains or outlets to existing or proposed drainage systems or structures.

This work shall be performed in a workmanlike manner satisfactory to the Engineer by installation of tees or wyes branches or by providing a hole in the main line underdrain.

Where the upgrade end of the underdrain does not enter a structure, it shall be capped or plugged as directed.

MEASUREMENT:

This work will be measured for payment by the actual number of linear feet of underdrains, foundation underdrains, slope underdrains, structure underdrains and outlets for underdrains, completed, accepted and measured in place.

The crushed stone bedding complying with the provisions of Item 305, when required in the installation of underdrains, shall not be measured for payment but shall be included in the linear foot price for installation of underdrain as shown in the Proposal Form:

Trench excavation will be measured for payment under Item 205.

PAYMENT:

This work will be paid for at the contract unit price per linear foot for “Underdrain”, “Foundation Underdrain”, “Slope Underdrain”, “Structure Underdrain” and “Outlets for Underdrain” complete in place, which price shall include pipe of the size specified, elbows, tees, wyes, couplings, fittings, filter fabric, ¾” crushed stone bedding, tools, material and labor incidental thereto. The necessary excavation for the installation of the underdrain shall be paid for under the appropriate trench excavation Item included within the Proposal Form.

There will be no direct payment made for capping, plugging or connecting underdrains or outlets to existing or proposed drainage systems or structures, but the cost thereof shall be included in the cost of the underdrain items involved.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
751.01	Underdrain and Outlets (Size) (Type)	Linear Foot
751.02	Foundation Underdrain (Size) (Type)	Linear Foot
751.03	Slope Underdrain (Size) (Type)	Linear Foot
751.04	Structure Underdrain (Size) (Type)	Linear Foot
751.05	Outlets for Underdrain (Size) (Type)	Linear Foot

ITEM 755 GEOTEXTILE

DESCRIPTION:

Under this Item, the Contractor shall furnish and install geotextile in the locations and to the dimensions shown on the plans as directed or as approved by the Engineer.

MATERIALS:

Geotextile shall conform to the requirements of Article M.08.01-26. Materials incidental to and necessary for the installation of the geotextile, such as, but not limited to sewing thread, staples, pins, etc., shall conform to the requirements of the manufacturer of the Geotextile.

CONSTRUCTION DETAILS:

The geotextile shall be installed at the locations and to the dimensions shown on the plans or as directed by the Engineer. Geotextile shall be installed as recommended by the manufacturer for the specific use or purpose intended, or as otherwise approved by the Engineer.

MEASUREMENT:

This work will be measured for payment by the actual number of square yards of the type indicated on the plans or authorized by the Engineer. Geotextile specifically included in the payment of another Item will not be measured for payment under this Item. No additional measurement will be made for necessary lap material.

PAYMENT:

This work will be paid for at the contract unit price per square yard of "Geotextile (Type)", complete in place, which price shall include all materials, labor, tools, and equipment incidental and necessary for each type of installation and removal where necessary.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
755	Geotextile (Type)	Square Yard

ITEM 811 CONCRETE CURBING

DESCRIPTION:

This work shall consist of the removal of the existing curbing and the construction of new concrete curb in accordance with these specifications and the lines and grades shown on the plans or as established by the Engineer

MATERIALS:

Materials for this work shall conform to the requirements of Article M.03.01 for Class "C" Concrete.

Air-entraining portland cement and air-entraining admixtures shall conform to Article M.03.01.

Premoulded Bituminous Joint Filler shall conform to the requirements of A.S.T.M. Designation: D1751.

Resin Based Liquid Membrane Curing Compound shall conform to the requirements of Article M.03.01-10.

CONSTRUCTION:

Excavation: The Contractor shall line cut the existing pavement a sufficient distance from the curbing to be replaced but under no circumstances is the distance to exceed eighteen inches from the face of the curbing

Excavation shall be made to the required depth, and the base upon which the curbing is to be set shall be compacted to a firm, even surface.

Casting Segments: Curb shall be cast in segments having a uniform length of approximately twenty (20) feet. Segments shall be separated by construction joints with provisions made at each joint for $\frac{1}{4}$ inch expansion. When the curb is constructed next to cement concrete pavement, the construction joint adjacent to the end of pavement slab shall line up with the pavement joint.

Expansion Joints: Expansion joints $\frac{3}{4}$ inch in width shall be formed with "Premoulded Bituminous Joint Filler", placed at intervals shown on the plans or specified by the Engineer. The filler material shall be cut to conform to the cross section of the curb. When the curb is cast adjacent to cement concrete pavement constructed with expansion joints, expansion joints in the curb shall be located at expansion joints in the pavement.

Forms: Forms shall be steel or wood, straight, free from warp, and of such construction that there will be no interference to inspection for grade or alignment. All forms shall

extend for the full depth and shall be braced and secured adequately so that no displacement from alignment will occur during the placing of concrete.

Concrete Placing and Vibrating: The concrete shall contain not less than 5 nor more than 7 percent entrained air at the time the concrete is deposited within the forms. Concrete shall be placed only on a moist base. Concrete shall not be placed on a soft, muddy or frozen base.

Concrete shall be placed in the forms in accordance with the applicable requirements of Item 601, Concrete for Structures, and shall be compacted with an approved, immersion type mechanical vibrator. The vibrator shall be of the size and weight capable of thoroughly vibrating the entire mass without damaging or misarranging the forms and shall be approved by the Engineer.

Forms shall be left in place for 24 hours or until the concrete has sufficiently hardened, as determined by the Engineer, so that they can be removed without injury to the curb. Upon removal of the forms, the exposed faces of the curb shall be immediately rubbed to a uniform surface. Rubbing shall be accomplished by competent finishers. No plastering will be permitted.

Concrete Curing: A two application resin based liquid membrane curing compound shall be required

Protection: The Contractor shall keep the curb clean, aligned, and protected from damage until final acceptance of the work. Any curb damaged prior to the final acceptance of the work shall be repaired or replaced at the Contractor's expense.

Backfilling: After the concrete has set sufficiently, the grading shall be completed to the lines shown on the plans, or as ordered, by refilling to the required elevation with approved material which shall be placed in layers of not over 6 inches in depth and compacted until firm and solid.

In the roadway area and upon completion of the work the Contractor shall backfill in front of the curbing with process aggregate base and install a two course bituminous concrete pavement repair consisting of 1 1/2" of Class I and 1 1/2" of Class II. The cost of this work shall be included within the unit price bid for the curbing item.

MEASUREMENT:

This work will be measured for payment on the basis of linear feet along the top front arris line of the curb constructed in conformance with these specifications and as ordered by the Engineer.

PAYMENT:

The unit price bid per linear foot shall include the cost of Saw Cutting, removal of the

existing curbing and furnishing all labor, materials, equipment, excavation to bed the curb, and backfill, pavement repair, necessary to satisfactorily complete the work.

Any cleaning, repair or replacement of curbs that is necessary prior to final acceptance of the work shall be completed at the Contractor's expense.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
811	Concrete Curbing (Type)	Linear Foot

ITEM 813 GRANITE STONE CURBING

DESCRIPTION:

This item shall include the furnishing and installing of straight or curved granite stone curb on a prepared base at the location and to the details shown on the plans or as directed by the Engineer and in accordance with these specifications. This item also includes installing bituminous concrete pavement and base materials to the dimensions shown on the detailed drawings. All curbing shall be properly installed and backfilled prior to the placement of the bituminous concrete pavement.

MATERIALS:

All curbing material shall be created from hard and durable granite, light gray in color, free from seams which impair its structural integrity, and of a smooth splitting character. Natural color variations characteristic of the deposit shall be permitted. Granite shall come from approved quarries acceptable to the Engineer.

1. Radius Granite Curb

Type V 6 x 18 curbstones set on a radius of one hundred (100) feet or less shall be cut to the curve required. All radius curb shall be set in a subbase of Class "A" concrete.

2. Straight Granite Stone Curb shall be cut to the following dimensions:

<u>Type</u>	<u>Width At Top, Inches</u>	<u>Depth Inches</u>	<u>Minimum Length, Feet</u>	<u>Minimum Width at Bottom Inches</u>
V 5 x 18	5	18"-19"	4	5

3. Mortar for pointing joints shall conform to Article M.11.04.

4. Class "A" Concrete shall conform to Article M.03.01.

5. Processed Aggregate Base shall conform to the material requirements of Item 304, Processed Aggregate Base.

6. Bituminous Concrete Pavement

The materials for the Bituminous Concrete mixture, the sources of supply, formula for the mix, mix tolerances, approval of mix formula and the control of the mixture shall conform to the requirements of Article M.04.01 for the Class as specified.

The tack coat to be used on all cold joints shall conform to the requirements of Article M.04.

CONSTRUCTION DETAILS:

1. Delivery

All granite curb shall be accepted by the Engineer at the time of delivery and before curbing is installed.

2. Excavation

Excavation shall be made of sufficient depth and width to accommodate the processed aggregate base as shown on the detailed drawings. The processed aggregate base shall be compacted to a firm, even surface and shall be approved by the Engineer.

3. Transition Section

a. Roadway Transitions:

A six (6) foot transition section of granite curb shall be installed at all end sections that do not match to other types of curbing. The end section shall match flush with the existing edge of the pavement.

b. Driveway Transition:

All transition sections of granite curbing along driveways shall be set in Class "A" concrete and meet the requirements of the detailed drawings.

4. Backfilling

After all curb is set, the space between it and the wall of the trench will be backfilled with processed aggregate base material thoroughly tamped to the depth directed, care being taken not to affect the line or grade of the curb.

All curved granite stone curbing will be set in Class "A" concrete as shown on the detailed drawings.

5. Bituminous Concrete Pavement

The surface shall be constructed in accordance with the requirements of Item 406, Bituminous Concrete, except that the material may be spread by hand and thoroughly compacted by multiple passes of a roller weighing not less than 500 pounds

6. Protection

The contractor shall protect curb stones and keep them in first class condition until completion and acceptance.

7. Joints

Joint openings between sections of curbing shall not vary from between ½ inch to ¾ inch over the entire width of the exposed curb.

Joints are to be mortared to the full depth and width of the curb, and all excess mortar wiped clean off face of curb.

At intervals of fifty (50) feet one joint shall be left open for expansion purposes.

MEASUREMENT:

This work will be measured for payment by the actual number of linear feet of straight, curved or transition granite stone curbing installed and accepted, which includes the installation of bituminous concrete pavement and base.

Measurement shall be made along the top arris line of face of curb. Curbing to be set on a radius of 100 feet or less will be measured for payment as curved granite stone curbing.

PAYMENT:

Payment for this work will be made at the contract unit price per linear foot of “Granite Stone Curbing,” complete in place. The price shall include all sawcutting of existing bituminous concrete, all excavation as shown on the detailed drawings, granite stone curbing, granite stone transition curbing, processed aggregate base, pointing, Class “A” concrete, bituminous concrete pavement, backfilling, compaction, disposal of all surplus material, equipment, tools and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
813	Granite Stone Curbing	Linear Foot

ITEM 814 RESET STONE CURBING

DESCRIPTION:

This work shall consist of the removing and resetting or adjusting of existing stone curbing to the lines and grades given, in accordance with the dimensions and details of the plans or as ordered and in conformity with these specifications.

MATERIALS:

All existing curbing which is acceptable shall be used. The reset stone curbing shall be in lengths of not less than 4 feet, except where necessary for closures, where no piece shall be less than 3 feet in length. Mortar for this work shall conform, as regards materials, proportions and mixing, to the mortar specified in Article M.11.04.

CONSTRUCTION DETAILS:

The construction methods for this work shall conform to the requirements of Item 813, Granite Stone Curbing, as supplemented by the following requirements:

The curbing to be reset shall be removed with care to avoid damage and, if ordered, shall be transported to a point or points on the project which will allow all the reset curbing to be installed in continuous lines. Curbing removed and not reset shall remain the property of the Authority unless otherwise ordered by the Engineer, and shall be transported to such points, adjacent to the work, as the Engineer may designate. Where adjustments only have to be made to curbing, such adjustments shall be carried out as specified by the Engineer.

MEASUREMENT:

This work will be measured for payment by the actual number of linear feet of the class of curbing, reset and accepted.

PAYMENT:

This work will be paid for at the contract unit price per linear foot for "Reset Curbing," complete in place, which price shall include all materials, equipment, tools and labor incidental thereto and all excavation, backfilling, disposal of surplus material and all drainage openings.

There will be no direct payment for furnishing, placing and compacting gravel and/or concrete base, beveling or rounding the ends of the curbing, sealing the joints with mortar, removing the curbing and hauling it to any location on or adjacent to the project as directed by the Engineer; but the cost of this work shall be considered as included in the general cost of the work.

Item Number

Pay Item

Pay Unit

814

Reset Stone Curbing

Linear Foot

ITEM 815 BITUMINOUS CONCRETE LIP CURBING

DESCRIPTION:

Bituminous concrete lip curbing shall consist of machine laid bituminous concrete, constructed on the pavement to the dimensions and details shown on the plans, or as ordered, and in conformity with the specifications.

MATERIALS:

Materials, including tack coat, for this work shall conform to the requirements of Article M.04, Bituminous Class 3.

CONSTRUCTION DETAILS:

The methods employed in performing the work and all equipment, tools machinery and plant used in handling materials and executing any part of the work shall be subject to the approval of the Engineer before the work is started, and whenever found unsatisfactory, it shall be changed and improved as required by the Engineer. All equipment, tools machinery and plant used must be maintained in a satisfactory working condition. The curbing shall be constructed in accordance with the following requirements.

Prior to the arrival of the mixture on the work, the surface of the pavement where the curbing is to be constructed shall be cleaned of all loose and foreign material. The surface; which shall be perfectly dry and clean at the time the mix, is placed, shall be coated with an approved tack coat just prior to placing the mixture.

On arrival at the site, the mixture shall be transferred from the truck to the hopper of the curbing machine; and the mixture shall be kept clean and free from dirt or foreign materials at all times.

The surface of the curbing shall be tested with a 10-foot straight-edge, and any variation from a true line exceeding 1/4 inch shall be satisfactorily corrected. The only compaction required shall be that obtained by the approved mechanical curbing machine.

Where machine work is impractical, the Engineer may permit hand laid curbing to be constructed.

If the design of the curbing machine is such that the outside wheels operate outside of the curb, the Contractor will be required to obtain a smooth surface by grading and consolidating the area on which the outside wheel of the machine rides, and this work shall be done at his expense.

After the completion of curbing, traffic shall be kept at a safe distance for a period of not less than 24 hours and until the curbing has set sufficiently to prevent injury to the work.

MEASUREMENT:

This work will be measured for payment along the top of the curb and will be the actual number of linear feet of bituminous concrete lip curbing completed and accepted.

PAYMENT:

This work will be paid for at the contract unit price per linear foot for "Bituminous Concrete Lip Curbing" complete in place, which price shall include all materials, equipment, tools and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
815	Bituminous Concrete Lip Curbing	Linear Foot

ITEM 921 CONCRETE SIDEWALK AND DRIVEWAY

DESCRIPTION:

This item shall consist of concrete sidewalks and driveways constructed on a processed aggregate base course in the locations and to the dimensions and details shown on the plans or as ordered and in accordance with these specifications.

MATERIALS:

Materials for this work shall conform to the requirements of Article M.03.01 for Class "C" Concrete.

Air-entraining portland cement and air-entraining admixtures shall conform to Article M.03.01.

Processed Aggregate Base shall conform to Item 304.

Welded Wire Fabric shall conform to Article M.06.01.03.

Premoulded Bituminous Joint Filler shall conform to the requirements of A.S.T.M. Designation: D1751.

Resin Based Liquid Membrane Curing Compound shall conform to the requirements of Article M.03.01-10.

CONSTRUCTION:

Excavation: Excavation, including removal of any existing sidewalk, shall be made to the required depths below the finished grade, as shown on the plans or as directed. All soft and yielding material shall be removed and replaced with suitable material.

Processed Aggregate Base: The processed aggregate base shall be placed in layers not to exceed 6 inches in depth and to such a depth that after compaction it shall be at the specified depth below the finished grade of the walk. The base shall be wetted and rolled or tamped after the spreading of each layer.

Forms: Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the pressure of the concrete. If of wood, they shall be of 2-inch surfaced plank except that at sharp curves thinner material may be used. If of metal, they shall be of approved section and shall have a flat surface on the top. Forms shall be of a depth equal to the depth of the sidewalk.

Forms shall be securely staked, braced and held firmly to the required line and grade and shall be sufficiently tight to prevent leakage of mortar. All forms shall be cleaned and oiled or wetted before concrete is placed against them. Sheet metal templates

1/8-inch in thickness, or the full depth and width of the walk, shall be spaced at intervals of 12 feet or as directed. If the concrete is placed in alternate sections, these templates shall remain in place until concrete has been placed on both sides of the template. As soon as the concrete has obtained its initial set the templates shall be removed.

Concrete: The concrete shall be proportioned, mixed, placed, etc, in accordance with the provisions of Item 601.02, Concrete Class "C," except as modified herein.

The concrete shall contain not less than 5 or more than 7 percent entrained air at the time the concrete is deposited in the forms.

A two application resin based liquid membrane curing compound shall be required.

Welded Wire Fabric for concrete reinforcement shall be embedded at mid-depth in the slab. The wire fabric shall consist of No. 6 gauge wire at six (6) inch centers transversely and longitudinally.

A premoulded bituminous joint filler shall be installed at all joints between sidewalk and curb, pavement, buildings, etc. and at all transverse construction joints.

Finishing: Transverse construction joints shall extend to the full depth of the slab spaced 20 to 25 feet apart. The edges of such joints shall be finished with an edging tool having a 1/4 inch radius.

The concrete surface shall be scored at intervals of three (3) to five (5) feet so that the finished walk will be marked in squares. The concrete shall be finished to produce a smooth and uniform surface.

The surface of the concrete shall be finished with a wood float or by other approved means. Immediately after smoothing operations have been completed and prior to the application of the curing compound, the surface of the concrete shall be textured with a light broom in a direction perpendicular to the centerline of the sidewalk.

Backfilling and Removal of Surplus Materials: The sides of the sidewalk shall be backfilled with suitable material thoroughly compacted and finished flush with the top of the sidewalk. All surplus material shall be removed and the site left in a neat and presentable condition to the satisfaction of the Engineer.

MEASUREMENT:

Concrete Sidewalk: This work will be measured by the actual number of square feet of completed and accepted concrete sidewalk furnished in accordance with the Contract Drawings and Specifications and incorporated in the work.

Concrete Driveway: This work will be measured by the actual number of square feet of completed and accepted concrete driveway furnished in accordance with the

Contract Drawings and Specifications and incorporated in the work.

Excavation: Excavation below and above the finished grade of the sidewalk, backfilling, and disposal of surplus material will not be measured for payment, but the cost shall be included in the unit price bid for the sidewalk and/or driveway.

Processed Aggregate Base: This work will not be measured for payment, but the cost shall be included in the unit price bid for the sidewalk and/or driveway.

PAYMENT:

This work will be paid for at the contract unit price per square foot for "Concrete Sidewalk," or "Concrete Driveway," complete in place, which price shall include furnishing of all materials including portland cement concrete, all excavation as specified above, preparation of the subgrade, backfill, disposal of surplus material, processed aggregate base, welded wire fabric, liquid membrane curing compound, equipment, tools, materials and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
921.01	Concrete Sidewalk	Square Foot
921.02	Concrete Driveway	Square Foot

ITEM 922 BITUMINOUS CONCRETE SIDEWALK AND DRIVEWAY

DESCRIPTION:

This Item shall consist of a Bituminous Concrete Sidewalk or Driveway constructed on a processed aggregate base course in the locations and to the dimensions and details shown on the plans or as ordered and in accordance with these specifications.

MATERIALS:

Materials for this work shall conform to the following requirements:

1. Processed Aggregate Base Course shall conform to the requirements of Item 304.
2. Bituminous Concrete Surface: Materials for this surface shall conform to the requirements of Article M.04, Class 2.

CONSTRUCTION DETAILS:

1. Excavation: Excavation, including removal of any existing sidewalk, or driveway, shall be made to the required depth below the finished grade, as shown on the plans or as directed. All soft and yielding material shall be removed and replaced with suitable material.
2. Forms: When the bituminous concrete is spread by hand, forms shall be used. Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the impact of the roller. If made of wood, they shall be of 2 inch surfaced plank except that at sharp curves thinner material may be used; if made of metal, they shall be of an approved section. All forms shall be of a depth equal to the depth of the sidewalks or driveways and shall be securely staked, braced, and held firmly to the required line and grade. All forms shall be cleaned and oiled each time they are used.
3. Base Course: Processed Aggregate Base for the base course shall be uniformly spread upon the subgrade to the required depth and thoroughly compacted with a roller weighing not less than 500 pounds.
4. Bituminous Concrete Surface: This surface shall be constructed in accordance with the requirements of Item 406, Bituminous Concrete, except that the material may be spread by hand and thoroughly compacted by multiple passes of a roller weighing not less than 500 pounds
5. Backfilling and Removal of Surplus Material: The sides of the sidewalk or driveway shall be backfilled with suitable material thoroughly compacted and finished flush with the top of the sidewalk or driveway. All surplus material shall

be removed and the site left in a neat and presentable condition to the satisfaction of the Engineer. In sections inaccessible to the roller, the base course, surface course and backfill shall be hand-tamped with tampers weighing not less than 12 pounds, the face of which shall not exceed 50 square inches in area.

MEASUREMENT:

Bituminous Concrete Sidewalk: This work will be measured by the actual number of square feet of completed and accepted bituminous concrete sidewalk furnished in accordance with the Contract Drawings and Specifications and incorporated in the work.

Bituminous Concrete Driveway: This work will be measured by the actual number of square feet of completed and accepted bituminous concrete driveway furnished in accordance with the Contract Drawings and Specifications and incorporated in the work.

Excavation: Excavation below and above the finished grade of the sidewalk, backfilling, and disposal of surplus material will not be measured for payment, but the cost shall be included in the unit price bid for the sidewalk and/or driveway.

Processed Aggregate Base: This work will not be measured for payment, but the cost shall be included in the unit price bid for the sidewalk and/or driveway.

PAYMENT:

This work will be paid for at the contract unit price per square foot for "Bituminous Concrete Sidewalk," or "Bituminous Concrete Driveway," complete in place, which price shall include furnishing of all materials including the bituminous concrete, all excavation as specified above, preparation of the subgrade, backfill, disposal of surplus material, processed aggregate base, equipment, tools, materials and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
922	Bituminous Concrete Sidewalk and Driveway	Square Yard

ITEM 927 DRIVEWAY RESTORATION

DESCRIPTION:

Under this Item, the Contractor shall restore existing driveways disturbed during the course of the construction and as directed by the Engineer in accordance with these specifications and as shown on the contract drawings.

MATERIALS:

Materials utilized in the restoration of disturbed driveways shall be identical to the existing materials prior to the commencement of construction.

CONSTRUCTION DETAILS:

These Standard Specifications shall apply for the appropriate materials used in the driveway restoration.

MEASUREMENT:

Driveway Restoration: The quantity to be paid for will be measured by the actual number of square yards of Driveway Restoration performed in accordance with the Contract Drawings and Specifications and incorporated in the work.

Excavation: Excavation below the finished grade of the driveway, backfilling, and disposal of surplus material will not be measured for payment, but the cost shall be included in the unit price bid for the sidewalk and/or driveway.

Processed Aggregate Base: This work will not be measured for payment, but the cost shall be included in the unit price bid for the driveway restoration.

PAYMENT:

The unit price bid per square yard shall include the furnishing of all materials, all excavation as specified above, preparation of the subgrade, backfill, disposal of surplus material, processed aggregate base, equipment, tools, materials and incidental labor to complete the work as specified on the plans or directed by the Engineer.

Driveways damaged during the construction due to carelessness on the part of the Contractor shall be restored to their original condition by the Contractor at no expense to the Authority

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
927	Driveway Restoration	Square Yard

ITEM 942 CALCIUM CHLORIDE FOR DUST CONTROL

DESCRIPTION:

This Item shall consist of furnishing calcium chloride and spreading it on the subgrade or in other areas of a project under construction, for the purpose of allaying dust conditions.

MATERIALS:

Calcium chloride shall conform to the requirements of AASHTO M 144, except that the pellet form and the flake form shall be equally acceptable.

CONSTRUCTION DETAILS:

Calcium chloride shall be applied only at the locations, at such times and in the amount as may be directed by the Engineer. It shall be spread in such manner and by such devices that uniform distribution is attained over the entire area on which it is ordered place.

MEASUREMENT:

Weights as marked on the shipping containers shall be used; or if directed by the Engineer, scales shall be furnished by and at the expense of the Contractor, and the calcium chloride weighed in a manner satisfactory to the Engineer.

PAYMENT:

Payment for this work will be made at the contract unit price per ton for "Calcium Chloride for Dust Control," which price shall include all material, equipment, tools, labor and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
942	Calcium Chloride for Dust Control	Ton

ITEM 944 TOPSOIL

DESCRIPTION:

This work shall consist of furnishing, placing and shaping topsoil in areas shown on the plans or where directed by the Engineer. The topsoil shall be placed to the depth stated in the Contract.

MATERIAL:

The material shall conform to the requirements of Article M.13.01-1.

CONSTRUCTION DETAILS:

The areas on which topsoil is to be placed shall be graded to a reasonably true surface. Topsoil shall then be spread and shaped to the lines and grades shown on the plans, or as directed by the Engineer. The depth stated in the contract to which the topsoil is to be placed is to be the depth after settlement of the material has taken place. All stones, roots, debris, sod, weeds and other undesirable material shall be removed. After shaping and grading, all trucks and other equipment shall be excluded from the topsoiled area to prevent excessive compaction. The Contractor shall perform such work as required to provide a friable surface for seed germination and plant growth prior to seeding.

During hauling and spreading operations, the Contractor shall immediately remove any material dumped or spilled on the roadway. It shall be the Contractor's responsibility to restore to the line grade and surface all eroded areas with approved material and to keep topsoiled areas in acceptable condition until the completion of the Construction work.

MEASUREMENT:

This work will be measured for payment by the number of cubic yards of topsoil in place, furnished, placed and shaped, and the work accepted.

PAYMENT:

This work will be paid for at the contract unit price per cubic yard for "Furnishing and Placing Topsoil" which price shall include all materials, equipment, tools; labor and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
944	Furnishing and Placing Topsoil " _____ " Thickness	Cubic Yard

ITEM 945 FERTILIZING, SEEDING AND MULCHING

DESCRIPTION:

The work included under this Item shall consist of furnishing and placing fertilizer, seed and mulch on all areas to be seeded as shown on the plans, or where directed by the Engineer.

MATERIALS:

The materials for this work shall conform to the requirements of Section M.13.

CONSTRUCTION DETAILS:

Construction methods shall be those established as agronomically acceptable and feasible and which are approved by the Engineer.

1. Preparation of the Seedbed:
 - a) Level areas and lawns: These areas shall be made friable and receptive for seeding by discing or by other approved methods to the satisfaction of the Engineer. In all cases the final prepared and seeded soil surface shall meet the lines and grades for such surface as shown in the plans, or as directed by the Engineer.
 - b) Slope and Embankment Areas: These areas shall be made friable and receptive to seeding by approved methods which will not disrupt the line and grade of the slope surface. In no event will seeding be permitted on hard or crusted soil surface.
 - c) All areas to be seeded shall be reasonably free from weeds taller than three (3) inches. Removal of weed growth from the slope areas shall be by approved methods, including hand—mowing, which do not rut or scar the slope surface, or cause excessive disruption of the slope line or grade. Seeding on level areas shall not be permitted until substantially all weed growth is removed. Seeding on slope areas shall not be permitted without removal or cutting of weed growth except by written permission of the Engineer.
2. Seeding Season: The normal seasonal dates for seeding shall be as follows:

Spring seeding:	March 15th to June 15th
Fall seeding:	August 15th to October 15th

 - a) Out-of-Season Seeding at any time other than within the above season shall be allowed only when ordered by the Engineer or when the Contractor submits a written request for permission to do so and permission is granted. In the request, the Contractor must agree to apply

the specified seed, fertilizer, and mulch at a rate of not less than 25 percent greater per unit area than the rates specified for use within the seeding season. The additional materials shall be furnished and placed at the Contractor's expense. The Contractor must also agree to reseed, remulch and repair any areas seeded out-of-season that are damaged by fire, erosion, or any other cause, as directed by the Engineer at no expense to the Authority.

- b) Where out-of-season seeding is ordered by the Engineer, the cost of additional material will be paid for by the Authority; and in this event, the Contractor will not be held responsible for damage or failure beyond its control due to out-of-season seeding.
 - c) Areas of disturbed soil which will contribute significantly to air and stream pollution shall be established to the designated vegetative cover as soon as feasible or when directed by the Engineer.
3. Seeding Methods: Seed shall be uniformly applied by any agronomically acceptable and feasible method approved by the Engineer. Normal seed mixtures shall be applied at the rate of 100 pounds per acre.
- Fertilizer shall be uniformly placed at the rate of 640 pounds per acre.
4. Mulching: Areas seeded shall be mulched unless otherwise ordered by the Engineer. Woodchip mulch shall not be used on seeded areas, unless otherwise shown on the plans or called for in the provisions, hay mulch will be used.
- a) Hay shall be uniformly applied by an approved method to a placed depth of two (2) inches. Hay shall be held in place by one uniform application of asphalt emulsion Type SS—I, applied at the rate of 0.08 gallons per square yard. The emulsion shall have a temperature range within 50-120 F° at the time of the application. The emulsion may be applied during or immediately after the application of the mulch.
5. Compaction: The Contractor shall keep all equipment and vehicular and pedestrian traffic off areas that have been seeded to prevent excessive compaction and damage to young plants. Where such compaction has occurred, the Contractor shall rework the soil to make a suitable seedbed; then reseed and mulch such areas with the full amounts of the specified materials, at no extra expense to the Authority.
6. Maintenance: The Contractor shall be required to replant, using full amounts of all specified materials, those areas damaged by wind, fire, equipment, or pedestrian traffic to the satisfaction of the Engineer, except as specified herein.

Work under this Item shall not be complete until all stones, glass, cables, bale

wire, and other debris have been removed from the seeded areas. Cleanup shall also include the removal of all debris resulting from the seeding or planting operations on shoulders, pavement or adjacent property, public and private. The Contractor shall be required to shape, grade, and establish vegetative cover in accordance with the specifications on all areas disturbed outside the normal limits of construction. When the Contractor is ordered to do any mowing of established grass, such work will be paid for as extra work.

7. Warranties and Certifications: The Contractor shall surrender to the Engineer all warranties or certifications, or both, furnished with the seed mixture or fertilizer prior to use of the material.

Warranties and/or guarantees shall be consistent with nursery standards but at no time be less than one year from the date of installation and acceptance.

MEASUREMENT:

This work will be measured for payment by the number of square yards, surface area, actually covered by seeding and fertilizer as specified.

PAYMENT:

This work will be paid for at the contract unit price bid per square yard for “Fertilizing, Seeding and Mulching”, which price shall include all materials, maintenance, equipment, tools, labor and work incidental thereto except that when the Engineer orders any mowing to be done, the cost of such work will be paid for as extra work.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
945	Fertilizing, Seeding and Mulching	Square Yard

ITEM 949 PLANTING

DESCRIPTION:

The work under these items shall consist of furnishing, planting and mulching trees, shrubs, vines and ground cover plants of the type and size indicated on the plans or special provisions. It shall also include all incidental operations, such as the care of the living plants and the replacement of dead and unsatisfactory plants or unsatisfactory materials before final acceptance of the contract.

MATERIALS:

The material for this work shall conform to the requirements of Section M.13.

CONSRUCTION DETAILS:

Construction methods shall be performed in accordance with these specifications.

The Contractor is cautioned that within the limits of any project, buried cable for illumination or utilities, which may be energized, may be present.

- 1. Planting Season:** Unless otherwise shown on the plans or directed by the Engineer, the planting seasons shall be those indicated below. No planting shall be done in frozen ground or when snow covers the ground, or the soil is otherwise in an unsatisfactory condition for planting.

Deciduous Material

Spring: March 1st to May 1st (inclusive) except for balled and burlapped material, the planting of which will terminate on May 15th.

Fall: From October 15th until the ground freezes. Such plant items, as may be designated elsewhere in the contract documents, shall be planted in the spring planting season only.

Evergreen Material

Spring: March 1st to June 1st (inclusive).

Fall: August 15th to October 1st (inclusive).

- 2. Protection:** Plants received by the Contractor shall be kept moist, fresh and protected against exposure to sun, wind and freezing temperatures whether in the receiving yard, in transit, while being handled or in temporary storage on the job site awaiting planting. Bare-root plants, which are not planted immediately

upon receipt, shall be heeled-in in trenches with the bundles opened, the plants separated and all roots covered so as to leave no air spaces. Balled and burlapped plants shall have their earth balls covered by earth, wood chips, cloth, straw or other suitable material which shall be kept moist.

3. **Layout:** Plant material locations and bed outlines will be staked on the project site by the Engineer-Designer or their designee in the presence of the Contractor, or a representative, before any plant pits or beds are excavated. Requests by the Contractor for the staking of the plant layout shall be at least 48 hours, excluding weekends and holidays, prior to the date the Contractor wishes to have the layout staked. Labor, equipment and new, smooth stakes of approved quality are to be furnished by the Contractor for this purpose.
4. **Excavation:** Excavation for planting beds and pits shall conform to the approved staked locations and outlines. The latter shall be neatly formed by means of spades or other approved tools. All sod, weeds, roots and other objectionable material excavated from the plant beds or pit sites which are unsuitable for backfill shall be removed from the site immediately and disposed of by the Contractor in a manner satisfactory to the Engineer.

The Contractor at its option may apply, prior to excavating plant pits in designated planting bed locations, at no expense to the Authority, a post-emergent aqueous spray treatment of Glyphosate (isopropylamine salt of glyphosate) 41% acid equivalent (ae) to the existing bed vegetation in accordance with the manufacturer's recommendations for perennial vegetation control, instead of excavating the planting bed.

A minimum of fourteen (14) days post application, or when the perennial species shows the visible effects of the treatment, the Contractor shall mow, at no expense to the Authority, all treated bed areas to a maximum height of 4 inches.

Plant pits may then be excavated, and the excavated soil and vegetative debris shall then be immediately removed from the project site.

In planting bed areas following the excavation of the pits, but before the installation of plant material, the remaining turf grasses and unwanted vegetation shall be sprayed, unless otherwise directed by the Engineer, with Glyphosate at the manufacturer's recommended rate.

5. **Pits:** Size of pits, in earth excavation, shall bear the following relation to the spread of the roots (or the diameter of balls) of the plants to be planted in them:

Pit diameters shall be twice the rootspread up to and including a 2-foot rootspread.

Pit diameters shall be 2 feet greater than that for rootspreads of 2 to 4 feet.

Pit diameters shall be one and one-half times the rootspread diameter for rootspreads of over 4 feet.

The depth of all pits shall be adequate to permit a minimum of 12 inches of soil backfill under all roots or balls. Pits for vines shall be at least 10 inches (in diameter and 10 inches in depth.

Any excavation in excess of that required shall be replaced with planting soil.

6. **Obstructions Below Ground:** Any rock or underground obstruction shall be removed to the depth necessary for planting as specified, unless other locations for the planting are approved by the Engineer.
7. **Preparation of Backfill:** The planting soil shall be delivered to the project site and stockpiled. The peat shall be delivered to the project site in containers conforming to Subarticle M.13.07-13. The planting soil and peat shall be thoroughly mixed on the project site, in the presence of the inspector, at the rate of one part of peat to two parts of planting soil.
8. **Setting Plants:** All plants shall be set plumb and at such a level that after settlement they bear the same relation to the surrounding ground as they bore to the ground from which they were dug. Backfill material for all plants shall be thoroughly and properly settled by firming or tamping. Thorough watering shall accompany backfilling unless otherwise approved. Saucers capable of holding water shall be formed about individual plants (exclusive of plant beds) by placing ridges of planting soil around each, or as directed by the Engineer.

Balled or burlapped plants shall be carefully placed in the prepared pits so that the balls rest on the backfill material. Planting soil and peat backfill shall then be filled in around the plant ball and thoroughly tamped. The remaining burlap around the ball shall then be loosened and spread out away from the plants or cut away and removed. Such roots as may have been wrapped around the ball and contained within the burlap shall be straightened and the remainder of the pit filled with tamped planting soil and peat mixture, making certain that no air pockets remain. The bare roots plants shall be properly spread out in a natural position and planting soil and peat backfill carefully worked in among them. All broken or frayed roots shall be cleanly cut off.

9. **Fertilizing:** Shrub beds shall be fertilized at the rate of 3 pounds per 100 square feet of surface area (broadcast). The fertilizer shall be uniformly applied to the surface of the beds and worked into the upper 2 inches of soil. Individual trees shall be fertilized at the rate of 2 pounds per inch of trunk diameter, and the fertilizer shall be mixed into the upper 2 inches of soil.

A second application of fertilizer shall be applied to all plant items at the same specified rates over the wood-chip mulch at the end of the period of establishment.

10. **Watering:** All plants shall be watered within 48 hours after planting if conditions warrant, and as many times thereafter as ordered by the Engineer. At each watering, the soil around each plant shall be thoroughly saturated. All plants shall be watered at least once a week from April 1st to October 1st, inclusive, or as directed by the Engineer.
11. **Guying and Staking:** Immediately after planting, trees shall be guyed or staked as shown on the planting detail sheet of the plans, or as directed by the Engineer. Guy wires, hose and tree support stakes shall be removed after the initial establishment period.
12. **Wrapping:** Wrapping shall be placed around all trunks of deciduous trees 2 inches or more in caliper or as directed by the Engineer. The wrapping shall start at the base of trees, shall cover the entire trunk surfaces, and shall terminate at the first branches. The wrapping shall be tied at top, bottom, and at intervals of not more than 2 feet. Wrapping shall be done at the time of planting but not before inspection of the plant.
13. **Pruning:** As directed by the Engineer, plants shall be pruned at the project site before or immediately after planting in accordance with the best horticultural practice. No leader shall be cut unless directed by the Engineer. Broken, or badly bruised branches, sucker growth, etc., shall be removed with clean cuts. Cuts over 3/4 inches in diameter shall be painted with tree wound paint.
14. **Spraying:** Spraying with antidesiccant shall be at the Contractor's discretion and as approved by the Engineer at no additional cost to the Authority.
15. **Mulching:** Following the plant material installations woodchip mulch (or gravel mulch when specifically called for on the plans or in the special provisions) shall be hand placed and spread to a depth of 4 inches and raked to an even surface over all saucer areas for individual trees and shrubs and over the entire area of shrub beds and elsewhere as directed.
16. **Repair:** Repair of existing grass areas damaged by the Contractor in the progress of the work shall be the responsibility of the Contractor, who shall restore the disturbed areas to their original condition at no additional expense to the Authority.
17. **Establishment Period:** The acceptability of the plant material furnished and planted shall be determined at the end of a period of establishment during which period the Contractor shall, as necessary, employ all possible means to preserve

the plants in a healthy and vigorously growing condition to insure their successful establishment.

During this period, the Contractor shall water, cultivate, prune the plants, and repair, replace or readjust guy wires, stakes, posts and flagging, as may be required or as ordered by the Engineer. The Contractor shall reshape plant saucers, repair washouts and gullies, replace lost wood-chip mulch, keep all planting sites free from weeds, and do other work necessary to maintain the plants in a healthy growing condition. This shall include seasonal spraying with approved insecticides or fungicides as may be required.

All dead or rejected plants shall be promptly removed from the project during the period of establishment, and shall be replaced by the Contractor in kind, quantity and size with live, healthy specimens planted during the stipulated planting season.

The establishment period does not begin until all plant materials stipulated in the contract have been planted. When the plant establishment period begins at the end of the spring planting season, an inspection to determine the acceptability of plant establishment will be held by the Contractor and the Engineer no later than November 1st in the same year. When the plant establishment period begins at the end of the fall planting season, an inspection to determine the acceptability of plant establishment will be held by the Contractor and the Engineer by August 1st of the following year. During the plant establishment inspection, an inventory of losses and rejected materials will be made and corrective and necessary clean up measures will be determined.

Replaced plant material shall be subject to all the requirements specified for the original material.

MEASUREMENT:

1. **Planting:** The quantity for which payment will be made will be the number of each size and kind of plants counted in place, planted and accepted.
2. **Mulching:** This work will be measured for payment by the number of square yards surface measurement of the specified thickness for the area on which woodchip mulch (or gravel mulch) has been completed and accepted.

PAYMENT:

1. **Planting:** Payment for this work will be made at the contract unit price each for the kind and size of plant and method of planting, as the case may be, completed and accepted in place, except that when approved, partial payment for work satisfactorily performed in the excavation of plant pits and for furnishing and

placing planting soil and peat humus admixture may be made in amounts not to exceed 20% of the unit bid price for the respective plant.

2. **Mulching:** This work will be paid for at the contract unit price per square yard for wood chip mulch (or gravel mulch) complete in place.
3. **The unit prices** shall include all materials, equipment, tools, labor, transportation, operations and all work incidental thereto, including the removal of guy wires, hose and tree support stakes after the initial establishment period.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
949.01	Planting – Major Deciduous Trees	Each
949.02	Planting – Minor Deciduous Trees	Each
949.03	Planting – Evergreen Trees	Each
949.04	Planting – Deciduous Shrubs	Each
949.05	Planting – Evergreen Shrubs	Each
949.06	Planting – Vine and Ground Covers	Each
949.07	Wood Chip Mulch	Square Yard
949.08	Gravel Mulch	Square Yard
949.09	Spraying Glyphosate	Square Yard

ITEM 953 SODDING

DESCRIPTION:

Work under this item shall consist of furnishing and placing of live sod and also the furnishing and preparing of sodbed composed of four (4) inches, after tamping, of approved topsoil in the areas designated on the plans or where directed by the Engineer and in conformance with these specifications.

MATERIALS:

The material for this work shall conform to the requirements of Article M.13.01 for Topsoil, Article M.13.02 for Agricultural Ground Dolomitic Limestone, Article M.13.03 for Fertilizer, and Article M.13.08 for Sod. Stakes for pegging sod shall be of wood, approximately 1" x 2" and of sufficient length to penetrate the sod, the topsoil and to a minimum depth of two inches of subsoil.

CONSTRUCTION DETAILS:

Season: The work may be performed at any season of the year unless otherwise specified. The Contractor shall notify the Engineer at least 48 hours in advance of the start of the sodding installation and shall not proceed with such work until permission to do so has been granted. No frozen sod shall be placed. No sodding shall be done on frozen earth. When sodding is to be accomplished on the same general area where seeding is to be done under the same contract, the sodding work shall be carried out before the seed is sown.

Procuring Sod: Care shall be exercised at all times to retain the native soil on the roots of the sod during the process of transplanting. Dumping from vehicles will not be permitted. The sod shall be planted within twenty-four hours from the time it is harvested unless it is tightly rolled or stored roots-to-roots in a satisfactory manner. All sod in stacks shall be kept moist and shall be protected from exposure to the sun and from freezing. No storage longer than five days will be permitted. Sod which becomes dried out or does not meet the specifications will be rejected.

Ground Preparation: There shall be a minimum of four inches, after tamping, of topsoil under all sod unless otherwise specified. Excavations or trenches shall be made to a sufficient depth below the finished grade of the sod to accommodate the depth of topsoil as specified and the thickness of sod as specified. Fertilizer shall be applied at a rate to provide 100 pounds of nitrogen per acre unless fertilizer has been applied under another item in this contract to the topsoil in the sod bed. Lime, although not required in sodbed preparation, will be permitted in the sodbed if applied in a previous operation. Fertilizer applied under this item shall be incorporated with the topsoil to a depth of at least two inches before the sod is laid, unless otherwise specified or approved. Incorporation shall be accomplished by disking, harrowing, drilling, raking or other approved means.

Planting Sod: The soil on which the sod is laid shall be reasonably moist and shall be watered, if so directed. The sod shall be laid smoothly, edge to edge, and all opening shall be plugged with sod. In drainage-ways and where continuous or solid sodding is called for on the plans, the sod shall be laid with their longest dimensions parallel to the contours. Such sodding shall be begun at the base of slopes or grades and the sodding progress in continuous parallel rows working upward. Vertical joints between such sod shall be staggered. All sod shall be laid to the grades specified and the grades formed with special care at the junction of drainage-ways. Immediately after the sod is laid, it shall be pressed firmly into contact with the sodbed by tamping, rolling, or by other approved methods so as to eliminate all air pockets, provide true and even surfaces, insure knitting and protect all exposed sod edges but without displacement of the sod or deformation of the surface of the sodded areas and watered at the rate of 5 gallons per square yard of sodded area unless otherwise directed.

Pegging: Sod shall be held in place by stakes in all drainage-ways, on all slopes steeper than 4:1 and elsewhere where specified or as directed. Pegging shall be done immediately after tamping. At least one stake shall be driven through each sod to be staked, and the stakes shall be not more than two feet apart. Stakes shall have their flat sides against the slope and be driven flush.

Finishing: Excess sod or excess soil resulting from excavations or trenching shall be disposed of as approved. Excess soil shall not be left to form a ridge adjacent to the sodded area or sodded strips. No payment will be made for rejected or excess sod which is not laid.

Care During Construction: The Contractor shall care for the sodded areas until all work on the entire contract has been completed and accepted. Such care shall consist of providing protection against traffic by approved warning signs or barricades, and the mowing of grass to the height of two inches when the growth attains a maximum height of four inches.

Sod shall also be watered if so required by the Engineer. When watered, sufficient water shall be applied to wet the sod at least two inches deep in the sodbed. Watering shall be done in a manner which will not cause erosion nor other damage to the finished surfaces. Any surfaces which become gullied or otherwise damaged shall be repaired to re-establish the grade and conditions of the soil prior to sodding and shall then be re-fertilized and re-sodded as specified under this item.

MEASUREMENT:

This work will be measured for payment by the number of square yards of surface area acceptably sodded.

PAYMENT:

This work will be paid for at the contract unit price per square yard for "Sodding", which payment shall constitute full compensation for furnishing all labor, materials, including topsoil placed under the sod, equipment and incidentals necessary to complete and care for the work as specified, including water and its application.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
953	Sodding	Square Yard

ITEM 969 ENGINEER'S FIELD OFFICE

DESCRIPTION:

This work shall consist of providing, furnishing and maintaining an Engineer's Field Office for the exclusive use of and occupancy by the Authority and Consultant field engineers. It shall be the responsibility of the Contractor to install and maintain the Engineer's Office in compliance with all applicable building, safety, and health regulations and/or laws. The Contractor shall maintain all facilities and furnished equipment in good working condition. The office shall be cleaned weekly, or as required by the Engineer. The Contractor shall provide and pay for all utility charges to include but not limited to water, sewer, electric, telephone, and high speed internet access.

Engineer's Office (Type A, B, or C). The Contractor shall supply for the Engineer's use a building or mobile trailer, (specified at Type A, B, or C), which shall be erected at a location selected by the Engineer and shall be separate from any building used by the Contractor.

Furnishing Existing Facilities and Buildings. The Contractor may furnish equivalent facilities in existing buildings provided such facilities and building(s) are located to provide convenient service and provided that the building location(s) and facilities are approved by the Authority in writing.

Concrete Cylinder Curing Box. This work shall consist of furnishing, prior to placement of any structural concrete, an approved concrete cylinder curing box.

MATERIALS:

General Construction

Each Engineer's Office shall be an approved and weatherproof building or mobile trailer of the type specified in the contract documents. The structure shall have a minimum ceiling height of 7 feet and shall be provided with weatherproof windows and weatherproof doors each equipped with adequate locking devices. Each window shall have a minimum area of 8 square feet, shall be screened and of a type that will open and close to provide adequate ventilation.

1. General Requirements for all Engineers' Offices

Lighting - Electric light, non-glare type luminaires to provide a minimum illumination level of 95 foot candles at desk height level.

Heating and Cooling - Adequate equipment to maintain an ambient air temperature of 70°F plus or minus 3°.

Digital Camera - Canon PowerShot 5.0 Megapixel Digital ELPH Camera, Model SD 450 or equivalents. A soft storage/carry case shall be provided. The camera functions shall include the following:

- Shooting modes include auto, manual, portrait and special scene
- Through the lens continuous/single auto focus with program AE; evaluative, center-weighted and spot metering.
- Continuous shooting mode captures up to 2.1 fps.
- Auto, preset and custom white balance controls
- Built-in auto flash with on/off and red-eye reduction on/off and slow syncho flash modes.
- Movie mode with Fast Frame Rate Movie records 320 X 240 video clips at 60 fps or 640 X 480 video clips at 30 fps.
- Secure Digital / Multi-Media Card memory slot (16MB Secure Digital card included).
- Playback modes include single, magnification, jump, 9-image index, slideshow and sound memos for still images and normal playback, special playback and editing for movies.
- USB 2.0 interface and A/V outputs
- 1 Year Warranty (Parts and Labor)
- Image Resolution Up to 2592 X 1944
- Optical Zoom 3x
- Digital Zoom 4x
- LCD Screen Size 2.5"
- JPEG, Motion JPEG, AVI and WAVE file formats
- 2 rechargeable lithium NB-4L batteries
- Accessories Wrist strap, battery charger CB-2LV, lithium-ion battery packs NB-4L, 16 MB Secure Digital Card, software CD-ROM, interface cable and A/V cable.

Telephone - A separate phone for the exclusive use of Authority and Consultant personnel. The phone shall have modular jacks at the wall and phone and be adaptable to electronic communications. An extension telephone, of a type and location as required by the Engineer, with a minimum 20 foot cord shall also be provided. The number of telephones, each with an extension, to be provided is specified for each type of office.

Internet Access – High speed cable or DSL internet access for the exclusive use of Authority and Consultant personnel.

Telephone Answering Device - A FCC approved automatic answering device capable of recording outgoing messages of 60 seconds long and receiving a minimum of 40 incoming messages 30 of 60 seconds duration. The unit shall include a message mark so you can hear new messages without erasing old messages. The unit shall include remote programming of playback, backspace,

and out-going message re-record. The unit shall include computer generated voice marking of time and day of each message received. The unit shall allow for the retrieval of messages without a remote beeper unit or shall include a number of remote control units as ordered by the Engineer.

Potable Water - From a local municipal water line and/or bottled water with refrigerator unit - hot/cold water.

Adding Machine - Tape type registering to at least ten digits, four function. The number of adding machines to be provided is specified for each type of office.

First Aid Kit - The Contractor shall keep the kit properly stocked with appropriate first aid supplies at all times.

Toilet - A separately enclosed room, properly ventilated and complying with applicable sanitary codes. The Contractor shall provide all lavatory amenities, necessary paper and soap products, hot and cold running water and a flush-type toilet. Any other toilet will not be acceptable unless as ordered by the Engineer.

Locker - A metal or wood locker, with lock, of sufficient size for storage of surveying instruments and testing equipment.

Refrigerator - A standard electric cold storage type providing a minimum storage space of approximately 3 cubic feet.

Fire Extinguisher - Non-toxic dry chemical, fire extinguisher meeting Underwriters Laboratories, Inc., approval for Class A, Class B and Class C fires with a minimum rating of 2A: 10B: 10C. 1 per room.

Fire Resistant Cabinet - Fire resistant, 4 drawer, legal size file cabinet with lock and 2 keys, meeting the requirements for "Insulating Filing Devices, Class 350-1 Hour (D)" of ANSI/UL 72 or the Class D rating of the original Underwriters Laboratories specification for insulated filing devices. The number of cabinets to be provided is specified for each type of office.

Thermometer - A minimum - maximum Fahrenheit thermometer.

Multifunction Color Printer, Copier, Scanner, Fax: Photocopying Machine - Hewlett-Packard Officejet Network-Ready Color Printer/Copier/Scanner/Fax Model 7410 or equivalent. The multifunction printer shall include the following:

- 4 in 1 functionality – prints, copies, scans and faxes – all in color
- High print resolution up to 1200 X 1200 dpi in black, 4800 X 1200 optimized dpi in color.

- Built-in 10/Base-T Ethernet networking interface and wireless LAN enable multiuser sharing.
- Scan resolution up to 2400 X 4800 dpi; 48 bit color, 256 grayscale levels.
- High speed fax with 33.6 Kbps modem, 110 speed dials and up to 150 page fax memory; PC faxing (send only).
- Flatbed design to fax, scan or copy books and magazines; scan legal size documents and 3D objects.
- 250 sheet paper tray for a 400 sheet total capacity; auto 2-sided print, copy, scan and fax capabilities; 50 page auto document feeder
- Photo and imaging software
- USB interface; PC compatible.
- 1 Year Warranty (Parts and Labor)
- Automatic Document Feeder
- 110 Speed dials

Signs - The Contractor shall furnish and install necessary signs to locate and identify the Project Engineer's Office. The sign shall be installed at the location or locations directed by the Engineer. If erected at a location where the sign might be struck by passing traffic, as determined by the Engineer, the sign support shall be a breakaway type. Payment for the sign and its supports shall be included in the price for the Engineer's Office.

Tack Board - Cork Tack Boards (24" x 36") mounted on a wall of each room.

Bookcase - A self-standing 3 shelf metal bookcase. 1 per room. (Approximate size 4 foot high, 4 foot wide, 1 foot deep).

Waste Paper Baskets - Constructed of metal. 1 per room.

Parking Area - The Contractor shall provide/furnish a paved or hard surfaced (processed aggregate material) parking area adjacent to the building where the Engineer's Office is located. The number of spaces to be provided is specified for each type of office. Each space shall measure 9 feet by 20 feet.

Mailbox - Standard mailbox (with post if necessary) or post office box shall be provided.

Coat Rack - A metal or wooden coat rack capable of holding at least 4 coats, 1 per room.

2. **Specific Requirements for all Engineer's Offices (Type A, B, and C).**

A. **Engineer's Office Type A.** In addition to the general requirements, Type A shall provide a minimum of 200 square feet of floor space with one outside door and four windows. The office shall be partitioned to provide two rooms with an adjoining door. The smaller room shall not be less than 65 square

feet in floor area and shall contain at least one of the four windows. The furnishings shall be as indicated in Table 1, Specific Requirements for Offices.

B. **Engineer's Office Type B.** In addition to the general requirements, Type B office shall provide a minimum 325 square feet of floor space with two outside doors and six windows. The office shall be partitioned to provide two rooms with an adjoining door. The smaller room shall be not less than 100 square feet in floor area and shall contain two of the six windows. The furnishings shall be as indicated in Table 1, Specific Requirements for Offices.

C. **Engineer's Office Type C.** In addition to the general requirements, Type C office shall provide a minimum 450 square feet of floor space with two outside doors and six windows. The office shall be partitioned to provide three rooms with adjoining doors. The smaller rooms shall be not less than 100 square feet in floor area and shall contain two of the six windows. The furnishings shall be as indicated in Table 1, Specific Requirements for Offices.

Table 1 Specific Requirements for Offices

Office Type	A	B	C
Office Desks not less than 30" X 60" Each with Draws and Locks	1	3	4
Office Chairs	4	6	8
Fire Resistant Cabinet, 4 Drawer as specified	1	2	3
Drafting-type Tables, approximately 36" X 72" And supported by brackets and legs	1	2	2
Drafting Stools	2	4	4
Vertical filing plan rack for 6 sets of plans each	1	0	0
Vertical filing plan rack for 12 sets of plans each	0	1	1
Roll File Unit with 12 (12) 6" X 6" compartments	0	1	1
Office table, not less than 30" X 72" each	1	1	2
Metal storage cabinet with four adjustable shelves, Tumbler lock with two keys, approximate 72" high, 36" wide, 18" deep	0	1	1
Adding machine as specified	1	1	2
Telephone lines with extensions as specified	1	1	2
Parking lot spaces as specified	5	5	6

3. Concrete Cylinder Curing Box

The Concrete Cylinder Curing Box shall be constructed of non-corroding materials. A moisture proof seal shall be provided between the lid and body of the box. Provisions for automatic control of water temperature to 72° F plus or minus 3° F shall be made when the box is located in an uncontrolled environment. A bimetallic thermometer shall be installed with its sensing element in the storage water. The thermometer shall be capable of being read from the outside without opening the box. The thermometer shall have a minimum of 1° F and shall be protected from damage. Electric utility connections shall be made in a lockable switch box securely attached to the outside of the curing box.

A rustproof wire or metal rack shall be set above the bottom of the box to support cylinders in an upright position. This rack and all temperature control elements shall be positioned to allow free circulation of water around the cylinders. A combination hose connection and drain shall be provided at the lower front edge of the box so that it may be drained or water may be circulated. A drain shall also be provided on the box in such a position that when open will drain water to within 1" over the top of the cylinders. All areas of the box shall be easily drained and accessible for cleaning.

The concrete cylinder curing box shall be capable of maintaining the required water temperature through an ambient air temperature range of – 10° F to + 100° F. The box shall be capable of holding a minimum of 19 6" X 12" cylinders. When filled with water, the box shall not leak.

CONSTRUCTION DETAILS:

General Requirements

The buildings shall be fully equipped and made available for use and occupancy by the Authority personnel as well as comparable personnel employed by a Consultant prior to the start of any contract work. Such use and occupancy shall be made available after the work has been accepted by the Authority as directed in writing by the Authority.

All buildings shall be maintained in good condition and appearance by the Contractor for the designated period after which all portable buildings or trailers, fencing, surfacing and utilities shall be removed from the location, the areas cleaned, loamed and seeded if required and left in a neat and acceptable condition.

The Contractor shall be responsible, until use and occupancy of the Engineer's office building is relinquished by the Authority, for any and all damage, direct or indirect, of whatever nature, occurring to the property of the Authority, property of the Authority's personnel, property of the Authority's Consultant representative, including other employees of the Consultant assigned to this office, which is kept in the Engineer's

Office Building. Non-Authority owned or employee property shall only be those items used by appropriate personnel in the performance of project-related work activities. Such property shall be replaced within 30 days of the reported damages and would include any loss caused by, but not limited to, fire, theft, vandalism or malicious mischief.

The Engineer shall provide the Contractor a detailed list of items, with corresponding dollar values, belonging to the Authority, the Authority's personnel, the Authority's Consultant representative, and the Consultant's employees at least once every three months but not more than once a month. The Contractor shall not be responsible for items kept in the Engineer's office that are not on this list.

Concrete Cylinder Curing Box

The Contractor shall furnish the Engineer a concrete cylinder curing box and two locks with two keys for each lock. The locks shall fit each securing latch of the curing box. This concrete cylinder curing box shall remain exclusively available to the Engineer at the location selected by the Engineer. The Contractor shall relocate to any new location directed by the Engineer, repair or replace, if necessary, paint, clean and otherwise maintain the concrete cylinder curing box for the duration of the contract. The Contractor shall also provide and maintain all necessary utility connections to operate the curing box.

The concrete cylinder curing box will remain the property of the Contractor and shall be removed from the site of the work upon completion of the contract.

MEASUREMENT:

Engineer's Office (Type A, B, and C)

Payment will be made for each month (to the nearest 0.25 month increment), of availability for occupancy by the field engineers during the period of the contract. Payment will begin the first month that the office is fully equipped, serviced as specified, and made available for occupancy. Monthly payments will continue until the date of acceptance of the contract.

When directed in writing by the Authority, payment for each month's occupancy after the date of acceptance will be made as part of the final estimate. Failure of the Contractor to supply all documents required to complete the final estimate may result in a non-payment during this delaying period. This non-payment will be in the form of a charge to the Contractor as further stated in Payment Section of this Specification. Monthly payments may be terminated on a specified date prior to acceptance of the contract by written notification by the Authority that such office will no longer be required on the contract.

No payment will be made for occupancy and services during the periods of contract

extension of time where Engineering Charges are assessed, except that, in such cases, payment for each month's occupancy after the date of acceptance will be made as part of the final estimate when directed in writing by the Authority.

Concrete Cylinder Curing Box

Concrete cylinder curing boxes will be measured by the number of units furnished and installed and actually used in accordance with these specifications.

PAYMENT:

Engineer's Office (Type A, B, and C)

The unit price bid per month shall include the cost of all labor, material, equipment, ground rental and utility charges necessary to complete the work.

No payment will be made under Engineer's Office for each calendar day during which there are deficiencies in compliance with the requirements of any sub-section of this specification. The first calendar day shall commence 24 hours after notice to the Contractor of such a deficiency. This nonpayment shall be deducted from the Contractor's next estimate as a charge to Contractor on the item. The amount of such calendar day non-payment will be determined by dividing the unit price bid per month by 30.

Concrete Cylinder Curing Box

The unit price bid for each box shall include the cost of all labor, material, equipment, ground rental, relocation, repair or replacement, painting, cleaning, maintenance, and utility charges necessary for operation.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
969.01	Engineer's Field Office (Type A)	Month
969.02	Engineer's Field Office (Type B)	Month
969.03	Engineer's Field Office (Type C)	Month
969.04	Concrete Cylinder Curing Box	Each

ITEM 971 MAINTENANCE AND PROTECTION OF TRAFFIC

DESCRIPTION:

The Contractor shall maintain and protect traffic in the project area in accordance with the requirements and regulations of the applicable municipality and these Specifications. Unless otherwise specified, the Contractor must maintain pedestrian and vehicular traffic to permit access to commercial and industrial businesses, residences, and intersecting streets. It shall be the sole responsibility of the Contractor to warn the Local Regulatory Agencies (including but not limited to the Police and Fire Departments) at least 72 hours in advance of changes in traffic patterns due to reduction of pavement widths or closing of streets. The Contractor shall furnish, install, maintain, adjust, and store all signs, suitable barricades, and traffic cones, as necessary to carry out the traffic routing plan and maintain vehicular and pedestrian traffic. All of this work shall meet with the approval of the applicable municipality.

MATERIALS AND METHODS:

1. Access: The Contractor shall arrange its operations to provide access to properties along the street including temporary bridges to driveways, and provide access to fire hydrants, manholes, gate boxes, or other utilities. Whenever any trench obstructs traffic in or to any public way, private driveway, or property entrance, the Contractor shall take such steps as required to maintain necessary traffic and access including temporary bridging if required. The Contractor shall confine its occupancy of public or travel way to the smallest space compatible with the efficient and safe performance of the work.

The Contractor shall observe and obey all local and state laws, ordinances, regulations and permits in relation to the obstruction of streets and highways, keeping passageways open and protecting traffic where there may be danger from blasting or other construction activities.

If the Contractor's operations shall interfere with the removal or sanding of snow or ice by the public authorities or adjoining land owners, in an ordinary manner with regular highway equipment, the Contractor shall be required to perform such services for the public authorities or adjoining owners without charge. If the Contractor fails to do so, it shall reimburse the said authorities or adjoining owners or the Authority for any additional cost to them for doing such work occasioned by conditions arising from the Contractor's operations, occupancy, or trench surfaces, together with any damage to the equipment of said parties by those conditions, or claims of any parties for damage or injury or loss by reason of failure to remove snow or ice or to said icy spots under these conditions.

2. Detours: If a detour is shown on the plans or deemed necessary, a proposed detour plan will be submitted to the Engineer and the applicable municipal agencies.

3. Signs: Properly lighted, adequately sized clear, concise, legible signs shall be furnished as necessary for the safe regulation of traffic.

4. Barricades: Suitable lighted barriers or barricades shall be furnished by the Contractor and put up and maintained at all times during the night or daytime, around all open ditches, trenches, excavations, or other work potentially dangerous to pedestrians and traffic. Barricades shall be placed on all sides and throughout the entire length of all open ditches, trenches, excavations, or other work which must be barred to the general public. Barricades shall be properly painted in order to retain a high degree of visibility to vehicular and pedestrian traffic. Construction barricades shall consist of the following materials:

The frame shall be of polyvinyl chloride pipe conforming to ASTM D 2241 for PVC 1120 or 1220, SDR21 (pressure rating 200 psi); ASTM D3034, SDR 35 or an approved equal. All straight members shall be of white color.

Wyes, tees and elbows for joint connections shall be polyvinyl chloride of suitable size and strength for the purpose intended.

Joints shall not be glued and a 3/16-inch nylon rope (or equivalent) shall be threaded loosely through the pipe to keep sections from flying if hit by a vehicle.

Face panels used as horizontal members shall be constructed of a suitable plastic material, .060-inch high impact styrene, anodized aluminum of no less than .025-inch thickness or a comparable substitute approved by the Engineer.

All hardware shall be in accordance with standard commercial specifications and shall be approved by the Engineer.

Retro-reflective sheeting shall conform to the requirements of Article M.18.09.

Materials Certificates shall be required confirming conformance to the requirements set forth in the plans and specifications for these barricades.

5. Flashers: Barricades shall be lit by flashers in accordance with this paragraph or other lighting methods approved by the Engineer in lieu thereof. Flashers shall be placed along the entire length of the barricades at an interval no greater than 8 feet, center to center.

Flashers shall be power operated, lens directed, enclosed light units which shall provide intermittent light from 70 to 120 flashes per minute, with the period of light emittance occurring not less than 25 percent of each on-off cycle, regardless of temperature. The emitted light shall be yellow in color and the area of light on at least one face of the unit shall not be less than 12 square inches. The discernable light shall be bright enough to

be conspicuously visible during the hours of darkness at a minimum distance of 800 feet from the unit under normal atmospheric conditions.

For units which beam light in one or more directions the foregoing specifications shall apply 10 degrees or more to the side and 5 degrees or more above and below the photometric axis.

Barricade warning lights shall be in accordance with the requirements of the ITE Standard for Flashing and Steady-Burn Barricade Warning Lights and the following table:

	Type A Low Intensity	Type B High Intensity	Type C Steady Burn
Lens Directional Faces	1 or 2	1	1 or 2
Flash Rate per minute	55 to 75	55 to 75	Constant
Flash Duration ¹	10%	8%	Constant
Minimum Effective Intensity ²	4.0 Candelas	35 Candelas	— — —
Minimum Beam Candelas	— — —	— — —	2 Candelas
Hours of Operation	Dusk to dawn	24 hrs. per day	Dusk to dawn

¹ Length of time that instantaneous intensity is equal to or greater than effective intensity.

² These values must be maintained within a solid angle 9° on each side of the vertical axis and 5° above and 5° below the horizontal axis.

6. **Traffic Cones:** Traffic cones shall be constructed of materials to a thickness to withstand impact without damage to cones or to vehicles. The traffic cones shall be of sufficient mass or have bases to which ballast may be added to assure that they will not be blown over or displaced by wind from passing vehicles. Traffic cones used at night shall be reflectorized by utilizing Type VI Retroreflective Sheeting, in accordance with Subarticle M.18.09.01.

7. **Traffic Drums:** Traffic Drums shall be manufactured plastic or rubber devices designed in accordance with the latest edition of the MUTCD. The design of the device will allow for the installation of barricade warning lights. The device shall be stabilized with the use of sandbags or other approved means.

The traffic drum shall have, as a minimum, two 4-inch (100-millimeter) wide retroreflective orange stripes and two 6-inch (150-millimeter)-wide retroreflective white stripes. The stripes shall be placed horizontally and alternated with the orange stripe on top. The alternated stripes should not touch. The sections of the traffic drum not covered with retroreflective sheeting shall be orange.

Either Type III or Type VI Retroreflective Sheeting, in accordance with Subarticle M.18.09.01, shall be used on traffic drums. Only one type sheeting shall be used on a drum and all drums furnished on a construction project shall be manufactured with the same type retroreflective sheeting. Retroreflective sheeting shall conform to the requirements of Article M.18.09.01. For this material, a Materials Certificate shall be required.

8. *Non-Performance*: Should the Contractor or its employees neglect to set out and maintain barricades or lights, as required in these Specifications, the Engineer immediately, and without notice, may furnish, install and maintain barricades or lights. The cost thereof shall be borne by the Contractor and may be deducted from any amount due or to become due to the Contractor under this contract.

The Contractor will be held responsible for any damages that the Authority, Engineer, Governmental units, or their heirs or assigns may have to pay as a consequence of the Contractor's failure to protect the public from injury, and the same may be deducted from any payments that are due or may become due to the Contractor under this contract.

9. *Traffic Men*: The Contractor shall utilize traffic personnel in the project area in accordance with the requirements and regulations of the applicable municipality. The Contractor shall be responsible for providing well-trained, qualified and adequately equipped personnel for the direction of traffic and for the adequate protection of traveling public at such locations and for such time as necessary or as ordered by the Engineer.

The Contractor may select to utilize the services of off-duty Police personnel as traffic men during the course of construction. Regardless of whether off-duty Police personnel or personnel furnished by the Contractor are utilized as traffic men, the Contractor shall be responsible for the adequate maintenance and protection of both vehicular and pedestrian traffic throughout the project site.

If the Contractor utilizes off-duty Police personnel, payment for their services shall be made by the Contractor, the cost for this work shall be included in the lump sum price bid for this Item.

All signs, barricades, flashing lights, traffic personnel, detours, etc. and all else necessary and incidental shall conform to the Manual on Uniform Traffic Control for Streets and Highways as approved and amended.

MEASUREMENT AND PAYMENT:

Monthly payments will be made in proportion to the amount of work done. Said payments will be a proportionate amount of the unit price bid (Lump Sum) for "Maintenance and Protection of Traffic" and shall include all costs for furnishing lighted barricades and traffic protection devices and for labor, equipment and services involved in the erecting, maintaining, adjusting, storing of signs, flashers, lights, barricades, traffic cones, and other devices furnished by the Contractor, as well as the cost of all labor and equipment involved in the maintenance of traffic lanes and detours ordered or included in the approved scheme for maintenance of traffic.

The Contractor will be required under the unit price bid for "Maintenance and Protection of Traffic" to maintain and protect the traffic throughout the entire duration of the Contract. No claim for additional payment due to unusual construction conditions encountered or delay caused by the Contractor or other outside agencies shall be considered.

The Contractor will not be paid separately for repair and maintenance "such as patching, grading, snow removal, etc." or detours; said cost to be included in the unit price bid for "Maintenance and Protection of Traffic."

The Contractor shall include in the unit price bid for "Maintenance and Protection of Traffic" bridging for trenches at all street and driveway crossings in such manner as the Engineer may direct in order that the traffic on intersecting streets may not be blocked, and in order that entrance may be made to properties along the line of work.

No payment will be made under maintenance and Protection of Traffic for each calendar day during which there are deficiencies in compliance with the specification requirements of any subsection of this Item.

The amount of such calendar day non-payment will be determined by dividing the lump sum amount bid for Maintenance and Protection of Traffic by the number of calendar days between the date the Contractor commences work and the date of completion as designated in the proposal, without regard for any extension of time or the amount of Five Hundred Dollars (\$ 500.00) whichever is the greatest amount.

Where major nonconformance with the requirements of this specification is noted by the Engineer, and prompt contractor compliance is deemed unobtainable, all contract work may be stopped by direct order of the Engineer.

If no Item "Maintenance and Protection of Traffic" appears in the Bid Schedule, the cost of this work shall be included in the prices bid for other Items.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
971	Maintenance and Protection Of Traffic	Lump Sum

ITEM 975 MOBILIZATION

DESCRIPTION:

Under this work the Contractor shall set up the necessary general plant, including shops, storage areas, office and sanitary and other facilities as are required by local or state law or regulations.

MATERIALS:

Such material as are required for mobilization and that are not to be a part of the completed contract shall be determined by the Contractor, except that they shall conform to any pertinent local or state law, regulation or code.

CONSTRUCTION DETAILS:

The work required to provide the above facilities and services for mobilization shall be done in a safe and workmanlike manner and shall conform with any pertinent local or state law, regulation or code. Good housekeeping consistent with safety shall be maintained.

MEASUREMENT:

Payment for mobilization will be made on a lump sum basis.

PAYMENT:

The amount bid for mobilization shall not exceed three percent (3%) of the total contract price excluding the bid price for mobilization. Should the bidder exceed the foregoing three percent (3%), the Authority will make the necessary adjustment to determine the total amount bid based on the arithmetically correct proposal.

The amount bid shall include the furnishing and maintaining of services and facilities noted herein under "Description", to the extent and at the time the Contractor deems them necessary for its operations, consistent with the requirements of this work and the respective contract.

The amount bid shall be payable to the Contractor whenever it has completed at least ten percent (10%) of the contracted work. For the purposes of this Item, ten percent (10%) of work shall be considered complete when the total of payments earned, as reflected by estimates of work done, as set forth in **§109-06, Payment of Estimates**, not including the amount bid for this work, shall exceed ten percent (10%) of the total amount of the Contractor's bid for this contract.

Unless otherwise provided for elsewhere, the cost of required insurance and bonds

and/or any initiation of the Contract work may be included in this work.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
975	Mobilization	Lump Sum

ITEM 985 PROJECT SURVEY AND STAKEOUT

DESCRIPTION:

Under this work the Contractor shall do all necessary surveying required to construct all elements of the project as shown on the plans and specified in the proposal and specifications. This shall include but shall not be limited to stakeout, layout, and elevations for the roadway, structures, forms, pile layouts, sanitary and storm sewers, and appurtenances as shown and required consistent with the current practice of the Authority, and shall be performed by competently qualified personnel under the direction of a Land Surveyor, licensed in the State of Connecticut and acceptable to the Engineer. The stakeout survey shall proceed immediately following the award of the contract and shall be expeditiously progressed to completion in a manner and at a rate satisfactory to the Engineer. The Contractor shall keep the Engineer fully informed as to the progress of the stakeout survey.

In addition, under this Item, the Contractor shall furnish a set of record plans by updating a copy of the contract drawings, both "red-line" and digital format, to show "As-Built" conditions in accordance with these specifications and as directed by the Engineer.

MATERIALS:

All instruments, equipment, stakes and any other material necessary to perform the work satisfactorily, shall be provided by the Contractor.

All stakes used shall be of a type approved by the Engineer. It shall be the Contractor's responsibility to maintain these stakes in their proper position and location at all times.

CONSTRUCTION DETAILS:

PROJECT SURVEY AND STAKEOUT

The Contractor shall trim trees, brush and other interfering objects, not inconsistent with the plans, from survey lines in advance of all survey work to permit accurate and unimpeded work by the stakeout survey crews and the Authority's cross-section survey crews.

The location and length shown on the plans for culverts shall be considered to be approximate. The ordered length of culverts will be determined by the Engineer after the Contractor accurately stakes the proposed culvert in the planned location as approved by the Engineer and after appropriate and necessary engineering study

The exact position of all work shall be established from control points, base line transit points or other points of similar nature and/or modified by the Engineer. Any error, apparent discrepancy or absence of data shown or required for accurately

accomplishing the stakeout survey shall be referred to the Engineer for interpretation or furnishing when such is observed or required.

The Contractor shall place two offset stakes or references at each center line station and at such immediate locations as the Engineer may direct. From computations and measurements made by the Contractor, these stakes shall be clearly and legibly marked with the correct centerline station number, offset and cut or fill so as to permit the establishment of the exact center line location and elevation during construction. If markings become faded or blurred for any reason, the markings shall be restored by the Contractor at the request of the Engineer. The Contractor shall locate and place all cut, fill, slope, fine grade or other stakes and points, as the Engineer may direct for the proper progress of the work. All control points shall be properly guarded and flagged for easy identification.

Drainage structures shall be staked out by the Contractor at the locations and elevations shown on the plans or specified by the Engineer.

All required Right-of-Way and easement limits shall be established, staked and referenced by the Contractor concurrent with the Construction stakeout survey. Right-of-Way and easement limits shall be staked by or under the direction of, a Licensed Land Surveyor. The Contractor shall supply proof to the Engineer that such work is being performed by or supervised by a Licensed Land Surveyor

Permanent Survey Marker locations shall be established and referenced by the Contractor

The Contractor shall be responsible for the accuracy of the work and shall maintain all are reference points, stakes, etc. throughout the life of the contract. Damaged or destroyed points, bench marks or stakes, or any reference points made inaccessible by the progress of the construction shall be replaced or transferred by the Contractor. Any of the above points which may be destroyed or damaged shall be transferred by the Contractor before they are damaged or destroyed. All control points shall be referenced by ties to acceptable objects and recorded. Any alterations or revisions in the ties shall be so noted and the information furnished to the Engineer immediately. All stakeout survey work shall be referenced to the center line shown on the Plans. All computations necessary to establish the exact position of the work from control points, shall be made and preserved by the Contractor. All computations, survey notes and other records necessary to accomplish the work shall be neatly made. Such computations, survey notes and other records shall be made available to the Engineer upon request and shall become the property of the Authority and delivered to the Engineer not later than the date of acceptance of the Contract.

The Engineer may check all or any portion of the stakeout survey work or notes made by the Contractor. Any necessary correction to the work shall be made immediately by the Contractor. Such checking by the Engineer shall not relieve the Contractor of any responsibility for the accuracy or completeness of the work.

Prior to the final cross-section survey of the project by the Engineer, the Contractor shall reestablish center line or base line points and stationing as required by the Engineer.

The Contractor will not be required or permitted to take the pre-construction or final cross-sections that are used for payment purposes.

During the progress of the construction work the Contractor will be required to furnish all of the surveying and stakeout incidental to the proper location by line and grade for each phase of the work. For paving and any other operation requiring extreme accuracy, the Contractor will re stake with pins or other acceptable hubs located directly adjacent to the work at a spacing directed by the Engineer.

Any existing stakes, iron pins, survey monuments or other markers defining property lines which may be disturbed during construction, shall be properly tied in to fixed referenced points before being disturbed and accurately reset in their proper position upon completion of the work.

Just prior to completion of the Contract, the Contractor shall re-establish if necessary and re-tie all control points as permanently as possible and to the satisfaction of the Engineer.

AS-BUILT DOCUMENTS

Prior to the commencement of work required under this Item, the contractor shall arrange a meeting to discuss the procedures for preparation of the As-Built documents. The Contractor shall be required to furnish a paper As-built record plan and an Auto-CAD .dwg drawing. Original bid .dwg drawings files will be furnished to the Contractor.

The As-Built record plans indicate all field changes to project plans and location of rock elevations, groundwater levels and soil conditions.

All work, both in the field and in the office, shall be under the direct supervision of a Land Surveyor, licensed in the State of Connecticut. The Land Surveyor shall be required to seal, date and sign each of the As-Built" plans. These "As-Built" drawings must be submitted at the same time as the request for final payment. No final payment will be considered unless accompanied by "As-Built" drawings.

The Contractor will not be required or permitted to take the pre-construction or final cross-sections that are used for payment purposes.

The word Record Plans shall be emblazoned in at least 1" high letters across the top of the first sheet of the contract plans

The contract plans shall contain a blank box located in the lower left-hand corner of the front sheet. The box shall be completed by the Contractor and contain the following

information:

1. Contract Number
2. Contractor's Name
3. Date of Award
4. Completion Date
5. Final Contract Dollar Amount
6. Inspector

The Estimate of Quantities Tables, if one exists, shall be updated for Record Plan purposes. Any additional Items added to the Contract by Orders on Contract shall be shown in the Tables.

All Permanent Survey Markers and Right of Way Markers must be shown on the Plan. They must be labeled and include the station and offset. Permanent Survey markers must also be shown on the sheet showing base line and center-line ties.

Ties to all centerline controls, which are not monumented with a permanent survey marker, must be shown.

The contract drawings have a blank 1" high box provided in the lower right hand corner of each sheet. This box is to be used to record the type of revisions made on that sheet.

Sheets that require no change should be so noted in the lower right hand corner, "No As-Built Revisions".

Any sheet which requires modifications to indicate field changes should be indicated as such by the words "As-Built" written above the Title Box.

The Contractor shall be responsible for the care and preparation of the record drawings during the course of construction.

The original lines or lettering should not be erased when making corrections.

All work on the Record Plans is to be done in red ink. No entries should be made on the backs of the Record Plans.

Line revisions should be made by using lines which stand out clearly. No shading is allowed.

All lettering must be done using 1/8" minimum height letters to provide clarity copying and microfilming.

Revisions to the notes and written matter on the drawings should be made by crossing out the original and inserting the revision as close to the original as is possible without

impairing the legibility. New lettering should be similar in size (1/8" minimum) and spacing to the original lettering so that it will be legible.

When sheets are added to the contract, these sheets should be added to the index in the plans.

All computations, survey notes and other records necessary to accomplish the work shall be neatly made. Such computations, survey notes and other records shall be made available to the Engineer upon request and shall become the property of the Authority and delivered to the Engineer not later than the date of acceptance of the Contract.

The Contractor shall be responsible for obtaining all the necessary field information which is required to be shown on the "As-Built" Documents. Information obtained by the Authority is for its own use and is not intended to substitute for the information required in these specifications.

MEASUREMENT:

Payment will be made at the lump sum price bid for this work.

PAYMENT:

The price bid shall include the cost of furnish all labor, equipment, instruments and other material necessary to satisfactorily complete the project survey and stakeout and the preparation and submission of the as-built documents.

Monthly payments will be made under this work in proportion to the amount of work done as determined by the Engineer.

Included shall be the cost of all field work by the Licensed Land Surveyor, drafting and furnishing the Authority with the necessary information and all else necessary to satisfactorily complete the work in accordance with the specifications.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
985	Project Survey and Stakeout	Lump Sum

ITEM 1111 SAWCUT FOR LOOP VEHICLE DETECTOR

DESCRIPTION:

Under this item, the Contractor shall replace loop vehicle detectors disturbed during the Work as shown on the plans or as directed by the Engineer and in conformity with these specifications.

MATERIALS:

The materials for this work shall conform to the requirements of Article M.16.12.

CONSTRUCTION DETAILS:

Loop detectors installed in new or resurfaced pavements shall have the slots saw cut in the pavement base course and the loop wires placed and sealed before the placing of the pavement wearing course.

No loop detector saw cut shall be placed over a patched trench or existing pavement without the approval of the Engineer. The Contractor shall remove the existing pavement and replace it with new pavement for installation of the loop detectors, at the direction of and within the limits prescribed by the Engineer, where the condition of the existing pavement is not suitable for installation.

The existing pavement shall be removed a minimum of 3 inches in depth. The replaced pavement shall be overlaid as directed. The loop detector shall be installed in the new pavement, under the overlay.

The size of the loop shall be as shown on the plans and shall be made using a power saw having an abrasive or diamond blade 3/8 inch wide. The depth of the slot shall be 1 3/4 inches to 2 inches and shall extend from the loop to the location shown on the plan. The cuts shall overlap at the corners of the loop and at any angles in the saw cut to the controller to ensure full depth. The corners are to be rounded off by drilling a 1 1/4-inch diameter hole to eliminate kinking of the wire. When the cutting has been completed, the slot shall be cleaned of all cutting dust and grit with oil-free compressed air. The slot shall be completely dry before inserting the wire. The entire loop and lead-in shall consist of 1 continuous #14 stranded wire encased in tubing, unless otherwise shown on the plans. The lead-in wires shall be twisted together with at least 5 turns per foot and taped at 2-foot intervals, beginning at a point where the wire leaves the saw cut and enters the plastic conduit to the terminals in the controller cabinet, or when spliced to a 2-conductor lead-in cable. The twisted wire shall remain together and shall not be coiled at any point. Splices will not be permitted at any point of the loop or lead-in unless otherwise indicated on the plans or as directed by the Engineer.

At the time of installing the loop wire, the ends of the tubing shall be sealed to

prevent any entrance of moisture into the tubing. When splices are required in handholes or junction boxes, they shall be made in accordance with the installation details. The saw cuts on all lead-ins shall be as shown on the plans or as directed by the Engineer. The number of turns of wire for each loop shall be as shown on the plans. After installation, the wire shall be checked for slack or raised portions in the saw cut slot. A paint mix stock or similar blunt instrument shall be used to push the wire in the slot. The wire shall be held in the slot with wooden pegs or by inserting wedges formed from 1-inch sections of the plastic tubing, folded before insertion. The loop should be tested prior to sealing the saw cut. An unacceptable loop installation would consist of leakage to ground below 10 megohms or an open circuit. The saw cut shall then be filled with plastic compound to a level of approximately 1/16 inch below the pavement surface. In no case shall the plastic compound overflow the saw cut and all excess material shall be removed. The plastic compound shall be applied in accordance with the manufacturer's recommendations. The plastic compound shall adhere to the sides of the saw cut and not show a separation when pressure is applied by a blunt instrument.

Each pair of lead-in wires in the cabinet shall be tagged and identified to determine phase and geographical location of each loop.

When a 1-part urethane elastomeric compound is used to seal the sawcut the manufacturer's installation procedure shall be followed.

The sawcut, complete and tested with wire installed and retained with plastic wedges, shall be filled with the elastomeric compound from the bottom up. The sawcut shall be filled to 0.125 inch from the surface of the pavement. The elastomeric compound shall not be applied if the pavement surface temperature is less than 40°F or more than 100°F.

MEASUREMENT:

The quantity to be paid for under this item shall be the actual number of linear feet of sawcut, measured along the center of the cut, with #14 Stranded Wire encased in tubing completely installed, tested and accepted in place. #14 Stranded Wire encased in tubing shall not be measured for payment separately but shall be included in the measurement for saw cut.

PAYMENT:

Sawcut for loop detector be paid for at the Contract unit price per linear foot of "Sawcut for Loop Detector," which price shall include; saw cut, #14TW stranded wire (including that to handholes, traffic control foundations or controller cabinets), necessary fittings, flexible plastic tubing, plastic compound, splicing and connecting, equipment, labor, materials and work incidental thereto.

Item Number

Pay Item

Pay Unit

1111

Sawcut for Loop Detector

Linear Foot

ITEM 1208 SIGN FACE - SHEET ALUMINUM

DESCRIPTION:

This item shall consist of furnishing and installing sign face-sheet aluminum signs of the type specified, metal sign posts at locations indicated on the plans or as ordered and in conformance with the plans and these specifications.

MATERIALS:

Reflective sheeting shall conform to the requirements of Article M.18.09.01, Type I, II or III.

Sheet aluminum sign blanks shall conform to the requirements of Article M.18.13.

Silk screening of Type I, Type II or Type III reflective sheeting shall conform to the requirements specified by the reflective sheeting manufacturer.

Metal sign posts and parapet mounted sign supports shall conform to the requirements of Article M.18.14.

Sign mounting bolts shall conform to the requirements of Article M.18.15.

CONSTRUCTION DETAILS:

Placement and dimensions of copy, border and mounting holes shall conform to details of the Department of Transportation for Regulatory Warning and Guide signs which are available for inspection at the Department of Transportation office. Non-reflective copy, border and background shall be applied by the silk-screen process in a manner specified by the reflective sheeting manufacturer. The silk screening of all copy, border and background on Type III reflective sheeting shall be accomplished prior to the application of the reflective sheeting to the finished aluminum sign blank. Type III reflective sheeting shall be of the heat activated adhesive type and shall be applied in a manner specified by the reflective sheeting manufacturer.

Reflective sheeting shall be applied in such a manner that the finished sign will be wrinkle and bubble free. No splices of the reflective sheeting will be permitted on any sign face less than 30 square feet in area with one dimension of 4 feet or less and no more than one splice will be permitted on any one sign without the approval of the Engineer.

Direct application of cutout Type I, Type II or Type III reflective sheeting copy and border shall conform to the requirements specified by the reflective sheeting manufacturer. Cutout copy and border shall be applied directly to clean, dust free reflective sheeting background panels. Borders shall be cut neatly and butt-joined at corners and panel joints. Type I or Type II reflective sheeting used for direct applied

cutout copy and border shall be uniform in brightness and color.

The fabrication of aluminum sign blanks including cutting to size and shape and the punching of mounting holes shall be completed prior to metal degreasing and the application of reflective sheeting. Aluminum sign blanks shall be free of buckles, warp, dents, cockles, burrs and defects resulting from fabrication.

After complete fabrication of the sign as indicated on the plans and in conformance with the requirements contained in the specifications, the sign shall be mounted on the type of support designated on the plans after the support has been satisfactorily installed at its proper location. The reinforcing plate shall be installed as shown on the plans.

Metal sign posts shall be driven or the holes augered and the backfill thoroughly tamped after the posts have been set level and plumb. Parapet-mounted sign supports shall be installed as shown on the plans and shall be level and plumb.

MEASUREMENT:

This work will be measured for payment by the number of square feet of sign face-sheet aluminum of the type specified, installed and accepted.

PAYMENT:

This work will be paid for at the Contract unit price per square foot for "Sign Face-Sheet Aluminum" of the type specified complete in place, which price shall include the completed sign, metal sign post(s), mounting hardware, including reinforcing plates, and all materials, equipment, labor and work incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
1208	Sign Face – Sheet Aluminum (Type)	Square Foot

ITEM 1209 PAINTED PAVEMENT MARKINGS

DESCRIPTION:

This item shall consist of furnishing and installing painted pavement markings, hot applied painted pavement markings and painted legend, arrows and markings, of the type and color specified at the locations indicated on the plans and in conformity with the plans, these specifications, and as directed by the Engineer.

Painted legend, arrows, and markings includes paint installed with a hand striping machine such as: stop bars, crosswalks, parking stalls, lane arrows, legends, markings within gore areas, and painting of paved islands or medians.

Painted pavement markings and hot applied painted pavement markings include paint installed with a truck-mounted painting machine such as center lines, lane lines and shoulder lines.

MATERIALS:

Materials for this work shall conform to the requirements of Article M.07.20 for waterborne pavement marking paint, Article M.07.21 for hot-applied waterborne pavement marking paint and Article M.07.30 for glass beads.

CONSTRUCTION DETAILS:

Pavement areas to be painted shall be dry and sufficiently cleaned of sand and road debris so as to provide an acceptable bond between the paint and the pavement.

Paint shall be applied at a rate of 100 to 115 square feet per gallon, with glass beads applied at a rate of 6 pounds per gallon of paint for painted pavement markings and painted legend, arrows, and markings, and 8 pounds per gallon of paint for hot-applied painted pavement markings.

Hot-applied paint shall be applied at a temperature of 130° F to 145° F at the spray gun.

All painting shall be performed in a neat and workmanlike manner. The lines shall be sharp and clear with no feathered edging or fogging and precautions shall be taken to prevent tracking by tires of the striping equipment. Paint shall be applied parallel to the centerline or as shown on the plans with no unsightly deviations.

After application, the paint shall be protected from crossing vehicles for a time at least equivalent to the drying time of the paint.

MEASUREMENT:

Painted pavement markings and hot-applied pavement markings will be measured for payment by the number of linear feet of paint applied by a truck-mounted painting machine on the pavement and accepted. Painted legend, arrows and markings will be measured for payment by the number of square feet of paint installed with a hand striping machine on the pavement and accepted.

PAYMENT:

This work will be paid for at the Contract unit price per square foot (square meter) for "Painted Legend, Arrows and Markings" and per linear foot (meter) of paint for "Painted Pavement Markings" and "Hot-Applied Painted Pavement Markings," of the width and color specified, installed on the pavement and accepted. This price shall include all pre-marking layout, cleaning off pavement, paint, glass beads, application of paint and glass beads, protection during drying and all materials, equipment, tools and labor incidental thereto.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
1209.1	Painted Pavement Markings (Width) (Color)	Linear Foot
1209.2	Painted Legend, Arrows and Markings	Square Foot
1209.3	Hot-Applied Painted Pavement	Linear Foot

ITEM 1210 EPOXY RESIN PAVEMENT MARKINGS

DESCRIPTION:

This item shall consist of furnishing and installing retro reflective white and yellow epoxy resin pavement markings of the width and color specified and epoxy resin pavement markings, symbols and legends at the locations indicated on the plans and in conformity with the plans, these specifications and as directed by the Engineer.

Epoxy resin pavement markings include epoxy resin installed with a truck-mounted machine such as center lines, lane lines, and shoulder lines.

Epoxy resin pavement markings, symbols and legends include stop bars, crosswalks, parking stalls, lane arrows, legends, and markings within areas such as paved islands, gore areas and paved medians.

MATERIALS:

Materials for this work shall conform to the requirements of Article M.07.22.

CONSTRUCTION DETAILS:

1. Equipment:

Equipment furnished shall include an applicator truck of adequate size and power, together with (a) remote application equipment designed to apply an epoxy resin material in a continuous pattern and (b) portable glass bead applicators, one for each size bead, designed to provide uniform and complete coverage of the epoxy binder by a controlled free-fall method. Pressurized glass bead application shall not be used. Before epoxy color is changed, equipment shall be cleaned out sufficiently to ensure that the color of material applied will be correct.

When working on a street with more than one lane in either direction, the applicator truck (striper) shall have a permanently mounted direction variable illuminated arrow board, fully operational and visible to approaching traffic. There will be no additional payment for the arrow board. Its cost shall be included in the bid price for this item.

For markings applied on pavements over one year old, equipment furnished shall also include a power washing machine capable of cleaning the pavement with a pressure of 2,400 to 2,800 psi with water heated to 180° F - 195° F. No chemicals shall be added to the water used in the process. The power washer shall be equipped with a turbo blast tip with an oscillating head and shall be capable of supplying a minimum of 5 gallons/minute gun.

All guns on the spray carriages shall be in full view of the operator(s) during operation.

Each vehicle furnished shall include at least one experienced operator, who shall be fully knowledgeable about all equipment operations and application techniques.

The Contractor shall also furnish one technical expert, who shall be fully knowledgeable about all equipment operations and application techniques, to oversee the project operation.

2. Procedures:

Pavement markings shall be applied in accordance with the details shown on the plans and the control points established by the Contractor and approved by the Engineer.

The road surface shall be cleaned at the direction of the Engineer just prior to application. Pavement cleaning shall consist of power washing using clean water heated to 180° F - 195° F at a pressure of 2,240 - 2,800 psi. The areas to be power washed shall include all areas where epoxy marking symbols and legends (including stop bars and crosswalks) are to be applied and at least 1 inch beyond the area to be marked. The surface shall be cleaned to the satisfaction of the Engineer. For other pavement areas, cleaning shall consist of brushing with rotary broom (non-metallic), and any additional work as recommended by the material manufacturer and acceptable to the Engineer. New portland cement concrete surfaces shall be cleaned by abrasive blasting to remove any surface treatments and/or laitance. New bituminous concrete surfaces are not to be power washed.

All surfaces that are power washed shall be allowed to dry sufficiently prior to the application of the epoxy markings. The areas to be marked shall be broom cleaned immediately prior to the application of the epoxy markings. Glass beads shall be applied immediately after application of the epoxy resin marking to provide an immediate no-track system.

The Contractor will place necessary "spotting" at appropriate points to provide horizontal control for striping and to determine necessary starting and cutoff points. Broken line intervals will not be marked. Longitudinal joints, pavement edges and existing markings shall serve as horizontal control when so directed.

A tolerance of 0.25 inch under or 0.25 inch over the specified width shall be allowed for striping provided the variation is gradual and does not detract from the general appearance. Alignment deviations from the control guide shall not exceed 2 inches provided the variation is gradual and does not detract from the general appearance. Material shall not be applied over a longitudinal joint.

Establishment of application tolerances shall not relieve the Contractor of the responsibility to comply as closely as practicable with the planned dimensions. Operations shall be conducted only when the road surface temperature is at least 40° F

or as allowed by the Engineer. They shall be discontinued during periods of rain, and shall not continue until the Engineer determines that the pavement surface is dry enough to achieve adhesion.

Glass beads conforming to the requirements of Grading "B" (larger beads) shall be applied at a rate of 12 pounds per gallon of epoxy pavement marking material, immediately followed by a second drop of glass beads conforming to the requirements of Grading "A" (smaller beads) applied at a rate of 13 pounds per gallon of epoxy pavement marking material. Traffic cones or some other acceptable method shall be used to protect the pavement markings until cured.

Time to No-Track: The material shall be in "no-tracking" condition within 15 minutes, or as allowed by the Engineer. The no-tracking time shall be determined by passing over the line with a passenger car or pickup truck in the simulated passing maneuver. A marking showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet shall be considered as showing "no-tracking" and conforming to this requirement for time to no-track.

When stencils are used during the application of epoxy markings, care must be used when removing the stencils so that the epoxy resin does not drip on the road, sidewalk, grass, etc., and so that the applied markings have edges which are clean, straight and neat.

3. Performance and Warranty:

In order to be accepted, the applied markings must meet the following minimum retro-reflectivity reading as measured using an LTL 2000 Retrometer with 30-meter geometry 1 to 2 weeks after installation:

White Epoxy 250 millicandelas per square foot per foot candle.

Yellow Epoxy 175 millicandelas per square foot per foot candle.

WARRANTY:

The Contractor shall warrant for the period and percentage level indicated below that the installation shall remain intact and serviceable. The installed material shall show no fading, lifting, shrinking, tearing, rollback, distortion or chipping due to vehicular traffic or normal maintenance activities including snow plowing. Although some wear is expected, the markings shall not wear out for the period and percentage level indicated below.

First Year

Epoxy Resin Pavement Markings 95% linear feet

Epoxy Resin Pavement Markings, Symbols and Legends 95% square feet

In addition, the epoxy resin pavement markings shall be warranted to retain a minimum retro-reflective value of 150 millicandelas per foot candle per square foot one year after installation. The measurements shall be made utilizing an LTL 2000 Retrometer with 30-meter geometry.

Determination of percentages of serviceability and minimum retro-reflective values will be made jointly at the end of 1 year by the Contractor's representative and by the Engineer. The decision of the Engineer shall be final. The term "percentage of serviceability" shall be defined as follows: The percentage of serviceability of the markings shall apply to the total linear feet for Epoxy Resin Pavement Markings and total square feet for the Epoxy Resin Pavement Markings, Symbols and Legends measured on the project for payment.

The Contractor shall replace, entirely at the Contractor's expense, such amount of markings, if any, required to meet the above stated percentage. The Engineer will indicate the areas and lines to be replaced to meet the above stated percentages. The Contractor shall also replace those markings that fail the minimum value for retro-reflectivity. Replacement under either situation shall include all materials, equipment, labor and work incidental thereto.

The Contractor shall provide to the Authority, at no extra cost, any manufacturer's warranties or guarantees that exceed the minimum requirements stated previously, that are normally provided by the manufacturer.

These written warranties shall be provided when the documentation for the product is provided. These warranties will be retained by the Authority.

4. Crosswalks:

Only glass beads conforming to the requirements of Grading "A" (smaller beads) shall be applied at a rate of 25 pounds per gallon of epoxy pavement marking material.

MEASUREMENT:

Epoxy resin pavement markings shall be measured for payment by the actual number of linear feet of epoxy resin pavement markings installed on the pavement and accepted by the Engineer. Epoxy resin pavement markings, symbols and legends will be measured for payment by the actual number of square feet of epoxy resin pavement markings, symbols and legends installed on the pavement and accepted by the

Engineer.

PAYMENT:

This work shall be paid for at the contract unit price per linear foot for "Epoxy Resin Pavement Markings" of the width and color specified, and/or the contract unit price per square foot for "Epoxy Resin Pavement Markings, Symbols and Legends" installed on the pavement and accepted. This price shall be for all the work required by this section and all materials, equipment, tools and labor incidental thereto. Payment will not be made for pavement markings affected by Contractor error and ordered removed.

<u>Item Number</u>	<u>Pay Item</u>	<u>Pay Unit</u>
1210.01	Epoxy Resin Pavement Markings (Width) (Color)	Linear Foot
1210.02	Epoxy Resin Pavement Markings, Symbols and Legends	Square Foot