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NEW JERSEY STATE HIGHWAY DEPARTMENT

STANDARD SPECIFICATIONS

for

ROAD AND BRIDGE CONSTRUCTION

1961

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NEW JERSEY STATE HIGHWAY
DEPARTMENT

STANDARD SPECIFICATIONS

FOR

ROAD AND BRIDGE CONSTRUCTION

1961

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DIVISION 1

General Provisions

SECTION 1

General Information

1. 1. 1. Headings.

The headings of the articles herein are for convenience of reference only and shall have no bearing on their interpretation.

1. 1. 2. Numbering of Articles.

The articles herein are numbered in 3 parts. The first part denotes the division number; the second, the section number of the division; and the third, the article number of the section.

1. 1. 3. Definitions.

Whenever in the Contract the following terms and abbreviations or pronouns in place of them are used, their intent and meaning shall be interpreted as follows:

ABBREVIATIONS.

A. A. N., American Association of Nurserymen, Inc.
A. A. S. H. O., American Association of State Highway Officials.
A. S. A., American Standards Association.
A. S. N. S., American Standard for Nursery Stock.
A. S. T. M., American Society for Testing Materials.
I. P. C. E. A., Insulated Power Cable Engineers' Association.
N. E. C., National Electric Code.
S. P. N., Standardized Plant Names.

BIDDER, an individual, firm, partnership or corporation, acting directly or through a duly authorized representative, legally submitting a Proposal.

BUREAU OF PUBLIC ROADS, the Department of Commerce, Bureau of Public Roads, Washington, D. C., acting through its representatives on work in which the Federal Government participates.

COMMISSIONER, the State Highway Commissioner of New Jersey, as established by and defined in R. S. 27:1-1.

CONTRACT, the agreement covering the performance of the Project and payments therefor, including Advertisement for Proposal, Proposal, Certification as to Publication and Notice of Advertisement for Proposal, Appointment of Agent by Nonresident Contractors, Noncollusion Affidavit, Warranty Concerning Solicitation of the Contract by Others, Progress Schedule, Resolution of Award of Contract, Executed Form of Contract, Contract Bond, Standard Specifications, Supplementary Specifications, Plans, Change Orders, Supplementary Agreements, and letters or other information giving interpretations or revisions of any of the foregoing documents which are mailed to prospective bidders not less than 3 days prior to the date scheduled for the receipt of bids, all of which are to be treated as one instrument whether or not set forth at length in the form of Contract.

CONTRACTOR, the party of the second part to the Contract, acting directly or through agents or employees, and primarily liable for the acceptable performance of the Project and for the payment of all debts pertaining to the Project.

COUNTY AND MUNICIPAL PROJECTS shall mean projects carried out with County or Municipal Aid from the State, for which the County or Municipality, and not the State, is the contracting party.

DEPARTMENT, the State Highway Department of New Jersey, as established by and defined in R. S. 27:1-1.

ENGINEER, the State Highway Engineer, or his duly authorized representative.

INSPECTOR, the authorized representative of the Engineer assigned to inspection of work and materials.

LABORATORY, the main testing laboratory of the Department located at 999 Parkway Avenue, Trenton.

MATERIALS, all raw or prepared materials and manufactured or fabricated products entering into the finished Project.

PLANS, drawings or reproductions thereof furnished by the Engineer, pertaining to the Project.

PROJECT, the entire work to be performed under the Contract.

PROPOSAL, the prepared form furnished by the Department, properly filled out and executed and submitted as a bid for the performance of the Project.

SOILS FIELD LABORATORY, the field laboratory provided by the Contractor on the site of the Project for the Engineer's use in soil testing.

SPECIFICATIONS, the Standard Specifications, the Supplementary Specifications and all written agreements, made or to be made, pertaining to the method or manner of performing the Project or to the quantities or qualities of materials to be furnished for the Project.

STANDARD SPECIFICATIONS, this document of Standard Specifications.

STATE, State of New Jersey, as represented by the Commissioner.

SUPPLEMENTARY SPECIFICATIONS, additions to or amendments of the Standard Specifications pertaining to the Project.

SURETY, the corporate body which is bound with and for the Contractor, and which contracts responsibility for his acceptable performance of the Project and for his payment of all obligations pertaining thereto.

WORKING DAY, a calendar day, exclusive of Saturdays, Sundays and legal holidays, on which weather and working conditions permit the Contractor to make effective use of not less than 50 per cent of the usual daily man hours during regular working hours.

SECTION 2

Information for Bidders

1. 2. 1. Invitation to Bid.

In accordance with the Advertisement, Proposals will be received for the performance of the Project, the designation of which is stated in the Advertisement. Bids are requested on the items stated in the form of proposal for the Project. The prices bid shall cover all costs of any nature, incident to and growing out of the work. In explanation but not in limitation thereof, these costs shall include the cost of all work, labor, material, equipment, transportation and all else necessary to perform and complete the Project in the manner and within the time required, all incidental expenses in connection therewith, all costs on account of loss by damage or destruction of the Project, and any additional expenses, for unforeseen difficulties encountered, for settlement of damages, and for replacement of defective work and materials. The Bidder shall not attach conditions, limitations or provisos to his Proposal. The attention of bidders is directed to the provisions of Art. 1. 2. 7,

Submitting Proposal, with particular reference to the documents and statements to be submitted with the Proposal, and to the provisions of Art. 1. 2. 9, Causes for Rejection.

The Bidder warrants that, before submitting his Proposal, he became familiar with the Plans, Specifications and other documents that will form parts of the Contract, investigated in detail the site of the Project and the available means of access, and made such examination thereof as necessary to satisfy himself in regard to the character and amount of work involved. He also warrants that he can secure the necessary labor and equipment, and that the materials he proposes to use will conform to the requirements therefor and can be obtained by him in the quantities and at the time required. The cost of providing access to the Project will not be paid for under any specific scheduled item but shall be included in the prices bid for the various items scheduled in the Proposal.

1. 2. 2. Prequalification of Bidders.

Proposals will be received only from Bidders who, prior to the delivery of the Proposal have, as required by statute, submitted under oath statements relating to their financial ability, adequacy of plant and equipment, organization and prior experience and other matters, on forms furnished by the Department; who have been prequalified in accordance with Regulations Covering the Classification of Prospective Bidders issued in accordance with Chapter 35, Title 52 of the Revised Statutes; and who at the time of delivery of Proposals have effective prequalification ratings of not less than the amounts of their respective bids.

1. 2. 3. Plans and Specifications.

The project shall be performed in accordance with the requirements of the Plans and Specifications, subject to modifications as provided in Art. 1. 8. 4. The Plans and Specifications are intended to complement and supplement each other. Any work required by either of them and not by the other shall be performed as if denoted both ways. Should any work be required, which is not denoted in the Specifications or on the Plans because of an obvious omission, but which is nevertheless necessary for the proper performance of the Project, such work shall be performed as fully as if it were described and delineated.

1. 2. 4. Proposal.

Proposals shall be submitted on the form of proposal furnished by the Department properly filled out, and shall be duly executed. The Bidder shall state in the form of proposal the price per unit of measure for each scheduled item of work for which he will agree

to carry out the work, and the Total Price for the performance of the Project, as determined by multiplying each estimated quantity by the price per unit of measure bid therefor and adding together the resulting amounts. For the purpose of comparison of bids received, the Total Price stated in the Proposal will be considered to be the amount bid for the Project and award will be made on that Total Price. When award is made as provided in Art. 1. 3. 1, and the Total Price is found to have been incorrectly computed, changes will be made in any or all unit prices so as to attain conformity with the Total Price before the Contract is executed.

When the Proposal is made by an individual, his post office address shall be stated, and he shall sign the Proposal; when made by a firm or partnership, its name and post office address shall be stated, and the Proposal shall be signed by one or more of the partners; when made by a corporation, its name and principal post office address shall be stated, and the Proposal shall be signed by an authorized official of the corporation, with corporate seal affixed and signatures notarized in all cases. Before award is made to a Bidder not a resident of the State of New Jersey, such Bidder shall appoint, on the form therefor attached to the form of proposal, a proper agent in the State of New Jersey on whom service can be made in event of litigation.

1. 2. 5. Estimate of Quantities.

The estimated quantities of the several scheduled items of work involved in the performance of the Project and stated in the form of proposal are approximate. The actual quantities may be greater or less. Payment will be made only for the actual quantity of authorized work done under each scheduled item.

1. 2. 6. Proposal Guaranties.

The Proposal when submitted shall be accompanied by two Proposal Guaranties as follows: (1) a certified check, made payable to the State Treasurer of New Jersey in the sum of not less than 10 per cent of the amount of the Proposal, except that the amount of the check needs not exceed $20,000 and shall be not less than $500; and (2) a Proposal Bond satisfactory to the Commissioner, on the form to be furnished by the Department and attached to the form of proposal, for a sum of not less than 50 per cent of the Total Price bid for the Project.

1. 2. 7. Submitting Proposal.

The Proposal shall be enclosed in a sealed envelope, furnished by the Department for this purpose, and shall bear on the outside the name and address of the Bidder as well as the designation of the Project as named in the form of proposal. Proposals will be

received at the place and time stated in the Advertisement. Enclosed in the sealed envelope with the Proposal shall be submitted the following documents: (a) the two Proposal Guaranties, as described in Art. 1.2.6; (b) a Financial Statement on form A (PQ)-88 (Part 1 of the Prequalification Questionnaire) furnished by the Department, as submitted for prequalification but revised to show conditions at the time of bidding; (c) a Plan and Equipment Statement on form A (PQ)-88 (Part 3 of the Prequalification Questionnaire) furnished by the Department outlining the Bidder's plan of construction and enumerating the plant and equipment that is owned or definitely controlled by the Bidder and available for the Project; (d) a Noncollusion Affidavit on form # DC-4 executed in duplicate; and (e) a Warranty Concerning Solicitation of the Contract by Others as specified in Art. 1. 6. 3.

When the Bidder submits Proposals for two or more projects, a single prequalification questionnaire, submitted in a separate sealed envelope, will be accepted in lieu of a separate questionnaire for each project, provided that Part 3 is filled out to show separately the plan of operations the Bidder proposes to use and the plant and equipment owned or controlled by him that will be available for each project.

When letters and other forms of notice, giving revisions and interpretations of the Plans, Specifications, Proposal and other contract documents, are mailed or otherwise sent to prospective bidders not less than 3 days prior to the date scheduled for the receipt of bids, acknowledgment thereof must be made by the Bidder, if an individual, by an officer of the company, or a partner. The acknowledgment shall be sent to the Secretary of the Department and must be received by him before the Proposal of the Bidder concerned is opened.

The required Noncollusion Affidavit, properly signed and sworn to, shall be submitted on form # DC-4 attached to the form of proposal.

On Federal Aid projects, false statements made in the noncollusion affidavits pertaining to matters mentioned therein are in violation of the Federal Aid Highway Act of 1954 and are subject to a penalty of 5 years imprisonment, or a fine of $10,000, or both, as provided in Section 18 of that Act.

On Nonfederal Aid projects, false statements made in the noncollusion affidavits pertaining to matters mentioned therein are in violation of New Jersey Revised Statutes 2A:131-4 and are subject to a penalty of not more than 3 years imprisonment, or a fine of $1,000, or both, as provided in the New Jersey Revised Statutes Annotated 2A:85-7.

The Warranty Concerning Solicitation of the Contract by Others, required by Chapter 34, Title 52, Revised Statutes, as cited in Art. 1.6.3 herein, shall be signed and submitted, in

duplicate, by the Contractor on the form therefor attached to the form of proposal.

1. 2. 8. Withdrawing Proposal.

A Proposal, after having been submitted, may be withdrawn by the Bidder on a given project prior to the opening of any bid on that project upon immediate execution by him of the appropriate withdrawal form to be furnished by the Department.

1. 2. 9. Causes for Rejection.

Proposals from bidders not qualified to bid according to the provisions of Art. 1. 2. 2 will be rejected as required by law. Proposals that are not accompanied by the two Proposal Guaranties as specified in Art. 1. 2. 6 and 1. 2. 7 and by a Financial Statement, a Plan and Equipment Statement and a Noncollusion Affidavit as specified in Art. 1. 2. 7, will be rejected. In addition, Proposals may be rejected (a) if not accompanied by the Warranty Concerning Solicitation of the Contract by Others, as specified in Art. 1. 2. 7 and 1. 6. 3, (b) if acknowledgments of letters and other notices to prospective bidders, giving revisions of or amendments to contract documents, have not been received as prescribed in Art. 1. 2. 7, (c) if conditions, limitations or provisos are attached by a bidder to his Proposal, if Proposals are otherwise irregular, or if the enclosed or accompanying documents are not completed and properly executed, (d) if the prices are obviously unbalanced, (e) if received from bidders who have performed work previously for the State in an unsatisfactory manner, and (f) if the Commissioner, in his sole discretion, deem it advisable to do so in the interest of the State.

1. 2. 10. Laws and other Requirements.

Attention is called to Art. 1. 6. 3, 1. 6. 4 and 1. 6. 5, relating to Observance of Laws, Federal Aid, and Permits and Licenses and to Art. 1. 4. 7, 1. 4. 8 and 1. 4. 9, relating to Materials, Superintendence and Workmen, and Equipment.

1. 2. 11. Familiarity with Work.

It is the obligation of the Bidder to ascertain for himself all the facts concerning conditions to be found at the location of the Project including all physical characteristics above, on and below the surface of the ground, to fully examine the Plans and read the Specifications, to consider fully these and all other matters which can in any way affect the work under the Contract and to make the necessary investigations relating thereto, and he agrees to this obligation in the signing of the Contract. The State assumes no responsibility whatsoever with respect to ascertaining

for the Contractor such facts concerning physical characteristics at the site of the Project. The Contractor agrees that he will make no claim for additional payment or extension of time for completion of the work or any other concession because of any misinterpretation or misunderstanding of the Contract, on his part, or of any failure to fully acquaint himself with all conditions relating to the work.

Before submitting his Proposal, the Bidder shall ascertain from the Director, Division of Right of Way Acquisition and Titles, the status of right-of-way acquisition, of the availability and vacation of buildings which are to be removed or demolished by the Contractor, and of the vacation and removal or demolition of buildings on the site of the Project by other parties, and he shall ascertain the provisions of agreements between the State and property owners that may relate to his bid or to the work to be performed. The Contractor shall also confer with the said Director on the above mentioned matters immediately after award of the Contract and at such other times thereafter as may be necessary or advisable. The Contractor shall be governed by the provisions of the above mentioned right of way agreements.

1. 2. 12. Subsurface Conditions.

It is the obligation of the Bidder to make his own investigations of subsurface conditions prior to submitting his Proposal. Borings, test excavations and other subsurface investigations, if any, made by the Engineer prior to the construction of the Project, the records of which may be available to bidders, are made for use as a guide for design. Said borings, test excavations and other subsurface investigations are not warranted to show the actual subsurface conditions. The Contractor agrees that he will make no claims against the State, if in carrying out the Project he finds that the actual conditions encountered do not conform to those indicated by said borings, test excavations and other subsurface investigations.

Any estimate or estimates of quantities shown on the Plans or in the form of proposal, based on said borings, test excavations and other subsurface investigations, are in no way warranted to indicate the true quantities. The Contractor agrees that he will make no claims against the State, if the actual quantity or quantities do not conform to the estimated quantity or quantities, except in acordance with the provisions of Art. 1. 8. 4.

SECTION 3

Contract and Subcontract Procedure

1. 3. 1. Award of Contract.

Award, if made, will be to the lowest responsible Bidder whose Proposal conforms in all respects to the requirements stated herein. The award shall not be binding upon the State until the Contract has been executed by the Commissioner, nor shall any work be performed on account of the proposed contract until the Contract has been duly executed and delivered.

1. 3. 2. Progress Schedule.

Within 10 days of the date of award of the Contract, the Contractor shall furnish a progress schedule, satisfactory to the Engineer, showing the times he intends to commence and complete the various work stages and operations and the principal items of work included in the Project, and the quantity and kinds of equipment and character of labor force which he intends to use therefor.

1. 3. 3. Return of Proposal Guaranties.

The Proposal Guaranties of all but the lowest and next lowest Bidders on each project will be returned the day of receipt of bids. The Proposal Guaranties of the lowest and next lowest Bidders on each project will be returned when the Contract and Contract Bond have been executed and delivered in accordance with the provisions of Art. 1. 3. 5 or, if not executed, when other disposition of the matter shall have been made by the Commissioner except, however, when the award of contract shall have been annulled, due to failure of the Bidder to whom award shall have been made to execute and deliver the Contract and Surety Corporation Bond, the certified check of such bidder shall be forfeited and his proposal bond shall become operative, as provided in Art. 1. 3. 6.

1. 3. 4. Contract Bond.

Within ten days of the date of award of the Contract, the Bidder to whom the Contract has been awarded shall furnish and deliver a Surety Corporation Bond, satisfactory to the Commissioner, in the following form:

"KNOW ALL MEN BY THESE PRESENTS,
that we, the undersigned .....

as principal, and .....
a corporation organized and existing under the laws of the State of .....
and duly authorized to do business in the State of New Jersey, as Surety, are held and firmly bound unto the State of New Jersey in the penal sum of .....
..... dollars, for the payment of which well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.
Signed this ..... day of .....
A. D. nineteen hundred and .....

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that whereas the above named principal did on the ..... day of ..... 19..... enter into a contract with the State Highway Commissioner of the State of New Jersey, which said contract is made a part of this the bond the same as though set forth herein;

Now, if the said ..... shall well and faithfully do and perform the things agreed by ..... to be done and performed according to the terms of said contract, or any changes or modifications therein made as therein provided, and shall pay all lawful claims of subcontractors, materialmen, laborers, persons, firms or corporations, for labor performed or materials, provisions, provender or other supplies, or teams, fuels, oils, implements or machinery furnished, used or consumed in the carrying forward, performing or completing of said contract; we agreeing and assenting that this undertaking shall be for the benefit of any subcontractor, materialman, laborer, person, firm or corporation having a just claim, as well as for the obligee herein; and shall indemnify and save harmless the party of the first part mentioned in the contract aforesaid, its officers, agents and servants, and each and every one of them against and from all suits and costs of every kind and description, and from all damages to which the said party of the first part in said contract mentioned, or any of its officers, agents or servants may be put by reason of injury to the person or property of others resulting from the performance of said work, or through the negligence of the said party of the second part to said contract, or through any improper or defective machinery, implements or appliances used by the said party of the sec-

ond part in the aforesaid work, or through any act or omission on the part of the said party of the second part, or his agents, employees or servants; and shall further indemnify and save harmless the party of the first part mentioned in the contract aforesaid, its officers, agents and servants from all suits and actions of any kind or character whatsoever, which may be brought or instituted by any subcontractor, materialman or laborer who has performed work or furnished materials in or about the work required to be done pursuant to the said contract or by, or on account of, any claims or amount recovered for any infringement of patent, trade-mark or copy right; then this obligation shall be void, otherwise the same shall remain in full force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall in no event exceed the penal amount of this obligation as herein stated. The said Surety hereby stipulates and agrees that no modifications, omissions, or additions in or to the terms of the said contract or in or to the Plans or Specifications therefor, shall in anywise affect the obligations of said Surety on its bond."

The bond shall be for a sum of not less than the Total Price bid for the Project and shall be maintained by the Contractor until acceptance of the Project, and in the event of insolvency of the Surety, the Contractor shall forthwith furnish and maintain, as above provided, other Surety satisfactory to the Commissioner.

1. 3. 5. Execution of Contract.

Within ten days of the date of award of the Contract, the Bidder to whom the Contract is awarded shall execute and deliver the necessary documents entering into the Contract with the State, as provided in Sec. 27:7-31 of Revised Statutes. The Contract Bond shall have been furnished, executed and delivered before the Contract will be executed by the Commissioner.

1. 3. 6. Failure to Execute Contract.

Failure upon the part of the Bidder, to whom the Contract has been awarded, to execute and deliver the Contract as provided in Art. 1. 3. 5, and the Surety Corporation Bond as provided in Art. 1. 3. 4, in the manner and within the time provided shall be just cause for annulment of the award and for the exclusion of the Bidder from bidding on subsequent projects for such period as the Commissioner may deem appropriate. It is understood and agreed by said Bidder that if the award is annulled for the above

reasons, the certified check as described in Art. 1. 2. 6, shall become the property of the State, not as a penalty but as liquidated damages, and that the State may proceed to recover under the terms and provisions of the Proposal Bond, at the discretion of the Commissioner.

1. 3. 7. Subletting and Assigning Contract.

The Contractor shall not sell, transfer, assign, hypothecate or otherwise dispose of the Contract to any other party. The Contractor shall perform with his own organization and with the assistance of workmen under his immediate superintendence work amounting to not less than 50 per cent of the Total Price bid for the Project, exclusive of specialty items not commonly found in contracts for similar work or which require highly specialized knowledge, craftsmanship or equipment, not ordinarily available in the organization of contractors performing work of the character embraced in this Contract. Specialty items, if any, shall be as set forth in the Supplementary Specifications. Where the value of the work to be sublet is $25,000 or more, subletting will be permitted only to subcontractors prequalified with the Department.

Application for subletting any part, or parts, of the work shall be made by the Contractor and shall be addressed to the appropriate official, or officials, of the Department having charge of the work to be sublet. The application shall be made in duplicate, on form No. C-224 to be furnished by the Department. When the Contractor proposes to sublet a portion of an item which involves a breakdown of the unit of measurement of that item, he shall submit, on or attached to form C-224, a breakdown of cost showing the value of the portion of the item to be sublet in relation to the value of the whole item, which shall be subject to the approval of the Engineer. The Contractor shall give assurance that, when minimum wage rates are specified, they shall apply to labor performed on all work sublet, assigned or otherwise disposed of in any way.

Subject to the above provisions and to the consent of the Commissioner, work may be sublet. It is understood however, that any consent of the Commissioner for the subletting of any of the work of the Contract in no way relieves the Contractor from his full obligations under the Contract. The consent to sublet any part of the work shall not be construed to be an approval of the said subcontract or of any of its terms, but shall operate only as an approval of the Contractor's request for the making of a subcontract between the Contractor and his chosen subcontractor.

The subcontractor shall look only to the Contractor for the payment of any claims of any nature whatsoever arising out of the said subcontract, and said subcontractor agrees, as a condition of the Commissioner's consent to the making of said subcontract, that he shall make no claim whatsoever against the Commissioner

or his agents or employees for any work performed or thing done by reason of said subcontract, or for any other cause whatsoever that may arise by reason of the relationship created between the Contractor and subcontractor by the subcontract. The Commissioner will not consent to the making of any subcontract unless the proposed subcontractor furnishes a statement to the effect that said subcontractor is acquainted with all the provisions of the Contract and agrees thereto.

SECTION 4

Scope of the Work

1. 4. 1. Work to be Performed.

The work of the Contract comprises the performance and completion of the Project, including the furnishing of all materials, equipment, transportation, labor and all else necessary therefor and incidental thereto, and final cleaning up as provided in Art. 1. 4. 4, the payment of all due obligations as provided in Art. 1. 8. 5, and the replacing of defective work and materials as provided in Art. 1. 8. 7, all in accordance with the Plans and Specifications.

1. 4. 2. Other Contractors.

The right is reserved by the State to do work with its own employees or by other contractors and to permit public utility companies and others to do work during the progress and within the limits of, or adjacent to, the Project, and the Contractor shall conduct his work and cooperate with such utility companies and others so as to cause as little interference as possible with their work, as the Engineer may approve. The Contractor shall allow other Contractors and utility companies and their agents access to their work within the site of the Project. The Contractor shall and hereby does agree, to make no claims against the State for additional payment due to delays or other conditions created by the operations of such other parties. If there be a difference of opinion as to the respective rights of the Contractor and others doing work within the limits of or adjacent to the Project, the Engineer will decide as to the respective rights of the various parties involved in order to secure the completion of the State's work in general harmony and in a satisfactory manner. His decision shall be final and binding on, and shall not be cause for claims by, the Contractor.

The Contractor will not be held responsible for damage to work performed on the Contract or on other contracts within or adjacent to the site of the Project that may be caused by or on account of the work of other contractors or utility companies. The Contractor will be held responsible for any damage done or caused by his

work or forces to the work performed by other contractors or utility companies within or adjacent to the site of the Project and he shall repair or make good any such damage in a manner satisfactory to the Engineer and without cost to the State.

1. 4. 3. Maintenance and Protection of Traffic.

Highway Traffic. When vehicular or pedestrian traffic, or both, is to be maintained over existing highways within the scope of the Project, the Contractor shall plan and carry out his work to provide for the convenient and safe passage of such traffic.

All roadways within the limits of the Project which are reserved for traffic shall be maintained by the Contractor, free from obstructions and in a smooth riding condition at all times.

The Contractor shall provide for the laying of dust as specified in Art. 1. 6. 8.

The Contractor shall erect or place, and maintain in good condition, barricades, warning signs, lights, flares, approved red-flashing electric flasher units, rubber traffic cones, and other warning and danger signals and devices, appropriate and adequate for the specific needs and subject to the Engineer's approval, at working sites, closed roads, intersections, open excavations, locations of material storage, standing equipment and other obstructions, at points where the usable traffic width of the road is reduced, at points where traffic is deflected from its normal courses or lanes, and at other places of danger to vehicular or pedestrian traffic or to completed work.

Wood traffic guides conforming to the design shown on the Plans shall be furnished and erected if and where shown on the Plans or prescribed in the Supplementary Specifications.

Barricades shall be painted with diagonal black and white stripes. They shall be kept lighted from 1 hour before sunset until 1 hour after sunrise, and through all hours of fog, smog, and other adverse atmospheric conditions affording insufficient visibility for the safe operation of traffic. Barricades shall be lighted with red-flashing electric flasher units, or with standard flares, subject to the approval of the Engineer. The lighting units shall be not more than 5 feet apart and each barricade shall have not less than 3 lighting units.

Traffic cones shall be of rubber, of 28 inches over-all height, 2 inches outside diameter at the top and 15 inches outside diameter at the bottom tapering to a 15-inch square base. The top portion of the cones shall be painted red and the body yellow, with latex rubber base paint over primer. The cones shall be painted at the place of manufacture. The cone base shall be black-pigmented rubber, unpainted. The minimum weight of the cones shall be 7½ pounds exclusive of attachments. The cones shall be subject to the

Engineer's approval before and during the time of their use on the Project.

In addition to the warning signs and other traffic maintenance devices specified hereinabove and any other signs he may consider necessary, the Contractor shall provide, erect, maintain, and replace if necessary, the signs hereinafter enumerated, for each direction of traffic, at every location where the usable traffic width of an existing State highway is reduced by reason of the Contractor's operations or equipment, or by material delivery trucks. The signs shall be maintained clean so as to provide maximum visibility at all times.

1 sign bearing the message HIGHWAY CONSTRUCTION AHEAD

2 signs bearing the message SLOW—SINGLE LANE AHEAD

1 sign bearing the message END OF CONSTRUCTION

Signs bearing the message SLOW—NO PASSING shall be located at intervals of 200 feet throughout the areas of reduced usable highway width.

At each location where the usable traffic width of an existing road or street other than a State highway is reduced by reason of the Contractor's operations, equipment, or material delivery trucks, the Contractor shall provide, erect, maintain, and replace if necessary, the following signs for each direction of traffic affected by the reduction of usable highway width:

1 sign bearing the message DANGER—ROAD CONSTRUCTION AHEAD.

If, however, the abovementioned existing road or street other than a State highway normally accommodate more than one lane of traffic in each direction within or immediately adjacent to the area of work, such road or street shall be signed as hereinabove specified for the signing of existing State highways.

Wherever a detour is established, the Contractor shall furnish, erect and maintain, for each direction of traffic, 1 sign bearing the message DANGER—DETOUR AHEAD.

The signs shall bear no symbols or message, and the supports no signs, other than specified above.

All signs for use on the Project as hereinabove specified shall have a background of yellow reflectorized sheeting of Scotchlite or similar material that will provide equivalent reflectance at all times. The minimum acceptable size and character of lettering and spacing of letters on all signs shall be as shown for 8-inch, Series D lettering in the Public Roads Administration 1945 publication entitled "Standard Alphabets for Highway Signs." Lettering on all signs shall be black. The over-all background

dimensions of each sign shall be such as to provide a reflectorized border of at least 4 inches around the message.

Signs shall be erected on good, substantial posts, with the bottom of the sign 30 inches above the ground and so as to withstand normal winds, subject to the approval of the Engineer.

Signs, barricades, traffic cones, flares and electric flasher units shall be established, relocated, repaired and replaced in such manner and at such times and places as may be necessary for adequate protection of vehicular and pedestrian traffic, subject to approval by the Engineer.

The Contractor shall provide sufficient watchmen and traffic directors and shall take all other precautions, including any which may be ordered by the Engineer, that may be necessary for the safety of the public and protection of the work. Watchmen shall patrol hourly and replace missing flares and other lighting units.

The Contractor shall not perform any construction work above vehicular or pedestrian traffic unless there be explicit provision therefor in the Supplementary Specifications or specific, written permission by the Engineer. Subject to such provision or permission, the Contractor shall provide the necessary devices and means to protect such traffic from falling construction materials and other objects, and from painting operations, during the time that construction work is carried on above traffic. Before starting work on bridge spans or other operations above traffic, the Contractor shall obtain the Engineer's approval of the precautions he intends to take for the protection of traffic.

When it is provided in the Supplementary Specifications that the Department will establish a detour, the Department will make all arrangements for establishing, maintaining and signing it, and will assume the cost thereof. The Contractor, at his own expense, shall furnish, erect and maintain barricades, as specified above, to close the highway and protect traffic and his work at the beginning and end of the detour.

When the construction of a detour is provided for in the Plans, the Contractor shall furnish and erect signs and provide safety measures on the detour as are necessary to provide traffic guidance and protection equivalent to such provisions for the remainder of the Project, except that the number and location of the signs shall be subject to the Engineer's approval.

The Contractor shall not erect directionary or detour signs except as hereinafter provided for detours that are not specified to be established by the Department and which are arranged by the Contractor.

If the Contractor reroute traffic over detours that are not specified to be established by the Department, he shall first obtain therefor approval of the Engineer and consent of the appropriate authorities having jurisdiction. The Contractor shall make all

necessary arrangements with such authorities regarding the establishment, maintenance and repair of such detours, the regulation and direction of traffic thereon, and signing. Adequate directionary and detour signs, acceptable to the appropriate authorities, shall be furnished by the Contractor and shall be erected by him at the locations where such authorities may direct. The cost of all work in connection with such detours shall be borne by the Contractor.

Existing roads and streets that are proposed to be dead-ended or abandoned shall not be closed to traffic until so authorized by the Engineer.

Work which closes or alters the use of existing roads and streets shall not be undertaken until adequate temporary or permanent provisions for traffic have been provided or arranged for by the Contractor and such provisions have been approved by the Engineer.

Where it is necessary for pedestrians to cross, or walk within the limits of, the Project, the Contractor shall provide, without specific or additional compensation therefor, adequate temporary sidewalks of soil aggregate, Type 2, stone or slag screenings or other suitable material and shall maintain them in a condition acceptable to the Engineer.

Within 10 days after notice to the Contractor of the award of the Contract, he shall submit, in writing, for the approval of the Engineer, a plan of the methods, facilities and devices he proposes to use for the maintenance and protection of highway traffic.

The means provided for the maintenance of highway traffic shall be removed upon completion of the work and any damage done to public or private property shall be made good by the Contractor at his own expense.

The cost of maintenance and protection of highway traffic as described above will not be paid for under any specific item but the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal except as follows:

Items of work involved in construction of cross-overs, detour roadways and detour bridges prescribed in the Plans or Supplementary Specifications will be paid for at the prices bid therefor in the Proposal, or at the bid prices for similar work when so specified.

When provided for in the Supplementary Specifications and an item therefor is scheduled in the Proposal, payment for Traffic Directors will be made for the number of man-hours of traffic directors actually furnished and employed by the Contractor, by the order or authorization of the Engineer, at the unit price bid for the item TRAFFIC DIRECTORS in the Proposal which price shall include the cost of uniforms, when prescribed, and overtime costs in excess of "straight time" hourly wage rates.

Railroad Traffic and Property. Where the Project includes work across, over, under or adjacent to railroad tracks or railroad right of way, the Contractor shall safeguard the traffic, tracks and appurtenances, and other property of the railroad affected by his work. He shall comply with the regulations of the railroad company relating to the work, shall keep the tracks clear of obstructions, shall provide barricades, warning signs, lights, flares, and other danger signals and means of protection, and shall arrange with the railroad company for the furnishing of watchmen and flagmen and other protective service that may be required by the railroad company. The Contractor shall arrange with the railroad company for direct payment to the company for watchmen, flagmen and other protective service which it may require.

In addition to any other insurance or bonds that may be required under the terms of the Contract, the Contractor shall carry insurance covering the work to be performed on, over or under railroad property, when and as prescribed in the Supplementary Specifications.

The maintenance and protection of railroad traffic will not be paid for under any specific scheduled item but the cost thereof, including the safeguarding of tracks, traffic and appurtenances of the railroad, watchmen, flagmen, barricades, lights, signs, signals, warnings, all other protection and services, and insurance when and as specified in the Supplementary Specifications, but excluding work, labor, materials and equipment specifically provided to be performed and furnished by the Railroad Company at its own expense or under direct reimbursement by the State, shall be included in the prices bid for the various items scheduled in the Proposal.

1. 4. 4. Final Cleaning Up.

Before the final acceptance of the Project, the Contractor shall remove all equipment, temporary work, unused and useless materials, rubbish and temporary buildings, shall repair or replace in an acceptable manner fences or other private or public property which may have been damaged or destroyed on account of the prosecution of the work, shall fill all depressions and water pockets on public and private property caused by his operations, shall remove all obstructions from waterways caused by his work, shall clean all drains and ditches within and adjacent to the site of the Project which have been obstructed by his operations, and shall leave the site of the Project and adjacent public and private property in a neat and presentable condition wherever his operations have disturbed conditions existing at the time of starting work. The Contractor shall procure and submit to the Engineer signed statements from property owners affected that he has fulfilled his obligations in the matters enumerated above with regard to their

respective properties. Payment for final cleaning up and restoration of property as above provided will not be made under any specific item but the cost of this work shall be included in the prices bid for the various items scheduled in the Proposal.

1. 4. 5. Field Office and Soils Field Laboratory.

The Contractor shall provide and maintain in good condition for the exclusive use of the Engineer one or more of the hereinafter described construction field offices at a location or locations to be approved by the Engineer. The number and type or types of field offices shall be as designated in the Supplementary Specifications or Proposal.

Type A. An office of weatherproof construction having a floor space of not less than 576 square feet, located on or in the immediate vicinity of the Project, and having partitions and doors providing three communicating rooms, one with a floor space of not less than 288 square feet and two with floor space of not less than 144 square feet each. The office shall be provided with sufficient natural and artificial light and shall be adequately heated. Doors and windows shall be equipped with adequate locks, and all keys shall be in the possession of the Engineer. Suitable sanitary conveniences for the use of the Engineer, conforming to the requirements of Art. 1. 4. 6, shall be provided in or adjoining the field office or offices which shall be maintained clean and in good working condition and shall be stocked with lavatory and sanitary supplies at all times during the period of the Contract. If a field office is not required, these conveniences shall be provided at a location directed or approved by the Engineer. The office shall be equipped with drafting tables and chairs for the use of 16 men and shall have sufficient drawers for the standard size plans, either attached to the tables or in cabinet form, 1 rough plan rack, 1 supply cabinet, 1 or more clothes closets of ample size for the maximum office requirements, and 1 fire-resistant, 4-drawer legal size file cabinet meeting fire underwriters approval for not less than a 1-hour test. Each room also shall be provided with a desk and chair.

Type B. An office conforming to the requirements specified hereinabove for Type A except that it shall have a floor space of 432 square feet and shall be divided into two communicating rooms with floor spaces of 288 and 144 square feet and equipped with tables and chairs for the use of 12 men.

Type C. An office conforming to the requirements specified hereinabove for Type A except that it shall consist of one room having a floor space of not less than 288 square feet and shall be equipped with tables and chairs for the use of 8 men.

The Department will provide for the installation of telephone facilities in the field offices for the exclusive use of the Engineer and will make payment for the service direct.

In lieu of the field office or offices specified above, the Contractor may provide equivalent office space, equipment and facilities subject to approval of the Engineer.

A soils field laboratory as hereinafter described shall be provided and maintained in good condition by the Contractor at a location to be approved by the Engineer. It shall be a building of weatherproof construction with a floor space of not less than 100 square feet in which to house and use the equipment for soil testing. It shall be provided with sufficient natural and artificial light, shall be adequately heated and shall be equipped with a sink having running water and an attached drain capable of handling elutriable material, necessary electrical outlets, a table, 2 chairs or stools, and locks on all doors and windows. All keys shall be in possession of the Engineer.

The field office, soils field laboratory, furniture, fixtures and facilities shall remain the property of the Contractor. No compensation will be allowed for loss, alteration or damage during their use on the Project.

The field office and soils field laboratory shall be ready for use not later than 10 days after the date of mailing the fully executed Contract and before any other work is started, shall be maintained until 1 month after final acceptance of the Project by the Commissioner and then shall be removed.

Payment for Field Office will be made for the number furnished in accordance with the Specifications and Proposal at the price or prices bid for the item or items FIELD OFFICE in the Proposal and shall include the cost of furnishing, erecting and removal of the office, furnishing light and heat, providing furniture, equipment, and sanitary conveniences for the Engineer, all labor and materials, and all else necessary therefor and incidental thereto, or the cost of providing equivalent office space and facilities.

Payment for Soils Field Laboratory will be made at the price bid for the item SOILS FIELD LABORATORY in the Proposal, which price shall include erection of the laboratory, providing and maintaining heat and light, providing and installing the specified facilities and furniture, the furnishing of all building and other materials, labor and equipment, and all else necessary therefor and incidental thereto.

1. 4. 6. Sanitary Provisions.

The Contractor shall provide and maintain in a neat and sanitary condition, properly secluded, accommodations for himself and his employees, complying with the regulations of the State Department of Health and other bodies having jurisdiction.

Necessary conveniences, properly secluded, shall be provided and maintained for the use of the Engineer, satisfactory to the Engineer and sanitary authorities. The cost of sanitary conveniences for the Engineer shall be included in the price or prices bid for the item or items for Field Office in the Proposal. The cost of accommodations for the Contractor and his employees shall be included in the prices bid for the various items scheduled in the Proposal.

1. 4. 7. Materials.

General. All materials for the Project shall be furnished by the Contractor, unless otherwise specifically prescribed. They shall conform to the Plans and Specifications, and shall be from approved sources. Only materials which have been approved by the Engineer shall be used. Within 12 hours after receiving a shipment of materials, the Contractor shall advise the Engineer of the kind, size, quantity and location thereof.

Approval of Source. Promptly after the execution of the contract, the Contractor shall notify the Engineer, on forms furnished by the Department, of the sources of materials he expects to use during the 6 month period thereafter. Such notice shall be received by the Engineer at least 10 days prior to the shipment of materials from a previously approved source and at least 30 days prior to the shipment of materials from a source not previously approved except that, with the Engineer's consent, shipments of materials from approved stocks may be made 3 days after notice to the Engineer. For materials which are not required until more than 6 months after the execution of the Contract the Contractor may delay such notice until 1 calendar month prior to the date that such materials need to be ordered so that they will be available for the Project at the proper time. In any item of construction the sources, brands or types of materials shall not be changed without the consent of the Engineer. The Contractor's request for such changes shall be filed with the Engineer the number of days in advance of such changes as required above. The Contractor's notice shall state the name and address of the owner, the location of the proposed source, the method of shipment, and the intended use of the material. The Contractor also shall furnish this information for all materials whenever he places an order therefor. The foregoing provisions shall apply also with regard to requests by subcontractors for the sources of the materials they propose to use, such requests to be submitted through the Contractor.

Inspection. Materials shall be inspected at their source and approved before being shipped. Shipment before approval shall be sufficient cause for rejection. Approval applies only so long as the materials conform to requirements of the Specifications, are uniform in quality and composition and can be supplied at the time and in the quantities required. Approval for a specific case or use

shall not imply approval for other cases or uses. At the discretion of the Engineer, permission may be granted to ship materials which may be inspected upon arrival at the job site, but in no case shall materials be used until approved by the Engineer. Approved materials which appear defective when received or which may have been damaged in storage or handling shall not be used until retested and reapproved. Orders placed with producers or jobbers for materials shall provide a detailed description and the intended use of the materials, the official designation of the project for which they are to be used, and that the materials shall be in accordance with the Plans and Specifications for that project and be subject to inspection, test, and acceptance by the New Jersey State Highway Department. A copy of all orders shall be furnished the Engineer at the time the order is placed.

Material delivery slips shall show such information as may be prescribed by the Engineer.

Sampling and Testing. General. Methods of test shall be those prescribed or referred to in the specifications for the various materials.

If no methods of test are provided for in the specification for a particular material, that material shall be tested in accordance with an appropriate A. A. S. H. O. method or, if there be no appropriate A. A. S. H. O. method of test, such material shall be tested in accordance with an appropriate A. S. T. M. method of test.

Results of tests made with the Department Laboratory's apparatus, conforming to the requirements specified in the prescribed methods of tests, shall be official.

All samples shall be taken by the Inspector.

The Contractor shall furnish representative samples for test, as hereinafter specified. He shall also furnish the necessary assistance to the Inspector in the taking, preparation and furnishing of the samples. The cost to the Contractor in connection with or incidental to sampling as specified above shall be included in the prices bid for the various items scheduled in the Proposal.

Except as otherwise hereinafter provided, all materials will be tested at the expense of the State.

Manufacturers furnishing pipe under these Specifications shall furnish all facilities necessary to carry out the tests required by the Specifications, at their own expense.

The required samples of the various materials to be taken by the Inspector shall be as hereinafter prescribed in Table 1. This table shows the required minimum number of samples for the rates of use of the materials as indicated. Additional samples shall be furnished whenever in the opinion of the Engineer additional tests are required to determine the quality and suitability of material for their respective uses.

For materials not shown in Table 1 that may be required by provisions of the Plans, Supplementary Specifications or Change Orders, samples shall be furnished at the rates necessary for test requirements.

Samples required to be furnished by the Contractor shall be made available by contractor's suppliers of materials whenever tests and inspections are made at plants, quarries, mills, foundries, warehouses, shops or other points of manufacture, treatment, fabrication, assembly or storage.

Samples of materials, units of manufactured items and prototypes shall be furnished in such quantities and numbers as may be required for establishing quality, classification, suitability, verification of performance and mix formulations.

Table 1.—Samples Required

Material	Samples	Rate of Sampling	Delivery Instructions
Aggregates, Coarse			
2½" size	35 lb.	1,000 tons	Large sample bag
1½", 1", ¾" size	25 lb.	500 tons	Large sample bag
⅝", ½", ⅜" size	15 lb.	250 tons	Large sample bag
¼", grits	10 lb.	250 tons	Small sample bag
Aggregate, Fine			
Bituminous	10 lb.	500 tons	Small sample bag
Concrete and mortar	10 lb.	500 tons	Small sample bag
Cover	10 lb.	Each source	Small sample bag
Additives and Admixtures for Bituminous Materials			
Liquids	1 qt.	Each source	Screw top can
Semisolids and solids	1 qt.	Each source	Friction top can
Additives and Admixtures for Concrete			
Liquids	1 qt.	Each source	Screw top can
Powders	10 lb.	Each source	Dampproof container
Alkyd Resin Solution	1 qt.	Each source or lot	Friction top can
Aluminum Alloy Products		In accordance with applicable ASTM test methods	
Aluminum Paint			
Paste	1 pt.	Each source or lot	Friction top can
Vehicle	1 qt.	Each source or lot	Friction top can
Asphalt Cement	1 qt.	First 10,000 gallons and each additional 30,000 gallons	Friction top can
Asphalt, Emulsified	1 gal.	First 10,000 gallons and each additional 30,000 gallons	Glass container

Table 1.—Samples Required—Continued

Material	Samples	Rate of Sampling	Delivery Instructions
Asphaltic Oil	1 qt.	First 10,000 gallons and each additional 30,000 gallons	Screw top can
Asphalt Plank, Premolded	3 ft.	Each source	Securely wrapped
Bearing and Expansion Plates	1 unit	Each source	Suitable package
Bituminous Concrete, Hot-mixed			
Mixture	5 lb.	Each type produced daily	Securely wrapped
Pavement	8 inch square, full depth	Each 3,000 sq. yds. or fraction thereof laid daily	Securely wrapped
Cold-mixed Mixture	5 lb.	Each type produced daily	Securely wrapped
Bituminous Stabilized Base Course	8 lb.	Each type produced daily	Securely wrapped
Block, Concrete	10 each size and type	10,000 units	By truck
Block, Granite Paving	5	Each source	Crated
Brick, Construction, All Types	10 units	10,000 units	Crated or boxed
Burlap	1 sq. yd.	Each source	Suitable package
Calcium Chloride	1 qt.	Each source	Friction top can
Carbon Black	1 pt.	Each source	Friction top can
Castings, Carbon Steel		In accordance with applicable ASTM or AASHO test methods, before shipment	
Castings, Gray Iron and Malleable Iron	2 test bars	Each heat	Crated or boxed
Cable, Electric	Subject to manufacturer's certified test		
Cast Iron Culvert Pipe		In accordance with applicable AASHO test method, before shipment	
Cast Iron Water Pipe		In accordance with applicable ASA test method, before shipment	
Cement, Portland		In accordance with applicable ASTM specifications, before shipment	
Chrome Oxide Green	1 pt.	Each source	Friction top can

Table 1.—Samples Required—Continued

Material	Samples	Rate of Sampling	Delivery Instructions
Cinders	1 cu. ft.	Each source	Large sample bag
Clay Pipe, Each Size	Whole lengths	0.5% number of lengths with a minimum of 2 lengths, each source	By truck
Concrete Pipe		In accordance with applicable AASHO specifications, before shipment	
Concrete Test Cylinders	Three 6" x 12"	Each 100 cu. yds., each class	Common carrier in crates, or delivery by vehicle
Conduits and Fittings, Electric	Job site inspection or one 3 ft. piece with thread and coupling	Each lot or shipment	Suitable package
Controllers and Controller Housings, Signal		Approval by test of prototype	
Copper Flashing	1 sq. ft.	Each source	Ship flat in suitable package
Corrugated Metal Pipe and Arches		Manufacturer's certified analysis with each shipment	
Crib, Concrete, Members		Plant inspection before shipment	
Curbs and Headers, Granite	2-ft. long full end section	Each source	Crate
Curing Compound, Concrete Clear or Pigmented	1 qt.	Each lot	Friction top can
Detectors, Signal		Approval by test of prototype	
Driers, Paint	1 pt.	Each source or lot	Friction top can
Fertilizer		Manufacturer's certified analysis with each shipment	
Forgings, Steel		In accordance with AASHO specifications, before shipment	
Glass Beads	1 qt.	5,000 lb.	Friction top can
Joint Filler, Liquid	1 qt.	Each source	Friction top can
Joint Filler Preformed	3 ft. long	Each shipment	Suitable package

Table 1.—Samples Required—Continued

Material	Samples	Rate of Sampling	Delivery Instructions
Joint Sealer			
Cold-poured	Proportional components to make 1 qt.	*Each source and batch	Friction top can
Hot-poured rubber—asphalt	10 lbs.	*Each source and batch	Original package
Landscaping Materials, Miscellaneous		Subject to job site inspection	
Lead, Sheet	1 lb.	Each shipment	Suitable package
Lignin Binder	1 qt.	10,000 gal.	Screw top can
Limestone, Ground, Agricultural	1 qt.	Each source	Friction top can
Lime, Hydrated	1 qt.	Each source	Friction top can
Linseed Oil, Heat-Bodied, Raw	1 qt.	Each source or lot	Friction top can
Liquefier	1 qt.	Each source	Screw top can
Manure	25 lb.	Each source	Moistureproof package
Mineral Filler	1 qt.	Each source	Friction top can
Mulch			
Binder		See asphaltic oil	
Hay		Subject to job site inspection	
Paint Pigments	1 pt.	Each source or lot	Friction top can
Paint, Ready-mixed	1 qt.	Each source or lot	Friction top can
Paint Stabilizers	½ pt.	Each source or lot	Friction top can
Paint Thinners	1 qt.	Each source or lot	Friction top can
Paint Vehicles	1 qt.	Each source or lot	Friction top can
Resin	1 pt.	Each source or lot	Friction top can
Varnish	1 pt.	Each source or lot	Friction top can
Peat and Peat Moss	10 lb.	Each source	Moistureproof container
Plant Materials			
Plants, Trees, Shrubs, etc.		Subject to job site inspection	
Polyethylene Sheeting	1 ft. strip cut across full width of roll	Each source	Suitable package
Rubble Stones		Subject to job site inspection	
Rust-inhibitive Primer—See Paint, Ready-mixed			
Screenings, Stone or Slag	10 lb.	250 tons	Small sample bag
Seamless Steel Pipe, for Railing and Posts		Subject to test and inspection prior to shipment	
Seed Mixtures	Supplier's certified analysis to accompany each shipment		
Shoulder Aggregates	50 lb.	500 tons	Large sample bag

* Manufacturer's certified analysis shall be furnished with each batch

Table 1.—Samples Required—Continued

Material	Samples	Rate of Sampling	Delivery Instructions
Signal Heads	Subject to job site inspection of approved types		
Sod		Subject to job site inspection	
Sodium Chloride	2 qt.	50 tons	Friction top can
Soil Aggregates			
Max. size larger than No. 4 sieve	50 lb.	500 cu. yd.	Large sample bag
Max. size smaller than No. 4 sieve	10 lb.	500 cu. yd.	Small sample bag
Steel, Bolts		Subject to test and inspection before shipment	
Steel, Copper-bearing		Subject to test and inspection before shipment	
Steel, Eye Bar		Subject to test and inspection before shipment	
Steel, Grid Floors		Subject to test and inspection before shipment	
Steel, Joint		Subject to job site inspection	
Steel, Low-alloy		Subject to test and inspection before shipment	
Steel, Piles		Subject to test and inspection before shipment	
Steel Posts for Beam Guard Rail		Subject to test and inspection before shipment	
Steel Rail Element for Beam Guard Rail		Subject to test and inspection before shipment	
Steel Reinforcement, High-tensile Alloy Bars	Manufacturer's certified analysis to accompany each shipment		
Steel Reinforcement, Post-tensioning Strands and Tendons	One 6 ft. piece	50,000 ft.	Ship uncoiled
Steel Reinforcement, Pretensioning Strands	One 6 ft. piece	50,000 ft.	Ship uncoiled
Steel Reinforcement, Plain and Deformed Bars	One 2 ft. piece	**Each 10 tons, min. sample 4 pieces	Suitable package

** Each heat shall be accompanied by manufacturer's certified ladle analysis

Table 1.—Samples Required—Continued

Material	Samples	Rate of Sampling	Delivery Instructions
Steel Reinforcement, Welded Wire Mesh	One piece 2 ft. square	15,000 sq. ft.	Suitable package
Steel Sheet Piling		Subject to mill inspection before shipment	
Steel, Structural		Subject to mill inspection before shipment	
Steel, Structural Rivet		Subject to mill inspection before shipment	
Steel, Studs, Automatic End-welded		Subject to mill inspection before shipment	
Structural Plate Pipe, Pipe-arches and Arches		Subject to mill inspection before shipment	
Tars	1 qt.	First 10,000 gallons and each additional 30,000 gallons	Grades 7-12 Friction top can —others screw top can
Tar Paint	1 qt.	Each lot or shipment	Screw top can
Thinner, Mineral Spirits	1 qt.	Each source or lot	Screw top can
Tiles		Subject to approval by the engineer	
Tile, Drain	Whole lengths	0.5% total lengths with a minimum of 3 lengths each size	Crated
Timber Bearing Piles, Treated		Subject to test and inspection before shipment	
Timber Connectors		Subject to test and inspection before shipment	
Timber for Guard Rail Posts and Struts		Subject to inspection before shipment	
Timber Preservatives	1 qt.	Each source	Screw top can
Timber Sheet Piles		Subject to job site inspection	
Timber for Structures		Subject to inspection before shipment	
Topsoil	10 lb.	Each source	Small sample bag
Tung Oil	1 qt.	Each source or lot	Friction top can
Water	1 gal.	Each source	Clean glass container
Waterproof Paper, Concrete Curing	1 ft. wide cut across roll	Each shipment	Rolled and wrapped

Table 1.—Samples Required—Continued

Material	Samples	Rate of Sampling	Delivery Instructions
Waterproofing Asphalt or Pitch	1 qt.	Each source	Friction top can
Waterproofing, Fabric	3 ft. wide strip cut across width of roll	Each source	Rolled and wrapped
Waterproofing Protection, Insulation Board	1 sq. ft.	Each shipment	Suitable package
White Lead Basic Carbonate	1 pt.	Each source or lot	Friction top can
Wire, Electrical	Subject to manufacturer's certified test		
Wire Rope, Guard Rail	One 7 ft. piece	Each shipment	Loose coil
Wrought Iron Pipe, Welded	One 3 ft. piece	Each shipment	Suitable package
Wrought Iron Plates, Rolled Shapes and Bars		Subject to mill inspection before shipment	
Zinc Dust-Zinc Oxide Paint Primer	1 qt.	Each source or lot	Friction top can
Zinc, Sheet	1 sq. ft.	Each shipment	Suitable package

Note: In Table 1 above, where there are provisions that certain materials shall be subject to inspection, or inspection and test, before shipment, sampling and testing of such materials after delivery to the project ordinarily will not be required. However, it shall not be inferred from such provisions that inspection and approval before shipment is waived with respect to other materials listed in the table.

Sampling and Field Testing of Soils. The sampling and field testing of soils shall conform to the general requirements for sampling and testing specified above and with the following requirements provided, however, that the following requirements shall govern where there is any conflict or inconsistency between them. The soils subject to sampling and testing under these provisions shall be borrow excavation (except Zone 3 borrow excavation for which no grading requirements are specified), subbase and porous fill materials, and vertical sand drain, soil stabilization, road gravel and soil aggregate materials for underdrain backfill.

The Contractor shall determine initially, by means of proper sampling and laboratory tests, that soil materials from proposed sources will conform to the specification requirements. Written notice of the proposed sources of the above named materials shall

be given the Engineer by the Contractor after his initial determination as specified above, and not less than 10 days prior to the time of their intended use. Then, before approving or disapproving a source, the Engineer will sample and test materials representative of that portion of the source which the Contractor intends to use.

Approval by the Engineer of a proposed source of soil materials shall not constitute approval of materials delivered to the site of the work from that source but shall be deemed as permission for the Contractor to select and use materials from that source only so long as they conform to the Specifications. The Contractor shall progressively determine for himself by proper sampling and laboratory tests, while the sources are in use, that materials selected from approved sources will conform to the Specifications.

The final and governing determination of conformance or nonconformance with Specifications shall be based on sampling and testing of the materials by the Engineer after they have been placed and compacted in the work as specified, or if compaction be not specified, when they have been placed in accordance with the Plans and Specifications. All materials in place in the work which do not conform to the Specifications shall be removed and replaced with materials which do conform thereto, or their deficiencies shall be corrected.

The Contractor shall excavate test pits and provide such facilities as the Engineer may require in order properly to sample the source and shall, if the source be approved, remove any overburden which would contaminate the material intended for use on the Project. If soil materials be obtained by dredging, the Contractor shall provide safe and adequate water transportation for the Engineer to and from the dredges or other boats and shall cooperate with the Engineer in every reasonable way to expedite inspection and sampling of the materials. The cost of such work, facilities and transportation, in connection with sampling by the Engineer at the proposed source of soil materials, and the initial and progressive sampling and testing of materials at their sources performed by the Contractor, will not be paid for under any specific item but shall be included in the prices bid for the various items scheduled in the Proposal.

The sampling and testing by the Engineer of soil materials used in the work which meet the Specifications will be performed without cost to the Contractor.

The cost of all sampling and testing of samples, performed by the Engineer, of soil materials which do not comply with the Specifications, and of soil materials which do meet the Specifications but are not used in the work, shall be paid to the State by the Contractor at the sampling and testing rates of the Department, and such costs may be recovered by the State from any monies due or that may become due the Contractor.

Vehicles and Receptacles. Vehicles and receptacles used for shipping and transporting materials shall be strong, tight, clean, and in good repair, or materials therein may be rejected. Receptacles shall be plainly marked with the name of the producer, kind of material contained therein, net weight, and grade. If the material contained in the receptacle has been inspected at the point of production before shipment, the container shall be marked also with the lot number of the approved material from which the content is taken, the date of approval, and other pertinent information.

Storage. Materials liable to damage by the elements shall be stored in proper structures or in such other manner as may be necessary to protect them from damage. Materials shall be kept clean and free from foreign matter of any kind before, while, and after being placed in the finished work, and provisions necessary therefor shall be made by the Contractor.

1. 4. 8. Superintendence and Workmen.

The Contractor shall attend to the work personally or through a competent, English-speaking superintendent on the work, authorized to receive and carry out instructions. The workmen shall be competent and shall perform their work in a neat and workmanlike manner. Any workman not properly qualified for his work or who is doing it in an unsatisfactory manner or contrary to the Specifications or the Engineer's instructions, or who is disorderly, shall be discharged if so requested by the Engineer, and shall not be employed again on the Project except with the approval of the Engineer. The superintendence and the number of workmen shall be sufficient, in the opinion of the Engineer, to insure the completion of the Project within the time stipulated therefor.

1. 4. 9. Equipment.

Good equipment only shall be used, and it shall be in proper working condition. Sufficient equipment shall be used to insure the completion of the Project within the time specified. The equipment shall be operated so as not to damage public or private property. When a specific type or character of equipment is called for it shall be provided and used. All equipment shall be subject to the approval of the Engineer.

If the Contractor or his subcontractors do not own all or part of the equipment required, a written statement shall be submitted by the Contractor or his subcontractors, respectively, of the name and address of the owner or owners, stating that an agreement has been made to lease or loan the equipment and that in event of default, as set forth in Art. 1. 7. 6, the Commissioner has the right to take over and use such equipment or cause it to be used for completing the Project.

1. 4. 10. Working Site.

Any space that the Contractor may require for plant, equipment, storage or other purposes, in addition to that available therefor at the site of the Project, shall be procured by the Contractor and the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal. In event of default as set forth in Art. 1. 7. 6, the Commissioner has the right to take over and occupy such space, or cause it to be occupied, for the purpose of completing the Project, at the Contractor's expense. If leased, the lease shall contain a provision that in event of default by the Contractor the lease may be assigned to the State or its nominee. The Contractor agrees in event of said default, that he will make such assignment.

1. 4. 11. Contractor's Organization.

The working force, equipment and working site, provided by the Contractor for the Project shall at all times be adequate and sufficient to insure the completion of the Project within the time stipulated therefor. When, in the opinion of the Engineer, either the working force, the equipment or the working site, or any or all of them, are inadequate or insufficient to insure completion within said time, the Engineer may order the Contractor to correct the deficiency, and the Contractor shall comply with such order.

The Contractor and his subcontractors shall not engage, on a full or part-time or other basis during the period of the Contract, any of the professional or technical personnel of the New Jersey State Highway Department, or of any state, county or municipality, who are or have been at any time during the period of the Contract, or for 30 days prior to the award of the Contract, in the employ of such public agencies, except regularly retired employees, without the written consent of the public employer of such personnel.

SECTION 5

Control of the Work

1. 5. 1. Duties of Engineer.

The Engineer will furnish Plans and Specifications, set stakes as provided in Art. 1. 5. 4, and prepare monthly and final certificates as provided in Art. 1. 8. 5. He will give instructions necessary to attain due and full effect of the provisions of the Specifications. Should any differences of opinion arise as to the meaning or intent of the Plans and Specifications, his decision when approved by the Commissioner shall be final and conclusive. All materials and work

shall be subject to his inspection and approval provided, however, that his approval or acceptance of materials furnished or work performed does not commit the Commissioner to acceptance thereof if said materials or work do not conform to the requirements of the Specifications.

1. 5. 2. Plans and Specifications.

Plans and Supplementary Specifications for the Project, and the Standard Specifications, form a part of the Contract and are on file with the Department at 1035 Parkway Avenue, Trenton, New Jersey. One or more copies of the Plans and Specifications shall be kept at the site of the Project by the Contractor.

Standard Specifications and Construction Plans will be furnished upon request, at a charge of $5.00 per copy for the Specifications, and at the charges per copy for the Plans as hereinafter specified in Table 1A, except that the successful bidder will receive one copy of each, without charge, upon award of the Contract, if requested; provided, however, that not more than one copy of the current Standard Specifications will be furnished any Contractor, regardless of repeat contract awards to him except upon payment of $5.00 per copy.

Table 1A.—Charges for Plans

Construction Plans consisting of	Charge per copy
100 sheets or less	$15.00
101 to 150 sheets	25.00
151 to 200 sheets	35.00
201 to 250 sheets	45.00
For each additional multiple of 50 sheets, or part thereof, an additional charge of	10.00

Copies of boring plans and boring logs will be furnished upon request at a charge of the actual cost of blueprinting.

One copy of Supplementary Specifications will be furnished, without charge, with each copy of construction plans. Additional copies of Supplementary Specifications will be furnished upon request, at a charge of $1.00 per copy except that, after award of the Contract, a maximum of 5 additional copies will be furnished the successful bidder upon request, without charge.

Construction plans, boring plans, Specifications and proposal forms will be issued only by the Secretary of the Department and all requests therefor shall be directed to him.

On the plans, figured dimensions shall govern in case of discrepancy between scaled and figured dimensions. If any discrep-

ancy be found between the Plans and Specifications, the requirements of the Plans shall govern. If there be a discrepancy between the Standard Specifications and the Supplementary Specifications, the requirements of the latter shall govern. The Engineer shall have the right to correct apparent errors or omissions in the Plans and Specifications and to make such interpretations as he may deem necessary for the proper fulfillment of the intent of the Plans and Specifications.

1. 5. 3. Working Drawings.

The Contractor shall submit to the Engineer for his approval such detailed shop or working drawings as may be required for carrying out the Project. These drawings will be checked, and approved or returned for correction, as promptly as the conditions will permit. The Contractor shall order no materials and do no work relating to said drawings before their approval. The carrying out of the work or the ordering of the materials before the approval of the drawings may constitute a cause for rejection of such work or materials. No deviations from approved working drawings shall be made without the written approval of the Engineer.

Working drawings for steel structures shall consist of shop, erection and other drawings, showing details, dimensions, sizes and other information necessary for the complete fabrication and erection of the metal work. Working drawings for concrete structures shall consist of such additional detailed drawings as may be required for the prosecution of the work and may include drawings of falsework, bracing, centering and formwork, and masonry layout diagrams. The Contractor shall check completely the rod lists and details of reinforcement steel shown on the Plans and shall submit complete working drawings for the reinforcement steel to the Engineer for his approval. It is expressly understood that the approval by the Engineer of the Contractor's working drawings relates to the requirements for design and conformance to Plans only and that such approval does not relieve the Contractor from responsibility for errors in dimensions. The Contractor shall furnish the Engineer with such a number of blueprint copies of the working drawings as may be required for approval and construction purposes, and on completion of the Project the original tracings of the drawings shall be furnished to the Engineer if so required by him. The tracings of working drawings shall be in ink on cloth, or reproductions on cloth acceptable to the Engineer, and they shall be of such uniform size as may be directed by the Engineer. The cost of preparing and furnishing working drawings as above described shall be included in the prices bid for the various items scheduled in the Proposal.

1. 5. 4. Construction Stakes.

Unless otherwise prescribed in the Supplementary Specifications, the Engineer will stake out such lines and grades for road work as he may deem necessary in order that the Contractor, with reasonable effort, can transfer them accurately to the work. For structures, the Engineer will stake out the center lines and furnish such bench marks as may be necessary for the Contractor to lay out the work correctly.

The Contractor shall maintain the line and grade stakes furnished by the Engineer and shall lay out therefrom the work he is to perform under the Contract. If any such stakes be damaged, lost, displaced or removed, they shall be reset or replaced at a charge to the Contractor for the actual cost of the work. The Contractor shall be responsible for the finished work conforming to the lines and grades furnished by the Engineer as specified above.

The Contractor shall notify the Engineer in writing not less than 5 days in advance when stakes are required, and no claims shall be made because of delays if the Contractor fail to give such notice. Requests for stakes and other engineering services as above described shall, except in emergency, cover sufficient work for not less than one full day of the engineering force needed for the work.

The cost to the Contractor of laying out the work from lines and grades furnished by the Engineer and the cost of stakes reset or replaced by the Engineer, as above described, shall be included in the price bid for the various items scheduled in the Proposal except that, when provision is made in the Supplementary Specifications for the Contractor to furnish and set the line and grade stakes, payment therefor will be made at the lump sum price bid for the item CONSTRUCTION STAKES in the Proposal which price shall include furnishing and setting the stakes, furnishing all engineering personnel, equipment, materials, field office if necessary, and all else incidental thereto. Monthly or other payments on account for this item will be made prorata as the value of all contract work completed at the time of such payments bears to the total value of the Contract.

1. 5. 5. Inspectors.

The State shall have the right to inspect all work done and all materials furnished, including the preparation, fabrication and manufacture in mill, plant, shop and field of the materials to be used, and may assign an Inspector or other authorized representative for this purpose. The Contractor shall provide all facilities necessary for such inspection and shall furnish or cause to be furnished to the said Inspector or other authorized representative safe access at all times to the places where preparation, fabrication

or manufacture of materials and construction of the work is in progress, as well as such information and assistance as may be required to make a complete and detailed inspection. When the said Inspector or other authorized representative is in or about the premises above referred to in the course of his employment, he shall be deemed conclusively to be an invitee of the Contractor. If the Contractor be not the owner of the place where fabrication, preparation or manufacture is in progress, the owner thereof shall be deemed to be the agent of the Contractor with respect to the obligation assumed hereunder. The Contractor or his agent shall be responsible for the payment of claims for injuries to the State's authorized representative due to negligence on the part of the said Contractor or his agent. The cost of providing the necessary facilities, information, assistance and protection and of satisfying claims for injuries to the State's representative, as specified above, shall be included in the prices bid for the various items scheduled in the Proposal.

Inspectors or other authorized representatives may be stationed on the work to report to the Engineer as to the progress thereof and the manner in which it is being performed; to inform him whenever it appears that the materials furnished and the work performed by the Contractor fail to conform to the requirements of the Plans and Specifications; and to direct the attention of the Contractor to such failure. The inspection, however, shall not relieve the Contractor from his obligations to furnish materials or perform work in conformity with the requirements of the Plans and Specifications. The Contractor shall provide safe transportation for Inspectors to dredges and boats used for procuring or delivering materials to the Project.

The Inspector or other authorized representative is not authorized to revoke, alter, enlarge, relax or release any requirements of the Specifications or to issue instructions contrary to the Plans and Specifications. If a difference of opinion arise between the Inspector and the Contractor relating to the materials furnished or the performance of the work, the Inspector has the authority to reject the materials and notify the Contractor that further work on the construction involved will be unauthorized and subject to nonpayment until the question at issue can be referred to and decided by the Engineer.

1. 5. 6. Unauthorized or Defective Work.

The Contractor shall use no materials in the work before they have been approved as provided in Art. 1. 4. 7; he shall perform no work before the lines, grades and benchmarks have been set and established as provided in Art. 1. 5. 4; and he shall perform no work not provided for in the Contract unless a Change Order therefor has been issued as provided in Art. 1. 8. 4. Work per-

formed and materials furnished which do not conform to the requirements therefor will be rejected and shall be removed, replaced or repaired as the Engineer may direct and in a manner satisfactory to him, at the Contractor's expense. Materials which have been rejected, the defects of which have been subsequently removed or corrected, shall not be used unless approved by the Engineer.

1. 5. 7. Claims for Additional Compensation or Extension of Time.

When the Contractor deems that additional compensation or extension of time is due him for work required to be performed or materials required to be furnished which in his opinion cannot be classified under the scheduled items of work and which have not been covered by a Change Order as hereinafter specified in Art. 1. 8. 4, and it is his intention to make claim therefor, he shall notify the Engineer in writing of such intention before he begins the work or furnishes the materials in question. If such notice be given, the Engineer shall be afforded the opportunity to modify the design or construction procedure, or both, before the Contractor begins the work or furnishes the materials in question, and the opportunity and proper facilities for keeping account of the actual cost of such work and materials after the work begins. If such notice be not given, in writing, or if the Engineer be not afforded such opportunity and facilities, then the Contractor shall and hereby does agree to waive the claim for such additional compensation or extension of time or both. However, if the Contractor have complied with all the foregoing provisions, this circumstance in no way shall be construed as proving the validity of the claim. The claim will be passed on by the Commissioner and, if he find it to be justifiable under the provisions of the Contract, the work or materials in question will be paid for under an appropriate Change Order. Attention is directed to the provisions of Art. 1. 8. 4 regarding limitation of increase and reduction of quantities of major scheduled items.

1. 5. 8. Acceptance of Work.

When the Project has been completed, the Contractor shall so notify the Engineer. If it be not acceptable to the Engineer he will advise the Contractor as to the particular defects to be remedied before final acceptance will be made. Payments made to the Contractor before the final acceptance do not commit the Commissioner to acceptance of the Project. The final inspection and acceptance will be made by the Commissioner when the Project has been completed.

The State shall not be precluded or estopped by any measurement, estimate or certificate, made either before or after the

completion and acceptance of the Project and payment therefor, if such measurement, estimate or certificate be found to be in error or untrue, from showing the true amount and character of the work performed and materials furnished by the Contractor, or from showing that any such measurement, estimate or certificate is incorrectly made or untrue, or that the work or materials do not conform in fact to the requirements of the Contract. The State shall not be precluded or estopped, notwithstanding any such measurement, estimate or certificate, and payment made in accordance therewith, from recovering from the Contractor and his Surety such damages as it may sustain by reason of the Contractor's failure to comply or to have complied with the terms of the Contract.

Neither the acceptance of the whole or any part of the Project by the Commissioner or by any representative of the Commissioner, nor any payment made for the work, nor any extension of time granted the Contractor, nor any possession taken by the Commissioner, shall operate as a waiver of any portion of the Contract or of any power herein reserved, or of any right to damage herein provided. A waiver of any breach of the Contract shall not be held to be a waiver of any other or subsequent breach.

SECTION 6

Legal and Public Relations

1. 6. 1. Personal Liability.

In carrying out the provisions of this Contract or in exercising any power or authority granted them by their position, there shall be no liability upon the Commissioner, the Engineer, and their authorized representative or assistants, either personally or as officials of the State, it being understood that in such matters they act as agents and representatives of the State.

1. 6. 2. Damage Claims.

The Contractor shall indemnify and save harmless the Commissioner, his officers, agents and servants and each and every one of them against and from all suits and costs of every kind and description and from all damages to which the Commissioner or any of his officers, agents or servants may be subjected by reason of injury to the person or property of others resulting from the performance of the Project, or through the negligence of the Contractor, or through any improper or defective machinery, implements or appliances used by the Contractor in the performance of the Project, or through any act or omission on the part of the

Contractor or his agents, employees or servants; and he shall further indemnify and save harmless the Commissioner, his officers, agents and servants from all suits and actions of any kind or character whatsoever which may be brought or instituted by any subcontractor, materialman or laborer who has performed work or furnished materials in or about the Project or by, or on account of, any claims or amount recovered for any infringement of patent, trademark or copyright. The cost of such indemnification shall be included in the prices bid for the various scheduled items in the Proposal. So much money due to the Contractor under and by virtue of the Contract as shall be considered necessary by the Commissioner may be retained by the State and held until such suits, actions, claims or amounts shall have been settled, and suitable evidence to that effect furnished to the Commissioner.

1. 6. 3. Laws, Ordinances and Regulations.

The Contractor shall observe and comply with all Federal and State laws, rules and regulations, and local ordinances, that affect those engaged or employed on the Project, the materials or equipment used, or the conduct of the work.

Attention is called to the following State laws and regulations:

Chapter 9, Title 34, Revised Statutes, providing that citizens of the State of New Jersey who have resided in the State not less than 1 year be given preference in employment on public works. If the provisions of these laws be not complied with, the Contract shall be voidable at the instance of the State.

Chapter 10, Title 34, Revised Statutes, providing, as a condition of the Contract, establishment of an eight-hour working day for laborers, workmen and mechanics and requiring payment of prevailing rates of wages and providing penalties for violations.

Chapter 2, Title 10, Revised Statutes, whereby the Contractor, as a condition of the Contract, shall and hereby does agree:

(a) That in the hiring of laborers, workmen and mechanics for the performance of work under this Contract or any subcontract hereunder, neither the Contractor or his subcontractors, nor any person acting on their behalf shall, by reason of race, creed, color, national origin or ancestry, discriminate against any citizen of the State of New Jersey who is qualified and available to perform the work to which the employment relates;

(b) That neither the Contractor or his subcontractors, nor any person on their behalf shall, in any manner, discriminate against or intimidate any employee hired for the performance of work under this Contract on account of race, creed, color, national origin or ancestry.

(c) That there may be deducted from the amount payable to the Contractor by the State, under this Contract, a penalty of five dollars ($5.00) for each person for each calendar day during which such person is discriminated against or intimidated in violation of the provisions of the Contract; and

(d) That this Contract may be cancelled or terminated by the Commissioner, and all money due or to become due hereunder may be forfeited, for a second or any subsequent violation of the terms or conditions of this section of the Contract.

Chapter 15, Title 40, and Chapters 32 and 33, Title 52, Revised Statutes, whereby the Contractor, as a condition of the Contract, shall and hereby does agree that in the performance of the Project only domestic materials and manufactured and farm products of the United States will be used, whenever available, unless otherwise specifically provided in the Contract with respect to any material which the Commissioner may deem advisable to except from this requirement in the interest of the State.

Chapter 34, Title 52, Revised Statutes, whereby the Contractor, as a condition of the Contract, shall and hereby does agree to give a suitable warranty that no person or selling agency has been employed or retained to solicit or secure such contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, except bona fide employees or bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business, for the violation of which warranty the State shall have the right to annul such contract without liability or in its discretion to deduct from the contract price or consideration the full amount of such commission, percentage, brokerage or contingent fee.

Chapter 2, Title 34, Revised Statutes pertaining to Child Labor.

Chapter 5, Title 34, Revised Statutes, Safety Code for Workers in the Construction Industry, and the following rules and regulations of the State Department of Labor and Industry promulgated to implement and supplement this law:

"Rules and Regulations Concerning Precautions to be Taken in the Proximity of High-Voltage Lines for the Prevention of Accidents."

"Rules and Regulations Governing Blasting on Construction and Related Operations."

Attention is also called to soil removal ordinances which may be in effect in municipalities, governing the removal of soil materials within the municipal limits. It shall be the responsibility of bidders

and the Contractor to ascertain the existence and provisions of any such ordinances that may affect their bids and the prosecution of the Project.

1. 6. 4. Federal Aid.

When the Project is carried out with Federal Aid, it shall be subject to inspection and approval by the Bureau of Public Roads and in accordance with the rules and regulations promulgated by it, pursuant to any Act of Congress relating thereto.

1. 6. 5. Permits and Licenses.

Except as otherwise hereinafter provided, the Contractor shall procure all required permits and licenses, pay all charges and fees therefor, and shall give all notices necessary and incident to the due and lawful prosecution of the Project. The cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

Before the Contractor performs dredging or channel excavation within tidal waterways for the procurement of materials, or performs therein other work of his own, when such work is not part of the permanent or temporary work provided for in the Contract, he shall advise the District Engineer, Corps of Engineers, U. S. Army, and the State Department of Conservation and Development, Division of Navigation and Division of Water Policy and Supply, of his intended work. If the waterway be not tidal, he shall notify the Division of Water Supply only. The Contractor shall procure all necessary permits for such work from the above named agencies having jurisdiction and interest and shall comply with their rules and regulations in the performance of the above mentioned work. Before any work as described above is performed within the limits of riparian grants or leases issued by the State Department of Conservation and Development, Division of Navigation, the Contractor shall procure from the grantees or lessees consent for such work and for the necessary occupation of the premises. Charges for permits and all other charges by the above named agencies, grantees and lessees in connection with the work described above shall be paid to them direct by the Contractor and shall be included in the unit prices bid for the various items scheduled in the Proposal.

For all temporary and permanent construction prescribed in the Contract, the necessary official permits and consents from the above named agencies, and from riparian grantees and lessees, will be procured, and all charges therefor will be paid, by the State. However, the Contractor shall advise such agencies and parties of his proposed operations and obtain their cooperation and such supplemental permission as may be necessary.

1. 6. 6. Responsibility for Work.

The Contractor assumes full responsibility for materials and equipment employed in the construction of the Project and agrees to make no claim against the State for damages to such materials and equipment from any cause whatsoever. Until its final acceptance, the Contractor shall be responsible for damage to or destruction of the Project, or to any part thereof, due to any cause except as otherwise hereinafter specified.

Upon written request of the Contractor, if a continuous section of the Project not less than 1 mile in length has been entirely completed prior to completion of the Project, the Contractor may be relieved of the maintenance of such completed section when the work has been approved by the Engineer.

The Engineer may order completed or partly completed sections of the Project to be opened to traffic prior to acceptance of the Project. If the maintenance of traffic through the portions of the Project so opened prior to acceptance of the Project be not prescribed in the Supplementary Specifications, the Department shall be responsible for the additional costs to the Contractor of the maintenance and protection of traffic, additional protection of the work because of such traffic and the repair of work damaged by traffic, provided that all such costs shall be subject to the Engineer's approval.

The Contractor shall not be responsible for damage to the Project caused by the operation of snow plows or other snow removal or de-icing operations carried on by or under the supervision or direction of the Department or of the various Counties and Municipalities.

The provisions of the foregoing three paragraphs shall not operate as waivers of the Contractor's guarantee to replace defective work and materials for a period of 1 year from the date of acceptance of the entire Project, as specified in Art. 1.8.7.

Subject to the exceptions and limitations specified above, the Contractor shall make good all work damaged or destroyed before the final acceptance of the Project and the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

1. 6. 7. Explosives.

Explosives shall be stored safely under lock and key. The storage places shall be marked plainly DANGEROUS EXPLOSIVES and be in care of a competent watchman at all times. The storing and handling of explosives and highly inflammable materials shall conform to the State and local regulations relating thereto. Proper means shall be used to avoid blasting damage to public and private property. Flagmen shall be provided, when

necessary, who shall warn and keep traffic from the danger area, and all persons within the danger area shall be warned and given time to withdraw. The cost of the above shall be included in the prices bid for the appropriate items scheduled in the Proposal.

1. 6. 8. Public Safety and Convenience.

The Contractor shall conduct his work with the least possible obstruction to traffic. The convenience of the public and of the residents adjacent to the Project, and the protection of persons and property, are of first importance and shall be provided for by the Contractor in an adequate and satisfactory manner. Adequate temporary crossings shall be constructed and maintained where access to adjacent property is desired, and fire hydrants shall be kept accessible.

Trucks hauling materials shall have tight tail gates and shall be loaded with adequate freeboard of not less than 3 inches, without precarious cones or piles of material.

The Contractor shall provide for prompt removal from existing roadways of all dirt and other materials that have been spilled, washed, tracked or otherwise deposited thereon by his hauling and other operations whenever the accumulation is sufficient to cause the formation of mud, interfere with drainage, damage pavements or create a traffic hazard.

The Contractor shall employ construction methods and means that will keep flying dust to the minimum. He shall provide for the laying of dust on the Project, and on roads, streets and other areas immediately adjacent to the Project limits, wherever traffic, or buildings that are occupied or in use, are affected by such dust caused by his hauling or other operations. The materials and methods used for dust laying shall be subject to the approval of the Engineer. The cost of carrying out the foregoing provisions shall be included in the prices bid for the various items scheduled in the Proposal.

1. 6. 9. Accident Prevention.

Precaution shall be exercised at all times for the protection of persons and property. The safety provisions of applicable laws, building and construction codes, and the rules and regulations of the State Department of Labor and Industry, shall be observed. Machinery, equipment and other hazards of whatsoever character shall be guarded in accordance with the safety provisions of the Manual of Accident Prevention in Construction, published by the Associated General Contractors of America, to the extent that such provisions are not inconsistent with applicable Federal, State and local laws and regulations.

If any operation, practice or condition during the course of the work be deemed by the Engineer to be unsafe, the Contractor shall take corrective action when notified in writing by the Engineer. However, where in the opinion of the Engineer, any operation, practice or condition endangers persons or property, it shall be discontinued and adequate remedial action taken before the affected part of the work is resumed.

Nothing in the foregoing paragraphs shall be construed as relieving the Contractor from full responsibility for safe prosecution of the work at all times.

1. 6. 10. Property Damage.

The Contractor shall not enter on or make use of private property in the prosecution of the Project unless written permission therefor is secured in duplicate, from the owner, one copy of which shall be filed with the Engineer. He shall promptly restore or repair, without cost to the State and in a manner satisfactory to its owner, property damaged or destroyed by his operations. Special attention shall be given to the protection of existing landscape features and natural vegetation as specified in Art. 2. 1. 3.

1. 6. 11. Public Utilities.

The terms public utility or public utilities used in this Article shall be construed to include those publicly and privately owned.

Within the site of the Project there may be public utility structures, and notwithstanding any other clause or clauses of this Contract, the Contractor shall not proceed with his work until he has made diligent inquiry at the offices of the Engineer, the utility companies and municipal authorities or other owners to determine their exact location. The Contractor shall notify, in writing, the utility companies and municipalities or other owners involved of the nature and scope of the Project and of his operations that may affect their facilities or property. Two copies of such notices shall be sent to the Engineer.

The Contractor shall carry out his work carefully and skillfully and shall support and secure public utility structures so as to avoid damage to them. Flow in drains and sewers shall be satisfactorily maintained. He shall not move without the owner's written consent any public utility structures, and at the completion of the work their condition shall be as safe and permanent as before. When public utility structures, facilities or equipment are damaged by the Contractor, he shall notify their owners, who may cause the damage to be repaired at the Contractor's expense. If the cost thereof be not paid by the Contractor within 30 days after repairs have been completed, the Commissioner may retain an amount sufficient to cover the cost from any moneys due or that

may become due the Contractor under this Contract. House service connections damaged by the Contractor shall be repaired by competent skilled mechanics.

When the removal, relocation or replacement of public utility structures or facilities is not deemed essential by the Engineer for carrying out the Project as planned, but is performed for the Contractor's convenience, the cost of such work shall be included in the prices bid for the various items scheduled in the Proposal. When such removal, relocation or replacement is deemed essential by the Engineer for carrying out the work of the Project as planned, the cost shall be borne by the State or by the owner of the utility in accordance with Department policy.

Due notice will be given to all interested parties in accordance with Revised Statutes 27:7-26 and 27, that all surface openings within the site of the Project shall be made prior to the laying of the finished pavement.

1. 6. 12. Existing Monuments.

Existing monuments and title stones which need not be removed shall be left in place and protected by the Contractor against damage and dislocation. When relocation or change in the grade of existing monuments is necessary, they shall be protected in their original position until their removal is approved by the Engineer, and shall be reset when directed, and in conformance with the new lines and grades to be furnished, by him. Monuments and title stones that are to be left in place or reset and are moved without approval of the Engineer shall be replaced at the Contractor's expense. The resetting of monuments as provided above, and payment therefor, shall be as provided in Division 5, Section 13.

SECTION 7

Procedure and Progress

1. 7. 1. Commencement and Procedure.

The Contractor shall commence work within 10 days after the date of mailing the fully executed Contract and shall continue without interruption until the work is completed, except as provided in Art. 1. 7. 3. The sequence of the work shall conform to the progress schedule submitted in accordance with Art. 1. 3. 2, provided, however, that said schedule may be modified from time to time as directed or approved by the Engineer. The Contractor shall give the Engineer not less than 7 days notice of the time and place or places he will start the work.

1. 7. 2. Progress and Time of Completion.

The progress and the time of completion of the Project shall conform to the requirements therefor as stated in the Supplementary Specifications, except as provided in Art. 1. 7. 8. When the progress and the time of completion are stated in terms of working days, these as defined in Art. 1. 1. 3 will be counted starting 10 days after the date of mailing the fully executed Contract to the Contractor; and when specified in terms of calendar days or months or specific dates, the actual number of working days will not be considered, but the Contractor shall arrange his working force and equipment so as to insure completion within the specified time.

1. 7. 3. Suspension of Work.

If the Engineer deem it advisable, he may notify the Contractor in writing to suspend work on all or any part of the Project, and the Contractor shall do no work where so suspended until he has received written notice from the Engineer to resume work. When work is suspended as above provided, payments for the completed parts of the work will be made as provided in Art. 1. 8. 5 and a suitable extension of time for completing the suspended work will be granted. No other compensation or allowance will be made on account of such suspension unless it shall be for more than 10 days. Should the suspension be for more than 10 days and should the Contractor be put to additional expense on account thereof, he shall have the right to file with the Commissioner a statement showing the character and amount of such additional expense and, if the Commissioner deem it a proper charge, the Contractor will be reimbursed therefor. However, he shall have no claim for additional expense for said first ten days of suspension, and any claim for allowance as above provided shall be filed, in writing, with the Commissioner before the expiration of the first ten days of suspension. No payment will be made for work done by the Contractor on suspended work. If the suspension extend for one year and the value of the suspended work, based on bid prices and estimated quantities, exceed 25 per cent of the Total Price bid, the Commissioner will, at the Contractor's request, annul the Contract as provided in Art. 1. 7. 5. When said value is 25 per cent or less and the suspension extends for one year, the Commissioner will at the Contractor's request, by Change Order as provided in Art. 1. 8. 4, omit the suspended work from the Contract.

1. 7. 4. Unavoidable Delays.

If for any reason beyond the control of the Contractor other than as provided for in Art. 1. 7. 3 the work be delayed, the Contractor may be granted an extension of time as provided in Art. 1. 7. 8, but he shall have no right to nor shall he make any claim

whatsoever for damages or additional compensation by reason of the delay.

1. 7. 5. Annulment of Contract.

When the Commissioner deems it advisable in the interest of the State, or if in the event of a National emergency construction be stopped, directly or indirectly, by any National or State agency, he may annul the Contract on 30 days' written notice to the Contractor and, if the Contractor be not in default, payments will be made as provided in Art. 1. 8. 5 for all work done under the terms and conditions of the Contract, except that payments will be made in such amounts as the Commissioner may consider just and proper for such parts of the work that are not fully completed and for that reason not susceptible of classification under the bid prices, and for expenditures in connection with the preparing for and moving equipment to and from the work for which the Contractor is not otherwise compensated. It is understood and agreed, however, that no payments shall be made for any claim for loss of anticipated profits.

Attention is directed to the provisions of Chapter 34, Title 52, of the Revised Statutes, cited herein under Art. 1. 6. 3, whereby, for violation of the Contractor's warranty concerning solicitation of the Contract by others under an agreement or understanding for compensation, the State shall have the right to annul the Contract without liability or in its discretion to deduct from the contract price or consideration the full amount of such compensation.

When the Contract is annulled as above provided the Contractor shall, if so required by the Commissioner, remove promptly any or all of his equipment and supplies from the site of the Project or other property of the State, failing which the Commissioner may remove such equipment and supplies at the expense of the Contractor.

1. 7. 6. Default of Contract.

When, in the opinion of the Engineer, the Project or any part thereof has been abandoned, is unnecessarily delayed, or cannot be completed by the Contractor within the time specified at his rate of progress, or the Contractor is willfully violating any of the covenants of the Contract, or is carrying out the Contract in bad faith, then the Engineer may so certify in writing to the Commissioner, and the Commissioner may declare the Contractor in default on the Contract and notify him to discontinue the Project. The Commissioner may then call on the Surety to complete the Project or may complete it by other means, as he may elect. He may take over any working site procured by the Contractor and may use materials and equipment at the site of the Project and other equip-

ment used elsewhere for the Project at the time of default, and may procure other materials, equipment and all else necessary for the completion of the Project. The Commissioner shall recover the cost of finishing the work of the original Contract, over and above the cost thereof at the original bid prices, by deducting the amount thereof from any moneys due or which may become due the Contractor under the Contract, and when such moneys are insufficient to pay said cost, the amount of said cost in excess of such moneys shall be paid by the Contractor or the Surety.

1. 7. 7. Liquidated Damages.

If the Contractor fail to complete the Project and each and every part and appurtenance thereof fully, entirely and in conformity with the provisions of the Contract within the time stated in the Contract, or within such further time as may have been granted in accordance with the provisions of the Contract, then the Contractor shall and hereby does agree to pay the Commissioner for each and every day, as hereinafter defined, that he is in default on time to complete the work, the amount of 0.02 per cent of the Total Price bid in the Proposal, provided, however, that when said Total Price is less than $100,000 the amount per day shall be $20; which said amount per day is agreed upon by the parties hereto to be liquidated damages, not a penalty. The days in default mentioned above shall be the number of calendar days in default when the time for completion of the Project is specified on the basis of calendar days or a fixed date; and shall be the number of working days in default when the time for completion is specified on the basis of working days. The Commissioner shall recover said damages by deducting the amount thereof from any monies due or that may become due the Contractor, and if said monies be insufficient to cover said damages, then the Contractor or his Surety shall pay the amount due.

1. 7. 8. Extension of Time.

Extension of the time stipulated in the Contract for completion of the Project will be made if and as the Engineer may deem proper, when work under a Change Order as hereinafter provided is added to the work of the Contract; when the work is suspended as provided in Art. 1. 7. 3; and when the work of the Contractor is delayed on account of conditions, other than daily weather conditions, which in the opinion of the Commissioner warrant such extension; provided, however, that no extension on account of delay will be granted unless notice of such delay, and of the Contractor's intention to claim an extension of time be given the Engineer, in writing, within 5 days after the beginning of such delay, and said notice shall give complete information of the nature, cause and probable extent of the delay. Extensions of time shall be binding only when issued in writing.

SECTION 8

Measurement and Payment

1. 8. 1. Measurement of Quantities.

All work completed under the Contract will be measured for payment by the Engineer according to United States standard measures.

1. 8. 2. Scope of Payment.

The Contractor hereby agrees to accept payment as provided in Art. 1. 8. 5 as full payment for performing and completing the Project, for furnishing all labor, materials, equipment, transportation and all else necessary therefor, for all incidental expenses in connection therewith, for loss by damage to or destruction of the Project as provided in Art. 1. 6. 6, for any additional expenses on account of unforeseen difficulties encountered, for settlement of claims, and for replacement of defective work and materials for one year after acceptance of the Project by the Commissioner.

1. 8. 3. Adjustment of Estimated Quantities.

When the Project is completed, the authorized quantities of the various items scheduled in the Proposal and placed in the Project will be measured. When these quantities are greater or less than the corresponding estimated quantities stated in the Proposal, Change Orders will be issued by the Engineer to cover the difference between estimated and actual quantities, and no payment will be made for work done in excess of the quantities stated in the Proposal until such Orders have been issued and approved.

1. 8. 4. Change of Plans.

It is understood and agreed, that the Commissioner may change the Plans so as to increase or decrease the quantities of work to be performed or materials to be furnished under the various items scheduled in the Proposal at the unit bid prices, except as otherwise hereinafter provided, and such changes will be authorized by the issuance of fully executed Change Order DC-12. The Order will show in detail the kind and quantity of work to be performed or omitted, or of materials to be furnished or omitted, the amount to be added or deducted from the Total Price bid in the Proposal for each scheduled item increased or decreased by the Order, and the number of days, if any, that will be added to or deducted from

the time for completion stipulated in the Contract on account of the added or decreased work covered by the Order. The Contractor shall do no work and furnish no materials, except as shown on the Plans, until he has received a copy of said Change Order duly approved. If the Contractor refuse to accept said Change Order he may be declared in default as provided in Art. 1. 7. 6.

Major items, as hereinafter defined, and foundation excavation and bearing piles whether they be major items or not, shall be eligible for negotiation of price adjustment if the quantities of any such items be increased or decreased more than 25 per cent (except as otherwise provided in Art. 2. 6. 4, Foundation Excavation, Quantity and Payment), provided the Project is prosecuted to completion. If a quantity be increased as provided above, only the quantity in excess of 125 per cent of the original quantity shall be eligible for such negotiation except as otherwise provided for Foundation Excavation in Art. 2. 6. 4. If a quantity be reduced as provided above, the revised quantity after the reduction shall be eligible for such negotiation.

Any adjustment of unit prices as specified above shall be limited as follows:

1. When the quantity of the item is increased more than 25 per cent, adjustment of the unit price shall not exceed 15 per cent.
2. When the quantity of the item is reduced more than 25 per cent, adjustment of the unit price shall not exceed the lesser of (a) or (b) as follows:
   (a) 15 per cent.
   (b) A percentage, or price differential, such that the product of the adjusted unit price multiplied by the total revised quantity of the item, will equal 75 per cent of the original quantity multiplied by the unit price bid.

A major item is defined as any scheduled item of the Proposal which amounts to more than 10 per cent of the Total Price bid, based on the original quantity of the item multiplied by the unit price bid.

Negotiations for the adjustment of the unit price of any item will be completed only when that item and other work or items affecting its quantity have been completed and the total net change in the quantity of such item can be ascertained with sufficient accuracy to determine if it be eligible for consideration in accordance with the foregoing provisions, except as otherwise provided in Art. 2. 6. 4 relating to additional depth of Foundation Excavation.

If, upon completion of negotiations, the Department find there is not sufficient hardship to the Contractor or the State, by reason of changes in quantities of any eligible items, to warrant

adjustment of unit bid prices, payment for the entire revised quantities of such items will be made at the unit bid prices.

If, at the time of a proposed change in the quantity of a scheduled item, either party to the Contract deem such item to be eligible for price adjustment in accordance with the foregoing provisions, the Change Order therefor shall be executed at the unit bid price and the prospective claimant shall give the other party written notice, at that time, of intention to make request for price adjustment. Upon such notice by either party, the Contractor shall afford the Engineer opportunity to modify the design or construction procedure or both, and opportunity and facilities for ascertaining the cost to the Contractor of the work already performed and for keeping account of the cost of any remaining work to be performed, under that item. If such notice be not given or such opportunities and faciliies be not afforded by the Contractor, he shall and does hereby agree to waive claim for price adjustment of the item of work involved. If such notice be not given by the Department, it shall and does hereby agree to waive claim for such price adjustment.

Adjustment of prices as provided above shall be for the benefit of either party to the Contract, whichever is adversely affected by the change of quantities.

The foregoing provisions regarding adjustment of prices of major and other specified items shall not apply in the case of changes in quantities caused by suspension of the work or annulment of the Contract.

Subject to the above provisions and to a complete presentation of the Contractor's actual costs, the Commissioner may enter into supplementary agreements with the Contractor for changes in the contract prices of scheduled items, in equity to both parties to the Contract. However, under any such agreements the Contractor shall not be paid for loss of anticipated profits.

It is further understood and agreed that the Commissioner and the Contractor may enter into supplementary agreements, executed on Change Order DC-12 forms, for the Contractor to furnish materials or perform work of a kind not susceptible of classification under any of the items scheduled in the Proposal. The Change Order shall state the kind and character of such work to be performed or materials to be furnished under the supplementary agreement and the amount to be paid therefor, and the number of days, if any, that will be added to or deducted from the time for completion stipulated in the Contract on account thereof. The work and materials covered by the supplementary agreements shall conform to the requirements therefor of the Specifications. The amount to be paid the Contractor for performing the work or furnishing the materials covered by the supplementary agreements may be determined at the discretion of the Engineer on a lump

sum or unit price basis, or on the basis of actual cost to which a percentage of the actual cost or a fixed sum is added. If the Contractor fail to execute the Change Order for the supplementary agreement, the Commissioner may have the materials furnished or the work performed by others, and the Contractor shall not interfere therewith. If any acceptable materials may have been furnished, which cannot be used on account of the supplementary agreement, such materials may be purchased from the Contractor at the actual cost to the Contractor and shall then become the property of the State, or other allowance may be made therefor as approved by the Engineer.

On Federal Aid projects, all changes of Plans and other modifications of the Contract shall be subject to approval by the Bureau of Public Roads before they shall become effective.

1. 8. 5. Payment.

Payment will be made for the actual quantity of authorized work done under each item scheduled in the Proposal at the unit price bid therefor, except as otherwise provided in Art. 1. 8. 4, and under supplementary agreements, if any, at the price or prices stipulated therein.

Monthly certificates will be made of the approximate quantities of work done during the preceding month and payments on account therefor will be made based on the prices bid in the Proposal and stipulated in supplementary agreements, if any, except that 10 per cent of the amount due on such partial payments, on the first 50 per cent of the Total Contract Price, will be withheld from the Contractor pending completion of the Contract. Thereafter, on the remaining 50 per cent of the Total Contract Price, no percentage of the partial payments will be withheld from the Contractor pending such completion of the Contract. The monthly certificates and payments on account will also include 80 per cent of the value of materials furnished but not incorporated in the work, as determined by the Engineer, provided that such materials have been delivered at or near the site of the work, are properly stored and protected and have been inspected and approved, and that the Contractor has furnished the Engineer with satisfactory releases of liens for said materials; and provided further, that if claims have been filed with the Commissioner against the Contractor, sufficient money may be withheld to satisfy such claims until they have been satisfied.

When the Project is completed and accepted by the Commissioner, a final certificate of cost of the Project will be made by the Engineer, based on the actual As Built quantities of authorized work done under each item scheduled in the Proposal and under supplementary agreements, if any, at the unit price or prices stipulated therein. When this final certificate is approved, the money due the Contractor for the performance of the Project as deter-

mined by said final certificate, after deduction of previous payments on account, will be paid the Contractor, provided however, that before such final payment is made the following requirements shall be satisfied: (a) there shall be no outstanding claims against the Contractor filed with the Commissioner, (b) the Contractor shall have paid all due obligations and shall have furnished, when directed by the Engineer, receipted bills or other satisfactory evidence that all obligations incurred by him and by his subcontractors in carrying out the Project have been satisfied, and (c) the Contractor shall have delivered a bond as hereinafter specified in Art. 1. 8. 7.

If it be determined by the Engineer that the final certificate of cost cannot be made and approved as provided above within 2 months after acceptance of the Project, payment will be made, at the request of the Contractor, for 100 per cent of the value of the completed work, upon acceptance of the Project and approval of a conditional final certificate of cost therefor by the Commissioner, as closely as such value can be ascertained at that time, after deduction of previous payments on account; provided (1) that, if the subsequent approved final certificate of cost shows that the Contractor has been underpaid or overpaid, adjustment shall be made in favor of the Contractor or of the State, respectively; (2) that such payment shall be subject to the conditions and requirements specified under (a), (b) and (c) in the foregoing paragraph; and (3) that before such payment is made the Contractor shall furnish to the Commissioner a satisfactory Surety Corporation bond, for a sum of not less than 10 per cent of the adjusted contract amount, which shall guarantee reimbursement to the State by the Contractor of any overpayment that may have been made to him on the conditional final certificate of cost if the adjusted contract amount thereof be more than that shown on the subsequent approved final certificate of cost.

When the work is suspended as provided in Art. 1. 7. 3, a semifinal certificate may be made at the discretion of the Engineer. This certificate will show the cost of the work completed and the estimated cost to complete the work, based on the unit prices bid and the quantities scheduled in the Proposal as amended by Change Orders, if any, except that for such parts of the work that are not fully completed at the time of suspension of the work and for that reason are not susceptible of estimate as above provided, the estimated cost to complete will be determined by the Engineer. When the semifinal certificate is approved, payment will be made to the Contractor in the sum of the cost of the work completed after deduction of previous monthly payments on account and deduction of 25 per cent of the estimated cost to complete the work determined as described above, provided, however, that before said payment is made the following requirements shall be satisfied:

(a) there shall be no outstanding claims against the Contractor filed with the Commissioner, (b) when directed by the Engineer, the Contractor shall have furnished receipted bills or other satisfactory evidence that all obligations incurred by him and his subcontractors in carrying out the work have been satisfied, and (c) the Contractor shall have delivered a bond as hereinafter specified in Art. 1. 8. 7.

Before semifinal payment will be made, the Contractor shall execute and deliver a release substantially in the following form:

> "In consideration of the above payment (I) (we) hereby release the State of New Jersey, the State Highway Commissioner and his agents from all claims and liability of whatsoever nature for anything done or furnished or in any manner growing out of the performance of the Project, except that it is understood that credit will be given in the final certificate for the amount, covering 25 per cent of the estimated cost to complete the work, which has been deducted in the semifinal certificate."

Before payment will be made for 100 per cent of the value of the Contract based on a conditional final certificate of cost, subject to the furnishing of a bond guaranteeing reimbursement of the State for any overpayment, as hereinabove provided, the Contractor shall execute and deliver a release substantially in the following form:

> "In consideration of the above payment (I) (we) hereby release the State of New Jersey, the State Highway Commissioner and his agents from all claims and liability of whatsoever nature for anything done or furnished or in any manner growing out of the performance of the Project, except that it is understood that credit will be given on the final certificate of cost for any monies due for increased quantities that may be indicated by the As Built survey and Plans."

Before final payment based on the final certificate of cost and actual As Built quantities will be made, the Contractor shall execute and deliver a release substantially in the following form:

> "In consideration of the above payment (I) (we) hereby release the State of New Jersey, the State Highway Commissioner and his agents from all claims and liability of whatsoever nature for anything done or furnished or in any manner growing out of the performance of the Project."

The acceptance by the Contractor of payment of said final, conditional final, or semifinal certificate shall operate as and shall be a release to the State, the Commissioner and his agents from all

claims of, or liability to, the Contractor for anything done or furnished for or relating to the Project, or any act or neglect of the State, the Commissioner or any person, relating thereto, except for the credits specified in the release forms hereinabove set forth, and except that in the case of semifinal certificate being paid as above described the Contractor has the right and is obligated to continue and complete the Project when notice to resume has been received by him.

1. 8. 6. Termination of Responsibility.

When all the work included in this Contract has been accepted by the Commissioner and the final or a conditional final certificate has been paid, the Project shall be considered as completed, and the Contractor shall be released from all further obligations and requirements, except as set forth and provided in Art. 1. 5. 8 and 1. 8. 7 and as provided in Art. 1. 8. 5 regarding reimbursement to the State of any overpayment to the Contractor on a conditional final certificate.

1. 8. 7. Guaranty Against Defective Work.

Before final, conditional final, or semifinal payment is made as provided in Art. 1. 8. 5, the Contractor shall furnish a surety corporation bond to the Commissioner in a sum equal to 5 per cent of the Contract price. The bond and the surety corporation shall be satisfactory to the Commissioner. The bond shall remain in full force and effect for a period of 1 year from the date of acceptance of the Project by the Commissioner and shall provide that the Contractor guarantees to replace for said period of 1 year all work performed and all materials furnished that were not performed or furnished according to the terms and performance requirements of the Contract, and make good the defects thereof which have become apparent before the expiration of the said period of 1 year.

If, in the judgment of the Engineer, any part of the Project need be replaced, repaired or made good during the specified guaranty period, for the reasons stated above, he will so notify the Contractor in writing. If the Contractor refuse or neglect to start such work within 5 days from the date of service of such notice or at such other time as the Engineer may direct, or if he fail to complete such work within the time prescribed by the Engineer, then the Commissioner will have the work done by others and the cost thereof shall be paid by the Contractor or his Surety. Before the Surety is released from its bond, the Engineer shall certify in writing that the foregoing obligations have been duly performed.

SECTION 9

County and Municipal Projects

State Aid

1. 9. 1. Amendments.

For County and Municipal Projects (State Aid), the provisions of Division 1 of these Standard Specifications shall apply except as hereinafter provided.

When the words Commissioner or Department, and the word State, occur in the text of Division 1 except in Art. 1. 1. 3 and except hereinafter in amendments to Art. 1. 3. 1, 1. 3. 4, 1. 4. 7, 1. 7. 1 and 1. 7. 2, their meaning shall be Board, and Municipality or County, respectively.

Art. 1. 1. 3 is amended and added to as follows:

BOARD shall mean the county or municipal body, legally constituted to enter into contracts for highway and bridge construction and to make payments therefor.

COUNTY OR MUNICIPALITY shall mean the political subdivision of the State of New Jersey as represented by the Board.

Engineer shall mean the engineering representative of the Board.

Art. 1. 2. 2 is amended to provide that the prequalification requirements, if any, shall be those of the Board or as prescribed in the Supplementary Specifications.

Art. 1. 2. 6 is amended as follows:

The certified check shall be made payable to the Treasurer of the County or Municipality.

A Proposal Bond will not be required except when provision is made therefor in the Supplementary Specifications and, when so provided, it shall be executed on the form furnished by the County or Municipality with the form of proposal.

Art. 1. 2. 7 is amended to provide that the Proposal Bond and the Financial and Plan and Equipment Statements will not be required unless provision is made therefor in the Supplementary Specifications and forms therefor are furnished with the proposal form.

Art. 1. 2. 9. The provision in Art. 1. 2. 9 for rejection of Proposals that are not accompanied by a Proposal Bond does not apply unless a requirement for a Proposal Bond is provided in the Supplementary Specifications.

The reference to Art. 1. 2. 2 in this Article shall be construed to mean Art. 1. 2. 2 as amended hereinabove.

Art. 1. 2. 11. Paragraph 2 of this Article does not apply.

Art. 1. 3. 1. The following is added to this Article.

The award shall be subject to the approval of the Commissioner.

Art. 1. 3. 4 is amended to provide that the bond shall conform to the provisions of R. S. 27:14-12 and shall be in the form prescribed by the Board.

Art. 1. 3. 5 is amended to provide that the 10-days period applies after the date of approval of the award of Contract by the Commissioner.

Art. 1. 3. 6 is amended as follows:

The provision for recovering under the Proposal Bond does not apply except when such a bond is required by the Supplementary Specifications.

Art. 1. 3. 7 is amended as follows:

When the value of the work to be sublet is $25,000 or more, the subcontractor shall be prequalified if required by the Board and according to the regulations of the Board or to the requirements that may be prescribed in the Supplementary Specifications.

When prequalification is required, application shall be made to the appropriate official of the Board on forms furnished, and in the manner prescribed, by the Board, and there shall be submitted on or with the application such prequalification statements as the Board may require or as may be prescribed in the Supplementary Specifications.

Art. 1. 4. 5 is amended to provide that the field office requirements do not apply except when prescribed in the Supplementary Specifications.

Art. 1. 4. 7. The provisions of Art. 1. 4. 7 shall apply except that the Contractor will not be required to sample and test soils and no charges will be made against the Contractor for any sampling and testing performed by the State, County or Municipality.

Art. 1. 5. 2. The provisions of Art. 1. 5. 2 pertaining to the furnishing, issuing and charges for Plans and Specifications do not apply. A charge of $5.00 will be made for each and every copy of Standard Specifications furnished.

Art. 1. 7. 1. The first sentence of Art. 1. 7. 1 is amended to provide that the Contractor shall commence work within 20 days after the date of approval by the Commissioner of the award of Contract except that no work shall be performed prior to the execution of the Contract.

Art. 1.7.2. The following is added to this Article:

When the progress and time of completion are stated in terms of calendar days, these will be counted starting 20 days after the date of approval by the Commissioner of the award of the Contract, or starting from the date of execution of the Contract by the County or Municipality, whichever is the later.

Art. 1.7.7 shall apply only when so specified in the Supplementary Specifications, and the amount of liquidated damages, if any, shall be as specified therein. However, if the Contractor be in default on the time to complete the Project, as specified, he shall be charged with all Project inspection costs accruing after the specified completion time and any extensions thereof that may have been granted.

Art. 1.8.4 is amended as follows:

In the first sentence of paragraph 1 the words "except as otherwise hereinafter provided" do not apply.

In paragraph 1 "form DC-12" is changed to "form SA-1."

Paragraph 1, page 50, to paragraph 4, page 51, inclusive, shall not apply.

In paragraph 5, page 51, "DC-12 forms" are changed to "SA-1 forms."

Art. 1.8.5 is amended as follows:

Paragraph 2 pertaining to monthly certificates and payments on account applies only when so provided in the Supplementary Specifications.

In the first sentence of paragraph 3 the words "As Built" do not apply.

Paragraph 4 does not apply.

Paragraphs 8 and 9, pertaining to releases prior to payment for 100 per cent of the value of the Contract based on a conditional final certificate, do not apply.

In paragraph 12, the reference to conditional final certificate does not apply.

Art. 1.8.6. The reference to a conditional final certificate does not apply.

Art. 1.8.7 is amended to provide that the bond shall conform to the provisions of R. S. 27:14-14.

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DIVISION 2

Earthwork

SECTION 1

Clearing Site

2. 1. 1. Description.

Clearing site shall consist of the work of clearing the site of the Project within the limits hereinafter specified, including the removal and resetting of street and road signs and mail boxes, removal of trees and grubbing, removal of existing bridges and other structures and other work as herein described. Dwellings and other buildings, except cellar floors, foundations and foundation walls below the ground surface, will be removed from the right of way by the owners or their agents or will be removed or demolished by the Department under separate contracts, unless provision is made in the Plans or Supplementary Specifications for their demolition or removal under the Contract. When buildings are prescribed to be demolished or removed by the Contractor and items therefor are not scheduled in the Proposal, such demolition or removal shall be performed as a part of the work of clearing site.

Demolition work under the Contract shall be performed in accordance with the requirements therefor as hereinafter specified under the heading Demolition of Buildings.

2. 1. 2. Materials.

Tree paint shall comply with the requirements therefor specified in Art. 8. 3. 5.

2. 1. 3. Methods of Construction.

The site of the Project shall be cleared within the limits of construction. The ground surface shall be cleared of all trees, brush, weeds, roots, matted leaves, small structures, debris and other unsuitable matter, except as otherwise hereinafter provided. Tree stumps shall be grubbed out except that they may remain extending not more than 1 foot above the ground surface where the proposed pavement subgrade will be more than 3½ feet above the ground surface.

2. 1. 3.

CLEARING SITE

Trees, shrubs and other landscape features within the limits of construction which do not interfere with the Project and are shown on the Plans or designated by the Engineer for preservation shall not be removed but shall be protected during the progress of the work in a manner satisfactory to the Engineer, and shall be trimmed of overhanging branches to a height of 16 feet above the roadway.

All dead trees and those which die during the life of the Contract, along the edge of wooded areas remaining after clearing site, shall be removed. Individual free-standing trees within the right of way but outside the limits of construction which are dead or which shall have died during the life of the Contract shall be removed. Such removals shall be a part of the work included in Clearing Site.

In the performance of clearing site, the Contractor shall be responsible for the preservation of all public and private property, existing trees, plants and other vegetation that are to remain within or adjacent to the highway and shall use every precaution necessary to prevent damage or injury thereto. He shall give special attention to the protection of the natural vegetation and other existing landscape features and surroundings. At locations adjacent to operations performed by motorized equipment, the Contractor shall erect and maintain 4-foot high, red-painted snow fence around all trees and areas containing vegetation which are to be preserved. The Contractor shall repair all injuries to bark, trunk, limbs, and roots of remaining plants by properly dressing, cutting, tracing and painting, using only approved tree surgery methods, tools and material, and shall replace to their original condition, by approved seeding methods and materials, all grass areas beyond the limits of construction which have been damaged by his work. The Contractor shall not remove, cut, injure or destroy trees or shrubs outside the limits of construction without authority of the Engineer.

When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct, on the part of the Contractor in the execution of the work, such property shall be restored by the Contractor, at his expense, to a condition equal to that existing before such damage or injury was done, or he shall make good such damage or injury in such other manner as may be acceptable to the Engineer.

Selective thinning and other landscaping treatment of areas within the right of way but outside the limits of construction shall be as provided on the Plans and in accordance with the provisions of Division 7, Landscaping, and such work shall not be considered a part of the work of clearing site.

The removal and disposal of elm trees in all counties of the State are subject to provisions of State laws and to regulations of

the State Department of Agriculture. Before removing any trees within the site of the Project the Contractor shall consult the Plant Pathologist of said department and shall comply with his instructions relating to the removal of elm trees and the marking, segregation and disposal of elm wood. The Contractor shall submit to the said Plant Pathologist an "Application for Instructions for Disposal of Encountered Elm Wood" on the form supplied with the notification of award of the Contract.

R.F.D. mail boxes shall be removed carefully and shall be reset at the exact locations approved by the owners and by the Engineer so as to be accessible to the postman without his leaving the mail truck.

Street and road signs shall be removed carefully and shall be reset at the exact locations and in the manner required by the public authorities having jurisdiction thereof.

Existing bridges and other structures within the Project which are to be removed by the Contractor shall be taken down and disposed of as may be specified. If needed for maintenance of traffic until new structures have been built, they shall not be removed until provisions for traffic, satisfactory to the Engineer, have been made. Cellars of houses, cesspools and similar cavities shall be cleaned out.

Materials accumulated by clearing, grubbing, removal of bridges and other structures and cleaning out as above described shall be disposed of by the Contractor at sites to be provided by him outside the property of the State and out of sight from any State highway, in a manner satisfactory to the Engineer, except that materials suitable for embankment shall be used for that purpose if needed therefor, and that wood, trees and brush cleared from the site may be burned within the limits of the right of way by approval of the Engineer, and in conformance with State and local laws and regulations, at such places and times, and in such manner, that adjacent forests, and vegetation which is to be preserved, shall not be damaged by fire.

Demolition of Buildings. Buildings shall be demolished or removed from the right of way by the Contractor if and where specifically provided for in the Plans or Supplementary Specifications except as otherwise hereinafter provided. The work shall consist of complete demolition or removal of the buildings including removal of equipment and fixtures, foundation walls above the ground, concrete floors (except in cellars), porches, steps, sheds, garages, barns and other outbuildings, concrete, masonry and timber structures, fences, hedges, gasoline pumps, islands and tanks, and other miscellaneous structures appurtenant to the buildings shown to be demolished; disconnecting and terminating utility service facilities; cleaning out of cellars; refilling of cellars unless otherwise specified; breaking up concrete and masonry cellar floors

for drainage; constructing sidewalk canopies and barricading open cellars where necessary for protection of the public; the removal and disposal of materials and debris; final cleaning up of the site and other incidental work.

With regard to any building or group of buildings scheduled for demolition or removal by the Contractor under a separate item of the Proposal, the Department reserves the right to occupy any such building or group of buildings or to sell and remove it from the right of way, and to eliminate such item of demolition or removal from the Contract, without claim for compensation by the Contractor.

Buildings which are provided to be demolished or removed under the Contract shall not be destroyed by burning but shall be torn down or moved to new locations outside the right of way of the Project and outside other right of way proposed or contemplated for acquisition by the State.

It shall be the responsibility of bidders to ascertain, by their own inspection and investigation, the sizes and condition of buildings, their types of construction, data concerning equipment and fixtures in, or a part of, the buildings, whether or not such information be shown or given in the Plans, Specifications or other contract documents, and to make such other investigations that may be necessary for a complete understanding of the work to be performed. Bids shall be based on the bidders' own findings.

Attention is directed to the last paragraph of Art. 1. 2. 11 regarding information to be obtained from the Director, Division of Right of Way Acquisition and Titles.

The Department does not guarantee that the condition and contents of buildings will be the same at the time of starting work as they were when bidders inspected the site or prepared their bids; neither does the Department assume any responsibility for destruction or loss due to fire, theft or vandalism that may occur prior to the time that the Contractor takes possession of the buildings for demolition. The Contractor shall accept buildings in the condition prevailing at the time they are made available to him for demolition.

The Contractor shall not start the demolition of any building before he has been notified by the Engineer that the building is available for demolition. He shall not start the demolition of any building that will damage, or jeopardize occupancy or use of, an attached or adjacent building that is proposed for demolition before such attached or adjacent building is declared by the Engineer to be available for demolition. The demolition of buildings attached or adjacent to other buildings that are not to be demolished under the Contract shall be performed carefully to prevent damage to such other buildings and so that occupancy or use thereof is not

jeopardized. Damage to attached or adjacent buildings due to violation of the foregoing provisions, or otherwise caused by the Contractor's work, shall be repaired and made good by the Contractor without specific payment therefor and the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

All building materials, fixtures and equipment in, attached or belonging to, the buildings at the time they are declared available for demolition shall become the property of the Contractor unless otherwise provided in the Supplementary Specifications or in the right of way agreements with the owners.

All building materials, equipment, fixtures and debris shall be removed from cellars of buildings demolished or removed by the Contractor. Concrete and masonry cellar floors shall be broken into pieces having areas of not more than 4 square feet with well defined cracks through the full depth of the floors, or holes of not less than 1 square foot area shall be made through the floors on approximately 10-foot centers, to provide vertical drainage. Cellar floors of wood shall be removed.

Materials and debris shall not be placed or stored within the limits of any existing street. The parking, loading and operation of trucks on existing highways or streets shall be governed by existing laws, ordinances and regulations and by the pertinent provisions of Art. 1. 4. 3.

Cellars of buildings demolished or removed by the Contractor shall be filled with suitable embankment material to be approved by the Engineer. Cellar fills shall be placed and compacted to a density of not less than 95 per cent by the Dry Fill, Density Control method specified in Art. 2. 3. 3.

Wherever necessary for protection of the public or where required by State or local laws, regulations or ordinances, the Contractor shall construct and maintain adequate sidewalk canopies abutting the buildings to be demolished and substantial barricades or fences closing off open cellars.

Prior to the demolition of any building, the Contractor shall provide for the disconnection and termination of all water, sewer, gas, electric and telephone service facilities that are connected to the building, in conformance with the requirements of municipalities and utility companies owning or controlling them. The Contractor shall notify the municipalities and utility companies of the time any such disconnections may need be made and he shall perform the work according to their standard practices and requirements and under their supervision, or arrange for its performance by their forces. The cost of any and all such utility work, including charges, if any, which may be made by the municipalities and utility companies, shall be borne by the Contractor and shall be included in the prices bid for the various demolition items.

2. 1. 3.

CLEARING SITE

Prior to acceptance of the Project all materials and debris accumulated from demolition of buildings and from other work in connection therewith shall be removed from the site of the Project and shall be disposed of by the Contractor as hereinbefore specified for the disposal of materials accumulated by clearing and grubbing. The ground surface shall be graded, if necessary, to eliminate water pockets and the entire site of the Project shall be cleaned up and left in a condition satisfactory to the Engineer. If cellars are not required to be filled under the Contract, barricades or fences that have been erected adjacent thereto shall be left in place for the protection of the public, unless the Engineer orders their removal.

2. 1. 4. Quantity and Payment.

The quantity of Clearning Site for which payment will be made will be a lump sum covering all the work of clearing site specified above, including the required removal of bridges and structures and the demolition or removal of buildings for which payment is not provided under other scheduled items of the Proposal.

Payment for Clearing Site will be made for the quantity as above determined at the lump sum price bid for the item CLEARING SITE in the Proposal, which price shall include the cost of clearing, demolition of buildings and removal of existing bridges and structures included in the Contract except as otherwise hereinafter provided, grubbing, cleaning out cesspools, disposal of elm trees and other accumulated materials, the removal and resetting of mail boxes and road and street signs, all as above described, all materials, labor, equipment and all else necessary therefor and incidental thereto; provided, however, that when the item Clearing Site is not scheduled in the Proposal the cost thereof shall be included in the prices bid for other items scheduled therein.

Payment for Demolition of Buildings, if building demolition items are scheduled in the Proposal, will be made for the number of buildings, or groups of buildings, actually removed or demolished by the Contractor, at the prices bid for the various items DEMOLITION OF BUILDINGS in the Proposal, which prices shall include the performance of all the work of demolition hereinbefore specified in Art. 2.1.3 under the heading Demolition of Buildings, the cost of furnishing all labor, materials and equipment and all else necessary therefor and incidental thereto and shall include the filling of cellars when no item for borrow excavation or for roadway excavation is scheduled in the Proposal. Attention is directed to the provisions of paragraph 2 under the subheading "Demolition of Buildings" hereinabove.

If items are scheduled therefor in the Proposal, payment will be made for the removal of bridges at the lump sum price or prices

bid for the item or items CLEARING SITE, REMOVAL OF BRIDGES, in the Proposal, which price or prices shall include the cost of removal of the bridges, clearing of stream bed and bridge site, disposal of material and all else necessary therefor and incidental thereto.

SECTION 2

Roadway Excavation

2. 2. 1. Description.

Roadway excavation shall consist of the excavation and removal of all earth, rock, boulders, brick, stone and concrete masonry, small structures and other materials encountered of whatever nature, required for the construction of roadways and their appurtenances, exclusive of those materials provided for payment under other items scheduled in the Proposal; the transportation of the excavated materials; the construction of embankments with the materials excavated; the disposal of unsuitable and surplus materials; and other work as herein described.

Roadway excavation other than Wet excavation may be provided for in the Contract as Earth, as Unclassified, or on a classified basis as Earth and Rock.

Unclassified excavation shall consist of the removal of earth, rock and all other materials encountered of whatever nature.

Earth excavation shall consist of the removal of all materials encountered except rock as hereinafter defined.

When roadway excavation is classified, **rock excavation** shall include only such rock that cannot be removed by means of a 1½-yard power shovel, in good condition and properly operated, without continuous drilling and blasting, and boulders and masses of concrete and existing rock fragments more than ½ cubic yard in volume.

Wet excavation shall consist of the removal and disposal of muck, mud, swamp, bog and other unstable materials that cannot be excavated practicably by ordinary dry excavation methods and equipment, and shall include the removal of all other materials and objects of whatever nature encountered within the prescribed limits of wet excavation except those materials that are removed as a part of the work of Clearing Site.

Pavement excavation shall consist of the removal of reinforced and nonreinforced concrete pavement courses including any overlying surface courses.

2. 2. 2. Materials.

No materials are involved.

2. 2. 3. Methods of Construction.

Before grading work is commenced, the vegetation and underlying topsoil within excavation and embankment areas shall be stripped off to a depth of not less than 4 and not more than 6 inches below the existing ground surface, where shown on the Plans or directed by the Engineer. Stripped material which is or may be made suitable for topsoiling shall be stored and used therefor if needed. Stripped topsoil in excess of the quantity required for the Project topsoiling shall be stored at locations specified or shown on the Plans, for future use of the State. Topsoil shall not be stored in areas where it will interefere with surface drainage or with the conservation of trees, shrubs and other vegetation that are to remain.

Roadway excavation shall be carried to the lines, grades and slopes shown on the Plans.

Whether the excavation be classified or unclassified, rock and boulders shall be excavated to the subbase subgrade (or to bottom limits shown on the Plans if a subbase course is not provided for) between lateral limits 1 foot outside the shoulders or front face of curbs, and to the neat bottom lines of excavation shown on the Plans in median, island, sidewalk and berm areas. Rock shall be excavated and finished to fairly uniform slopes, parallel to the prescribed slope lines shown on the Plans, no point on which shall be more than 1 foot inside or outside such prescribed slope lines, measured normal thereto, except that all pieces of rock outside the slope surfaces as excavated which have been loosened or may become loose, in the opinion of the Engineer, on account of the Contractor's operations, shall be removed.

Any space created by rock excavation in pavement, shoulder and curb areas, below the prescribed bottom limit of excavation, shall be backfilled with the specified subbase material when a subbase course is provided for in the Contract, or with a granular material as specified in Art. 2. 3. 3 when a subbase course is not provided for. In other areas, any space which may be excavated below the prescribed limits of rock excavation shall be backfilled with material as specified in the Supplementary Specifications.

Cellar walls and other foundations shall be removed to a depth of not less than 2 feet below the proposed pavement subgrade. Earth slopes, shoulders and other formed surfaces shall have a neat finish. When permission is given to widen an excavation to obtain additional embankment material, the slopes and other surfaces of the widened work shall be neatly finished to the lines prescribed by the Engineer, and shall be topsoiled and seeded, if and as directed, without additional compensation. Road-

way excavation shall be carried out so that the subgrade throughout the work is kept properly drained. Unless otherwise prescribed, a plough furrow, 6 inches deep, shall be cut in the existing ground surface, approximately 4 feet outside the slope line at the top of the excavation, and turned toward the excavation. Drainage cutoff ditches shall be excavated outside the top of excavation slopes if shown on the Plans or directed.

Unless otherwise prescribed in the Supplementary Specifications, all excavation material, including rock, that is not required for ordinary backfill for structures shall be placed in Zone 3 upland or swamp embankment as defined in Art. 2. 3. 1, in so far as space is available therein and the material conforms to the requirements for Zone 3 material as specified in Art. 2. 3. 2. Excavation material in excess of these requirements, and all unsuitable materials, shall be disposed of by the Conrtactor outside the limits of the Project at places to be provided by him, except as otherwise hereinafter provided for excess rock disposal within the Project limits. Excavation material suitable and needed for Zone 3 upland or swamp embankment, or for ordinary backfill for structures, that is used for other purposes, or that is wasted, shall be replaced with the specified Zone 3 embankment material, at the Contractor's expense. If the Supplementary Specifications prescribe that a portion or portions of the excavation material be used for purposes other than Zone 3 embankment, any of such excavation material that is wasted or used for purposes other than prescribed shall be replaced with material conforming to the requirements specified for the purpose for which the wasted or misused material was prescribed, at the Contractor's expense.

Unstable or unsuitable material encountered at the prescribed bottom limits of roadway excavation in upland areas shall be removed within the limits of the proposed pavement and shoulders or within such other limits as may be directed by the Engineer. The excavated areas shall be backfilled with suitable, approved material obtained from roadway excavation or borrow excavation, or with subbase material, as directed. The backfill shall be placed and compacted as specified for embankment, or as specified for subbase if this be used. When the unstable or unsuitable material removed is not wet excavation as hereinbefore defined, it shall be excavated and paid for as roadway excavation, earth, or unclassified, whichever is scheduled in the Proposal.

Rock shall be excavated and placed, and the work of excavation and embankment shall be arranged, so that all rock, or the maximum amount thereof, will be used in the embankment in accordance with the requirements for embankment as specified in Art. 2. 3. 3. If the Contractor fail to reserve space for the disposal of rock in the embankment, additional borrow excavation that may be necessary on that account shall be furnished and placed by the Contractor without compensation.

In the disposal of rock in embankments, priority shall be given to its use in the deeper embankments. If necessary, rock shall then be placed in progressively shallower embankments except that it shall not be placed within 2 feet of the proposed or future pavement subgrade. If there be rock in excess of that which can be disposed of as specified above within the normal lateral limits of Zone 3 embankment, it shall be used to widen embankments within the Project limits, or deposited along slopes adjacent to streams for slope protection, if and as specified. If no use be specified for surplus rock, it shall be disposed of as hereinbefore provided for the disposal of excess excavation materials.

When separate payment is to be made for rock excavation, the Contractor shall remove the earth cover in advance of the rock in order that proper measurements of its surface may be taken. The Contractor shall keep the Engineer informed of the exposure of the rock surface for measurement. Rock removed prior to such measurements will be measured and paid for as earth.

Existing reinforced and nonreinforced concrete pavement, and concrete bases and their surface courses, shall be removed, and bituminous concrete, block and brick surfaces shall be removed from their concrete base courses, when and as prescribed or as shown on the Plans.

Pavement breakers which involve the use of a ball, weight or punch, dropped mechanically or by gravity, shall not be used in the breaking or removal of pavement within 5 feet of a transverse joint, or within 3 feet of any structure or of a longitudinal joint adjacent to other pavement which is to remain in place. The pavement within such restricted areas shall be broken or removed with equipment and by methods, to be approved by the Engineer, that will not damage the adjacent joint structure, pavement, or other structure which is to remain. Where a partial slab of pavement is to be removed and a juncture with the existing pavement constructed, a generally straight, vertical cut shall be made and the top 2 inches shall be cut with a saw. Pavement breakers as described above shall not be used within 5 feet of the juncture. Concrete shall be carefully removed so as to leave not less than 20 inches of the existing reinforcement steel exposed. This reinforcement shall be incorporated into the new concrete pavement. If any existing transverse expansion joint be damaged by the Contractor's work to such an extent that it will no longer serve its function, in the opinion of the Engineer, the Contractor shall remove such joint, and furnish a duplicate thereof and install it complete, at his own expense.

Wherever feasible, materials from pavement excavation shall be placed in the lower portion of Zone 3 embankment. Broken concrete shall not be left in piles but shall be spread out in layers with the pieces lying flat and not arching, and all spaces between

pieces shall be filled with earth. Each layer shall be compacted by one of the methods specified for compaction of layers of embankment in Article 2. 3. 3, subject to the approval of the Engineer. When such use is not feasible, the broken concrete shall be disposed of outside the limits of the Project at places to be provided by the Contractor. As an exception to the foregoing, broken concrete shall be deposited on embankment slopes along waterways, for erosion control, when and where prescribed or shown on the Plans.

The Contractor shall make his own arrangement with owners of abutting property regarding permission to store topsoil, to dispose of excess and unsuitable excavation materials, to place embankment and other materials, and to excavate, beyond the limits of the right of way and of slope rights acquired for the Project. Where any such materials or excavations remain beyond the prescribed slope lines and outside of the right of way and slope right areas acquired by the State, when the Project is otherwise completed, the Contractor shall obtain and deliver to Engineer written releases from the owners of the abutting properties on whose land such materials or excavation remain. The releases shall be in a form satisfactory to the Engineer and shall protect the State against claims or actions of the owner with respect to the presence of such materials or excavations.

Existing vegetation that is to be preserved within the highway right of way and other property of the State shall be protected against damage from the runoff and spread of topsoil and excavation materials that may be stored or disposed of adjacent to the highway right of way or other State property in accordance with the foregoing provisions. If any vegetation be killed or be dying, in the opinion of the Engineer, prior to or within one year after the date of acceptance of the Contract, as a result of such runoff or spread, the Contractor shall remove all such dead or dying vegetation at his own expense.

Wet Excavation. Wet excavation material shall be removed down to firm bottom and, unless otherwise directed by the Engineer, within the lateral limits shown on the Plans. The Contractor shall regulate the depth of wet excavation according to the directions or approval of the Engineer. After the excavation of any area, all muck, silt and other unsuitable material that enters the prescribed wet excavation area by sloughage, or from any other cause or action whatever, shall be excavated before backfilling is commenced or resumed in that area.

The wet excavation shall be performed by methods and in a manner which will assure the removal of all muck, mud and other unstable materials down to firm bottom within the required limits and so that the unstable materials will not be mixed with the embankment material. The Engineer reserves the right to require

the Contractor to change his methods and equipment if and when the results specified above are not being attained.

The wet excavation shall be completed for a sufficient distance in advance of the filling to afford the Engineer ample opportunity to measure the bottom of the excavation. Minor accumulations of liquefied muck that may have been forced to the sides of the original excavation due to displacement by the fill shall be removed.

The Contractor, at his own expense, shall make soundings, take samples or otherwise test the bottom of the wet excavation area at frequent intervals as the excavation progresses and determine for himself that the entire depth of muck and other unstable materials has been removed down to firm bottom. When the Contractor has completed the wet excavation to firm bottom at the locations where firm bottom is to be cross sectioned by the Engineer, he shall notify the Engineer that the wet excavation areas at such locations are in proper condition to receive the embankment and are ready for measurement. Then the Engineer will take cross sectional measurements of the firm bottom for use in the determination of payment quantities.

After the embankment has been performed up to approximately two feet above water level the Contractor, at his own expense, shall make borings through it down to, and for a depth of 1 to 2 feet below, firm bottom and shall take samples to determine if there be any muck or other unstable material remaining below the bottom of the embankment. The borings shall be made as the embankment progresses and as closely behind the filling operations as conditions will permit. If the wet excavation be performed by suction dredging, one boring shall be made on each 100-foot cross section. If methods other than suction dredging be used, borings shall be made at intervals of 50 feet, longitudinally and transversely. The borings shall be made in the presence of the Engineer at points to be approved by him. The equipment and methods used for making the borings and taking samples, and the number of samples to be taken, shall be subject to approval by the Engineer and shall be such as to assure vertical borings and to provide data from which the elevations of the bottom of the embankment can be determined satisfactorily. Sufficient samples shall be taken to show the quality of the materials within a range of 4 feet at the critical depth necessary to locate the plane or transition between the embankment and underlying materials.

If muck, mud, silt or clay be entrapped within or under the embankment, or between the new and an existing embankment, and the quantity and location or distribution thereof be such as to cause visible unstable areas in the embankment, or to be detrimental to the stability of the embankment or of the proposed or future roadway or structures, in the opinion of the Engineer, the entrapped muck, mud, silt and clay and the overlying Zone 2

material shall be removed and all such excavated areas shall be backfilled with the specified Zone 2 material. No additional compensation will be made for such excavation and backfilling.

The Contractor shall provide 2 adequately equipped rowboats, to be approved by the Engineer, at each location where wet excavation is in progress and he shall provide the Engineer ample space and opportunity for their operation in the work of measuring the bottom of the excavation.

Unless otherwise shown on the Plans or specified in the Supplementary Specifications, all areas of wet excavation outside the prescribed embankment slopes and within the prescribed wet excavation limits shall be refilled to the adjacent meadow level with, and shall be paid for as, borrow excavation. Any areas of wet excavation outside the prescribed wet excavation limits shall be refilled to adjacent meadow level with wet excavation or other approved material at the Contractor's expense.

Wet excavation material shall be disposed of within the disposal sites that may be designated in the Plans or Supplementary Specifications. If sites be not so designated, or if the designated sites will not accommodate all the wet excavation material, the Contractor shall dispose of all such material, or the excess, respectively, at sites to be provided by him, and according to arrangements to be made by him with property owners as hereinbefore specified. Disposal sites provided by the Contractor shall not be located adjacent to any State highway except with approval of the Engineer and provided that, upon such approval, the material shall be graded to a reasonably even, well-drained surface not higher than the adjacent roadway. The provisions hereinbefore specified regarding the permission of property owners for the disposal of excess and unsuitable excavation materials beyond the right of way and slope areas acquired by the State, releases from the owners protecting the State against claims for damage on this account, the protecting of existing vegetation from damage due to the runoff and spread of such materials, and the removal of vegetation that is killed or is dying as a result of such runoff and spread, shall apply to the disposal of wet excavation material.

The Contractor shall conduct his operations within all disposal areas so as not to create conditions dangerous to persons who may be in the area, whether authorized or unauthorized. As the work progresses, the completed portions thereof, as directed by the Engineer, shall be graded and, if necessary, drained to eliminate the formation of pools and other dangerous or undesirable conditions. If the above measures are inadequate or are not being executed properly, the Engineer may require the Contractor to construct temporary fences enclosing unsafe areas and to maintain them until the unsafe conditions have been rectified.

The Contractor shall construct sod or other adequate retaining banks around the perimeters of disposal areas as and where necessary to protect State highways and other roads, railroads, stream channels and adjoining properties against the spread of the wet excavation material. Stream channels and ditches within and adjacent to the Project shall be maintained as at present or as altered by the design of the Project. With respect to the maintenance and protection of water channels, the Contractor shall comply with all regulations and requirements of the Department of the Army and of the New Jersey State Department of Conservation, Division of Navigation and Division of Water Policy and Supply. The disposal of the wet excavation material shall be subject also to the regulations and requirements of the County Mosquito Extermination Commission or Commissions and local authorities having jurisdiction.

2. 2. 4. Quantity and Payment.

Roadway Excavation will be measured in the original position of the excavated materials by the cross section method, and the volumes of earth and rock will be computed by averaging end areas. The quantities for which payment will be made will be the volumes actually removed within the neat lines of excavation shown on the Plans or as directed by the Engineer, except as follows:

Stripping of topsoil will not be measured as roadway excavation. The quantity of Stripping Topsoil for which payment will be made will be the area stripped in accordance with the Plans or as directed by the Engineer, measured in acres.

If rock be entirely removed to within 1 foot of the prescribed slope lines shown on the Plans, measured normal to such slope lines, as hereinabove specified in Art. 2. 2. 3, or if it be removed to a greater width without written order of the Engineer, the lateral payment limits of rock excavation shall be the prescribed slope lines as shown on the Plans.

If rock be entirely removed to the subgrade of the subbase, or to other prescribed bottom limits of excavation, the bottom payment limit or limits of rock excavation shall be the subbase subgrade or other prescribed bottom limits of excavation, respectively.

If the Plans show the earth slope lines above rock as meeting the top edge of the rock, payment for earth excavation above the rock cut shall be for the volume within payment slope lines parallel to the prescribed earth slopes and meeting the top edge of the rock as excavated, provided, however, that such earth payment lines shall be not more than 1 foot outside the prescribed rock slope lines shown on the Plans at the top of the rock cut.

Any material outside the slopes, as excavated, which has been shattered or loosened, or which may become loose, in the opinion of the Engineer, because of blasting or other operations of the

Contractor, shall be removed without compensation in addition to payment as hereinabove specified.

Re-excavation due to slips, slides and other causes will not be measured for payment unless, in the opinion of the Engineer, the slopes shown on the Plans are too steep for stability.

If the excavation be unclassified, the volume for payment shall be equal to the total combined volume of earth and rock, measured and determined as above specified except that the earth and rock will not be measured and computed separately. Where rock is encountered and the excavation is unclassified, payment for unclassified excavation will be made within the payment limits hereinabove specified for earth and rock payment.

When roadway excavation is provided for as earth excavation only and rock is encountered but is not scheduled in the Proposal, payment for the rock will be made at 5 times the unit price bid for the item Roadway Excavation, Earth.

When the item Pavement Excavation is scheduled in the Proposal, the excavation of plain and reinforced concrete pavement and base courses together with any overlying surface courses will be paid for as Pavement Excavation and the quantity thereof for which payment will be made will be the area of concrete pavement or concrete base course actually removed in accordance with the Plans or as directed by the Engineer.

When bituminous concrete, block or brick surface courses are removed from their concrete foundations and an item therefor is scheduled in the Proposal the quantity of Pavement Surface Removal for which payment will be made will be the area of the pavement surface removed in accordance with the Plans or as directed by the Engineer.

The quantity of Wet Excavation for which payment will be made will be the volume actually removed from within the payment limits shown on the Plans, as determined by cross sectional measurements of the original ground surface and of the bottom of the excavation, and by check borings made through the embankment as hereinbefore specified. Payment will not be made for the excavation of muck or other unstable material which enters the excavated area from areas outside of the prescribed payment lines of wet excavation, whether by sloughage or from any other cause or action whatever.

The removal of existing pipes, culverts and other subsurface structures outside the limits of the excavation for new pipes and subsurface structures and the refilling of the spaces left thereby will not be measured for payment, but the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

When permission is given to widen the excavation to obtain additional embankment material, the Contractor shall topsoil and

seed the additional ground surface exposed by such widening, at his own expense and as directed by the Engineer.

Payment for Roadway Excavation, Earth, Rock, and Unclassified as and when scheduled will be made for the quantities of each as above determined, measured in cubic yards, at the prices bid for the items ROADWAY EXCAVATION, EARTH; ROADWAY EXCAVATION, ROCK; and ROADWAY EXCAVATION, UNCLASSIFIED; respectively, in the Proposal, which prices shall include the cost of excavation of the materials encountered; removal of small structures; transportation of the excavated materials; the construction of embankment with the materials excavated; refilling cellars; backfilling in rock excavation as hereinafter specified; the removal of existing pipes, culverts and other structures as specified and the refilling of spaces left thereby; the shaping and dressing of slopes, shoulders, islands and other surfaces; the disposal of all excess and unsuitable materials; cleaning pavements; all labor, equipment and all else necessary therefor and incidental thereto.

The unit price bid for Unclassified Excavation, or for Rock Excavation if classified, also shall include the cost of backfill in rock excavation areas below the prescribed unclassified or rock excavation limits with materials as specified therefor in Art. 2. 3. 3, Embankment, and Art. 2. 9. 3, Subbase. Backfill in rock excavation, above the prescribed rock or unclassified excavation limits, made with borrow excavation or subbase material will be paid for at the respective unit prices bid therefor, or as specified in Art. 1. 8. 4 if such items are not scheduled.

Payment for Stripping will be made for the quantity as above determined, measured in acres, at the price per acre bid for the item STRIPPING in the Proposal, which price shall include the cost of stripping and storing the stripped material, disposal of excess and unsuitable material, all labor, equipment and all else necessary therefor, and all other work in connection therewith and incidental thereto.

Payment for Pavement Excavation and Pavement Surface Removal will be made for the quantity of each as above determined, measured in square yards, at the price per square yard bid for the item PAVEMENT EXCAVATION and PAVEMENT SURFACE REMOVAL, respectively, in the Proposal, which price shall include the cost of excavation, transportation, placing in embankment, on slopes, or other disposal of the material as specified, all labor, equipment and all else necessary therefor and incidental thereto.

Payment for Wet Excavation will be made for the quantity as above determined at the unit price per cubic yard bid for the item WET EXCAVATION in the Proposal, which price shall cover all work as specified and shown on the Plans and all other work

incidental thereto, including furnishing rowboats and other necessary accessories; testing the bottom of the wet excavation; making check borings through the Zone 2 embankment and taking samples to determine if any muck or other unstable material remains within or under it; the removal of muck entrapped within or under the embankment, removal of the embankment material overlying the entrapped muck, and reconstructing that part of the embankment, if directed and as specified; disposal of the materials as specified including all work at disposal areas; and the furnishing of all materials, labor and equipment necessary therefor and incidental thereto.

SECTION 3

Embankment

2. 3. 1. Description.

Embankment shall include the construction of embankment with suitable materials obtained from the various scheduled items of excavation.

Embankment is hereinafter specified as zone construction and is designated as Zone 1, Zone 2 and Zone 3 which are defined as follows:

Zone 1 is the Sand Blanket placed on swamps, marshes and other unstable ground in connection with the formation and consolidation of embankment by the Vertical Sand Drain method and by the Sand Blanket method.

Zone 2 in swamp embankment constructed by the Vertical Sand Drain method and by the Sand Blanket method is that portion of the embankment extending upward from the top of Zone 1 to elevations or heights as prescribed in the Plans or Supplementary Specifications or as directed by the Engineer. Zone 2 also includes such volume of Zone 2 material that may be placed on the swamp or marsh surface, in channels and other critically soft areas, prior to placing the Zone 1 Sand Blanket, where specified or directed by the Engineer.

Zone 2 in swamp embankment constructed by the Wet Excavation and Backfill method is that part of the embankment extending upward from the firm foundation soil at the bottom of the wet excavation, commonly referred to as Firm Bottom, to the elevations prescribed in the Plans or Supplementary Specifications or directed by the Engineer.

Zone 3 in upland embankment is the entire embankment constructed on firm ground in upland areas. Wherever upland embankment is referred to it shall be construed to mean Zone 3 upland embankment whether or not it is designated as Zone 3.

Zone 3 in swamp embankment constructed by the Wet Excavation and Backfill method is that part of the embankment extending upward from the top of completed Zone 2 to the top of the embankment when completed in accordance with the Contract requirements.

Zone 3 in swamp embankment constructed by the Vertical Sand Drain method and by the Sand Blanket method is that part of the embankment extending upward from the top of completed Zone 2, after its settlement, to the top of the embankment when completed in accordance with the Contract requirements.

2. 3. 2. Materials.

Embankment zone materials for various conditions of use and source shall be soil aggregates of the types and classes hereinafter specified. The types and classes of soil aggregates shall comply with the requirements specified respectively therefor in Division 8, Section 8.

Table 2.—Types and Classes of Embankment Materials

Use	Source	Soil Aggregate	
		Type	Class
Zone 1 (Sand Blanket)	Dry Hydraulic	3 3	B B
Zone 2, Wet Excavation and Backfill Method; outside of bridge sites	Dry Hydraulic	4 4	C D
Zone 2, Wet Excavation and Backfill Method; within bridge sites	Dry Hydraulic	4 4	B B or D as specified
Zone 2, Vertical Sand Drain Method and Sand Blanket Method; placed above Zone 1	Dry Hydraulic	4 4	B or C as specified D
Zone 2, Vertical Sand Drain Method and Sand Blanket Method; placed below Zone 1	Dry Hydraulic	3 3	C C
Zone 3, in upland and swamp embankments	Dry Hydraulic	as specified below 4	 D

Zone 3 embankment material procured from excavation within the Project or from upland borrow pits or other dry sources, for use in upland or swamp embankments, shall be suitable therefor and approved by the Engineer and shall be free from stumps,

brush, weeds, roots, sod, rubbish, garbage and other matter that may decay.

The types and classes of materials for Drainage Windrows, Vertical Sand Drains and Porous Fill shall be as hereinafter specified under those subheadings, respectively, of Art. 2. 3. 3.

All suitable materials from roadway excavation, including rock, and those accumulated from the excess of channel, ditch, foundation, subsurface structure and other excavations, for which there is space available in Zone 3 embankment and which are approved for use therein by the Engineer, shall be placed in Zone 3 of upland or swamp embankments unless otherwise specifically provided in the Supplementary Specifications. When more material is needed for Zone 3 than is available from roadway and other excavations within the limits of the Project, it shall be procured from borrow excavation sources.

Materials for Zone 1 and Zone 2 embankment shall be procured from borrow excavation sources unless otherwise specified in the Supplementary Specifications.

2. 3. 3. Methods of Construction.

General.

Embankment may be constructed either by the Dry Fill method or the Hydraulic Fill method, with exceptions as hereinafter specified.

Embankment material shall not be placed by the Hydraulic Fill method against bridge abutments, piers, arches, rigid frame structures or retaining walls. When material in the vicinity of such structures is placed hydraulically, necessary measures shall be taken to keep the wash and spread of the materials clear of the structures.

Embankment shall not be constructed between December 1 and March 1 unless the soil moisture conditions are such that compaction can be performed as specified herein. Embankment shall not proceed during freezing weather except upon approval of, and under the regulations prescribed by, the Engineer. Embankment shall not be constructed on ice, frozen ground, or on frozen layers of embankment. The foregoing provisions do not apply to an embankment constructed under water. Frozen embankment material shall not be used under any conditions.

Wherever in the specifications for embankment or other construction, compaction is specified to a density of not less than 95 per cent, or other percentage, it shall be understood to mean compaction, at a moisture content within 2 per cent of optimum, to not less than the specified percentage of maximum density as determined by current A. S. T. M. Designation D 698 according to such procedures set forth therein as may be prescribed in the

Supplementary Specifications, and that density control in the field will be based on the Calibrated Sand Method.

Porous Fill. Porous fill shall be placed adjacent to bridges and other srtuctures where specified or shown on the Plans.

Porous fill material shall be soil aggregate Type 4, Class A, if obtained from dry sources, or Type 4, Class D, if obtained from hydraulic sources, conforming to the requirements specified respectively therefor in Division 8, Section 8.

The porous fill shall be constructed within the limits shown on the Plans or specified and shall be placed in layers and compacted as hereinafter specified for Upland Embankment, Zone 3, by the Dry Fill method. If material from hydraulic sources be used, it shall be stock-piled, rehandled and placed by the Dry Fill method.

Payment for porous fill shall be as specified in Art. 2. 3. 4.

Upland Embankment; Zone 3.

Before embankment material is placed, vegetation and topsoil shall be stripped off the existing ground surface as specified in Art. 2. 2. 3 and the stripped surface shall be compacted as hereinafter specified for compaction of layers of embankment by the Dry Fill method.

When the embankment is to be placed against the slope of an existing embankment or hill, the existing slope shall be plowed to a depth of not less than 6 inches and as the Engineer may direct. No material shall be placed above the top of an existing embankment until the new embankment has been formed to that level. The slopes, earth shoulders and other surfaces of embankments, and of widenings of embankments permitted by the Engineer to dispose of surplus material, that are not proposed or required to be topsoiled shall be neatly shaped and finished to the required lines. Cellars of houses removed, grub holes and other cavities below the proposed pavement subgrade elevation, in embankment and roadway excavation areas, shall be filled with suitable embankment material which shall be placed and compacted to a density of not less than 95 per cent by the Dry Fill, Density Control method hereinafter specified. Prior to filling cellars, existing floors shall have been broken or removed to permit vertical drainage, as specified in Art. 2. 1. 3 herein in connection with demolition of buildings.

Where existing pipes and conduits have insufficient earth cover during embankment construction, the Contractor shall protect them against damage by his equipment and operations. The embankment above and for a distance of not less than 2 feet each side of such facilities shall be compacted to a density of not less than 95 per cent by such means as the Contractor may choose so as to prevent damage to such facilities. The Contractor shall repair or make good any damage to such facilities that may be caused by his operations, as specified in Art. 1. 6. 11.

EMBANKMENT

Embankments constructed in the vicinity of bridges and similar structures prior to the completion of abutments and wing walls shall terminate temporarily on slopes 5:1 or flatter which shall be located so as to allow ample space for construction of the structure and for placing and compacting the backfill, porous fill and remaining embankment adjacent thereto. Embankment and porous fill around and adjacent to arches, rigid frame bridges, culverts and piers shall be placed simultaneously on both sides thereof to approximately the same elevation.

Backfill in rock excavation areas, whether the excavation be classified or unclassified, shall be made with subbase material as prescribed and scheduled in the Contract. If an item for subbase be not scheduled, the backfill shall be made with sand or sand and gravel containing not more than 12 per cent, by weight, of material that will pass the No. 200 sieve, obtained from roadway excavation, or from borrow excavation if it be not available from roadway excavation. The backfill shall be compacted as specified in Art. 2. 9. 3 for the compaction of subbase. Provisions for payment for backfill in rock shall be as specified in Art. 2. 2. 4.

Rock larger than 12 inches in any dimension shall not be placed within a distance of 3 feet from proposed pipes, culverts, utility poles and mains and other subsurface structures above an elevation 1 foot below the bottom of such facilities, or within 3 feet of similar existing facilities that are to remain in place. Rock shall not be placed within 10 feet of the outside limits of bridges, retaining walls and similar structures, or within the limits prescribed for porous fill. These requirements shall apply to the aforesaid facilities and structures which will be constructed under or concurrently with the Project, and to those proposed for future construction the locations and grades of which can be ascertained in advance of the affected embankment work. All surface voids in the rock placed below and each side of structures and facilities, as above specified, shall be closed earthtight with rock spalls and rock fines, or with earth, except that earth shall not be used if the adjacent portions of the embankment have been constructed entirely or preponderantly with rock.

When the roadway excavation, or roadway and borrow excavation combined, provides a sufficiently high ratio of earth to rock, the embankments shall be constructed so that all rock voids are filled with earth, or with rock spalls, rock fines and earth. The rock shall be placed and compacted in layers of the minimum thickness that will accomodate rock of the size as excavated, up to a maximum layer thickness of 3 feet. Rock, rock spalls, rock fines and earth shall be distributed through each embankment layer and manipulated by bulldozing or otherwise, so that all rock voids are filled. Rock shall not be end-dumped over the edges of the layer being constructed but shall be deposited on the layer and

bulldozed ahead so as to advance the layer with a mixture of rock, rock spalls, rock fines and earth. Rock fragments 3 feet or less in size but larger than the general depth of the embankment layers shall be widely distributed so that compacting equipment can pass between and around them. Rock fragments larger than 3 feet may be used if thoroughly embedded in the embankment and surrounded with compacted 3-foot layers containing rock of smaller sizes. Each layer shall be compacted by not less than 4 passes of a 3-wheel, 10-ton roller as hereinafter specified under alternative (1) for the Dry Fill method of construction.

When there is not sufficient earth available from roadway excavation, or from roadway and borrow excavation combined, to construct the embankments with rock and earth as above specified, they shall be constructed entirely with rock except for a minimum depth of 2 feet at the top and a minimum width of 18 inches at the sides. The rock shall be placed in layers not exceeding 3 feet in thickness. The larger fragments shall not be permitted to arch, thereby creating large voids which cannot be filled with smaller fragments, but shall be distributed throughout the embankment area. The rock fragments in each layer shall vary in size so that there will be a minimum of voids. Each layer of rock shall be compacted as hereinbefore specified for embankments constructed with earth and rock. Rock fragments of sizes larger than 3 feet may be used if thoroughly embedded in the embankment and surrounded by compacted layers of sizes smaller than 3 feet. The rock surface at a depth of not less than 2 feet below the top of the proposed embankment shall be chinked with rock spalls and then shall be sealed earthtight with rock fines or soil aggregate, Type 2, or with ¾-inch or 1-inch size broken stone, washed or screened gravel or blast furnace slag conforming approximately to the grading requirements specified therefor in Art. 8. 5. 4, Table 28.

In embankments constructed with rock, or with rock and earth, as above specified, the top 6-inch layer shall be constructed with earth, the next lower 6-inch layer with earth or with earth and rock fragments of a size not larger than 4 inches in longest dimension, and the next lower 12-inch layer with earth or with earth and rock fragments of a size not larger than 10 inches in longest dimension. All voids in the rock shall be filled with rock fines or earth, or both. The two 6-inch layers shall be compacted as hereinafter specified for the Dry Fill method. The 12-inch layer shall be compacted as above specified for layers of rock. All voids in the rock along the face of embankment slopes shall be well filled with rock spalls and rock fines and the outermost 18 inches of the embankment shall be constructed with earth and topsoil. This earth face of the slopes shall be placed and compacted in layers of the same thickness, at the same time, and in the same manner, as specified for the layers of rock.

EMBANKMENT

The Contractor shall so time and arrange his work of roadway excavation, embankment and borrow excavation that space is reserved in the embankment for the disposal of all excavated earth and all excavated rock that can be placed in conformance with the requirements hereinabove specified. If any earth or rock from the excavation be wasted because of the Contractor's failure to conduct his work as specified above, the quantity so wasted will be deducted from the payment quantity of borrow excavation.

Dry Fill Method. The embankment shall be compacted by the Rolling or Vibrating method or by the Density Control method, whichever is prescribed in the Supplementary Specifications, and as hereinafter described.

ROLLING OR VIBRATING METHOD. The embankment shall be placed in layers not more than 6 inches thick, loose measurement, and each layer compacted by one of the following alternative types of equipment and number of passes of each:

(1) Smooth-faced power rollers, either solid surface or pad type, weighing not less than 10 tons and having a load of not less than 330 pounds per inch of width of roller surface when all wheels are in contact with a level surface. The load requirements for solid surface rollers apply to the rear wheels. There shall be a minimum of 4 passes per layer. A pass is defined as one passage of a compacting wheel over the entire surface of the layer.

(2) Pneumatic tire rollers having a load of not less than 225 pounds per inch of width of tire surface in contact with the ground, with the tires on the front and rear axles staggered with respect to each other so that they cover the entire strip over which the roller travels. There shall be a minimum of 5 passes per layer. A pass is defined as one passage of one tire over the entire surface of the layer.

(3) Tamping type or sheepsfoot roller, each unit of which shall consist of one or more cylindrical sections having studs or feet projecting not less than 6½ inches from the surface of the drums, and developing a load of not less than 200 pounds per square inch of bearing surface when a complete row of tampers is in contact with a level surface. There shall be a minimum of 8 passes per layer. A pass is defined as one passage of such a unit over the entire surface of the layer.

(4) 50-Ton Compactor. A pneumatic tire type roller capable of being loaded in increments to a gross weight of 50 tons. The tires shall be spaced so that the clear width between adjacent tire treads on the same axle shall be not more than the width of the tire. When operating at a gross weight of 50 tons, the tire inflation shall be not less than 90 pounds per square inch and the load on each tire shall be not less than 25,000 pounds. There shall be a minimum of 5 passes per layer by the compactor loaded to a gross weight of not less than 50 tons. A pass is defined as one passage

of a wheel of the compactor over the entire surface of the layer.

(5) Dynamic Compactor. A vibratory compactor, acceptable to the Engineer, capable of operating at the optimum frequency of vibration required for the size and type of the compactor in use and the material being compacted. There shall be not less than 2 and not more than 5 passes per layer and the actual number, within this range, shall be as directed by the Engineer depending upon the type of material being compacted. A pass is defined as one passage of the vibrating unit over the entire surface of the layer.

If the embankment material be sand, or sand and gravel, pneumatic tire rollers or dynamic compactors shall be used as specified in (2), (4) or (5) above. If the embankment material be other than sand, or sand and gravel, 3-wheel rollers, tamping type rollers, or pneumatic tire rollers shall be used as specified in (1), (2), (3) or (4) above. The compacting effect of equipment other than as specified in the foregoing requirements will not be considered a part of the required compaction when the Rolling or Vibrating Method is specified to be used.

Where the conditions are such that access with compacting equipment specified above is not possible, the embankment shall be placed in 6-inch layers and shall be compacted to a density of not less than 95 per cent.

Water shall be applied to the loose layers of embankment when directed by the Engineer. The construction of embankment shall not proceed when its moisture content exceeds the optimum by more than 2 per cent as determined in the test for compaction hereinabove specified.

When there is evidence of instability of the embankment during the construction of any layer, or instability of the ground underlying the embankment when the Contractor is ready to proceed with the initial layer, due to excessive moisture in the embankment or in the ground below it, embankment construction in the affected area shall be deferred until the embankment or underlying ground, as the case may be, has attained satisfactory stability, in the opinion of the Engineer.

DENSITY CONTROL METHOD. The Density Control method shall consist of compaction to a density of not less than 95 per cent, or other specified percentage, as previously specified herein. Density control in the field shall be based on the Calibrated Sand Method. The Contractor may choose his own methods and means of attaining the density specified.

When water is furnished and applied by the Contractor at the direction of the Engineer, to provide optimum moisture in the embankment material, such work shall be performed without specific payment therefor under any scheduled item.

Hydraulic Fill Method. If the Hydraulic method of filling be used, the points on the cross section at which the material is

discharged, and the location of spillways, shall be regulated so that material finer than No. 200 sieve size will not accumulate within the embankment or between it and an existing adjacent embankment. If material finer than No. 200 sieve is found in the embankment such that its quantity, location or distribution will be detrimental to the stability of the embankment, in the opinion of the Engineer, such material and any overlying material shall be removed and the area shall be backfilled by the Contractor with material conforming to the Specifications, without additional compensation.

Material that is bulldozed or otherwise moved or spread after its hydraulic placement shall be compacted to a density of not less than 95 per cent.

The surface of the completed embankment shall be compacted by 5 passes of a 50-ton compactor or the upper 3 feet shall be compacted to a density of not less than 95 per cent.

The Contractor shall obtain, and assumes full responsibility for obtaining, the necessary rights and permits from affected property owners for the construction and maintenance of the supply lines from the site of pumping to the Project.

The Contractor shall protect adjacent properties and water channels against the spread of the hydraulic fill material and the runoff from the filling operations unless he obtains permission for the discharge and runoff of such material from the property owners and public authorities or agencies affected. Prior to final acceptance of the work, the Contractor shall secure and deliver to the Engineer written releases from such property owners, public authorities and agencies protecting the State against claims on account of any such discharge and runoff on their properties, or by reason of any other conditions adversely affecting their properties which are caused by the Contractor's operations.

Existing vegetation within the highway right of way and other property of the State which is not to be removed under the Contract shall be protected against damage from the runoff and spread of hydraulic fill material. If any such vegetation be killed or be dying prior to or within a period of one year after the date of acceptance of the Project by the Commissioner, as a result of the runoff or spread of such material, in the opinion of the Engineer, the Contractor shall remove all such dead or dying vegetation from the right of way or other State property without cost to the State.

Maintenance of adequate drainage flow shall be provided at all times either in existing or new ditches and channels. Upon completion of the embankments, existing and new streams, ditches and other water channels shall be restored to their former or prescribed cross section where filling material or sediment from runoff has washed, spread, or has been deposited otherwise therein. If directed, ditches or water channels in addition to those shown on

the Plans shall be constructed so that drainage affected by hydraulic fill operations will be equivalent to that which existed prior to construction. Separate payment will not be made for the restoration and construction of ditches and other water channels as specified above. All the work of property protection, maintenance of drainage flow, restoration of existing, and construction of new, ditches and other water channels and all work incidental thereto, as described above, shall be performed without additional compensation over and above the unit prices bid for borrow excavation.

Swamp Embankment; Wet Excavation and Backfill Method; Unstable Material Removed to Firm Bottom.

ZONE 2 EMBANKMENT.

Dry Fill Method. Wet excavation shall be performed as specified in Art. 2. 2. 3.

In the construction of Zone 2 embankment by the Dry Fill method the material may be end-dumped to the prescribed elevation for the top of this zone. The embankment shall not proceed at any point until the Contractor has tested the bottom of the excavation and has made sure that all the muck, mud and other unstable material has been removed down to firm bottom. The Contractor shall test the bottom of the excavation longitudinally and transversely at sufficient points to make sure that all muck and other unstable materials have been removed. At points to be designated by the Engineer for cross sectional measurements of the bottom of the excavation, the embankment shall not proceed until the Engineer has taken such measurements. The formation of the embankment shall proceed continuously except with the necessary interruptions to allow for the abovementioned testing and measurements. When interrupted for a period of more than 24 hours, embankment construction shall not be resumed until the Contractor has again tested the bottom of the excavated area and found it to be in satisfactory condition.

The formation of embankment shall proceed in the form of a wedge of 60 degrees with its axis following the centerline of the roadway. The manner of filling and advancing the wedge shall be such as to force all remaining muck and silt laterally to the sides of the excavation, and not entrap it under the fill. All accumulations of muck and other unstable material at the sides of the excavated area shall be removed by clamshells or other equipment as the embankment wedge advances. If any muck or silt is spilled or otherwise deposited on the top or sides of the embankment during this operation, it shall be entirely removed by the Contractor without additional compensation.

In widening an existing embankment, the construction of the new embankment shall proceed along and outward from the exist-

ing embankment in close coordination with the wet excavation and in such manner that muck and silt will not be entrapped between the existing and new embankments and so as to prevent displacement of unstable materials that may be under the existing embankment.

When the embankment has been placed up to approximately 2 feet above water level, the Contractor shall make borings through the embankment, and take samples, to determine if any muck, mud, silt, clay or other unstable material be entrapped under the embankment, as specified in Art. 2. 2. 3 under the subheading Wet Excavation.

If muck, mud, silt or clay be entrapped within or under the embankment, or between the new and an existing embankment, and the quantity and location or distribution thereof is such as to cause visible unstable areas in the embankment, or to be detrimental to the stability of the embankment or of the proposed or future roadway or structures, in the opinion of the Engineer, the entrapped muck, mud, silt or clay and the overlying Zone 2 material shall be removed and all such excavated areas shall be backfilled with the specified Zone 2 material. No additional compensation will be made for such excavation and backfilling.

The Contractor shall take all necessary precautions to prevent settlement or dislocation of, or damage to, any existing adjacent roadways and utility or other facilities therein. If such roadways or facilities be damaged by or as a result of the Contractor's work, they shall be repaired, replaced or otherwise restored to a condition as good as prevailed at the time the Project started, by and at the expense of the Contractor.

Hydraulic Fill Method. Construction of Zone 2 embankment by the Hydraulic Fill method shall conform to the requirements hereinbefore specified for the Hydraulic Fill method for Upland Embankment, Zone 3, and with amendments and additions as hereinafter specified.

The hydraulic filling shall be performed in such a manner that muck, mud or silt will not be entrapped under or within the embankment.

Testing by the Contractor, and cross sectional measurements by the Engineer, of the bottom of the wet excavation area, prosecution of the work of embankment in coordination with such testing and measurements, borings through the Zone 2 embankment and sampling by the Contractor, and the removal of entrapped muck and overlying material and backfilling, shall be as hereinbefore specified for Zone 2 embankment by the Dry Fill method.

When Zone 2 embankment has been completed, the surface thereof shall be compacted by 5 passes of a 50-ton compactor loaded to a gross weight of not less than 50 tons if the proposed top of Zone 3 embankment be less than 10 feet above the top of Zone 2.

ZONE 3 EMBANKMENT.

Construction shall comply with the requirements hereinbefore specified for Upland Embankment, Zone 3.

Swamp Embankment; Vertical Sand Drain Method.

ZONE 1 AND ZONE 2 EMBANKMENT.

The provision hereinafter specified under Zone 3 regarding procedure adjacent to areas of embankment constructed by the Wet Excavation and Backfill method applies also to Zone 1 and Zone 2.

A few settlement platforms shall first be placed on the original ground surface as shown on the Plans or as directed by the Engineer. Zone 1 material then shall be deposited to a minimum in-place thickness of 4 feet, or to such other thickness as may be specified in the Supplementary Specifications, and shall be graded to a reasonably level surface, free from appreciable depressions or abrupt changes in contour. Zone 2 material then shall be placed on top of Zone 1 material to form a reasonably level working table at the elevation shown on the Plans. If the working table settle below a limiting elevation to be determined by the Engineer, before vertical sand drains are installed, additional Zone 2 material shall be placed to bring the working table up to the elevation shown on the Plans or directed by the Engineer.

Existing ditches, channels, pockets, and other low areas shall be filled with Zone 1 or Zone 2 material at the locations specified, shown on the Plans or as required by the Engineer. If excessive settlement occur, or be expected to occur, in these or other critically soft or unstable areas, Zone 2 material shall be placed directly on the mud or swamp surface in the manner hereinafter specified, before Zone 1 material is placed, at the locations as prescribed or directed.

Dry Fill Method. Zone 1 material may be placed in one layer provided that, in the opinion of the Engineer, this will not cause excessive displacement of the underlying material. If excessive displacement be anticipated, Zone 1 material shall be placed in two layers as directed by the Engineer, the second layer being spread initially at least twenty feet back from the outer edges of the first layer. The second layer may then be completed to the full width as called for on Plans not less than one day after the first layer has been placed.

Zone 2 material shall be placed on top of the Zone 1 material to form the working table as hereinabove specified. Not more than one foot of Zone 2 material shall be placed in any one day above the Zone 1 sand blanket and below the working table. Zone 2 material shall be placed in one or two layers, as specified above for Zone 1, when the Zone 2 material is placed directly on the

mud or swamp surface. Equipment for installing vertical sand drains shall be supported on mats, if necessary.

End-dump methods may be used in placing the initial layer of Zone 1 or Zone 2 material over the mud provided the material is end-dumped at least twenty feet back from the outer edges of the fill and then spread ahead over the mud in a thin layer in a manner that will cause a minimum of displacement of underlying material. The spreading shall be performed with a light bulldozer or other equipment having caterpillar treads giving equivalent effect, the gross weight of which shall not exceed 17,000 pounds. Heavier bulldozers may be used only with written consent of the Engineer and then only if they are equipped with marsh-type extension treads so that they will not displace the mud or force the sand blanket into the mud. In order to avoid the development of mud waves ahead of the placement of the Zone 1 or Zone 2 material in very soft areas or channel areas, the material shall be cast ahead over the mud in a thin layer with a small clamshell crane, or with other suitable equipment approved by the Engineer, in writing, before spreading additional material with the light bulldozer.

If any mud waves or boils develop within the proposed limits of the Zone 1 or Zone 2 materials in advance of the placing of these materials, they shall be removed down to the elevation of the original ground as directed by the Engineer. If any mud waves or heaves be entrapped under the Zone 1 or Zone 2 materials to a height of more than one foot above the original ground surface, they and the overlying Zone 1 or Zone 2 materials shall be removed and replaced with satisfactory layers of Zone 1 and Zone 2 material as above described and in accordance with the directions of the Engineer. All work of removing mud waves and boils and replacement of Zone 1 and Zone 2 materials as specified above shall be performed without additional quantity allowance or other additional payment therefor.

In the event that Zone 1 material shall have been placed in which the portion passing the No. 4 sieve contains an average of more than 2 per cent, but less than 3 per cent, passing the No. 200 sieve, all such substandard material shall be removed and replaced with the specified Zone 1 material, or transverse drainage windrows shall be constructed across the full width of the embankment at intervals not exceeding 40 feet, under the direction of the Engineer, within the entire limits of such substandard material.

In the event that Zone 1 material shall have been placed in which the portion passing the No. 4 sieve contains an average of more than 3 per cent, but not more than 5 per cent, passing the No. 200 sieve, all such substandard material shall be removed and replaced with the specified Zone 1 material, or transverse drainage windrows shall be constructed across the full width of Zone 1

over, and connecting with, each vertical sand drain in each row and offset row thereof, under the direction of the Engineer, within the entire limits of the substandard Zone 1 material.

In the event that Zone 1 material shall have been placed in which the portion passing the No. 4 sieve contains an average of more than 5 per cent passing the No. 200 sieve, all such substandard material shall be removed and replaced with Zone 1 material conforming to the specified requirements therefor.

After Zone 1 and Zone 2 materials have been placed to form the working table, the vertical sand drains shall be installed, drainage windrows constructed, settlement platforms and control stakes installed, borings made, cross sectional measurements of the working table and slopes taken, and pore pressure measuring devices installed, all as hereinafter specified.

After completion of the work specified in the preceding paragraph, additional Zone 2 material shall be placed above the working table if, as, and to the elevations or heights, specified in the Supplementary Specifications or shown on the Plans. Zone 2 material above the working table shall be deposited at the controlled rates, and compacted, as hereinafter specified for Zone 3 embankment.

Readings on the settlement platforms and cross sectional measurements shall be taken at the top of such Zone 2 material, for use in the determination of the Zone 2 payment quantity, before any Zone 3 material is placed.

Hydraulic Fill Method. The construction of Zone 1 and Zone 2 embankment by the Hydraulic Fill method shall conform to the provisions hereinafter specified, and to the provisions hereinbefore specified for Upland Embankment, Zone 3, by the Hydraulic Fill method except (1) the removal of material finer than No. 200 sieve size found in the embankment shall be as hereinafter specified and (2) compaction of the surface of Zone 2 with the 50-ton compactor is not required.

If muck, mud or silt be found within the embankment such that its quantity, location or distribution will be detrimental to the stability of the embankment, such materials and the overlying material, shall be excavated and wasted and the pockets refilled with material conforming to the specified requirements, without additional compensation.

Zone 1 material shall be placed ahead over the mud or swamp surface in continuous thin increments or layers by means of multiple discharge lines, bleeder pipes and baffle boards, in a manner that will prevent the lateral displacement of the mud and the formation of heaves, mud waves and boils in advance of or under the Zone 1 embankment. The entire depth of Zone 1 material may be placed in this manner without rest periods between the thin increments or layers unless displacement, heaves, waves or boils occur. The material shall be spread initially on slopes of 8:1 or flatter entirely

within the proposed embankment area, and then leveled and reshaped to the proposed embankment slope lines shown on the Plans not less than 2 days after the entire depth of Zone 1 material has been placed. Where Zone 2 material shall have been placed on the mud prior to the placing of Zone 1 material as hereinafter specified, the total prescribed thickness of the Zone 1 material may be placed over the Zone 2 material in one uniform continuous layer not less than one week after the last layer of such Zone 2 material has been placed.

Where Zone 2 material is placed directly over the mud below water in channel areas, discharge pipes equipped with bleeder valves shall be floated on pontoons so that the material is spread on flat slopes in a continuous layer not more than five feet in thickness over the entire embankment area within the channels before the second layer is placed. The second layer shall be placed in small increments, up to the elevation of the adjacent swamp surface, not less than 2 days after the first layer, in a manner that will prevent displacement of the mud and the formation of mud waves and heaves, as above specified for placing Zone 1 material.

Zone 2 material shall be placed over completed Zone 1 to form the working table at its prescribed elevation, as hereinabove specified, and may be deposited in one layer but not less than one full week after the Zone 1 material has been placed. In this case the Zone 2 material shall be spread on flat slopes in the manner specified above for the placement of Zone 1 material.

If any mud waves, boils or heaves develop within the proposed areas of Zone 1 and Zone 2 materials in advance of the placement of these materials, or are entrapped under or within the Zone 1 material to a height of more than one foot above the original surface of the mud, they and the overlying fill materials shall be removed and replaced with the specified Zone 1 and Zone 2 materials as hereinbefore specified therefor under the Dry Fill method, without additional compensation.

The provisions hereinbefore specified under the Dry Fill method pertaining to the removal and replacement of substandard Zone 1 material, or construction of additional windrows in lieu thereof, apply also to the Hydraulic Fill method.

After Zone 1 and Zone 2 materials have been placed to form the working table, the vertical sand drains shall be installed, drainage windrows constructed, settlement platforms and control stakes installed, borings made, cross sectional measurements of the working table and slopes taken and pore pressure measuring devices installed, all as hereinafter specified.

After completion of the work specified in the preceding paragraph, additional Zone 2 material shall be placed above the working table if, as, and to the elevation or height, provided in the Supplementary Specifications or shown on the Plans. This part of Zone 2

material shall be deposited at the controlled rates, and shall be constructed, as hereinafter specified for Zone 3 embankment placed by the Hydraulic Fill method except that compaction of the surface of Zone 2 with the 50-ton compactor is not required.

Readings on the settlement platforms and cross sectional measurements shall be taken at the top of Zone 2 when constructed above the working table, for use in the determination of Zone 2 payment quantity.

ZONE 3 EMBANKMENT.

Zone 3 embankment construction shall conform to the requirements for Upland Embankment, Zone 3, hereinbefore specified and with the following requirements:

If rock be placed in Zone 3 embankment, sufficient earth shall be placed over the settlement platform bases and other control devices and around the standards, in advance of placing the rock, to prevent disturbances of or damage to them.

When Zone 1 and Zone 2 materials have been placed to form the working table, or when Zone 2 has been constructed to a level higher than the working table, if prescribed, and all the required devices have been installed and measurements taken at the appropriate levels as hereinbefore specified under Zone 1 and Zone 2 Embankment, Zone 3 material shall be placed to complete the embankment and overload as shown on the Plans. The overload thickness shall be increased, if and as directed, to expedite and compensate for subsidence.

Priority shall be given to the construction of embankments in the descending order of their heights above the ground surface, and to embankments adjacent to bridges and other structures as may be specified or directed so as to coordinate with proposed bridge construction schedules.

Embankment operations shall proceed simultaneously at as many locations and with sufficient forces and equipment as may be necessary to complete all embankment on the Project within the critical time necessary to complete the highest embankments at the prescribed controlled rates of filling.

Where embankment that is to be constructed by the Vertical Sand Drain method adjoins embankment to be constructed in wet excavation areas, the wet excavation and backfill shall be completed, before work is started in the sand drain area, for a sufficient distance from the connection to avoid a later thrust upon, or sloughing of, the adjacent swamp mud and damage to the construction in the vertical sand drain area after the latter work is started.

Compaction of the embankment overload is required except such portion thereof as may be exempted by provisions of the Supplementary Specifications.

EMBANKMENT

The Contractor shall perform the work in a manner, and shall use the necessary precautions, such as to prevent slips and slides in the embankment itself, and shall perform the work in strict accordance with the Plans, Specifications and directions of the Engineer to prevent damage to or failure of the foundation. The term foundation as used in this connection shall be construed to mean the existing swamp materials and the vertical sand drains below the bottom of the Zone 1 Sand Blanket or below any Zone 2 material placed prior to and under the Zone 1 blanket. Responsibility for the cost of repairing the embankment and foundation damaged by slips and slides shall be as hereinafter specified in Art. 2. 4. 4.

All of the work of placing and compacting the embankment shall be as herein specified and directed by the Engineer, who will be guided by the data obtained from readings on the settlement platforms, pore pressure measuring devices, and control stakes and by inspection of the filling operations as they proceed. The Engineer will order the suspension of operations at such times as conditions develop which may be detrimental to the work or may cause damage to adjacent property, but neither the giving of such orders nor failure to do so will relieve the Contractor of full responsibility for the satisfactory performance of the work. The Engineer reserves the right to suspend operations for a total of 45 calendar days in any area within the limits designated in writing by him during the progress of the work.

Dry Fill Method. The construction of Zone 3 embankment by the Dry Fill method shall conform to the requirements for Upland Embankment, Zone 3, Dry Fill method, as hereinbefore specified except as follows:

A depth of not more than 1 foot of embankment material shall be placed per week at any point and at such point not less than 1 week shall elapse before placing additional material.

Hydraulic Fill Method. The construction of Zone 3 embankment by the Hydraulic Fill method shall conform to the requirements for Upland Embankment, Zone 3, Hydraulic Fill method, as hereinbefore specified except as follows:

The same rate of placing the embankment material may be used as specified above for the dry fill method, or a depth of 3 feet of material may be placed at one time at any one point provided that not less than 3 weeks shall elapse after the full 3-foot increment has been placed at that point before additional material is placed at such point. If more than 1 foot, but less than 3 feet, of material be placed at one time at any one point, the time elapsing before additional material is placed at such point shall be directly proportional to that specified above.

EMBANKMENT

Embankment material shall not be placed by the Hydraulic Fill method above the elevation prescribed in the Supplementary Specifications. Material procured hydraulically must be stockpiled, rehandled and spread by the Dry Fill method, if placed above such specified elevation.

Vertical Sand Drains. Vertical sand drains, not less than 20 inches in diameter, shall be installed at the locations shown on the Plans except as otherwise hereinafter specified.

Material for backfilling vertical sand drains shall be soil aggregate Type 3, Class A, conforming to the requirements specified therefor in Division 8, Section 8. Frozen or lumpy material shall not be used.

Vertical holes not less than 20 inches in diameter shall be formed from the working table hereinbefore specified and shall extend through the zone materials and underlying unstable material down to the firm stratum, or to such depths as the Engineer orders. The holes shall be backfilled with the soil aggregate in advance of placing embankment material above the established working table.

The holes shall be formed by jetting a casing down to the required depth, by driving a plugged mandrel with a pile driver, or by other methods approved by the Engineer. If the holes be formed by driving a plugged mandrel, the mandrel shall be not less than 20 inches, outside diameter, for its full depth and the plug shall have a diameter of at least 20 inches, and the driving rig shall be equipped with a compressed air supply for forcing the soil aggregate out of the mandrel. If other methods be used, the equipment shall be of such design as to obtain holes of equivalent size and to maintain them at that size until they are completely filled with soil aggregate. Provisions shall be made for durable markings on equipment for measurement of the depth of holes.

If the Contractor elect to excavate the holes by jetting a suitable casing to the required depth, the jetting shall be continued for a sufficient length of time, after the casing has reached the required depth, to remove all solid materials within the casing. Holes that contain muddy water shall be pumped out until the water contains not more than a total of 2 per cent, by weight, of silt and clay. After the hole has been backfilled with soil aggregate, the casing shall be removed by such method that will leave the hole completely filled with soil aggregate. Jetted material shall not be permitted to come in contact with Zone 1 materials.

Where obstructions are encountered that cannot be penetrated by the mandrel or other methods in use, the holes shall be formed by spudding with a pointed steel spud of such type, and operated by equipment with sufficient driving capacity, as to punch through

the materials encountered, except that the following variations in procedure will be permitted:

1. Where obstructions are encountered with the mandrel or spud, the Contractor may abandon the hole and install the sand drain at a distance not more than 3 feet from the prescribed location of the sand drain except that, where an obstruction is encountered at a depth of more than one-half the depth of the proposed sand drain, and such obstruction cannot be dislodged or penetrated by spudding, a vertical sand drain shall be constructed above the obstruction subject to approval of the Engineer.

2. If and where unusual obstruction difficulties arise in forming the holes such that a satisfactory pattern of vertical sand drains cannot be constructed at the affected location, the Contractor shall remove the obstruction, dispose of same as directed or approved by the Engineer, and refill all excavation caused thereby with such material as the Engineer may direct.

Any method of excavating or constructing the holes which, in the opinion of the Engineer, causes an appreciable disturbance of the adjacent existing ground, shall be discontinued. Holes that must be abandoned on account of obstructions shall be backfilled with material conforming to Zone 1 requirements. Holes that are out of place and those that are damaged in excavating or forming the hole or during the placing of soil aggregate therein, shall be backfilled with Zone 1 material and abandoned, if so ordered by the Engineer. If any previously completed sand drains be damaged or destroyed in excavating for the removal of obstructions, the Contractor shall replace such sand drains with new ones.

Each hole shall be inspected and approved by the Engineer before and while the soil aggregate is being placed therein. The material jetted or excavated from the holes shall be disposed of outside the right of way. The Contractor shall make his own arrangements for disposing of such material. This material shall not be disposed of on property abutting the Project unless the Contractor has secured permission of the owners and other parties affected as specified hereinabove for protection against the spread and runoff from hydraulic fill operations.

Payment for vertical sand drains shall be as specified in Art. 2. 3. 4.

Pore Pressure Measuring Devices. Pore pressure measuring devices, including all appurtenances and conforming to the design therefor shown on the Plans, shall be furnished and installed by the Contractor under the direction of the Engineer, at the locations and depths shown on the Plans or directed, immediately after placing the vertical sand drains and, where installed, they shall be grouped approximately equidistant from the sand drains. The method of installation shall be as described below, except that

other methods approved by the Engineer may be used provided the Contractor submits to the Engineer, in writing, an outline of his proposed method and evidence that all necessary materials can be obtained without delay:

Method of Installation. Drive casing to approximate elevation above the centerline of well point as shown on detail plan.

Thoroughly clean out the entire length of casing by washing or by other method satisfactory to the Engineer.

Obtain dry samples of material from bottom of casing to a depth of 12 inches and deliver the samples in sealed jars to the Engineer.

Attach the prescribed well point to tubing and lower the well point and tubing within the casing until the centerline of well point reaches the elevation shown on the Plans or directed by the Engineer. All joints of the entire system shall be sealed with a nonhardening joint-sealing compound.

Pour sufficient clean sand slowly into the casing to surround the well point.

Pour a clay slurry into casing to form a seal above the sand surrounding the well point.

Withdraw the casing.

Attach tubing to the vertical tubing from the well point and extend the tubing to the gauge box in the manner shown on the Plans. Attach the Bourdon gauge, air valves and coupled appurtenances to the tubing as shown on the Plans and fasten to the gauge box. The extension pipe and tubing shall be filled with kerosene, the quantity of which shall be measured. The operation of sealing the system shall be performed under the direction of the Engineer in order to insure a proper initial pore pressure reading.

The foregoing method may be modified by the Engineer to conform to field conditions encountered during the progress of the work.

The Contractor shall maintain the pore pressure measuring devices in proper working condition during construction and shall immediately replace or repair, at his own expense, any or all components which may be damaged or worn out during the period of the Contract. The approximate total number of pore pressure measuring devices and the length of well points required for the Project shall be as specified or shown on the Plans. The devices shall remain in place and become the property of the State except those which the Engineer orders removed because of interference with pavement construction.

Separate payment will not be made for furnishing and placing pore pressure measuring devices and the cost thereof shall be included in the prices bid for other items scheduled in the Proposal.

Settlement Platforms. After the vertical sand drains have been installed, settlement platforms of the size, design and at the locations shown on the Plans shall be placed on the working table in addition to the few hereinbefore specified to be placed on the original ground surface. Pipes shall be attached to the settlement platforms by substantial flanges and extend upward in sections, as the filling progresses, to one foot above the top of the embankment overload. They shall remain in place upon completion of the work and become the property of the State, except those pipes which the Engineer orders to be removed because of interference with pavement construction.

Platforms above water level shall be built of timber or steel as the Contractor elects, but shall be of steel below water level. Platforms and pipes shall conform to the details shown on the Plans. The platforms shall be carefully set and leveled. The pipes shall be firmly secured to the platforms by flanges and shall be kept plumb. If the platforms or pipes are disturbed during construction, by the action of tides or otherwise, they shall be restored to their proper condition before additional embankment material is placed at their locations. The pipes shall be marked at intervals by the Contractor to facilitate measurement of the depth of fill and of settlement. The total number of settlement platforms for all areas shall be as provided in the Supplementary Specifications.

Separate payment will not be made for settlement platforms or the pipes and the cost thereof shall be included in the unit prices bid for other items scheduled in the Proposal.

Drainage Windrows. Drainage windrows shall be constructed within the Zone 1 sand blanket where shown on the Plans. Additional windrows may be constructed, as hereinbefore specified under the Vertical Sand Drain method, as an alternative for the removal and replacement of any substandard Zone 1 material which departs, within specified limits, from the prescribed requirements.

The material for drainage windrows shall be clean broken stone, washed gravel or blast furnace slag conforming to the requirements therefor specified in Art. 8. 5. 5, 8. 5. 6 and 8. 5. 7, respectively, and shall be of a grading not finer than that of the ½-inch size and not coarser than that of the 1-inch size shown in Table 28, Art. 8. 5. 4. The specific size or grading within these limits shall be as provided in the Supplementary Specifications or as directed.

Trenches shall be excavated in the Zone 1 Sand Blanket and backfilled with the broken stone, washed gravel or blast furnace slag. The windrows shall be constructed to the lines, grades and cross section prescribed or shown on the Plans.

Payment for drainage windrows will be made as hereinafter specified in Art. 2. 3. 4.

Control Stakes. Control stakes, constructed as shown on the Plans, shall be driven at distances from the toe of the fills as directed, to indicate any foundation movement. The total number of control stakes required for the Project shall be as provided in the Supplementary Specifications. Stakes shall be of sound lumber 2″ x 2″ x 8′ – 0″ with ¾″ x 2″ x 2′ – 0″ cross arms, painted as indicated on the Plans.

Separate payment will not be made for furnishing and installing control stakes, taking readings thereon and other work pertaining thereto and the cost thereof shall be included in the prices bid for other items scheduled in the Proposal. It is agreed that any increase or decrease in the number of stakes, as ordered by the Engineer, shall not be cause for additional compensation.

Borings. Borings in connection with the Vertical Sand Drain method shall be made from the working table to determine the thickness of the Zone 1 material or the total combined thickness of Zone 1 and Zone 2 materials, as the case may be, in place below the working table. The borings shall proceed following the construction of vertical sand drains and installation of settlement platforms and prior to placing any embankment materials above the level of the working table. Not less than 3 nor more than 7 borings shall be made across the embankment at intervals of 100 feet measured along the centerline of the roadway, to the depths directed by the Engineer and at such other points as he may deem necessary. If the Contractor desire to make additional borings for his own satisfaction he may do so in the manner specified for the prescribed borings, without payment therefor.

Borings shall be made by the Contractor, in the presence and under the supervision of the Engineer, with a sampler approved in writing by the Engineer, which will satisfactorily exclude materials during the driving of the sampler and allow the taking of samples so that a line of demarcation can be established between the fill materials and the underlying wet or unstable material. Samplers which may prove satisfactory for the work are the so-called peat sampler or the retractable piston-type sampler. Samplers will not be approved by the Engineer if they require a washing operation or other methods which will force the embankment materials to depths below the actual bottom of the embankment, or which develop a high wall friction such as to drag fill materials below their true depth. The methods to be employed in obtaining samples shall be only those which meet with the approval of the Engineer, and which assure a vertical boring that will determine the true depth of the embankment materials placed by the Contractor.

Payment for the Borings described above shall be as specified in Art. 2. 3. 4.

Swamp Embankment; Sand Blanket Method.

This method consists of the construction and stabilization of swamp embankment by placing a sand blanket of Zone 1 material upon the swamp surface, and by placing Zone 2 and then Zone 1 materials in channel and other critically soft areas if specified or directed; then placing Zone 2 material if necessary to form a satisfactory working table, and additional Zone 2 material above the working table up to the elevation or height as specified or shown on the Plans; then placing Zone 3 material to complete the embankment and overload; also the construction of gravel or stone windrows in the Zone 1 sand blanket, installation of settlement platforms on the working table and a few on the original ground surface, control stakes and pore pressure measuring devices, and making borings from the working table for use in the determination of Zone 1 and Zone 2 payment quantities.

The materials, methods of construction and procedures shall be the same as hereinbefore specified for the Vertical Sand Drain method with amendments and additions as hereinafter specified.

No vertical sand drains shall be installed.

The rate or rates of placing embankment material shall be as prescribed in the Supplementary Specifications.

The thickness of Zone 1 sand blanket may be varied as directed, according to the actual ground conditions encountered during progress of the work, particularly at locations of relatively high ground surface.

The working table for this method of construction shall be established, at the height or elevation specified or shown on the Plans, as the surface upon which settlement platforms shall be installed and cross sectional measurements taken, from which borings shall be made, and below which end-dumping will be permitted if the embankment be constructed by the Dry Fill method.

The provisions under the Vertical Sand Drain method for Embankment Zone 1, pertaining to the removal and replacement of substandard Zone 1 material, or the construction of additional drainage windrows in lieu thereof under certain conditions, shall apply except that, if material shall have been placed in which the portion passing the No. 4 sieve contains an average of more than 3 per cent, but not more than 5 per cent, passing No. 200 sieve, all such substandard material shall be removed and replaced with the specified Zone 1 material or, in lieu thereof, transverse drainage windrows shall be constructed across the full width of Zone 1, spaced not more than 10 feet apart.

2. 3. 4. Quantity and Payment.

Embankment. The cost of embankment construction including the furnishing and installing of settlement platforms, con-

trol stakes, and pore pressure measuring devices shall be included in the unit prices bid for the various scheduled items of Roadway Excavation within the Project limits, and in the unit prices bid for the various items of Borrow Excavation, if scheduled, as hereinafter specified in Art. 2. 4. 4.

Porous Fill. The quantity of Porous Fill for which payment will be made will be the volume of porous fill material furnished and placed in accordance with the Plans and Specifications, measured in place in the embankment.

Payment for Porous Fill will be made for the quantity as above determined, measured in cubic yards, at the unit price per cubic yard bid for the item POROUS FILL in the proposal, which price shall include the cost of furnishing, placing and compacting the material, all labor, equipment and all else necessary therefor and incidental thereto.

Vertical Sand Drains. The quantity of Vertical Sand Drains for which payment will be made will be the actual total length of vertical sand drains, measured from the surface of the approved working table to the bottom of the hole as approved by the Engineer, installed in accordance with the Plans and Specifications.

Payment for Vertical Sand Drains will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item VERTICAL SAND DRAINS in the Proposal, which price shall cover the cost of opening of the holes, use of spud if necessary, furnishing and placing the specified backfill in holes, disposing of material removed from the holes and all costs of labor, material, equipment and all else necessary to install the drains in accordance with the Plans and Specifications, including all labor, materials and other costs involved in the work hereinafter specified in paragraphs (a), (b), (c) and (d).

(a). Changing methods due to appreciable disturbance of the existing ground.

(b) Materials furnished for, and the work done on, abandoned holes.

(c). The replacement of previously completed sand drains with new ones if any such drains are damaged or destroyed in excavating for or removing obstructions encountered in the construction of other sand drains.

(d). Sand drains rejected because of unsatisfactory backfill.

Where unusual obstruction difficulties arise in forming vertical sand drain holes such that a satisfactory pattern of sand drains cannot be constructed at the affected location, and the obstructions are removed by order of the Engineer, payment will be made at the unit prices bid for appropriate scheduled items of the Proposal for any portions of the work that may be classified properly under

such scheduled items. Work of a character that is not susceptible of such classification shall be paid for under supplemental agreement as provided in Art. 1. 8. 4.

Drainage Windrows. The quantity of Drainage Windrows for which payment will be made will be the volume of broken stone, washed gravel or slag, actually furnished and placed in accordance with the Plans, Specifications and directions of the Engineer, measured in place in the windrows, excluding additional windrows constructed in lieu of the removal and replacement of substandard Zone 1 embankment material.

Payment for Drainage Windrows will be made for the quantity as above determined, measured in cubic yards, at the unit price per cubic yard bid for the item DRAINAGE WINDROWS in the Proposal, which price shall include trench excavation, furnishing and placing the broken stone, washed gravel or slag, and all else necessary therefor and incidental thereto.

The cost of additional drainage windrows that may be placed in lieu of the removal and replacement of substandard Zone 1 material shall be included in the unit price bid for Borrow Excavation, Zone 1 (Sand Blanket).

Borings. The quantity of Borings for which payment will be made will be the number of borings within each of the ranges of depth itemized in the Proposal, or the total number if only one item is scheduled, made in accordance with the Specifications and at the direction of the Engineer. No payment will be made for borings which do not show a line of demarcation between the embankment and the underlying materials.

Payment for Borings will be made for the number thereof as above determined, at the unit price or prices bid for the item or items BORINGS in the Proposal, which prices shall include the cost of all labor, materials and equipment, recording the boring data and furnishing it to the Engineer, and all else necessary therefor and incidental thereto.

Payment for borings as specified above applies only to those borings made from the working table in connection with the Vertical Sand Drain and Sand Blanket methods of construction.

SECTION 4

Borrow Excavation

2. 4. 1. Description.

Borrow excavation shall include furnishing, transporting, placing and compacting material required for embankment in excess of that obtained from roadway and other Project excavation, and incidental work.

2. 4. 2. Materials.

Borrow excavation materials shall conform to the requirements for embankment materials as hereinbefore specified in Art. 2. 3. 2.

The sampling and testing of borrow pits and the approval of materials therefrom shall be in accordance with the provisions hereinbefore specified in Art. 1. 4. 7.

2. 4. 3. Methods of Construction.

Borrow excavation material may be procured from upland borrow pits or from hydraulic sources. Before using a borrow pit, the Contractor shall have complied with all the requirements of Art. 1. 4. 7 regarding his initial sampling and testing and notice to the Engineer, and he shall have received the Engineer's conditional approval of the use of material from such pit. After such approval by the Engineer, the Contractor shall remove from the surface of the borrow pit all topsoil, sod, brush, weeds and other materials that are unsuitable for embankment. Then the Engineer will take elevations and measurements of the surface of the pit, before the Contractor starts excavation of the borrow material.

Borrow pits shall not be located within sight of any State highway except by written permission of the Engineer.

When located within sight of a State highway, borrow pits shall be graded and shaped finally to slopes of 3:1 or flatter, wherever possible, and so that they will blend into the general topography of the area. Steep slopes and sheer faces shall be avoided. The pit areas shall not be left in such condition that ditches and other drainage facilities become silted or cause a mosquito problem. The pit areas shall be seeded to grass except that, if the conditions be not suitable for seeding only, they shall be topsoiled, fertilized and seeded if and as directed by the Engineer. The pit areas shall have satisfactory natural drainage or may be left as ponds provided that they have a source of fresh water supply, that a minimum depth of 7 feet can be maintained therein, that they shall be fenced as hereinafter specified, and that written approval of the Engineer and the property owner shall be obtained therefor. The Contractor, at his own expense, shall furnish and erect around the entire periphery of such ponds a steel post and galvanized wire field fence, 4 feet high, with one access gate, as shown on the Plans or prescribed in the Supplementary Specifications or, if not so shown or prescribed, the fence shall be of a type to be approved by the Engineer.

All borrow pits shall be left in a condition acceptable to the property owner, and those pits located within sight of a State highway shall conform to the foregoing requirements and shall be left in a condition acceptable to the Engineer as well as to the owner, after the Contractor has removed all the required material

therefrom. Prior to final acceptance of the Project, the Contractor shall submit to the Department written releases from the owners of land on which such borrow pits are located, stating that the borrow pit sites have been left in a condition satisfactory to them.

The Contractor shall not use a borrow pit for the Project simultaneously or intermittently with its use by him or other parties for work other than that of the Project. The same borrow pit shall not be used to furnish materials for more than one item of the Project except by written approval of the Engineer. If such approval be given, separate areas of the pit shall be reserved for supplying materials for each item of the Project for which the pit is used, and operations in such pits shall be conducted so that the respective volumes of materials removed therefrom and used for various items of the Project can be determined accurately and conveniently by the Engineer with the minimum of borrow pit measurements and other engineering and inspection work.

The Contractor shall keep separate, accurate records of the number and sizes of truck or other approved type vehicle loads of borrow excavation leaving the borrow pit which are to be placed in embankment, and those to be placed in each other item of the Project for which the use of the pit may have been approved, and of the number and sizes of those actually placed in the work of the respective items of the Project, by a method to be approved by the Engineer and all such records shall be furnished to the Engineer.

2. 4. 4. Quantity and Payment.

The quantity of Borrow Excavation for which payment will be made will be determined by such of the methods hereinafter described under the headings lettered A, B, C, and D as will be specified in the Supplementary Specifications and as may be amended therein.

If the payment quantity of borrow excavation be determined by measurement of the material in borrow pits, material removed from the borrow source before the Engineer has taken cross sections of the surface and other necessary measurements, or material removed and wasted or used for purposes other than that specified, or used to replace excavated material required for embankment which is wasted or used for other purposes, will not be included in the quantity of borrow excavation for which payment will be made.

A. For Upland Embankment, Zone 3.

1. *Measurement in Upland Borrow Pits.*

The payment quantity of Borrow Excavation, Zone 3, will be the volume of material actually used in the em-

bankment, Zone 3, measured in the borrow pits except that deduction will be made from the quantity so determined of all material that is found to be outside the prescribed Zone 3 embankment slope limits, or outside other payment limits that may be prescribed, upon acceptance of the Project.

2. *Measurement in Place in the Embankment.*

The payment quantity of Borrow Excavation, Zone 3, shall be the excess volume of the authorized Zone 3 embankment over and above the specified shrunken volume of the authorized roadway excavation and other Project excavation suitable and available for Zone 3 embankment.

The volume of the abovementioned authorized embankment that will be used in the determination of the payment quantity of Borrow Excavation, Zone 3, will be the computed volume of embankment, in place, actually constructed above the ground surface as it existed at the time of starting construction, within the required Zone 3 embankment limits shown on the Plans, or within other payment limits therefor if prescribed, and remaining within such limits at the time of acceptance of the Project, plus a volume equal to that of the prescribed topsoil stripping in the embankment areas, excluding the volume of porous fill and other items for which payment is provided under other scheduled items.

The volume of the abovementioned authorized roadway excavation and other Project excavation that will be used in the determination of the Zone 3 Borrow Excavation payment quantity will be determined as follows: The sum of the volume of roadway excavation actually performed below the ground surface as it existed at the time of starting construction, within the required excavation limits or within other payment limits therefor if prescribed, and the volume of other Project excavation performed that is available for embankment, will be reduced by the volume of the prescribed top soil stripping in excavation areas. The resulting volume of excavation then will be reduced by a shrinkage factor as prescribed in the Supplementary Specifications or as shown on the Plans. Excavation material that the Engineer deems unsuitable for Zone 3 embankment and is wasted as directed by him shall not be included in the above determination.

No allowance will be made in the payment quantity of Borrow Excavation for shrinkage of the borrow excavation needed to complete the embankment. The cost of furnishing, placing and compacting the additional borrow

excavation on this account shall be included in the unit price bid for the item Borrow Excavation.

B. For Swamp Embankment; Wet Excavation and Backfill Method; Unstable Material Removed to Firm Bottom.

ZONE 2.

1. *Measurement in Upland Borrow Pits.*

The payment quantity of Borrow Excavation, Zone 2, will be the volume of material actually used in the embankment, Zone 2, measured in the borrow pits except that deduction will be made from the quantity so determined of all material that is found to be outside the prescribed Zone 2 embankment slope limits, or outside other payment limits that may be prescribed, upon acceptance of the Project.

2. *Measured in Place in the Embankment.*

The quantity of Borrow Excavation, Zone 2, for which payment will be made will be the computed volume of Zone 2 embankment, in place within the required Zone 2 embankment limits shown on the Plans, or within other payment limits therefor if prescribed, and remaining within such limits at the time of acceptance of the Project.

The abovementioned volume of Zone 2 embankment will be computed from cross sectional measurements of the top surface and slopes of completed Zone 2 and from those previously taken of the firm bottom except that deductions will be made from the volume so computed (1) of all material above and outside the required limits of Zone 2 embankment as shown on the Plans, or outside other payment limits therefor if prescribed, at the time of acceptance of the Project, and (2) of the volume of muck, mud, silt or other unstable material entrapped within or under the embankment as disclosed by borings made by the Contractor through the Zone 2 embankment, as specified, provided the Engineer does not order the removal of the entrapped materials.

ZONE 3.

3. *Measurement in Upland Borrow Pits.*

The payment quantity of Borrow Excavation, Zone 3, will be determined as hereinbefore specified for Upland Embankment, Zone 3, under heading A. 1.

4. *Measurement in Place in the Embankment.*

The payment quantity of Borrow Excavation, Zone 3, shall be the excess volume of the authorized Zone 3 em-

bankment over and above the specified shrunken volume of the authorized roadway excavation and other Project excavation suitable and available for Zone 3 embankment.

The volume of the abovementioned authorized Zone 3 embankment that will be used in the determination of the payment quantity of Borrow Excavation, Zone 3, will be the computed volume of Zone 3 embankment, in place, constructed within the required limits therefor shown on the Plans, or within other payment limits therefor if prescribed, and remaining within such limits at the time of acceptance of the Project, as determined from cross sectional measurements of the top surface of completed Zone 2 and the top surface and slopes of Zone 3, excluding the volume of porous fill and other items for which payment is provided to be made under separate scheduled items of the Proposal.

The volume of the abovementioned authorized roadway excavation and other Project excavation that will be used in the determination of the payment quantity of Zone 3 Borrow Excavation will be as hereinbefore specified in paragraph 3 of A. 2. for Upland Embankment.

C. For Swamp Embankment; Vertical Sand Drain Method.

Borrow Excavation, Zone 1 (Sand Blanket), Borrow Excavation, Zone 2, and Borrow Excavation, Zone 3, will be measured for payment in place in the embankment. The payment quantities for each zone will be determined as follows:

1. *Borrow Excavation, Zone 1 (Sand Blanket).*

The payment quantity of Borrow Excavation, Zone 1 (Sand Blanket), will be the volume of Zone 1, when constructed as specified, computed as the product of the thickness specified or shown on the Plans, plus 6 inches tolerance, multiplied by the average width of Zone 1 between the prescribed embankment slope lines, except as otherwise hereinafter specified. Deduction will not be made for the space occupied by drainage windrows.

If the Engineer order a thickness of Zone 1 material less than the specified minimum thickness, so as to conform to actual ground conditions in any areas, the payment quantity will be determined as specified above except that it will be based on the depth as ordered plus a 6-inch tolerance.

If there be less than the specified minimum thickness of Zone 1 material, or less than such other thickness thereof that may be ordered, in place in any area or areas,

as indicated by borings, Zone 1 material shall be added to correct the deficiency. If the Contractor place Zone 2 material over any areas of Zone 1 material having less than the specified minimum or other ordered thickness, (1) he shall remove the Zone 2 material, add the deficiency of Zone 1 material and replace the Zone 2 material, all without additional compensation over and above the specified payment for Zone 1 Borrow Excavation, or (2) if the deficiency and the area or areas over which it extends be such that subsequent operations of embankment consolidation and the efficiency and objectives of the Vertical Sand Drain method will not be adversely affected, in the opinion of the Engineer, the Contractor shall have the option of correcting the deficiency as specified above or of accepting payment for Zone 1 Borrow Excavation as hereinbefore specified except that the payment quantity will be based on its actual thickness, in place, as determined by borings or test pits to be made by the Engineer, with no tolerance allowed.

2. *Borrow Excavation, Zone 2.*

The combined volume of Zone 1 and Zone 2 Borrow Excavation in place in the embankment below the working table will be determined by borings made from the working table and from cross sectional measurements of the working table and slopes, with the aid of readings on the settlement platforms previously placed on the original ground surface at a few locations designated by the Engineer, when such platforms are prescribed.

When Zone 2 embankment is prescribed to extend above the working table, the volume of Zone 2 Borrow Excavation in place above the working table will be determined by cross sectional measurements of the working table as hereinbefore mentioned and by cross sectional measurements of the top of completed Zone 2 and readings on the settlement platforms erected on the working table.

The total combined volumes of Zone 1 and Zone 2 Borrow Excavation will be the sum of the combined volumes thereof below the working table and the volume of Zone 2 Borrow Excavation above the working table.

The payment quantity of Borrow Excavation, Zone 2, shall be the difference between the total combined volume of Zone 1 and Zone 2 embankment, determined as above specified, and the volume of Borrow Excavation, Zone 1, determined and computed for payment as hereinbefore specified in C. 1. Deduction will not be made for the space occupied by gravel windrows.

3. *Borrow Excavation, Zone 3.*

The payment quantity of Borrow Excavation, Zone 3, shall be the excess volume of the authorized Zone 3 embankment over and above the specified shrunken volume of the authorized roadway excavation and other Project excavation suitable and available for Zone 3 embankment.

The volume of the abovementioned authorized embankment that will be used in the determination of the payment quantity of Borrow Excavation, Zone 3, will be the difference between the total combined volume of Zone 1, Zone 2 and Zone 3 embankment, determined as specified in the following paragraph, and the total combined volume of Zone 1 and Zone 2 embankment determined and computed as hereinbefore specified in paragraphs 1, 2 and 3 under the heading C. 2, excluding the volume of porous fill and other items for which payment is provided to be made under separate scheduled items of the Proposal.

The total combined volume of Zone 1, Zone 2 and Zone 3 embankment will be determined by borings made from the working table aided by readings on the few settlement platforms erected on the original ground surface if such platforms are prescribed, by cross sectional measurements of the working table and slopes therefrom, by readings, at the top of the completed overload, on the settlement platforms erected on the working table, and by cross sectional measurements of the surface of the completed overload and embankment slopes.

The volume of the abovementioned authorized roadway excavation and other Project excavation that will be used in the determination of the payment quantity of Zone 3 Borrow Excavation will be as hereinbefore specified in paragraph 3 of A. 2. for Upland Embankment.

Zone 1 and Zone 2 materials that are placed in existing channels and other critically soft areas, and are forced or carried outside of the prescribed payment limits of the embankment due to lateral displacement of the underlying unstable materials, will be measured and included in the payment quantity of Borrow Excavation, Zone 2, if this occur when the Contractor has fully complied with the Specifications and directions of the Engineer, and provided that, in the critically soft areas, he has made every reasonable effort to avoid mud waves and displacements by casting thin layers of Zone 1 and Zone 2 materials ahead of his operations by clamshell or other equipment, as hereinbefore specified in Art. 2. 3. 3.

If slips or slides occur within the embankment itself while the foundation remains firm, any portions of the embankment,

sand drains, sand blanket, drainage windrows, pore pressure devices, settlement platforms and other devices that are damaged thereby shall be replaced by the Contractor without additional compensation therefor. If slides occur due to failure of the foundation, the Department will pay for the replacement of the work damaged thereby at the appropriate unit bid prices, and by supplementary agreement as provided in Art. 1. 8. 4, if necessary, provided the Contractor has performed his work in strict accordance with the Plans, Specifications and directions of the Engineer.

D. For Swamp Embankment; Sand Blanket Method.

The payment quantities of Borrow Excavation, Zone 1, Zone 2 and Zone 3 constructed by the Sand Blanket method shall be determined as hereinbefore specified for each zone, respectively, under the Vertical Sand Drain method except that reference thereunder to sand drains does not apply and that all references to the vertical sand drain method shall be understood to mean the sand blanket method.

For all methods of construction and methods of measurement of quantities, material will not be measured for payment that is placed, or that washes, spreads or sloughs outside of the required embankment slopes, or outside of other prescribed payment lines, which remains outside thereof at the time the embankment, including overload, if any, is completed, measured and approved by the Engineer.

For all methods of construction and methods of measurement of quantities, the approximate quantities of work performed each month shall be computed, for payment on monthly certificates, by methods similar to those specified hereinabove but shall not be added together to determine the quantities for the final certificate of cost except such portions thereof that have been computed strictly in accordance with the methods hereinabove specified.

Payment for Borrow Excavation, Zone 1, Zone 2 and Zone 3, will be made for the quantities determined in accordance with such of the detailed methods described hereinabove as are prescribed in the Supplementary Specifications, and as they may be amended therein, at the unit prices bid for the scheduled items BORROW EXCAVATION, ZONE 1, BORROW EXCAVATION, ZONE 2 AND BORROW EXCAVATION, ZONE 3, respectively, in the Proposal which prices shall include the cost of dredging and pumping or excavating and hauling, placing and compacting the material and forming and shaping the embankment and slopes; furnishing, installing and maintaining settlement platforms, pore pressure measuring devices and control stakes and the removal of portions thereof as specified; sampling and testing required to be

performed by the Contractor; charges for certain sampling and testing, performed by the Engineer, of unused borrow pits and of materials placed and rejected for noncompliance, as specified; furnishing row boats and accessories for the use of the Engineer; furnishing boat transportation to dredges; repair or replacement, as directed by the Engineer, of embankment, vertical sand drains and other construction damaged by slips or slides occurring while the foundation remains firm; removal and replacement of substandard Zone 1 material or the construction of additional drainage windrows as specified; restoration of existing and new ditches and water channels and the construction of new ditches and channels necessitated by the wash and spread from hydraulic fill operations, as specified and directed; protection of public and private property; borings through the completed Zone 2 embankment constructed by the Wet Excavation and Backfill method; and all other work incidental to borrow excavation that is provided to be performed without specific payment or additional compensation; the furnishing of all labor, equipment and materials; and all else necessary for and incidental to the work of borrow excavation, except as follows:

Porous fill, drainage windrows, vertical sand drains, and borings made from the working table by the Contractor as specified, will be paid for separately as provided hereinbefore under Quantity and Payment for these items of work, respectively, in Art. 2. 3. 4.

SECTION 5

Channel and Ditch Excavation

2. 5. 1. Description.

Channel excavation and ditch excavation shall consist of the excavation required for the construction of new water channels, and for deepening, widening and relocating existing water channels.

The excavation of water channels is defined as channel excavation if the bottom width thereof is more than 5 feet, and as ditch excavation if the bottom width is 5 feet or less.

Channel excavation and ditch excavation shall be classified as earth and rock or shall be unclassified, as specified or shown on the Plans. If classified, rock and earth in channel excavation shall be governed by the definitions thereof as specified for roadway excavation, earth and rock, in Art. 2. 2. 1 and rock in ditch excavation shall be governed by the definition of rock in subsurface structure excavation as specified in Art. 2. 7. 1.

2. 5. 2. Materials.

No materials are required.

2. 5. 3. Methods of Construction.

Water channels shall be constructed to the lines, grades and cross sections, and at the locations shown on the Plans, and the excavation shall be neatly sloped and finished. Suitable material excavated shall be used for embankment when needed for this purpose. Surplus material shall be disposed of by the Contractor at places to be provided by him. The Contractor shall obtain and submit to the Engineer written permission of the property owners for the temporary storage and final disposal of any excavation materials on private lands outside of the right of way or easement areas acquired by the State. Excavated material that may be disposed of adjacent to the channels shall be neatly graded and sloped to provide adequate drainage flow from the adjacent lands to the channels, and the sites shall be restored to a condition satisfactory to the property owners and the Engineer. Prior to final acceptance of the Project the Contractor shall obtain and submit to the Engineer, releases from all property owners, public and private, on whose land materials from channel excavation have been temporarily stored or permanently placed. The releases shall be in a form satisfactory to the State, shall recite that the owner's land has been satisfactorily restored, and shall protect the State against claims or other actions of the owners with respect to materials stored or disposed of on their lands.

2. 5. 4. Quantity and Payment.

The quantities of Channel Excavation and of Ditch Excavation, in earth, for which payment will be made will be the actual volumes, measured in place, removed within the neat lines shown respectively therefor on the Plans or as directed by the Engineer.

When rock is encountered, payment will be made as Channel Excavation, Rock or Unclassified, and Ditch Excavation, Rock or Unclassified, as specified and scheduled, for the respective quantities thereof actually excavated within limits 1 foot outside the above-mentioned neat lines at the bottom and sides, measured normal thereto.

Payment for Channel Excavation and for Ditch Excavation will be made for the quantities of each as above determined, measured in cubic yards, at the respective unit prices bid for the various items of CHANNEL EXCAVATION AND DITCH EXCAVATION, EARTH AND ROCK, or UNCLASSIFIED, as specified and as scheduled in the Proposal, which prices shall include the costs of excavation, placing and compacting the material in embankment or disposal of the material as specified, shaping and dressing slopes and other surfaces, final restoration of the sites adjacent to the water channels, necessary permits and releases, all labor and equipment, and all else necessary therefor and incidental thereto.

SECTION 6

Foundation Excavation

2. 6. 1. Description.

Foundation excavation shall include the excavation required for the construction of piers, walls and other structures (except for road structures included in Division 5), and other work as hereinafter specified.

2. 6. 2. Materials.

Timber for cofferdam flooring shall be sound and subject to the approval of the Engineer.

Broken stone at weep holes shall be of a quality and size approved by the Engineer.

Backfill shall be suitable material, free from large and frozen lumps, wood and other foreign materials, and shall be acceptable to the Engineer.

2. 6. 3. Methods of Construction.

Excavations for foundations shall be properly supported and if necessary, shoring, sheathing, sheet piling or other means of support shall be used. The Contractor shall at frequent intervals inspect rangers, braces, props, sheathing and other parts of excavation supports and maintain them, so as to guard against cave-ins. Sheathing shall be properly supported by backfill, and wedges holding the supports in place shall be tightly driven. In running sand, sheathing shall be caulked with suitable material. Cofferdams and cribs shall be carried sufficiently below the bottom of the foundation level and shall be properly braced and watertight. Their interior dimensions shall be ample to permit construction, inspection of forms, and pumping outside of forms. Before the work of construction within the cofferdam is started, the cofferdam shall be unwatered and maintained in that condition and, if necessary therefor, the excavation shall be carried below the established elevation of the bottom of the foundation and a concrete seal shall be constructed below said elevation in accordance with the requirements of Art. 4. 1. 3. When required by the Engineer, the bottom of the excavation in cofferdams shall be covered with 1-inch planking supported on 2″ x 4″ wales, securely spiked to the cofferdam, all in a manner approved by the Engineer. The planking shall be level and tight and shall be nailed to the wales. Cofferdams shall be constructed and maintained so that masonry placed therein is protected against damage from erosion and rising water. No

lumber shall be left extending into the masonry without the approval of the Engineer. Pumping in an excavation shall be done so as to preclude concrete materials being carried away. Pumping shall not be done while concrete is being placed and for a period of 24 hours thereafter, except from a suitable sump separated from the masonry by a watertight wall or by other approved method. Unwatering of a sealed cofferdam shall not commence until the concrete seal has attained sufficient strength.

When an excavation has been carried to the required depth the material below shall not be disturbed, and in soft soil the last part of the excavation shall not be made until immediately before placing the masonry. If the structure is to be founded on rock or other hard material, loose and soft material shall be removed therefrom, and the hard surface shall be cleaned and cut either level, stepped or serrated as the Engineer may direct. Seams in the rock shall be cleaned out and filled with concrete, mortar or grout as may be directed. The Contractor shall notify the Engineer when an excavation is completed, and masonry shall not be placed therein until the Engineer has approved the suitability of the underlying material. The Engineer may issue written orders for changes in elevations and dimensions of footings as he may deem necessary to secure satisfactory foundation support, and the Contractor shall comply therewith.

When the masonry has been placed, cofferdams and other temporary supports shall be removed, and excavated spaces not occupied by the permanent structure shall be backfilled to the surface of the surrounding ground with sufficient allowance for settlement of the fill. Backfill shall be placed in successive horizontal layers not more than 6 inches deep and each layer shall be properly compacted by flat-faced mechanical tampers, or by approved vibratory soil compactors if the material is preponderantly sand or sand and gravel, before the succeeding layer is placed. To prevent wedge action against the masonry, slopes bounding the excavation shall be stepped. Backfill around culverts, arches, rigid frame structures and piers shall be placed simultaneously on both sides thereof to the same elevation. Backfill shall not be placed against concrete masonry until the latter has been in place 14 days. At weep holes and elsewhere behind the masonry, broken stone shall be placed as shown on the Plans.

For work in stream channels and other waterways, excavation shall not be made, and the bed of the waterway shall not be disturbed, outside of the areas occupied by caissons, cofferdams, sheet piling or sheathing, unless such work is shown on the Plans or approved by the Engineer. On completion of the work, any excess material outside of the limits of the structure resulting from the work shall be removed. When the Project is within or adjacent to navigable waterways, the carrying out of the Project and the

removal of excess material shall be subject to the approval of the District Engineer, Corps of Engineers, U. S. Army, as well as of the Engineer.

The Contractor shall exercise particular care in excavating to avoid any damage to existing drains, sewers, gas and water mains and other subsurface utilities. Before starting any work which might endanger any existing subsurface structures the Contractor shall locate them and make provision for their protection. If existing subsurface structures are damaged due to the Contractor's operations, he shall repair or replace them at his own expense to the satisfaction of the owners and the Engineer.

The Contractor shall sheathe and shore all excavations adjacent to permanent roadway pavement, sidewalks and curbs so as to prevent undermining or displacing them. Any damage to roadway pavement, sidewalks or curbs beyond the limits of foundation excavation due to the Contractor's operations shall be repaired or replaced by him at his own expense to the satisfaction of the Engineer.

Excavation material from foundation excavation not required for backfill shall be placed and compacted in the roadway embankment as specified in Art. 2. 3. 3 if it be suitable therefor in the opinion of the Engineer. Surplus material which is not suitable for embankment shall be disposed of by the Contractor outside the Project at places to be provided by him.

The Contractor shall exercise particular care in excavating for stepped wall footings so as to avoid any disturbance of the bearing material adjacent to the steps. If this material be disturbed so that, in the opinion of the Engineer, it does not provide a satisfactory bearing surface, the unsatisfactory material shall be replaced with footing concrete, as directed by the Engineer, at the Contractor's expense.

2. 6. 4. Quantity and Payment.

The quantity of Foundation Excavation for which payment will be made will be the volume in place within vertical planes, 6 inches outside of the neat lines of the footings, from the surface of the ground as it exists at the time when the foundation excavation is started to the elevations shown on the Plans or to such elevation as the Engineer may direct, provided, however, that where foundation excavation underlies excavation for which payment is made under other scheduled items, the quantity for which payment will be made under this item will include only material below the payment lines of such other items and provided further, that additional excavation for concrete seal in cofferdams will not be measured for payment unless concrete seals are called for on the Plans. When, in the opinion of the Engineer, it is necessary to carry any foundation below the elevation shown on the Plans in order to reach

suitable foundation material, the volume of excavation for the first 3 feet of additional depth will be included in the quantity for which payment will be made at the unit price bid for the item Foundation Excavation. All excavation below this additional depth will be eligible for consideration of price adjustment as provided in Art. 1. 8. 4 except that negotiations therefor may be completed when the additional excavation at any location has been performed. If the quantity of foundation excavation be reduced more than 25 per cent, the quantity as reduced shall be eligible for consideration of price change in accordance with the provisions of Art. 1. 8. 4. Material forced up between piles and re-excavated, or additional material excavated to compensate for swelling due to driving of piles or on account of swelling, slips, slides or cave-ins, will not be measured for payment. The quantity of Foundation Excavation which will be measured for payment will include the volume of masonry, utilities and other structures which are removed from within the specified payment limits of Foundation Excavation and for which no other specific payment is provided.

The quantity of Flooring in Cofferdams for which payment will be made, will be the actual volume of lumber placed as directed by the Engineer, based on the actual area placed and the nominal thickness.

Payment for Foundation Excavation will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item FOUNDATION EXCAVATION in the Proposal, which price shall include the cost of excavation of all materials encountered of whatever nature, placing and compacting excess material in embankment or otherwise disposing of it, excavation for concrete seal in cofferdams except as otherwise hereinbefore provided, backfill, stepping slopes, preparing, cleaning and sealing rock surfaces, shoring, sheathing, bracing, sheet piling, cofferdams, cribs and removal thereof, pumping, cleaning up waterways, all materials, labor, equipment and all else necessary therefor and incidental thereto, except that, if specific items of payment for cofferdams be provided in the Proposal, payment for the construction and removal of the cofferdams, including all costs of shoring, sheathing, sheet piling, cribbing, pumping, all materials, labor, equipment, and all other work in connection therewith and incidental thereto, will be made at the lump sum price bid for COFFERDAMS at each bridge.

If the Contractor wishes to use dikes, well points or other means for dewatering his areas of foundation excavation, he shall submit plans showing his proposed construction to the Engineer and obtain his approval before proceeding with the work. The Engineer's approval will not, however, relieve the Contractor from his responsibility for producing a dry excavation satisfactory to the Engineer.

If the alternative method used by the Contractor results in a dry excavation and enables him to construct the abutments to the satisfaction of the Engineer, payment will be made for this work at the lump sum price bid for Cofferdams.

Payment for Flooring in Cofferdams will be made for the quantity as above determined, measured in feet board measure, at the price per M. ft. B. M. bid for the item FLOORING IN COFFERDAMS in the Proposal, which price shall include the furnishing and placing of the lumber and fastenings, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 7

Subsurface Structure Excavation

2. 7. 1. Description.

Subsurface structure excavation shall include excavation for drain pipes and culverts, sewers, water pipe, gas pipe, conduits, manholes, inlets, catch basins and similar structures.

Rock in the excavation for subsurface structures is defined as boulders more than ½ cubic yard in volume and rock in ledge formation which, in the opinion of the Engineer, cannot be removed by means of heavy equipment ordinarily used for trench excavation, without blasting.

2. 7. 2. Materials.

No materials are involved.

2. 7. 3. Methods of Construction.

Before laying pipes of any connected drainage system, or any pipe line or culvert, the Contractor shall ascertain the location and grade of utility pipes and other subsurface structures which may interfere with such construction. Test pits shall be excavated wherever necessary to obtain the required information, subject to the approval of the Engineer.

Subsurface structure excavation shall be made in open cut unless otherwise specified and shall be wide and deep enough to permit the installation of the subsurface structure in a workmanlike manner. Trenches and openings for subsurface structures located within proposed and existing pavement, shoulder and sidewalk areas shall be excavated with vertical sides except that the sides may be sloped above the bottom of proposed subbase or other prepared foundation course. Trenches for pipes shall be not less than 1 foot wider at the bottom than the outside diameter of the

pipe and, when conditions permit, shall be opened for a distance of not more than 300 feet in advance of the laying of the pipe. The excavation shall be properly shored, braced and sheathed as conditions may warrant. If close to existing pavement, sidewalks, curbs, pipes, railroads, or structures of any kind, the excavation shall be secured by sheet piling or otherwise so that such facilities and structures will be adequately protected. Suitable trench crossings shall be provided and maintained where necessary.

When the material at the bottom of a trench or other subsurface structure excavation is soft or otherwise unsuitable, it shall be removed to such depth as the Engineer may require and the space backfilled with suitable granular material obtained from the Project excavation, or from borrow excavation if it be not available within the Project. Rock and boulders in the excavation for all pipes, and all earth, rock and other materials in excavations for concrete and clay pipes, shall be removed within 6 inches of the outside surface of the barrel of the pipes at the bottom and sides. The space excavated below the pipe grade shall be filled with suitable fine material from trench or roadway excavation which shall be compacted with mechanical tampers or vibratory soil compactors so that it is uniformly dense and firm. The bottom of the trenches prepared as above specified shall conform to the grades of the bottoms of pipes or structures and shall be recessed for pipe bells.

Backfill to a height of 2 feet above the top of pipes and culverts, except underdrains, shall be made with earth, which shall be free from stones or rock fragments of a size larger than 2 inches. Below this level the backfill shall be placed in layers not more than 6 inches thick and each layer shall be compacted with approved flat-faced mechanical tampers.

All backfill more than 2 feet above the top of pipes and culverts, except underdrains, shall be compacted as follows:

(1) By approved vibratory soil compactors, if the backfill material be preponderantly sand, or sand and gravel, but contains more than 12 per cent by weight, of material that will pass the No. 200 sieve.

(2) By approved vibratory compactors or flat-faced mechanical tampers or by puddling, if the material be preponderantly sand, or sand and gravel, and contain not more than 12 per cent, by weight, of material that will pass the No. 200 sieve, except that puddling will not be permitted in trenches for pipes or culverts with open joints.

(3) By approved flat-faced mechanical tampers, if the backfill material be not preponderantly sand, or sand and gravel.

Backfill around inlets, manholes, and other subsurface structures shall be compacted by flat-faced mechanical tampers.

In (1) and (2) above, approved flat-faced mechanical tampers may be substituted for the vibratory soil compactors where the shoring and bracing of trenches or other special conditions make the use of vibratory compactors impracticable.

The special backfill in trenches for underdrains shall be compacted by approved vibratory soil compactors or flat-faced mechanical tampers except that it needs not be compacted if the underdrains be located outside of the areas of proposed or future pavements, improved shoulders or improved sidewalks. Earth backfill above the special backfill material shall be compacted as specified in (1), (2) and (3) above except that puddling will not be permitted.

Where mechanical tampers or vibratory soil compactors are used in accordance with the foregoing provisions, the backfill shall be placed and compacted in layers not more than 6 inches thick, loose measurement.

Where trenches are puddled in accordance with the foregoing provisions, the backfill shall be placed in successive lifts not more than 4 feet thick and each lift shall be thoroughly puddled before the next lift is placed. If more than a 6-inch depth of trench remain unfilled after the final puddling, the remaining backfill shall be tamped or vibrated, as specified in (1) or (2) above. The surface of the trench backfill shall be rounded to allow for compression and shall be finally compacted by a 3-wheel, 10-ton roller having a load of not less than 330 pounds per inch of width of rear wheels.

Shoring, bracing and sheathing shall be withdrawn as the filling proceeds unless otherwise specified or approved by the Engineer. Surplus material from subsurface structure excavation that is suitable for embankment shall be used therefor as hereinbefore specified for the use of roadway excavation material. Suitable surplus material not required for embankment, and all unsuitable materials, shall be disposed of by the Contractor at places to be provided by him outside the limits of the Project.

2. 7. 4. Quantity and Payment.

No specific payment will be made for subsurface structure excavation and backfill and the cost thereof shall be included in the prices bid for the subsurface structures for which the excavations are made, except as otherwise hereinafter provided.

Rock and boulders as hereinbefore defined in Art. 2.7.1 will be measured for payment as Rock Excavation, Subsurface Structures, when encountered. Measurement for rock in mass formation will extend 1 foot beyond the external barrel diameter of pipes and outmost neat lines of other structures at the bottom and sides except that in underdrain trenches measurement will extend 6 inches beyond the prescribed limits of the special backfill material

at the sides and bottom if such backfill limits be more than 6 inches beyond the outside barrel diameter of the pipes. For boulders exceeding ½ cubic yard in volume, measurement will be made of the actual volume excavated within the payment limits prescribed above for rock in mass formation.

Earth excavation below the proposed grades of pipes or subsurface structures shown on the Plans, caused by changes in grades of such pipes and structures or made upon order of the Engineer to remove unsuitable material, will be measured for payment as Earth Excavation, Subsurface Structures, Additional Depth, for the quantity excavated within vertical planes located 1 foot outside the external surface of the barrels of pipes and 6 inches outside the outmost neat lines of other structures except that for pipes of less than 12 inches measurement for payment will be based on a trench width of 36 inches.

The removal of buried cribbing, heavy timbers and similar materials encountered in subsurface structure excavation which cannot be performed practicably by means of the equipment and methods ordinarily used for trench excavation, without special work, will be paid for as provided in Art. 1. 8. 4.

When subsurface structure excavation is within the lateral limits of roadway excavation or of any excavation which is paid for under other scheduled items, measurement for payment of rock excavation and boulders and the removal of cribbing, heavy timbers and similar materials in the subsurface structure excavation, as hereinbefore specified, will apply only below the prescribed bottom limit of such roadway or other excavations unless, in the opinion of the Engineer, the subsurface structure excavation must be made before the roadway or other excavation.

Payment for rock and boulders in excavation for subsurface structures, as above described, will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item ROCK EXCAVATION, SUBSURFACE STRUCTURES, in the Proposal which price shall include excavation, backfilling, use or disposal of surplus material as specified, all labor, equipment and all else necessary therefor and incidental thereto.

Payment for earth excavation below the proposed grades of pipes and subsurface structures, as above described, will be made for the quantities as above determined, measured in cubic yards, at the price per cubic yard bid for the item EARTH EXCAVATION, SUBSURFACE STRUCTURES, ADDITIONAL DEPTH, in the Proposal, which price shall include the cost of excavation and the use or disposal of surplus material as specified, backfilling except as otherwise hereinafter specified, pumping, sheathing, shoring and bracing below such proposed grades, all

labor, equipment and all else necessary therefor and incidental thereto.

Where backfill below the bottom of pipes or other subsurface structures is ordered by the Engineer to be made with granular or other selected material obtained from outside the Project, payment will be made for such material, measured in place in the trenches, within the payment limits prescribed for the trench excavation below the proposed grade, at the unit price bid for the item Borrow Excavation. If no item be scheduled for Borrow Excavation, payment will be made as provided in Art. 1. 8. 4.

The foregoing provisions for quantity and payment for earth excavation and backfill below the proposed grade of pipes and other subsurface structures shall not apply (1) to the excavation and backfill required for a depth of 6 inches below the bottom of concrete and clay pipes, (2) to the special backfill and excavation therefor below underdrains, or (3) to the extra depth of excavation necessary for the extra depth of inlets and manholes paid for under separate scheduled items of the Proposal.

Payment for Earth Excavation for Test Pits will be made for the volume actually excavated with approval of the Engineer, within the authorized limits, at the unit price bid in the Proposal for the item EARTH EXCAVATION FOR TEST PITS, which price shall include the cost of excavation, backfilling, all labor and equipment, and all else necessary therefor and incidental thereto, except that test pits and related work in connection with conduits installed as a part of electrical work will not be paid for as test pit excavation.

SECTION 8

Road-Mixed Stabilization

2. 8. 1. Description.

Road-mixed stabilization shall consist of soil, or soil and aggregate, combined with stabilizing agents and water, uniformly mixed in place on the existing roadway, or at a designated area off the roadway, by road-mixed method, spread on the roadway and compacted, and the application of a curing treatment if and as hereinafter specified.

2. 8. 2. Materials.

The material to be stabilized shall consist of the natural material on the grade, or selected material from roadway excavation or from borrow pits or other sources outside the Project, or a combination of two or more of the above materials, as prescribed in the Supplementary Specifications.

All rocks, stones or lumps of material greater than 2½ inches in size shall be removed from the material to be treated before the addition of the stabilizing agent. All lumps of material greater than 1 inch in size which will soften when soaked in water shall be broken and crushed so that all the pieces will pass a 1-inch sieve.

The stabilizing agent shall be one of the following materials as specifically designated in the Supplementary Specifications. The materials shall conform to the requirements therefor as specified below:

Bituminous material	Type and grade as specified in Supplementary Specifications.
Calcium chloride	Conforming to Art. 8. 5. 19. Pellet or flake type may be used.
Lime and fly ash	Lime conforming to Art. 8. 5. 33. Fly ash conforming to Art. 8. 5. 30.
Standard portland cement, Type I or II	Conforming to Art. 8. 5. 22.
Air-entraining portland cement, Type IA or IIA	Conforming to Art. 8. 5. 23.
Rock salt (sodium chloride)	Conforming to Art. 8. 5. 36.

Curing materials shall be as hereinafter specified under each method of stabilization and shall conform to the requirements of the various Articles of Division 8 as follows:

Asphaltic oil	Art. 8. 1. 7.
Emulsified asphalt	Art. 8. 1. 5.
Polyethylene sheeting	Art. 8. 5. 29.
Waterproof paper blankets	Art. 8. 5. 29.
Water	Art. 8. 5. 38.

2. 8. 3. Methods of Construction.

Preparation of Material to be Stabilized. Prior to the incorporation of the stabilizing agents, the areas to be stabilized shall be graded and shaped to conform to the prescribed line, grade and cross section. The proper quantity of soil conforming to specified requirements shall be incorporated with the existing material to be stabilized and to replace unsuitable material which shall have been removed when directed by the Engineer.

2. 8. 3.

ROAD-MIXED STABILIZATION

The existing material to be stabilized, and added material procured from roadway excavation or outside sources when necessary, shall be scarified and pulverized for sufficient width and depth to give the compacted cross section shown on the Plans. The length of material scarified and pulverized at any time shall not exceed the length which can be completely stabilized in accordance with the Specifications in 2 working days. The use of a road mixing machine which cuts a true plane at a specified depth in the material to be stabilized will be permitted, provided furrows of loosened material below the proposed bottom of the stabilization are not formed.

When all of the material to be stabilized for any area is procured from roadway excavation in other areas or from sources outside the Project, the area to be stabilized shall be graded, shaped and compacted as specified in Art. 2. 2. 3 and 2. 3. 3. The subgrade of the course to be stabilized shall be formed at the proper line, grade and contour and shall be compacted as specified for the subgrade of subbase in Art. 2. 9. 3.

The material when ready for stabilization shall be bladed or placed in a windrow or blanket which shall be shaped to a uniform section and density such that after being mixed with the stabilizing agents, and with water as necessary, and spread and compacted as hereinafter specified, the road-mixed stabilization will be of the required width and thickness.

Addition of Stabilizing Agents. Stabilizing agents to be mixed with the windrowed or blanket material shall be spread by hand, by mechanical equipment or by pressure distributor at the rate or rates specified in the Supplementary Specifications and in such a manner as to insure that correct and uniform proportions will enter the mixer at all times. Stabilizing agents shall not be spread or distributed sooner than 2 hours before they are to be mixed with the materials to be stabilized. No calcium chloride, portland cement, lime and fly ash, or rock salt shall be applied when the moisture content of the windrowed or blanket material exceeds the optimum moisture content by more than 2 per cent. For bituminous stabilizing agents, the range of moisture content of the soil shall be as prescribed in the Supplementary Specifications. No stabilizing agents shall be applied when the moisture of the subgrade material exceeds its optimum moisture content. No equipment except that used in spreading and mixing shall be allowed to pass over the freshly spread stabilizing agents. During seasons of probable freezing temperatures, no stabilizing agents shall be applied unless the atmospheric temperature is at least 40° F. in the shade, and rising.

Mixing. The stabilizing agents, windrowed or blanket material and water shall be mixed by means of a road mixing

machine of a type approved by the Engineer. The machine shall be of the type which, during the time of mixing, picks up from the windrow or blanket all the scarified and pulverized material to be stabilized. The device by which the mixing machine picks up the ingredients to be mixed shall be subject to control and shall be controlled on each pass to prevent cutting below the required grade or picking up unmixed material on successive passes. The mixer shall be of the pugmill type or auger type, or of the transverse shaft type which mixes the materials by means of revolving tines or paddles which lift the loose materials off the ground.

Water shall be added to and mixed with the ingredients in such quantity that, regardless of the method of introducing it, the percentage of moisture in the mixture shall not vary from the optimum by more than 2 per cent when the watering and mixing have been completed. It shall be introduced prior to or at the time of mixing by means of control devices to be approved by the Engineer which will supply uniformly the proper ratio of water to the amount of material to be stabilized. If water be added in increments, each increment shall be incorporated in the mixture by the mixing machine to avoid concentration of water near the surface. In the section being processed, all water shall be added, and all mixing performed, as necessary to meet this condition in a continuous operation within 3 hours. Mixing shall be continued until the mixture is uniform in appearance and homogeneous. When stabilization is required in multiple lanes, not more than 25 minutes shall elapse between mixing time in adjacent lanes at any location.

After final mixing has been completed on a section of roadbed, or after mixing operations have been completed off the grade and the stabilized mixture has been deposited and spread, the stabilized material shall be shaped and compacted to the prescribed lines, grades, and cross sections.

Compaction. Immediately after the stabilized material has been mixed, spread and shaped, it shall be uniformly compacted for its entire depth by the methods specified in the Supplementary Specifications. The surface shall be rolled finally with a smooth steel 3-wheel roller or 2-axle or 3-axle tandem roller. The gross weight of either type of roller shall be not less than 8 tons, nor more than 12 tons. The number of rollers and their rate of operation for the entire compaction operation shall be sufficient to compact uniformly the section being processed within 2 hours.

Rolling shall commence at the outer edge of the treated material and shall proceed without interruption across the area on successive passes of the roller so that each pass will overlap the previous pass by not less than one quarter of the roller width. Rolling shall be done in such a manner as to avoid surface irregularities in excess of the specified tolerances.

ROAD-MIXED STABILIZATION

When calcium chloride, portland cement, lime and fly ash, or rock salt is used, the surface of uncompacted, partially compacted and completely compacted mix shall be kept moist until the curing treatment is applied. An adequate water supply shall be maintained at the area of compaction, and equipment shall be available so that water can be applied without driving equipment over the uncompacted material.

When a bituminous stabilizing agent is specified, no water shall be added after the soil has been prepared to the moisture content specified in the Supplementary Specifications and the bituminous material has been mixed with the soil.

Prior to final compaction with a tandem roller or 3-wheel roller, the surface of the stabilized mixture shall be reshaped and lightly scarified to loosen any imprints left by the compacting or shaping equipment until a surface mulch not more than 1 inch in thickness is obtained. Then the resulting surface shall be thoroughly rolled with a smooth wheel tandem or 3-wheel roller of the types and size specified hereinabove. The rolling shall be done in a manner such as to produce a smooth, closely knit surface free from cracks, ridges, or loose material and conforming to the grade and crown shown on the Plans. There shall be no projections or depressions in the completed stabilized surface exceeding ⅜ inch in 10 feet.

Construction Joints; *For Portland Cement Stabilization Only.* At the end of each day's work a construction joint shall be made by trimming the end of the compacted stabilized mix to a straight line normal to the center line of the area being stabilized and with a vertical face in a thoroughly compacted material. Stabilization construction shall not be resumed beyond the construction joint until it has been approved by the Engineer.

Curing. After the road-mixed stabilization has been finished as hereinbefore specified, a curing agent shall be applied if and as hereinafter specified.

The curing agent shall be applied in a manner that will provide a continuous cover over the stabilized mix. The curing agent shall be applied as soon as possible after the completion of the final compacting operations. No subsequent construction shall be performed thereon by the Contractor or others during the curing period.

Light vehicles and construction equipment shall be permitted to use completed portions of the stabilization immediately provided the stabilization has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic, and provided the curing agent specified above is not impaired. When it is mandatory for traffic, which will mar or distort the stabilized surface, to use portions of the stabilization immediately, the surface

shall be covered with 6 inches of earth or other protection satisfactory to the Engineer.

Should it be necessary for construction equipment or light vehicles to use a bituminous-cured surface before the bituminous curing agent has dried sufficiently to prevent pick up, cover materials as specified for bituminous surface treatment in Art. 3. 6. 2 and 3. 6. 3 shall be applied at the rate of not less than 12 and not more than 15 pounds per square yard.

Curing agents and methods, for the various types of stabilization, shall be as follows:

1. For Bituminous Stabilization:

   No specific curing agent shall be applied to the road-mixed stabilized surface. However, the length of conditioning time prior to surface treatment or other surfacing shall be as prescribed in the Supplementary Specifications.

2. For Calcium Chloride Stabilization:

   No curing required.

3. For Lime and Fly Ash Stabilization:

   (a) Water. Intermittent sprinkling for not less than 7 days or until such time as a surface treatment or other surfacing, if prescribed, is applied. Number of applications as directed, dependent upon weather conditions.

   (b) Bituminous Materials. Asphaltic oil, Grades RC-0, RC-1, MC-0 or MC-1, or emulsified asphalt Grade RS-1 or SS-1, applied at the rate of 0.10 to 0.15 gallon per square yard as directed by the Engineer. Prior to the application of the bituminous curing agent the surface of the stabilization shall be sprayed with water applied at a rate sufficient to moisten or dampen the surface, but not to the extent that free water remains on the surface.

   Exception: If the stabilized course is to be given a bituminous surface treatment immediately after its completion, no curing agent shall be applied. Prior to application of bituminous surface treatment, the stabilized surface shall be sprayed with water at a rate sufficient to moisten or dampen it, but not to the extent that free water remains on the surface.

4. For Cement Stabilization:

   (a) Bituminous Materials. Asphaltic oil, Grades RC-0, RC-1, MC-0, or MC-1, or emulsified asphalt, Grade RS-1 or SS-1. A light application of water will be required prior to applying the bituminous curing agent, if the surface of the stabilized mix appears dry. The rate of application of

curing material shall be 0.1 to 0.2 gallon per square yard as directed by the Engineer. The curing period shall be not less than 7 days.

Exception: Same exception to curing as specified for Lime and Fly Ash Stabilization.

(b) White Polyethylene sheeting which shall remain in place for a period of not less than 7 days.

(c) Waterproof paper blankets which shall remain in place for a period of not less than 7 days.

(d) Hay or Straw. Not less than 6 inches, loose thickness, which shall remain in place and be kept wet for a period of not less than 7 days.

(e) Earth Cover. Not less than 2 inches, loose thickness, which shall remain in place and be kept moist for a period of not less than 7 days.

5. For Rock Salt Stabilization:

No curing is required.

2. 8. 4. Quantity and Payment.

The quantity of Road-Mixed Stabilization for which payment will be made will be the area, measured in place, constructed in accordance with the Plans and Specifications.

The compacted thickness of the road-mixed stabilization will be determined by the Engineer from measurements of test holes or cores dug in the finished work at intervals not to exceed 500 feet. The average thickness of stabilized mix constructed shall be not less than 85 per cent and not more than 115 per cent of the thickness specified or shown on the Plans, except that the thickness at any one place may be not less than 80 per cent and not more than 120 per cent of that shown on the Plans. Any part of the work which fails to conform to these provisions shall be reconstructed without additional payment.

Payment for Road-Mixed Stabilization will be made for the quantity as above determined at the unit price per square yard bid for the item ROAD-MIXED STABILIZATION in the Proposal, which price shall include furnishing all materials (except stabilizing agents), applying water and stabilizing agents, mixing, compacting, finishing, curing, furnishing all labor, equipment and tools, protection and maintenance of the stabilization as specified, and all else necessary therefor and incidental thereto.

Stabilizing Agents will be paid for at the unit price bid for the item STABILIZING AGENT in the Proposal, which price shall include furnishing, but not applying or mixing, the stabilizing agent, provided that payment will be made only for that quantity of the material actually incorporated in the completed work. The

unit price bid shall be based on the unit of measurement hereinafter specified respectively for the various types of stabilizing agents.

If lime and fly ash be used as the stabilizing agent, separate payment will be made at the unit prices bid per ton for the items STABILIZING AGENT, LIME, and STABILIZING AGENT, FLY ASH.

Stabilizing Agent	*Unit of Measurement*
Bituminous material	Gallon
Calcium chloride	Ton
Lime and fly ash — lime	Ton
Lime and fly ash — fly ash	Ton
Portland cement	Barrel
Rock salt	Ton

Payment for bituminous material used for the stabilizing agent will be determined as the number of gallons used, measured at 60° F., as determined by the temperature-volume corrections shown in the table or tables of Art. 9.2.1 which are applicable to the types and grades of materials used.

SECTION 9

Subbase

2. 9. 1. Description.

Subbase shall consist of furnishing, placing and compacting the prescribed thickness of the specified soil aggregates.

2. 9. 2. Materials.

Subbase material shall consist of the type and class, or classes, of soil aggregates as prescribed in the Supplementary Specifications. Each type and class shall conform to the requirements specified therefor in Division 8, Section 8.

2. 9. 3. Methods of Construction.

Subbase shall not be constructed when the subgrade therefor is frozen or when it is soft or unstable. The subbase subgrade shall be shaped and compacted to the proper grade and contour and shall be free from water pockets.

The subbase subgrade shall be compacted by 5 passes of a 50-ton compactor of the type specified for the compaction of upland embankment in Art. 2.3.3, with the compactor loaded to a gross weight of 50 tons. Where access with the 50-ton compactor is not possible, the subbase subgrade shall be compacted to a density of not less than 95 per cent as defined in Art. 2.3.3.

SUBBASE

The subbase shall be constructed of the thickness or thicknesses shown on the Plans or as provided in the Supplementary Specifications.

Subbase shall not be constructed during freezing weather or with frozen material.

Subbase of more than 8 inches compacted thickness shall be placed and compacted in two or more courses of approximately equal thickness, no course to be more than 8 inches thick. The bottom course shall be compacted as specified in Art. 2. 3. 3 for compaction of Upland Embankment Zone 3, Dry Fill method, by Alternative (2) or by Alternative (5). The top course and intermediate course, if any, shall be compacted similarly except that Alternative (4) with a minimum of 5 passes of the 50-ton compactor loaded to a gross weight of 25 tons, or Alternative (5), shall be used. Subbase of not more than 8 inches compacted thickness shall be placed in one course and shall be compacted in accordance with the foregoing requirements for compaction of the top course of subbase. Each layer of subbase shall be maintained, during its compaction, at a moisture content within 2 per cent of optimum.

Previous to the construction of pavement that would make adjacent areas of the subbase inaccessible to the specified compaction equipment, the subbase in those areas shall be brought to grade and compacted in accordance with the foregoing requirements. The subbase in unavoidably inaccessible areas shall be compacted to a density of not less than 95 per cent as defined in Art. 2. 3. 3.

If a subbase course be prescribed in the Plans or Supplementary Specifications, backfill in rock excavation areas shall be made with the specified subbase material above the top of the rock as excavated.

If large aggregate be exposed in any areas after the subbase for proposed concrete surface pavement has been shaped and compacted at subgrade elevation, a very thin layer of soil aggregate, Type 4, Class E, or stone or slag screenings, shall be spread over such areas of the subbase. The layer of soil aggregate or screenings shall be of the minimum thickness to prevent bonding of the concrete pavement with the large aggregate of the subbase.

If voids develop at or near the surface of the subbase, fine material of stone, or of sand or sand and small gravel particles, shall be applied and vibrated, or broomed and rolled, into place so as to fill all such voids and close the surface.

If utility pipes, drains, sewers or other subsurface pipes or facilities be close to, or above, the proposed subbase subgrade such that compaction of the subbase or subgrade therefor by the methods and equipment hereinbefore specified may cause damage to the pipes or other facilities, the use of such methods and equipment

will be waived. At such locations the subbase and the subbase subgrade within the necessary limits above and each side of these facilities shall be compacted to not less than 95 per cent density as defined in Art. 2. 3. 3 by such means as the Contractor may choose so as to avoid such damage. The Contractor shall repair any damage to the abovementioned facilities that may be caused by his operations as specified in Art. 1. 6. 11.

2. 9. 4. Quantity and Payment.

The quantity of Subbase for which payment will be made will be the compacted volume, measured in place in the roadway, actually constructed in accordance with the Plans and Specifications except that, if rock excavation is made below the specified bottom payment limit for rock excavation, the backfill with subbase material below that limit will not be included in the subbase payment quantity, but the cost thereof shall be included in the prices bid for other scheduled items.

Payment for Subbase will be made for the quantity as above determined, measured in cubic yards, at the unit price bid for the item SUBBASE in the Proposal, which price shall include the cost of furnishing, placing and compacting the subbase materials, as specified, furnishing and applying water for compaction if necessary, all labor, materials, equipment and all else necessary therefor and incidental thereto.

SECTION 10

Subgrade

2. 10. 1. Description.

Subgrade shall include the preparing of the surface upon which pavements and paved shoulders will be constructed.

2. 10. 2. Materials.

No materials are involved.

2. 10. 3. Methods of Construction.

The subgrade shall be prepared after the underlying drains and other subsurface structures have been placed and the backfill therefor has been properly consolidated, and when the subbase has been completed if it is provided for on the Plans. Where existing macadam and gravel pavements underlie the subgrade, they shall be scarified when and as prescribed in the Supplementary Specifications.

The subgrade shall not be prepared during freezing weather or when frozen, or when it is unstable because of excessive moisture.

SUBGRADE

The pavement subgrade shall be shaped and compacted and, when finished, it shall conform to the required grade and contour. If subbase shall have been constructed under the Contract, the pavement subgrade shall be shaped and smoothed to correct ridges and other surface irregularities caused by the subbase compaction equipment or otherwise, and shall be well compacted by smooth steel 3-wheel power rollers weighing not less than 330 pounds per linear inch of tread of the rear wheels. If subbase shall have been constructed under a previous contract, or if the pavement will be constructed without a special subbase, the pavement subgrade shall be compacted initially by 5 passes of a 50-ton compactor of the type specified for the compaction of upland embankment, Dry Fill method, in Art. 2. 3. 3, with the compactor loaded to a gross weight of 50 tons before the forms are set for concrete pavement surface or concrete base course and before materials are placed for other types of pavement. Where access with the 50-ton compactor is not possible, the pavement subgrade shall be compacted initially to a density of not less than 95 per cent as defined in Art. 2. 3. 3.

The subgrade shall be prepared initially to a surface slightly above its required grade and contour so that the final subgrading operation will be one of blading or scraping, wherever this is practicable. Where the subgrade will be formed in coarse gravel, shale or other coarse material that cannot be bladed or scraped to grade in a practicable manner, the subgrade shall be prepared initially to a surface that is not more than 1 inch below the required grade and contour and shall be compacted as hereinbefore specified. The final compaction at subgrade level between forms for concrete surface or base course, or in advance of construction of other types of pavement, shall be performed by a 3-wheel power roller as described above. Water shall be applied without additional compensation, wherever necessary to attain satisfactory compaction of the subgrade. The final preparation of the subgrade shall be completed for a distance of not less than 500 feet in advance of pavement construction.

There shall be no hauling or operation of construction equipment between forms on the finally prepared subgrade for concrete pavements and concrete base courses. When finished, the subgrade shall be at the proper grade and contour, firm, even and free from depressions that may form water pockets and shall be so maintained until the pavement is placed thereon.

The compaction of pavement subgrade above and each side of utility and other subsurface pipes and structures that are located at or close to the subgrade shall be as specified in Art. 2. 9. 3 for compaction of subbase and its subgrade under similar conditions, and the Contractor shall repair any damage to such facilities that may be caused by his operations as specified in Art. 1. 6. 11.

2. 10. 4. Quantity and Payment.

The quantity of Subgrade for concrete and surface courses for which payment will be made will be the area of subgrade actually prepared in accordance with the Plans.

Payment for Subgrade for concrete base and surface course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item SUBGRADE in the Proposal, which price shall include the cost of preparing the subgrade complete, all materials, labor, equipment and all else necessary therefor and incidental thereto.

The cost of preparation of subgrade for all other types of pavement shall be included in the prices bid for such pavement.

SECTION 11

Shoulders

2. 11. 1. Description.

Shoulders shall include the construction of earth, gravel and stone shoulders and, when prescribed and designated as shoulders in the Plans or Supplementary Specifications, the construction of road mixed stabilization, penetration aggregate, penetration macadam, bituminous concrete, portland cement concrete and other types of shoulder surface and shoulder base courses, and the preparation of the shoulder subgrade except the subgrade for concrete surface and concrete base course in shoulders.

2. 11. 2. Materials.

The material for gravel shoulder surfaces and base courses shall be soil aggregate, Type 2, Class A or B, conforming to the requirements specified therefor in Art. 8. 8. 1.

Material for stone shoulder surfaces and base courses shall be broken stone of trap rock, dolomite, granite, gneiss, or limestone, conforming to the requirements of Art. 8. 5. 5, or blast furnace slag conforming to the requirements of Art. 8. 5. 7. The stone and slag shall conform to the grading specified for Shoulder Aggregate in Table 28. The fine material of the top course shall be uniformly distributed therein.

2. 11. 3. Methods of Construction.

The construction of earth shoulders shall be part of the work of excavation and embankment construction and shall include the necessary excavation and filling with suitable embankment material to the required surface, and shaping, dressing and compacting the shoulder to a dense, hard surface.

Construction of gravel shoulders shall conform to the requirements for construction of Gravel Surface Course as specified in Art. 3. 5. 3.

Stone shoulders shall be constructed in 2 courses. Before the bottom course is placed, the subgrade shall have been compacted and finished to the prescribed grade and contour. The bottom course shall be spread and thoroughly compacted, and subsequently the top course shall be spread and compacted so that the finished surface is hard, dense and smooth and conforms to the prescribed lines and grades. Compaction shall be attained by three-wheel power rollers having a load on the rear wheels of not less than 330 pounds per inch of width of tread. The thickness of the compacted top course shall be 2 inches, and the total thickness of the stone shoulders shall be as shown on the Plans.

The preparation and compaction of the subgrade for gravel and stone shoulders shall be as specified for subgrade in Art. 2. 10. 3.

2. 11. 4. Quantity and Payment.

The quantity of Gravel Shoulders and of Stone Shoulders for which payment will be made will be the area actually constructed in accordance with the Plans. Earth shoulders will not be measured for payment and the cost thereof shall be included in the unit prices bid for other items scheduled in the Proposal.

Payment for Gravel Shoulders and Stone Shoulders will be made for the quantity of each type as above determined, measured in square yards, at the prices per square yard bid for the items GRAVEL SHOULDERS and STONE SHOULDERS, respectively, in the Proposal, which prices shall include the furnishing, placing and conpacting of the shoulder material, preparing and compacting the subgrade, all materials, labor, equipment and all else necessary therefor and incidental thereto.

Shoulders Other Than Earth, Gravel or Stone. Materials, methods of construction and quantity and payment for types of shoulders mentioned above in Art. 2. 11. 1, other than earth, gravel and stone, shall be as specified for identical types of pavement and base course construction in Division 2, Section 8, for Road Mixed Stabilization, and as specified in the respective Sections and Articles of Division 3 for other types except that payment will be made at the unit prices bid in the Proposal for the items SHOULDERS of the various types prescribed and scheduled in the Contract.

SECTION 12

Concrete Bag Slope Protection

2. 12. 1. Description.

Concrete bag slope protection shall include the furnishing and placing of concrete in bags on slopes.

2. 12. 2. Materials.

Concrete shall be Class D conforming to the requirements of Art. 4. 1. 2.

Cement shall be standard portland cement, Type II, or air-entraining portland cement, Type II A, conforming to the requirements specified respectively therefor in Art. 8. 5. 22 and 8. 5. 23.

Coarse aggregate shall be ¾ or ⅝-inch size broken stone of trap rock, granite or gneiss, or washed gravel, conforming to the requirements specified respectively therefor in Art. 8. 5. 5 and 8. 5. 6.

Fine aggregate shall conform to the requirements of Art. 8. 5. 10.

Bags shall be of cloth, burlap or coarse fiber, shall be of a quality approved by the Engineer, and shall have a capacity of 1 cubic foot.

2. 12. 3. Methods of Construction.

The slope on which the protection is to be placed shall be shaped to an even surface. The consistency of the concrete shall be as stiff as satisfactory discharge from the mixer and the process of bagging will permit. The bags shall be filled three-quarters full with concrete and shall be laid as shown on the Plans, in close contact, with staggered joints and tied ends turned in. The entire surface shall be pounded flat with plank and maul so that all spaces between the bags are closed and the surface is even and uniform.

2. 12. 4. Quantity and Payment.

The quantity of Concrete Bag Slope Protection for which payment will be made will be the volume of concrete actually placed in accordance with the Plans or as directed by the Engineer.

Payment for Concrete Bag Slope Protection will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item CONCRETE BAG SLOPE PROTECTION in the Proposal, which price shall include the cost of furnishing and placing concrete in bags as above provided, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 13

Concrete Block Slope Protection

2. 13. 1. Description.

Concrete block slope protection shall include furnishing and placing concrete blocks on slopes as hereinafter specified.

2. 13. 2. Materials.

Concrete blocks shall conform to the requirements specified in Art. 8. 5. 16.

Cement for grout shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements specified therefor in Art. 8. 5. 22 and 8. 5. 23, respectively.

Fine aggregate for grout shall conform to the requirements specified therefor in Art. 8. 5. 14.

Fine aggregate for cushion course shall conform to the requirements specified in Art. 8. 5. 10.

Water shall conform to the requirements specified therefor in Art. 8. 5. 38.

2. 13. 3. Methods of Construction.

Grout for joints shall be composed of 1 part cement, 2 parts fine aggregate, and water. The consistency of the grout shall be no thinner than necessary to assure full penetration of the joints. The blocks shall be set on a cushion of fine aggregate 2 inches thick. Before setting the blocks, the earth slope shall be shaped and compacted to an even surface. Compaction shall be attained by the use of approved flat-faced tampers or by other means approved by the Engineer. Setting the blocks, grouting and curing shall conform, in general, to the requirements for such work as specified in Art. 3. 13. 3 for Granite Block Pavement except as follows:

The blocks shall be set in the position shown on the Plans and with joints broken one-half the length of the block. The blocks shall not be sprinkled. The blocks shall be firmly and uniformly bedded on the cushion. Rammers or tampers shall be of a type and weight that will not break the blocks.

2. 13. 4. Quantity and Payment.

The quantity of Concrete Block Slope Protection for which payment will be made will be the slope surface area actually covered with concrete blocks in accordance with the Plans and Specifications.

Payment for Concrete Block Slope Protection will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item CONCRETE BLOCK SLOPE PROTECTION in the Proposal, which price shall include preparation and compaction of the slope surface, furnishing and placing the concrete blocks, cushion and grout, furnishing all labor and equipment, replacement of broken blocks, and all else necessary therefor and incidental thereto.

SECTION 14

Granite Block Slope Protection

2. 14. 1. Description.

Granite block slope protection shall consist of furnishing and placing granite blocks on slopes as hereinafter specified.

2. 14. 2. Materials.

The blocks shall be new or used granite blocks.

New granite blocks shall conform to the requirements of Art. 8. 5. 17 except that they shall be dressed to allow for setting with joints not exceeding ½ inch in width. The blocks shall conform to the A. S. T. M. requirements for blocks for Moderately Heavy Traffic.

Used blocks shall conform to the requirements for new blocks except that minor variations in dimensions will be permitted. Used blocks shall be free of all bituminous and cement grout coating and other foreign matter.

Cement shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements therefor specified in Art. 8. 5. 22 and 8. 5. 23, respectively.

Fine aggregate for grout shall conform to the requirements therefor specified in Art. 8. 5. 14.

Fine aggregate for cushion course shall conform to the requirements specified in Art. 8. 5. 10.

Water shall conform to the requirements specified therefor in Art. 8. 5. 38.

2. 14. 3. Methods of Construction.

Grout for joints shall be composed of 1 part cement, 2 parts fine aggregate, and water. The consistency of the grout shall be no thinner than necessary to assure full penetration of the joints.

The blocks shall be set on a cushion of fine aggregate, 2 inches thick. Before setting the blocks, the earth slope shall be shaped and compacted to an even surface. Compaction shall be attained by the use of approved flat-faced tampers or by other means approved by the Engineer. Setting the blocks, grouting and curing shall conform, in general, to the requirements for such work as specified in Art. 3. 13. 3, for Granite Block Pavement except that the blocks shall be set in the position shown on the Plans and shall not be sprinkled.

2. 14. 4. Quantity and Payment.

The quantity of Granite Block Slope Protection for which payment will be made will be the surface area actually covered with granite blocks in accordance with the Plans and Specifications.

Payment for Granite Block Slope Protection will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRANITE BLOCK SLOPE PROTECTION in the Proposal, which price shall include preparation and compaction of the slope surface, furnishing and placing the sand cushion, blocks and grout, furnishing all labor and equipment, replacement of broken blocks, and all else necessary therefor and incidental thereto.

SECTION 15

Riprap Slope Protection

2. 15. 1. Description.

Riprap slope protection shall include the furnishing and placing of stones on slopes.

2. 15. 2. Materials.

The stones shall be of durable rock, approved by the Engineer, weighing not less than 50 and not more than 150 pounds each, and shall be reasonably well graded. Not more than 40 per cent shall weigh more than 100 pounds each. An allowance of 10 per cent, by weight, of quarry spalls (weighing less than 50 pounds each) will be permitted.

2. 15. 3. Methods of Construction.

The slope on which the protection is to be placed shall be shaped to an even surface. The stones shall be placed with their longest axis perpendicular to the slope and in close contact and shall be firmly bedded in the slope. Open spaces between stones

shall be filled with spalls firmly rammed in place. The larger stones shall be used in the lower courses. The finished surface shall be even and to the required lines.

2. 15. 4. Quantity and Payment.

The quantity of Riprap Slope Protection for which payment will be made will be the surface area actually covered in accordance with the Plans.

Payment for Riprap Slope Protection will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item RIPRAP SLOPE PROTECTION in the Proposal, which price shall include the cost of furnishing and placing the stones as above described, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 16

County and Municipal Projects

State Aid

2. 16. 1. Amendments.

For County and Municipal Projects (State Aid), the provisions of Division 2 shall apply except as hereinafter provided.

Whenever the words Commissioner or Department, and the word State, occur in Division 2 of these Standard Specifications, their meaning shall be Board, and Municipality or County, respectively.

Art. 2. 3. 2. Only the provisions pertaining to embankment material for use in upland embankment, Zone 3, shall apply.

Art. 2. 3. 3. The specifications relating to swamp embankments and the facilities, devices and operations pertinent thereto, as specified on pages 84 to 97, inclusive, shall not apply unless provided for in the Supplementary Specifications.

Art. 2. 3. 4 is amended as follows:

In the first paragraph, the inclusion of settlement platforms, control stakes and pore pressure measuring devices shall not apply unless provided for in the Supplementary Specifications.

Beginning with paragraph 4, the remainder of Art. 2. 3. 4 covering payment for vertical sand drains, drainage windrows and borings shall not apply unless provided for in the Supplementary Specifications.

Art. 2. 4. 2. In the first paragraph, the reference to Art. 2. 3. 2 shall include its amendment as specified above in paragraph 3 of this Art. 2. 16. 1.

Art. 2. 4. 2, paragraph 2, and *Art. 2. 4. 3,* paragraph 1. The references to Art. 1. 4. 7 include its amendment as provided in Art. 1. 9. 1.

Art. 2. 4. 4 shall be amended as follows:

The various methods of measurement and computation of payment quantities of Borrow Excavation, as described under major subheadings lettered B, C and D on pages 103 to 107, inclusive, shall not apply unless specific provisions therefor are included in the Supplementary Specifications.

In the next to the last paragraph of Art. 2. 4. 4, page 107, covering payment for various items of Borrow Excavation, references to work, operations, devices and facilities that are pertinent to the construction of swamp embankments shall not apply unless provision is made in the Plans and Supplementary Specifications for the construction of swamp embankments, and in that event the coverage of the abovementioned paragraph shall be applicable only in so far as it is pertinent to the methods of embankment construction specified for the Project. Reference in the same paragraph to sampling and testing to be performed by the Contractor, and to charges for certain sampling and testing performed by the Engineer, shall not apply.

The provisions of the last paragraph of Art. 2. 4. 4, page 108, shall not apply unless and to the extent provided for in the Supplementary Specifications.

Art. 2. 6. 4 is amended as follows:

The third sentence of paragraph 1 is changed to read as follows:

Excavation below this additional depth will be paid for by supplementary agreement, executed under a Change Order, according to the provisions of Art. 1. 8. 4 as amended in Art. 1. 9. 1 herein.

The fourth sentence of paragraph 1 shall not apply.

Art. 2. 10. 3. Paragraphs 3 and 4 shall apply except as follows:

The subgrade for gravel surface courses, base courses and shoulders which are to be constructed without stabilization, bituminous surface treatment or penetration, or without a surface course of bituminous concrete, shall be shaped to the required grade and crown but compaction is waived when the soil at and below the subgrade is preponderantly sand, or sand and gravel.

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DIVISION 3

Pavements

SECTION 1

Gravel Base Course

3. 1. 1. Description.

Gravel base course shall consist of the construction of pavement base courses of gravel and the reconstruction of existing gravel roads for base courses. New base courses shall include also the preparation of subgrade.

3. 1. 2. Materials.

The materials shall be soil aggregate Type 2, Class A or Class B, conforming to the requirements specified respectively therefor in Division 8, Section 8. Wherever the term gravel or road gravel is used in this Section, with reference to new material, it shall be construed to mean soil aggregate as specified above.

3. 1. 3. Methods of Construction.

The method of construction shall be as specified for Gravel Surface Course in Art. 3. 5. 3.

3. 1. 4. Quantity and Payment.

The quantity of Gravel Base Course and Reconstructed Gravel Base Course for which payment will be made will be the area actually constructed in accordance with the Plans or as directed by the Engineer. In addition, for Reconstructed Gravel Base Course the truck volume of new gravel required and used, or the weight thereof, as may be specified, will be measured for payment.

Payment for new Gravel Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRAVEL BASE COURSE in the Proposal, which price shall include the cost of preparing subgrade, construction of the gravel course complete, all materials, labor, equipment and all else necessary therefor and incidental thereto.

Payment for Reconstructed Gravel Base Course will be made for the quantity as above determined, measured in square yards,

at the price per square yard bid for the item RECONSTRUCTED GRAVEL BASE COURSE in the Proposal, which price shall include the cost of construction complete, materials, labor, equipment and all else necessary therefor and incidental thereto except furnishing and placing new gravel.

Payment for new Road Gravel for reconstructed gravel base course will be made for the quantity as above determined, measured in cubic yards or tons, at the price per cubic yard or ton bid for the item ROAD GRAVEL in the Proposal, which price shall include the cost of furnishing and placing the gravel.

When new road gravel is to measured in tons, payment will be made on the basis of truck loads weighed on certified scales by a certified weighmaster, as specified in Art. 3. 5. 4.

SECTION 2

Macadam Base Course

3. 2. 1. Description.

Macadam base course shall consist of the construction of pavement base courses of macadam and the preparation of the subgrade.

3. 2. 2. Materials.

The materials for large aggregate and screenings shall be broken stone of trap rock, granite, gneiss, dolomite or limestone, or blast furnace slag, conforming to the requirements of Art. 8. 5. 5 and 8. 5. 7, respectively. The large aggregate shall be 2½-inch size for courses 4 inches or more in thickness and 1½-inch size for courses of less than 4-inch thickness.

3. 2. 3. Methods of Construction.

Dynamic compactors shall be vibratory compactors acceptable to the Engineer, capable of operating at the optimum frequency of vibration required for the size and type of compactor in use and material being compacted.

Three-wheel rollers shall be power driven, shall have a total weight of not less than 10 tons and a weight on the rear rolls of not less than 330 pounds per inch of width of roll.

Two-axle tandem rollers shall be power driven, shall have a total metal weight of not less than 8 tons and a weight of not less than 250 pounds per inch of width on the drive roll.

Three-axle tandem rollers shall be power driven and shall conform to the requirements specified in (1) or (2) below:

(1) Rollers having two guide rolls of equal diameter and a larger diameter drive roll, all rolls having equal width. The drive roll shall have a compression of not less than 250 pounds per inch of width of tread when all rolls are in contact with a level surface. The rollers shall have a total metal weight of not less than 12 tons, and a wheel base of not less than 17 feet measured from the center of the front guide roll to the center of the drive roll. The rolls, when locked in position for all treads to be in the same plane shall conform to the rigidity requirements prescribed under the following tests with full load:

(a) With the weight of the roller supported on the central roll and drive roll, the tread of the central roll shall be not more than ⅛ inch above the plane tangent to the treads of the end rolls, and

(b) With the weight of the roller supported on the end rolls, the tread of the central roll shall be not more than ¼ inch below the plane tangent to the treads of the end rolls.

(2) Rollers as described in (1) above which, when the rolls are in a semilocked position, will meet the rigidity test described in *(a)* above, and which shall be so designed that, with the rolls in a semilocked position and with the weight of the roller supported on the end rolls, the central roll will ride freely on the surface being rolled and there will be no transfer of weight from any one roll to another.

Trench rollers, for use in areas inaccessible to the larger compacting equipment described above, shall be of acceptable design and shall have a load of not less than 300 pounds per inch of width of tread of drive roll.

Small vibratory compactors, for use in areas inaccessible to the larger compacting equipment specified above, shall be of a design acceptable to the Engineer.

Stone spreaders shall be equipped with a strike-off bar or screed capable of being adjusted to the required grade and crown and shall be subject to the approval of the Engineer.

Pressure distributing trucks shall conform to the requirements therefor specified in Art. 3. 6. 3.

The subgrade shall be prepared as specified in Art. 2. 10. 3. It shall be in a properly finished condition and not wet or frozen, when the base course is about to be placed thereon.

An inverted choke layer of stone or slag screenings, 1 inch loose thickness, shall be placed on the subgrade by means of stone spreaders before the large aggregate is placed. The screenings shall not be compacted. If the base course be constructed in two layers, the screenings shall be placed only below the bottom layer.

Where the macadam base course will be constructed adjacent to proposed curbs, the construction, curing and backfilling of the

curbs shall be completed before the macadam aggregate is spread adjacent thereto.

The surface of the completed base course shall be at all points within ½ inch of the prescribed grade of the base course. Within any distance of 16 feet, the sum of the departures from the prescribed base course grade of any two points, one of which is above and the other below such prescribed grade, shall not exceed ½ inch except that the base course shall conform to its prescribed grades where it adjoins curbs. There shall be no projections or depressions in the surface of the base course such as to form waves exceeding ½ inch in any distance of 16 feet.

The Contractor shall test the surface of the completed base course for conformance to grade, crown and evenness of surface using straight edges, 16 feet long, applied parallel to the centerline of the base course, and similar straight edges, or crown templates if appropriate, conforming to the prescribed crown of the strip of base course being tested, applied transversely. In testing parallel to the centerline, each successive application of the straight edge shall overlap its previous application approximately one-half its length. For transverse checking, the straight edge or crown template shall be applied at intervals of 10 feet. The testing shall be performed in the presence of the Engineer and subject to his direction and approval. Straight edges and templates shall be of approved design, supported on legs or bases at each end and free from deflection. They shall be checked for accuracy and approved by the Engineer once or more each day while in use.

If irregularities exceeding the tolerances hereinabove specified be found in the surface of the completed base course, they shall be corrected, where possible, by additional rolling of the high areas. When this does not suffice, the surface shall be brought within the specified tolerances by first applying a prime coat, as specified in Art. 3. 10. 3, to the low areas and then filling them with hot-mixed bituminous concrete Type SP-1, or with cold-mixed bituminous concrete Type ASW-1 or TSW-1, as directed.

When the Contract includes a general surfacing of the macadam base course with bituminous concrete and payment therefor is to be made at a bid price per ton, the abovementioned low areas shall be prime coated and the bituminous concrete placed therein, as specified above, as a separate operation in advance of the general pavement surfacing, and the quantities thereof shall not be included in the quantity determined for payment.

When a general surface course of bituminous concrete is included in the Contract and payment therefor is to be made at a price bid per square yard, the irregularities in the macadam base course shall be corrected as specified above as a part of the general surface course operation and shall be included in the unit price bid per square yard for that work.

MACADAM BASE COURSE

The completed base course shall be of sufficient stability that no perceptible movement is produced in it by the passage of a wheel load of 8 tons concentrated on a width of not more than 24 inches. It shall be smooth and even and at the prescribed grade, within the tolerances hereinabove specified, free from voids, ruts, loose aggregate and raveled areas, surplus binder that hides the top of the coarse aggregate, dirt and other foreign matter, and shall be in this condition at the time an intermediate or a surface course is to be constructed thereon under the Contract, or until final acceptance of the Project if no such cover course be included in the Contract. The Contractor shall repair or replace all such defective areas and shall clean the surface and put it in the prescribed condition without additional compensation.

Prior to the construction of a bituminous concrete surface on the macadam base course, the base course shall be given a bituminous prime coat. The materials, rate of application, and quantity and payment for the prime coat shall be as provided therefor in the specifications for hot-mixed bituminous concrete surface course in Art. 3. 10. 2, 3. 10. 3 and 3. 10. 4.

The vibrating method and the rolling method of construction are hereinafter described and the various types of equipment therefor shall conform to the requirements hereinabove specified. For base courses of not more than 5 inches total compacted thickness, either the vibrating method or rolling method may be used. For base courses of more than 5 inches total compacted thickness, the vibrating method shall be used.

A. Vibrating Method. The macadam base course shall be constructed in one or more layers, no layer to be more than 7 inches compacted thickness.

The large aggregate shall be spread by means of a stone spreader in a layer, or layers, of proper thickness, and shall be shaped so that after ultimate binding and compaction the base course will conform to the prescribed thickness, grade and crown. The aggregate shall not be deposited in piles on any areas of the subgrade over which it will be spread. When so ordered by the Engineer, the thickness of the course shall be measured by wood blocks of the required depth placed on the subgrade or on the previously laid course. These blocks shall be removed when they have served their purpose for testing and the holes shall be filled with aggregate which shall be thoroughly compacted. Only sufficient aggregate for a day's work shall be spread in advance of compacting and binding. All segregated or poorly graded aggregate shall be removed and replaced with properly graded aggregate.

After the large aggregate has been spread, it shall be compacted over its entire area by the vibratory compaction equipment hereinbefore specified. Vibration shall continue until the aggregate is keyed sufficiently to permit its being rolled with the specified

rollers, provided, however, that there shall be not less than 2 and not more than 5 passes, the exact number to be determined by the Engineer during construction. The entire area of the base course shall then be rolled longitudinally with three-wheel rollers or with two-axle or three-axle tandem rollers and, where practicable, diagonally with three-wheel rollers. Longitudinal rolling shall start at the edges and progress towards the center except that on superelevated curves the rolling shall begin on the low side and progress to the high side. On each pass of the roller, the drive rolls shall uniformly overlap their preceding tracks.

Where the macadam course is constructed against a prepared berm, the longitudinal rolling shall proceed back and forth over the edge of the aggregate and on the adjacent berm for a width of not less than 18 inches until the berm is compacted thoroughly and will provide sufficient lateral support to prevent sidewise displacement of the aggregate during subsequent operations.

As the rolling progresses, any irregularities in the surface of the base course shall be corrected by the addition or removal of aggregate where necessary, and reshaping and rerolling. The process shall continue until the base course has been brought to an even surface, free from excessive projections and depressions, and does not creep or wave under the operation of the roller.

After completion of the shaping, vibrating and rolling specified above, screenings shall be spread over the aggregate in 3 applications, by means of stone spreaders, sufficient in total quantity to completely fill the voids in the stone course. Approximately 50 per cent of the total quantity of screenings shall be placed in the first application, approximately 25 per cent in the second application and the remainder in the third application. The screenings of each application shall be spread uniformly over the aggregate course and shall be vibrated into the voids by a single pass of the dynamic compactor over the entire area. No further mechanical vibration shall be performed unless directed by the Engineer. If there be any visible voids after the completion of the operations specified above, they shall be filled by hand spreading, brooming and rolling. All screenings shall be dry when vibrated into the voids. A mechanical dryer shall be used to dry the screenings if and when necessary. The quantity of screenings, the vibrating equipment, and the regulation of the vibrating, shall be such that all voids in the stone aggregate will be filled without causing floating of the aggregate. The entire surface shall be rolled with three-wheel and tandem rollers, as specified hereinabove for rolling of the aggregate prior to its filling, until the base course shows no perceptible movement under the roller.

Areas of the base course that are inaccessible to the large rollers and dynamic compactors shall be vibrated by small vibratory compactors and rolled with trench rollers in a manner acceptable to the Engineer.

In small, narrow or irregular shape areas where the use of stone spreaders is not practicable, the large aggregate and screenings may be applied, spread and shaped by hand methods.

B. Rolling Method. The requirements and provisions hereinabove specified for the vibrating method shall apply except as otherwise hereinafter specified.

Macadam base courses of not more than 5 inches total compacted thickness shall be constructed in one layer. Base courses of more than 5 inches total compacted thickness shall be constructed in two or more layers of approximately equal thickness but no layer shall be more than 5 inches thick.

The keying and compaction of the layer or layers of large aggregate shall be accomplished by rolling, using three-wheel rollers and two-axle or three-axle tandem rollers.

After the large aggregate has been compacted and surface irregularities have been corrected, screenings shall be spread in thin uniform layers by means of stone spreaders and shall be broomed into all visible voids and rolled. The screenings shall not be applied in such quantity as to completely cover or form a layer or coating over the large aggregate. Screenings that do not properly work into the voids and all excess screenings shall be removed. Where a deficiency of screenings develops during the rolling operations, more shall be added and swept into all visible voids. This procedure shall continue until all the voids are filled. Rolling shall be performed with the same type of rollers and in the same general manner as specified for the vibrating method.

Screenings shall be dry when rolled. A mcehanical dryer shall be used to dry the screenings when necessary.

In areas inaccessible to the specified stone spreaders and the larger rollers, the large aggregate and screenings may be spread by hand methods and shall be rolled with trench rollers.

3. 2. 4. Quantity and Payment.

The quantity of Macadam Base Course, for which payment will be made, will be the area actually constructed in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar structures within the pavement area.

Payment for Macadam Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item MACADAM BASE COURSE in the Proposal, which price shall include the cost of preparing subgrade, construction of base course complete, correction of excessive surface irregularities with bituminous concrete under the conditions as specified, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 2A

Bituminous-Stabilized Base Course

3. 2A. 1. Description.

Bituminous-stabilized base course shall consist of soil aggregate and bituminous material uniformly mixed as hereinafter specified, and placed on a previously prepared surface.

3. 2A. 2. Materials.

Soil Aggregates. Soil aggregates shall be natural or prepared mixtures consisting predominantly of hard durable particles or fragments of stone, sand, and stone dust for Stone Mix; or hard durable particles or fragments of gravel and sand containing some silt-clay or stone dust for Gravel Mix; meeting the requirements as specified under Definitions or Constituents Materials in Art. 8. 8. 1, Soil Aggregates, and so combined that they will produce mixtures conforming to the gradation requirements hereinafter specified. The soil aggregates shall be free from vegetable matter, lumps or balls of clay, adherent films of clay or other matter that will prevent thorough coating with bituminous material. The portion passing the No. 40 sieve shall be nonplastic when tested in accordance with A. A. S. H. O. Designation T 91.

Bituminous Material. Bituminous material shall be asphalt cement, Penetration Grade 85-100, conforming to the requirements specified therefor in Art. 8. 1. 2.

Composition of Mixtures. The mineral constituents for each mix shall be combined in such proportions that the resulting mixture will comply with the grading requirements shown in the following table. The bitumen content (solubility in benzol) shall be not less than 4 and not more than 7 per cent. In calculating percentages of aggregates of the various sizes bituminous material is excluded.

Gradation

Sieve Size	Total Per Cent Passing—Dry Weight	
	Stone Mix	Gravel Mix
1½″	100	100
¾″	55-90	65-100
⅜″	—	50-90
No. 4	25-60	35-75
No. 10	20-50	25-60
No. 40	15-30	12-30
No. 80	—	6-20
No. 200	5-12	3-8

The stability of the completed mixture, as determined by means of the Marshall apparatus, shall have a value of not less than 500 pounds at 140° F.

Formula for Job Mix. The provisions pertaining to Job Mix Formula and its application as specified for Hot-Mixed Bituminous Concrete in Art. 3. 10. 2 shall apply except the ranges of tolerances shall be as follows:

Aggregate passing No. 10 Sieve	plus or minus 7%
Bitumen Content	plus or minus 0.4%
Temperature of bituminous material	plus or minus 15° F.
Temperature of aggregate	plus or minus 20° F.
Temperature of bituminous stabilized base course when leaving plant	plus or minus 15° F.

3. 2A. 3. Methods of Construction.

The methods of construction shall be as specified for Hot-Mixed Bituminous Concrete Surface Course in Art. 3. 10. 3 with the following amendments:

The mixture shall leave the plant at a temperature sufficient for workability under prevailing conditions. However, the temperature of the mixture when laid shall not be less than 200 degrees F.

The total compacted thickness of bituminous-stabilized base course shall be as shown on the Plans or as prescribed in the Supplementary Specifications. The base course shall be constructed in layers of not more than 2½ inches compacted thickness.

A tack coat shall be applied to any one or more layers of the bituminous stabilized base course if, in the opinion of the Engineer, such layer or layers become coated with dust, dirt, or other foreign material sufficiently to prevent a good bond between the layers of base course or between the completed base course and surface course.

Traffic shall be carried, if necessary, on the completed base course for the minimum time required to maintain traffic. The Contractor shall be responsible for the maintenance of the base course at all times while it is available to traffic.

Bituminous-stabilized base course shall have a minimum weight per square yard of 100 pounds per inch of depth of compacted thickness.

3. 2A. 4. Quantity and Payment.

Quantity and payment for Bituminous-Stabilized Base Course and for Tack Coat shall be as specified for Hot-Mixed Bituminous Concrete Surface Course and Tack Coat in Art. 3. 10. 4 except that payment for the base course will be made at the unit price per square yard bid for the item BITUMINOUS-STABILIZED BASE COURSE.

SECTION 3

Concrete Base Course

3. 3. 1. Description.

Concrete base course shall consist of the construction of pavement base course of portland cement concrete as hereinafter specified.

3. 3. 2. Materials.

Class D concrete conforming to the requirements specified therefor in Art. 4. 1. 2 shall be used and shall be air-entrained.

The materials for concrete, the materials for and methods of producing its air entrainment, and materials for curing, shall be as specified for concrete surface pavement in Art. 3. 12. 2. Joint filler for use around inlets, manholes and other structures projecting through the base course shall be ½ inch preformed bituminous type joint filler conforming to the requirements specified in Art. 8. 5. 31.

If reinforcement be prescribed in the Plans or Supplementary Specifications, it shall conform to the requirements specified in Art. 8. 4. 18.

3. 3. 3. Methods of Construction.

The concrete base course shall be constructed as specified for concrete surface pavement in Art. 3. 12. 3 except as follows:

No transverse or longitudinal expansion joints are required. When the concrete is not constructed full width in one operation or when the placing of the concrete is temporarily discontinued, it shall be finished against a vertical form or bulkhead, and when resumed the form or bulkhead shall be removed and the concrete shall be placed against the previously finished concrete. Hand finishing may be used. The surface needs not be belted or tooled, but shall be rough broomed. Edges need not be rounded. The finished surface shall not vary from the required grade and crown by more than ⅜ inch in a distance of 10 feet. The minimum age of the concrete required for temporary opening to traffic and construction equipment or for placing of pavement surface thereon, shall be as shown below:

May 16-Oct. 15	Standard Concrete	12 days
Oct. 16-May 15	Standard Concrete	15 days
May 16-Oct. 15	High Early Strength Concrete	6 days
Oct. 16-May 15	High Early Strength Concrete	7 days

Opening the base course as provided above shall in no manner relieve the Contractor from his responsibility for the work in accordance with Art. 1. 6. 6.

3. 3. 4. Quantity and Payment.

The quantity of Concrete Base Course for which payment will be made will be the area actually constructed in accordance with the Plans or as directed by the Engineer, without deductions of areas occupied by manholes and similar structures within the pavement area.

Payment for Concrete Base Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item CONCRETE BASE COURSE in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the base course, reinforcement if prescribed, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 4

Modified Penetration Macadam Intermediate Course

(B. P. R. Class D)

3. 4. 1. Description.

Modified penetration macadam intermediate course shall consist of the construction of an intermediate course of hot application modified penetration macadam. If the modified penetration course be constructed on an earth subgrade, gravel base or prepared subbase course, it shall include the work of preparing the subgrade on which it will be constructed.

3. 4. 2. Materials.

Coarse aggregate shall be broken stone of trap rock, granite, gneiss, dolomite or limestone, conforming to the requirements specified therefor in Art. 8. 5. 5. The large aggregate shall be 2½-inch size for courses 4 inches or more in thickness and 1½-inch size for courses less than 4 inches thick. The choke aggregate shall be ⅝-inch or ½-inch size.

Bituminous binder shall be asphalt cement, Penetration Grade 85-100 or 100-120, or tar, Grade RT-11 or RT-12, conforming to the requirements specified respectively therefor in Art. 8. 1. 2 and 8. 1. 12. For tar, Grade RT-12 shall be used in hot weather as directed. For asphalt cement, Penetration Grade 100-120 shall be used in cold weather, as directed.

3. 4. 3. Methods of Construction.

If preparation of subgrade as mentioned in Art. 3. 4. 1 be necessary, the work shall conform to the requirements of Art. 2. 10. 3.

The modified penetration macadam intermediate course shall be constructed as specified for penetration macadam surface course, hot application, in Art. 3. 9. 3 except that the second and third hot applications of bituminous binder and their cover materials shall be omitted, and that the single application of bituminous binder shall be applied to various course thicknesses at the rates shown below:

Course Thickness, Inches	*Bituminous Binder, Gallons per Square Yard*	
	Min.	*Max.*
2	1.6	1.8
3	2.0	2.25
4	2.0	2.5

The finished course shall be firmly rolled and bound, without raveled or improperly choked areas, porous places or other defects, and shall be true to grade and contour.

3. 4. 4. Quantity and Payment.

The quantity of Modified Penetration Macadam Intermediate Course for which payment will be made will be the actual area constructed, without deductions of areas occupied by manholes and similar structures within the area paved, and the volume of bituminous binder used, within the prescribed areas, all in accordance with the Plans or as directed by the Engineer. The volume of bituminous binder will be the number of gallons used, measured at 60° F., as determined by the temperature-volume corrections specified in Art. 9. 2. 1, Table 37 for asphalt products and Table 39 for tar products.

Payment for Modified Penetration Macadam Intermediate Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item MODIFIED PENETRATION MACADAM INTERMEDIATE COURSE in the Proposal, which price shall include the cost of all materials, labor, equipment, and all else necessary therefor and incidental thereto, except furnishing and applying the bituminous binder.

If the modified penetration macadam be constructed as a base course upon an existing earth foundation or on a prepared subbase, the unit price bid for the modified penetration macadam course shall include preparation of subgrade for the macadam in addition to the work specified above.

Payment for bituminous binder will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item BITUMINOUS BINDER, MODIFIED PENETRATION MACADAM in the Proposal, which price shall include the cost of furnishing and applying the bituminous binder, all labor, equipment and all else necessary therefor and incidental thereto.

SECTION 5

Gravel Surface Course

3. 5. 1. Description.

Gravel surface course shall include the construction of pavement surface courses of gravel, and the reconstruction of existing gravel surfaces. For new surface courses, it shall include also preparation of subgrade.

3. 5. 2. Materials.

The material for new gravel surface course and new gravel required for reconstructed gravel surface course shall be soil aggregate, Type 2, Class A or Class B, conforming to the requirements specified in Division 8, Section 8. Wherever the term gravel or road gravel is used in this Section with reference to new material, it shall be construed to mean soil aggregate as specified above.

3. 5. 3. Methods of Construction.

New Surface Course. For new surface courses, the subgrade shall be prepared as specified in Art. 2. 10. 3 and shall not be wet or frozen when the surface course is about to be placed thereon.

The gravel shall be spread in the quantity, and shaped with road scrapers, so that when compacted and finished it will be of the thickness and at the required grade and crown shown on the Plans. Frozen material shall not be used.

For surface course of more than 8 inches prescribed thickness, the gravel shall be placed and compacted in two or more layers of approximately equal thickness, no layer to be more than 8 inches compacted thickness. The bottom layer shall be compacted as specified in Art. 2. 3. 3 for the compaction of Upland Embankment, Zone 3, Dry Fill method, by Alternative (2) or Alternative (5). The top layer shall be compacted similarly except that Alternative (4) with a minimum of 5 passes of a 50-ton compactor loaded to a gross weight of 25 tons, or Alternative (5) shall be used. Inaccessible areas which cannot be compacted by these methods shall be compacted to a density of not less than 95 per cent. Con-

currently with compaction operations, the top course shall be worked and shaped with road scrapers.

Areas deficient in density or stability, or having a tendency to ravel, shall be repaired as the Engineer may direct, and material that does not compact properly shall be replaced with suitable gravel.

Surface course of not more than 8 inches prescribed thickness shall be placed in one layer and shall be compacted in accordance with the foregoing requirements for compaction of the top layer.

Each layer of the gravel shall be maintained during the compaction at a moisture content within 2 per cent of optimum.

The surface shall be scraped and rolled finally with a three-wheel roller, weighing not less than ten tons and having a load on the rear rolls of not less than 330 pounds per inch of width of the rolls, until the surface is thoroughly bound, free from defects, hard and even, and at the proper grade and contour.

Reconstructed Surface Course. The existing gravel pavement shall be thoroughly scarified to a depth of 3 to 4 inches or as directed by the Engineer. Scarified material containing an excess of clay or other unsuitable materials shall be removed and replaced with new road gravel and, if necessary, new road gravel shall be added to obtain the required grade. The new gravel shall be applied while the existing gravel pavement is in a loose, scarified condition, and the materials shall be bladed to a uniform mixture and shaped to the required contour of the surface course. The surface course shall then be constructed and finished as provided above for new surface course.

3. 5. 4. Quantity and Payment.

The quantity of New and Reconstructed Gravel Surface Courses for which payment will be made will be the area of each actually constructed in accordance with the Plans or as directed by the Engineer. In addition, for Reconstructed Gravel Surface Course, the truck volume of new gravel required and used, or the weight thereof, will be measured for payment, as may be specified.

Payment for new Gravel Surface Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRAVEL SURFACE COURSE in the Proposal, which price shall include the cost of preparing subgrade, construction of the course complete, all materials, labor, equipment and all else necessary therefor and incidental thereto.

Payment for Reconstructed Gravel Surface Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item RECONSTRUCTED GRAVEL SURFACE COURSE in the Proposal, which price shall include the cost of construction complete, all

materials, labor, equipment and all else necessary therefor and incidental thereto except furnishing and placing new gravel.

Payment for new Road Gravel for reconstructed gravel surface course will be made for the quantity as above determined, measured in cubic yards, or tons, at the price per cubic yard or ton bid for the item ROAD GRAVEL in the Proposal, which price shall include the cost of furnishing the gravel, all labor, equipment and all else necessary therefor and incidental thereto.

When payment for new Road Gravel is specified on a ton basis, each truck load of gravel delivered shall be weighed by a certified weighmaster on certified scales approved by the New Jersey Department of Weights and Measures. The weighmaster shall furnish to the truck driver duplicate weighmaster slips showing the gross, tare and net weight. The weighmaster's signature and official seal shall be affixed to each slip. One copy of these delivery slips shall be furnished the Department representative on the Project. No material will be accepted unless accompanied by such a delivery slip.

SECTION 6

Bituminous Surface Treatment

(B. P. R. Class A)

3. 6. 1. Description.

Bituminous surface treatment shall include the furnishing and placing of bituminous and cover materials on road surfaces, and incidental work as hereinafter described.

3. 6. 2. Materials.

Materials shall be as enumerated below and shall conform to the requirements of the appropriate Articles of Division 8 as shown:

Broken stone	Art. 8. 5. 5
Washed gravel	Art. 8. 5. 6
Blast furnace slag, cover material	Art. 8. 5. 7
Boiler slag, cover material	Art. 8. 5. 8
Fine aggregate	Art. 8. 5. 12
Fine aggregate, cover material	Art. 8. 5. 13
Sand-gravel	Quality and grading acceptable to the Engineer
Road gravel {soil aggregate Type 2, Class A or B}	Art. 8. 8. 1
Asphaltic oil	Art. 8. 1. 7
Emulsified asphalt	Art. 8. 1. 5
Inverted emulsified cutback asphalt	Art. 8. 1. 6
Tar	Art. 8. 1. 12

Materials for specific purposes are shown in Division 8, Table 18, and shall be used except as may be otherwise prescribed in the Supplementary Specifications.

3. 6. 3. Methods of Construction.

Distributing Trucks. Bituminous materials shall be applied by means of motor-driven pressure distributing trucks of modern design, in good mechanical condition, of not less than 600-gallon capacity.

These trucks shall be equipped with the following mechanisms and devices:

1. Suitable mechanical circulating and heating appliance which will provide a uniform temperature of the entire mass of material.

2. Sufficient pressure shall be provided to apply the number of gallons per square yard required on any given contract, with any length of spray bar ordered, up to a maximum of 24 feet, and to maintain a uniform rate of distribution over the entire road surface, or any part thereof, regardless of any changes in gradient or direction of the road.

3. A tachometer wheel, or other approved device, to assist in gauging the amount of material required for each application.

4. Spray nozzles and the construction of the pressure system shall provide a sufficient and uniform fan-shaped spray throughout the entire length of the spray bar, which spray shall uniformly and completely cover the portion of the surface receiving the application.

5. A positive cut-off shall be provided on the spray bars so that no extra material spills on the adjacent pavement at the beginning of any application. This cut-off may be in the form of a suck-back feature, or a continuous circulating feature with a quick shut-off valve, or may be provided by other methods approved by the Engineer.

6. Suitable means shall be provided for applying bituminous materials at intersections and other areas which cannot be treated properly by spraying from the manifold.

7. The following shall be furnished with each truck for the specific purposes of gauging the quantity of material in the truck, identifying the material, recording the temperature and other pertinent information concerning the material:

(a) An approved gauge sheet which shall show the number of the truck body, the capacity thereof, and an outage table in increments of not over one-half inch. This gauge sheet must be certified by the State Superintendent, Department of Law and Public Safety, Division of Weights and Measures.

(b) A metal rod with accurate ¼-inch divisions, having the inch divisions more prominently marked, starting with the first inch at the bottom. This rod is to be used for gauging the quantity

of material in the tank and shall be not less than one foot longer than the diameter of the tank.

(c) Thermometers must be so placed and installed in the truck body as to gauge properly the temperature of the bituminous material contained therein at the time of application. Evidence of the accuracy of the thermometer shall be furnished to the Engineer upon request.

(d) Duplicate delivery slips shall accompany each load delivered and contain the following information, and any other the Engineer may require:

1. The name of the producer
2. The name of the supplier
3. The kind and grade of material
4. The lot number and date of approval of the material from which delivery is made

(e) Two men shall operate each truck, one of whom shall drive and the other shall control the application of the bituminous material at the rear of the truck.

8. Each truck shall be provided with the following equipment for safety and convenience in sampling, gauging and checking of material contained in the truck:

(a) Slipproof steps with hand rail, to reach ground level.

(b) Slipproof catwalk with hand rail running parallel to the tank on truck.

(c) Slipproof steps with hand rail, leading from catwalk to dome.

(d) Fire extinguisher in proper working order.

The Engineer reserves the right to refuse inspection and application of materials delivered in trucks that do not conform to all the requirements set forth hereinabove. The Engineer's safety representative shall have the authority to inspect all distributing trucks for conformance with safety requirements.

Temperature. The temperature at which the various bituminous materials shall be applied are as follows:

Emulsified asphalt. 50° F., min.—175° F., max.

Inverted emulsified cutback asphalt. deg. F.	IE-MC-0 IE-RC-0 50-120	IE-MC-1 IE-RC-1 80-150	IE-MC-2 IE-RC-2 125-175	IE-MC-3 IE-RC-3 140-180	IE-MC-4 & 5 IE-RC-4 & 5 160-185
Asphaltic oils deg. F.	MC-0, RC-0 50-120	MC-1, RC-1 80-125	RC-2 100-175	MC-2, RC-3 150-200	MC-3, 4, 5, RC-4, 5 SC0- 175-250 80-150
Tars deg. F.	RTCB-5 & 6 60-120	RT-1 & 2 60-125	RT-3 & 4 80-150	RT-5 & 6 100-175	RT-7, 8, 9 RT-10, 11, 12 150-225 175-250

BITUMINOUS SURFACE TREATMENT

Preparation of Surface. On new construction the bituminous material shall be applied when the surface is properly shaped and compacted and when notice is received from the Engineer that it is in condition for such application. Immediately before such application, the surface shall be thoroughly cleaned and all loose and foreign material that may interfere with proper penetration of the bituminous material shall be swept off.

Previously treated surfaces shall be prepared for the bituminous treatment as specified in the Supplementary Specifications. Where there are indications of unstable bottom or subbase failure, excavation shall be made to the depth required by the Engineer, and the space shall be filled with approved subbase material and surfaced with material conforming to the existing surface. Where directed or approved by the Engineer, the pavement shall be patched with cold patch material as hereinafter specified by cutting out the present pavement so as to form square openings with straight sides. The openings shall be properly cleaned out and painted with asphaltic oil or tar, then filled with patch material which shall be thoroughly compacted. After the surface is properly prepared and notice is received from the Engineer that it is in condition for application, the surface shall be cleaned and swept, as above described.

Cold patch material shall be Grade A with fine aggregate, Grade B with medium aggregate or Grade C with coarse aggregate, conforming to the requirements hereinafter specified. The kind, grade and amount of each ingredient in the mixture will be determined by the Laboratory within the limits shown. For gravel surfaces, Grade A shall be used. For other types of surfaces, Grade B or Grade C shall be used as prescribed.

The composition of the cold patch material shall conform to the requirements given hereinbelow. When more than one grade of the same bituminous material is specified, the higher numbered grade shall be used in hot weather. The quantity of each ingredient shall be measured by weight. When ready to be coated, the aggregates shall be dry and have a temperature between 35° F. and 125° F. The temperature of the bitumen shall be within the range given hereinabove. The resultant cold patch material must be thoroughly mixed and uniform in composition, and the method of mixing shall be approved by the Engineer. The plant used for the preparation of cold patch material shall conform to the requirements of Art. 3. 10. 3, Bituminous Plant and Equipment.

Grade A shall be sand-gravel of a quality and grading acceptable to the Engineer, or fine aggregate, mixed with 4.5 to 7 per cent of asphaltic oil, Grade MC-2, 3 or 4, asphaltic oil, Grade SCO, or tar, Grade RT-5 or 6.

Grade B shall be ½-inch, ⅜-inch or ¼-inch broken stone or washed gravel mixed with 10 to 20 per cent of fine aggregate and 4 to 6 per cent of asphaltic oil, Grade RC-2, 3 or 4, or tar, Grade RTCB-5 or 6.

Grade C shall be 1-inch and ⅜-inch broken stone or washed gravel mixed with 5 to 10 per cent of fine aggregate and 4 to 5.5 per cent of asphaltic oil, Grade RC-2, 3 or 4, or tar, Grade RTCB-5 or 6.

Application. The bituminous materials shall not be applied when the surface is wet. If dust remains that cannot be removed by sweeping, the surface shall be moistened by sprinkling. Application shall be made only when the condition of the surface is acceptable to the Engineer.

Application of Asphaltic Oil, Grade SC-0, MC-0, MC-1 and MC-2. On new construction the first application shall be at the rate of 0.4 to 0.5 gallon per square yard. After the oil has properly penetrated, fine aggregate cover material shall be placed at the rate of not less than 25 pounds per square yard. Four or five weeks later, and only when so directed by the Engineer, the second application of asphaltic oil shall be made at the rate of about 0.3 gallon per square yard and it shall be covered immediately with fine aggregate cover material at the rate of 25 pounds per square yard. On previously treated surfaces, the application shall be as prescribed in the Supplementary Specifications.

After each application and during the curing process the surface shall be dragged with an approved drag two or three times a week, as the Engineer may direct. When the oil comes to the surface before the acceptance of the Project, additional cover material shall be spread so as to keep the surface in proper condition.

Application of Other Asphaltic Oils and Tars. On new construction, the first application (prime coat) shall be at the rate of 0.25 to 0.45 gallon per square yard of the bituminous material specified or directed by the Engineer, and about 10 pounds of cover material per square yard shall be spread if so directed by the Engineer. Traffic shall not be permitted on the surface until the prime coat has thoroughly penetrated the surface and will not pick up under traffic. The second application (seal coat) shall be applied when the prime coat has penetrated properly. The bituminous material used for seal coat shall be applied at the rate of 0.25 to 0.4 gallon per square yard, as directed, and shall be covered immediately with cover material at the rate of about 35 pounds per square yard. The exact quantities shall be as directed by the Engineer.

After this application, the surface shall be dragged with a lightweight broom drag and shall then be rolled with a 3-wheel

power roller, weighing not less than 3½ tons, or a self-propelled, 5-10 ton pneumatic tire roller with full oscillation of all wheel pairs. When the bituminous material comes to the surface before the acceptance of the Project in such a manner as to be likely to pick up, additional cover material of the proper grade shall be spread where required to keep the surface in proper condition. A sufficient number of barricades or guards shall be placed to keep the traffic off the treated pavement until it is ready to receive traffic. On previously treated surfaces, the application shall be as prescribed in the Supplementary Specifications.

3. 6. 4. Quantity and Payment.

The quantities of Bituminous Surface Treatment for which payment will be made will be the volume of bituminous material and the weight of cover material actually placed in accordance with the Plans or as directed by the Engineer, except that cover material for SCO, MC-0, MC-1 and MC-2 treatment will not be measured by weight, but by the surface area covered in accordance with the Plans or as directed by the Engineer. The volume of bituminous material will be the number of gallons used, measured at 60° F., as determined by the temperature-volume corrections specified in Art. 9. 2. 1, Tables 37 to 41, inclusive, whichever covers the type and grade of material used.

Payment for bituminous materials and cover materials will be made for the quantities as above determined, measured in gallons, and tons or square yards, respectively, at the unit prices bid for the item SURFACE TREATMENT, BITUMINOUS MATERIALS and the item SURFACE TREATMENT, COVER MATERIALS, respectively, in the Proposal, which prices shall include the cost of furnishing and placing the bituminous and cover materials complete; sweeping and cleaning; cutting out, cleaning and painting patches; all materials, labor, equipment and all else necessary therefor and incidental thereto. Subbase and existing pavement reconstruction in unstable areas, other than ordinary patching, will be paid for as provided in Art. 1. 8. 4 or in the Supplementary Specifications.

Payment for Cold Patch Material will be made as provided in Art. 3. 10. 4, or as prescribed in the Supplementary Specifications, at the unit price per ton or square yard bid for the item COLD PATCH MATERIAL, which price shall include furnishing, placing and compacting the material, all labor, equipment and all else necessary therefor and incidental thereto.

SECTION 7

Lignin Treatment

3. 7. 1. Description.

Lignin treatment shall include the treatment of gravel base and surface courses with lignin binder.

3. 7. 2. Materials.

Lignin binder shall be liquid extracts from the manufacture of wood pulp and shall conform to the requirements specified therefor in Art. 8. 5. 32.

3. 7. 3. Methods of Construction.

When not more than 0.2 gallon per square yard is specified, only 1 application of the lignin binder is required, unless 2 are found necessary for proper penetration. When 0.2 to 0.4 gallon is specified it shall be applied in 1 treatment with not less than 2 applications. When more than 0.4 gallon is specified it shall be in 2 treatments, each with not less than 2 applications. The amount of lignin binder to be applied shall be as prescribed in the Supplementary Specifications, and the time intervals between applications shall be as approved or directed by the Engineer. Immediately before each treatment, the surface shall be lightly scarified, and immediately after the last application of any treatment, and after heavy rain, the surface shall be scraped.

Before application, the lignin binder shall be diluted with water. The normal mixture shall contain 50 per cent lignin binder by volume. The exact percentage and quantity to be used for each application, and the exact number of applications for each treatment, will depend on the conditions of the pavement and the weather at the time of application and will be determined by the Engineer. Applications shall not be made during heavy rain or when the surface is muddy or excessively wet. When the condition of the gravel or the weather may require it, in the opinion of the Engineer, the pavement shall be watered before applying the lignin binder. The lignin binder mixture shall be applied uniformly over the whole surface of the pavement at such a rate that it will be absorbed by the gravel and not run off or form a surface crust.

The lignin binder shall be applied by means of distributing trucks conforming to the requirements therefor as specified in Art. 3. 6. 3 except as follows:

Furnishing thermometers and recording temperature of the lignin is not required.

Only one truck operator is required.

Instead of delivery slips, the Contractor shall furnish an accurate gauge record of the quantity applied. The lignin binder shall not be heated in the distributing trucks or elsewhere.

Unless otherwise specifically provided, scarifying, scraping and watering the surface is not included in the bid item Lignin Treatment.

3. 7. 4. Quantity and Payment.

The quantity of Lignin Treatment for which payment will be made will be the volume, in gallons, of lignin binder after dilution, actually used in accordance with the Plans or as directed by the Engineer. The volume, after dilution, will be the number of gallons used, measured at 60° F., as determined by the temperature-volume corrections specified in Art. 9. 2. 1, Table 42.

Payment for Lignin Binder will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item LIGNIN TREATMENT in the Proposal, which price shall include the cost of furnishing and applying the lignin binder, diluting water, all labor, equipment and all else necessary therefor and incidental thereto. When scarifying, scraping and watering the surface is included in the Contract, it shall be paid for under a separate scheduled item at the unit price per square yard bid therefor in the Proposal.

SECTION 8

Penetration Aggregate Surface Course

3. 8. 1. Description.

Penetration aggregate surface course shall consist of the construction, on a previously prepared base course, of a pavement surface of washed gravel or broken stone penetrated with a hot application of bituminous binder.

3. 8. 2. Materials.

Large aggregate shall be 1-inch size broken stone or washed gravel. **Cover material** shall be ⅜-inch size broken stone, washed gravel or blast furnace slag, with certain limitation of their use as hereinafter specified.

Broken stone, gravel and blast furnace slag shall conform to the requirements specified respectively therefor in Art. 8. 5. 5, 8. 5. 6 and 8. 5. 7, respectively.

Large aggregate of both gravel and broken stone shall not be used on the same project except when and as approved by the Engineer.

The ⅜-inch size cover material, when used in shoulder construction, shall be of gravel if the shoulder is adjacent to bituminous concrete or other black top pavement, and shall be of gravel, broken stone or blast furnace slag, if the shoulder is adjacent to portland cement concrete pavement.

Bituminous binder shall be asphalt cement, Penetration Grade 120-150, or Tar, Grade RT-8 or RT-9, conforming to the requirements respectively therefor in Art. 8. 1. 2 and 8. 1. 12. When tar is used in hot weather, it shall be Grade RT-9, if directed by the Engineer.

3. 8. 3. Methods of Construction.

The surface course shall be constructed on a previously constructed base course which shall be dry, free from frost and loose or adhering foreign materials, and properly finished, at the time the surface course is placed thereon.

The 1-inch size aggregate shall be spread on the base course to such a depth that the surface course, when completed, will have at least the prescribed thickness and will not exceed the prescribed thickness by more than ½ inch. The large aggregate shall be spread by self-propelled stone spreaders equipped with a strike-off bar or screed capable of being adjusted to the required grade and crown. After being spread, the aggregate shall be kept clean and protected from coatings of foreign materials. Not more than sufficient aggregate for a day's work shall be spread in advance of rolling and application of bituminous binder, unless otherwise approved by the Engineer. After spreading, the aggregate shall be rolled longitudinally with a 3-wheel power-driven roller, weighing not less than 10 tons and having a load on the rear wheels of not less than 330 pounds per inch of width of the wheels, until it is properly compacted to the prescribed grade and contour, and then the surface shall not be used for any purpose until the bituminous binder is applied. Before the application of bituminous binder, any depressions or projections in excess of the tolerances hereinafter specified for the completed surface shall be corrected.

Bituminous binder shall be applied to the large aggregate by pressure distributing trucks conforming to the requirements therefor specified in Art. 3. 6. 3. The rate of application for a prescribed 2-inch thickness of surface course shall be not less than 1.5 and not more than 1.8 gallons per square yard if broken stone be used, and not less than 1.0 and not more than 1.5 gallons per square yard if gravel be used. If the prescribed thickness be other than 2 inches,

the rate of application shall be as specified in the Supplementary Specifications. The temperature of the bituminous binder at the time of application shall be 300°-350° F. for asphalt cement and 150°-225° F. for tar. The bituminous binder shall be applied only when the atmospheric temperature is above 50° F. and has remained above 40° F. for the preceding eight hours, when the aggregate is dry for the full depth of the course and the conditions are favorable for proper penetration and adhesion, and when the weather conditions otherwise are favorable in the opinion of the Engineer.

Precautions satisfactory to the Engineer shall be taken to prevent spilling of the bituminous binder on the surface course when the equipment is being readied for operation and to prevent duplication of application when operations are stopped temporarily. Adequate shields shall be provided and operated to prevent spilling bituminous binder on areas or structures adjacent to the penetration surface course.

Immediately after the application of the bituminous binder, ⅜-inch cover material shall be spread uniformly over the large aggregate in the amount of approximately 25 pounds per square yard and such as to provide a slight excess over that required to fill the surface voids. Immediately after spreading the ⅜-inch cover material the surface shall be rolled longitudinally with the 3-wheel roller specified above, dragged with an approved type drag and rerolled. The final rolling operation or operations shall be longitudinal or a combination of longitudinal and diagonal rolling as may be necessary to smooth out ridges and other unevenness.

In all rolling herein specified, the rear wheels of the roller shall uniformly overlap their tracks of the previous pass. The wheels of the rollers shall be kept moistened when operating after the bitumen has been applied. When bituminous binder sticks to the roller wheels, additional ⅜-inch cover material shall be spread.

The completed surface course shall have the required thickness, shall be thoroughly compacted and bound together, shall be at the prescribed grade and crown and free from projections and depressions of more than ⅜ inch in 10 feet when tested longitudinally and transversely.

3. 8. 4. Quantity and Payment.

The quantity of Penetration Aggregate Surface Course for which payment will be made will be the actual area constructed, without deduction of areas occupied by manholes and similar structures within the paved area, and the volume of bituminous binder used. The volume of bituminous binder will be the number of gallons used, measured at 60° F., as determined by the temperature-

volume corrections specified in Art. 9. 2. 1, Table 37 for asphalt products and Table 39 for tar products.

Payment for Penetration Aggregate Surface Course will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item PENETRATION AGGREGATE SURFACE COURSE in the Proposal, which price shall include the cost of the surface course complete, all materials, labor, equipment, and all else necessary therefor and incidental thereto, except furnishing and applying the bituminous binder.

Payment for the Bituminous Binder will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item BITUMINOUS BINDER in the Proposal, which price shall include the cost of furnishing and applying the bituminous material, all labor, equipment, and all else necessary therefor and incidental thereto.

SECTION 9

Penetration Macadam Surface Course

Hot Application and Cold Application

(B. P. R. Class D)

3. 9. 1. Description.

Penetration macadam surface course shall consist of the construction, on a previously prepared base course, of a pavement surface course of bituminous bound macadam with the binder applied hot or cold as may be prescribed in the Supplementary Specifications or Plans.

3. 9. 2. Materials.

Aggregates. The aggregates shall be 1½-inch and ⅝-inch or ½-inch size broken stone, and ⅜-inch size cover aggregate of broken stone or blast furnace slag.

Broken stone shall be trap rock, granite, gneiss, dolomite or limestone. Broken stone and blast furnace slag shall conform to the requirements therefor specified in Art. 8. 5. 5 and 8. 5. 7, respectively.

Bituminous Binder, First and Second Hot Applications. The bituminous binder shall be asphalt cement, Penetration Grade

85-100 or Grade 100-120, or tar, Grade RT-11 or RT-12, conforming to the requirements therefor specified in Art. 8. 1. 2 and 8. 1. 12, respectively. For tar, Grade RT-12 shall be used in hot weather, as directed. For asphalt cement, Penetration Grade 100-120 shall be used in cold weather, as directed.

Bituminous Binder, Third Hot Application. Bituminous binder as specified above for the first and second hot applications, asphaltic oil, Grade RC-2 or RC-3, or tar, Grade RT-7, RT-8, RT-9 or RT-10 shall be used, subject to the approval of the Engineer. Asphaltic oil and tar shall conform to the requirements specified therefor in Art. 8. 1. 7 and 8. 1. 12, respectively.

Bituminous Binder, Cold Application. For cold application, the bituminous binder shall be emulsified asphalt, Grade RS-1 or RS-2, as directed by the Engineer, conforming to the requirements therefor specified in Art. 8. 1. 5.

3. 9. 3. Methods of Construction.

General Requirements. The surface course shall be constructed on a base course which shall be dry, clean, free from frost and loose or adhering foreign materials, and properly finished at the time the surface course is placed thereon. All rolling shall be done with 3-wheel power-driven rollers and tandem rollers of the 2-axle or 3-axle type conforming to the requirements specified therefor in Art. 3. 2. 2. The rolling shall be first parallel to the axis of the pavement, starting at the edges and working towards the center, and subsequently it shall be diagonal as well as parallel to the axis. All parts of the pavement shall be rolled by the rear wheels of the rollers and they shall uniformly overlap their previous tracks on each pass.

The 1½-inch size aggregate shall be spread on the base course to the proper depth. It shall be spread directly by an approved stone spreader of the type specified in Art. 3. 2. 2, and shall not be dumped in piles within the area on which it is to be spread. After being spread the aggregate shall be kept clean and protected from coatings of foreign materials until the bituminous binder is applied. Not more than sufficient aggregate for a day's work shall be spread in advance of rolling and application of bituminous binder, unless otherwise approved by the Engineer. The aggregate shall be rolled until thoroughly compacted to the proper grade and contour. The surface shall be tested at this stage and all depressions and projections in excess of the specified tolerances shall be corrected by scarifying, removing or adding aggregate, and rerolling. Then the surface shall not be traveled upon or used for any purpose until the bituminous binder is being applied. The bituminous binder material shall then be applied as hereinafter described by pressure distributing trucks conforming to the require-

ments therefor specified in Art. 3. 6. 3. Precautions satisfactory to the Engineer shall be taken to prevent spilling of the bituminous material on the pavement surface or adjacent ground when the equipment is being made ready for operation, and to prevent duplication when operations have stopped temporarily. Broom drags and other equipment shall be subject to the approval of the Engineer. After the required applications of bituminous binder and aggregates have been made as hereinafter specified, any places found insufficiently coated or bound shall be treated with additional binder and cover aggregate, applied by hand, and shall be rerolled, or shall be repaired as the Engineer may direct. If it be desirable to roll the surface after it is opened for traffic, in the opinion of the Engineer, this shall be done when and as directed by him.

The finished surface shall be at the proper grade and crown, firmly bound together, free from improperly rolled or consolidated spots, porous places, and excess ⅜-inch aggregate. The surface shall be checked with a 10-foot straightedge and depressions and projections of more than ¼ inch in 10 feet shall be corrected.

Hot Application. When the bituminous binder is being applied its temperature in deg. F. shall be as follows:

Air temp. 50-65° F.	Asph. Cem. 325-350	Tar 225-250
Air temp. over 65° F.	Asph. Cem. 300-350	Tar 185-250

The bituminous binder shall be applied only when the atmospheric temperature is above 50 deg. F., and has remained above 40 deg. F. for the preceding 8 hours, when the aggregate surfaces are dry for the full depth of the course and the conditions are favorable for proper penetration and adhesion, and when the weather conditions otherwise are favorable in the opinion of the Engineer.

After the 1½-inch size aggregate has been spread and compacted as hereinabove specified under General Requirements, the first application of bituminous binder shall be applied. For a course thickness of 3 inches this application shall be made at the rate of 1.75 to 2.25 gallons per square yard of surface. For course thicknesses other than 3 inches, the first application shall be made at the rate prescribed in the Supplementary Specifications. While the bituminous binder is still liquid it shall be choked with a uniform layer of clean, dry ⅝-inch or ½-inch size aggregate just sufficient to fill the surface voids, and the surface shall then be rolled until the choke aggregate is thoroughly embedded in the bituminous binder and anchored in place and there is no perceptible movement under the roller. The wheels of rollers shall be kept moistened when operating after the bitumen has been applied. If the bituminous binder stick to the roller wheels, additional aggregate shall be spread.

Immediately after the completion of the rolling, a second application of the bituminous binder shall be made at the rate of 0.5

to 0.75 gallon per square yard, and it shall be covered with a layer of ⅜-inch size aggregate. Then the surface shall be rolled, dragged and rerolled until it has the proper density, crown and grade, after which it shall be opened for traffic. If bituminous binder appear on the surface, additional ⅜-inch size aggregate shall be spread so as to keep the entire surface covered for a period of not less than 30 days after the second application of binder.

After 30 to 60 days' use by traffic and at such time as the Engineer may approve, the surface shall be swept thoroughly with a mechanically operated broom, and all dust, dirt and excess ⅜-inch aggregate shall be removed. A third application of the bituminous binder then shall be made at the rate of not less than 0.33 gallon per square yard, and it shall be covered immediately with ⅜-inch size aggregate at the rate of not less than 25 pounds per square yard of surface, and immediately thereafter the surface shall be dragged and rolled thoroughly.

Cold Application. After spreading the 1½-inch size aggregate as above described under General Requirements and before the bituminous binder is applied, ⅝-inch or ½-inch size aggregate shall be spread uniformly thereon sufficiently to fill the voids in the larger size aggregate. The surface shall then be rolled with a 3-wheel roller as described above until it is thoroughly consolidated, uniform and even and at the proper grade and contour. Emulsified asphalt shall then be applied at the rate of 1 gallon per square yard of surface for a course thickness of 3 inches. If the course thickness be other than 3 inches, the rate of application shall be as prescribed in the Supplementary Specifications. When the bituminous binder is applied, the atmospheric temperature shall be above 40 deg. F., and shall have been above 32 deg. F. for the preceding 8 hours, and the aggregate shall be free from water for its full depth but may be damp. Immediately after the application and while the emulsified asphalt is brown and unbroken, a second layer of ⅝-inch or ½-inch size aggregate shall be spread in sufficient quantity to permit rolling without picking up, and shall be immediately rolled, dragged and rerolled. If necessary the wheels of the roller shall be wet to prevent pick up.

A second application of emulsified asphalt shall then be made at the rate of 1 gallon per square yard of surface for a 3-inch course, as above specified, or at the rate prescribed in the Supplementary Specifications for other course thicknesses. Immediately after the second application and while the emulsified asphalt is brown and unbroken, a layer of ⅜-inch size aggregate shall be spread in sufficient quantity to permit rolling without picking up, and this course shall be rolled, dragged and rerolled as above specified.

A third application of emulsified asphalt shall then be made at the rate of 0.5 gallon per square yard, and immediately thereafter

while the asphalt is brown and unbroken a second layer of ⅜-inch size aggregate shall be spread uniformly to a one-stone thickness, sufficient to fill all surface voids and cover the emulsified asphalt. The surface shall then be rolled, dragged and rerolled.

A fourth application of emulsified asphalt shall then be made at the rate of 0.35 to 0.45 gallon per square yard, and immediately thereafter while the asphalt is brown and unbroken, a third layer of ⅜-inch size aggregate shall be spread uniformly to a one-stone thickness, sufficient to fill all surface voids and cover the emulsified asphalt. The surface shall then be rolled, dragged and rerolled. When this application is thoroughly broken and set, the surface may be opened for traffic. The finished pavement shall be thoroughly compacted and bound together, hard, smooth and even, free from defects and at the proper grade and contour.

3. 9. 4. Quantity and Payment.

The quantities of Penetration Macadam Surface Course, Hot and Cold Application, for which payment will be made, will be (a) the actual area constructed without deductions of areas occupied by manholes and similar structures within the paved area; (b) the volume of bituminous binder used for the first and second Hot Application and for all four Cold Applications; and (c) the actual area covered by the third Hot Application, all in accordance with the Plans or as directed by the Engineer. The volume of bituminous binder will be the number of gallons used, measured at 60° F., as determined by the temperature-volume corrections specified in Art. 9. 2. 1, Tables 37 and 38 for Asphalt Products, Table 39 for tar products and Table 41 for emulsified asphalt.

Payment for Penetration Macadam Surface Course, Hot Application, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item PENETRATION MACADAM SURFACE COURSE, HOT APPLICATION, in the Proposal, which price shall include the cost of the construction of the surface course complete, all materials, labor, equipment and all else necessary therefor and incidental thereto, except furnishing and placing 3 applications of bituminous binder and the cover material for the third application.

Payment for Penetration Macadam Surface Course, Third Hot Application, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item PENETRATION MACADAM, THIRD HOT APPLICATION, in the Proposal, which price shall include the cost of furnishing and placing the bituminous binder and cover material for the third application complete, all labor, equipment and all else necessary therefor and incidental thereto.

Payment for Bituminous Binder for First and Second Hot Application will be made for the quantity as above determined,

measured in gallons, at the price per gallon bid for the item BITUMINOUS BINDER, FIRST AND SECOND HOT APPLICATION, which price shall include the cost of furnishing and applying the bituminous binder, all labor, equipment and all else necessary therefor and incidental thereto.

Payment for Penetration Macadam Surface Course, Cold Application, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item PENETRATION MACADAM SURFACE COURSE, COLD APPLICATION, in the Proposal, which price shall include furnishing all materials, labor, equipment and all else necessary therefor and incidental thereto, except furnishing and applying the bituminous binder.

Payment for Bituminous Binder for Penetration Macadam Surface Course, Cold Application, will be made for the quantity as above determined, measured in gallons, at the price per gallon bid for the item BITUMINOUS BINDER, COLD APPLICATION, in the Proposal, which price shall include the cost of furnishing and applying the bituminous binder, all labor, equipment and all else necessary therefor and incidental thereto.

Provided, however, that when an item for Penetration Macadam Surface Course, Hot Application, or for Penetration Macadam Surface Course, Cold Application, is scheduled in the Proposal, and no items are scheduled therein for furnishing and applying the bituminous binder, payment for Penetration Macadam Surface Course will be made for the actual area constructed, measured in square yards, in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar structures within the paved area, at the price per square yard bid for the item PENETRATION MACADAM SURFACE COURSE, HOT APPLICATION, or PENETRATION MACADAM SURFACE COURSE, COLD APPLICATION, respectively, in the Proposal, which price shall include the cost of the construction of the surface course complete; all stone, bituminous binder, cover and other materials; all labor, equipment and all else necessary therefor and incidental thereto.

SECTION 10

Bituminous Concrete Surface Course, Hot-Mixed (B. P. R. Class I)

Sheet Asphalt Surface Course (B. P. R. Class J)

3. 10. 1. Description.

Hot-mixed bituminous concrete and sheet asphalt surface courses shall consist of the construction of these surface courses on previously constructed base courses. Types CA-BC-1, MA-BC-1, FA-BC-1, SM-1 and SP-1 are bituminous concrete, laid in one course. Types CA-BC-2, MA-BC-2, FA-BC-2, SM-2 and SP-2 are bituminous concrete, and type SA is sheet asphalt, all laid in two courses.

In this Section, all pavement surfaces are designated as bituminous concrete irrespective of type.

3. 10. 2. Materials.

Bituminous Material. The bituminous material shall be asphalt cement, Penetration Grade 85-100, conforming to the requirements specified therefor in Art. 8. 1. 2, unless otherwise directed by the Laboratory.

Bituminous material of only one kind and grade and from only one source shall be used for a specific type of mixture in any one contract except that the use of more than one grade for that mixture may be directed by the Engineer when the mixture is used for more than one purpose or where deemed necessary by the Laboratory for other reasons.

Mineral Filler. Mineral filler shall conform to the requirements specified therefor in Art. 8. 5. 34.

Coarse Aggregate. Coarse aggregate for top course (total retained on No. 10 sieve) shall be broken stone prepared from trap rock, gneiss, granite or dolomite, conforming to the quality requirements as specified respectively therefor in Art. 8. 5. 5. Broken stone of only one kind and from only one source shall be used in the top course on any one contract unless otherwise approved by the Laboratory.

Coarse aggregate for bottom course (total retained on No. 10 sieve) shall be broken stone prepared from trap rock, gneiss, granite, limestone or dolomite, conforming to the quality requirements as specified therefor in Art. 8. 5. 5.

Coarse aggregate for the various types and mixtures of hot-mixed bituminous concrete shall be of the following sizes, subject to approval by the Laboratory, and shall conform to the grading requirements specified respectively therefor in Art. 8. 5. 4, Table 28.

Bottom Courses	Mixture No. I	1" or ¾" size
CA-BC-1, CA-BC-2 Top	Mixture No. II	Combination of 1" and ½" or a combination of 1", ⅝" and ⅜" sizes
MA-BC-1, MA-BC-2 Top	Mixture No. III	½" size or combination of ⅝" and ⅜" sizes
FA-BC-1, FA-BC-2 Top	Mixture No. IV	⅜" size
SM-1, SM-2 Top	Mixture No. V	⅝" size
SP-1, SP-2 Top	Mixture No. VI	¼" size

Fine Aggregate. Fine aggregate shall conform to the requirements specified therefor in Art. 8. 5. 12.

Tack Coat Materials. Where a tack coat is specified, the material shall be asphaltic oil, Grade RC-0, or emulsified asphalt, Grade RS-1, conforming to the requirements therefor specified in Art. 8. 1. 7 and 8. 1. 5, respectively.

Prime Coat Materials. Where a prime coat is specified, the material shall be asphaltic oil, Grade MC-0 or MC-1, or tar, Grade RT-1 or RT-2, or emulsified asphalt, Grade SS-1, conforming to the requirements specified therefor in Art. 8. 1. 7, 8. 1. 12 and 8. 1. 5, respectively.

Composition of Mixtures. The bituminous concrete for bottom course shall be composed of coarse aggregate, fine aggregate and bituminous material. The bituminous concrete for top course of Type CA-BC, MA-BC, FA-BC, SM and SP shall be composed of coarse aggregate, fine aggregate, mineral filler and bituminous material. For Type SA top course, the bituminous concrete shall be composed of fine aggregate, mineral filler and bituminous material.

The several mineral constituents for each mixture shall be combined in such proportions that the resulting mixture will meet the grading requirements shown in Table 3. In calculating the percentages of aggregates of the various sizes, the bituminous material is included therein.

In all mixes except Bottom Course Mix No. I and SM Mix No. V, at least one-half of the amount of aggregate passing the No. 200 sieve shall be mineral filler.

Table 3.—Bituminous Concrete Mixtures, Hot-Mixed

Total Aggregate Passing and Retained on Screen and Sieve Size		Percentage by Weight, Mix No.						
Passing	Retained on	I	II	III	IV	V	VI	VII
Screen 1½"	Screen 1"	0–35	0–25					
1"	½"	25–70	20–45	8–25	0–10	0–5		
½"	¼"	0–20	10–25	20–45	12–40	20–35	0–10	
¼"	Sieve No. 10	0–15	5–15	5–25	8–30	15–30	8–25	0–5
Sieve No. 10	No. 30	1–11	2–14	2–14	2–17	8–22	3–20	4–25
No. 30	No. 50	2–15	5–18	5–18	4–24	4–15	8–30	10–35
No. 50	No. 80	2–14	4–18	4–18	6–22	3–15	10–28	12–33
No. 80	No. 200	2–13	3–16	3–16	3–20	4–9	6–25	8–28
No. 200		0–5	4–8	4–8	4–8	4–8	4–10	10–15
Total Retained on No. 10 Sieve		55–85	45–65	45–65	30–60	40–55	15–30	0–5
Bitumen Content (Solubility in Benzol)		4–6	5–7	5–8	5.5–9	5–8	8–11	9–11.5
To be used for Pavement Courses		All Bottom Courses	CA-BC-1 CA-BC-2 Top	MA-BC-1 MA-BC-2 Top	FA-BC-1 FA-BC-2 Top	SM-1 SM-2 Top	SP-1 SP-2 Top	SA Top

Note: All screens ¼" and larger are round openings.

Formula for Job Mix. The composition limits for every mixture as prescribed in Table 3 above are extreme ranges that must not be exceeded.

The Laboratory will establish a job mix formula for each mixture to be supplied for the Project. The job mix formula shall be in effect until modified by the Laboratory. The job mix formula for each mixture shall establish a single definite percentage of mineral aggregate to be weighed from each bin, a single definite percentage of bituminous material to be added to the aggregate, the percentage or amount of any other ingredient that may be required, and the temperature at which the mixture is to leave the plant, all within the ranges of the specifications for the specific type of mixture. Should a change in sources of materials be made, a new job mix formula may be established before the mixture containing the new materials is produced.

After the job mix formula is established for a mixture as prescribed above, all mixtures of that type furnished for the Project shall conform thereto within the following tolerances:

Coarse Aggregate, Bottom Course .....plus or minus 5%
(total retained on No. 10 Sieve)
Coarse Aggregate, Top Course .....plus or minus 4%
(total retained on No. 10 Sieve)
Bitumen content for Type SA Top
Course .....plus or minus 0.5%

Bitumen content for all other types .....plus or minus 0.3%
Temperature of the bituminous material .....plus or minus 15° F.
Temperature of the mineral aggregate ..plus or minus 20° F.
Temperature of bituminous concrete when leaving plant .....plus or minus 15° F.

Each day the asphalt plant Inspector will take as many samples as he considers necessary for checking the uniformity of the mixture.

3. 10. 3. Methods of Construction.

Plant and Equipment. The plant and equipment shall consist of suitable units including one or more bituminous concrete plants, bituminous concrete pavers and rollers, sufficient vehicles for transporting bituminous mixtures, small tools and all other equipment necessary for the construction of the bituminous concrete pavement and for conditioning the existing or previously constructed base course, as specified.

All equipment, tools, machinery and other appliances 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 they shall be changed and improved, or new equipment substituted, as required by the Engineer. All equipment, tools, machinery and plant used must be maintained in a satisfactory working condition.

Bituminous Concrete Plant and Equipment. Plants used in the preparation of bituminous paving mixtures may be of the Batch type or Continuous Mixing type.

General Requirements for All Mixing Plants. The plant shall be of sufficient capacity and shall be designed and coordinated to handle adequately the proposed bituminous concrete mixtures within the specified job mix tolerances as provided in the Contract. The plant shall be maintained in good mechanical condition. Any defect which adversely affects the functioning of a plant or plant unit, or the quality of the mixture, in any manner shall be corrected immediately upon instructions from the Laboratory. The plant site shall have adequate storage facilities. Sufficient storage space shall be provided for separate stock piles, bins or stalls for each size of aggregate, and the different aggregate sizes shall be kept separated until they have been delivered, without segregation, by the feeder or feeders to the boot of the cold elevator, or elevators, in their proper proportions. The storage yard shall be maintained neat and orderly and the separate stock piles shall be readily accessible for sampling.

Scales. All mixing plant scales shall be certified and sealed by a duly constituted Weights and Measures officer prior to the

delivery of the material. The scales shall be accurate within the tolerances permitted by the Department of Law and Public Safety, Division of Weights and Measures.

Equipment for Preparation of Bitumen. Tanks for storage of bitumen shall be equipped for heating the entire contents uniformly, under effective and positive control at all times, to the temperature requirements specified for the paving mixture. Heating shall be accomplished by steam coils, electrically or by other means, so that no flame shall come in contact with the heating tank. A circulating system for the bitumen shall be provided of adequate size to insure the proper and continuous circulation between storage tank and bitumen bucket or meter during the entire operating period. Other systems of conveying the bitumen to the bitumen bucket may be used when approved by the Laboratory.

All pipe lines and fittings shall be steam-jacketed or otherwise properly insulated to prevent heat loss. Storage tank capacity shall be sufficient for at least one day's run.

Feeder for Dryer. The plant shall be provided with an accurate mechanical means for uniformly feeding the mineral aggregates into the dryer so that a uniform production and temperature will be secured.

Dryer. A dryer of any satisfactory design for drying and heating the mineral aggregate shall be provided. The dryer shall be capable of drying and heating the mineral aggregate to the temperature requirements specified for the paving mixture.

Screens. Plant screens, capable of screening all aggregate to the sizes required for proportioning, and having normal capacities slightly in excess of the production capacity of the mixer, shall be provided.

Bins. The plant shall have storage bins of sufficient capacity to insure uniform and continuous operation. Bins shall be divided into at least three compartments arranged to insure separate and adequate storage of appropriate fractions of the aggregate. Each compartment shall be designed so that the material therein will not overflow into any other compartment. Adequate additional dry storage shall be provided for mineral filler, and provisions made for its proper proportion for each batch of the mixture. Gates on the bins shall be constructed so as to prevent leakage when they are closed.

Thermometric Equipment. A thermometer of suitable range shall be fixed in the bitumen feed line at a suitable location near the discharge valve at the mixer unit. Other thermometric equipment which accurately registers the temperature of the bitumen being used may be approved by the Laboratory.

The plant shall be further equipped with an approved dial scale, mercury-actuated thermometer, an electric pyrometer, or other approved thermometric instrument so placed at the discharge chute of the dryer as to register automatically or indicate the temperature of the heated aggregate.

The dial of the instrument shall be in full view of the dryer fireman or aggregate feed operator. The Laboratory reserves the right to pass upon the efficiency of the thermometric instruments and, for better regulation of temperature of aggregates, may direct replacement of any instrument by some approved temperature recording apparatus and may further require that daily temperature charts be filed with the Laboratory.

Dust Collectors. When plants are located in any vicinity where dust may be objectionable, or when dust interferes with the efficient operation of the plant, proper housings, mixer covers, or dust collecting systems shall be installed. When dust collectors are used, they shall be constructed to waste or return uniformly the material collected to the hot elevator. Waste or return of the collected material shall be as directed by the Laboratory.

Safety Requirements. Adequate and safe stairways to the mixer platform and guarded ladders to other plant units shall be placed at all points required for accessibility to all plant operations. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading space, free of drippings from the mixing platform, to permit easy and safe inspection of the mixture as it is delivered into the trucks. A platform also shall be provided away from the plant to permit further inspection and taking temperatures of the mixture before delivery. Easy and safe access shall be provided to the location above the mixer where samples of the aggregate in the bins can be procured. Adequate overhead protection shall be provided where necessary. In addition to the above, the plant shall conform to all other State and local safety requirements.

Inspection of Bituminous Plant Operation. For checking the adequacy of the equipment in use, for inspection of the conditions and operation of the plant, for verification of weights, proportions and character of materials, and for the determination and checking of temperatures being maintained in the preparation of mixtures, the Laboratory's authorized representative shall have access at all times to any part of the plant.

At each plant there shall be provided a field laboratory for use as an office and for testing by the Engineer or Inspector during

construction. This laboratory may be a separate building or part thereof, not less than 10 feet x 12 feet x 7 feet high, with a wooden floor, two windows, electric lighting and plugs for heating apparatus, workbench, table and chairs. It shall be waterproofed, heated in cold weather, and so located that plant operations are plainly visible from one of its windows. The Contractor shall pro ide for convenient access of the Engineer to telephone service either in the field laboratory or in close proximity thereto.

The field laboratory shall be furnished with testing equipment provided by the asphalt plant owner for use of the Engineer and Inspector. Equipment shall include that required for determining the penetration of asphalt cements; for determining the bitumen content using a rotary or other approved type extractor; mechanical shaker, screens and sieves for determining the gradation of the aggregates and for verification of the mix formula; and other necessary equipment and materials as requested by the Laboratory. Testing equipment shall be of the standard type and approved by the Laboratory.

BATCH TYPE PLANT.

Mineral Aggregate Weigh Box or Hopper. The equipment shall include the means for accurately weighing each bin size of aggregate in a weigh box or hopper, suspended on scales, ample in size to hold a full batch without hand raking or running over. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be thrown out of alignment or adjustment easily. Gates on the weigh box shall be constructed so as to prevent leakage when they are closed.

Mineral Aggregate Scales. Scales for the mineral aggregate weigh box or hopper shall be of either the beam or springless dial type and shall be of a standard make and design. When the beam type scale is used, provision shall be made for indicating to the operator that the required weight in the weighing hopper is being approached. The device shall indicate at least the last 200 pounds of load. The scale shall also be equipped with a tare beam or adjustable counterbalance for balancing the hopper.

Mixer Unit. The plant shall be equipped with a batch mixer of an approved twin pugmill type and shall be capable of producing a uniform mixture within the permissible job mix tolerances. It shall have a capacity of not less than 1,000 pounds. The mixing blades shall be placed so as to rotate the mixture around the mixer unit, unless otherwise approved by the Laboratory. The mixer shall be constructed so as to prevent leakage of contents.

When directed by the Laboratory, the mixer shall be equipped with an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer until the closing of the mixer gate at the completion

of the cycle; it shall lock the bitumen bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods. The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the application of the bitumen. The wet mixing period is the interval of time between the application of the bitumen and the opening of the mixer gate. The control of the timing shall be flexible and capable of being set at intervals of not more than 5 seconds throughout cycles up to 3 minutes. A mechanical batch counter shall be installed as a part of the timing device and shall be so designed as to register only completely mixed batches.

Bitumen Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bitumen. Suitable means shall be provided, either by steam-jacketing or other insulation, for maintaining the specified temperature of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

Where the quantity of bitumen is controlled by metering, provisions shall be made whereby the delivery of bitumen from the meter may be checked readily by actual weight.

If a bucket be used for weighing the bitumen, it shall have sufficient capacity to hold the amount of bitumen required for one batch. The scales may be either of the beam or springless dial type. They shall be accurate within 1 per cent under operating conditions. When beam type scales are used, provision shall be made for indicating to the operator that the required weight in the bitumen bucket is being approached. The device shall indicate at least the last 20 pounds of load. The beam type scales shall be equipped with a tare beam or adequate counterbalance for balancing the bucket and compensating periodically for the accumulation of bitumen on the bucket. The bucket shall be so arranged that it will deliver the bitumen in a thin uniform sheet or in multiple streams at least three-quarters the length of the mixer, except in the case of a mixer where the bitumen is sprayed.

CONTINUOUS MIXING TYPE PLANT.

Gradation Control Unit. The plant shall include a means for accurately proportioning each bin size of aggregate either by weighing or by volumetric measurement. When gradation control is by volume, the unit shall include a feeder mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The orifice shall be rectangular with dimensions of about 8 inches by 9 inches and with one dimension adjustable by positive mechanical means provided with a lock. Indicators shall be provided on each gate to show the gate opening in inches. Mineral filler, if specified,

shall be proportioned separately and added to the mix in such a manner that uniform distribution will be obtained.

Each compartment of the hot aggregate bin shall be equipped with an approved switch attachment which shall automatically shut off the plant when any one bin reaches a minimum operating level.

Weight Calibration of Bitumen and Aggregate Feed. The plant shall include a means of calibrating gate openings and meters by means of weight test samples. The aggregate fed out of the bins through individual orifices shall be bypassed to a suitable test box and each compartment material shall be confined in a separate box section. The plant shall be equipped to handle conveniently such test samples weighing up to 800 pounds and to weigh them on accurate scales. Means shall be provided for calibrating the flow of bitumen.

Synchronization of Aggregate and Bitumen Feed. Satisfactory means shall be provided to afford positive interlocking control between the flow of aggregate from the bins and the flow of bitumen from the meter or other proportioning source. This device shall be accompanied by interlocking mechanical means or any positive method for accurate control.

When a standard surge tank is not used, a pressure relief valve, or control, shall be provided in the bitumen supply line to the metering pump to provide a constant pressure equal to the pressure supplied by the surge tank.

Mixer Unit for Continuous Method. The plant shall include a continuous mixer of an approved twin pugmill type and shall be capable of producing a uniform mixture within the permissible variations from the job mix formula. The paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of the mix. The discharge end of the pugmill mixer shall be equipped with a hopper or other approved device for loading the mixed material into the delivery truck without segregation. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge. Charts shall be prepared giving the rate of aggregate feed per minute at the plant operating speed. Continuous mixers not conforming in all respects to the above requirements, but capable of producing a uniform mixture within the permissible variations from the job mix formula, will be considered for approval.

The weight per unit volume relationship of the coated loose mix shall be determined and, by reference to the volume gauge on the side of the mixer, the dead weight at any operating height

and the mixing time shall be calculated, using the following formula:

$$\text{Mixing time in seconds} = \frac{\text{pugmill dead capacity in pounds}}{\text{pugmill output in pounds per second}}$$

Bituminous Concrete Pavers. Bituminous concrete pavers shall be self-contained; power-propelled units, provided with an activated screed or strike-off assembly, heated if necessary, and capable of spreading and finishing courses of bituminous concrete 8 feet to 12 feet wide and from ¾ inch to 6 inches in depth, true to the line, grade and crown, with or without the use of forms or side supports. The screed or screeds shall be adjustable to lay courses in widths of more than 8 feet in 6-inch increments or less. The paver shall have sufficient power and traction to operate efficiently on grades up to 8 per cent.

The receiving hopper shall be of such size and capacity as to prevent any delay in emptying the trucks during spreading operations. The hopper shall be equipped with distribution screws or paddles to place the mixture in front of the screed or screeds evenly.

Pavers shall be equipped with mechanical devices such as equalizing runners, straightedge runners, evener arms or other compensating devices to adjust the grade line so that any unevenness in the foundation or other course upon which the paver travels will not be reflected in the surface of the course being laid, and with devices to confine the edges of the mixture to true lines.

The screed or strike-off assembly shall operate by cutting, crowding or other practical action which is effective on mixtures at the workable temperature specified, without tearing, shoving or gouging, and shall produce a finished surface without segregation and of the evenness and texture specified. The screed or screeds shall be adjustable as to level and shall have an indicating level attached thereto in full view of the operator.

The pavers shall be so designed that they will provide a connection of the bituminous concrete between adjacent strips of pavement which will be smooth and well bonded.

When laying mixtures, the pavers shall be capable of being operated at forward speeds varying from 10 to 50 feet per minute consistent with satisfactory work, and shall be equipped with a quick and efficient steering device.

Vehicles for Transporting Bituminous Mixtures. The mixture shall be transported from the mixing plant to the Project in motor trucks equipped with tight, clean bodies which shall be lightly lubricated with a thin oil, soap or lime solution or dusted with hydrated lime, as directed by the Laboratory, to prevent the mixture from sticking to the bodies. Each truckload of mixture delivered shall be covered with a canvas tarpaulin or other ap-

proved material of such size, and so fastened, as to protect the mixture from the weather. When directed by the Laboratory, the trucks shall be suitably insulated to insure delivery of the mixture to the Project within the temperature requirements and in a suitable condition for proper laying. Any truck causing excessive segregation of the mixture by its spring suspension or other contributing factors or that shows oil leaks of any magnitude or causes undue delays shall, upon direction of the Engineer, be removed from the work until such conditions are corrected.

Rollers. Rollers shall be in good condition, capable of reversing without backlash and shall conform to the following requirements:

Three-wheel power-driven rollers shall have a load of not less than 330 pounds per inch of width of tread of rear wheels and a total metal weight of not less than 10 tons.

Two-axle tandem rollers shall be power-driven and shall have a load of not less than 250 pounds per inch of width of tread of drive roll and shall have a total metal weight of not less than 8 tons.

Three-axle tandem rollers shall be power-driven and shall conform to the requirements specified in (1) or (2) below:

1. Rollers having two guide rolls of equal diameter and a larger diameter drive roll, all rolls having equal width. The drive roll shall have a compression of not less than 250 pounds per inch of width of tread when all rolls are in contact with a level surface. The rollers shall have a total metal weight of not less than 12 tons, and a wheel base of not less than 17 feet measured from the center of the front guide roll to the center of the drive roll. The rolls, when locked in position for all treads to be in the same plane, shall conform to the rigidity requirements prescribed under the following tests with full load:

(a) With the weight of the roller supported on the central roll and drive roll, the tread of the central roll shall be not more than ⅛ inch above the plane tangent to the treads of the end rolls, and

(b) With the weight of the roller supported on the end rolls, the tread of the central roll shall be not more than ¼ inch below the plane tangent to the treads of the end rolls.

2. Rollers as described in (1) above which, when the rolls are in a semilocked position, will meet the rigidity test described in *(a)* above, and which shall be so designed, that with the rolls in a semilocked position and with the weight of the roller supported on the end rolls, the central roll will ride freely on the surface being rolled and there will be no transfer of weight from any one roll to another.

Retaining Forms. If the Supplementary Specifications specify the use of retaining forms, they shall be of such material and design, and shall be so placed, as to prevent the lateral dis-

placement or squeezing out of the mixture by either the finishing machine or the roller.

Construction.

Weather Limitations. Bituminous concrete mixtures shall not be placed when the atmospheric temperature is below 40° F. except when approved by the Engineer, or when the weather is foggy, rainy, or otherwise unfavorable in the opinion of the Engineer.

Conditioning of Existing Surface. The surface of the base course or existing pavement upon which the bituminous concrete pavement is to be placed shall be clean, dry and free from frost when the paving operations are about to start and shall be maintained in that condition.

When bituminous concrete is laid on portland cement concrete, existing bituminous concrete or surface treated macadam or gravel surfaces, the existing paved surface shall be given an application of tack coat material, as specified in Art. 3. 10. 2, at the rate of 0.02 to 0.10 gallon per square yard as directed by the Engineer, prior to placing the new surface.

Equipment for applying the tack coat shall be power-operated pressure spraying or distributing equipment suitable for the materials to be applied and approved by the Engineer.

When the bituminous concrete is to be placed on newly constructed macadam base or on a new or existing gravel course, the surface shall be cleaned of all loose aggregate and binder and given a prime coat of asphaltic oil, tar or emulsified asphalt as specified in Art. 3. 10. 2, at the rate of 0.10 gallon to 0.25 gallon per square yard as directed by the Engineer. Application of the prime coat shall be made not less than twelve hours prior to the placing of the bituminous concrete and shall not be made when the macadam or gravel course is wet or frozen. Application methods and equipment shall meet with the approval of the Engineer.

Contact surfaces of curbing, gutters, manholes and other structures shall be painted with a thin uniform coating of asphaltic oil, Grade RC-2 or RC-3, conforming to the requirements specified therefor in Art. 8. 1. 7 just prior to the placing of the bituminous concrete mixture against them.

Preparation of Bituminous Material. The bituminous material shall be heated to a temperature between 250° F. and 325° F. in tanks conforming to the requirements hereinbefore specified.

Preparation of Mineral Aggregates. The mineral aggregates for the mixture shall be dried and heated at the mixing plant before being placed in the mixer. Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregates. The aggregates shall be heated to a temperature between 225° F. and 350° F. as determined on the mixing platform except that

for Types SM-1 and SM-2 they shall be heated to between 225° F. and 325° F.

Immediately after heating, the aggregates shall be screened into three or more fractions and conveyed into separate bins ready for batching and mixing with bituminous material.

Preparation of Bituminous Concrete Mixture. The dry mineral aggregate, prepared as specified above, shall be combined in the proportional amounts of each fraction of aggregate required to meet the job mix formula.

The ingredients shall be heated and combined in such a manner as to produce a mixture which, when discharged into the delivery truck, shall be at a temperature as directed by the Laboratory, suitable for proper workability, placing, spreading and compaction under prevailing conditions. In no case, however, shall the temperature of the mixture exceed 325° F., except that for Types SM-1 and SM-2 the temperature shall not exceed 300° F.

When a batch type plant is used, the Laboratory will determine the size of the batch, based on the manufacturer's capacity rating, and will determine the proportions and sequence of introducing the materials into the weigh box and mixer. The bituminous material shall be measured by weight or metered and introduced into the mixer in the proportional amount determined by the Laboratory for the particular material being used. Prior to adding the bituminous material, the combined mineral aggregate shall be thoroughly mixed dry, after which the proper amount of bituminous material shall be distributed over the mineral aggregate, and the whole thoroughly mixed for a period of at least 45 seconds, but longer if necessary to produce a homogeneous mixture in which all particles of the mineral aggregate are coated uniformly. The mineral filler, when used, shall be introduced in such a manner that it will be uniformly incorporated with the mass.

The introduction of the materials into the mixer, and the mixing operation, shall be carried out as specified above, unless the mixing operation specified for the particular type of paving mixture that is being produced requires another method of procedure, in which case the mixing operation of that particular specification shall be followed.

When the Laboratory finds that there is difficulty in obtaining the specified mixing time, it may require that the plant be equipped with positive means to regulate the time of mixing and to maintain the specified time constantly.

When a continuous mixing type plant is used, the quantity of each size of coarse and fine aggregates required shall be uniformly fed to the mixer through the gate openings after volumetric tests have been made. The flow of bituminous material into the mixer shall be at the required rate and shall be synchronized at that rate with the flow of the aggregate as described under the requirements

for this type of plant. The total mixing time shall be sufficient to coat the aggregate totally and thoroughly and produce a uniform mixture.

Transportation and Delivery of Mixtures. The mixture shall be transported from the mixing plant to the point of use is vehicles conforming to the requirements hereinbefore specified. No loads shall be sent out so late in the day as to prevent completion of the spreading and compaction of the mixture during daylight, unless artificial light satisfactory to the Engineer is provided.

Spreading and Finishing. The mixture shall be laid only upon a base or existing surface which is dry and when the weather conditions are suitable, as hereinbefore specified under Weather Limitations. Upon arrival at the point of use, the mixture shall be spread and struck off so as to obtain, after compaction, the grade and crown shown on the Plans or adjustments thereof made or ordered by the Engineer to obtain the prescribed thickness of bituminous concrete. For this purpose bituminous concrete pavers conforming to the requirements hereinbefore specified shall be used to distribute the mixture either over the entire width or over such partial width lanes as may be practicable.

Whether one or more pavers are used, the spreading and finishing of adjacent partial width strips of the pavement surface shall proceed by such sequence or timing in the adjacent strips that the prescribed full width of the pavement will be completed without the formation of longitudinal joints. When only one paver is used, the spreading and finishing shall advance in any one partial width strip for not more than 500 feet, and for a period of not more than one hour, after the starting or resumption of paving in that strip, and then the paver shall be moved back and spreading and finishing started or resumed in the adjacent strip. When two or more pavers are used to pave adjacent strips simultaneously at the same location, spreading and finishing in any one strip shall proceed in advance of spreading and finishing in the strip adjacent thereto, in distance and time, not more than specified above. The foregoing requirements of this paragraph shall not apply where paving must be confined to one lane at a time in order to provide for the required maintenance of traffic.

If, due to the required maintenance of traffic or to unforeseeable conditions, the longitudinal edge of the mixture laid in one strip be too cool to form a proper bond with the mixture in the adjacent strip being laid against it, the edge shall be painted first with a coat of asphaltic oil, Grade RC-2 or RC-3, or emulsified asphalt, Grade RS-1 or RS-2, conforming to the requirements specified therefor in Art. 8. 1. 7 or Art. 8. 1. 5, respectively, in a manner to be approved by the Engineer.

If during construction it be found that the spreading and finishing equipment in operation leaves in the new pavement course tracks or indented areas that are not satisfactorily corrected by normal operations, or if it produces other permanent blemishes, the use of such equipment shall be discontinued and satisfactory spreading and finishing equipment shall be provided by the Contractor when directed by the Engineer.

On areas where irregularities or unavoidable obstacles make the use of self-powered spreading and finishing equipment impracticable, in the judgment of the Engineer, the mixture may be spread and raked by hand. On such areas the mixture shall be dumped on steel dump boards and spread and raked to give the thickness of material required.

The Contractor shall provide suitable means for keeping all small tools clean and free from accumulation of bituminous material. He shall provide and have ready for use at all times enough tarpaulins or other suitable covers, as may be directed or approved by the Engineer, for use in any emergency such as rain, chilling wind, or unavoidable delay, for the purpose of covering or protecting any material that may have been dumped and not spread.

No bituminous concrete material shall be placed against the edge of a course or layer that has been rolled and has cooled, unless such edge is vertical or has been cut back to a vertical face and in either case has received a brush coat of bituminous material conforming to the requirements given above and approved by the Engineer.

Compaction. After the spreading and strike-off and while still hot, the course shall be compacted thoroughly and uniformly by rolling. At least two rollers shall be used one of which shall be a three-wheel roller and the other a tandem roller of the two-axle or three-axle type. The rollers shall conform to the requirements hereinbefore specified respectively for each type under the heading Rollers. The initial rolling shall be done with a three-wheel roller. When more than 2000 square yards of bottom or top course are laid each day, the Engineer reserves the right to order the use of additional three-wheel and tandem rollers for proper finishing and compaction.

Each roller shall be operated by a competent experienced roller operator and must be kept as nearly as practicable in continuous operation while the work is under way. Rolling shall begin at the sides and progress gradually to the center, except that on superelevated curves rolling shall progress from the lower to the upper edge parallel to the center line of the road and uniformly lapping each preceding track, as directed by the Engineer, until the entire surface has been rolled by the rear wheels. If the width of the surface course permits, it shall be subjected to a diagonal rolling

in two directions, the second diagonal rolling crossing the lines of the first. Rolling shall be continued until all roller marks are eliminated and the finished surface meets the requirements hereinafter specified under Surface Requirements. The speed of the roller shall not exceed 3 miles per hour and at all times shall be slow enough to avoid displacement of the hot mixture. Any displacement occurring as a result of the reversing of the direction of the roller, or from any other cause, shall be corrected at once by the use of rakes and of fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened with water by means of saturated mats or by other means approved by the Engineer, but excess water will not be permitted. Care shall be exercised in rolling not to disturb the line and grade of the edges of the bituminous concrete.

Along forms, curbs, headers, and walls and at other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand or mechanical tampers, and smoothing irons. On depressed areas, a trench roller may be employed, or cleated compression strips may be used under the roller, to transmit compression to the depressed area.

The surface of the pavement after compaction shall be smooth and true to the established crown and grade within the tolerances hereinafter specified. Any pavement that becomes loose and broken or mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be immediately compacted to conform to the surrounding area. Any area showing an excess of bituminous material shall be removed and replaced.

Joints. Placing of a pavement course shall be as nearly continuous as possible and the roller shall pass over an unprotected end or side of a freshly laid mixture only when the laying of the course is to be discontinued long eough to permit the mixture to be chilled. In all cases, including the formation of joints as hereinafter specified, provision shall be made for proper bond with the new surface for the full depth of the course. Joints shall be formed by cutting back on the previous run so as to expose a vertical face the full depth of the course. When the laying of the course is resumed, the exposed edge of the point shall be painted with a thin coat of asphalt cement. The fresh mixture shall be raked against the joint, thoroughly tamped with hot tampers, and rolled.

Thickness and Weight. The final compacted thickness shall be not less than the thickness prescribed in the Contract. The weights per square yard for various thicknesses of pavement courses shall be not less than those shown in Table 4 based on the number of square yards laid each day. If the prescribed

thickness, in place, does not provide the prescribed minimum weight, the thickness shall be increased to provide that weight.

Table 4.—Bituminous Concrete, Hot-Mixed, Thickness and Weight

Type of Pavement	Thickness, Inches	Minimum Weight, Lbs. per Sq. Yd.
Bottom Course, all types	1½	155
CA-BC-1, FA-BC-1, MA-BC-1, SM-1	2	220
CA-BC-2, FA-BC-2, MA-BC-2, SM-2, Top Course	1½	165
SA Top Course	1½	150
SP-1	2	210
SP-2, Top Course	1½	157

The minimum weight for thicknesses other than those shown in the table above shall be greater or less than the weights shown based on the same weight-thickness ratio.

Before final acceptance of the Project or during the progress of the work, the thickness of the bottom and top courses, as constructed, will be determined by the Engineer and areas deficient in thickness shall be repaired, replaced or corrected as directed by the Engineer.

Pavement Samples. When and as directed by the Engineer, the Contractor shall cut samples from the completed pavements. The areas of pavements so removed shall be replaced with new mixtures and refinished. No additional compensation will be allowed for furnishing test samples and replacing the areas with new pavement.

Surface Requirements. Before final acceptance, the finished surface of the bituminous concrete shall be tested at right angles to the centerline of the pavement with a crown template if the prescribed cross section have a parabolic or circular crown, or with a 10-foot straightedge if the prescribed cross section have one or more plane surfaces, and shall be tested parallel to the centerline with a 10-foot straightedge. Variations of the finished pavement surface from the required surface shall be not more than 3/16 inch when tested at right angles to the pavement centerline and not

more than ⅛ inch when tested parallel thereto. The templates and straightedges shall have projections on the bottom at each end, either built-in or firmly attached, so that they will be supported 6 inches above the pavement surface at the ends. They shall be free from warp and deflection, shall be subject to approval by the Engineer, and shall be furnished by the Contractor without additional compensation.

The tests for surface smoothness specified above shall be made by the Contractor immediately after initial compression, and variations shall be corrected by removing or adding materials as may be necessary. Then rolling shall be continued as specified. Immediately after final rolling and while the pavement is still hot, the smoothness of the course shall be checked again and all projections or depressions exceeding the specified tolerances shall be corrected by removing defective work and replacing it with new surface course as specified. Portions of the surface otherwise unsatisfactory shall be replaced to the satisfaction of the Engineer.

All testing of the pavement surface shall be performed by the Contractor in the presence, and in a manner subject to the approval, of the Engineer and without additional compensation.

Opening for Traffic. Traffic will not be permitted on newly finished surfaces prior to 12 hours after their completion except by permission or direction of the Engineer in emergencies.

3. 10. 4. Quantity and Payment.

The tonnage of bituminous concrete delivered and used shall be determined whether payment is provided to be made on the ton or square yard basis. In computing the tonnage, proven truck weights shall govern. The net weight of mixture delivered in each truckload shall be determined in the following manner:

Each truckload of bottom and top course material delivered shall be weighed by a certified weighmaster on certified scales approved by the Division of Weights and Measures, Department of Law and Public Safety. The weighmaster shall furnish to the truck driver duplicate weigh slips showing the gross, tare and net weight. To each weigh slip shall be affixed his signature and official seal or approved commissioned stamp attesting that he is a duly constituted weighmaster. One of these delivery slips shall be furnished to the Department's representative on the Project. No material will be accepted unless accompanied by such a delivery slip, which shall be completely legible and clearly indicate the title of the Project for which delivery is intended.

The Engineer shall deduct the weight, or the weight equated to square yards when payment is specified on the square yard basis, of all material lost, wasted, damaged or rejected, or laid in excess of the Engineer's direction or contrary to the Specifications, in determining the quantity for payment.

The quantity of one course and two course Hot-Mixed Bituminous Concrete Surface Course of the various types, and of Sheet Asphalt Surface Course, for which payment will be made will be the weight in tons, or the area in square yards, actually constructed in accordance with the Plans and Specifications or as directed by the Engineer.

If the Contract provides for payment on the ton basis, the payment quantity will be determined and computed from proven truck weights of the material delivered and used as specified above.

If the Contract provides for payment on the square yard basis, the payment quantity will be the area actually constructed without deduction of the areas occupied by manholes and similar structures within the pavement areas.

Payment for Hot-Mixed Bituminous Concrete Surface Courses, Types CA-BC-1, CA-BC-2, MA-BC-1, MA-BC-2, FA-BC-1, FA-BC-2, SM-1, SM-2, SP-1, SP-2 and SA will be made for the quantity as above determined, measured in tons or square yards, at the prices per ton or square yard bid for the items PAVEMENT TYPES CA-BC-1, CA-BC-2, MA-BC-1, MA-BC-2, FA-BC-1, FA-BC-2, SM-1, SM-2, SP-1, SP-2 and SA, respectively, in the Proposal, which prices shall include the cost of the bituminous concrete and sheet asphalt pavement complete, all materials, labor, equipment, and all else necessary therefor and incidental thereto.

Separate payment for furnishing and applying tack coat and prime coat, when required, will be made at the unit prices per gallon bid respectively therefor in the Proposal. The volumes of tack coat and prime coat will be the number of gallons used, measured at 60° F., as determined by the temperature-volume corrections specified in Art. 2. 9. 1, Table 38 for asphalt products, Table 40 for tar products and Table 41 for emulsified asphalt.

SECTION 11

Bituminous Concrete Surface Course, Cold-Mixed

(B. P. R. Class H)

3. 11. 1. Description.

Cold-mixed bituminous concrete surface courses shall consist of the construction of these surface courses on previously constructed base courses. Types A-1, T-1, ASW-1, TSW-1, HA, and HT are bituminous concrete laid in one course. Types A-2, T-2, ASW-2, and TSW-2 are bituminous concrete laid in two courses.

In this Section, all pavement surfaces are designated as bituminous concrete irrespective of type.

3. 11. 2. Materials.

Bituminous Material. The asphalt cement for Type A and Type HA mixtures shall be Penetration Grade 85-100 conforming to the requirements specified therefor in Art. 8. 1. 2. The tar for Type T and Type HT mixtures shall be Grade RT-9 or RT-10 as directed by the Engineer, and shall conform to the requirements specified therefor in Art. 8. 1. 12.

Bituminous material of only one kind and grade and from only one source shall be used for a specific type of mixture in any one contract except that the use of more than one grade for that mixture may be directed by the Engineer when the mixture is used for more than one purpose, or where deemed necessary by the Laboratory for other reasons.

Coarse Aggregate. The coarse aggregate for top course (total retained on No. 10 sieve) shall be broken stone prepared from trap rock, gneiss, granite or dolomite, conforming to the quality requirements specified therefor in Art. 8. 5. 5. Broken stone of only one kind and from only one source shall be used in the top course on any one contract, unless otherwise approved by the Laboratory.

The coarse aggregate for bottom course (total retained on No. 10 sieve) shall be broken stone prepared from trap rock, gneiss, granite, limestone or dolomite, conforming to the quality requirements therefor as specified in Art. 8. 5. 5.

Coarse aggregate for the various types and mixtures of cold-mixed bituminous concrete shall be of the following sizes, subject to approval by the Laboratory, and shall conform to the grading requirements specified therefor in Art. 8. 5. 4, Table 28.

Bottom Course HA or HT	Mixture No. VIII	1″ or ¾″ size
	Mixture No. IX	Combination of of 1″ & ⅜″ sizes
A-1, or A-2 Top	Mixture No. X	⅜″ size
T-1, or T-2 Top	Mixture No. XI	⅜″ size
ASW-1, or ASW-2 Top	Mixture No. XII	¼″ size
TSW-1, or TSW-2 Top	Mixture No. XII	¼″ size

Fine Aggregate. Fine aggregate shall conform to the requirements specified in Art. 8. 5. 12.

Hydrated Lime. Hydrated lime shall conform to the requirements specified in Art. 8. 5. 33.

Liquefier. Liquefier shall conform to the requirements specified therefor in Art. 8. 1. 11.

Aggregate for Top Dressing. The aggregate for top dressing for Type A and Type T mixtures shall be dry stone screenings, and for Type HA and HT shall be dry broken stone

of grits or ¼" size, conforming to the requirements specified in Art. 8. 5. 5.

Tack Coat Materials. Where a tack coat is specified, the materials shall be as specified therefor in Art. 3. 10. 2.

Prime Coat Materials. When a prime coat is specified, the materials shall be as specified therefor in Art. 3. 10. 2.

Table 5.—Bituminous Concrete Mixtures, Cold-mixed

Total Aggregate Passing and Retained on Screen and Sieve Size		Percentage by Weight, Mix No.				
Passing	Retained on	VIII	IX	X	XI	XII
Screen 1½"	Screen 1"	0-35	0-35			
1"	½"	35-70	35-70	0-7	0-7	
½"	¼"	0-20	10-25	30-50	25-50	0-10
¼"	Sieve No. 10	0-15	5-15	20-45	15-45	50-75
Sieve No. 10	No. 30	0-10	3-10	5-20	10-25	5-18
No. 30	No. 80	1-4	2-4	2-8	3-12	2-8
No. 80	No. 200	1-5	1-5	1-6	1-6	2-8
No. 200		0-5	2-6	2-6	2-7	2-7
Total Retained on No. 10 Sieve		70-85	60-80	65-80	55-70	55-70
Liquefier—Type A and HA		0.5-1.0	0.5-1.0	0.5-1.0		0.5-1.0
Hydrated Lime—Type A and HA		0.5-1.0	0.5-1.0	0.5-1.0		0.5-1.0
Bitumen Content—Type A and HA		4-6	4.5-6.5	5.3-7		6.5-8.5
Tar Content—Type T and HT		4.5-6.5	5.0-7.0		6.5-9.5	8-10
To be used for Pavement Courses		All Bottom Courses	HA HT	A-1 A-2 Top	T-1 T-2 Top	ASW-1 TSW-1 ASW-2 Top TSW-2 Top

Note: All screens ¼" and larger are round openings.

Composition of Mixtures. The bituminous concrete for Type A and Type HA mixtures shall be composed of coarse aggregate, fine aggregate, asphalt cement, liquefier and hydrated lime, and for Type T and Type HT mixtures it shall be composed of coarse aggregate, fine aggregate and tar.

The several mineral constituents for each of the mixtures shall be combined in such proportions that the resulting composite blend will meet the grading requirements specified hereinabove in Table 5. In calculating the percentages of aggregates of the various sizes, the bituminous material and hydrated lime are included and liquefier and moisture content are excluded.

Job Mix Formula. The provisions pertaining to Job Mix Formula and its application as specified for hot mixed bituminous concrete in Art. 3. 10. 2 herein shall apply to cold mixed bituminous concrete with the added provision that the tolerance of the tar content of Type T and Type HT mixtures shall be plus or minus 0.3 per cent.

3. 11. 3. Methods of Construction.

Plant and Equipment. The plant and equipment shall conform to requirements specified therefor in Art. 3. 10. 3 except as otherwise hereinafter provided.

A continuous mixing type plant will not be permitted for use in the preparation of Type A and Type HA mixtures.

No mechanical feeder for the dryer and no plant screens will be required if the plant is equipped with a satisfactory method of feeding and delivering the aggregates to the dryer and plant bins in the sizes and condition for proper proportioning to the satisfaction of the Laboratory.

If the dryer is not equipped to heat, dry and cool the aggregate in one operation, the plant shall have sufficient storage bins equipped with cooling devices to condition the aggregates in accordance with the requirements specified.

The plant shall be equipped with an accurate measuring device, approved by the Laboratory, for measuring by volume the quantity of liquefier required for the preparation of Type A and Type HA mixtures.

Construction. Construction shall be as prescribed under that heading in Art. 3. 10. 3 with the following modifications:

Conditioning Existing Surface. Contact surfaces of curbs, gutters, manholes, and other structures shall be painted with a thin uniform coating of asphaltic oil, Grade RC-2 or 3 for Type A and Type HA mixtures, and of tar, Grade RTCB-5 or 6 for Type T and Type HT mixtures. The asphaltic oil and tar shall conform to the requirements specified respectively therefor in Art. 8. 1. 7 and 8. 1. 12.

Preparation of Bituminous Material. Tar for the preparation of Type T and Type HT mixtures shall be brought to a temperature between 150° F. and 250° F. in tanks, at the time of use.

Preparation of Aggregates. Both coarse and fine aggregates shall be dried until there is no surface water visible and not more

than 0.5 per cent of contained moisture. The temperature of the aggregate at the time of mixing with the bitumen shall be not less than 75° F. nor more than 140° F.

The screening of the aggregates into three or more fractions and conveying into separate bins, as specified in Art. 3. 10. 3, will not be required if a satisfactory method is provided for feeding and delivering the aggregates to the dryer and plant bins in the sizes and condition necessary for proper proportioning to the satisfaction of the Laboratory.

The amount of hydrated lime and liquefier required for each batch shall be measured by volume on the basis of the volume-weight relation unless otherwise directed by the Laboratory.

Preparation of Bituminous Concrete Mixtures. Type A and Type HA mixtures shall be prepared by either of the two methods hereinafter described or by other methods subject to approval by the Laboratory.

(a) The coarse and fine aggregates shall be placed in the mixer first and a portion of the required liquefier added thereto such as to wet the aggregates uniformly. Then asphalt cement shall be added slowly to the aggregates and mixing continued until the aggregates are coated thoroughly. Hydrated lime shall be added next in such a manner that it is distributed evenly and not dumped in one end of the mixer. Then the remaining portion of the required liquefier shall be added to attain proper distribution of the asphalt cement and to produce proper workability of the mixture for laying. The mixing for each step of this procedure will vary in relation to the nature of the aggregates, job mix, and size of batch, but in no case shall the mixing time after the introduction of the asphalt cement be less than two minutes.

(b) The mixing shall be done as described above except that the fine aggregate shall be placed in the mixer after the asphalt cement and hydrated lime have been added to the coarse aggregate. In this procedure, the mixing time after the introduction of the fine aggregate shall be not less than two minutes.

Type T and Type HT mixtures shall be prepared by either of the two methods hereinafter described or by other methods subject to approval by the Laboratory.

(c) The coarse and fine aggregates shall be placed in the mixer first. Then the tar shall be added slowly to the aggregate and the mixing continued until all of the particles of the aggregates are coated completely and uniformly with the tar. The mixing time, after the introduction of the tar, shall be not less than one minute.

(d) Mixing shall be done as described above for Type A mixture except that the fine aggregate shall be placed in the mixer after the tar has been added to the coarse aggregate. In this procedure, the mixing time after the introduction of the fine aggregate shall be not less than one minute.

Compaction. Compaction shall be as specified in Art. 3. 10. 3 with the following modifications:

Compaction of both bottom and top courses of Type A and Type HA mixtures shall be attained by rolling only when these mixtures have cured sufficiently for proper stability and when the mixture will not adhere to the roller. The top course shall not be placed on the bottom course for a period of 12 hours after completion of the rolling of the bottom course. The top course shall not be rolled for a period of at least four hours after it has been laid unless otherwise directed by the Engineer.

Immediately after rolling of the top course of all asphalt and tar mixtures has been completed, an application of aggregate for top dressing as specified in Art. 3. 11. 2, shall be applied uniformly to the surface at the rate of 5 to 8 pounds per square yard and then rolled without wetting the wheels of the rollers. All places inaccessible to rollers shall be compacted with tampers.

Thickness and Weight. The provisions governing the thickness and weight of hot-mixed bituminous concrete as specified in Art. 3. 10. 3 shall apply to the thickness and weight of cold-mixed bituminous concrete with the following modifications:

The minimum weight per square yard for various thicknesses shall be as shown in Table 6.

Table 6.—Bituminous Concrete, Cold-Mixed, Thickness and Weight

Type of Pavement	Thickness, Inches	Minimum Weight, Lbs. per Sq. Yd.
Bottom Course, all types	1	103
Bottom Course, all types	1½	155
Bottom Course, all types	2	206
A-1, ASW-1, T-1, TSW-1	1	100
A-1, ASW-1, T-1, TSW-1	1½	150
A-2, ASW-2, T-2, TSW-2, Top Course	¾	75
A-2, ASW-2, T-2, TSW-2, Top Course	1	100
HA, HT	2	225

Types A-2, ASW-2, T-2 and TSW-2 shall be laid in the approximate proportion of two-thirds bottom course and one-third top course.

3. 11. 4. Quantity and Payment.

The quantity of one and two course Cold-Mixed Bituminous Concrete Surface Course of the various types for which payment will be made will be determined as specified for hot mixed bituminous concrete surface course in Art. 3. 10. 4.

Payment for Cold-Mixed Bituminous Concrete Surface Course Types A-1, T-1, A-2, T-2, HA, HT, ASW-1, ASW-2, TSW-1 and TSW-2 will be made for the quantity as above determined, measured in square yards or tons, at the prices per square yard or ton bid for the items PAVEMENT TYPE A-1, T-1, A-2, T-2, HA, HT, ASW-1, ASW-2, TSW-1 and TSW-2, respectively, in the Proposal, which prices shall include the cost of the bituminous concrete pavement complete, all materials, labor, equipment, and all else necessary therefor and incidental thereto.

Payment for Tack Coat and Prime Coat shall be as specified therefor in Art. 3. 10. 4.

SECTION 12

Concrete Surface Pavement

3. 12. 1. Description.

Concrete surface pavement shall consist of the construction of reinforced and nonreinforced portland cement concrete pavements.

3. 12. 2. Materials.

Concrete shall be Class B conforming to the requirements specified therefor in Art. 4. 1. 2. The concrete shall be air-entrained.

Air-entrained concrete shall be produced by the use of the following materials and methods:

1. Air-entraining portland cement.
2. Air-entraining portland cement and, if necessary, air-entraining admixtures incorporated at the site of mixing concrete.
3. Standard portland cement and air-entraining admixtures incorporated at the site of mixing concrete.

The quantity of the air-entraining admixture and the methods governing its use shall be such as to produce in the concrete not less than 3 and not more than 6 per cent of entrained air as determined by the provisions of current A. A. S. H. O. Designation T 152, Air Content of Concrete-Pressure Method. The amount of entrained air shall be within these percentage limits after it is in place in the Project irrespective of the method of obtaining the air entrainment and of the methods and equipment used for mixing the concrete.

Cement shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements specified respectively therefor in Art. 8. 5. 22 and 8. 5. 23.

Air-entraining additives used in the manufacture of air-entraining portland cement shall conform to the requirements of Art. 8. 5. 1.

Air-entraining admixtures incorporated at the site of mixing shall be as specified in Art. 8. 5. 2.

Coarse aggregate shall be broken stone of trap rock, granite or gneiss, conforming to the requirements of Art. 8. 5. 5, or washed gravel conforming to the requirements of Art. 8. 5. 6.

Fine aggregate and water shall conform to the requirements specified respectively therefor in Art. 8. 5. 10 and 8. 5. 38.

Reinforcement steel shall conform to the requirements therefor specified in Art. 8. 4. 18.

Joint Fillers, Preformed. Preformed bituminous cellular type joint filler and preformed bituminous type joint filler shall conform to the requirements specified respectively therefor in Art. 8. 5. 31.

Joint Sealer. Hot-poured rubber-asphalt joint sealer shall conform to the requirements therefor specified in Art. 8. 1. 10.

Curing materials for alternative methods of curing the pavement as hereinafter specified in Art. 3. 12. 3, shall conform to the requirements specified respectively therefor in Art. 8. 5. 29.

3. 12. 3. Methods of Construction.

Handling, Measuring and Batching Materials. Cement and aggregates for concrete shall be proportioned by volume as specified in Art. 4. 1. 2 and shall be measured and batched by weight, as specified in Art. 3. 12. 3.

The equipment for batching of concrete materials shall conform to the following requirements except that, with the Engineer's approval, portable batch weighing equipment of a suitable type and capacity may be used where only small quantities of concrete or mortar can be placed at a time.

The batching equipment shall be substantially constructed on a firm foundation and with sufficient clearance at all points for the weighing hoppers to function properly. All batching plant structures shall be maintained properly level within the accuracy required by the design of the weighing mechanism. A platform with suitable steps for access shall extend around the weighing hopper for easy means of inspection, adjustment and weighing. The scales for weighing aggregates and cement may be of either the horizontal beam or springless dial type designed as an integral unit of the batching plant, and shall be of rugged construction to withstand hard usage due to working conditions. All batching plant scales shall be certified and sealed by a duly constituted Weights and Measures officer prior to the delivery of the material. These scales shall be accurate to within the tolerances permitted by the Department of Law and Public Safety, Division of Weights and Measures. Scales shall be so located that they will be in full view of the operator and inspector at all times and shall be arranged for ready standardization and for checking their accuracy. Ten 50-pound weights shall be available for checking, with a shelf or suitable provision for attaching them to the weighing hopper. When beam scales are used, there shall be separate beams for each size of aggregate and provision, such as a telltale dial, shall be made for indicating to the operator and inspector that the required load in the weighing hopper is being approached. This device shall indicate at least the last 200 pounds of load. A device on weighing beams shall indicate the critical position clearly. Poises shall be designed for locking in any position and to prevent unauthorized removal. The weighing beam and telltale device shall be in full view of the inspector and operator while charging the hopper, and there shall be convenient access to all controls. Clearance between scale parts and hopper and bin structures shall be such as to avoid displacement of, or friction between, parts due to accumulations, vibration, or other cause. Pivot mountings shall be designed so that none of the parts will jar loose and so as to insure unchanging spacing of knife edges under all conditions. Scales shall be constructed of noncorrosive materials and so designed that all exposed fulcrums, clevises and similar working parts may be kept clean readily. Scales shall be maintained in proper operating condition and shall be sealed at the expense of the Contractor when required by the Engineer.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such a manner as to secure a typical grading and a uniformity of moisture content of the material. Stockpiles of aggregates for batching purposes shall be placed on bases of ample size consisting of 2-inch planks or other suitable approved material.

In stockpiling aggregates, the location and preparation of the sites, the minimum size of pile, and the method adopted to prevent coning or other segregation of component sizes shall be subject to the approval of the Engineer. In any case, stockpiles shall be not less than 6 feet in height and built up in layers of not more than 3 feet in thickness. Each layer shall be completely placed before beginning the next, and no layer shall be allowed to come down over the layer below. Aggregates from different sources and of different gradings shall not be stockpiled together. Each separated size of coarse aggregate, if separated sizes are required, shall be stored separately, and durable partitions of sufficient height shall be provided to prevent mixing.

Aggregates that have become mixed with earth or foreign material shall not be used. All washed aggregates shall be stockpiled or binned for draining at least 24 hours before being batched. Aggregates shall be removed from stockpiles in a manner such as to prevent segregation. The fine aggregate and each required separated size of coarse aggregate shall be weighed separately into the hopper in the respective amounts set by the Engineer for the particular proportions desired. The batching plant for aggregates shall include storage bins with adequate separate compartments of not less than 35-ton capacity for the fine aggregate and also for each required separated size of coarse aggregate, with partitions between the compartments extending not less than 3 feet above the top of the bins. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided in each case so that when the quantity desired in the weighing hopper is being approached the material may be added slowly in small quantities and shut off with precision. Means of removing any overload of any one of the several materials in the weighing hopper shall be provided. Weighing hoppers shall be constructed with sufficient clearance and operated so as to eliminate accumulations of tare materials and to fully discharge without affecting the scale balance. The discharge gates shall open parallel to the partitions of the receiving truck. Aggregates which are to be trucked from the batching plant to the mixer shall be transported in batch boxes or other containers of adequate capacity and suitable construction to properly carry the volume required without subsequent manual leveling or adjustment. Partitions separating batches in the truck shall be adequate and effective to prevent spilling from one compartment to another while in transit or while being dumped. Batches shall be delivered to the mixer separate and intact, and batches which have become mixed shall be discarded. Each batch shall be dumped cleanly into the mixer without loss and, where more than one batch is carried on the truck, without spilling the material from one batch compartment to another.

Cement shall be measured by weight. Each bag of cement shall weigh 94 pounds and 94 pounds of bulk cement shall be considered one bag. Batches involving fractional bags will not be allowed except when bulk cement is used. When bulk cement is used, separate scales and hoppers shall be used for the cement, with a device to indicate positively the complete discharge of the batch of cement into the batch box or container. The weighing hopper and scale shall be of adequate size, completely encased, with provisions for locking. The hopper discharge mechanism shall be interlocked (1) against opening until the full batch is in the hopper and the scale balanced; (2) against opening while the hopper is being filled; (3) against closing until the hopper is entirely discharged and the scale back in balance; and (4) against opening if the batch in the hopper is either overweight or underweight by more than 0.5 per cent of the amount specified. The weighing hopper discharge gate shall operate in such a manner as will not affect the scale balance. The discharge chute, boot or other approved device shall be suspended from the encasement and not from the weighing hopper and shall be so constructed that cement will not lodge therein and there will be no loss of cement by air currents or otherwise. There shall be positive assurance of the actual presence in each batch of the entire cement content required. When bulk cement is used, the cement shall be transported to the mixer in waterproof compartments carrying the full amount of cement required for the batch. Cement in original shipping packages may be transported on the top of the aggregates, each batch containing the number of bags required by the job mix. Where bulk cement is to be used, there shall be provided suitable, adequate and separate storage for tested and approved cement, which shall be held in such storage for the particular project or projects for which it was consigned. Different brands of cement, or the same brand of cement from different mills, shall not be mixed during use, nor shall they be used alternately unless approval has been granted by the Engineer.

Mixing. Three methods of mixing as hereinafter described are permissible, i.e., (1) mixing on the Project in batch (paving) mixers, (2) mixing on the Project in transit mixers and (3) mixing at a central mixing plant, except that, with the Engineer's approval, mixers of a suitable type and capable of properly mixing not less than a one-bag batch of the class of concrete or mortar required, may be used where only small quantities of concrete or mortar can be placed at a time.

1. *Mixing on the Project in Batch (Paving) Mixers.* Concrete shall be mixed in a batch mixer of approved type and capacity so designed as to insure uniform distribution of the materials throughout the mass. The mixer shall be operated at a drum speed of not less than 14 and not more than 20 revolutions per minute.

After all materials have been deposited in the drum, they shall be mixed for a period of not less than 1½ minutes. The volume of concrete mixed per batch shall not exceed by more than 10 per cent the mixer's capacity in cubic feet as shown on the standard rating plate on the mixer.

The mixer shall be equipped with an approved timing device which will automatically lock the discharge lever when the drum has been charged and release it at the end of the mixing period. This device shall be equipped with a bell, adjusted to ring each time the lock is released. Failure of the timing device shall be cause for the discontinuance of the use of the mixer until the device is repaired or a new timer substituted. Each mixer shall be equipped with an approved discharge device, and the entire contents of the drum shall be discharged before being charged with any portion of the succeeding batch.

All batch mixers shall be equipped with an adequate water reservoir provided with an automatic device for accurately measuring and discharging the required volume of water, which can be adjusted easily to discharge a larger or smaller volume and to register the volume discharged accurately on a gauge or dial. The gauge or dial shall be calibrated before the mixer is used, and shall be kept properly calibrated. A bypass valve shall permit the discharge of the entire required volume of water into a measuring can for calibration purposes.

The loading skip of the mixer shall be substantially made and shaped so that wet sand and other materials will not remain in it when it is being discharged, and the skip and the throat of the drum shall be kept free from accumulations. The mixer shall not be used when any of the devices above stated are not functioning properly, or when the blades of the mixer have worn down to 90 per cent of their original width. Mixers shall be equipped with a boom and bucket, fully power-controlled and so operated that the concrete batches will be distributed over the subgrade without segregation.

Tandem mixers and dual drum mixers will be permitted providing such mixers conform to the pertinent requirements of the foregoing specifications, and provided the mixer units are designed and built for synchronized operation and have separate timing devices. Concrete shall be transferred from the drum of the first mixer to the drum of the second mixer in a continuous process and in such a manner that there will be no loss whatever of any of the mixture. The entire contents of each drum shall be discharged before a new batch is placed therein. The mixing time hereinabove specified shall be exclusive of the time of transfer of materials between mixing drums or compartments.

2. *Mixing on the Project in Transit Mixers.* Transit-mix concrete shall be materials proportioned at a central batching plant

and hydrated and mixed at the site of the work in truck mixers.

The concrete shall be mixed in an approved type, watertight, revolving drum truck mixer so constructed as to produce concrete with a uniform distribution of the materials throughout the mass and shall be equipped with a discharge mechanism which will insure the discharging of the mixed concrete with a satisfactory degree of uniformity.

Each truck mixer shall have permanently attached thereto, in a prominent place, a metal plate on which is stated the manufacturer's capacity in terms of gross volume of the mixing drum, the volume of mixed concrete based on the use of the truck as a mixer, and the manufacturer's stated speed of rotation for both mixing and agitation. The volume of concrete mixed per batch shall not exceed the number of cubic yards which the manufacturer has stated to be the mixing capacity of the truck, nor shall it be greater than 57.5 per cent of the gross volume of the drum. Drums and auxiliary parts of the mixer shall be kept free from accumulation of materials.

Each truck mixer shall be equipped with a counter permitting reading of the revolution count at the start and termination of the mixing, and with an automatic device which shall be readily adjustable for the measuring and control of the water. Measuring tanks shall be equipped with outside taps and bypass valves to provide for checking their calibration.

The water shall be added to the mix immediately previous to the start of the mixing operation and the mixing shall be continuous from the time of admitting water into the drum until the concrete is discharged. After all ingredients are in the drum, each batch shall be mixed not less than 70 nor more than 100 revolutions and at the rate of rotation designated by the manufacturer of the equipment as mixing speed. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. The volume of water, the time of mixing within the revolution limits specified above, and the control of the mixture shall be subject to regulation by the Engineer. Mixers shall be thoroughly cleansed and drained after each batch is discharged. The mixer shall not be used when any of the devices specified above are not functioning properly or when the blades of the mixer have worn down to 90 per cent of their original width.

Handling, measuring and batching materials shall conform to the requirements therefor hereinabove specified under that heading and shall be subject to inspection by and approval of the Engineer at all times while transit-mix concrete is being furnished. The concrete will be rejected if there be any evidence of setting up, improper batching and mixing, excessive segregation, use of excessive mixing water, or if the amount of entrained air be other than that specified.

The concrete shall be discharged from the truck mixer within 60 minutes after the cement has been loaded into the drum except that, under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85 degrees Fahrenheit or above, such time shall be not more than 45 minutes.

Each truck load of transit-mix concrete shall be accompanied by a delivery ticket which shall show the name of the project, the name of the contractor, the quantity of each ingredient, the brand name and type of cement, the source of the aggregates, the size or sizes of the coarse aggregate, and the time when the cement was loaded into the drum. The delivery tickets shall be signed by a responsible officer or employee of the concrete supplier. One copy of each delivery ticket shall be furnished to the Engineer.

When transit-mix concrete is used in concrete pavement construction, the concrete shall be deposited on the subgrade by means of crane and bottom dump bucket or shall be spread by an approved concrete spreader. The delivery of transit-mix concrete shall be of such regularity as to assure continuous placing of concrete from beginning to end of each slab.

3. *Mixing at a Central Mixing Plant.* Central-mix concrete shall be materials proportioned and mixed at a central plant and transported to the point of use in an agitator truck of approved design.

Central mixing plant mixers shall be of approved type and capacity, capable of combining the cement, aggregates, and water into a thoroughly mixed and uniform mass within the specified mixing time and of discharging the mixture with a satisfactory degree of uniformity.

Stationary mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. The device for the measurement of the water, either by volume or weight, shall be readily adjustable and under all operating conditions shall be accurate within a tolerance of not more than 0.5 per cent of its maximum capacity. The mixing time for mixers having capacities of 1 cubic yard or less shall be not less than 1 minute. For mixers of larger capacities, this minimum shall be increased 15 seconds for each cubic yard or fraction thereof of additional capacity. Mixing time shall be measured from the time all cement and aggregates are in the drum. The batch shall be so charged into the mixer that sufficient water will enter in advance of cement and aggregates to prevent caking, and all water shall be in the drum by the end of the first quarter of the specified mixing time.

Agitator trucks for the delivery of central-mix concrete shall be of a type approved by the Engineer, and shall have a revolving, watertight drum capable of transporting and discharging the mixed concrete with a satisfactory degree of uniformity. The speed of

the drum shall be that stated by the manufacturer to be the agitating speed. Each agitator truck shall have attached thereto, in a prominent place, a metal plate on which is stated the gross volume of the drum, the manufacturer's rating in terms of mixed concrete for agitation, and the speed of rotation for agitation. The volume of mixed concrete in the drum shall not exceed the manufacturer's rating nor shall it exceed 80 per cent of the gross drum volume.

Handling, measuring and batching materials shall conform to the requirements therefor hereinabove specified under that heading and be subject to inspection by and approval of the Engineer at all times while central-mix concrete is being furnished. The consistency and air content of the concrete at the central plant and when placed in the work shall be subject to the approval of the Engineer. The concrete will be rejected if there be any evidence of setting up, improper batching and mixing, use of excessive mixing water, excessive segregation, or if the amount of entrained air is other than that specified.

The concrete shall be completely discharged within 60 minutes after the agitator truck is fully loaded with completely mixed concrete except that, under conditions contributing to quick stiffening of the concrete or when the temperature of the concrete is 85 degrees Fahrenheit or above, such time shall be not more than 45 minutes. During these intervals, the concrete shall be agitated continuously.

Each truck load of central-mix concrete shall be accompanied by a delivery slip which shall show the name of the project, the name of the contractor, the quantity of each ingredient, the brand name and type of cement, the source of the aggregates, the size or sizes of the coarse aggregate and the time when the completely mixed concrete was loaded into the truck drum. The delivery slips shall be signed by a responsible officer or employee of the concrete supplier and 1 copy shall be delivered to the Engineer.

The Contractor shall provide the Engineer with two-way telephone or radiotelephone communication between the site of paving and the central mixing plant, without additional compensation.

When central-mixed concrete is used in concrete pavement construction, the concrete shall be deposited on the subgrade by means of crane and bottom dump bucket or shall be spread by an approved concrete spreader. The delivery of the concrete shall be of such regularity as to assure continuous placing of concrete from beginning to end of each slab.

Consistency. The required consistency of the concrete mixture will be established by the Laboratory. The mixture shall be cohesive and plastic, permitting proper handling and finish. When deposited it shall not flow, but shall remain in a conical pile. The slump of the concrete when placed in the pavement shall be not more than 2½ inches as tested by current A. A. S. H. O.

Designation T119. There shall be a minimum of segregation and surplus water during the process of handling and finishing. The total water content shall be not more than 5¼ and 5 gallons per bag of cement, when the coarse aggregate is broken stone and gravel, respectively.

Side Forms. Side forms shall be of steel not less than 3/16 inch thick, not less than 2 inches wide at the top, and not less than 8 inches wide at the base when the pavement is not more than 9 inches thick. Otherwise, the width shall be not less than 9 inches. The forms shall be properly stiffened to avoid deformation. The forms shall have anchoring pins of sufficient length and diameter to hold them securely in place. The devices through which the pins extend shall have a height of not less than one-half of that of the forms, and shall be arranged so that the forms can be held firmly in place, but they shall not interfere with the free movement of the finishing apparatus. The ends of the form sections shall be connected in such a manner that the deflection under load at the joints will be no greater than elsewhere and that the alignment can be maintained. The forms shall be straight, free from warp, clean and oiled. Forms for not less than 2 day's work shall be provided. Forms shall be subject to the approval of the Engineer and if unsatisfactory shall be removed from the Project and replaced with acceptable forms.

The side forms shall be placed to true line and grade and in such a manner that the completed pavement will have the required thickness. The forms shall be held firmly in place and shall have no vertical or horizontal movement when subjected to the load of the finishing machine, or from any other causes. Subsequent to the first passage of the finishing machine over the forms and prior to the last passage the forms shall be checked for line and grade, and such adjustments shall be made as are necessary in order that the forms will conform thereto. The side forms shall not be removed until the concrete within them has been in place for a period of at least 12 hours.

Placing Concrete and Reinforcement. In advance of concreting operations the subgrade shall have been prepared as specified in Art. 2. 10. 3, shall not be muddy or frozen, shall be free from dust and dry earth and, except as hereinafter provided, if dry it shall be sprinkled by means of a spray nozzle sufficiently in advance of placing the concrete so that the subgrade is uniformly dampened to a depth of not less than one-half inch without forming wet spots. Before May 15th and after October 1st, the subgrade shall not be sprinkled unless it is dry for more than one-half inch below the surface and its character is such that it should be dampened, in the opinion of the Engineer, and only sufficient water shall then be applied to dampen the surface.

CONCRETE SURFACE PAVEMENT

The placing of the concrete between two transverse joints shall be carried out as a continuous operation. If due to a breakdown in the plant or other emergency it be impossible to carry out this requirement, an intermediate transverse joint shall be constructed and so located that the short slab will have a minimum length of 15 feet or of one normal reinforcement mat, whichever is the lesser. The mixing and placing of the concrete shall progress only at such a rate as to permit proper finishing, protecting and curing of the pavement. A layer of concrete mixture shall be placed first and then spread and struck off with a mechanical spreader equipped with a screed board so that the entire area between side forms, and for a distance sufficient for placing a reinforcement mat, is covered to such a depth that the surface of the layer will be at the proper elevation to receive the reinforcement steel. Then the reinforcement steel shall be placed so that it overlaps adjacent reinforcement not less than 40 times the diameter of reinforcement member lapped. Hand tampers shall be used to secure the steel in place at its proper elevation. Then the next layer of the concrete mixture shall be placed and spread immediately in such a manner that any segregation will be corrected and so that the surface will be at the proper grade when the consolidation and finishing are completed. Concrete of the lower layer which has developed initial set or has been in place more than 15 minutes before being covered with the next layer shall be removed and replaced.

When pavement is constructed without reinforcement, the foregoing requirements for placing the concrete shall apply except that the concrete shall be placed in one layer.

After the concrete is placed the portions thereof within one foot of transverse, longitudinal and other joints and within one foot of all side forms shall be compacted with suitable tools and by virbrating unless otherwise approved by the Engineer. The method of vibrating and number of vibrating units shall be such as to assure of the proper density of the concrete adjacent to the ends and sides of the slab and within the areas of the transverse joint structures and shall be subject to the approval of the Engineer. The vibrating implement shall be subject to the approval of the Engineer and shall have a vibrating frequency of not less than 5000 impulses per minute.

Machine Finishing. Machine finishing shall be used unless conditions are such that, in the opinion of the Engineer, machines cannot be practicably operated. The finishing machines shall be power-driven, substantially constructed and subject to the approval of the Engineer. They shall be equipped with adjustable strike-off screeds and planers, the bottom surface of which shall have the contour of the finished surface. Separate machines shall be provided with transverse and with longitudinal screeds. All machines with transverse screeds shall have a scraping device that will keep the side forms clean.

After being placed and spread as above described, the concrete shall be struck off immediately with a transverse finishing machine above the required grade so that there will be sufficient concrete to fill low and porous places. A uniform amount of concrete shall be maintained in front of the mechanical spreader and transverse screeds across the entire strip or lane being paved. The operation shall be repeated as may be necessary to produce uniformly consolidated, dense concrete with the surface at the required grade and contour. After slumping and disappearance of excess water from the surface, the concrete shall again be planed so that the surface will be at the required grade over its entire area. Where there is insufficient mortar on the surface, the concrete shall be worked with a lute or long-handled float until sufficient mortar is present to allow operation of the finishing screed without tearing the surface of the concrete.

The surface then shall be finished with a longitudinal finishing machine to remove waves and other surface irregularities. Each successive pass of the longitudinal screed across the pavement shall overlap the preceding pass approximately one-half the length of the screed. The screedings shall be performed carefully and skillfully and ridges in the surface at the ends of the screed shall be eliminated.

Following the longitudinal machine finish all remaining waves and other surface irregularities shall be eliminated by scraping straight edges, or lutes, which shall be operated lightly over the surface by workmen who are skilled in their use. Two types of lutes shall be used, one made of wood conforming to the design shown on the detail plan, and the other a metal lute commercially available and of a type to be approved by the Engineer. The lutes shall be operated in the following manner:

Immediately after the final passage of the finishing machine, the wooden lute shall be placed on the form or edge of completed pavement nearest the operator. The handle shall be lowered to knee height and pushed lightly across the pavement surface. When it reaches the opposite form or completed pavement edge, the handle shall be raised to shoulder height and the lute drawn back lightly across the pavement. Both passes shall be made over the same surface area. Additional passes shall be made if all irregularities be not removed by these two passes. The operation shall progress longitudinally by lifting the lute from the pavement surface, moving it ahead one-half its length and continuing the same procedure. After the use of the wooden lute, the same procedure shall be repeated lightly with a metal lute to remove any slight irregularities which may remain in the pavement surface. The metal lute shall be operated approximately 25 feet behind the wooden lute or at such other distance therefrom as may be directed or approved by the Engineer. Lutes shall be checked on a master

straightedge twice a day, once in the morning before use and again at noon. Any variation from a true plane must be corrected before further use.

After final operation of the lutes, the pavement surface shall be checked with a straightedge not less than 10 feet long. The Contractor shall furnish the straightedge and shall perform the work of checking in the presence of, and as directed by, the Engineer. Irregularities found, measuring more than ⅛ inch vertically, shall be corrected as the Engineer may direct or approve and the entire pavement surface shall be made smooth and even. Straightedges shall be checked each day before they are used and shall be maintained straight.

The final pavement finish shall be performed with a burlap drag. Then the transverse and longitudinal joints shall be rounded neatly to a radius of ¼ inch. When necessary, the joint rounding shall be performed from a bridge not in contact with the pavement surface.

The entire pavement surface completed each day shall be checked again with a straightedge on the following day, as specified above, and if surface irregularities are found in excess of the specified tolerances, they shall be corrected as directed or approved by the Engineer.

Hand Finishing. When hand finishing is used, the major part of the concrete above the required grade shall be removed by a hand-operated screed, moved forward with a combined longitudinal and transverse motion and so manipulated that it remains on the side forms. A slight excess of material shall be kept in front of the cutting edge. The concrete shall be worked so as to embed coarse aggregate and remove porous spots, but not to force excess mortar or water to the surface. Low spots shall be filled and the material worked into place. The finished worked surface shall be only slightly above the required grade and shall be uniform in appearance, density and composition. The concrete shall be brought to the required grade and density and all surplus material removed by a heavy planer. The planer shall be operated with a combined longitudinal and transverse motion advancing each stroke one-half the width of the planer, which shall be held firmly on the forms and operated at a slow, even speed. Not less than one-half inch of concrete shall be kept above the cutting edge of the planer and projections and depressions shall immediately be removed. Excess material in front of the planer shall be removed in such a manner that depressions will not be formed thereby. The planing shall be continued until the required surface is attained. The final operation of the planer shall be made after the concrete has taken its final slump.

After the final operation of the planer, the surface shall be screeded longitudinally with a wooden handscreed approved by the

Engineer. It shall be worked back and forth across the pavement, with an overlap of not less than one-half the length of the screed when lifted to successive positions, so as to remove remaining waves and other surface irregularities. The longitudinal screeding shall be carefully and skillfully performed so as to minimize the formation of transverse ridges.

Immediately and progressively following the longitudinal screeding, further finishing with scraping straightedges, or lutes, final finishing with a burlap drag, rounding of joint edges, checking of the pavement surface with a straightedge, and correction of excessive surface irregularities, shall be performed as hereinabove specified for Machine Finishing.

Marking. The pavement slabs shall be numbered consecutively as the work progresses and the last slab placed each day shall be dated the day laid. The marking shall be made on a corner of the slab at the end last completed. The figures shall be of uniform type, 1½ inches high, and plainly and neatly stamped after the final finish of the surface. When two or more mixers are working, a distinguishing letter for each mixer shall be stamped adjacent to the number.

Protection. For both machine and hand finishing, if surface checking or cracking develop, the surface shall be covered with wet burlap during the finishing operations and shall be kept so covered and wet until the curing material is to be applied. Any cracking of the pavement or any considerable surface checking shall be cause for the rejection of the work.

The pavement, including its edges, shall be protected from damage due to traffic, the Contractor's own operations or any other cause, by barricades, flares or other approved lights, and other suitable means until opened for traffic. Pavement damaged shall be replaced or repaired in a manner satisfactory to the Engineer at the Contractor's expense.

Transverse Expansion Joints. Transverse expansion joints shall be installed at the locations and spacings prescribed in the Plans or Supplementary Specifications. If the location or spacing be not so prescribed at intersections and other special locations, the joints shall be installed where directed by the Engineer.

Expansion Joint, Type A, as shown on the detail plans, or an approved alternative design, shall be installed at all transverse joints except where Type B joints or other types are shown on the Plans or ordered by the Engineer.

Expansion Joint, Type B, as shown on the detail plans, or an approved alternative design, shall be installed at the locations shown on the Plans or ordered by the Engineer.

The requirements for alternative joint devices for expansion joints Type A and Type B shall be prescribed on the Plans.

At least two weeks prior to concrete paving, the Contractor shall submit for the approval of the Engineer a representative assembled joint of each type required on the Project. The representative joint, or joints, shall be complete with all appurtenances, and installation tools and equipment. When so directed by the Engineer, the Contractor shall maintain the approved representative joint, or joints, on the Project. All joints furnished for use on the Project shall be at least equivalent to the approved joint or joints. A sample of the dowel-coating material shall also be submitted for the Engineer's approval.

If more than 5 per cent of the joints, or any parts thereof, do not conform to the requirements of the Plans and Specifications, or are not equivalent to the approved representative joint, the entire shipment of joints will be rejected, and the Contractor shall furnish joints that conform to the requirements therefor.

The Contractor shall provide and use an accurately constructed template approved by the Engineer to check the elevation of the finished subgrade. The template shall bear on the forms or adjacent pavement surface. After checking with the template, low spots shall be filled and high spots scraped to the proper grade and the surface recompacted. Immediately prior to placing the joint on the subgrade, the subgrade at the joint shall have been finished to its required surface and shall have received its final compaction.

Unless otherwise shown on the Plans, the joint openings in all transverse expansion joints shall be filled with preformed bituminous cellular type joint filler and sealed with hot-poured rubber-asphalt joint sealer. After the concreting operations are completed, the joint filler shall be straight and plumb.

Transverse Contraction Joints. Transverse contraction joints shall be constructed if, and at the locations and spacings, shown on the Plans or prescribed in the Supplementary Specifications.

Longitudinal Joints. Longitudinal joints between adjoining strips or lanes of new pavement shall be of the keyway type shown on the Plans. The keyway type longitudinal joint also shall be constructed between strips of existing pavement and pavement widening where the side of the existing pavement is recessed; but where there is no such recess the longitudinal joint shall be constructed with vertical plane faces and filled with ¼ inch preformed bituminous joint filler. Longitudinal expansion joints with ½ inch preformed bituminous type joint filler shall be provided between the pavement and manholes, inlets and other structures adjacent to or projecting through the pavement. The side of the pavement abutting shoulders and curbs shall be constructed with a recessed face as in the keyway type joint. The joint between the pavement

and curbs shall be filled with ½ inch preformed bituminous cellular type joint filler.

Curing. The concrete pavement shall be cured by one of the following alternative methods:

1. White-pigmented liquid compound maintained and protected from damage for a period of not less than 72 hours.
2. Waterproof paper maintained in place for not less than 72 hours.
3. White polyethylene sheeting maintained in place for not less than 72 hours.
4. Cotton mats, burlap, hay or straw maintained wet and in place for not less than 72 hours.
5. Any of the coverings specified in 2, 3 and 4 above maintained in place until at least the day following pavement construction. If these coverings be removed before 72 hours, the pavement shall be sprayed with clear or translucent, or with white-pigmented, liquid compound as and at the rate hereinafter specified, immediately after removal of the coverings. The spray coating shall be maintained and protected from damage for the balance of the 72 hour period.

Equipment and methods of application to be used for the various curing methods shall be as hereinafter specified.

White-Pigmented Liquid Compound. Application of the curing material shall be made immediately following final finishing, before any marked dehydration of the concrete or surface checking occurs. The compound shall be applied in one or two applications as directed by the Engineer. When the compound is applied in two applications, the second shall follow the first within 30 minutes.

The compound shall be applied in a continuous uniform film by means of power-operated pressure spraying or distributing equipment at the rate directed by the Engineer but not less than one gallon per 200 square feet of surface. The equipment for applying the compound shall provide for adequate agitation of the compound during application and must be approved by the Engineer before work is started. If the compound be too thick for satisfactory application during cold weather the material may be warmed in a water bath at a temperature not over 100° F. Thinning with solvents will not be permitted. Should the method of applying the compound produce a nonuniform film, its use shall be discontinued and the curing shall be done by another method, approved by the Engineer, that will conform to the requirements specified above.

If rain fall on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film be damaged in any other way, the Contractor shall apply a new coat of material

to the affected areas equal in curing value to that specified for the original coat. The treated surface shall be protected from injury for a period of at least 3 days. All vehicular and pedestrian traffic is considered injurious to the film of the applied compound and is prohibited except that a minimum of walking will be permitted on the dried film as necessary to carry on the work properly, provided any damage to the film is immediately repaired by the application of a second coat of the compound. If hair-checking develop during finishing operations before the curing membrane can be applied, of if there be a breakdown of the spraying equipment, protection of the pavement with wet burlap shall be provided as hereinabove specified under the heading Protection.

Waterproof Paper. Waterproof paper blankets shall be not less than 20 nor more than 75 feet in length and shall be of a width that, when in place, will provide a complete cover for the surface of the pavement. Unless the paper has been pretreated to resist such action, an 8-inch pleat to allow for shrinkage of the paper shall be formed and placed near one edge of the pavement. All joints in the blankets shall be securely cemented together in such a manner as to provide seams with a minimum lap of 4 inches, producing and maintaining a waterproof joint.

The blankets shall be placed as soon as possible after the final finishing operation without marring or otherwise damaging the surface of the concrete. The blankets shall be securely weighted down by placing a ridge of earth, or light planks, on the edges of the blankets just inside the forms or by other means approved by the Engineer, such that depressions will not be formed in the pavement surface. When placed, the adjoining blankets shall overlap not less than 12 inches. This lap shall also be securely weighted down to form a closed joint. If hair-checking develop before the paper can be placed, the pavement shall be covered initially with wet burlap as hereinabove specified under the heading Protection.

Before moving the blankets ahead to successive positions, they shall be inspected and all holes and tears shall be repaired with cemented patches. When the blankets are no longer serviceable as a single unit, the Contractor may select from the rejected blankets those which, in the opinion of the Engineer, will serve for further applications, provided that 2 blankets are used as a single unit. However, the double blanket may be rejected when, in the opinion of the Engineer, it no longer provides an airtight cover.

White Polyethylene Sheeting. The polyethylene sheets shall be not less than 100 and not more than 300 feet in length and of such width that, when in place, will provide a complete cover for the surface of the pavement. The sheeting shall be placed as soon as possible after the final finishing operation without marring or otherwise damaging the surface of the concrete. Adjoining sheets shall overlap not less than 12 inches. The edges of the blankets

and joint laps shall be weighted down with a ridge of earth, light planks or by other means satisfactory to the Engineer, that will not form depressions in the pavement surface. If hair-checking develop before the sheeting can be placed, the pavement surface shall be covered initially with wet burlap as hereinabove specified under the heading Protection.

Before moving the sheets ahead to successive positions, they shall be inspected and all holes and tears shall be repaired by cemented patches. When sheets are no longer serviceable as a single unit, the Contractor may select from such sheets and reuse those which, in the opinion of the Engineer, will serve for further applications provided 2 sheets are used as a single unit. However, the double sheet units may be rejected when the Engineer deems that they no longer provide an airtight cover.

Cotton Mats. Cotton mats shall be placed on the pavement as soon as possible after the final finish without marring the concrete. They shall be placed across the pavement, adjoining mats overlapping not less than 2 inches. The mats shall be held in place firmly by weights or by other approved means that will prevent their displacement and will not form depressions in the pavement surface. The mats shall be wet when placed and shall be maintained wet in place for the time specified in Method 4 or Method 5, whichever one of these methods be used. If hair-checking develop before the cotton mats can be placed, the pavement shall be covered initially with wet burlap as hereinabove specified under the heading Protection.

If a pipe line be used to furnish water for sprinkling, it shall have tees and stop cocks not more than 200 feet apart. If this pipe line be used for supplying water for the concrete mixer and other operations, it shall be of sufficient size, and operated under sufficient pressure, to serve all such operations and to permit proper sprinkling of the curing material, and shall not be removed from the site of sprinkling until the curing period is over.

Burlap. The pavement shall be covered with strips of wet burlap which, after shrinkage, shall be not less than 2½ feet longer than the width of the pavement slab. Approximately 2 feet shall be allowed for shrinkage of new burlap. The strips shall be laid across the slab and shall overlap not less than one-half the width of the strip to provide a double thickness of burlap. The burlap shall be laid immediately after the final finishing of the pavement and shall be maintained wet and in place for the time specified hereinabove under Method 4 or Method 5 whichever of these methods be used.

If a pipe line be used for supplying the sprinkling water, the provisions relating thereto as specified hereinabove for curing with cotton mats shall apply.

Hay or Straw. The entire surface of the pavement shall be covered with a layer of hay or straw of not less than 6 inches uniform thickness which shall be placed directly upon the pavement, and thoroughly wet by sprinkling, as soon as possible after its final finishing without marring or otherwise damaging the surface of the concrete. The hay or straw shall be free from decayed matter and free from foreign matter, soluble in water. It shall be maintained wet and in place for the time specified hereinabove for Method 4 or Method 5 whichever of these methods be used.

If a pipe line be used for supplying the sprinkling water, the provisions relating thereto as specified hereinabove for curing with cotton mats shall apply.

Clear or Translucent Liquid Compound. When this compound is used as permitted in Method 5, the equipment, method and rate of application and other provisions specified hereinabove for curing with white-pigmented liquid compound shall apply except the requirement that the compound be applied immediately after pavement finishing.

General. After the removal of forms, the sides of the pavement slab shall be cured by one of the methods specified above.

For all methods of curing hereinabove specified, suitable signs, warning workmen and the general public, shall be erected and maintained during the entire curing period at each end of the section that is being cured and at intervals of approximately 500 feet along such section. In residential and business areas the signs shall be erected at intervals of 100 feet. Wood bridging for pedestrian crossovers shall be placed at street intersections and at other established pedestrian crosswalks. The words KEEP OFF shall appear conspicuously on each warning sign and shall be stenciled on each waterproof paper blanket and each sheet of polyethylene sheeting.

Concreting in Cold Weather. In cold weather the temperature of the concrete mixture when discharged from the mixer shall be not less than 50 deg. F., and the concrete when placed shall be protected from freezing by covering it with a layer of hay or straw not less than 8 inches thick, over which canvas shall be spread. The canvas shall be not less than 4 feet longer than the width of the pavement and shall be laid across it with edges overlapping and ends firmly fastened. In severe weather another layer of hay or straw shall be placed above the canvas. Concrete which has frozen before it is 5 days old shall be replaced at the Contractor's expense.

Concrete shall not be mixed and placed when the atmospheric temperature is at or below 36 deg. F., except with the written approval of the Engineer. If such approval be given, the Engineer may prescribe the manner in which the work shall be done, which

may include the heating of the aggregates and water and the use of accelerators or nonfreezing compounds. The water shall not be heated above 165 degrees Fahrenheit. Such approval, however, shall not relieve the Contractor from his obligation to produce a pavement in strict conformity with the requirements of the Contract.

All additional work in connection with concreting in cold weather, as specified hereinabove, shall be performed by the Contractor without specific or additional payment therefor.

Strength and Thickness. The thickness of the pavement and the compressive strength of the concrete will be determined on cores cut from the finished pavement at locations as directed by the Engineer. The cores shall be approximately 6 inches in diameter and of the full depth of the pavement. They shall be tested for strength, when not less than 28 days old, in accordance with current A. A. S. H. O. T-24.

Bridge Approach and Transition Slabs. Bridge approach slabs and the transition slabs adjacent thereto shall be constructed in all respects in conformity with the requirements specified above, except that side forms shall be of a design acceptable to the Engineer, and that the reinforcement steel for the bridge approach slabs shall conform to the requirements specified in Art. 4. 1. 2 and 8. 4. 19.

Defective Work. The Engineer may from time to time make an examination of the pavement laid and as a part of such examination he may cut cores or otherwise remove sections therefrom. If such examination disclose the pavement to be of less than the required thickness, to contain cracks or other defects caused by the Contractor's negligence, poor workmanship or failure to meet the requirements of the Plans and Specifications, the Engineer may require the Contractor to remove such defective work and replace it with pavement meeting the requirements of the Plans and Specifications, without cost to the State.

Opening to Traffic. The pavement shall not be opened to traffic or construction equipment until the number of days after finishing shown below shall have lapsed, provided however, that no pavement shall be opened for traffic before joints have been filled and sealed, all concrete spilled on the surface has been removed, and all curing and other extraneous materials have been removed.

May 16 – Oct. 15	Standard concrete	9 days
Oct. 16 – May 15	Standard concrete	12 days
May 16 – Oct. 15	High early strength concrete	4 days
Oct. 16 – May 15	High early strength concrete	5 days

Opening to traffic as provided above shall in no manner relieve the Contractor from his responsibility for the work in accordance with Art. 1. 6. 6.

3. 12. 4. Quantity and Payment.

The quantity of Concrete Surface Pavement for which payment will be made will be the area paved within the limits shown on the Plans or as directed by the Engineer without deduction of the areas occupied by transverse joints, interior longitudinal joints between pavement slabs, or by manholes, catch basins and similar structures within the pavement area.

The quantity of Transverse Expansion Joints, Type A and Type B, for which payment will be made will be the actual length, in linear feet, of each type constructed in accordance with the Plans or as directed by the Engineer.

The quantity of Bridge Approach Slabs and Bridge Approach Transition Slabs for which payment will be made will be the areas of each actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Concrete Surface Pavement will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item CONCRETE SURFACE PAVEMENT in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the pavement; the construction of all longitudinal joints between the outer edges of the pavement; the construction of transverse contraction joints and any dowels and supporting and holding devices necessary therefor; all work and materials for constructing necessary transverse junctures with existing pavements; furnishing reinforcement steel and all other materials, all equipment and labor, and all else necessary therefor and incidental thereto except transverse expansion joints for which payment will be made as hereinafter specified.

Where concrete pavement is constructed monolithic with concrete curb, the full depth of the concrete within the curb area shall be included in the unit price bid in the Proposal for the appropriate curb item.

Payment for Transverse Expansion Joints, Type A and Type B, will be made for the quantity of each as above determined, at the unit prices per linear foot bid for the items TRANSVERSE EXPANSION JOINTS, TYPE A, and TRANSVERSE EXPANSION JOINTS, TYPE B, respectively, in the Proposal, which prices shall include installation of the joints complete and the furnishing of all labor, materials, equipment and tools, and all else necessary therefor and incidental thereto.

Payment for Bridge Approach Slabs will be made for the quantity as above determined, measured in square yards, at the unit price per square yard bid for the item BRIDGE APPROACH SLABS in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the slabs; longitudinal joints between the outer edges of the pavement; the transverse joints between the bridges and approach slabs; reinforcement and

all other materials; all equipment and labor, and all else necessary therefor and incidental thereto.

Payment for Bridge Approach Transition Slabs will be made for the quantity as above determined, measured in square yards, at the unit price per square yard bid for the item BRIDGE APPROACH TRANSITION SLABS in the Proposal, which price shall include the cost of constructing, finishing, curing and protecting the slabs; longitudinal joints between the outer edges of pavement; transverse contraction joints; furnishing reinforcement steel and all other materials; all equipment and labor, and all else necessary therefor and incidental thereto.

Payment for Subgrade will be made as provided in Art. 2. 10. 4.

SECTION 13

Granite Block Pavement Surface

3. 13. 1. Description.

Granite block pavement surface shall cover the construction of pavement surface of granite blocks set in a mortar cushion course on a previously prepared base course.

3. 13. 2. Materials.

Paving blocks shall be of granite and shall conform to the requirements specified in Art. 8. 5. 17 and to the A. S. T. M. requirements for Heavy Traffic type block. The blocks for the Project shall be from one quarry only and of the same quality.

Cement for mortar cushion and grout joint filler shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements of Art. 8. 5. 22 and 8. 5. 23, respectively.

Fine aggregate for mortar cushion, grout joint filler, and for cover material when grout filler is used, shall conform to the requirements specified in Art. 8. 5. 10 except that for joint filler all the material shall pass a No. 10 sieve and shall have a mortar strength of not less than 75 per cent of similarly prepared mortar using standard ottawa sand.

Fine aggregate for cover material, when bituminous joint filler is used, shall conform to the requirements specified in Art. 8. 5. 10.

Bituminous joint filler shall be oil asphalt joint filler conforming to the requirements specified in Art. 8. 1. 10.

3. 13. 3. Methods of Construction.

Mortar Cushion. The base course shall be dry, clean and free from adhering matter and frost when the pavement is placed

thereon. The mortar for the cushion course shall be 1:3 cement-sand mortar, thoroughly mixed without water in a mechanically operated batch mixer of a size suitable for the work, and approved by the Engineer. The dry mortar shall be placed on the base course in a uniform layer having an average thickness of 1 inch, a minimum thickness of ½ inch and a maximum thickness of 1¼ inches, or as may be otherwise shown on the Plans. The cushion course shall be placed not more than 15 feet in advance of laying the blocks and shall be covered with the blocks without delay.

Setting Blocks. The blocks shall be set in straight rows at right angles to the centerline of the pavement with the longitudinal joints broken not less than 3 inches. The blocks in each row shall have a uniform width, and the joints at the surface shall be not less than ¼ and not more than ½ inch in width. The blocks shall be set plumb and fully bedded on the mortar cushion without crowding it into the joints. The best face of the block shall be uppermost. Adjacent to railway tracks the blocks shall be set as shown on the Plans so as to provide for a flangeway and shall not be in contact with the rail. When set, the blocks shall be rammed with a hand rammer weighing not less than 35 and not more than 50 pounds until each block has a solid, even bearing and the surface is uniform and at the proper grade. Blocks which have not a firm bedding or which have been damaged shall be taken up, reset and rerammed. The surface shall be tested with a straight-edge not less than 10 feet long, and blocks found to be above or below the grade shall be taken up by means of suitable tongs, reset and rerammed. No fine aggregate, gravel or other material shall be placed in the joints. Blocks shall be laid not more than 15 feet in advance of ramming. Immediately after the blocks have been rammed, tested and approved, they shall be sprinkled with water from a spray nozzle sufficient to wet the mortar cushion but not damage it. No walking or other traffic shall be permitted on the pavement for a period of at least 24 hours after sprinkling.

Grout Joint Filler. When grout joint filler is prescribed, the joints shall be filled with 1:1 cement-fine aggregate grout as hereinafter provided. The grout shall be mixed in a mechanically operated batch mixer as hereinabove specified for mixing the cushion course, with only sufficient water to permit the grout to enter the joints to the full depth. The amount of water used shall be subject to the approval of the Engineer and shall be kept constant in all batches. The mixing time shall be not less than 1½ minutes, and the mixture shall be kept agitated until used. The blocks shall be sprinkled with water, as specified above under Mortar Cushion, immediately before the grout is applied, and the joints shall be filled completely with grout so that an excess appears on the surface. The excess grout shall be swept or scraped

into the joints. The grouting operations shall be repeated before initial set until the joints remain completely filled. The surface shall then be swept and all excess grout shall be removed before it has developed initial set. After initial set, the surface shall be covered with a layer of fine aggregate not less than ½ inch thick. The fine aggregate shall be kept moist for a period of not less than 7 days and the surface shall be closed to traffic for a period of not less than 10 days after being grouted. Grout shall not be applied when the temperature of the atmosphere or the blocks is below 40 degrees F., or during rainy weather.

Bituminous Joint Filler. When bituminous joint filler is prescribed, it shall be applied with hand pouring equipment approved by the Engineer, and the pouring shall be repeated until the joints are completely filled. Surplus material shall be removed from the tops of the paving blocks. Subject to the approval of the Engineer, other methods may be used that will insure proper filling of the joints without leaving any bituminous coating on the surface of the blocks. After the pouring is completed a thin coating of fine agregate shall be spread over the surface. When the joint filler is applied it shall have a temperature of not less than 350 and not more than 425 deg. F., the temperature of the atmosphere and the blocks shall be above 40 deg. F., and the blocks and joints shall be dry.

Reset Blocks. Reset stone block pavement surface shall include the removal of existing paving blocks within the area to be repaved, cleaning of blocks so as to remove adhering joint filler, storing of blocks until ready for repaving, furnishing and placing of cushion course as described above, except that its thickness may be increased to alter the elevation of the pavement, furnishing of additional blocks as may be required to replace lost or damaged blocks, placing and ramming blocks and furnishing and placing joint filler, in conformity with the requirements above.

3. 13. 4. Quantity and Payment.

The quantity of Granite Block Pavement Surface for which payment will be made will be the area actually paved in accordance with the Plans or as directed by the Engineer, without deduction of areas occupied by manholes and similar appurtenances within the pavement area.

Payment for Granite Block Pavement Surface will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item GRANITE BLOCK PAVEMENT SURFACE in the Proposal, which price shall include the cost of cushion course, paving blocks and joint filler complete in place, all materials, labor, equipment and all else necessary therefor and incidental thereto.

Payment for Reset Stone Block Pavement Surface will be made for the area of stone block reset in accordance with the Plans and Specifications or as directed by the Engineer, measured in square yards, at the price per square yard bid for the item RESET STONE BLOCK PAVEMENT SURFACE in the Proposal, which price shall include the cost of removing, cleaning, storing and resetting the blocks, furnishing additional blocks as above specified, furnishing and placing joint filler and cushion course, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 14

Traffic Stripes

3. 14. 1. Description.

Traffic stripes shall include the striping of pavements with white traffic paint and applying glass beads thereto.

3. 14. 2. Materials.

White traffic paint shall conform to the requirements specified in Art. 8. 6. 14 for Type I, Vegetable Oil Modified Alkyd Resin Type, with pigment of titanium-calcium, magnesium silicate and calcium carbonate.

Glass beads shall conform to the requirements of Art. 8. 6. 15.

3. 14. 3. Methods of Construction.

All dirt, oil, grease and other foreign material shall be removed from the areas of the pavement upon which the traffic stripes are to be painted, by a method and in a manner to be approved by the Engineer.

Traffic stripes shall be painted at the locations and on the lines shown on the Plans or as directed by the Engineer. The stripes shall be 4 inches wide and shall be single or double as prescribed.

The paint shall be applied only on thoroughly dry surfaces, when the atmospheric temperature is above 40 degrees Fahrenheit, and when the weather is otherwise favorable in the opinion of the Engineer.

The paint shall be applied with atomizing spray type striping machines to be approved by the Engineer. The stripes shall have clear-cut edges, true and smooth alignment, and uniform film thickness.

The glass beads shall be applied over the wet painted stripes in a uniform pattern and at the specified rate. The bead dispensers

shall be of a type that will mechanically and automatically give such performance.

The paint shall be applied with a coverage rate, per gallon, of 300 to 330 linear feet of 4-inch wide stripe with 0.015-inch film thickness. The glass beads shall be applied at the rate of 5 pounds per gallon of paint.

Traffic shall not be permitted on the pavement until the painted stripes are thoroughly dry.

3. 14. 4. Quantity and Payment.

The quantity of Traffic Stripes for which payment will be made will be the length of 4-inch wide stripes actually painted (excluding gaps) in accordance with the Plans and Specifications, or as directed by the Engineer.

Payment for Traffic Stripes will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item TRAFFIC STRIPES in the Proposal, which price shall include cleaning the pavement surface, painting stripes, application of glass beads, furnishing paint, glass beads and all other materials, all labor and equipment, and all else necessary therefor and incidental thereto.

SECTION 15

County and Municipal Projects

State Aid

3. 15. 1. Amendments.

For **County and Municipal Projects (State Aid)**, the provisions of Division 3 of these Standard Specifications shall apply except as hereinafter provided.

Art. 3. 2. 3 is amended as follows:

Macadam base course shall be constructed by Vibrating Method A, as specified in Art. 3. 2. 3, if the prescribed compacted thickness be 6 inches or greater, and for any thickness where the grade is 5 per cent or steeper. Otherwise, Rolling Method B may be used.

The inverted choke of screenings as specified in Art. 3. 2. 3, will not be required unless prescribed in the Supplementary Specifications.

Art. 3. 5. 3 is amended as follows:

New Surface Course. In paragraph 1 the reference to Art. 2. 10. 3 shall include its amendment in Art. 2. 16. 1.

Paragraph 3 is deleted and the following substituted therefor:

The gravel shall be placed in layers not less than 4 inches and not more than 6 inches thick. Each layer shall be compacted as specified in Art. 2. 3. 3, under Upland Embankment, Zone 3, Dry Fill Method, by the equipment and number of passes prescribed under (1) Smooth-faced power rollers, solid surface or pad type, (2) Pneumatic tire rollers, or (5) Dynamic compactor. Where conditions are such that access with the compacting equipment specified above is not possible, the gravel shall be compacted with flat-faced mechanical tampers or vibratory soil compactors of a type to be approved by the Engineer. Concurrently with compaction operations, the gravel shall be worked and scraped by road scrapers.

The completed surface shall be thoroughly bound, free from defects, hard and even, and at the proper grade and contour.

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DIVISION 4

Bridge Structures

SECTION 1

Concrete Structures

4. 1. 1. Description.

Concrete structures shall include the construction of concrete bridges, viaducts, trestles, culverts 5 feet or more in span, retaining walls, the concrete abutments, piers and deck slabs of steel and concrete structures, and other structures constructed of concrete except those included in other Divisions of these specifications.

4. 1. 2. Materials.

Cement for the decks of concrete structures, except in white concrete curbs and prestressed concrete construction, shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements specified respectively therefor in Art. 8. 5. 22 and 8. 5. 23. Cement for all other parts of concrete structures shall be standard portland cement, Type II. Only one brand of cement shall be used in any structure except where the use of another brand in a specific part of a structure is authorized in writing by the Engineer.

Fine aggregate, except for white concrete curb, shall conform to the requirements specified in Art. 8. 5. 10.

Coarse aggregate, except for white concrete curb, shall be washed gravel, or broken stone of trap rock, granite or gneiss conforming to the requirements specified respectively therefor in Art. 8. 5. 6 and 8. 5. 5.

The materials for white concrete curbs on structures shall be as specified therefor in Art. 5. 6. 2.

Except where otherwise specifically provided, the size of coarse aggregate shall be 5/8-inch or 3/4-inch for Class A concrete. When 3/4-inch size is not produced at the quarry as such, it shall be proportioned at the batcher by combining 1-inch size and 5/8-inch size.

For Classes B, B-1, C, C-1, D and D-1 concrete, the coarse aggregate shall be 3/4-inch size or a combination of 1 1/2-inch size with either 3/4-inch or 5/8-inch size. The combination of 1 1/2-inch with either 3/4-inch or 5/8-inch size shall be prepared at the batcher.

The proportional parts used in the combining of sizes as specified above shall be determined by the Laboratory.

Water shall conform to the requirements specified therefor in Art. 8. 5. 38.

Concrete. Concrete for bridge decks, including deck slabs, curbs, sidewalks and parapets, shall be air-entrained. The requirements for air-entrained concrete, air-entraining additives and air-entraining admixtures shall be as specified in Art. 3. 12. 2.

The classes of concrete required for the various items of work shall be Class A, B, C or D for standard concrete and Class B-1, C-1 or D-1 for high early strength concrete, as prescribed in the Plans or Specifications, and shall be proportioned as shown in Table 7 except that, when the coarse aggregate has a percentage of voids above or below 45, the volume of coarse aggregate or fine aggregate, respectively, shall be decreased so that the volume of the coarse aggregate voids will equal 90 per cent of the fine aggregate volume.

Voids shall be determined by the requirements of current A. A. S. H. O. Designation T20, except that the specific gravity shall be that of saturated surface dry material. The unit weights of aggregates shall be determined on surface dry material in accordance with the requirements of current A. A. S. H. O. Designation T 19, except that the cubic foot measure shall have an inside diameter of 10.5 inches and an inside height of 20 inches. For aggregates with maximum size larger than 1¼ inches, the measure may be the 8-foot cube in accordance with Article 9. 1. 2. The cement and aggregates for all concrete shall be proportioned by volume as hereinafter provided and shall be measured and batched by weight as specified in Art. 3. 12. 3.

The unit weight of coarse aggregate will be determined as specified in Art. 9. 1. 2, "Method of Test for Unit Weight of Coarse Aggregate (Dry Loose Measure)."

Table 7.—Concrete Proportioning

Class	Cement, Cubic Feet (Bags)	Fine Aggregate, Cubic Feet	Coarse Aggregate, Cubic Feet	Void Content, Coarse Aggregate Cubic Feet
A	1	1.50	3.0	1.350
B	1	1.75	3.5	1.575
C	1	2.00	4.0	1.800
D	1	2.25	4.5	2.025
B-1	1	1.40	2.80	1.260
C-1	1	1.60	3.20	1.440
D-1	1	1.80	3.60	1.620

The unit weight of fine aggregate will be determined as specified in Art. 9. 1. 5., "Method of Test for Unit Weight of Fine Aggregate (Dry Loose Measure)."

The classes of concrete required for the various items of work of concrete structures shall be as specified below:

Footings of nonreinforced concrete abutments, piers and walls	Class D
Footings of reinforced concrete abutments, piers and walls	Class C
Nonreinforced abutments, piers and walls, above footings	Class C
Reinforced concrete abutments, piers and walls, above footings	Class B
Arch spans and rigid frames	Class B
Deck slabs, curbs, sidewalks and parapets	Class B
Seal concrete	Class B
Balustrades and posts	Class A

Reinforcement steel shall be of the deformed type except where other types are shown on the Plans. Reinforcement steel shall conform to the requirements specified therefor in Art. 8. 4. 19.

Copper for flashing shall be 16-ounce soft annealed copper and shall conform to the requirements specified in Art. 8. 4. 5.

Cast iron shall conform to the requirements specified in Art. 8. 4. 4 for Gray Iron Castings.

Preformed bituminous cellular type joint filler shall conform to the requirements of Art. 8. 5. 31.

Preformed bituminous type joint filler shall conform to the requirements specified therefor in Art. 8. 5. 31.

Cork joint material shall conform to the requirements specified therefor in Art. 8. 5. 31.

Curing materials shall be burlap, hay or straw, cotton mats, waterproof paper, white polyethylene sheeting, or white pigmented liquid compound, conforming to the requirements specified respectively therefor in Art. 8. 5. 29.

Clay, concrete, corrugated metal, cast iron culvert and cast iron water pipes shall be as specified respectively therefor in Art. 5. 2. 2.

Joint sealer, cold-poured, shall conform to the requirements specified therefor in Art. 8. 1. 10.

4. 1. 3. Methods of Construction.

All operations pertaining to handling, measuring, and batching materials, and mixing concrete, shall conform to the requirements

specified therefor in Art. 3. 12. 3 except that the slump of the concrete shall be 3 inches plus or minus ½ inch.

Forms. Forms may be of wood or metal except that approved fiber tubes may be used for column forms. Forms shall be constructed to conform to the lines and grades established by the Engineer and to the exact dimensions of the structure. Where necessary, the forms shall be constructed to compensate for variations in camber of supporting members and to allow for deflections. They shall be substantially constructed, strong, rigid and mortar-tight, and properly braced and tied. The forms shall be designed so that they can be removed without causing damage to the concrete.

Metal forms shall be of substantial thickness and have a smooth, true surface, free from rust. Bolts and rivets shall be countersunk.

Wood forms for exposed surfaces shall be lined with plywood or fiber board or constructed of plywood except where other types of surface finish are specified. Plywood for lining forms shall be not less than ⅜ inch thick, of a grade suitable for concrete forms, and shall have a smooth finish. Fiber board for lining forms shall have a thickness of not less than ¼ inch and shall have a hard, smooth surface on one side. The form lining shall be adequately backed to prevent deflection. Grooves shall be formed with finished lumber. If paneling is prescribed, the plywood shall be arranged in the proper widths and lengths to conform to the Plans.

Corrugated concrete surfaces shall be formed by corrugated sheet metal or suitably milled wood boards conforming to the details shown on the Plans.

Preservative treatment and form oil applied to forms shall be such as will not stain the concrete surface.

All forms shall be constructed, braced and lined up so as to produce smooth concrete surfaces without bulges and warps. When the forms appear unsatisfactory, either before or during concreting, the placing of the concrete shall be deferred until the forms have been erected to the satisfaction of the Engineer. Re-used forms shall be in good condition in all respects.

Form ties and anchorages within the forms shall be arranged so that they can be removed to a depth of not less than 2 inches from the surface of the concrete without damage to the surface. Ordinary wire ties shall not be used. The cavities left in the concrete when the ties are removed shall be filled with mortar similar to that of which the concrete is prepared, and the surface of the concrete shall be left sound, smooth, even and uniform in color and texture. Before concrete is placed in the forms, they shall be thoroughly cleaned, all loose and foreign material within them removed, and they shall be coated with material approved by the Engineer which will prevent adherence of concrete and will not

discolor it. For concrete exposed to sea water the forms shall be heavily coated with shellac or approved oil.

Removal of Forms. When the placing of the concrete has been completed, under good weather conditions, and subject to the approval of the Engineer, forms and their supports may be removed from under arches, beams and floor slabs after the expiration of 14 days; column forms after 5 days; and wall forms, and side forms for beams carrying no loads, after 1 day; provided, however, that for structures exposed to sea water the time for removal shall be as hereinafter specified. If high early strength concrete be used, these periods may be reduced as directed by the Engineer. Days when the temperature is below 40 degrees F. shall be excluded from the day count. In general, forms shall be removed from the lowest level upward. Supports shall be removed so that the concrete will be subjected uniformly and gradually to its dead load stresses.

Falsework. Detail drawings of falsework and centering shall be submitted for the Engineer's approval when so required, but his approval of them, or acquiescence in the work constructed according to them, shall not relieve the Contractor of full responsibility. If necessary to secure unyielding support, the falsework shall be supported on piles. Screw jacks, hardwood wedges or other suitable means shall be used to correct slight settlements. Falsework shall be set to give the camber indicated and to allow for deflection, shrinkage and settlement. Centers for arches shall be gradually and uniformly lowered when struck so as to avoid injurious stresses in any part of the structure. In arch structures of 2 or more spans, the sequence of striking centers shall be as specified or approved by the Engineer.

Placing Reinforcement Steel. When placed in the work, reinforcement steel shall be clean and free from mill or rust scale, paint, oil, and other foreign matter. When heated for bending, the temperature of the steel shall be not higher than that producing a dark cherry red color. Proper appliances shall be used for cutting and bending.

The reinforcement steel shall be accurately placed and fastened in a manner approved by the Engineer. Distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved supports. Blocks for spacing of reinforcement bars shall be precast mortar blocks of approved design and short enough to permit their ends to be covered with concrete. Layers of bars shall be separated by such blocks, which may be reinforced, and which shall have slots to receive the bars and hold them in place, or by other approved means. When placed, the reinforcement steel shall be inspected and approved before the concrete is placed, otherwise the concrete will be rejected and shall be removed.

Splicing of reinforcement steel, except where shown on the Plans or approved by the Engineer, will not be permitted. Splices shall have a length sufficient to develop the full strength in bond of the bar, and shall be well distributed and located at points of low tensile stress. Splices shall not be made at points where the section is insufficient to provide at least 2 inches between the splices and the nearest adjacent bar or the surface of the concrete. At splices the bars shall be rigidly clamped or wired together in a manner acceptable to the Engineer. Sheets of metal mesh shall overlap so as to maintain uniform strength and shall be securely fastened. Metal caging shall be used for reinforcement of concrete around bottom of encased flanges of beams and girders, and special clips as shown on the Plans shall be used for securing the concrete on encased webs of beams and girders.

Placing Concrete. The placing of the concrete mixture shall be conducted so as to produce a dense, compact, impervious structure of uniform texture and with smooth exposed surfaces. The concrete mixture shall be placed immediately after being mixed and in such a manner that segregation does not occur and the reinforcement steel is not displaced. A concrete mixture not placed within 30 minutes of the time that water was first added to the mixture shall not be used. The concrete mixture shall not be dropped for a distance of more than 5 feet and shall not be deposited in quantity at one point and subsequently run or worked along the forms. Long chutes shall not be used except when approved by the Engineer, and if subsequently found unsatisfactory by the Engineer their use shall be discontinued. Long chutes will not be approved for work exposed to the effects of salt or brackish water. Troughs, pipes or short chutes may be used if of metal or lined with metal. Where the slope of the chute is steep, baffle boards or other approved arrangements shall be used. Troughs, pipes and chutes shall be kept clean and free from coatings of hardened concrete by flushing them with water after each run. The water used therefor shall be discharged at a point clear of the concrete in place. Troughs and chutes shall extend as nearly as possible to the place of deposit. Pipes shall be kept full of concrete mixture during the placing, and their lower ends shall be kept buried in the newly placed concrete. If the concrete is placed intermittently, a hopper or other device shall be used for regulating the discharge.

Placement of concrete by pumping will be permitted only if prescribed in the Supplementary Specifications or if authorized by the Engineer. The equipment shall be so arranged that no vibrations result which might damage freshly placed concrete.

Where concrete is conveyed and placed by mechanically applied pressure the equipment shall be suitable in kind and adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is pro-

duced. When pumping is completed, the concrete remaining in the pipeline, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients. After this operation, the entire equipment shall be thoroughly cleaned.

The placing shall be so regulated that the pressure of the concrete mixture will not cause damage to the forms. Care shall be taken to fill each part of the forms, to work the coarse aggregate back from the face, and to distribute the concrete under and around the reinforcement steel without displacing it. The concrete shall be compacted by continuous working with suitable tools and by vibrating, unless otherwise approved by the Engineer. The method of vibrating and the type and number of vibrating units used shall be as directed or approved by the Engineer. The vibrating implement shall have a vibrating frequency of not less than 5,000 impulses per minute.

Concrete mixtures for slabs, girders, arch ribs and other thin sections shall be placed carefully and thoroughly worked and compacted. The faces shall be well spaded to flush the mortar to the surface of the forms.

The concrete mixture shall be placed in continuous horizontal layers not exceeding 12 inches in thickness. If, in an emergency, a layer cannot be completed in one operation, it shall be terminated at a vertical bulkhead. The batches shall follow each other so closely that each layer is placed and compacted before the preceding one has taken initial set. The surface of each layer shall be sufficiently rough to secure proper bonding with the subsequent layer, and this shall be compacted so as to avoid the formation of a construction joint between the layers. Layers placed at the end of a day's work or when the operations are otherwise temporarily discontinued shall be cleaned as soon as the surface has become firm enough to do so. Visible joints on exposed faces shall be avoided as far as possible by smoothing the top surface of each layer adjacent to the forms with a plaster mason's trowel. Feather edges shall be avoided by insets in the forms so that no layer will end in a thickness of less than 6 inches. When the work has progressed to within 18 inches of the top, the remainder shall be placed monolithically.

Unless otherwise approved or directed by the Engineer, or shown on the Plans, the concrete shall be placed as follows: In concrete slab and girder bridges, the concrete shall be placed by beginning at the center of the span and working towards the ends. Concrete in girders shall be placed uniformly for the full length of the girder and brought up evenly in horizontal layers. Concrete in slab spans shall be placed in one continuous operation for each span. The concrete for floors and girders of through girder structures, for T-beam or deck girder spans, and for columns shall

in each case be placed in one continuous operation. The concrete in columns shall be not less than 12 hours old before the caps are placed, and no concrete shall be placed above the columns until the column forms have been removed sufficiently to determine the character of the concrete in the columns.

In arch rings, the concrete shall be placed so as to load the centering uniformly. If not otherwise approved, arch rings shall be constructed in transverse sections of such size that each section can be cast in a continuous operation. The arrangement of the sections and the sequence of placing shall be approved by the Engineer and shall be such as to avoid creation of initial stress in the reinforcement. The sections shall be bonded by suitable keys or dowels. When permitted by the Engineer, arch rings may be cast in a single continuous operation. For arches, the railing and coping, and for filled spandrel arches, such portions of the spandrel walls as may be necessary, shall be left for construction subsequent to the striking of centers to avoid jamming of expansion joints and to attain proper alignment.

On steel spans, the concrete shall be placed symmetrically about the center line of the span, beginning either in the center or simultaneously at both ends except that in continuous structures concrete in the parts that will be subject to tension shall be placed last. If it become necessary to introduce a construction joint, it shall be formed by means of a vertical bulkhead constructed so as to form a keyed or dovetailed joint. Concrete around steel shapes shall be placed only on one side of the shape until it flushes up over the bottom flange of the shape on the opposite side, after which it shall be placed on both sides to completion. After the concrete of finished surfaces has begun to set it shall not be walked upon or otherwise disturbed for a period of at least 48 hours.

The Contractor shall exercise particular care to construct the roadway surfaces on the bridge decks in exact conformity with the required roadway profile and cross section. He shall construct and erect his forms to make allowance for the dead load deflection and variations in camber and make any adjustment necessary to produce the desired result during the placing of the concrete. If the bridge decks as constructed do not conform to the roadway profile and cross section as shown on Plans, the Contractor shall alter or reconstruct the decks at his own expense as directed by the Engineer.

Placing Concrete Under Water. Concrete shall not be deposited in running water and, except with the written approval or direction of the Engineer, it shall not be deposited in any water, or exposed to water before setting. When deposited in water, the concrete shall be Class B, and it shall be placed carefully in a compact mass in its final position by means of a tremie, or closed bottom dump bucket or other approved method, in such a manner

that it will not become segregated, and after being placed it shall not be disturbed.

A tremie shall be a sectional, watertight tube not less than 10 inches in diameter with flanged couplings. The tremie shall be supported so as to permit quick lowering of the pipe and free movement of its discharge end over the entire surface to be concreted. The discharge end shall be plugged at the start of the work, and during the work the tube shall be kept full of concrete mixture. During placing of concrete the tremie shall not be raised above the level of the concrete placed. Bottom dump buckets for placing concrete under water shall be of not less than ½-cubic yard capacity. The bucket shall be lowered carefully and slowly, and it shall not be emptied until it rests on the surface on which the concrete is to be placed. It shall then be raised slowly while being emptied so as to maintain still water at the point of discharge and avoid agitating the concrete mixture.

Concrete seals of cofferdams shall be placed in a continuous operation in horizontal layers, and each succeeding layer shall be placed before the preceding layer has taken its initial set. Laitance and foreign matter shall be removed before concrete is placed upon the finished seal. Class B concrete shall be used.

Concrete Exposed to Sea Water. Concrete for structures exposed to sea water shall be Class B. The clear distance from the face of the concrete to the nearest face of reinforcement steel shall be not less than 4 inches. The concrete shall be mixed for a period of not less than 2 minutes and the water content of the mixture shall be carefully controlled and regulated so as to produce concrete of maximum impermeability. The concrete shall be thoroughly compacted and stone pockets shall be avoided. No construction joints shall be formed between levels of extreme low water and extreme high water, as determined by the Engineer. Between these levels sea water shall not come in direct contact with the concrete for a period of 30 days after being placed. The original surface, as the concrete comes from the forms, shall be left undisturbed.

Concreting in Cold Weather. In cold weather, the concrete aggregates and water shall be heated so that the concrete mass, when placed in the forms, shall have a temperature not lower than 60 degrees F., and higher if the Engineer so directs.

The aggregates and the water may be heated by dry heat, steam or, if approved by the Engineer, by torch, so as to produce a uniform temperature throughout the mass without local overheating. The water shall not be heated to a temperature of more than 165 degrees F.

The concrete shall be kept at a temperature not lower than 60 degrees F. for a period of seven days after placing the concrete, and at a temperature not lower than 40 degrees F. for a period of

four days thereafter; then the temperature may be gradually changed to that of the atmosphere.

The concrete shall be protected by means of an enclosure or by insulation.

If the concrete be protected by the use of an enclosure, it shall be sufficiently tight to prevent local cooling due to draughts and shall be heated in such a manner as to maintain uniform temperatures throughout the enclosure.

If the concrete be protected by insulation, the insulation material shall be of a thickness and have thermal conductivity properties such as will insure the maintenance of the required temperatures for the specified period of time throughout the entire mass of concrete.

If concrete be damaged by low temperatures, it shall be removed and replaced by the Contractor at his own expense.

Concrete shall not be placed when the atmospheric temperature is below 36 degrees F., except with the Engineer's approval.

Curing. Concrete structures shall be cured by one of the alternative methods designated as 1, 2, 3, 4 and 5 in Art. 3. 12. 3. The provisions pertaining to the various curing materials and their application, as specified in Art. 3. 12. 3, shall apply with modifications necessary to adapt them to the curing of concrete structures, subject to the approval of the Engineer.

Contraction and Construction Joints. Contraction and construction joints shall be constructed only where shown on the Plans or as directed or approved by the Engineer. When a concrete mixture is to be placed against set concrete, all loose and foreign material shall be removed from the surface of the latter and the surface shall be cleaned with wire brooms and saturated with water. Immediately before placing the new concrete, the forms shall be drawn tight. Tar paper and paraffin shall be used in joints where indicated.

Expansion Joints. Expansion joints shall be provided where shown on the Plans and shall be of the type prescribed in the Plans or Supplementary Specifications.

Type 1 expansion joints shall be formed by means of preformed bituminous type joint filler.

Type 2 expansion joints shall be formed in the following manner: One-ply cotton fabric, conforming to the requirements for waterproofing fabric, shall be impregnated with waterproofing asphalt or tar and shall be cut into pieces of such length that, when tightly rolled, the rolls shall have a diameter equal to the width of the expansion joints. The rolls shall be caulked into the joint openings so as to fill them. Additional waterproofing asphalt or tar shall then be poured into the opening until it is completely filled.

Type 3 expansion joints shall be formed by means of preformed bituminous cellular type joint filler.

Type 4 expansion joint shall be formed with preformed cork joint material. Exposed edges of the cork shall be painted to match the adjacent concrete surface.

Where shown on the Plans, copper flashing shall be furnished and placed in joints. When the flashing for a joint is in more than one piece, the pieces shall be soldered together.

Waterproofing and Dampproofing. Waterproofing shall consist of priming the surfaces to be waterproofed and covering such surfaces with a membrane of cotton fabric and asphalt or pitch, protected by a cement-fine aggregate mortar course or insulation board, and other work as specified.

Dampproofing shall consist of priming and seal coating wall surfaces and other designated areas when prescribed in the Plans or Supplementary Specifications.

The materials and methods of construction for waterproofing, and for dampproofing, shall conform to the provisions of the current A. A. S. H. O. Standard Specifications for Bridges with the following amendments:

Either tar or asphalt may be used. Either mortar protection or insulation board may be used for the protection course. Insulation board shall conform to the requirements therefor specified in Art. 8. 5. 39.

Defective Work. Defective work shall be replaced or repaired as the Engineer may direct. If the surface of the concrete is bulged or uneven, develops cracks, or shows honeycombing or joint marks which cannot be repaired satisfactorily, in the opinion of the Engineer, the entire section of concrete affected shall be removed and replaced at the Contractor's expense.

Surface Finish. As soon as the forms have been removed, the concrete surfaces shall be carefully examined and cavities, irregularities, honeycombing and other defects, which in the opinion of the Engineer may not justify rejection of the work, shall be pointed with mortar of the same composition as that in the concrete or shall be repaired otherwise, as the Engineer may direct. Except as hereinafter provided, exposed surfaces of concrete not specifically exempted on the Plans shall be finished in the following manner: As soon as the pointing described above has set, the entire surface shall be thoroughly covered with water by means of a brush and rubbed with blocks of carborundum No. 16, bringing the surface to a paste. The rubbing shall be continued until all form marks and projections are removed and a smooth dense surface without pits and irregularities is obtained. The paste shall be spread or brushed uniformly over the surface and allowed to take a reset. The final finish then shall be obtained by rubbing with blocks of

carborundum No. 30 until the entire surface is smooth and of uniform color. When this rubbing is completed the surface shall be cured as specified above.

Concrete surfaces of the underside of deck slabs and the walls of stream bridges need not be rubbed.

Where concrete forms are of plywood or lined with plywood or fiber board, the surfaces of concrete need not be rubbed unless specified or called for on the Plans, but shall be finished smooth and of uniform color to the satisfaction of the Engineer. All bolt holes for form ties shall be filled with mortar which matches the color of the concrete surface and rubbed or finished to conform to the texture of the adjacent concrete. Surfaces which are not acceptable to the Engineer shall be repaired or resurfaced to his satisfaction.

Top of balustrades, parapets, copings, bridge seats and other similar horizontal surfaces not subject to wear shall be formed by placing an excess of material in the forms and striking it off with a wood template, forcing the coarse aggregate below the surface. Mortar topping shall not be used. The surface shall then be thoroughly worked with a wood, canvas or cork float, and before this finish has set, the surface shall be lightly stroked with a fine brush to remove surface film, leaving a smooth, fine-grained texture. The surfaces shall then be cured as specified above. Concrete surfaces intended for roadway surfaces shall be finished as provided in Art. 3. 12. 3. Sidewalk surfaces shall be finished as provided in Art. 5. 8. 3.

Cast Stone. Cast stone lettering panels, conforming to the plan details and accompanying notes, shall be erected in place at the locations shown.

The finished product shall conform to the requirements of Federal Specification SS-S721. If required by the Engineer, samples of white portland cement, crushed quartz, granite aggregates and other required ingredients to be used in manufacturing the stone shall be submitted for approval of the Engineer before manufacture. Coloring used in the mixture shall be an approved nonfading mineral especially prepared for use in cast stone.

Cast stone units shall be furnished in one piece, including anchors, shall be made true to required dimensions and shall be straight. Arrises shall be accurate and clean. A sample of cast stone showing design, coloration and surface finish shall be submitted for approval before casting, if required by the Engineer.

Name Plates. No permanent plates or markers shall be placed other than those shown on the Plans or approved by the Engineer.

Weep Holes and Scuppers. Weep holes shall be constructed in concrete walls and lined with 4-inch clay or non-

reinforced concrete pipe as shown on the Plans. Cast iron scuppers as shown on the Plans shall be constructed where indicated.

4. 1. 4. Quantity and Payment.

Except where otherwise specifically provided, the quantity of Concrete for which payment will be made will be the volume of each class of concrete within the neat lines of the construction actually placed as shown on the Plans or as directed by the Engineer. The volumes occupied by structural steel and pile heads will not be measured for payment and timber pile heads will be assumed to have a volume of 0.8 cubic foot per linear foot of pile; but the volumes occupied by reinforcement steel and by pipes not more than 18 inches in diameter will be measured for payment.

The quantity of Concrete Balustrade for which payment will be made will be the sum of the over-all lengths of the individual balustrade sections including posts and panels, constructed as shown on the Plans or directed by the Engineer.

The quantity of Concrete Parapet for which payment will be made will be the sum of the over-all lengths of the individual parapet sections constructed as shown on the Plans or as directed by the Engineer.

The quantity of Reinforcement Steel for which payment will be made will be the net theoretical weight of reinforcement steel of the specified nominal cross section, forming part of the permanent work, actually in place in accordance with the Plans or as directed by the Engineer. Fastenings and fastening devices will not be measured for payment. Reinforcement steel for splices, unnecessary in the opinion of the Engineer, will not be measured for payment. If bars larger than those specified have been permitted to be used, the excess material will not be measured for payment. Metal caging will not be measured for payment but the cost thereof shall be included in the price bid for Class B concrete.

The quantity of Waterproofing for which payment will be made will be area of waterproofing membrane and protection course actually constructed in accordance with the Plans or as directed by the Engineer.

The quantity of Dampproofing for which payment will be made will be the area of dampproofing actually completed in accordance with the Plans or as directed by the Engineer.

Payment for Class B, C and D Concrete will be made for the quantity of each class as above determined, measured in cubic yards, at the price per cubic yard bid for items CLASS B, C AND D CONCRETE IN STRUCTURES, respectively, in the Proposal.

Payment for Concrete Seal in Cofferdams, if shown on the Plans and scheduled in the Proposal, will be made for the quantity placed in accordance with the Plans or as directed by the Engineer, measured in cubic yards, at the price per cubic yard bid for the

item CONCRETE SEAL IN COFFERDAMS. No payment will be made for concrete seals that are not shown on the Plans unless they are specifically ordered in writing by the Engineer.

Payment for Concrete Balustrade will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item CONCRETE BALUSTRADE in the Proposal.

Payment for Concrete Parapet will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item CONCRETE PARAPET in the Proposal.

These prices shall include the cost of the concrete construction complete in place, including falsework, forms, bracing, curing, curing materials, heating in cold weather, surface finish, cast stone lettering panels, scuppers, metal caging, drain pipe for weep holes, expansion and construction joints, joint fillers of any kind specified, tar paper joints, paraffined joints, copper flashing, drilling for dowels, all materials, labor, equipment and all else necessary therefor and incidental thereto, except as follows:

Payment for Reinforcement Steel will be made for the quantity as above determined, measured in pounds, at the price per pound bid for the item REINFORCEMENT STEEL IN STRUCTURES in the Proposal, which price shall include the cost of furnishing, bending, placing and securing in place, the reinforcement steel, all materials, labor and equipment and all else necessary therefor and incidental thereto.

Payment for a Waterproofing will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item WATERPROOFING in the Proposal.

Payment for Dampproofing will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item DAMPPROOFING in the Proposal.

SECTION 2

Prestressed Concrete Structures

4. 2. 1. Description.

Prestressed concrete structures shall consist of the manufacture, storage and installation of bridge members of prestressed concrete, including transverse post-tensioning, bearing plates and anchor bolts, according to the Plans and Specifications.

4. 2. 2. Materials.

The provisions of Art. 4. 1. 2 shall apply except as hereinafter amended and with conflicting provisions deleted.

PRESTRESSED CONCRETE STRUCTURES

All materials for prestressed concrete structures shall conform to the requirements specified therefor in the current Criteria for Prestressed Concrete Bridges of the U. S. Bureau of Public Roads except as hereinafter amended.

Steel Strands and Wires. Steel strands and wires shall conform to the requirements specified therefor in Art. 8. 4. 20 and 8. 4. 21. For both wire and strand, the manufacturer shall submit, on request, typical loadstrain curves. Specific curves will not be required. For each lot of ten tons or fractions thereof, certified copies of the manufacturer's test reports shall be supplied. Additional testing, if required, will be performed by the State. The Contractor shall furnish, free of charge, one 10-foot length of strand or wire per ton, or fraction thereof, for this purpose.

Steel Bars for Post-Tensioning. Steel bars for post-tensioning shall conform to the requirements specified therefor in Art. 8. 4. 20 for High-Tensile Alloy Bars. For each lot of 15 tons of bars, or fraction thereof, certified copies of the manufacturer's test reports shall be supplied. Additional testing, if required, will be performed by the State. The Contractor shall furnish samples for this purpose, free of charge, upon the request of the Engineer.

Cement. Cement shall be standard portland cement conforming to the requirements of Art. 8. 5. 22. Type II or Type III cement may be used. Air-entraining cement shall not be used unless approved by the Engineer. Unless otherwise approved in writing by the Engineer, all cement used in the manufacture of the members in any one structure shall be from the same mill and of the same type.

Coarse Aggregate. Coarse aggregate shall be washed gravel, or broken stone of trap rock, granite or gneiss, conforming to the requirements therefor specified in Art. 8. 5. 6 and 8. 5. 5, respectively, and shall be graded as specified for ¾-inch size.

Concrete for Prestressed Members. The Contractor shall design and submit for the Engineer's approval the proportions for a concrete mix which shall attain a minimum average strength of 5,000 p. s. i. at 28 days for three cylinders when sampled in accordance with the requirements of current A. S. T. M. Designation C 172, molded and cured in accordance with the requirements of current A. S. T. M. Designation C 31, and tested in accordance with the requirements of current A. S. T. M. Designation C 39. No cylinder shall test less than 4,500 p. s. i. Concrete for post-tensioned diaphragms shall conform to the requirements specified for Class B Concrete in Art. 4. 1. 2. The concrete mix shall have a cement content of not less than 6.5 and not more than 7.5 bags per cubic yard. The slump shall not exceed 2½ inches.

To check the Contractor's design mix, the Engineer will make test specimens of concrete mixed with the aggregates and cement

which are proposed for use. The Contractor shall inform the Engineer of the sources from which he proposes to obtain the materials in ample time to permit of these tests, and shall furnish at his own expense whatever quantities of these materials may be required for the tests.

An approved retarding densifier to increase the plasticity and strength of the mixture may be used in the preparation of the concrete. It shall be a nonhygroscopic powder, free from calcium chloride, foaming or air-entraining agents. The quantity of retarding densifier to be added shall be varied with the air temperature. The following proportions per bag of cement shall be used except if otherwise noted in the manufacturer's instructions, or if experience in the field prove these proportions unsatisfactory, or if otherwise directed by the Engineer:

Below 65° F. — ½ lb.
65° - 85° F. — ¾ lb.
86° F. or above — 1 lb.

The concrete shall have attained an ultimate strength of 4,000 pounds per squire inch when sampled, cured and tested as previously specified herein, before any prestressing force is transferred to the concrete.

Grout. Grout for grouting in bridge strands, wires and bars, after post-tensioning, shall conform to the requirements specified hereinafter under Post-Tensioning.

4. 2. 3. Methods of Construction.

All operations pertaining to the construction of prestressed concrete members shall conform to the requirements therefor specified in the current Criteria for Prestressed Concrete Bridges of the U. S. Bureau of Public Roads, as hereinafter amended, and to the provisions of Art. 4. 1. 3 herein.

Drawings giving complete information as to the proposed method of manufacturing the precast prestressed members, and as to gripping devices, jacking arrangement and other details necessary to prosecute the work shall be submitted to the Engineer for approval.

Satisfactory proof shall be given the Engineer that the fabricator of the prestressed concrete members is capable of, and has the organization and plant for, performing the work involved in prestressing.

Forms. All forms shall be made and maintained true to the shapes and dimensions shown on the Plans. Bottom forms shall be maintained in true alignment and of sufficient stiffness to prevent excessive deflection under load of wet concrete. The surface shall be smooth and, if necessary, joints shall be treated so that no joint marks are evident in the finished girder.

Minor variations in shape and dimensions of prestressed concrete members which the Contractor may propose in order to use forms he has on hand will be approved if, in the opinion of the Engineer, the proposed variations do not weaken the member or result in an objectionable appearance.

Forms shall be constructed and end bearing plates placed so as to compensate for any shortening of beams due to compressive stresses resulting from release of stress and from shrinkage so that the beams will be of the correct length when delivered to the project.

A horizontal bow of more than one six-hundredth of the span length in any beam shall be cause for rejection of that beam.

Side forms shall be of steel and shall be supported without resort to ties or spreaders within the body of the member. They shall be braced and stiffened so that no undesirable deflection or curvature takes place under concrete pressure. They shall be so designed that proper cleaning of the forms between uses is facilitated.

The form faces in contact with the concrete shall be thoroughly cleaned after each casting operation and coated with form lacquer or oil before concrete is placed. The form lacquer or oil shall be of such quality as to leave no stains or discoloration on the girder faces.

No form ties, spreaders or forming facilities shall penetrate the body of the member, except those necessary to provide ultimate openings as shown on the Plans. Before any forms are removed, the concrete shall have attained sufficient strength to prevent injury due to such removal. No forms shall be removed without the approval of the Engineer. Proper care and precautions shall be exercised in removing forms so that no damage results to the finished surfaces.

Holes for post-tensioning tendons in precast stringers shall be formed by means of flexible metal conduit or metal tubing. The size of the holes shall be no larger than necessary. The post-tensioning tendon shall be placed in the conduit or tubing prior to pouring the concrete.

Placing of Pretensioning Strands and Application of Prestress. Prior to stressing, the Contractor shall submit to the Engineer for approval, the computations of the proposed gauge pressures, the elongations of pretensioning strands and the method of pretensioning and sequence of operations.

The pretensioning strands shall be placed symmetrically about the vertical axis of each stringer and in proper position to achieve the locations of c. g. s. as shown on the Plans. Each strand shall be stretched individually to a minimum gauge pull of 400 pounds before the gripping device is applied. No wires with kinks, bends, nicks or other defects will be permitted. All strands shall be in

position before the stressing operation is begun. Except for normal reinforcing in bottom flange, the reinforcing shall be placed in position after stressing is performed.

Stressing of the strands shall be performed by simultaneous application of tension to the individual strands to produce an elongation indicating a total initial prestressing force, as required to achieve the specified final prestress after all losses have taken place.

If permitted by the Engineer, draped pretensioned strands may be used where the centroid of prestressing strands is required to have a parabolic variation. Draped strands shall be stressed to a uniform tension throughout the length of the strands, and the stress shall be checked by the use of extensometers at each end and near the middle at a point where the strand changes direction until it is established that uniform strains acceptable to the Engineer are obtained.

The prestressing strands of the pretensioned girders shall be connected to the jack or jacks in such a manner that the prestressing force will be distributed equally among the strands.

Hydraulic jacks shall be equipped with accurate-reading calibrated pressure gauges. The Contractor may elect to substitute screw jacks or other types for hydraulic jacks. In that case, proving rings or other approved devices must be used in connection with the jacks. All devices, whether hydraulic jack gauges or other types, shall be calibrated and, if necessary, recalibrated so as to permit the stress in the prestressed steel to be computed at all times. A certified calibration curve shall accompany each device.

Safety measures must be taken by the Contractor to prevent accidents due to possible breaking of the prestressed steel or the slipping of the grips during the prestressing process.

A record shall be kept of the jacking force and the elongation produced thereby. Several units may be cast in a continuous line and stressed at one time. No bond stress shall be transferred to the concrete, nor the anchorages released, until the concrete has attained a compressive stress of at least 4000 p. s. i., as shown by cylinder tests. Prestressing forces shall be released by means of jacks. The strands shall be cut flush with the face of the concrete and the ends painted with two (2) coats of approved tar base coating conforming to the requirements of Article 8. 1. 13, except for the fascia beams which shall have their end blocks finished with concrete as shown on the Plans.

The cutting shall be done in such an order that lateral eccentricity of prestress will be a minimum.

Placing of Post-Tensioning Units. Prior to casting of the beams, the Contractor shall submit to the Engineer for approval detailed drawings showing the location of the units throughout the beams.

Application of Prestress of Post-Tensioning Units. The Contractor shall note that the prestressing forces shown on the Plans for the post-tensioned beams are the final prestressing forces required, i. e., after all losses have taken place in the steel and concrete due to elastic shortening, creep and shrinkage.

The post-tensioning units shall be connected to jacks at both ends of beams in such a manner that the post-tensioning force shall be equal at both ends of the beam at all times.

Prior to stressing the beams, the Contractor shall submit to the Engineer for approval details of the proposed type of stressing unit and anchorage device, together with the computations of the proposed initial tensioning loads. Such loads shall allow for the aforementioned losses, together with losses incurred during the tensioning process, such as friction, anchorage slip and jack losses.

The Contractor shall also submit to the Engineer for approval, the computation of the proposed gauge pressures and elongations of the post-tensioning units based on the proposed initial tensioning loads.

Stressing of the units shall be performed by application of load to the units to produce an elongation indicating a total prestressing force in accordance with the initial tensioning load approved by the Engineer. Precautions shall be taken to prevent damage to the concrete under the bearing devices.

The tensioning process shall be conducted so that the tension being applied and the elongation of the post-tensioning units may be measured at all times. A record shall be kept of gauge pressures and elongation at all times and submitted to the Engineer for his approval.

Stressing of the post-tensioning units shall not be performed until the concrete has attained a compressive stress of at least 4000 p. s. i. as shown by cylinder tests. Before stressing, care shall be taken to insure against any bond of the units with the concrete.

Individual units shall be stressed in such an order that lateral eccentricity of prestress will be a minimum.

Care shall be exercised to provide that the line of action of the prestressing force is exactly normal to the face of the beam at the anchorages.

After tensioning and the transferring of the tensioning force to the end anchorage, the space in the duct between the duct and the unit shall be filled with cement grout introduced under pressure. Approved grouting pipes and nipples, one at each end of each duct enclosing post-tensioning units, shall be provided and the grout shall be forced in at one end under moderate pressure until all entrapped air is forced out through the grout pipe at the other end, as evidenced by a steady stream of grout at the pipe, whereupon the open pipe shall be closed under pressure and the

grouting pressure gradually increased to refusal at approximately 35 p. s. i. and the grouting connection closed under that pressure. The grout shall have the consistency of thick paint and shall be mixed in the proportions, by volume, of 1 part portland cement to 0.75 part (maximum) of fine aggregate passing a No. 30 sieve and 0.75 part (maximum) of water. If necessary, fine aggregate may be eliminated and a neat cement grout used.

Aluminum powder may be used to expand the grout, but must be used in accordance with the requirements of the Bureau of Public Roads "Criteria for Prestressed Concrete Bridges." If grouting is done during cold weather, suitable precautions shall be taken to prevent freezing of the grout.

After stressing, excess wires of cables shall be removed beyond a point 3 inches from the face of the anchorage. High strength alloy bars shall be cut ½ inch beyond the face of the wedge anchorage. The cutting shall be done in such a manner as to cause no damage to the anchorage fitting. The exposed parts of the end anchorages shall then be painted with two coats of approved tar base coating conforming to the requirements of Article 8. 1. 13, except for the fascia beams which shall have their end blocks finished with concrete as shown on the Plans.

If transverse post-tensioning is required, the post-tensioning bars, wires or strands and end fittings shall be placed in position according to Plans through holes, or with a suitable sheath throughout the length of the strand, to prevent bonding to the concrete.

Holes for post-tensioning bars, wires or strands in transverse diaphragms shall be formed by means of flexible metal conduit, metal tubing or other approved means. The size of the holes shall be not larger than as shown on the Plans.

Three hours after the concrete for the deck and diaphragms has been placed, the bars, wires or strands shall be moved longitudinally a distance of approximately two inches and returned to position, to insure against any bond of the bars, wires or strands with the concrete. This process shall be repeated at twenty-four hours after concrete for diaphragms has been placed.

When the concrete in the diaphragms has reached a minimum compressive strength of 3,500 p. s. i., when sampled, cured and tested as hereinbefore specified, the transverse post-tensioning elements shall be stressed to their prescribed tension, with precautions taken to prevent damage to the concrete under the outside washers. Before stressing is performed, calculations for proposed elongation shall be submitted to the Engineer for approval. The tensioning process shall be conducted so that the tension being applied and the elongation of the prestressing elements may be measured at all times.

Placing Concrete. Concrete shall be deposited only in the presence of the Engineer and by methods approved by him.

All reinforcement shall be free from dirt, loose rust, grease and other deleterious substances. All items to be encased in the concrete shall be accurately placed in the position shown on the Plans and firmly held during the placing and setting of the concrete.

Concrete shall be thoroughly compacted by means of external and internal mechanical vibrations. The type, number and method of application shall be approved by the Engineer. Internal vibrations shall be applied to the concrete for time intervals of approximately 10 seconds and at points not more than 30 inches apart. Vibrators shall not be used to move the concrete horizontally in the form. The vibrating shall be done with care and in such a manner as to avoid displacement of the reinforcement, prestressing strands, sheaths, shoes and inserts.

Concrete Finish. Except in areas where the Plans show keys to be provided, the top surface of all precast stringers shall be finished reasonably true by striking off at the top of the forms. As soon as its condition permits, before the concrete has fully hardened, all dirt, laitance and loose aggregate shall be removed from the surface by means of a wire brush, which shall leave the coarse aggregate slightly exposed, or the surface otherwise roughened. If the concrete has been allowed to harden so that it is impossible to roughen the top surface of the stringers by brushing, the surface shall be cleaned and prepared for bond by chipping or by other methods approved by the Engineer.

Holes and voids in the surfaces of the concrete resulting from bolts and ties shall be wetted and filled with mortar composed of the same materials as those in the mortar of the concrete except that all material larger than ¼-inch size shall be removed from the fine aggregate. The exposed mortar surfaces shall be finished smooth and even with a wood float. Patching of any surface irregularities, especially those resulting from honeycombing, shall be done only after inspection by the Engineer for his determination as to whether or not the work is acceptable.

During the construction of the precast pretensioned girders, the Engineer will take at least one sample from the concrete mixed each day and will make specimens for laboratory control tests in accordance with the requirements of current A. S. T. M. Designation C 31. The specimens will be tested in accordance with the requirements of current A. S. T. M. Designation C 39. The primary purpose of these tests will be to determine the time after placing the concrete at which the wire strands can be cut, thus transferring the tension to the pretensioned girders. The Engineer will make frequent observations of the consistency of the freshly mixed concrete as measured by the slump. The Contractor shall provide the labor necessary for and the means of obtaining the samples of concrete.

Curing. All members shall be protected against the loss of moisture, after casting, by either of the following methods, or by other methods approved by the Engineer.

a. By covering, as soon as possible after concrete is placed, with one or more layers of 12-ounce burlap, which shall be kept wet continuously for not less than seven days if Type II cement be used, and not less than three days if Type III cement be used.

b. Live steam shall be employed as the means of applying moisture and controlled heat to the freshly cast concrete members in order to accelerate the rate of curing. The Contractor shall furnish sufficient canvas and framework, or other type of housing, to completely enclose the prestressed members so that the curing temperature can be properly controlled.

Live steam shall be introduced into the enclosure through a series of steam jets which shall be evenly spaced within the enclosure and in no case shall the steam jet impinge directly on the concrete or form work of the stringers.

After the concrete is placed in the forms the introduction of live steam into the enclosure shall be delayed for a period of 5 to 6 hours when the air temperature is 50° F. or lower and shall be delayed for 3 hours when the air temperature is 51° F. or higher. In cold weather, prior to the application of the steam cure, the temperature within the enclosure shall be maintained at a minimum of 40° F. and a maximum of 60° F. The application of live steam shall be controlled so that the temperature within the enclosure does not rise faster than 1° F. per minute, and shall be kept controlled at maximum 145° F., plus or minus 5° F., for a period of 18 hours. After 18 hours, the steam may be shut off and, in order to avoid too rapid cooling, the enclosure shall remain closed for an additional two hours.

Representative concrete test cylinders, similarly cured, shall be tested after the curing procedure specified above. Should the tests indicate that the concrete members have not achieved a compressive strength of 4000 p. s. i., the members shall be further steam-cured until the required strength is achieved as specified above.

Inspection. The Engineer or his representatives shall have free entry for the purpose of inspection, at all times while work is being performed, to all parts of the manufacturer's works which concern the manufacture of the materials ordered. The manufacurer shall afford the Inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with the Specifications.

Handling and Storage of Precast Stringers. Special care shall be taken in handling and storing the precast prestressed members so as to avoid any damage to the concrete. They shall be lifted only at the designated points by approved lifting devices

imbedded in the stringers. They shall be transported in an upright position, and the points of support and direction of the reactions with respect to the member shall be approximately the same as when the member is in its final location. They shall not be subjected to any damaging torsional or impact stresses. Any member which has been damaged in handling shall be removed from the premises and replaced at the Contractor's expense.

Erection. Girders shall be erected by means of suitable equipment in good operating condition. Girders damaged in any manner shall not be patched but shall be replaced by new girders by and at the expense of the Contractor.

4. 2. 4. Quantity and Payment.

The quantity of Prestressed Concrete Members for which payment will be made will be the actual length, in linear feet of completed members, measured in place, furnished in accordance with Plans and Specifications.

The quantity of Cast-in-Place Concrete Diaphragms for which payment will be made will be the actual volume, in cubic yards of concrete in place, as specified and shown on Plans.

Payment for Prestressed Concrete Members, except cast-in-place concrete diaphragms, will be made for the quantity as above determined at the unit price bid per linear foot, complete in place, for each particular size beam for the items PRESTRESSED CONCRETE BEAMS in the Proposal, which price shall include the cost of stressing, grouting, tendons, ducts, anchorages, sole plates, straps, reinforcing bars and all other labor and materials, and all work in connection therewith and incidental thereto.

Payment for Cast-in-place Concrete Diaphragms will be made for the quantity as above determined, complete in place, at the price per cubic yard bid for the item CLASS B CONCRETE in the Proposal, which price shall include the cost of transverse prestressing, grouting, strands, sheaths and end fittings, all labor and materials, and all else necessary therefor and incidental thereto.

SECTION 3

Steel Structures

4. 3. 1. Description.

Steel structures shall consist of the furnishing, fabrication, erection and painting of the steel portions of bridges and other structures. Curb angles, steel nosings, bronze bearing plates, steel expansion joint construction and other metal work required for steel structures, for which provision has not otherwise been made, are included in this item of work.

4. 3. 2. Materials.

Transportation and Storing. Plain and fabricated materials shall be stored on platforms, skids or other supports above the surface of the ground, shall be protected from surface deterioration and damage, and shall be kept clean. The loading, transportation and unloading of the materials shall be conducted so as to avoid injury and deformation of the metal.

The materials for steel structures enumerated below shall conform to the requirements of the respective Articles of Division 8 as shown for each material:

Bearing and expansion plates, bronze	Art. 8. 4. 2
Bearing and expansion plates, rolled copper alloy	Art. 8. 4. 2
Castings, steel	Art. 8. 4. 3
Castings, iron and malleable	Art. 8. 4. 4
Forgings, steel	Art. 8. 4. 6
Paint, foliage green	Art. 8. 6. 4
Paint, graphite, black	Art. 8. 6. 5
Paint, red lead	Art. 8. 6. 7
Paint, red lead-graphite	Art. 8. 6. 8
Paint primer, zinc dust-zinc oxide	Art. 8. 6. 13
Steel bolts, corrosion-resistant	Art. 8. 4. 8
Steel bolts, nuts and washers, high-strength	Art. 8. 4. 9
Steel, eye bar	Art. 8. 4. 11
Steel, grid floor	Art. 8. 4. 12
Steel, low-alloy, high-strength	Art. 8. 4. 14
Steel H-piles	Art. 8. 4. 15
Steel sheet piling	Art. 8. 4. 22
Steel, structural carbon	Art. 8. 4. 23
Steel, structural, for welded members	Art. 8. 4. 24
Steel, structural nickel	Art. 8. 4. 25
Steel, structural rivet	Art. 8. 4. 26
Steel, structural rivet, high strength	Art. 8. 4. 27
Steel, structural silicon	Art. 8. 4. 28
Steel studs, automatic end-welded	Art. 8. 4. 29
Structural plates arches	Art. 8. 7. 8
Wrought iron plates	Art. 8. 4. 31
Wrought iron rolled shapes and bars	Art. 8. 4. 32
Zinc coating, hot-galvanized, on steel	Art. 8. 4. 33

Concrete filler for closed type steel grid floors shall be Class B concrete conforming to the requirements therefor specified in Art. 4. 1. 2 except that the coarse aggregate shall be ¾-inch size.

4. 3. 3. Methods of Construction.

The methods of construction for steel structures, including fabrication, erection, and welding shall conform to the require-

ments specified therefor in the current A. A. S. H. O. Standard Specifications for Highway Bridges and to the following amendments and additions thereto:

Welding. All welds shall be electric arc welds and where practicable shall be made by the submerged arc welding methods. Other welds shall be made with electrodes of the shielded arc type. Welding shall be done according to the best modern practice and shall conform to the requirements of current Specifications for Welded Highway and Railway Bridges of American Welding Society. All welders shall show satisfactory proof that they are able to make welds according to the requirements of these Specifications. The electrodes of the shielded arc type shall be coated or covered electrodes meeting the requirements of the tentative Specifications for Mild Steel Arc Welding Electrodes, Serial Designation A233 of the American Society for Testing Materials for electrodes suitable for conditions of intended use. The electrodes for submerged arc welding shall conform to the requirements specified therefor in the current specifications for Welded Highway and Railway Bridges of American Welding Society.

All butt welds in the top and bottom flange of welded plate girders, the outer one third of the tension area of web butt welds, and any other welds specified on the Plans, shall be completely radiographed at the Contractor's expense. The radiographic procedure shall conform to A. S. M. E. Boiler Code, Section VIII, Paragraph UW51 or other commercial practice subject to the approval of the Engineer. Radiographs shall be furnished to the Department in the number of copies requested. Sections of weld that are shown by radiography to have any types of imperfection as outlined in the above mentioned Boiler Code, shall be judged unacceptable and shall be repaired as outlined in the Boiler Code by the Contractor at his own expense before the member will be accepted for placement in the structure.

All web to flange fillet welds of welded plate girders shall be inspected by the magnetic particle method at the Contractor's expense. The method of inspection shall conform to the current A. S. T. M. Designation E109. Sections of weld that are shown by magnetic particle inspection to have any of the following types of imperfection shall be judged unacceptable.

(1) Any type of crack or zone of incomplete fusion or penetration.

(2) Any elongated slag inclusion which has a length greater than:

¼″ for T up to ¾″
⅓ T for T from ¾″ to 2¼″
¾″ for T over 2¼″

where T is the thickness of the thinner plate to be welded.

(3) Any group of slag inclusions in line that have an aggregate length greater than T in a length of 12 T, except when the distance between the successive imperfections exceeds 6 L, where L is the length of the longest imperfection in the group.

The Contractor shall furnish the Department with a certification that the girders have been inspected and are free of any of the above-described imperfections before the girders will be accepted for placement in the structure.

Satisfactory proof shall be given the Engineer that the personnel performing the inspection and interpreting the results are fully qualified by experience to do so.

Welding shall be performed using methods and procedures which will minimize distortion, working and locked-in stresses. The Contractor shall submit his proposed method of welding to the Engineer and obtain his approval before proceeding with welding. If the finished work shows any evidence of distortion, the Contractor shall straighten the members without damaging them, to the satisfaction of the Engineer.

All welding shall be performed in shops that are qualified by experience and have the equipment necessary to perform work satisfactory to the Engineer. The Contractor shall notify the Engineer where he intends to have his work performed and obtain the Engineer's approval before placing his order.

To minimize distortion and to prevent warping, welding of flange plates of stringers to the web, also final welding of stiffeners to the web, shall be performed simultaneously on both sides of the web.

All portions of each flange shall be joined and all portions of the web shall be joined before the flanges are joined to the web.

When welding flange plates to web plates, welding shall begin at the center of the stringer and proceed outward to the ends, leaving the ends free to move as the welds contract.

When welding comparatively thick flange plates to thin web plates special precautions must be exercised in the positioning of the electrode so that the major portion of the welding heat is applied to the thicker plate.

Camber. All structural steel members shall be cambered at the mill or fabricated in the shop to provide cambers in the amounts shown on the Plans. The cambers shall conform to a true parabolic or circular curve without abrupt changes in curvature. Where shear lugs or other members are to be welded to flanges, the fabricator shall take the necessary precautions to prevent loss of camber due to these operations. The steel members shall have the required camber when delivered at the bridge site.

Setting Bearings. Allowance shall be made for the effect of stress deformation and temperature changes when setting bearings. The axes of rockers and segmental roller bearings shall be set in an inclined position so that the rocker or roller will be vertical under dead load at a temepature of 60 degrees Fahrenheit. A sketch shall be shown on the erection drawing prepared by the fabricator indicating the proper inclination for setting the bearings at various temperatures.

The Contractor shall finally adjust rocker bearings, after all loads from the bridge superstructure and roadway approaches are in place, so as to provide the inclination from the vertical necessary to compensate for expansion or contraction in the bridge deck in conformity with the temperature of the deck.

The rocker bearings shall have the correct inclination at the time the bridge is accepted.

Whenever possible the embankment shall be in place in back of abutment walls before bearings are set in order to avoid displacement of bearings due to movement of the abutments.

High-Strength Bolts. High-strength bolts may be used in place of rivets where shown on the Plans or where their use is approved in writing by the Engineer. The installation of high-strength bolts shall be in accordance with the Specifications for Assembly of Structural Joints Using High-Strength Steel Bolts as approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation. Before proceeding with the installation of high-strength bolts, the Contractor shall furnish evidence to the Engineer that he has the necessary equipment and trained personnel to install the bolts to the required tension and torque values.

Automatic End-Welded Studs. Automatic end-welded studs may be used as shear connectors or for other purposes where called for in the Plans or directed by the Engineer. They shall be welded by the use of automatically-timed stud welding equipment or machines with suitable arc shields. The welds shall fully develop the strength of the bolt in tension and shall withstand a 90-degree bend in the bolt.

Defective Work. Twisted or bent members shall not be erected until the defects are corrected in a manner satisfactory to the Engineer. Only minor defects, which can be remedied without injury to the metal, shall be corrected in the field. Members with major defects, in the opinion of the Engineer, shall be returned to the shop for repairs or replacement.

Painting. Painting shall include preparation of surfaces to be painted; application, protection and drying of paint coatings; protection of traffic on and under the structure; protection of structure against disfigurement by paint, paint materials or rust;

and supplying all tools, tackle, scaffolding, labor, materials and all else necessary for performing and completing the work. Painting shall be done with brushes, unless otherwise permitted, in a neat and workmanlike manner. The paint for shop coat and field coats shall be of the kind hereinafter specified. The color of each subsequent coat shall be sufficiently different from that previously applied to distinguish it therefrom and shall be approved by the Engineer.

Paint shall be applied only in dry air on dry, frost-free surfaces and at an atmospheric temperature above 40 deg. F. Painting shall not be done on hot metal, causing paint to blister. Material painted under cover in damp or cold weather shall remain under cover until dry or until the weather conditions permit its exposure in the open. Paint shall be applied so as to produce a uniform, even coat, filling all surface irregularities. Rivet heads and edges of metal shall be striped in advance of the general painting. Surfaces inaccessible to paint brushes shall be coated by means of sheepskin daubers. Impure, unauthorized or improperly applied paint shall be removed and the surfaces cleaned and repainted at the Contractor's expense. Paint shall be thoroughly stirred before being removed from containers, and shall be kept stirred until applied. Mechanical mixers shall be used for stirring paint in original containers and necessary thinning in cold weather shall be done by heating only, unless otherwise approved by the Engineer. Steel to be encased in concrete shall not be painted.

Shop Painting. Surfaces to be painted shall be thoroughly cleaned, and all rust, loose scale, dirt, grease and other foreign matter shall be removed. Except as hereinafter specified, the surfaces shall be painted with one coat of red lead paint after the steel work has been accepted by the Inspector and before it is shipped. Surfaces not in contact but inaccessible after erection shall be painted 2 coats. Shop contact surfaces shall not be painted. Where a shop coat would make difficult erection of main splices for chords of trusses and of large girder splices involving multiple thicknesses of material, the field contact surfaces shall not be painted with the shop coat, but they shall be given a coat of approved lacquer or other protective coating if the steelwork is not expected to be erected within one month. Erection marks shall be painted on the shop coat. The paint shall be dry before the steelwork is loaded for shipment. Machined surfaces, except at splices and surfaces to be set on masonry, shall not be painted, but shall be covered with a hot coat of white lead and tallow mixture or other approved preparation.

Field Painting. When the erection and riveting is completed, all adhering rust, scale, dirt, grease and other foreign matter shall be removed. When this has been done, heads of rivets, surfaces with defective shop coat and shop or erection marks shall be painted

with shop coat paint. All small cracks, cavities or openings shall be filled with red lead and linseed oil. The first, and subsequently the second, field coat shall then be applied. No paint shall be applied over a previous coat until the latter is dry throughout the full thickness of the paint film.

All exposed structural metal shall be painted one shop coat and two field coats of paint. The shop coat and the first field coat shall be of red lead paint. The field coat paint shall be tinted to distinguish it from the shop coat. The second field coat shall be of graphite paint except for the outside face of the bottom flange of fascia beams and the fascia beam bearings which shall be painted with foliage green paint.

Painting of Galvanized Surfaces. No shop coat of paint will be required for galvanized surfaces. Where painting is required it shall consist of the two field coats as specified for painting structural steel. Before the application of the field coats, the galvanized surfaces shall be treated as follows: All grease and flux present shall be completely removed just prior to the paint application by wiping the surface with a cloth saturated with lead-free gasoline, followed by a second wiping with a clean cloth also saturated with lead-free gasoline. The galvanized surface shall then be given one brush application of zinc dust-zinc oxide paint primer, Class A.

Steel Grid Floors. The construction of steel grid floors shall conform to the requirements therefor specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges. Open type grid floor shall be used and shall be hot-dip galvanized. All roadway grid floors shall have serrated top surface throughout.

Structural Plate Arches. This work shall consist of structural plate arches as hereinafter specified and of the sizes and dimensions shown on the Plans.

The construction of structural plate arches shall conform to the requirements specified therefor in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

4. 3. 4. Quantity and Payment.

Except as hereinafter provided, the quantity of steelwork for which payment will be made will be the shop scale weight of structural steel, shoes, rockers, bronze plates, shop welds, floor joints, and other structural metals for which payment is not elsewhere provided, forming part of the permanent structure. The weight of welding electrodes used in field welds, excess field rivets shipped and not incorporated in the structure, members or parts used for erection purposes but not forming part of the permanent structure, excess weight of substituted members, excess weight of members increased in size for erection purposes, and excess weight

above that computed of more than 1.5 per cent, will not be measured for payment.

If authorized by the Engineer, the payment quantity for all or part of the work may be the computed weight instead of the scale weight. In weight computations, the weight of structural steel and steel castings shall be considered as 0.2833 pound per cubic inch; of cast iron 0.26 pound per cubic inch and of bronze 0.315 pound per cubic inch. The weights of plates 36 inches or less in width and of rolled shapes shall be computed on the basis of their nominal weight, deducting for cuts and open holes. Plates of greater width shall be computed on the basis of their dimensions, deducting for cuts and open holes, and adding one-half of the allowed percentages of overrun in weight given in current A. S. T. M. Designation A 6. The weight of rivet heads per 100 shall be included as follows: For ¾-inch rivets 12.5 pounds, for ⅞-inch rivets 18.5 pounds, and for 1-inch rivets 27 pounds. The weight of castings shall be computed from the net dimensions shown on the approved shop drawings with 10 per cent added for fillets and overrun. For painted metal, 0.4 per cent shall be added to the computed weight when the shop coat is red lead paint, and 0.2 per cent when the shop coat is red lead-graphite paint. The Contractor shall compute the weight of all members and furnish complete and detailed records of the computed weight of all metal work when so requested by the Engineer.

If the Contractor elect to use high-strength bolts in place of rivets for field connections, the weight of structural steel, for which payment will be made, will be based on the use of rivets.

The quantity of Steel Grid Floor for which payment will be made will be the actual number of square feet of top surface of grid floor, measured in place in the completed structure.

The quantity of Structural Plate Arch for which payment will be made will be the total length, in linear feet, of arch measured in place along the intrados at the center line of the span of the arch.

Payment for Structural Steel and other metal work as above described will be made for the quantity as above determined, measured in pounds, at the price per pound bid for the item STRUCTURAL STEEL in the Proposal, which price shall include the cost of all equipment, tools, final adjustment of rocker bearings, handling, falsework, scaffolding, transportation, labor, materials and all else necessary for the complete fabrication, erection, shop and field painting and proper completion of the work and all other work in connection therewith and incidental thereto.

Payment for bulb angles or studs used as shear connectors, complete in place including welding and all incidental work, will be made at the lump sum price bid for the item SHEAR CONNECTORS in the Proposal.

Payment for Steel Grid Floor, complete in place, will be made for the quantity as above determined at the unit price per square foot bid in the Proposal for the item STEEL GRID FLOOR, which price shall include galvanizing, welding, all labor, materials and equipment, and all else necessary therefor and incidental thereto.

Payment for Structural Plate Arch will be made for the quantity, in linear feet, as above determined at the unit price per linear foot bid for the item STRUCTURAL PLATE ARCH in the Proposal, which price shall include construction of the arch, complete in place, including the furnishing of all materials, labor and equipment, and all else necessary therefor and incidental thereto.

SECTION 4

Timber Structures

4. 4. 1. Description.

Timber structures shall include the furnishing of all materials for and the erection of framed timber structures except as otherwise provided in these Specifications.

4. 4. 2. Materials.

Timber for structures shall conform to the requirements or Art. 8. 9. 5 and shall be of southern yellow pine or Douglas fir of dense select structural grade. The stress grade or grades shall be as shown on the Plans or as prescribed in the Supplementary Specifications.

If timber is to be treated, the preservative shall be coal tar creosote conforming to the requirements specified in Art. 8. 9. 6. Preservative treatment shall be as specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

4. 4. 3. Methods of Construction.

The methods of construction shall conform to the requirements therefor specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

4. 4. 4. Quantity and Payment.

The quantity of Timber Structures, for which payment will be made, will be the actual volume of Timber Structures, or for the quantities of the various classifications if any, remaining in the finished structure, based on nominal cross section dimensions and actual lengths. No allowance will be made for waste.

Payment for Timber Structures will be made for the quantity or quantities as above determined, measured in 1,000 feet board measure, at the price or prices per M. feet B. M. bid for the item TIMBER STRUCTURES or for the various classified items of timber work, if any, in the Proposal, which price or prices shall include the cost of timber, hardware, preservatives and preservative treatment, painting, equipment, tools, labor and all else necessary for furnishing and placing the timber work as specified, and all other work in connection therewith and incidental thereto.

SECTION 5

Bearing Piles

4. 5. 1. Description.

Bearing piles shall include the furnishing and placing of piles of the material and dimensions prescribed and other specified work in connection therewith.

4. 5. 2. Materials.

Concrete Piles. Cast-in-place concrete piles shall be of Class B concrete. Precast concrete piles shall be of Class A concrete.

The materials for concrete piles, including reinforcement steel, shall be as specified for Concrete Structures in Art. 4. 1. 2 except as follows:

The coarse aggregate shall be ⅝ or ¾-inch size.

For precast concrete piles, the coarse aggregate shall be broken stone of trap rock, granite or gneiss, conforming to the requirements of Art. 8. 5. 5.

Metal shells for cast-in-place piles shall be of the diameter and thickness provided for in the Plans or Supplementary Specifications. If the thickness be not prescribed, the shells shall be of such thickness and shall be so reinforced that they will show no sign of distortion when driven, shall be watertight, and shall withstand collapsing forces until filled with concrete. Shells for steel pipe piles shall conform to the requirements of current A. S. T. M. Designation A 252, Grade 2. Joints shall be butt-jointed, arc-welded. All shells shall be equipped with heavy steel points having a diameter not less than the outside diameter of the pile tip. The design of the metal shells shall be submitted to and approved by the Engineer before the shells are driven.

Timber bearing piles shall conform to the requirements of Art. 8. 9. 2. Piles to be treated shall be of southern yellow pine.

Timber preservative for piles that are to be treated shall be coal tar creosote conforming to the requirements of Art. 8. 9. 6.

Preservative treatment shall be as specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

Steel H-piles shall conform to the requirements of Art. 8. 4. 15.

Test piles for all types of piles shall conform to the requirements specified for permanent piles.

4. 5. 3. Methods of Construction.

All operations pertaining to the driving of piles, determination of order lists for piling, determination of bearing values by loading tests, manufacture, storage and handling of piles and painting of exposed steel piles, shall conform to the requirements specified therefor in the current A. A. S. H. O. Standard Spceifications for Highway Bridges except that the provisions which require timber piling to be driven to a minimum value of 20 tons, if bearing values are not given on the Plans, are amended to provide that timber piles shall be driven to such depths as the Engineer may consider satisfactory.

Test piles shall be driven at the location of permanent piles.

Steel H-piles or other steel piles that are intended to bear on rock shall be driven to the extent necessary to penetrate the rock sufficiently to provide uniform and adequate bearing as determined by the Engineer.

For all types of piles, the Contractor shall provide, if necessary, for jetting, boring, blasting or the use of spuds, and other work necessary to obtain the penetration required by the Engineer.

If, in the opinion of the Engineer, cut-offs from timber piles or steel H-piles are of sufficient length to be used in the structure or structures included in the Project, they shall be so used if directed by the Engineer. If necessary, in order to produce the required length, cut-offs from steel H-piles shall be joined by splices, when directed by the Engineer. Cut-offs from steel shells of cast-in-place concrete piles may be spliced to produce the required lengths at the option of the Contractor.

Splices for steel H-piles shall conform to the details shown on Plans. Splices for steel shells of cast-in-place concrete piles shall fully develop the strength of the steel shells.

The Contractor shall submit, for the approval of the Engineer, his proposed method of making and handling cast-in-place concrete piles, and of assembling and driving the metal shells therefor. This method shall cover the assembly and welding of shells, and the assembly of reinforcement steel if required, the driving and cleaning of the shells, the depositing of concrete, and the cut-off procedure. This work shall not be started until the Engineer's approval is received.

4. 5. 4. Quantity and Payment.

If test piles are provided for on the Plans or in the Supplementary Specifications, and a specific number of test piles have been scheduled in the Proposal for payment on the basis of a unit price per test pile, the quantity of Test Piles for which payment will be made will be the number actually driven as prescribed and forming part of the permanent structure.

If test piles are provided for on the Plans or in the Supplementary Specifications and no specific item for payment therefor is scheduled in the Proposal, they will be paid for at the unit price bid for the same type of permanent pile and the length to be paid for will be the full length of test pile ordered by the Engineer.

The quantity of Piles, other than test piles, for which payment will be made will be the actual total length of piles of the type specified, in place in the finished work, in accordance with the Plans or as directed by the Engineer.

In the following, Cut-off shall mean the difference between the pile length ordered by the Engineer and that remaining in the finished structure.

The quantity of Cut-offs for which payment will be made will be the actual total length of cut-offs, except that individual cut-offs measuring less than one foot in length will not be measured for payment, and no payment will be made for cut-offs which are used in the structure or structures included in the Project. No payment will be made for cut-offs from test piles or cast-in-place piles. Cut-offs, unless used in the structure, shall become the property of the Contractor and shall be removed by him clear of the site of the work.

The quantity of Splices for Steel H-piles, for which payment will be made, will be the actual number of splices made as directed by the Engineer.

Payment for Test Piles, if scheduled in the Proposal for payment on the basis of a unit price per test pile, will be made for the number as above determined at the price per pile bid for the item TEST PILES in the Proposal. If no item of payment for test piles be scheduled in the Proposal, they will be paid for as above determined at the unit price bid for permanent piles of the same type as used for test piles.

Payment for Piles of the type or types specified will be made for the quantity as above determined, measured in linear feet, at the price or prices bid for the appropriate item or items TIMBER PILES, TREATED TIMBER PILES, STEEL H-PILES, PRECAST CONCRETE PILES, and CAST-IN-PLACE CONCRETE PILES, in the Proposal. These prices shall include the cost of furnishing, driving including jetting, boring, blasting or the use of spuds or other equipment or work necessary to obtain the penetration required by the Engineer, cutting off the

piles, treating timber piles, splicing of piles except as hereinafter provided, furnishing and placing steel dowels, all materials, equipment, labor and all else necessary therefor and incidental thereto.

Payment for CUT-OFFS as above determined will be made according to the prices therefor stated in the Supplementary Specifications.

Payment for Splices for Steel H-piles will be made for the quantity as above determined at the unit price bid for the item SPLICES FOR STEEL H-PILES in the Proposal, which price shall include the cost of all materials, equipment, labor and all else necessary for making the splices. No payment will be made for splices in steel shells of cast-in-place concrete piles.

No payment will be made for splices within the pile lengths ordered by the Engineer, except as provided above for splices for steel H-piles, unless the ordered lengths are in excess of those commercially available. Should it become necessary to increase the length of steel H-piles beyond the lengths ordered by the Engineer, splices used in extending them will be paid for as specified above.

Payment for pile Loading Tests will be made, for each pile loaded and tested as directed by the Engineer, at the price bid for the item LOADING TESTS in the Proposal, which price shall include the cost of all materials, equipment, labor and all else necessary for furnishing and constructing loading platforms, procuring and placing the load, making and recording the test, removing and disposing of loads and platforms, and all other work in connection therewith and incidental thereto.

SECTION 6

Bulkheads

4. 6. 1. Description.

Bulkheads shall include the construction of timber, concrete and steel bulkheads.

4. 6. 2. Materials.

Timber sheet piles shall conform to the requirements of Article 8. 9. 3 and shall be of dense southern yellow pine or Douglas fir.

Timber bulkhead piles shall conform to the requirements for timber bearing piles as specified in Article 8. 9. 2. Piles to be treated shall be of southern yellow pine.

Timber (except for piles and sheet piles) shall conform to the requirements of Article 8. 9. 5 and shall be of southern yellow

pine or Douglas fir of dense select structural grade. The stress grade or grades shall be as shown on the Plans or as prescribed in the Supplementary Specifications.

Timber preservative, for timber that is to be treated, shall be coal tar creosote conforming to the requirements specified therefor in Article 8. 9. 6.

Preservative treatment of timber, when prescribed, shall be as specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

Concrete Sheet Piles. The materials for concrete sheet piles shall conform to the requirements of Article 4. 1. 2, except that the coarse aggregate shall be broken stone of trap rock, granite or gneiss. Class A concrete, as specified in Article 4. 1. 2, shall be used.

Steel sheet piling shall conform to the requirements of Article 8. 4. 22. The piling shall be of a type and weight, and shall have a section modulus equal to the section, provided for on the Plans.

Hardware shall conform to the requirements for the hardware for Timber Structures, as specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges, except that all nails, spikes, bolts, dowels, washers and lag screws shall have a hot-galvanized zinc coating.

Tie rods, plate washers, turnbuckles and nuts shall be of wrought iron conforming to the requirements of Article 8. 4. 31 and 8. 4. 32 with hot-galvanized zinc coating. The hot-galvanized coating shall conform to the requirements of Article 8. 4. 33.

4. 6. 3. Methods of Construction.

The methods of construction shall conform to the requirements specified for Timber Structures in the current A. A. S. H. O. Standard Specifications for Highway Bridges and to the following requirements:

The operations pertaining to the driving of timber piles and the determination of bearing values shall be as specified for Timber Bearing Piles in Article 4. 5. 3.

The methods of manufacture of concrete sheet piles and the construction of all prescribed types of sheet piling shall conform in general to the provisions therefor specified in Article 4. 5. 3 except that lighter driving equipment may be used when suitable, subject to approval of the Engineer. Wales and caps, when prescribed, shall be provided and installed, and painting of steel sheet piling, wales and caps shall be performed, as shown on the Plans. The finished piling shall be vertical, true to line, driven to the prescribed depth, cut off to a straight line at the prescribed elevation, and practically watertight at the joints.

The lower ends of timber sheet piles shall be drift-sharpened to wedge against the adjacent timbers. If the tops are battered in driving, they shall be left slightly high and then cut off at the required elevation. After cutting, the ends of sheeting members and wales shall be treated with two applications of coal tar creosote.

If necessary, in order to obtain the penetration required by the Engineer, the Contractor shall use a water jet in combination with a hammer.

4. 6. 4. Quantity and Payment.

Bulkheads will be paid for under the items Sheet Piling of the prescribed types, Timber Structures, Timber Bulkhead Piles and Tie Rods.

The quantity of Sheet Piling for which payment will be made will be the projected area of the outer faces of piling actually placed in accordance with the Plans or as directed by the Engineer, exclusive of indentation of pile sections.

Payment for Timber, Concrete and Steel Sheet Piling will be made for the quantity of each as above determined, measured in square feet, at the unit prices per square foot bid for the items TIMBER SHEET PILING, CONCRETE SHEET PILING and STEEL SHEET PILING, respectively, in the Proposal, which prices shall include the cost of furnishing, driving and cutting off the piling, furnishing, placing and fastening hardware, painting, all materials, labor and all else necessary therefor and incidental thereto.

Quantity and payment for timber wales, caps and other structural members except sheet piling, when prescribed for use, shall be as specified for Timber Structures in Article 4. 4. 4.

Quantity and payment for Timber Bulkhead Piles shall be as specified for timber bearing piles in Article 4. 5. 4.

The quantity of Tie Rods for which payment will be made will be the computed weight of rods, plates, turnbuckles, washers and nuts actually furnished and placed in accordance with the Plans or as directed by the Engineer.

Payment for Tie Rods will be made for the quantity as above determined at the price per pound bid for the item TIE RODS in the Proposal, which price shall include furnishing, placing and fastening the rods, plates, turnbuckles, washers and nuts, furnishing all labor and equipment, and all else necessary therefor and incidental thereto.

SECTION 7

Pneumatically-Applied Mortar

4. 7. 1. Description.

Pneumatically-applied mortar shall consist of a course of mortar on steel or concrete structure surfaces, and elsewhere if prescribed, placed pneumatically by means of a machine that discharges water and a mortar mixture under regulated pressure through pipes or hose and a discharge nozzle, the water being combined with the mortar mixture at the nozzle. The course shall be reinforced with rods and wire mesh and shall be constructed at the locations and to the dimensions prescribed.

4. 7. 2. Materials.

Cement, fine aggregate, water and steel shall conform to the requirements therefor specified in Art. 8. 5. 22, 8. 5. 10, 8. 5. 38 and 8. 4. 19, respectively. The mortar shall be mixed in the proportion of 1 part cement to 3 parts fine aggregate. When ready to be used the fine aggregate shall have a normal content of 4 to 8 per cent of moisture, and the mixture shall be screened so as to remove lumps and pieces more than ¼ inch in size.

4. 7. 3. Methods of Construction.

Cleaning Steel. The surface to be covered shall be thoroughly cleaned by sand blasting or other approved method and all rust, grease and other foreign, loose or deteriorated materials shall be removed before applying the mortar course.

Cleaning Concrete. All disintegrated concrete shall be removed down to a firm concrete surface and all firm concrete shall be thoroughly cleaned and roughened before applying the mortar course.

Reinforcement. Steel rods, ⅜ inch in diameter, shall be securely attached to the steel structure by spot welding or by wiring through holes provided for the purpose or other approved method. Wire fabric of 2″ x 2″ mesh, No. 12 gauge galvanized wire then shall be securely fastened to and outside of the rods with wires, spaced not more than 2 feet apart.

Approved anchors shall be used for fastening the mesh to concrete surfaces. Adjacent sheets of wire fabric shall lap not less than 4 inches and shall be securely fastened together. When in place, the wire fabric shall be approximately ¾ inch from the surface of the steel or concrete.

Mortar Course. Mortar course shall be applied by means of a suitable pneumatic machine under air pressure of not less

than 35 pounds per square inch. When a length of more than 100 feet of hose or a lift of more than 25 feet is required, air pressure shall be increased proportionately to maintain the same pressure at the nozzle. The water used for hydrating the mortar mixture at the nozzle shall be maintained at a uniform pressure of 60 pounds per square inch, or at a pressure of more than 25 pounds in excess of that of the air. Only men with extensive experience in similar work shall be used for placing the pneumatically-applied mortar. Their qualifications shall be proved to the satisfaction of the Engineer, but his approval of men or their qualifications shall in no way relieve the Contractor of his responsibility to produce satisfactory results.

In shooting all surfaces, the nozzle shall be held at such distances and in such position that the stream of material will impinge as nearly as possible at right angles to the surface being covered. Any previously placed mortar coating shall be thoroughly washed with water and compressed air before new material is applied on top of or adjacent to it. Any deposit of loose fine aggregate shall be removed before placing the mortar coating, and if loose fine aggregate be covered the mortar shall be cut out, the fine aggregate removed and the mortar coating replaced. No mortar shall be placed in freezing weather except when authorized by the Engineer and under such precautions as he may direct or approve. No mortar shall be placed against surfaces in which frost is present.

The pneumatically-applied mortar shall follow accurately the outline of the steel or concrete members and shall have a thickness of not less than 2 inches. Shooting strips shall be used for the purpose of securing true and uniform lines for all members. The surface finish shall be made by first truing the surface to a plane by cutting off all high spots with a sharp-edged tool and then dragging the surface with a wide long-haired whitewash brush, thoroughly wetted with clean water. The mortar coating shall be so protected and cured as to prevent its temperature falling below 50° F. or a loss of moisture from the surface for not less than 7 days after it is placed. The finished surfaces shall be workmanlike in character and appearance, of uniform color, straight and true, and satisfactory to the Engineer.

4. 7. 4. Quantity and Payment.

The quantity of Pneumatically-Applied Mortar for which payment will be made will be the superficial area thereof, as limited by the prescribed dimensions, placed in accordance with the Plans or as directed by the Engineer.

Payment for Pneumatically-Applied Mortar will be made for the quantity as above determined, measured in square feet, at the price per square foot bid for the item PNEUMATICALLY-APPLIED MORTAR in the Proposal, which price shall include

preparation of surfaces, furnishing and placing reinforcement steel and mortar course complete, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 8

Metal Bridge Railings

4. 8. 1. Description.

Metal bridge railings shall consist of the construction of steel, wrought iron or aluminum railings on bridges as may be shown on the Plans.

4. 8. 2. Materials.

The materials for metal bridge railings shall be those enumerated below and shall conform to the requirements of the various Articles of Division 8 as shown respectively for each:

Structural steel	Art. 8. 4. 23
Corrosion-resistant steel bolts	Art. 8. 4. 8
Seamless steel pipe	Art. 8. 7. 9
Wrought iron pipe	Art. 8. 7. 11
Wrought iron rolled shapes and bars	Art. 8. 4. 32
Wrought iron plates	Art. 8. 4. 31
Malleable iron castings	Art. 8. 4. 4
Lead, for shims	Art. 8. 4. 7
Aluminum alloys, as shown on Plans	Art. 8. 4. 1
Metallic sealing compound	Art. 8. 4. 35
Paint, foliage green	Art. 8. 6. 4
Paint, red lead	Art. 8. 6. 7
Paint, red lead-graphite	Art. 8. 6. 8
Paint, zinc chromate-iron oxide	Art. 8. 6. 12
Paint primer, zinc dust-zinc oxide	Art. 8. 6. 13
Zinc coating, hot-galvanized, on steel	Art. 8. 4. 33

4. 8. 3. Methods of Construction.

All railings shall be erected true to the prescribed lines, grades and dimensions. Posts shall be vertical, or perpendicular to the grade, as shown on the Plans. The base plates of the posts shall be attached to top of parapet by anchor bolts set in the concrete.

Where necessary for vertical alignment of the railing, lead strips for steel or wrought iron railings, and aluminum shims for aluminum railings, shall be placed under the perimeter of base plates. The strips shall be 1¼ inches wide and of the required thickness. The strips, when placed, shall project ⅛ inch from the base plates. When the railing has been properly aligned, the nuts shall be tightened on the anchor bolts and the lead or aluminum

shims caulked to form a watertight seal between the base plates and the concrete of the parapet or other foundation. The anchor bolts shall be tightened again, where necessary, and all bolts shall not project more than ¼ inch above the nut and shall be peened so as to have a smooth surface and neat appearance. Care shall be taken to prevent injury to the concrete and impairment of the bond between the bolt and the concrete.

Steel and Wrought Iron Railing. Rails shall be of the shape and size shown on Plans. When elliptical pipe is provided for on the Plans, it shall be of the required wall thickness and shape and may be (1) rolled pipe subsequently reshaped cold or (2) pipe rolled to the required shape. The flattened pipe shall have uniform contour with tolerance not to exceed the tolerance for the same type of pipe before flattening.

Base plates shall be cut from strip or plate in accordance with the design shown on Plans, with all cuts true and square. All sharp and uneven edges shall be removed to form smooth finished surfaces. The bottom of base plates shall be flat after having been welded to the posts. Curling of the base plates shall be cause for rejection.

Welds shall be continuous around the perimeter of the posts at their intersections with the rails and with the base plates. Finished welds shall be smooth. The metal to be welded shall be in full contact before welding except that, when the relative sizes of rails and posts permit, openings may be made in the rails for penetration of the posts through the bottom rail and into the top rail before welding provided that the metal of the two members shall not miss contact by more than 1/32 inch. Welding shall be performed as specified for the welding of structural steel in Art. 4. 3. 3.

Steel and wrought iron railing shall be galvanized. All galvanizing that has been chipped off or damaged in handling or transporting railings shall be field-galvanized by the application of a paste composed of approved zinc powder and flux with a minimum amount of water. Field welds shall be similarly field-galvanized. The places to be coated shall be thoroughly cleaned including removal of slag on welds, before the paste is applied. The surface to be coated shall first be heated with a torch to a sufficient temperature so that all metal in the paste is melted when applied to the heated surface. All black residue from the paste flux appearing on the surface of the coated parts shall be wiped off with waste or removed by the quick application of cold water. Precautions shall be taken so that galvanized surfaces are not damaged by the torch.

Steel and wrought iron railings that are not to be galvanized shall be painted as specified for Structural Steel in Art. 4. 3. 3. When so provided in the Plans or Supplementary Specifications,

galvanized railings shall be surface treated and painted as specified for galvanized surfaces in Art. 4. 3. 3.

Aluminum Railing. Tubing shall be seamless and uniform in quality and temper. Exterior and interior surfaces shall be clean, smooth, and free from seams, slivers, laminations, grooves, cracks and other defects. End plugs shall be welded and ground smooth.

Welding shall be done by the inert gas shielded arc method and no flux shall be used. Types of connections other than welded will be permitted only where specifically called for on the Plans or authorized by the Engineer.

Rails shall be sawed or milled to length. Flame cutting will not be permitted. When rails are to be bent, they shall be heated to a temperature not greater than 400 degrees for a period not exceeding 30 minutes. All exposed surfaces of the pipe rails shall be mill finish, free from scratches and other surface blemishes. When scratches, surface blemishes and other imperfections in the rails are sufficient in number, extent and depth to warrant rejection, the pieces so designated shall be refinished to the satisfaction of the Engineer or replaced by the Contractor.

Post castings shall be produced by the permanent mold process. Posts may be finished with a raised parting line strip, as shown on the drawings. If it be necessary to omit this 1-inch wide raised strip, the casting will not be accepted when, in the judgment of the Engineer, excessive grinding of the parting line seam is required.

The raised or leveled parting line, fins, burrs and other projections shall be finished smooth, and flange edges rounded, after which the entire exterior surface of the post flange shall be brought to a bright uniform finish by burnishing. In lieu of burnishing, the surfaces may be given a fine grit belt finish, No. 100 to No. 120 grit, with grain of finished markings paralleling flange edges. The completed casting shall present a uniformly finished appearance satisfactory to the Engineer.

Before erecting the posts and rails, the Contractor shall submit a sample of the post casting to the Engineer for approval, if requested.

In handling aluminum materials in the shop and field, precautions shall be taken to avoid scoring or marring of the surfaces. Any such scoring or marring which, in the opinion of the Engineer, will give an objectionable appearance, shall be cause for rejection of the material.

After the concreting and other operations have been completed, the aluminum railing shall be thoroughly cleaned by removing any accumulations of oil, grease, dirt and foreign materials with a solvent cleaner such as benzene, naphtha or an approved equal.

Where aluminum surfaces are to be in contact with metals other than stainless steel, zinc, cadmium or other compatible metals, the contact surfaces shall be coated by painting the dissimilar metals (a) with a prime coat of zinc chromate primer, followed by one coat of aluminum metal paint, or (b) with an approved aluminum-impregnated caulking compound of a heavy brushing consistency.

Aluminum surfaces to be placed in contact with concrete shall be given a heavy coat of an aluminum-pigmented alkaline-resistant bituminous paint conforming to Specification MIL-P-6883. The paint shall be applied without the addition of thinner.

After erection, all spaces between base plates and concrete shall be thoroughly caulked with an aluminum-impregnated caulking compound conforming to Federal Specification TT-C598, consistency Grade 2.

Where posts are set in aluminum sleeves which have been previously installed in the concrete, the annular space between the posts and sleeves shall be filled with metallic sealing compound as specified above in Art. 4. 8. 2. Surfaces receiving the sealer shall be dry and free from dirt, oil, paint and other deleterious materials. Care shall be taken to secure a dense and complete seal. The top of the compound shall be beveled sufficiently to drain freely. In freezing temperatures, the sealing compound shall be slightly heated by immersion of the containers in hot water so as to bring it to a suitable consistency for application, or a grade of sealing compound which is adapted to winter application shall be used.

Aluminum railings shall be painted when so provided in the Plans or Supplementary Specifications. In such event, they shall be given one shop coat of zinc chromate-iron oxide paint and, after erection, bare spots shall be touched up with zinc chromate-iron oxide paint after which two field coats of paint shall be applied as specified for field coats for structural steel.

4. 8. 4. Quantity and Payment.

The quantity of Metal Railing for which payment will be made will be the actual length constructed in accordance with the Plans or as directed by the Engineer. The length measured for payment will be the sum of the over-all lengths of the individual railing sections after installation.

Payment for Metal Railing of the type specified will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item METAL RAILING in the Proposal, which price shall include the cost of furnishing and placing the various sections of railing and anchorages, shims, galvanizing, welding, painting, caulking, all labor, equipment, material and all else necessary therefor and incidental thereto.

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DIVISION 5

Road Structures

SECTION 1

Underdrains

5. 1. 1. Description.

Underdrains shall consist of the excavation for, and the construction of, drains for subsoil drainage. Underdrains, Type F, shall consist of pipe laid in a trench filled with a special backfill material.

Subbase outlet drains shall consist of trenches excavated and filled with a special backfill material and outlet pipes installed at the lower ends of the drains, as shown on the Plans.

5. 1. 2. Materials.

Pipes for underdrains and subbase outlet drains shall be of the types shown on the Plans and shall conform to the requirements specified respectively therefor in the appropriate Articles of Division 8, Section 7.

Backfill materials shall be coarse aggregate or fine aggregate of the size or sizes, or soil aggregate of the type and class, shown on the Plans or prescribed in the Supplementary Specifications. Coarse aggregate shall be of broken stone, washed gravel or blast furnace slag, conforming to the requirements of Art. 8. 5. 5, 8. 5. 6 and 8. 5. 7, respectively. Broken stone shall be of trap rock, granite, gneiss or dolomite. Fine aggregate shall conform to the requirements specified in Art. 8. 5. 10. Soil aggregate shall conform to the requirements of Division 8, Section 8.

Cement, for joint mortar in outlet pipes outside the roadway, shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements specified respectively therefor in Art. 8. 5. 22 and 8. 5. 23. Fine aggregate for joint mortar shall be as specified in Art. 8. 5. 10.

Burlap for caulking joints shall be new, clean and approved by the Engineer.

Salt hay shall conform to the requirements therefore specified in Art. 8. 5. 29.

The Contractor shall defer ordering materials for underdrains until such time or times during progress of roadway excavation

when the Engineer can ascertain the quantity of underdrains that will be required.

5. 1. 3. Methods of Construction.

Excavation, Pipe Laying and Backfill. Excavation and backfilling of trenches shall be governed by the provisions therefor specified in Art. 2. 7. 3 and 2. 7. 4 and pipe laying shall conform to the requirements specified in Art. 5. 2. 3, except as otherwise hereinafter provided.

For underdrain, Type F, excavation shall be made to a depth of 6 inches below the invert grade of the pipe for the full width of the trench and the trench refilled with the special backfill material shown on the Plans. Joints of bell and spigot type pipes shall be caulked with burlap or salt hay in such manner that will permit the flow of water, but not the passage of the backfill material, into the pipe. When perforated pipe is prescribed, it shall be laid with the perforations at the bottom.

Subbase outlet drains shall be constructed as follows:

The trench shall be excavated to the cross sectional dimensions and backfilled with the special backfill material, as shown on the Plans. The backfill shall be compacted with 3-wheel power rollers having a load on the rear rolls of not less than 330 pounds per inch of width of the rolls, and then leveled off.

Pipe shall be installed at the outlet end of the trenches as shown on the Plans. Where perforated corrugated metal pipes in the ends of the subbase drains are extended with bell and spigot type pipes outside the roadway, the joint openings of the bell and spigot pipes shall be caulked with oakum and filled with 1 :2 cement-sand mortar, as specified for pipe joints for storm drains in Art. 5. 2. 2.

Combination Drain. Combination drain shall be constructed in general conformity with the requirements for underdrain, Type F, and to the requirements shown on the Plans.

5. 1. 4. Quantity and Payment.

The quantity of Underdrain, Type F, and of Combination Drain, for which payment will be made will be the length of each actually constructed in accordance with the Plans or as directed by the Engineer.

The quantity of Subbase Outlet Drain for which payment will be made will be the length of trench filled with special backfill material, the length of pipe in the outlet ends of this trench, and the length of any pipe extension thereof in earth-filled trenches, actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Underdrain, Type F, and for Combination Drain, will be made for the quantities of each as above determined, measured in linear feet, at the prices per linear foot bid for the items UNDERDRAIN, TYPE F, and COMBINATION DRAIN, respectively, in the Proposal, which prices shall include the cost of excavation (except rock), sheathing, shoring, bracing, pumping, furnishing and placing pipe, backfill and other materials specified, caulking joints as specified, furnishing all labor and equipment and all else necessary therefor and incidental thereto. Rock excavation will be paid for as specified in Art. 2. 7. 4.

Payment for Subbase Outlet Drain will be made for the quantity as above determined, measured in linear feet, at the prices per linear foot bid for the item SUBBASE OUTLET DRAIN and for the item or items of PIPE in connection therewith, respectively, in the Proposal. The price bid for Subbase Outlet Drain shall include excavation of the trench and filling it with the special backfill material, as specified. The price or prices bid for the pipe items shall include furnishing and laying the pipe, making connections to inlets or other drainage structures, and excavation and earth backfilling of trenches for pipe extensions beyond the limits of the subdrainage trenches. These prices shall include the furnishing of all materials, labor and equipment, and all else necessary for and incidental to the abovementioned items of work.

SECTION 2

Storm Drains

5. 2. 1. Description.

Storm drains shall consist of the excavation for and construction of drains for surface drainage.

5. 2. 2. Materials.

Pipes shall be of the kinds and sizes shown on the Plans. The prescribed sizes of pipes are inside diameters. Pipes shall conform to the requirements specified respectively therefor in the various Articles shown below and to other requirements hereinafter specified.

Clay pipe	Art 8.7.4
Reinforced concrete culvert, storm drain and sewer pipe	Art. 8.7.5
Nonreinforced concrete sewer pipe	Art. 8.7.5
Cast iron culvert pipe	Art. 8.7.2
Cast iron water pipe	Art. 8.7.3
Corrugated metal culvert pipe	Art. 8.7.6
Corrugated metal pipe arches (reformed pipe)	Art. 8.7.7

Structural plate pipe and structural plate pipe-arches shall be as specified in Art. 5. 12. 2.

Clay pipe and reinforced concrete culvert pipe shall be standard strength or extra strength whichever is prescribed in the Plans or Supplementary Specifications.

Cast iron culvert pipe shall be smooth cast iron, extra heavy.

Cast iron pipe larger than 48 inches diameter, for drains and culverts, shall be cast iron water pipe as specified in Art. 8. 7. 3 and shall conform to the requirements of current A. S. A. Specification A 21. 2 for Cast Iron Pit Cast Pipe for Water or Other Liquids. It shall be Class 200 pipe for Laying Condition B.

Pipes shall be inspected and approved before shipment.

Mortar for pipe joints shall be 1:2 portland cement-sand mortar.

Concrete for pipe encasements, saddles and other pipe protection and supports shall be Class C, and for plugging pipes the concrete shall be Class D, as specified in Art. 4. 1. 2. Air-entrained concrete is not required.

Cement, aggregate and water for joint mortar and for concrete for encasement, saddles and other concrete supports shall be as specified for these materials in Art. 5. 3. 2.

Reinforcement for incidental concrete as provided above shall be as specified for Concrete Structures in Art. 4. 1. 2 and shall conform to the requirements of Art. 8. 4. 19.

Oakum for joints shall be made from hemp (Cannabis Sativa) line, or Benares Sunn fiber, or from a combination of both. The oakum shall be thoroughly corded and finished, and practically free from lumps, dirt and extraneous matter.

5. 2. 3. Methods of Construction.

Excavation and backfill for all drains shall be governed by the provisions of Art. 2. 7. 3 and 2. 7. 4. Pipe laying shall start at the low end, unless otherwise approved by the Engineer, and the pipe shall be bedded in the underlying soil for its full length. Bell and spigot pipe shall be laid with the spigot entering the full depth of the socket and with the bell end upgrade. Each bell and spigot joint shall be caulked firmly around its entire circumference with a gasket of oakum so as to fill less than one-half the depth of the joint. The remaining greater part of the joint then shall be completely filled with mortar around its entire circumference, and the mortar beveled beyond the end of the joint. Joints of tongue and groove pipe shall be filled with mortar around their entire circumference.

Corrugated metal pipe shall have the connecting bands neatly fitting the corrugations and all bolts shall be drawn tight and burred.

Broken or otherwise damaged pipe shall be replaced, and the pipe shall be kept clean of any deposit and debris. The pipes of any connected drainage system, and those of single drainage lines, shall not be laid until the exact locations of utility structures in the vicinity have been determined in the field and the line and grade of the pipes have been approved by the Engneer. The drains, as laid, shall be approved by the Engineer before the trench is backfilled. Except when necessary to maintain flow, drains shall not be placed in embankment until it has been constructed to a height of at least 3 feet above the top of the drain, or to the top of the embankment, whichever is the lower, and then a trench shall be excavated for the placing of the drain.

Where existing pipes are shown on the Plans to be relaid, they shall be taken up without damage, cleaned, and relaid as specified for new pipe. Where existing pipes are prescribed to be removed and reserved for the State, they shall be carefully removed, cleaned, and stored on the Project where directed by the Engineer, for disposal by the State.

The installation of corrugated metal pipe-arches and the banding of joints shall be as specified above for corrugated metal pipe.

The methods of installation of structural plate pipe and structural plate pipe-arches and other requirements pertaining thereto, shall be as specified in Art. 5. 12. 3.

The construction of concrete encasement, saddles, and other concrete supports or bedding for pipes, shall conform in general to the requirements of Art. 4. 1. 3.

5. 2. 4. Quantity and Payment.

The quantities of storm drain Pipes and Relaid Pipes for which payment will be made will be the actual lengths constructed and relaid, respectively, in accordance with the Plans or as directed by the Engineer, measured in place where laid or relaid, except that the length between inner faces of catch basin, inlet and manhole walls will not be measured for payment.

Payment for storm drains and relaid drains of the types and sizes specified will be made for the length of each type and size as above determined, measured in linear feet, at the prices per linear foot bid for the various storm drain PIPE and RELAID PIPE items, respectively, in the Proposal, which prices shall include the cost of excavation (except rock), furnishing, laying, assembling, and caulking the pipe, galvanizing and bituminous coating of corrugated metal pipes, paved inverts in corrugated metal pipes when specified, sheathing, shoring, bracing, pumping, backfilling, all materials, labor, equipment and all else necessary therefor and incidental thereto. For relaid pipes, the prices also shall include the cost of excavation necessary for removal of the pipe for

which payment has not been provided otherwise and cleaning of pipe. Rock excavation will be paid for as specified in Art. 2.7.4.

Existing pipe which is proposed to be relaid, or reserved and stored for the State, that becomes broken during removal because of carelessness or unsatisfactory methods or workmanship shall be replaced with new pipe by the Contractor without compensation.

If existing pipe which is proposed to be relaid become broken unavoidably in the process of removal or relaying, the length of such broken pipe will be deducted from the appropriate item of relaid pipe and will be paid for as new pipe in the manner specified above except that, if no item is scheduled in the Proposal for new pipe of the kind and size involved, payment will be made under a supplementary agreement executed on Change Order form DC-12, as provided in Art. 1. 8. 4. Excavation for and the removal of such broken pipe will be made as provided in Art. 1. 8. 4 if no item is scheduled in the Proposal for such excavation and pipe removal.

Quantity and payment for Corrugated Metal Pipe Arches (Reformed Pipe) shall be as hereinabove specified for storm drain pipes except that, when the arches are constructed as culverts and the ends are beveled to conform to roadway slopes, the payment length will be determined as specified for structural plate pipes and pipe-arches in Art. 5. 12. 4.

SECTION 3

Manholes, Inlets and Catch Basins

5. 3. 1. Description.

Manholes, inlets and catch basins shall consist of the construction of these structures and the excavation and backfill therefor. Wherever inlets are mentioned in this Section, they shall be construed to mean catch basins also.

5. 3. 2. Materials.

Concrete for the foundations of brick, concrete block, and concrete manholes, inlets and catch basins shall be Class D. For the walls of concrete inlets, manholes and catch basins, the concrete shall be Class C. Top slabs, if required, shall be of Class B concrete. The concrete shall conform to the requirements therefor specified in Art. 4. 1. 2. Air-entrained concrete is not required.

Mortar shall be 1:2 cement-sand mortar.

Cement shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA.

Coarse aggregate shall be broken stone of trap rock, granite or gneiss, or washed gravel.

Materials for the various types of construction shall conform to the requirements specified in the respective Articles of Division 8 as follows:

Cement, standard portland	Art. 8. 5. 22.
Cement, air-entraining portland	Art. 8. 5. 23.
Broken stone	Art. 8. 5. 5.
Washed gravel	Art. 8. 5. 6.
Fine aggregate	Art. 8. 5. 10.
Water	Art. 8. 5. 38.
Concrete block	Art. 8. 5. 15.
Concrete brick	Art. 8. 5. 18.
Clay or shale brick	Art. 8. 5. 18.
Gray iron castings	Art. 8. 4. 4.
Wrought iron, rolled shapes and bars, for ladder rungs	Art. 8. 4. 32.

5. 3. 3. Methods of Construction.

Excavation and backfill shall be governed by the provisions of Art. 2. 7. 3 and 2. 7. 4.

Concrete Structures. The methods of construction shall conform to the requirements of Art. 4. 1. 3.

Brick and Concrete Block Structures. The concrete block and brick shall be laid with broken joints, and all vertical and horizontal joints shall be filled with 1:2 cement-sand mortar. Straight joints shall be not more than ⅜ inch wide and radial joints not more than ½ inch in average width. The masonry shall be carried to such a height that a mortar joint not more than ½ inch thick is needed for setting the head casting without using split blocks or bricks. The outside wall shall be plastered with a ½-inch thick coat of 1:2 cement-sand mortar, troweled to a smooth finish.

Cast iron frames, grates and covers shall be fitted together and match-marked before being delivered, to prevent rocking of covers. Ladder rungs shall be provided in manholes as shown on the Plans.

If shown on the Plans, manholes and inlets shall be constructed using existing head castings reclaimed from manholes and inlets on the Project that are to be abandoned or removed. The castings shall be removed carefully from the existing drainage structures, all concrete, mortar and other adhering matter shall be removed therefrom and the castings stored, if necessary, for later use. The Contractor shall be responsible for the safekeeping of the reclaimed castings and shall replace, without additional compensation, any which may be lost or stolen, or which may become broken or damaged so as to be unusable, during their removal, cleaning or

storage. The materials and methods of construction including setting of the reclaimed head castings on the new structures, shall conform to the requirements hereinabove specified.

The portions of manholes and inlets below a depth of 8 feet from the top of manhole casting or inlet grate shall be constructed with walls of greater thickness and with foundations of greater thickness and area, than those of standard manholes and inlets, when and as specified or shown on the Plans.

Reconstructing manholes and inlets shall consist of carefully removing and cleaning the existing head castings and removal of the walls and ladder rungs to the necessary depth, disposal of the masonry, reconstruction of the walls, installing existing ladder rungs if in good condition or new rungs if necessary, resetting head castings at the proposed grade, excavation, backfilling and incidental work, all in conformity with the Plans and the requirements hereinabove specified for new manholes and inlets.

Converting existing inlets into manholes shall conform in general to the requirements hereinabove specified for the reconstruction of manholes and inlets except as follows: The inlet walls shall be removed to the necessary depth and a satisfactory wall transition shall be constructed from the existing rectangular or square section to a circular section and the walls corbeled to meet the diameter of the manhole frames. New manhole frames and covers of the design shown for standard manholes shall be furnished and set on the reconstructed walls. The existing inlet castings shall be reserved for re-use on the Project if needed; otherwise they shall become the property of the Contractor and shall be disposed of by him, unless they are prescribed to be reserved and stored for the State.

Reset and New Heads. When shown on the Plans, head castings of present structures shall be removed and reset to new elevation, new head castings shall be furnished and set on present structures. Masonry of present structures shall be added to or removed as may be necessary to conform to new surface grades and elevations. The work shall be done in conformity with the requirements specified above for the setting of new head castings.

5. 3. 4. Quantity and Payment.

The quantity of Manholes, Inlets and Catch Basins, of the various categories hereinabove specified, and of Reset Heads and New Heads when separately scheduled in the Proposal, for which payment will be made will be the number of each type thereof constructed, reconstructed, reset or installed, in accordance with the Plans or as directed by the Engineer.

The quantity of Manholes, Inlets and Catch Basins, Additional Depth, for which payment will be made will be the depth, in feet,

constructed in excess of a depth of 8 feet, measured for each structure below the top of the cover or grate.

Payment for Manholes, Inlets and Catch Basins constructed with new heads; for those constructed with existing heads; for those Reconstructed; for Inlets Converted to Manholes; for New Heads and Reset Heads when such new and reset heads are separately scheduled in the Proposal; and for Manholes, Inlets and Catch Basins, Additional Depth; will be made for the quantity of each as above determined at the unit prices bid for the appropriate items MANHOLES; INLETS; CATCH BASINS; MANHOLES, USING EXISTING HEADS; INLETS, USING EXISTING HEADS; CATCH BASINS USING EXISTING HEADS; RECONSTRUCTED MANHOLES; RECONSTRUCTED INLETS; RECONSTRUCTED CATCH BASINS; INLETS CONVERTED TO MANHOLES; RESET HEADS; NEW HEADS; and MANHOLES, INLETS and CATCH BASINS, ADDITIONAL DEPTH; in the Proposal, which prices shall include the cost of excavation (except rock), backfill, sheathing, shoring, bracing, pumping, construction or reconstruction complete, as specified, all materials including new head castings and ladder rungs or those reclaimed from the Project as prescribed, labor, equipment and all else necessary therefor and incidental thereto. Rock excavation will be paid for as specified in Art. 2. 7. 4.

SECTION 4

Gutters

5. 4. 1. Gutters.

Gutters shall consist of the construction of concrete, rubble stone, and grouted rubble stone gutters.

5. 4. 2. Materials.

Concrete shall be Class B unless otherwise shown on the Plans and shall conform to the requirements specified in Art. 4. 1. 2. The concrete shall be air-entrained. The materials for concrete, and the materials for and methods of air entrainment, shall be as specified for concrete surface pavement in Art. 3. 12. 2.

Cement, fine aggregate and water, for grout in grouted rubble gutter, shall be as specified for concrete surface pavement in Art. 3. 12. 2, except that air-entraining cement needs not be used.

Rubble stones for the gutter shall conform to the requirements of Art. 8. 5. 35.

5. 4. 3. Methods of Construction.

Excavation. Excavation and backfill shall conform to the requirements of Art. 2. 2. 1 and Art. 2. 2. 3.

Concrete Gutters. The methods of construction shall conform, in general, to the requirements of Art. 3. 12. 3 except as follows: The gutters shall have a wood float finish. Before initial set of the concrete, it shall be finished to an even, smooth surface at the proper grade. Forms shall be left in place not less than 24 hours after finishing. Expansion joints with ½-inch preformed bituminous cellular type joint filler shall be provided at intervals of 20 feet.

Rubble Stone Gutters. Rubble stone gutters shall be laid on a sand cushion not less than 2 inches thick. The stones shall be laid on edge with the greatest dimension at right angles to the centerline of the gutter. Spaces between stones shall be filled with spalls hammered into place, and the surface shall be covered with dry sand which shall be swept into the joints until they are filled. The stones shall be rammed to firm bearing and true surface. Then additional sand shall be swept into the joints until they are filled.

Grouted Rubble Stone Gutter. Grouted rubble stone gutter shall be constructed on a sand cushion not less than 2 inches thick. The stones shall be laid on edge on the cushion with the greatest dimension at right angles to the centerline of the gutter, and spaces between stones shall be filled with spalls. Then the stones shall be rammed to firm bearing and true surface. The stones shall be thoroughly sprinkled with water, and a thick 1:1 cement-sand grout shall be poured into the joints until they are completely filled and the surface is covered with a thin layer of grout. The surface shall be cured as specified in Art. 3. 12. 3.

5. 4. 4. Quantity and Payment.

The quantity of gutter of the type prescribed for which payment will be made will be the area, measured by the length and horizontal width, actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for gutters will be made for the areas as above determined, measured in square yards, at the prices per square yard bid for the items CONCRETE GUTTER, RUBBLE STONE GUTTER, and GROUTED RUBBLE STONE GUTTER, respectively, in the Proposal, which prices shall include the cost of excavation, backfill, construction of foundation and gutter complete, joint fillers, sand cushion, and other cushion or foundation if prescribed, reinforcement if specified, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 5

Curbs and Headers

5. 5. 1. Description.

Curbs and headers shall consist of construction of concrete and granite curbs and headers, except white concrete curbs.

5. 5. 2. Materials.

Concrete shall be Class B as specified in Art. 4. 1. 2 and shall be air-entrained.

Cement, aggregates, water, and the materials for and methods of air entrainment of the concrete, shall be as specified for concrete surface pavement in Art. 3. 12. 2.

Dowels for curb doweled to pavement shall be of any grade of carbon steel.

Joint fillers of the preformed bituminous cellular type and preformed bituminous type shall conform to the requirements specified respectively therefor in Art. 8. 5. 31.

Hot-poured rubber-asphalt joint sealer shall conform to the requirements therefor specified in Art. 8. 1. 10.

Curing material of clear or translucent liquid compound shall conform to the requirements therefor specified in Art. 8. 5. 29.

Granite curbs and headers shall conform to the requirements specified in Art. 8. 5. 28 and shall be quarry-split.

5. 5. 3. Methods of Construction.

Excavation and backfill shall conform to the requirements of Art. 2. 2. 1 and 2. 2. 3. The foundation for the curb, and backfilling, shall be well compacted by means of flat-faced mechanical tampers or by other means to be approved by the Engineer.

Curbs at driveways and entrances shall be depressed so that the top is 2 inches above the adjacent pavement or shoulder surface, where shown on the Plans or directed by the Engineer.

Concrete Curbs and Headers. Preparation of the concrete shall be as specified in Art. 3. 12. 3 except that the consistency shall be as specified in Art. 4. 1. 3.

Forms shall conform in general to the requirements for side forms specified in Art. 3. 12. 3 except the provisions thereof which apply particularly to pavement construction, and to the following requirements: Metal forms shall be used except that wood forms may be used on curves too sharp for satisfactory construction with metal forms, and for curbs that are constructed monolithically

with the pavement or base course. The materials and methods used for lubricating the forms shall be such that will not discolor or stain the concrete. Forms shall be removed when the concrete has hardened sufficiently to be self-supporting yet in ample time to allow for finishing as hereinafter specified.

The concrete shall be tamped and spaded, or vibrated, so that the forms are completely filled, the concrete thoroughly compacted and mortar is flushed to the face and top. The top shall be finished with a wood float to an even, smooth and dense surface and, as soon as the forms can be removed, the face shall be similarly finished. The edges of the curb shall be rounded to the required radius with suitable edging tools. In curbs, expansion joints shall be provided opposite joints in abutting concrete pavement and at approximately equal distances of not more than 20 feet between pavement joints except as otherwise specified or shown on the Plans and shall be filled with preformed bituminous cellular type joint filler, ½ inch thick, which shall be inset ¼ inch from the top and face. Curb joints shall be neatly rounded to ¼-inch radius. For headers, joints shall be provided as shown on the Plans. Between concrete curbs and concrete surface or base course, ½-inch preformed bituminous joint filler shall be installed and the joint shall be sealed with hot-poured rubber-asphalt joint sealer. Where shown on the Plans, the curb shall be constructed monolithic with the adjoining pavement.

Concrete curbs and headers shall be cured with clear or translucent liquid compound which shall be applied as soon as the concrete has been finished. The rate and manner of application shall be as described in Art. 312. 3.

Gradual transitions shall be constructed where changes in the size or shape of curbs occur in a continuous section.

When the curb is to be constructed upon a concrete pavement, all dirt, bituminous material and other loose or adhering matter shall be removed from the pavement, and the curb shall be doweled to the pavement with steel dowels of the size, and having the spacing, shown on the Plans. The diameter of holes drilled in the pavement shall be not more than ¾ inch greater than the diameter of the dowels. The dowels shall be set in a 1:2 cement-sand mortar. Transverse joints in doweled curb shall be installed directly over transverse joints and over definite cracks in the pavement. Additional joints shall be installed between pavement joints and cracks so as to divide the curb into sections of approximately equal lengths of not more than 20 feet.

The finished curb and headers shall be neat and workmanlike in appearance, and shall not vary from the prescribed line and grade more than ¼ inch at any point.

Granite Curbs and Headers. When a concrete foundation is required, Class D concrete as specified in Art. 4.1.2 shall be

used therefor. The curbs and headers shall be set with the top surface at the required grade. Joints shall be not more than ¼ inch wide for dressed, and ⅜ inch wide for quarry-split, curbs and headers. The joints shall be pointed with 1:1 cement-sand mortar. Between granite curbs and adjacent concrete surface and base course, expansion joints shall be provided and filled with ¼-inch preformed bituminous joint filler and sealed with hot-poured rubber-asphalt joint sealer.

The finished curbs and headers shall be neat and workmanlike in appearance, and shall not vary from the prescribed line and grade more than ¼ inch at any point.

5. 5. 4. Quantity and Payment.

The quantities of Concrete and Granite Curbs and Headers for which payment will be made will be the lengths actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Concrete and Granite Curbs and Headers (other than white concrete curb) will be made for the quantity of each as above determined, measured in linear feet, at the price per linear foot bid for the various items of CONCRETE CURB, CONCRETE HEADERS, GRANITE CURB and GRANITE HEADERS, respectively, in the Proposal, which prices shall include the cost of excavation outside the payment limits for other items, backfill, concrete foundation for granite curbs, construction of the curbs and headers, expansion joints in curb and between curb and adjacent concrete pavement or base course, doweling curbs to pavement if prescribed and cleaning pavement in connection therewith, all materials, labor, equipment and all else necessary therefor and incidental thereto.

When curbs are constructed monolithic with concrete surface pavement, base course or gutter, payment for curb as above provided shall include only the part of the structure within the limits of the curb proper. Payment for the area of concrete outside of the curb limits will be made at the price bid for concrete surface pavement, concrete base course or concrete gutter.

SECTION 6

White Concrete Curb

5. 6. 1. Description.

White concrete curb shall consist of the construction of white concrete vertical, sloping and barrier curbs.

5. 6. 2. Materials.

Gray concrete shall be Class B conforming to the requirements of Art. 4. 1. 2 and may be prepared with or without air entrainment.

White concrete shall be Class B air-entrained. The materials for and methods of producing air-entrained concrete shall be as specified in Art. 3. 12. 2.

Cement for gray concrete shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements specified in Art. 8. 5. 22 and 8. 5. 23, respectively. Air-entraining admixtures are not required.

Cement for air-entrained white concrete and mortar shall be white portland cement or air-entraining white portland cement conforming to the requirements therefor specified in Art. 8. 5. 24 and 8. 5. 25, respectively. Air-entraining admixtures as specified in Art. 3. 12. 2 shall be incorporated at the mixer if necessary to produce the specified air content. The air-entraining admixtures shall conform to the requirements specified therefor in Art. 8. 5. 2.

Fine aggregate for gray concrete, and for white concrete and mortar, shall conform to the requirements specified respectively therefor in Art. 8. 5. 10 and 8. 5. 11.

Coarse aggregate for gray concrete shall be broken stone of trap rock, granite or gneiss, or washed gravel, conforming to the requirements specified respectively therefor in Art. 8. 5. 5 and 8. 5. 6.

Coarse aggregate for white concrete shall be broken stone of light-colored granite, or light-colored quartz gravel, conforming to the requirements specified respectively therefor in Art. 8. 5. 5 and 8. 5. 6. The coarse aggregate shall be of ¾ or ⅝-inch size for gray concrete and white concrete.

Joint filler and curing material shall be as specified for concrete curbs in Art. 5. 5. 2.

5. 6. 3. Methods of Construction.

White Concrete Vertical and Barrier Curbs. White concrete vertical and barrier curbs shall be constructed as specified for concrete curb in Art. 5. 5. 3 with the following modifications:

The curb shall be constructed of white and gray concrete as shown on the Plans, or entirely of white concrete. Mixers and agitator trucks used for white concrete shall be used exclusively for that purpose during the time that the white concrete involved is under construction. The drums of such mixers and trucks shall be thoroughly washed and all gray cement and concrete removed prior to their use for white concrete and shall be maintained in that condition during the entire time of such use. Gray concrete, if used, shall be placed so as not to touch the part of the form against which the white concrete is to be placed. The surface of gray concrete shall be roughened if necessary to obtain proper

bond. White concrete shall be placed immediately after the gray concrete has slumped and before its initial set. Suitable devices and methods shall be used to prevent gray concrete entering the minimum limits shown for white concrete and, if necessary, to insure obtaining the required thickness of white concrete.

White Concrete Sloping Curb. The materials for and construction of white concrete sloping curb shall be as specified hereinabove for white concrete vertical curb except that it shall have an outer course of 1 :1 ¾ white mortar as shown on the Plans.

5. 6. 4. Quantity and Payment.

The quantities of White Concrete Curb for which payment will be made will be the lengths of the various types of white concrete curb actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for White Concrete Curb will be made for the quantity of each type of curb as above determined, measured in linear feet, at the prices per linear foot bid for the various items of WHITE CONCRETE VERTICAL CURB, WHITE CONCRETE SLOPING CURB and WHITE CONCRETE BARRIER CURB in the Proposal, which prices shall include the cost of excavation outside the payment limits of other items, backfill, construction of curb complete, reinforcement steel if prescribed, cleaning of pavement in areas of doweled curbs, drilling pavement and doweling when prescribed, curb expansion joints, expansion joints between pavement and curb, joint filler, all materials, labor, equipment and all else necessary therefor and incidental thereto.

When white concrete curbs are constructed monolithic with concrete surface pavement, base course or gutter, the limits of payment for curb shall be as specified in Art. 5. 5. 4 for similar construction with gray concrete curb.

SECTION 7

Bituminous Concrete Curb

5. 7. 1. Description.

Bituminous concrete curb shall consist of the construction of bituminous concrete curb, machine-laid, on an existing or new pavement surface or base course.

5. 7. 2. Materials.

Bituminous concrete shall be Type FA-BC-1 conforming to the requirements of Art. 3. 10. 2.

Tack coat material, if used, shall be asphalt cement, Penetration Grade 85-100, conforming to the requirements therefor specified in Art. 8. 1. 2.

5. 7. 3. Methods of Construction.

The bituminous concrete shall be prepared and transported in conformity with the requirements of Art. 3. 10. 3. When delivered and ready to be spread, its temperature shall be not less than 250° F. and not more than 325° F.

If, in the opinion of the Engineer, the surface on which the curb is to be laid require it, a tack coat shall be applied in a manner, and at the rate per square yard, determined by the Engineer. The tack coat shall be applied at a temperature of not less than 275° F. and not more than 350° F.

After cooling of the curb and prior to placing any backfill material against it, the side which will be in contact with the backfill shall be given a paint coat of asphalt cement, Penetration Grade 85-100, over the expected contact area.

The machine used for placing bituminous concrete curb shall be an approved automatic curber capable of producing finished curb by extrusion through a worm gear into the curb mold under high pressure. No side forms are required, but where the curb is to be laid on an existing pavement that does not have a smooth grade, the Engineer may require 2″ x 2″ angle irons to be used as a track so that the finished curb will have a smooth and true line and grade. Where angle irons are not required, other approved method shall be used to provide a satisfactory curb line and grade. The completed curb shall have a smooth surface and shall conform to the prescribed cross section.

5.7. 4. Quantity and Payment.

The quantity of Bituminous Concrete Curb for which payment will be made will be the length of curb actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Bituminous Concrete Curb will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item BITUMINOUS CONCRETE CURB in the Proposal, which price shall include the cost of furnishing and placing the bituminous concrete, furnishing and applying tack coat and paint coat as specified and required, all labor and equipment, and all else necessary therefor and incidental thereto.

When the curb is founded upon a new pavement surface or base course constructed under the Contract, the unit price bid for the curb shall include the cost of the pavement surface and base course within the curb area and of the curb constructed thereon.

SECTION 8

Sidewalks

5. 8. 1. Description.

Sidewalks shall include the construction of portland cement concrete sidewalks and bituminous concrete sidewalks and the subgrade therefor. Portland cement concrete sidewalk is hereinafter termed concrete sidewalk.

5. 8. 2. Materials.

Concrete Sidewalk Materials. Concrete shall be Class C as specified in Art. 4. 1. 2 and shall be air-entrained. The materials for concrete and the materials and methods used for air entrainment shall be as specified in Art. 3. 12. 2. Preformed bituminous cellular type and preformed bituminous type joint fillers shall conform to the requirements specified respectively therefor in Art. 8. 5. 31.

Bituminous Concrete Sidewalk Materials. *Gravel base material* shall be soil aggregate, Type 2, Class A or B, conforming to the requirements specified therefor in Division 8, Section 8.

Aggregates for macadam base shall be broken stone or blast furnace slag conforming to the requirements specified respectively therefor in Art. 8. 5. 5 and 8. 5. 7. Broken stone shall be of trap rock, granite, gneiss, dolomite or limestone. The aggregate sizes shall be 1½-inch and screenings.

Prime coat material shall be asphaltic oil, Grade MC-0 or MC-1, tar Grade RT-1 or RT-2, or emulsified asphalt, Grade SS-1, conforming to the requirements therefor specified in Art. 8. 1. 7, 8. 1. 12 and 8. 1. 5, respectively.

Bituminous concrete for surface course shall be hot-mixed bituminous concrete, Type FA-BC-1, or cold-mixed bituminous concrete, Type ASW or TSW. The bituminous concrete and the materials therefor shall be as specified in Art. 3. 10. 2 for Type FA-BC and in Art. 3. 11. 2 for Types ASW and TSW. When the prescribed thickness of bituminous concrete is 1½ inches or less, only top course material shall be used. When the prescribed thickness is more than 1½ inches, top and bottom course material shall be used.

5. 8. 3. Methods of Construction.

Subgrade. The subgrade for all sidewalks shall be constructed smooth and even and at the prescribed grade. It shall be compacted by not less than 3 passes of a tandem roller weighing

not less than 3½ and not more than 5 tons except that, if the subgrade soil is preponderantly sand, or sand and gravel, compaction shall be attained by not less than 2 passes of a vibrating soil compactor of a type acceptable to the Engineer. Areas inaccessible to the rollers or vibrating equipment specified above shall be compacted by approved flat-faced mechanical tampers.

Concrete Sidewalk. Preparation of the concrete shall be as specified in Art. 3. 12. 3. After being placed, the concrete shall be tamped, screeded and finished to true grade and surface. The finish shall be made with a wood float, followed by brushing with a wet soft-hair brush to a neat and workmanlike surface. Transverse expansion joints, ½ inch wide, shall be provided at intervals of not more than 20 feet and filled with preformed bituminous cellular type joint filler. Longitudinal joints, ¼ inch wide, shall be provided between curbs and abutting sidewalks and shall be filled with preformed bituminous type joint filler. The top of all joint filler shall be ¼ inch below the top of the sidewalk. Transverse surface grooves shall be cut in the sidewalk between expansion joints at intervals equal to the sidewalk width. All edges shall be neatly rounded to ¼ inch. The concrete shall be cured as specified in Art. 5. 5. 3.

Bituminous Concrete Sidewalk. Bituminous concrete surface shall be constructed on a gravel or macadam base whichever is prescribed in the Plans or Supplementary Specifications.

GRAVEL BASE. The soil aggregate shall be spread to such depth, and shall be graded and shaped, that the base will have the prescribed thickness and will be at the required grade and crown after compaction. The gravel base shall be compacted either by rolling or vibrating, or by mechanical tampers in inaccessible areas, as hereinabove specified for the compaction of the subgrade.

MACADAM BASE. A layer of screenings, ¾-inch thick, shall be spread on the prepared subgrade and shall not be compacted. Then 1½-inch size coarse aggregate shall be spread over the screenings to such depth that when completed the base course will be of the prescribed thickness and at the required grade and slope. The 1½-inch size aggregate shall be compacted with a tandem roller weighing not less than 3½ nor more than 5 tons until there is no perceptible movement of the aggregate under the action of the roller. The voids in the aggregate shall be completely filled with screenings and the base course well bound and compacted. The filling, binding and compacting may be performed by the vibratory method or by the rolling method. The work shall be performed in general as specified respectively for these methods under Macadam Base Course in Art. 3. 2. 3 except as follows:

Vibrating Method. After the 1½-inch aggregate has been compacted as specified hereinabove, the quantity of screenings neces-

sary to fill all voids shall be spread uniformly over the aggregate in one layer. The screenings shall be vibrated into the voids by one pass of a vibratory soil compactor of a type suitable for this kind of work and acceptable to the Engineer. If any voids remain unfilled after vibrating, additional screenings shall be spread, broomed and rolled into the voids. After vibrating, the entire area of the macadam base shall be rolled with the 3½ to 5 ton roller specified above until there is no perceptible movement of the base course under the wheels of the roller. No water shall be used.

Rolling Method. The rollers shall be 3½ to 5 ton rollers and all rolling shall be parallel to the centerline of the macadam base. Water shall not be used.

Irrespective of the method of compaction, all excess screenings shall be removed from the macadam base and a prime coat of bituminous material shall be applied thereto as specified in Art. 3. 2. 3, at the rate of 0.05 to 0.10 gallon per square yard, immediately prior to the construction of a bituminous surface thereon.

BITUMINOUS CONCRETE SURFACE. The methods of construction shall be in general conformity with the provisions of Art. 3. 10. 3 and 3. 11.3 for hot-mix and cold-mix, respectively, except that rollers weighing 3½ to 5 tons shall be used and the rolling shall be longitudinal only. The thickness shall be as shown on the Plans.

5. 8. 4. Quantity and Payment.

The quantity of Sidewalk for which payment will be made will be the area actually constructed in accordance with the Plans or as directed by the Engineer.

Payment for Bituminous Concrete Surface on the prescribed base, and Concrete Sidewalk, will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the items CONCRETE SIDEWALK and BITUMINOUS CONCRETE SIDEWALK, respectively, in the Proposal, which prices shall cover the cost of the sidewalk complete, including base course (for bituminous concrete sidewalk), subgrade, backfill, joints, all materials, labor, equipment and all else necessary therefor and incidental thereto. The price bid also shall include the cost of excavation of the sidewalk pavement box when no provision is made for its payment under other scheduled items.

SECTION 9

Island Pavement

5. 9. 1. Description.

Island pavement shall consist of the construction of concrete, white concrete, and bituminous concrete island pavements.

5. 9. 2. Materials.

Concrete Island Pavement. Concrete shall be Class B conforming to the requirements of Art. 4. 1. 2 and shall be air-entrained. Cement, aggregates, water, and the materials for and methods of producing air entrainment shall be as specified in Art. 3. 12. 2. Joint fillers and curing materials shall be as specified in Art. 5. 5. 2.

White Concrete Island Pavement. Gray concrete for the bottom course shall be Class B as specified above for concrete island pavement except that air entrainment is not required. White concrete for the top course shall be Class B conforming to the requirements of Art. 4. 1. 2 and shall be air-entrained. Materials for white concrete and the materials for and methods of air entrainment shall be as specified in Art. 5. 6. 2. Joint fillers shall be as specified in Art. 5. 5. 2.

Bituminous Concrete Island Pavement. Materials for the macadam base course and prime coat shall be as specified for bituminous concrete sidewalk in Art. 5. 8. 2 except that the large aggregate shall be 2½-inch size when the thickness of the base course is more than 4 inches.

Concrete and the materials therefor, joint fillers, and curing materials for concrete base shall be as specified above for concrete island pavement except that Class D air-entrained concrete shall be used.

Bituminous concrete for the surface course shall be of the type or types prescribed in the Plans or Supplementary Specifications and shall conform to the requirements specified in Art. 3. 10. 2 or 3. 11. 2, or both, according to the type or types prescribed.

5. 9. 3. Methods of Construction.

When island pavement is constructed on earth or subbase material, the subgrade shall be prepared and compacted as specified for sidewalk subgrade in Art. 5. 8. 3.

Concrete Island Pavement. When concrete island pavement is constructed on a concrete pavement or concrete base course,

a layer of 30-lb. roofing felt shall be laid over the pavement and the island concrete shall be placed thereon. Preparation of the concrete shall be as specified in Art. 3. 12. 3. After having been placed, the concrete shall be tamped, screeded and finished to true grade and surface. The surface shall be finished finally with a wood float. When island pavement is constructed on earth or subbase material, ½-inch wide transverse joints shall be constructed at intervals of not more than 20 feet. When the island pavement is constructed upon a concrete pavement, the transverse joints specified above shall be installed directly over joints in the pavement and at approximately equal intervals of not more than 20 feet between the pavement joints. Transverse joints shall be filled with preformed bituminous cellular type joint filler. If shown on the Plans, longitudinal joints of the same width and type shall be provided between the island pavement and abutting curbs. Joints and edges shall be rounded to ¼-inch radius.

Curing shall be as specified for concrete curbs in Art. 5. 5. 3.

White Concrete Island Pavement. White concrete island pavement shall be constructed as specified above for concrete island pavement except as follows:

The pavement shall consist of a top course of white concrete and a bottom course of gray concrete. The white concrete shall be placed within 20 minutes after placing the gray concrete bottom course unless otherwise approved by the Engineer. The white concrete shall be worked and consolidated in such manner that it will make proper bond with the gray concrete.

Bituminous Concrete Island Pavement. The bituminous concrete island pavement shall be constructed on a macadam base or concrete base as shown on the Plans.

Macadam base shall be constructed as specified for the construction of macadam base for bituminous concrete sidewalk in Art. 5. 8. 3 except as follows:

When the island is too narrow for compaction by the methods and equipment specified in Art. 5. 8. 3, other methods approved or directed by the Engineer shall be used.

When the macadam base is constructed on a pavement surface or base course the spreading of a layer of screenings before placing the large aggregate will not be required.

Concrete base shall be constructed as specified above for Concrete Island Pavement except as follows: The concrete shall have a screeded or broomed finish and the surface shall conform to the required grade within a tolerance of ⅜ inch in 10 feet. Joints and joint fillers shall be of the type, and shall be located, as shown on the Plans.

Bituminous concrete surface shall be constructed as specified for bituminous concrete sidewalk in Art. 5. 8. 3 except that, where

the island is too narrow for the operation of the specified equipment, the bituminous concrete shall be spread by hand methods and shall be compacted and finished to a dense, even surface with hot tampers and smoothing irons.

General. Island pavement of all types shall be finished to meet the top of adjacent curbs within a tolerance of ¼ inch and shall be crowned or sloped as shown on the Plans. Shields or other approved methods shall be used to prevent discoloration of, or damage to, completed curbs by the island pavement materials and construction operations.

5. 9. 4. Quantity and Payment.

The quantity of Concrete Island Pavement, White Concrete Island Pavement, and Bituminous Concrete Island Pavement for which payment will be made will be the area of each actually constructed in accordance with the Plans or as directed by the Engineer, including the area occupied by longitudinal joints between the island pavement and abutting curbs or other structures.

Payment for Concrete Island Pavement, White Concrete Island Pavement, and Bituminous Concrete Island Pavement will be made for the quantity of each as above determined, measured in square yards, at the prices per square yard bid for the items CONCRETE ISLAND PAVEMENT, WHITE CONCRETE ISLAND PAVEMENT and BITUMINOUS CONCRETE ISLAND PAVEMENT, respectively, in the Proposal, which prices shall cover the construction of the island pavement complete, including base course and preparation of subgrade, if any, joints, roofing felt, all materials, labor and equipment and all else necessary therefor and incidental thereto.

SECTION 10

Rubble Masonry and Riprap Walls

5. 10. 1. Description.

Rubble masonry and riprap walls shall consist of the construction of mortar rubble masonry walls, dry rubble masonry walls and rubble riprap walls.

5. 10. 2. Materials.

Rubble stones for mortar rubble and dry rubble masonry walls shall conform to the requirements specified therefor in Art. 8. 5. 35.

Rubble stones for rubble riprap walls shall conform to the requirements specified therefor in Art. 8. 5. 35.

Mortar. Cement for mortar shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA, conforming to the requirements specified respectively therefor in Art. 8. 5. 22 and 8. 5. 23. Fine aggregate for mortar shall be as specified in Art. 8. 5. 10. Air entrainment of the mortar is not required.

5. 10. 3. Methods of Construction.

Rubble Masonry Walls. Excavation and backfill shall conform to the requirements of Art. 2. 6. 3. Rock encountered in excavation shall be shaped to provide a firm bearing. Excavation shall be approved before the construction of the wall is started. Selected stones, rough squared and cut to the required pitch, shall be used at angles and ends of walls. The largest stones shall be used for the bottom courses of the wall and the size shall gradually decrease toward the top. The stones shall be laid so as to break joints and bond together, with their bedding planes and lines of stratification approximately horizontal. Not less than 25 per cent of the face area shall be headers uniformly distributed. The face stones shall have exposed faces parallel to the face of wall. The finished wall shall be substantially built and have a neat and workmanlike appearance. Drainage openings shall be provided where shown on the Plans.

Dry Rubble Masonry Walls. Face joints shall be not more than 2 inches in width and other joints shall be not more than 4 inches in width. Spaces between stones shall be filled with spalls, neatly fitted into place, except that no spalls shall be used in the face.

Mortar Rubble Masonry Walls. All the stones shall be laid in a bed of 1:2 cement-sand mortar and all spaces between stones shall be filled with mortar and packed with spalls except that no spalls shall be used in the face. All voids shall be filled with mortar. The face joints shall be not more than 1 inch wide and shall be pointed before the mortar has set.

Rubble Riprap Walls. Laying of the stones in courses is not required. The larger stones shall be placed in the bottom of the wall and progressively smaller sizes shall be used from the bottom to the top. The stone sizes shall be appropriate for the sizes of the walls shown on the Plans. The stones shall be placed so that there will be the minimum of voids and maximum stability of the wall.

5. 10. 4. Quantity and Payment.

The quantity of Rubble Masonry Walls and Rubble Riprap Walls for which payment will be made will be the volume of walls constructed as above described and in accordance with the Plans or as directed by the Engineer.

Payment for Rubble Masonry Walls and Rubble Riprap Walls will be made for the quantity of each type as above determined, measured in cubic yards, at the prices per cubic yard bid for the items DRY RUBBLE MASONRY WALLS, MORTAR RUBBLE MASONRY WALLS, and RUBBLE RIPRAP WALLS, respectively, in the Proposal, which prices shall include the cost of shaping rock surface, backfill, furnishing and placing stone and mortar, drainage openings, all materials, labor, equipment and all else necessary therefor and incidental thereto. The prices bid for the walls also shall include the cost of excavation when it is not specified or shown on the Plans for payment under other scheduled items of the Proposal.

SECTION 11

Concrete Crib Walls

5. 11. 1. Description.

Concrete crib walls shall include the excavation for and construction of walls of precast reinforced concrete crib members, placed as headers and stretchers to form a cribbing of the required dimensions, and broken stone and porous fill material placed within the cribbing. The design of crib wall and crib members shown on the Plans, or other designs conforming to the requirements herein specified and acceptable to the Engineer, may be used, and the Contractor shall submit detail drawings of the crib members as well as assembly drawings for the Engineer's approval.

5. 11. 2. Materials.

Crib members shall conform to the requirements specified in Art. 8. 5. 27. Class A concrete shall be used.

Broken stone for crib fill shall be 2½-inch size and shall conform to the requirements specified in Art. 8. 5. 5.

Porous fill material for crib fill shall be soil aggregate, Type 4, Class A, conforming to the requirements therefor specified in Art. 8. 8. 1.

5. 11. 3. Methods of Construction.

Crib Members. The reinforcement steel shall be arranged symmetrically about the principal axis of the member. The cross section area of the reinforcement steel shall be not less than 1 per cent of that of crib members for headers and not less than 0.9 per cent for stretchers. The volume of concrete header and stretcher members shall be not less than 16 per cent of the gross volume of the finished wall.

Wall. Sill pieces not less than 20 inches in total width shall be laid at the front and back at starting course. Cap stretchers weighing not less than 50 pounds per linear foot shall be used at the top of the front of the wall. The front face of finished open face type walls shall have not more than 50 per cent openings. The total height of a course of headers and stretchers shall be not more than 12 inches. Stretchers shall be formed and arranged so as to retain backfill adequately. Exposed edges of crib members shall be beveled. The Contractor shall excavate as much as may be necessary to prepare a proper foundation for the wall and shall set it on a bed of approved bank-run gravel or other approved material to provide an even bearing. Crib members shall be free from cracks, spalls and depressions. Damaged members shall not be used and shall be replaced at the Contractor's expense. The finished face shall be neat and workmanlike. The maker of the cribbing shall instruct the Contractor in the placing of the cribbing for a limited time at the beginning of the work.

The fill for crib walls shall include a minimum thickness of two feet of broken stone behind the front face stretchers. The remainder of the enclosure shall be filled with porous fill material.

The broken stone, porous fill, and embankment behind the porous fill, shall be placed in lifts as the construction of the crib proceeds upward and shall extend up to the full height of the crib. As the filling progresses, bulkheads shall be placed, or other methods approved by the Engineer shall be used, to keep the broken stone and porous fill material within their respective prescribed limits. Each lift of broken stone, porous fill, and embankment immediately adjacent to the porous fill shall be placed in layers not more than 6 inches thick and each layer shall be thoroughly compacted by flat-faced pneumatic tampers of a type approved by the Engineer.

5. 11. 4. Quantity and Payment.

Except as hereinafter provided, the quantity of Concrete Cribbing for which payment will be made will be the volume of the concrete crib members in the finished wall placed in accordance with Plans or as directed by the Engineer.

The quantity of Broken Stone Fill for Crib Wall for which payment will be made will be the compacted volume of broken stone fill placed in accordance with the Plans, measured in place in the crib wall.

The quantity of Porous Fill for which payment will be made will be the compacted volume furnished and placed in accordance with the Plans, measured in place in the crib wall.

Payment for Concrete Cribbing will be made for the quantity as above determined, measured in cubic feet, at the price per cubic

foot bid for the item CONCRETE CRIBBING in the Proposal, which price shall include the cost of excavation, bedding, furnishing and placing crib members, all materials, labor, equipment and all else necessary therefor and incidental thereto; provided, however, that if a design other than that shown on the Plans is approved and used, and said design involves the use of a greater volume of concrete than that for the design shown, payment will be made only for the volume of concrete required for the construction of the cribbing of the design shown on the Plans.

Payment for Broken Stone Fill for Crib Wall will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item BROKEN STONE FILL FOR CRIB WALL in the Proposal, which price shall include furnishing and placing stone fill material as above described, all materials, labor, equipment and all else necessary therefor and incidental thereto.

Payment for Porous Fill for Crib Wall will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the item POROUS FILL FOR CRIB WALL in the Proposal, which price shall include the furnishing and placing of porous fill material as above described, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 12

Headwalls and Culverts

5. 12. 1. Description.

Headwalls and culverts include excavation for and the construction of concrete headwalls, built-in-place concrete culverts of less than 5 foot span, structural plate pipe and structural plate pipe-arches. Corrugated metal pipe arches (reformed pipe), when used for culverts, shall be governed by the provisions therefor specified in Division 5, Section 2.

The description of structural plate pipe and structural plate pipe-arch structures shall be as stated in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

Provisions covering structural plate arches are specified in Division 4, Section 3, and concrete foundations therefor in Division 4, Section 1, of these Specifications.

Concrete retaining walls built as appurtenances to roadway construction, except those for use as headwalls at the ends of pipes and culverts, shall be considered as concrete structures, and the materials, methods of construction and quantity and payment

therefor shall be governed by the provisions of Division 4, Section 1. Excavation for such retaining walls shall be performed and paid for as specified for Foundation Excavation in Art. 2. 6. 3 and 2. 6. 4 except such portion as may be shown or prescribed to be performed and paid for as Roadway Excavation.

5. 12. 2. Materials.

Class B concrete shall be used for built-in-place concrete culverts. Class C concrete shall be used for headwalls. Concrete may be prepared with or without air entrainment. Concrete and the materials therefor shall be as specified in Art. 4. 1. 2. Type II or Type IIA cement shall be used.

Structural plate pipe and structural plate pipe-arches, and bituminous coating, shall conform to the requirements specified therefor in Art. 8. 7. 8.

Bituminous material for paved invert of corrugated metal pipe-arches (reformed pipe) shall be the same as specified for bituminous coating.

Sheet asphalt mixture, top course, for the paved invert of structural plate pipe and structural plate pipe-arches shall conform to the requirements specified therefor in Art. 3. 10. 2.

Bituminous material for the fog spray tack coat hereinafter prescribed shall be emulsified asphalt, Grade RS-1, conforming to the requirements specified therefor in Art. 8. 1. 5.

The rise and span of structural plate pipe and pipe-arches are measured from inside crests of corrugations.

Plates for structural plate pipe and pipe-arches shall be inspected and approved before shipment unless otherwise directed by the Engineer.

5. 12. 3. Methods of Construction.

Excavation and backfill for all headwalls and concrete culverts shall be governed by the provisions of Art. 2. 7. 3 and 2. 7. 4. The methods of construction, including curing, of concrete headwalls and culverts shall conform to the requirements of Art. 4. 1. 3. Excavation and backfill for, and bedding of, structural plate pipes and structural plate pipe-arches shall conform to the requirements of Art. 2. 7. 3 of these Specifications and to the requirements of the current A. A. S. H. O. Standard Specifications for Highway Bridges. Where conflictions or inconsistencies occur between the two Specifications, the A.A. S. H. O. Specifications shall govern.

Field erection of structural plate pipes and structural plate pipe-arches shall conform to the requirements of the current A. A. S. H. O. Standard Specifications for Highway Bridges.

When elongated structural plate pipe is required, it shall be shop-elongated or field-strutted whichever is shown on the Plans or specified in the Supplementary Specifications and shall have a distortion of not less than 3 and not more than 5 per cent out of round. Field strutting shall conform to the requirements of the current A. A. S. H. O. Standard Specifications for Highway Bridges except that the strutting shall be done after the pipe has been erected in place and before any fill or backfill has been placed around it.

Where specified or shown on the Plans, the ends of structural plate pipe and structural plate pipe-arches shall be beveled to conform to the roadway slopes.

When a paved invert is prescribed for a structural plate pipe or structural plate pipe-arch, it shall be placed after the pipe or pipe-arch is erected. It shall cover 25 per cent of the periphery of the pipe and 40 per cent of the periphery of the pipe-arch and shall have a minimum thickness of 1 inch, measured over the crests of the corrugations. When the pipe or pipe-arch is not to be bituminous-coated, and a paved invert is specified, the area of the pipe or pipe-arch to be paved shall be uniformly precoated with a fog spray tack coat of emulsified asphalt, Grade RS-1. The tack coat shall be free of water and be tacky at time of installation of the invert pavement. The invert pavement shall be constructed with sheet asphalt mixture, top coarse. The bituminous mixture shall be prepared in a manner approved by the Engineer. The invert pavement shall be placed and tamped to the proper shape and thickness.

5. 12. 4. Quantity and Payment.

The quantity of Headwalls, and Concrete Culverts of less than 5 foot span, for which payment will be made will be the volume of concrete actually placed in accordance with the Plans or as directed by the Engineer.

The quantities of Structural Plate Pipe and Structural Plate Pipe-Arches for which payment will be made will be the lengths of each in linear feet, measured along the bottom, actually furnished and installed in accordance with the Plans and Specifications or as directed by the Engineer except that where these pipes and pipe-arches are beveled vertically, horizontally, or both, measurement for payment will be made from end to end along the bottom thereof, or on one springing line, whichever is the longer.

Payment for Headwalls, and for Concrete Culverts of less than 5 foot span, will be made for the quantities as above determined at the prices per cubic yard bid for the items HEADWALLS AND CONCRETE CULVERTS, respectively, in the Proposal, which prices shall cover the cost of construction complete, including excavation (except rock), sheathing, shoring, bracing, pumping,

backfill, furnishing reinforcement and all other materials, all labor and equipment, and all else necessary therefor and incidental thereto.

Payment for Structural Plate Pipe and Structural Plate Pipe-Arches will be made for the quantities as above determined at the prices per linear foot bid respectively for the items STRUCTURAL PLATE PIPE and STRUCTURAL PLATE PIPE-ARCHES in the Proposal, which prices shall include the cost of construction complete, including bituminous coating, paved invert when required, excavation (except rock), sheathing, shoring, bracing, pumping, backfill, furnishing all materials, labor and equipment, and all else necessary therefor and incidental thereto. Rock excavation will be paid for as specified in Art. 2. 7. 4.

SECTION 13

Monuments and Federal Project Marker Posts

5. 13. 1. Description.

Monuments and federal project marker posts shall include furnishing and setting new concrete monuments and federal project marker posts and the resetting of existing monuments.

5. 13. 2. Materials.

Concrete shall be Class A, as specified in Art. 4. 1. 2, with or without air entrainment.

Reinforcement shall be as specified in Art. 8. 4. 19.

Cement, aggregates, and water for concrete shall be as specified in Art. 5. 3. 2.

Bronze and copper markers in new monuments shall be of materials approved by the Engineer.

Black paint for federal marker posts shall be ready-mixed paint suitable for the purpose, of good quality and acceptable to the Engineer.

5. 13. 3. Methods of Construction.

New monuments and federal project marker posts shall conform to the design shown on Plans and shall be precast. Construction, including curing, shall conform to the requirements specified in Art. 4. 1. 3. Excavation and backfill shall be governed by the provisions of Art. 2. 7. 3 and 2. 7. 4. When in place, the top surface of monuments shall be horizontal and the metal marker shall be in the true position established by the Engineer.

Federal marker posts shall be set vertical at points near the end or ends of the Project where directed by the Engineer. The Federal project number shall be painted on the marker posts in black letters as shown on the plans.

The backfill around all monuments and federal project marker posts shall be thoroughly compacted by tamping with flat-faced hand tampers in a manner to be approved by the Engineer.

Existing monuments or title stones that are encountered shall be protected, and shall be reset where specified or directed by the Engineer, in conformance with the provisions of Art. 1. 6. 12 and with the requirements for the setting of new monuments as hereinabove specified.

The Contractor shall protect all U. S. Coast and Geodetic Survey monuments from disturbance and damage. Construction equipment, materials and material delivery trucks shall be kept at a safe distance from them. Those that are to be relocated shall not be moved or disturbed until they have been properly referenced by the Engineer. After having been referenced, they shall be carefully reset, as directed by and in the presence of the Engineer, in the exact position established by him, and as specified hereinabove for the setting of new monuments. If approved by the Engineer, new monuments may be cast-in-place, in lieu of resetting the existing monuments. Materials as specified above for new monuments in Art. 5. 13. 2, and a marker of the same kind as that in the existing monument, shall be used in the cast-in-place monuments. The upper part of the monument to a depth of 6 inches below the ground surface shall be formed to a square cross section of the same dimension as that of the existing monument. The marker shall be firmly imbedded in the concrete and set flush with the top of the monument.

5. 13. 4. Quantity and Payment.

The quantity of New Monuments, Reset Monuments, and Federal Project Marker Posts for which payment will be made will be the actual number of new monuments and marker posts furnished and set in accordance with the Plans or as directed by the Engineer.

Payment for New Monuments, Reset Monuments, and Federal Project Marker Posts will be made for the quantity of each as above determined at the unit prices bid for the items NEW MONUMENTS, RESET MONUMENTS, and FEDERAL PROJECT MARKER POSTS respectively, in the Proposal, which prices shall include furnishing and setting new monuments, resetting existing monuments, furnishing and setting federal project marker posts and painting the project numbers thereon, excavation (except rock) and backfilling, all materials, labor and equipment and all else necessary therefor and incidental thereto. Rock excavation will be paid for as specified in Art. 2. 7. 4.

Payment for resetting U. S. Coast and Geodetic Survey control monuments, or cast-in-place monuments in lieu of such resetting, will be made at the price bid for Reset Monuments as specified above.

SECTION 14

Beam Guard Rail

5. 14. 1. Description.

Beam guard rail consists of a steel rail element mounted on steel, wood or concrete posts.

5. 14. 2. Materials.

Steel rail element shall conform to the Plans and to the requirements specified in Art. 8. 4. 17.

Steel posts shall conform to the Plans and to the requirements of Art. 8. 4. 16 and shall have square ends.

Concrete Posts. Concrete posts shall conform to the design shown on the Plans. Concrete for posts shall be Class A conforming to the requirements of Art. 4. 1. 2. Air entrainment of the concrete is not required. Reinforcement steel shall be as shown on the Plans and shall conform to the requirements of Art. 8. 4. 19.

Wood posts shall be as shown on the Plans. They shall be of 1300#C dense structural grade southern pine, and shall be sound, square edge, saw-finished, with no heartwood requirements.

Timber for posts and its grading shall conform to the requirements of Art. 8. 9. 1 and will be inspected for grading at the treatment plant prior to treatment.

Timber preservatives shall be coal tar creosote, or pentachlorophenol solution in petroleum—5 per cent pentachlorophenol, conforming to the requirements specified respectively therefor in Art. 8. 9. 6.

Preservative treatment of timber and the inspection of treatment shall conform to the requirements of the latest issue of Federal Specification TT-W-571, Wood Preservative; Recommended Treating Practice, except that the minimum net retention of each of the preservatives specified above shall be 8 pounds per cubic foot. Inspection of treatment shall be made at the treatment plant.

Rust-inhibitive primer shall conform to the requirements of Art. 8. 6. 9.

White paint shall conform to the requirements of Art. 8. 6. 11.

5. 14. 3. Methods of Construction.

Only one of the alternative types of posts specified in Art. 5. 14. 1 and 5. 14. 2 may be selected and used on the Project.

If steel posts be used, steel channel cross pieces shall be attached to the last two posts at each end of guard rail sections as shown on the Plans. These last two steel posts and all wood and concrete posts shall be set in excavated holes and the backfill shall be firmly tamped in layers not more than 6 inches thick in a manner satisfactory to the Engineer. All other steel posts shall be driven to the required position.

All posts shall be plumb, properly spaced and to the prescribed line and grade. Post holes shall be excavated to such depth that backfill below the posts will be kept to the minimum and any such backfill shall be thoroughly compacted before setting the posts.

The rail elements shall be erected to the required grade and line with the top edge in a straight line or smooth curve, parallel to or concentric with the roadway. Where a vertical transition is required the top edge of rail elements shall form the chords of a smooth vertical curve. At each end post, a single terminal section of rail element shall be erected and lapped in the direction of traffic.

No punching, drilling, reaming, cutting or welding of the rail elements or terminal sections will be permitted in the field unless provided for on the Plans or specifically approved by the Engineer.

All bolts and nuts attaching the rail element to the posts shall be hot-dip galvanized in accordance with the current A. S. T. M. Designation A 153.

All metal parts that are not galvanized, including steel posts, shall be thoroughly cleaned and shop-painted with one coat of rust-inhibitive primer. Any metal surfaces from which the shop coat of rust-inhibitive primer has worn off, or on which the primer has become defective otherwise, shall be given a brush coat of the above specified rust-inhibitive primer before the first coat of white paint is applied. All exposed parts of the guard rail, including steel posts if used, shall be given 2 field coats of white paint. Paint shall not be applied over a previous coat which is not thoroughly dry.

Wood posts shall be treated with timber preservative as specified above in Art. 5. 14. 2 but shall not be painted.

Reset Beam Guard Rail. Existing beam guard rail shall be reset if and where shown on the Plans. The work shall consist of dismantling and removing the existing guard rail, salvaging, storing and protecting the materials deemed by the Engineer to be suitable for re-use, disposal of unsuitable and surplus materials, and resetting the guard rail with approved, salvaged materials and with new materials where necessary, as hereinafter specified.

BEAM GUARD RAIL

The Contractor shall furnish, at his own expense, all new bolts, nuts and washers that may be necessary, which shall be as specified in Art. 5. 14. 2 for those of new beam guard rail.

Existing posts and rail elements, which the Engineer deems suitable for re-use, that become broken or damaged during removal because of the Contractor's carelessness, negligence, or the use of improper methods of work, shall be replaced by the Contractor, at his own expense, with new posts and rail elements. Existing salvaged posts and rail elements which have been approved by the Engineer for re-use, but which have been broken, damaged, lost or stolen after their removal from the existing guard rail, also shall be replaced by the Contractor, at his own expense, with new posts and rail elements. The replacements by the Contractor, as specified above, will be required to the extent necessary for the completion of the quantity of reset beam guard rail shown on the Plans, or for the revised quantity or quantities thereof as the Engineer may direct during construction based on the number of salvaged posts and rail elements approved by the Engineer for re-use and those deemed suitable by him for re-use which have been broken or damaged in the process of removal due to the above-mentioned causes.

New posts and rail elements furnished by the Contractor, whether at his own or the State's expense, shall be as specified above in Art. 5. 14. 2 and shall be of the same type as those in the existing guard rail unless otherwise specified or approved by the Engineer.

Insofar as possible, individual sections of guard rail shall be arranged and reset as follows:

(1) Using existing approved posts.
(2) Using new replacement posts furnished at the Contractor's expense.
(3) Using new replacement posts furnished at the State's expense.

When all sections of guard rail that can be reset as specified in (1), (2) and (3) above have been completed, any remainder of existing and new posts shall be used in a composite section, or sections, of reset guard rail, with continuity of posts of each category (1), (2) and (3) above and by such arrangement as may be approved by the Engineer.

No combination of steel, wood and concrete posts shall be used in any one section of reset guard rail, except by written approval of the Engineer.

Wherever feasible, existing rail elements shall be used in guard rail sections, or portions thereof, that are reset with existing posts, and rail elements furnished as replacements at the Contractor's expense, as specified hereinabove, shall be used in guard rail sections, or in portions thereof, where new guard rail posts

are used. When it is necessary to use existing and new rail elements in the same guard rail section, a continuous length of each shall be installed.

All areas of the existing rail element and steel posts from which the white paint, or the paint and primer, has worn off shall be given a brush coat of white paint, or of rust-inhibitive primer and of white paint, respectively, after which the entire surfaces of the existing rail element and steel posts shall be given one coat of white paint.

If prescribed or shown on the Plans, new steel, wood or concrete guard rail posts shall be furnished and set for warning posts, without the attachment of a rail element. They shall conform to the requirements, and shall be erected, as specified for posts in new beam guard rail. Steel posts shall be painted as specified for steel posts in new beam guard rail. Wood posts shall be treated and painted as specified in Art. 5. 15. 2 and 5. 15. 3 for wood posts in wire rope guard fence.

5. 14. 4. Quantity and Payment.

The quantity of Beam Guard Rail for which payment will be made will be the sum of the over-all lengths of all sections of new beam guard rail constructed in accordance with the Plans and Specifications or as directed by the Engineer, measured along the face of the guard rail, including the terminal sections of the rail element.

The quantities of Reset Beam Guard Rail for which payment will be made will be the sum of the over-all lengths of all sections and portions of sections of beam guard rail reset with existing posts and with new replacement posts furnished at the Contractor's expense, and the sum of the over-all lengths of all sections reset with new posts furnished at the State's expense, in accordance with the Plans and Specifications or as directed by the Engineer, measured along the face of the guard rail, including the terminal sections of the rail element.

The quantity of New Guard Rail Posts, other than those in new and reset guard rail, for which payment will be made will be the number of such new posts actually furnished and set in accordance with the Plans or as directed by the Engineer.

Payment for new Beam Guard Rail will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item BEAM GUARD RAIL in the Proposal, which price shall include furnishing and erecting the guard rail complete, including excavation, backfilling, driving or setting posts, priming, painting, preservative treatment, the furnishing of all materials, labor and equipment, and all else necessary therefor and incidental thereto.

WIRE ROPE GUARD FENCE

Payment for Reset Beam Guard Rail will be made for the quantities as above determined, measured in linear feet, at the prices per linear foot bid for the items RESET BEAM GUARD RAIL WITH EXISTING POSTS and RESET BEAM GUARD RAIL WITH NEW POSTS, respectively, in the Proposal, which prices shall include the cost of dismantling and removing the existing guard rail; storing materials; resetting existing approved posts and painting existing approved steel posts; furnishing and erecting new replacement posts, rail elements, bolts, nuts and washers, as specified and directed; treating new wood posts and painting new steel posts; mounting existing rail element on posts and painting it; excavation in earth and rock; backfill; all labor, material and equipment; and all else necessary therefor and incidental thereto.

In the foregoing paragraph, the payment item RESET BEAM GUARD RAIL WITH EXISTING POSTS shall also include guard rail reset with new replacement posts furnished at the Contractor's expense.

Payment for New Guard Rail Posts, other than those used in new and reset guard rail, will be made for the quantity as above determined at the price per post bid for the item NEW GUARD RAIL POSTS in the Proposal, which price shall include excavation in earth and rock, backfilling, furnishing and erecting the posts, painting or treating as specified, all materials, labor and equipment, and all else necessary therefor and incidental thereto.

SECTION 15

Wire Rope Guard Fence

5. 15. 1. Description.

Wire rope guard fence shall consist of wood or concrete posts, and wire ropes supported by flexible offset brackets.

5. 15. 2. Materials.

Concrete Posts. Concrete posts shall conform to the design shown on the Plans. Concrete for posts shall be Class A conforming to the requirements of Art. 4. 1. 2. Air entrainment of the concrete is not required. Reinforcement steel shall be as shown on the Plans and shall conform to the requirements of Art. 8. 4. 19.

Wood posts shall be as shown on the Plans. They shall be of 1300#C dense structural grade southern pine, and shall be sound, square edge, saw-finished, with no heartwood requirements.

Timber for posts and its grading shall conform to the requirements of Art. 8. 9. 1 and will be inspected for grading at the treatment plant prior to treatment.

Timber Preservatives. The preservative shall be one of the following kinds, conforming to the requirements specified therefor in Art. 8. 9. 6.

a. Water-Borne Preservatives.
Acid Copper Chromate (Celcure)
Ammoniacal Copper Arsenite (Chemonite)
Chromated Copper Arsenate (Greensalt)
Chromated Zinc Chloride
Chromated Zinc Arsenate (Boliden Salt)
Copperized Chromated Zinc Chloride
Osmosar
Tanalith (Wolman Salts)

b. Oil-Borne Preservatives.
Pentachlorophenol Solution in Petroleum—5% Pentachlorophenol.
Copper Naphthenate Solution in Petroleum—equivalent to 0.5% Copper.

Timber Treatment. Treatment of guard rail posts and struts and inspection of treatment shall conform to the requirements of the latest issue of Federal Specification TT-W-571, Wood Preservative; Recommended Treating Practice. Inspection of treatment shall be made at the treatment plant.

Wire rope and fittings shall be as shown on the Plans and shall conform to the requirements specified therefor in Art. 8. 4. 30.

Concrete for anchorages and encasement of posts shall be Class D as specified in Art. 4. 1. 2. Materials for concrete shall be as specified in Art. 5. 3. 2 and the preparation of concrete shall be as specified in Art. 3. 12. 3.

White paint shall conform to the requirements specified in Art. 8. 6. 11.

Tar paint shall conform to the requirements of Art. 8. 6. 10.

5. 15. 3. Methods of Construction.

Both wood and concrete posts shall not be used on the Project.

Excavation and backfilling of post holes shall be as specified for wood and concrete posts in Art. 5. 14. 3. On curves having a radius of less than 1200 feet, the posts shall be set in concrete as shown on the Plans. After erection, the tops of wood posts shall be cut off to the required grade and bevel, and holes shall be bored for the bolts. The bolt holes in concrete posts shall be preformed. Struts shall be attached securely with 60d galvanized spikes and the holes for the spikes shall be drilled to a slightly smaller size. Ends of struts and notches in posts shall be painted as hereinafter specified before assembly. The lower end of struts shall be securely supported before concrete is placed. The offset

brackets shall be set at right angles to the grade of the fence. The lengths of the wire ropes and the arrangement and assembly of fittings shall be such as to provide at each end of each section not less than 6 inches for future take-up. The tension in each wire rope shall be such that the weight of a man, weighing approximately 160 pounds, applied midway between two posts, will cause a deflection of the wire rope of approximately 3½ inches. Intermediate anchorages as shown on the drawings shall be provided at intervals of not more than 500 feet, when the distance between end posts is more than 800 feet.

The portion of the posts and struts from the ground line to 1 foot thereabove shall be painted with 2 coats of tar paint. The remainder of the railing timber above the ground surface shall be painted 3 coats of white paint. To facilitate penetration, the paint for the first white paint coat may be thinned with not more than ½ pint of turpentine per gallon of ready-mixed paint. Each coat shall be thoroughly dry before the next is applied. Two coats shall be applied and shall be dry under each bracket before the cable brackets are atttached.

Reset Wire Rope Guard Fence. Reset wire rope guard fence shall consist of removing and dismantling the existing guard fence, salvaging and storing posts, wire rope and fittings that are deemed by the Engineer to be suitable for re-use, disposal of unsuitable materials, resetting of the guard fence with approved existing wire rope and fittings, and with approved existing posts or with new posts as directed by the Engineer.

The guard fence shall be reset with continuity of existing posts and of new posts. Existing and new posts shall not be installed in the same section of guard fence, except in one section if necessary in order to use completely the available supply of approved existing posts. The Contractor shall supply any necessary new fittings and struts, and shall replace, at his own expense, any posts and wire rope that may become lost, stolen, damaged or broken during removal, storage, hauling and resetting, because of the Contractor's carelessness, negligence, or use of improper work methods.

New posts, struts and fittings shall be as specified above in Art. 5. 15. 2 for new wire rope fence. Erection and painting of the reset guard fence and construction of anchorages shall be as specified above for new guard fence except that re-used posts and struts shall be given one coat of the paints specified above in Art. 5. 15. 2.

If prescribed or shown on the Plans, new guard rail posts shall be furnished and set without the attachment of wire rope. They shall conform to the requirements and shall be erected, treated and painted, as specified above for posts of new wire rope fence.

5. 15. 4. Quantity and Payment.

The quantity of Wire Rope Guard Fence for which payment will be made will be the sum of the lengths of all sections of fence, measured from end to end of each continuous section, actually constructed in accordance with the Plans or as directed by the Engineer. In addition, payment will be made for the number of end and intermediate anchorages actually constructed in accordance with the Plans or as directed by the Engineer.

The quantities of Reset Wire Rope Guard Fence for which payment will be made will be the length or lengths of fence reset with existing posts and the length or lengths reset with new posts, each determined as specified above for Wire Rope Fence except as follows: If both new and existing posts are used in one section of the guard fence, as permitted above, the payment lengths of each type in that section will be measured from the center of the common panel to the respective ends of that guard fence section. In addition, the number of end and intermediate anchorages in the reset guard fence will be measured for payment as specified above for those in new guard fence irrespective of their occurrence in guard fence reset with existing or new posts.

The quantity of New Guard Rail Posts, other than those in new and reset guard fence, for which payment will be made will be the number of such new posts actually furnished and set in accordance with the Plans or as directed by the Engineer.

Payment for Wire Rope Guard Fence will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item WIRE ROPE GUARD FENCE in the Proposal, and payment for Anchorages will be made for the number as above determined, at the price bid for the item GUARD FENCE ANCHORAGES in the Proposal, which prices shall include the cost of the guard fence and its appurtenances and anchorages, complete in place, preservative treatment, painting, excavation in earth and rock, concrete, backfill, all materials, labor, equipment and all else necessary therefor and incidental thereto.

The price bid for Guard Fence Anchorages shall apply to end anchorages and intermediate anchorages and shall include the cost of the concrete block and struts, additional excavation and refilling, additional timber in larger size posts, and additional cable and fittings within the anchorage panels, all in excess of the materials and construction required for a normal intermediate guard fence panel.

Payment for Reset Wire Rope Guard Fence with existing posts and that with new posts will be made for the quantity of each as above determined, measured in linear feet, at the prices per linear foot bid for the items RESET WIRE ROPE GUARD FENCE WITH EXISTING POSTS and RESET WIRE ROPE

GUARD FENCE WITH NEW POSTS, respectively, in the Proposal, which prices shall include the cost of removing and dismantling the existing guard fence; storing materials; painting and resetting existing approved posts and furnishing, treating, painting and erecting new posts, as directed; furnishing additional offset brackets and other fittings as required; furnishing new posts to replace those lost, stolen, broken or damaged, as specified; attachment of wire rope, brackets and other fittings; excavation in earth and rock; backfill; all materials, labor and equipment; and all else necessary therefor and incidental thereto.

Payment for Anchorages in reset wire rope guard fence will be made as provided above for Anchorages in new wire rope fence.

Payment for New Guard Rail Posts, other than those installed in new and reset guard fence, will be made for the number as above determined at the unit price bid for the item NEW GUARD RAIL POSTS in the Proposal, which price shall include furnishing, treating, painting and setting the posts, excavation in earth and rock, backfill, all materials, labor and equipment, and all else necessary therefor and incidental thereto.

SECTION 16

Pipe Railing

5. 16. 1. Description.

Pipe railing shall include the construction of steel, wrought iron and aluminum pipe railing in connection with or appurtenant to roadway construction. The type of metal pipe to be used shall be as provided in the Plans or Supplementary Specifications. When no specific type or types are provided therein, any of the three types mentioned above may be used.

5. 16. 2. Materials.

Materials shall be as specified for Metal Bridge Railings in Art. 4. 8. 2 amended as follows:

For steel or wrought iron railings, when the posts are perpendicular to the rails, galvanized steel fittings for steel railing, and galvanized wrought iron or galvanized malleable iron fittings for wrought iron railing, may be used in lieu of welded connections of the rails and posts.

Foundation sleeves, if used, shall be of the same type of metal as that of the railing, shall be 12 inches long and shall have an inside diameter not less than ⅜ and not more than ½ inch greater than the outside diameter of the posts. Steel and wrought iron sleeves shall be galvanized.

Cement for grout shall be standard portland cement, Type II or Type IIA, conforming to the requirements specified therefor in Art. 8. 5. 22. Fine aggregate for grout shall conform to the requirements specified in Art. 8. 5. 14. Water shall conform to the requirements therefor specified in Art. 8. 5. 38.

Art. 5. 16. 3. Methods of Construction.

For railings in which the posts are to be perpendicular to the rails, the methods of construction shall be as specified for Metal Bridge Railings in Art. 4. 8. 3 amended as follows:

The first paragraph under the heading Steel and Wrought Iron Railing, pertaining to elliptical pipe, shall not apply.

As an alternative to welding, the connections of rails and posts may be made with galvanized steel fittings for steel railing, and galvanized wrought iron or galvanized malleable iron fittings for wrought iron railing. The threads of fittings shall be painted with white lead. Exposed threads and places where the galvanizing has been damaged shall be field galvanized as specified in Art. 4. 8. 3.

The fourth paragraph under the heading Aluminum Railing, pertaining to post castings, shall not apply. Aluminum posts shall be welded to aluminum base plates. The base plates shall be bolted to the concrete foundation with corrosion-resistant steel bolts, and the plates shimmed for railing alignment, and caulked, as specified for post castings in Art. 4. 8. 3. The base plates shall be as specified in Art. 4. 8. 3 under the heading Steel and Wrought Iron Railing except that they shall be cut from aluminum-alloy plates or sheets.

For railings in which the posts are to be vertical and not perpendicular to the rails, the methods of construction shall be as specified for Metal Bridge Railings in Article 4. 8. 3 amended as follows:

The provisions pertaining to elliptical pipe, aluminum post castings, base plates, bolts and bolting to the parapet or foundation, shims, shimming, and caulking the space below base plates, shall not apply.

The railing shall be erected by one of the following methods:

(a) Installation of metal sleeves in the concrete foundation, and setting and grouting posts in the sleeves. The sleeves shall be flush with the top of the concrete and accurately positioned for the required post spacing and true alignment of the railing. The space between the posts and sleeves shall be completely filled with 1:2 portland cement-sand grout of a suitable consistency to be approved by the Engineer.

(b) Supporting the railing securely in its true, final position and constructing the concrete foundation around the posts, without the use of sleeves.

Art. 5. 16. 4. Quantity and Payment.

The quantity of Pipe Railing of the type or types prescribed for use, for which payment will be made, will be the actual length constructed in accordance with the Plans or as directed by the Engineer. The length measured for payment will be the sum of the over-all lengths of the individual railing sections after erection.

Payment for Pipe Railing will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item PIPE RAILING in the Proposal, which price shall include the cost of erecting the railing, installing anchorages and shims and caulking, or installing sleeves in the concrete foundation and grouting, or supporting the railing in its true position without sleeves during the construction of the concrete foundation, as specified, fittings if used, galvanizing, welding and painting, all labor, materials and equipment, and all else necessary therefor and incidental thereto.

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DIVISION 6

Electrical Work

SECTION 1

Common Provisions

6. 1. 1. Scope.

The specifications for electrical work include those for traffic signals, highway lighting and electric signs.

The provisions of Section 1 are common to the work of traffic signals, highway lighting and electric signs as indicated by the heading Common Provisions used above.

All electrical equipment and materials furnished by the Contractor shall be new, unless otherwise specified, and of approved type and manufacture.

6. 1. 2. Existing Systems.

Where existing systems are to be modified, the existing equipment and materials shall be salvaged and incorporated in the revised system, salvaged for other use by the Department, or removed and disposed of by the Contractor, as may be provided in the Supplementary Specifications. Material required to be salvaged shall be removed from place carefully and, when so specified, shall be stored at or near the site of the work for disposal by the Department. Existing equipment and materials specified for re-use, or to be reserved for the Department, which are disturbed, damaged or removed in performing the work shall be repaired or replaced with similar and equivalent new equipment and materials.

6. 1. 3. Lines, Grades and Benchmarks.

It shall be the responsibility of the Contractor to arrange for the furnishing of lines, grades and benchmarks by the Engineer as may be necessary to lay out his work correctly, as specified in Art. 1. 5. 4.

6. 1. 4. Excavation and Backfill.

Excavation and backfill for the construction of detector emplacements, junction boxes, foundations, conduits, cables and other appurtenances shall be governed by the provisions of Art.

2. 7. 3 and the cost of excavation and backfill shall be included in the prices bid for such structures and appurtenances. Quanity and payment for the excavation of rock encountered in the excavation for the abovementioned structures and appurtenances, shall be as specified in Art. 2. 7. 4.

6. 1. 5. Conduits.

Asbestos-cement and bituminized fiber conduits, and fittings therefor, shall conform to the requirements specified respectively therefor in Art. 8. 2. 2.

Rigid metallic conduits installed under ground and those installed above ground shall conform to the requirements specified respectively therefor in Art. 8. 2. 2.

Fill material for drainage pockets for conduit T-drains shall be washed gravel, broken stone or blast furnace slag, conforming to the requirements specified respectively therefor in Art. 8. 5. 6, 8. 5. 5 and 8. 5. 7, respectively. Broken stone shall be of trap rock, granite, gneiss or dolomite. The material shall be of the size or grading shown on the Plans.

Red lead paint and foliage green paint shall conform to the requirements therefor specified in Art. 8. 6. 7 and 8. 6. 4, respectively.

Conduit types and sizes shall be as shown on the Plans.

Conduits under roadways shall be installed by the open cut method or by jacking. In the event that obstructions are encountered during the course of jacking, the Contractor shall secure permission of the Engineer, or of the County or Municipal authorities having jurisdiction, to make test holes or excavations in the pavement and all such openings and subsequent repairs shall be made as directed by the Engineer and at the expense of the Contractor. Jacking pits shall be kept not less than two feet clear of the edge of any type of pavement. When installed in embankments, conduits shall not be laid prior to the completion and consolidation of the embankment.

Conduits terminating in a junction box shall not project more than 3 inches inside the inner face of the wall of the box, and shall enter the box not less than 3 inches above the bottom and not less than 6 inches below the top of the box.

T-drains shall be installed as shown on the Plans if conduits cannot be laid with sufficient grade to provide drainage. T-drains shall consist of standard pipe tee and nipple in metal pipes, and openings bored or otherwise made in asbestos-cement and bituminous fiber conduits, as directed, and coarse aggregate for seepage.

Immediately prior to the installation of cables, all conduit runs shall be carefully rodded, swabbed or otherwise cleaned to insure that the interior is free and clear of all obstructions.

All underground conduits entering meter cabinets shall be thoroughly sealed with a compound conforming to the requirements of the National Electric Code.

Rigid metallic conduits shall be cut square using a metal saw, and ends shall be properly reamed to remove all burrs and rough edges. All ends shall be threaded and the free ends of conduit runs shall be provided with bonding bush caps. Joints shall be made with an approved threaded coupling. When a standard coupling cannot be used, an approved threadless coupling may be substituted. The use of slip joints and running threads will not be permitted, and reducing couplings shall not be used except for expansion joints on bridges as may be called for on the Plans.

Conduit bends and elbows made in the field shall have a radius of not less than nine times the inside diameter of the conduit and all such bends shall be made without crimping, denting or otherwise damaging the conduit.

All threads, and all places where the galvanizing on conduits and fittings has been damaged, shall be painted with a field coat of red lead paint.

Asbestos-cement and bituminized fiber conduits shall be installed as shown on the Plans and in conformity with the provisions hereinabove specified except those referring specifically to rigid metallic conduits. The ends and couplings shall be coated with tar paint conforming to the requirements of Art. 8. 6. 10, before assembly of joints.

Rigid metallic conduit shall be installed in conformity with the requirements of the National Electric Code.

Rigid metallic conduit installations on bridges and other structures shall be provided with expansion fittings at all structure expansion joints. The expansion joint fittings shall be installed as shown on the Plans.

Payment for conduit including conduit T-drains and conduit expansion joints shall be as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

6. 1. 6. Foundations.

Foundations for push button station posts, poles, standards, pedestals, meter cabinets, detectors and other equipment shall be constructed of Class C concrete, conforming to the requirements therefor specified in Art. 4. 1. 2. Air entrainment of the concrete is not required. The materials for concrete shall conform to the requirements specified in Art. 6. 1. 7.

The preparation of the concrete shall be as specified in Art. 3. 12. 3. The construction of foundations shall conform in general to the provisions of Art. 4. 1. 3 and the following provisions: All foundations shall rest on firm ground and shall be poured monolithically. Conduits and anchor bolts shall be placed in proper

position and shall be held in place by means of a template until the concrete sets. Forms shall not be removed until the concrete has hardened properly and not less than 24 hours after the concrete has been placed. All exposed portions of foundations shall be neatly finished with a wood float followed by brushing with a wet, soft-haired brush. The tops of foundations shall be finished to the elevation above curb or sidewalk as shown on the Plans except that where curbs or sidewalks do not exist they shall be finished at an elevation 2 inches above the surrounding lawn or earth.

Payment for foundations shall be as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

6. 1. 7. Junction Boxes.

Junction boxes for underground conduit installations shall be rectangular, constructed of concrete, concrete block, or clay or concrete brick; or circular, constructed of asbestos-cement pressure pipe sections, as shown on the Plans.

Concrete for junction boxes shall be Class C as specified in Art. 4. 1. 2. Air entrainment of the concrete is not required.

Cement shall be standard portland cement, Type II, or air-entraining portland cement, Type IIA.

Coarse aggregate for concrete and for seepage shall be washed gravel, or broken stone of trap rock, granite or gneiss.

The materials for junction boxes shall conform respectively to the requirements of those Articles of Division 8 as shown below:

Standard portland cement	Art. 8. 5. 22
Air-entraining portland cement	Art. 8. 5. 23
Broken stone	Art. 8. 5. 5
Washed gravel	Art. 8. 5. 6
Fine aggregate for concrete and mortar	Art. 8. 5. 10
Water	Art. 8. 5. 38
Concrete block	Art. 8. 5. 15
Concrete brick	Art. 8. 5. 18
Clay or shale brick	Art. 8. 5. 18
Asbestos-cement pressure pipe	Art. 8. 7. 1
Gray iron castings for covers	Art. 8. 4. 4
Angle iron for frames	Art. 8. 4. 23
Galvanizing of angle iron	Art. 8. 4. 33

The construction of concrete junction boxes shall be as specified in Art. 4. 1. 3 except as follows:

Forms for rectangular concrete junction boxes shall not be removed until the concrete has hardened properly and not less than 24 hours after the concrete has been placed. All exposed portions of junction boxes shall be neatly finished with a wood

float followed by brushing with a wet, soft-haired brush. The junction box covers shall meet the grade of sidewalks or other surrounding area.

The construction of concrete block, and concrete or clay brick junction boxes shall conform to the Plans and the requirements specified in Art. 5. 3. 3.

Payment for junction boxes shall be as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

6. 1. 8. Meter Cabinets.

Meter cabinets and the electrical equipment therein shall be as shown on the Plans. The meter cabinet shall be an aluminum alloy casting. The castings shall be permanent mold or sand castings. Aluminum alloy sheet and castings shall conform to the requirements of Art. 8. 4. 1.

Payment for meter cabinets shall be as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

6. 1. 9. Bonding and Grounding.

Traffic signal, highway lighting and electric sign circuits, and the metallic conduits and aboveground equipment, shall be effectively bonded and grounded as hereinafter specified and as shown on the Plans for the respective installations. Bonding and grounding shall conform to the requirements therefor specified in the National Electric Code and as may be required by the utility company.

Ground wire and grounding rods shall conform to the requirements specified respectively therefor in Art. 8. 2. 6.

The cost of effective bonding and grounding shall be included in the prices bid for the various items scheduled in the Proposal. Furnishing and installing ground wire will be paid for as specified in Art. 6. 3. 4.

6. 1. 10. Installation Requirements.

All electrical work shall conform to the Plans and Specifications and to the requirements of the National Electric Code and the utility company.

6. 1. 11. Connection with Utility Services.

For traffic signal, highway lighting and electric sign installations, the Contractor shall install underground conduits and electric conductors therein, extending from a junction box or meter cabinet to a point on the service pole, as shown on the Plans and shall supply a sufficient length of conductors for extension to the overhead utility service, in accordance with the requirements of the utility company and subject to its approval. The extensions of the conductors from this point on the pole, and connections with overhead utility service, will be made by the utility company.

6. 1. 12. Testing.

Upon the completion of each wiring system, and before any connection is made to operating equipment, the Contractor shall perform, in the presence of the Engineer, the following tests of each circuit to determine whether the installations are in acceptable working order:

a. Tests for continuity.
b. Tests for grounds.
c. Tests for insulation resistance from circuit wires to ground, and between circuit wires. The insulation resistance shall be not less than the value specified in Section 1119 of the National Electric Code.

With all equipment connected to the wiring system, a functional test shall be performed by the Contractor, in the presence of the Engineer, to demonstrate that the system as a whole, and all parts thereof, function as specified or intended herein. Any defective materials or faulty or improper installation shall be permanently corrected by repairs or replacements to be made by the Contractor to the satisfaction of the Engineer and the utility company.

Series lighting circuits shall be subjected to such other tests as may be required by the utility company and it shall be the responsibility of the Contractor to ascertain what tests are required and to perform these tests in the presence of the Engineer and the utility company's representative. All tests shall be performed at the expense of the Contractor.

The cost of testing shall be included in the prices bid for other scheduled items of work as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

6. 1. 13. Painting.

All exposed steel for poles, structures, and junction box frames, also cast iron junction box covers installed on or in structures, shall be painted with one shop coat of red lead paint conforming to the requirements of Art. 8. 6. 7. All steel interior junction box bolts, and the exposed portions of foundation bolts and of metallic conduits, shall be field painted with one coat of the red lead paint. In addition all such steel and cast iron shall be painted one field coat of the above specified red lead paint tinted to distinguish it from the shop coat, and a final coat of foliage green paint conforming to the requirements of Art. 8. 6. 4.

The cost of painting shall be included in the prices bid for other scheduled items of work as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

6. 1. 14. Topsoiling and Seeding.

Topsoiling and seeding after excavation and backfill, shall conform to the provisions of Division 7, Section 5.

The cost of topsoiling and seeding shall be included in the prices bid for other scheduled items of work as specified in Art. 6. 2. 4, 6. 3. 4 and 6. 4. 4.

SECTION 2

Traffic Signals

6. 2. 1. Description.

A complete traffic signal installation is composed of two systems, one underground and the other aboveground.

The underground installation consists of conduits, junction boxes, concrete foundations for poles, pedestals, push button stations and meter cabinets, concrete emplacements for detectors, and the installation of detectors.

The aboveground installation ready for operation, consists of meter cabinets, controllers, signal poles, mast arms, pedestals, signal heads, lamps, pedestrian push button assemblies, wire and wiring, bonding and grounding, connection to utility service and incidental work, complete in place. The controller will be furnished and delivered to the site of the work by the Department without cost to the Contractor.

6. 2. 2. Materials and Equipment.

Pedestals, poles, mast arms and meter cabinets shall be of the types, and shall be fabricated of the aluminum alloys, shown on the Plans.

Controllers and controller housings shall be of the types prescribed in the Plans or Supplementary Specifications. Controller housings shall be permanent mold or sand castings of aluminum alloy.

Signal heads shall be of the types and of the aluminum alloys or other materials, as prescribed in the Plans or Supplementary Specifications.

Push button assemblies shall be of the types prescribed in the Plans or Supplementary Specifications and shall consist of heavy duty, waterproof, normally-open push button switches enclosed in aluminum housings. The housings shall be permanent mold or sand castings of aluminum alloy.

Detectors shall be of the types prescribed in the Plans or Supplementary Specifications.

Junction boxes shall be rectangular or circular, or both, as shown on the Plans and as specified in Art. 6. 1. 7.

Lamps for traffic signals shall be of the various sizes and types shown on the Plans.

The various electrical equipment and materials for traffic signals shall conform to the requirements therefor specified in the respective Articles as shown below:

Controllers and controller housings	Art. 8.2.3
Signal heads	Art. 8.2.5
Detectors	Art. 8.2.4
Aluminum alloys	Art. 8.4.1
Conduits and fittings	Art. 8.2.2
Junction box materials	Art. 6.1.7
Concrete materials for foundations	Art. 6.1.6
Concrete materials for detector emplacements	Art. 6.1.7
Signal wire	Art. 8.2.6
Utility service wire	Art. 8.2.6
Ground wire	Art. 8.2.6
Grounding rods	Art. 8.2.6
Red lead paint	Art. 8.6.7
Foliage green paint	Art. 8.6.4

Pedestals, signal poles and mast arms shall be as shown on the Plans and shall conform to the requirements of the following strength tests:

a. The pole shall sustain a horizontal load of 500 pounds, applied at the top of the shaft in any direction, without failure of any component part, and with a deflection of not more than 5 per cent of the shaft length.

b. With pole and mast arm completely assembled, and a 300-pound vertical load applied at the end of the mast arm, the deflection at the top of the shaft shall not be more than 9 inches.

6. 2. 3. Methods of Construction.

The provisions of Art. 6.1.1, 6.1.2, 6.1.3, 6.1.9, 6.1.10, 6.1.11 and 6.1.12 apply.

The methods of construction for concrete foundations, conduit, conduit drains, junction boxes and meter cabinets, and the provisions pertaining to excavation, backfill, topsoiling and seeding, and painting, shall be as specified in Section 1.

Poles, pedestals and meter cabinets shall be securely bolted to foundations in a vertical position, employing approved shims if required. Push button assemblies shall be accurately positioned and securely fastened in place. Push button assemblies shall be installed on poles, pedestals, wrought iron pipe standards or on controller housings as, and in the manner, shown on the Plans, to form the push button stations. Controller housings shall be securely fastened to top of meter cabinet in perpendicular position and the joint shall be sealed properly with a compound conforming

to the requirements of the National Electric Code. Mast arms and signal heads shall be positioned as shown on the Plans or as directed by the Engineer.

The concrete in detector emplacements shall be consolidated by the use of a spud vibrator or other approved means and the finished concrete shall be flush and true with the tops of inspection slots in the pan of the detector frame and with the pavement surface.

All wiring shall be installed, and the bonding and grounding shall be performed, in conformance with the Plans and the requirements of the National Electric Code.

Traffic signal metallic conduits, poles, pedestals, detectors, meter cabinets, and pedestrian push button stations shall be effectively bonded and grounded as shown on the Plans.

6. 2. 4. Quantity and Payment.

The quantities of the various items of traffic signal construction for which payment will be made will be the quantities actually furnished and installed or constructed in accordance with the Plans and Specifications and payment therefor will be made at the prices bid in the Proposal based upon the respective units of measurement hereinafter specified. The prices bid shall include the cost of the work of the various items as hereinafter specified, the cost of bonding and grounding, painting, testing, topsoiling and seeding where required, and of all labor, equipment and materials necessary for and incidental to the completion of the work items except the furnishing of such electrical equipment that is specified herein to be furnished by the Department without cost to the Contractor.

Pole Assemblies. Payment at the unit price bid for the item POLE ASSEMBLIES for the number of each type actually installed, which price shall include furnishing and erecting the pole and component parts, complete, as shown on the Plans.

Pedestal Assemblies. Payment at the unit price bid for the item PEDESTAL ASSEMBLIES for the number of each type actually installed, which price shall include furnishing and erecting the pedestal and component parts, complete, as shown on the Plans.

Controllers. Payment at the unit price bid for the item CONTROLLERS for the number actually installed, which price shall include installation of controller on meter cabinet previously installed, furnishing and installing all necessary wires and wiring between terminal blocks of controller and meter cabinet and connections thereto, and furnishing and placing sealing compound. Controller timing will be done by the Department. Payment at the unit price bid also shall include furnishing of the controller by the Contractor when it is specifically provided in the Plans or

Supplementary Specifications that the controller shall be furnished by him.

Detectors. Payment at the unit price bid for the item DETECTORS for the number actually installed, which price shall include excavation (except rock), backfill, construction of concrete emplacement, installation of the detectors, furnishing and installing conduit and fittings within the detector emplacement and from the detector to the conduit system. Payment at the unit price bid also shall include furnishing the detectors by the Contractor when specifically provided in the Plans or Supplementary Specifications that they shall be furnished by him.

Conduit. Payment at the unit price bid per linear foot for the items CONDUIT, for the length in linear feet of single line of each type and size actually installed, which price shall include furnishing and installing conduit and fittings, expansion joints, T-drains, excavation (except rock), backfill, and all necessary connections to junction boxes and foundations.

Junction Boxes. Payment at the unit price bid for the item JUNCTION BOXES, for the number actually constructed, which price shall include excavation (except rock), backfill, and construction of the junction boxes complete with frame and cover and the coarse aggregate for seepage.

Foundations. Payment at the unit prices bid for the various types of FOUNDATIONS, for the number of each type actually constructed, which prices shall include excavation (except rock), backfill, construction of the foundations complete including anchor bolts, conduit and ground rods within the foundation.

Meter Cabinets. Payment at the unit price bid for the item METER CABINETS for the number actually installed, which price shall include furnishing and installing the meter cabinets, terminal blocks, meter pan, wire and wiring, and service switch.

Push Button Assemblies. Payment at the unit price bid for the item PUSH BUTTON ASSEMBLIES for the number actually installed, which price shall include excavation (except rock), backfill, construction of foundation, furnishing and installing the push button assembly and instruction plate.

Signal Wire. Payment at the unit prices bid per linear foot for the items SIGNAL WIRE, for the quantity of each size actually installed, which prices shall include furnishing, installing and connecting the wires from meter cabinet terminal block to signal heads, push button stations, detectors and other equipment, and the effective bonding and grounding of detectors, meter cabinets, pole and pedestal assemblies and other equipment.

Service Wire. Payment at the unit price bid per linear foot for the item SERVICE WIRE, for the quantity actually

installed, which price shall include furnishing and installing the service wire in conduits previously installed, and connecting the service wire in meter cabinet to the live terminals of the service switch.

Payment for the additional wire supplied for extension to the overhead service will be made at the unit price bid for service wire.

SECTION 3

Highway Lighting

6. 3. 1. Description.

Highway lighting installations shall be of the series or multiple circuit type, whichever is specified. A complete series circuit highway lighting installation is composed of two systems, one underground and the other aboveground.

The underground series circuit installation consists of conduits, junction boxes, concrete foundations for lighting standards, and grounding rods.

The aboveground series circuit installation consists of lighting poles and brackets, luminaires, lamps, insulating transformers, pole and bracket wire and wiring between luminaires and transformers, series lighting cable of the armored or nonarmored type as specified, connections to transformers and extension of cable to utility service pole, ground wire as specified, bonding and grounding, and incidental work.

The underground multiple circuit installation consists of conduits, junction boxes, concrete foundations for lighting standards and meter cabinets, and grounding rods.

The aboveground multiple circuit installation consists of lighting poles and brackets, luminaires, lamps, meter cabinets, pole and bracket wire and wiring from luminaires to multiple lighting wires, multiple lighting wires and wiring from lighting pole bases to meter cabinet, including all connections, extension to utility service pole, grounding rods, bonding and grounding and incidental work.

6. 3. 2. Materials and Equipment.

Lighting standards and brackets shall be of the types, and shall be fabricated of the aluminum alloys shown on the Plans.

Luminaires shall be of the types shown on the Plans and each type shall conform to the respective light distribution characteristics recommended therefor in current A. S. A. Bulletin D 12. 1, Street and Highway Lighting, and shall conform to the requirements of the utility company.

Insulating transformers and ballasts shall be of the types shown on the Plans and shall conform to the requirements of the utility company.

Lamps for highway lighting shall be of the various types and sizes shown on the Plans.

Other electrical equipment and materials for highway lighting installations shall conform to the requirements therefor specified in the respective Articles as shown below:

Aluminum alloys	Art. 8. 4. 1
Conduits and fittings	Art. 8. 2. 2
Junction box materials	Art. 6. 1. 7
Concrete materials for foundations	Art. 6. 1. 6
Series lighting cable, nonarmored	Art. 8. 2. 1
Series lighting cable, armored	Art. 8. 2. 1
Multiple lighting wire	Art. 8. 2. 6
Pole and bracket wire	Art. 8. 2. 6
Utility service wire	Art. 8. 2. 6
Ground wire	Art. 8. 2. 6
Grounding rods	Art. 8. 2. 6
Red lead paint	Art. 8. 6. 7
Foliage green paint	Art. 8. 6. 4

Lighting poles and bracket arms shall be as shown on the Plans and shall conform to the requirements of the following strength tests:

a. Poles shall sustain a horizontal load of 500 pounds, applied at the top of the shaft in any direction, without failure of any component part, and with a deflection of not more than 5 per cent of the shaft length.

b. Bracket arms when mounted independently of the shaft shall have a deflection of not more than 5 per cent of the arm length with a 100-pound vertical load applied at the end of the arm; the arm shall also have a deflection of not more than 5 per cent of the arm length with a 50 lb. horizontal load applied at the end of the arm.

6. 3. 3. Methods of Construction.

The provisions of Articles 6. 1. 1, 6. 1. 2, 6. 1. 3, 6. 1. 9, 6. 1. 10, 6. 1. 11 and 6. 1. 12 apply.

The methods of construction for conduit, conduit drains and expansion joints, junction boxes, foundations and meter cabinets and the provisions pertaining to excavation, trenching and backfill, topsoiling and seeding, and painting shall be as specified in Section 1.

Series highway lighting metallic conduits, transformer secondary wiring sleeves, lighting poles, cable armor and corona shield

shall be effectively bonded and grounded to grounding rods in each pole foundation.

Series low voltage branch circuits installed in bridge underdecks, or at other locations, shall have metallic conduits, junction boxes and lighting poles effectively bonded and grounded as shown on the Plans.

Series highway lighting systems employing nonmetallic conduit shall be bonded and grounded as specified above, except that a continuous grounding circuit shall be provided, consisting of ground wire installed in all conduit runs.

Multiple highway lighting metallic conduits, junction boxes, meter cabinets and lighting poles shall be effectively grounded as shown on the Plans.

All wiring shall be installed and the bonding and grounding shall be performed in conformance with the Plans and the requirements of the National Electric Code.

Lighting poles shall be securely bolted to foundations in a vertical position employing approved shims if necessary. Brackets shall be securely attached to poles and shall be placed perpendicular to centerline of roadway. Luminaires shall be securely attached to ends of bracket arms and shall be accurately plumbed, with luminaire reflector properly and accurately placed.

6. 3. 4. Quantity and Payment.

The quantities of the various items of highway lighting construction for which payment will be made will be the quantities actually furnished and installed or constructed in accordance with the Plans and Specifications and payment therefor will be made at the prices bid in the Proposal based upon the respective units of measurement hereinafter specified. The prices bid shall include the cost of the work of the various items as hereinafter specified, the cost of bonding and grounding, painting, testing, topsoiling and seeding where required, and of all labor, equipment and materials necessary for and incidental to the completion of the work items.

Lighting Standard Assemblies. Payment at the unit price bid for the item LIGHTING STANDARD ASSEMBLIES for the number actually installed, which price shall include furnishing and erecting pole, bracket, luminaire, lamp, transformer, wire, and connection of wire to luminaire and to transformer at base of pole.

Conduit. Payment at the unit price bid per linear foot for the items CONDUIT, for the length in linear feet of single line of each type and size actually installed, which price shall include excavation (except rock), backfill, furnishing and installing conduit and fittings, expansion joints, T-drains, and all necessary connections to junction boxes and foundations.

Junction Boxes. Payment at the unit price bid for the item JUNCTION BOXES, for the number actually constructed, which price shall include excavation (except rock), backfill, construction of junction boxes complete with frame and cover and the coarse aggregate for seepage.

Foundations. Payment at the unit prices bid for the various types of FOUNDATIONS, for the number of each type actually constructed, which prices shall include excavation (except rock), backfill, construction of the foundations complete, and furnishing and installing anchor bolts, conduit and ground rods within the foundation.

Meter Cabinets. Payment at the unit price bid for the item METER CABINETS, for the number actually installed, which price shall include furnishing and installing the meter cabinets, terminal blocks, meter pan, wire and wiring, and service switch.

Series Lighting Cable, Nonarmored. Payment at the unit price bid per linear foot for the item SERIES LIGHTING CABLE, NONARMORED, which price shall include the furnishing and installing of cable in conduits previously installed, connection to all lighting transformers and extending to utility service pole with sufficient cable supplied for extension up the pole by the utility company. Payment for the wire supplied for the extension will be made at the unit price bid for Series Lighting Cable, Nonarmored.

Series Lighting Cable, Armored. Payment at the unit price bid per linear foot for the item SERIES LIGHTING CABLE, ARMORED, for the quantity actually installed, which price shall include excavation (except rock), backfill, furnishing and installing the cable, connection to all lighting transformers and extending to utility service pole with sufficient cable supplied for extension up the pole by the utility company. Payment for the wire supplied for the extension will be made at the unit price bid for Series Lighting Cable, Armored.

Multiple Lighting Wire. Payment at the unit price bid per linear foot for the item MULTIPLE LIGHTING WIRE, for the quantity of each size actually installed, which price shall include furnishing and installing the wire in conduits previously installed, connection to lighting standard assembly wires and to terminals in meter cabinet, and the effective bonding and grounding of poles, meter cabinets and other equipment.

Service Wire. Payment at the unit price bid per linear foot for the item SERVICE WIRE, for the quantity actually installed, which price shall include furnishing and installing the service wire in conduits previously installed, and connecting the service wire in meter cabinet to line terminals of the service switch.

Payment for the additional wire supply for extension to the overhead utility service will be made at the price bid for service wire.

Ground Wire. Payment at the unit price bid per linear foot for the item GROUND WIRE, for the quantity actually installed, which price shall include furnishing and installing the ground wire.

SECTION 4

Electric Signs

6. 4. 1. Description.

A complete electric sign installation is composed of two systems, one underground and the other aboveground.

The underground installation consists of conduits, junction boxes, concrete foundations for posts or other supporting structures and for meter cabinet.

The aboveground installation ready for operation, consists of signs, sign posts or other supporting structures, meter cabinet, and wire and wiring from signs to meter cabinet, including all connections and extension to utility service pole, bonding, grounding and incidental work.

6. 4. 2. Materials and Equipment.

Electric signs and supporting structures shall be of the types shown on the Plans. The sign boxes and component parts thereof shall bear the approval label of the Underwriters Laboratories, Inc.

Posts, supporting structures, sign boxes and meter cabinets shall be of the types, and shall be fabricated of the materials shown on the Plans.

Steel and other materials for fabricated steel supporting structures for overhead signs shall be as shown on the Plans and as specified in Art. 4. 3. 2 for Steel Structures.

Steel angle iron for sign boxes shall be structural carbon steel conforming to the requirements specified in Art. 8. 4. 23.

Galvanizing, where prescribed, shall conform to the requirements therefor in Art. 8. 4. 33.

Lamps for electric signs shall be of the various sizes and types shown on the Plans.

Other electric sign equipment and materials for electric sign installations shall conform to the requirements therefor specified in the respective Articles as shown below:

Aluminum alloys	Art. 8. 4. 1
Conduits and fittings	Art. 8. 2. 2
Junction box materials	Art. 6. 1. 7
Concrete materials for foundations	Art. 6. 1. 6
Circuit wire	Art. 8. 2. 6
Utility service wire	Art. 8. 2. 6
Ground wire	Art. 8. 2. 6
Grounding rods	Art. 8. 2. 6
Red lead paint	Art. 8. 6. 7
Foliage green paint	Art. 8. 6. 4

6. 4. 3. Methods of Construction.

The provisions of Art. 6. 1. 1, 6. 1. 2, 6. 1. 3, 6. 1. 9, 6. 1. 10, 6. 1. 11 and 6. 1. 12 apply.

The methods of construction for conduit, conduit drains, foundations, junction boxes and meter cabinets, and the provisions pertaining to excavation, trenching and backfill, topsoiling and seeding, and painting, shall be as specified in Section 1.

Sign posts and other supports shall be securely bolted to foundations in a vertical position, employing approved shims if required. Signs shall be mounted on posts or other supports in a horizontal position and shall be securely attached thereto as shown on Plans or as directed by the Engineer.

The furnishing, fabrication, erecting and painting of fabricated steel supporting structures for overhead signs shall conform to the requirements of Art. 4. 3. 1 and 4. 3. 3.

All wiring shall be installed, and the bonding and grounding shall be performed, in conformance with the Plans and the requirements of the National Electric Code.

Electric sign metallic conduits, meter cabinets, junction boxes, sign boxes and supporting structures shall be effectively bonded and grounded as shown on the Plans.

6. 4. 4. Quantity and Payment.

The quantities of the various items of electric sign construction for which payment will be made will be the quantities actually furnished and installed or constructed in accordance with the Plans and Specifications and payment therefor will be made at the prices bid in the Proposal based upon the respective units of measurement hereinafter specified. The prices shall include the cost of the work of the various items as hereinafter specified, the cost of bonding and grounding, painting, testing, topsoiling and seeding where required, and of all labor, equipment and materials necessary for and incidental to the completion of the work items.

ELECTRIC SIGNS

Electric Sign Assemblies. Payment at the unit price bid for the item ELECTRIC SIGN ASSEMBLIES for the number of the various types actually installed, which price shall include the furnishing and erecting of the sign post or posts, and frame if prescribed, or other supporting structure, and all signs and sign boxes erected and installed thereon, as shown on the Plans.

Conduit. Payment at the unit price bid per linear foot for the items CONDUIT, for the length in linear feet of single line of each type and size actually installed, which price shall include excavation (except rock), backfill, furnishing and installing conduits and fittings, expansion joints, T-drains and all necessary connections to junction boxes and foundations.

Junction Boxes. Payment at the unit price bid for the item JUNCTION BOXES, for the number actually constructed, which price shall include excavation (except rock), backfill, and construction of the junction boxes complete with frame and cover and the coarse aggregate for seepage.

Foundations. Payment at the unit prices bid for the various types of FOUNDATIONS, for the number of each type actually constructed, which prices shall include excavation (except rock), backfill, construction of the foundations, complete, and furnishing and installing conduits and ground rods within the foundation.

Meter Cabinets. Payment at the unit price bid for the item METER CABINETS for the number actually installed, which price shall include furnishing and installing the meter cabinets, terminal blocks, meter pan, wire and wiring, and servicec switch.

Circuit Wire. Payment at the unit price bid per linear foot for the item CIRCUIT WIRE, for the quantity of each size actually installed, which price shall include furnishing and installing the wire in conduits previously installed, connecting wire to equipment in sign boxes and to terminals in meter cabinet, and the effective bonding and grounding of sign supports, sign boxes and other equipment.

Service Wire. Payment at the unit price bid per linear foot for the item SERVICE WIRE, for the quantity actually installed, which price shall include furnishing and installing the service wire in conduits previously installed and connecting the service wire in meter cabinet to line terminals of service switch. Payment for the additional wire supplied for extension to the overhead utility service will be made at the price bid per linear foot for Service Wire.

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DIVISION 7

Landscaping

SECTION 1

Selective Thinning

7. 1. 1. Description.

Selective thinning shall include the removal of live and dead trees, both standing and fallen, shrubs, and other vegetation and debris designated for removal, to clean up unsightly areas, to produce irregular foliage lines, to create a natural transition between the artificial edge of the woods left by the clearing of the site and the undisturbed woods, to create bays and open areas in the woods and to open views, all as shown on the Plans and as directed by the Engineer.

7. 1. 2. Materials.

Herbicides and tree paint shall conform to the requirements therefor specified in Art. 8. 3. 5.

7. 1. 3. Methods of Construction.

All trees, shrubs and other vegetation to be removed under the item of, and within the areas designated for, selective thinning shall be designated by the Engineer before they are removed. Trees shall be carefully felled to prevent damage to adjacent vegetation, structures and property. Trees, stumps and all debris shall be removed in a manner that will not unduly compact or disturb the soil.

In open areas, stumps shall be completely removed. The stump hole shall be backfilled to the adjacent ground surface. In wooded areas stumps shall be cut off at the existing ground surface. Live stumps shall be treated with herbicide immediately after cutting. If suckering occur, the herbicide treatment shall be continued by the Contractor until no signs of growth recur. The herbicide shall be applied with a brush or by other method approved by the Engineer.

Within the areas of selective thinning, any and all trees that may have died subsequent to the time of thinning and prior to the time of acceptance of the Contract shall be removed by the Contractor. Such tree removal shall be considered a part of the

work of selective thinning and shall be performed without additional compensation.

Any damage to other vegetation or to structures or property shall be repaired by the Contractor without additional compensation. Damage to existing trees shall be treated in accordance with Art. 7. 2. 3. Damage to existing grass areas shall be repaired as specified in Art. 7. 5. 3.

All trees within the areas designated for selective thinning shall be trimmed to a height of 16 feet to remove all dead and undesirable limbs. The Engineer shall determine which live limbs are undesirable. Trees shall be trimmed in accordance with Art. 7. 2. 3.

All cleared material, deadwood, stumps and debris resulting from selective thinning shall be disposed of in accordance with the requirements of Art. 2. 1. 3.

7. 1. 4. Quantity and Payment.

The quantity of Selective Thinning for which payment will be made will be the areas actually thinned in accordance with the Plans and Specifications and as directed by the Engineer.

Payment for Selective Thinning will be made for the quantity as determined above, measured in acres, at the unit price per acre bid for the item SELECTIVE THINNING in the Proposal, which price shall include the cost of removing trees, stumps, shrubs and other vegetation, furnishing and applying herbicide; backfill; trimming of trees to a height of 16 feet; disposing of all debris; furnishing all materials, labor, equipment and all other work in connection therewith and incidental thereto.

SECTION 2

Trimming Existing Trees

7. 2. 1. Description.

Trimming existing trees shall include the complete removal of all defective or undesirable limbs and the repair of all injuries or wounds on existing trees as directed by the Engineer.

7. 2. 2. Materials.

Tree paint shall conform to the requirements therefor specified in Art. 8. 3. 5.

7. 2. 3. Methods of Construction.

All diseased, dead, broken and seriously injured branches shall be removed. Healthy low branches shall not be removed except as

otherwise directed by the Engineer. All wounds over one inch diameter shall be painted with tree paint. The bark around all wounds and other injuries shall be traced and treated in accordance with approved arboricultural practice. All pruning tools and methods employed shall be subject to the approval of the Engineer.

All tree trimming work shall be supervised by a certified tree expert.

All waste material and debris resulting from trimming existing trees shall be disposed of as specified in Art. 2. 1. 3.

7. 2. 4. Quantity and Payment.

The quantity of Trimming Existing Trees for which payment will be made will be the actual number of trees completely trimmed and treated in accordance with the Plans and Specifications and as directed by the Engineer. The diameter measured at 4½ feet above the ground shall determine the size category of the trees for which payment will be made.

Payment for Trimming Existing Trees will be made for the quantities of trees trimmed as determined above, at the respective unit prices bid for the items of TRIMMING EXISTING TREES in the Proposal, which prices shall include the cost of trimming, removing tree trimmings, treating wounds and injuries, disposing of debris, furnishing all materials, labor, equipment and all else in connection therewith and incidental thereto.

Separate payment for trimming trees to a height of 16 feet in areas of selective thinning will not be made but the cost thereof shall be included in the unit price bid for the item Selective Thinning.

SECTION 3

Tree Wells

7. 3. 1. Description.

Tree wells shall include the construction of dry rubble, concrete block and corrugated metal tree wells.

7. 3. 2. Materials.

Materials for tree wells shall conform to the appropriate articles of Division 8 as follows:

Cement for mortar	Art. 8. 5. 22
Fine aggregate for mortar	Art. 8. 5. 10
Broken stone, 1½″ size	Art. 8. 5. 5
Blast furnace slag, 1½″ size	Art. 8. 5. 7
Washed gravel, ¾″ size	Art. 8. 5. 6

Rubble stones	Art. 8. 5. 35
Concrete blocks	Art. 8. 5. 15
Corrugated metal culvert pipe, bituminous coated	Art. 8. 7. 6
Perforated corrugated metal pipe, bituminous coated	Art. 8. 7. 6

Corrugated metal and perforated corrugated metal shall be 16 gauge, galvanized and bituminous-coated.

7. 3. 3. Methods of Construction.

Dry rubble, concrete block and corrugated metal tree wells shall be constructed as shown on the Plans.

The applicable requirements of Art. 5. 10. 3 shall govern the construction of dry rubble tree well walls except as follows: The masonry pattern shall be coursed rubble or squared stone with joints not more than 1½ inches wide. Horizontal surfaces shall slope downward to the rear at the rate of 1½ inches per horizontal foot. All mortar face joints shall be recessed to a depth of 1½ inches.

Concrete block tree well walls shall be constructed with ½-inch wide mortar joints throughout except that every third vertical joint in the bottom course shall be left open for drainage purposes.

Corrugated metal for tree wells shall be securely bolted together and shall extend 1 inch above the finished grade. The entire perimeter of the tree well wall shall rest on the original ground surface. When the original ground surface slopes, the bottom of the corrugated metal shall be cut to conform to the ground surface. Four to six holes, 4 inches in diameter, spaced evenly around the bottom of the tree well wall, shall be provided for drainage purposes except when perforated corrugated metal is prescribed.

7. 3. 4. Quantity and Payment.

The quantity of Dry Rubble Tree Wells and Concrete Block Tree Wells for which payment will be made will be the volume of tree well walls constructed in accordance with the Plans and Specifications or as directed by the Engineer.

The quantity of Corrugated Metal Tree Wells for which payment will be made will be the number of units constructed in accordance with the Plans and Specifications or as directed by the Engineer.

Payment for Dry Rubble Tree Wells and Concrete Block Tree Wells will be made for the quantity as above determined, measured in cubic yards, at the price per cubic yard bid for the items DRY RUBBLE TREE WELLS and CONCRETE BLOCK TREE WELLS, respectively, in the Proposal. Payment for

Corrugated Metal Tree Wells will be made for the quantity as above determined, measured in units, at the price per unit bid for the item CORRUGATED METAL TREE WELLS in the Proposal. These prices shall include the cost of excavation, shaping of rock surface, backfill, furnishing and placing rubble stones, concrete blocks, corrugated metal sheets and pipes, porous backfill, broken stone or washed gravel, all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 4

Preparation of Exising Soil

7. 4. 1. Description.

Preparation of existing soil shall include the preparation for seeding of the existing soil within the areas shown on the Plans or where directed by the Engineer.

7. 4. 2. Materials.

Topsoil shall conform to the requirements therefor specified in Art. 8. 3. 12.

7. 4. 3. Methods of Construction.

The surface of the existing soil to be prepared shall first be cleared of all stumps, brush, weeds and debris. It shall next be cultivated to a depth of 3 to 4 inches to prepare a seed bed. The entire area shall then be brought to a smooth grade, free from any depressions that would collect water. If necessary, additional topsoil shall be used to fill small objectionable depressions. Where depressions exceed 8 inches in depth, subsoil shall be added and covered with 4 inches of topsoil which shall be graded to provide a satisfactory surface contour.

All waste material and debris resulting from preparation of existing soil shall be disposed of in accordance with the provisions of Art. 2. 1. 3.

7. 4. 4. Quantity and Payment.

The quantity of Preparation of Existing Soil for which payment will be made will be the areas of existing soil actually prepared in accordance with the Plans and Specifications or as directed by the Engineer.

Payment will be made for Preparation of Existing Soil for the quantity as determined above, measured in acres, at the unit price per acre bid for the item PREPARATION OF EXISTING

SOIL in the Proposal, which price shall include the cost of preparing the soil, furnishing and placing subsoil when necessary, disposing of debris, furnishing all materials, labor, equipment and all else necessary therefor and incidental thereto except that when additional topsoil shall be required it will be paid for at the unit price per cubic yard bid for the item Topsoil in the Proposal.

SECTION 5

Topsoiling and Seeding

7. 5. 1. Description.

Topsoiling and seeding shall include preparing topsoil stripped off the site of the Project for use as topsoil and placing it, furnishing and placing topsoil required in excess of that obtained from stripping, furnishing and placing seed mixtures and grain seed, fertilizer, ground limestone, and other materials as herein specified.

7. 5. 2. Materials.

The materials to be used for topsoiling and seeding shall conform to the appropriate Articles as follows:

Fertilizer, 5-10-5 commercial designation	Art. 8. 3. 1
Ground limestone	Art. 8. 3. 3
Mulch, hay	Art. 8. 3. 6
Grass seed mixture	Art. 8. 3. 10
Crown vetch seed	Art. 8. 3. 10
Grain seed	Art. 8. 3. 10
Topsoil	Art. 8. 3. 12

7. 5. 3. Methods of Construction.

The topsoil shall be spread over the surface in a uniform layer that will produce the prescribed compacted thickness. When required, ground limestone which has been protected from moisture and is dry and free flowing, shall be evenly spread over the area to be seeded at a rate that will produce a pH value of the soil of 6.5. The area shall then be raked, disked or otherwise worked to incorporate the limestone into the upper 3 to 4 inches of soil to remove stones, roots, debris and other unsuitable material and to form an even surface. Fertilizer shall be applied at the rate of 1200 pounds per acre. The soil shall be in a friable condition at the time of seeding.

The seed mixture shall be sown at the rate of 100 pounds per acre, together with rye or oat grain at the rate of 10 pounds per acre, except that, on slopes of 2:1 or steeper, rye or oat grain shall

be used at the rate of 25 pounds per acre. When seeding in the spring oats shall be used, and in the fall, rye.

When seeding by hand, by cyclone type seeder, or by the hydraulic method, seeded areas which are not to be mulched shall be raked lightly and rolled to cover the seed. When a tractor-drawn mechanical pulverizer and seeder is used, handraking and rolling may be omitted.

The finished seeded areas shall be even and shall conform to the prescribed lines and elevations.

All seeded areas shall be mulched as prescribed in Art. 7. 9. 3.

The Contractor shall complete as much of the seeding as possible from March 1 to May 15 and from August 15 to October 15 when weather and soil conditions are suitable therefor. No seeding shall be done when the soil is wet or frozen. Seeding which cannot be completed during these periods may be performed at other times when, in the opinion of the Engineer, weather and soil conditions are suitable. A satisfactory stand of grass and legumes practically weed-free, shall be established on all areas of topsoiling. All areas of topsoiling and seeding on which a satisfactory stand of grass and legumes is not produced shall be refertilized and reseeded by the Contractor, as directed by the Engineer, until a satisfactory stand of grass and legumes is established.

The Contractor shall protect areas outside the limits of his work, that shall have been topsoiled or topsoiled and seeded under a previous contract, against damage from or on account of his work. Any such damage shall be repaired and restored by the Contractor to the condition that prevailed previous to the time of the damage, without additional compensation.

If and where the excavation originally performed by the Contractor is below the general slope plane on which the topsoil is to be placed, the Contractor, at no additional cost, shall treat such portions of the slope as follows:

Stakes of 2″ x 4″ cross section shall be driven into the slope to such a depth that will give a penetration below the originally graded surface of twice the exposed length of the stake above that surface provided, however, that such penetration need not exceed 2 feet. In no case shall the total length of the stake be less than 2 feet. 1″ x 6″ slope boards placed as specified in Art. 7. 6. 3, then shall be extended down to the slope surface as originally graded and shall be securely nailed to 2″ x 4″ stakes. After the slope boards are placed, the low areas shall be refilled with embankment material to the prescribed bottom of the topsoil and the refilled material shall be thoroughly compacted by tamping in layers not exceeding 6 inches in thickness.

Where either embankment or excavation slopes become eroded during the work and before final acceptance, the Contractor, at his

own expense, shall make repairs in the same manner, or as directed by the Engineer, except that he shall be paid for the additional lumber used in the boards and stakes, over and above the quantity which normally would have been required, at the unit price bid for Slope Boards. If there be no item in the Proposal for Slope Boards, payment therefor will be made in the manner provided in Art. 1. 8. 4.

Topsoiled slopes constructed on a previous contract which have become eroded shall be repaired by the Contractor by additional topsoiling and seeding and the repair or replacement of slope boards, as directed by the Engineer.

If the quantity of topsoil obtained from stripping, or from storage piles when prescribed, or from both, is insufficient for the requirements of the Project, the Contractor shall furnish the required additional topsoil from other sources.

7. 5. 4. Quantity and Payment.

The quantity of Topsoiling and Seeding for which payment will be made will be the surface area of each prescribed thickness of topsoil actually placed and seeded in accordance with the Plans and Specifications or as directed by the Engineer.

Payment for Topsoiling and Seeding will be made for the quantity as above determined, measured in square yards, at the price or prices per square yard bid for the item of TOPSOILING AND SEEDING in the Proposal, which price or prices shall include the cost of preparing the stripped material for topsoil and placing it; furnishing, cleaning and placing topsoil furnished from sources outside the limits of the Project including furnishing and incorporating additional organic material if required; furnishing and sowing seed mixture and grain seed; furnishing and placing ground limestone, fertilizer, and other materials; raking, rolling, refertilizing and reseeding where required; the repair of previously topsoiled or topsoiled and seeded areas damaged by the Contractor's work; furnishing all labor and equipment; and all else necessary therefor and incidental thereto.

When the item Topsoiling is scheduled, without fertilizing and seeding, payment therefor will be made for the surface area actually topsoiled at the unit price bid for the item TOPSOILING in the Proposal, which price shall include all the work specified under payment for topsoiling and seeding in the preceding paragraph except seeding, reseeding, rolling, and the repair of damage to previously seeded areas.

Where the Engineer orders repairs of eroded topsoiled slopes constructed under previous contracts, payment for the work of topsoiling and seeding will be made at the price bid therefor in the Proposal, or as provided in Art. 1. 8. 4 if an item for topsoiling and seeding is not scheduled in the Proposal.

SECTION 6

Slope Boards

7. 6. 1. Slope Boards.

Slope boards shall include the furnishing and placing of slope boards on slopes that are to be topsoiled.

7. 6. 2. Materials.

Boards and stakes shall conform to the requirements therefor specified in Art. 8. 3. 5.

7. 6. 3. Methods of Construction.

Slope boards shall be placed over the entire area of slopes more than 8 feet high, measured vertically, and sloping 2:1 or steeper, before they are topsoiled.

Before placing slope boards, all undesirable depressions, gullies and other eroded areas occurring in slopes to be topsoiled shall be filled to the required surface with approved embankment material as directed by the Engineer. The embankment shall be placed in layers not exceeding 6 inches in thickness and each layer shall be thoroughly compacted by tamping, rolling or other method approved by the Engineer.

The slope boards shall be placed so they decline lengthwise at the rate of 3 feet horizontally to 1 foot vertically in the direction of the downgrade of the adjacent roadway. They shall be placed in continuous rows spaced 10 feet apart measured on the slope. The top edge of the boards shall be ½ inch below the prescribed surface of the topsoil and grooves shall be cut in the slope to make room for the boards. The boards shall be held firmly in place by being nailed to the 2-inch face of the stakes, which shall be not more than 3 feet apart, and driven into the ground so that the top of the stake is flush with the top of the board.

If slope boards erected on slopes topsoiled under the Contract become damaged, the Contractor shall repair or replace them as directed by the Engineer, without additional compensation.

7. 6. 4. Quantity and Payment.

The quantity of Slope Boards for which payment will be made will be the length of slope boards actually furnished and placed in accordance with the Plans and Specifications and as directed by the Engineer. The repair or replacement of damaged slope boards will not be measured for payment.

Payment for Slope Boards will be made for the quantity as above determined, measured in linear feet, at the price per linear foot bid for the item SLOPE BOARDS in the Proposal, which price shall include the cost of furnishing and placing boards and stakes, the repair of damaged slope boards as specified, furnishing all materials, labor, equipment and tools and all else necessary therefor and incidental thereto.

Where the Engineer orders repairs of eroded topsoiled slopes constructed under previous contracts, payment for new slope boards will be made at the price bid for the item SLOPE BOARDS in the Proposal, or as provided in Art. 1. 8. 4 if an item for slope boards is not scheduled in the Proposal.

SECTION 7

Fertilizing and Seeding

7. 7. 1. Description.

Fertilizing and seeding shall include fertilizing and seeding, Type A, and fertilizing and seeding, Type B, in areas prescribed or shown on the Plans where topsoiling and seeding as specified in Section 5 are not provided for.

Fertilizing shall include the fertilizing of turf areas, both constructed and salvaged, at such locations as may be designated on the Plans or by the Engineer, other than areas where fertilizing and seeding as specified above or where topsoiling and seeding as specified in Section 5 are provided for.

7. 7. 2. Materials.

Materials for fertilizing and seeding, Type A, shall conform to the requirements of the appropriate Articles as follows:

Fertilizer, 5-10-5 commercial designation	Art. 8. 3. 1
Ground limestone	Art. 8. 3. 3
Seed mixture	Art. 8. 3. 10
Crown vetch seed	Art. 8. 3. 10
Grain seed	Art. 8. 3. 10

The materials for fertilizing and seeding, Type B, shall be as specified above for fertilizing and seeding, Type A, and also shall include peat conforming to the requirements of Art. 8. 3. 7.

The material for fertilizing turf areas as specified above shall be fertilizer, 5-10-5 commercial designation, conforming to the requirements of Art. 8. 3. 1.

7. 7. 3. Methods of Construction.

Areas prescribed for fertilizing and seeding, Type A, shall first be prepared for seeding in accordance with Art. 7. 4. 3. They shall then be treated with ground limestone which has been protected from moisture, and is dry and free flowing, at a rate necessary to attain a pH value of the soil of 6.5. The soil shall be raked, disked or otherwise worked to incorporate the ground limestone with the upper 3 to 4 inches of soil and to remove all stones, roots, lumps and other unsuitable matter larger than 2 inches in any dimension and to form an even surface.

Grass seed and grain seed shall be sown and a satisfactory stand of grass and legumes shall be established. The requirements for sowing seed, fertilizing, mulching and establishing a satisfactory stand of grass and legumes shall be as specified in Art. 7. 5. 3.

The methods of construction in areas prescribed for fertilizing and seeding, Type B, shall be as prescribed above except for the following requirements:

After the areas to be seeded have been brought to the prescribed lines and grades, peat shall be spread in an even layer at the rate prescribed in the Supplementary Specifications. Ground limestone shall be evenly spread at a rate such as to obtain a pH value of the soil of 6.5. The peat and ground limestone shall then be thoroughly mixed into the upper 3 to 4 inches of soil. The soil shall then be brought to an even grade by use of a chain link fence drag or other approved means.

All areas of fertilizing and seeding, Type B, shall be mulched as prescribed in Art. 7. 9. 3.

In areas designated for fertilizing, the fertilizer shall be applied at the rate of 800 pounds per acre.

Seed mixtures and fertilizers shall be applied with hydraulic seeding equipment approved by the Engineer.

7. 7. 4. Quantity and Payment.

The quantity of Fertilizing and Seeding, Type A, or Fertilizing and Seeding, Type B, for which payment will be made will be the surface areas of each type actually fertilized and seeded in accordance with the Plans or as directed by the Engineer.

Payment for Fertilizing and Seeding will be made for the quantities as above determined, measured in square yards, at the prices per square yard bid for the items FERTILIZING AND SEEDING, TYPE A, and FERTILIZING AND SEEDING, TYPE B, respectively, in the Proposal, which prices shall include the cost of liming, fertilizing, seeding, raking, rolling, furnishing all materials, labor, equipment and all else necessary therefor and incidental thereto, and shall also include furnishing and incorporating peat in the areas of fertilizing and seeding, Type B.

The quantity of Fertilizing for which payment will be made will be the number of square yards actually fertilized in areas designated on the Plans or by the Engineer.

Payment for Fertilizing will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item FERTILIZING in the Proposal, which price shall include the applying of the fertilizer at the specified rate, the furnishing of all labor, equipment and materials, and all else necessary therefor and incidental thereto.

Separate payment will not be made for reseeding or refertilizing areas previously topsoiled and seeded or fertilized and seeded by the Contractor in which a satisfactory stand of grass has not been obtained, nor for any other materials, equipment or labor in connection therewith, but the costs thereof shall be included in the prices per square yard bid in the Proposal for the items Fertilizing and Seeding, Type A and Fertilizing and Seeding, Type B.

SECTION 8

Sodding

7. 8. 1. Description.

Sodding shall include furnishing and placing sod and 4 inches of topsoil for a bedding.

7. 8. 2. Materials.

Materials for sodding shall conform to the requirements of the appropriate Articles as follows:

Fertilizer, 5-10-5 commercial designation	Art. 8. 3. 1
Ground limestone	Art. 8. 3. 3
Pegs	Art. 8. 3. 5
Sod	Art. 8. 3. 11
Topsoil	Art. 8. 3. 12

7. 8. 3. Methods of Construction.

The sod shall be placed on a 4-inch thick bed of topsoil, soon after being cut. Immediately before placing the sod, the topsoil shall be fertilized at the rate of 600 pounds of 5-10-5 fertilizer per acre. The sod shall be laid with staggered joints, and on slopes the placing shall start at the bottom. The sod pieces shall be pressed closely together, and at the top of a slope the upper edge of the sod strips shall be turned into the soil and covered with earth. On slopes steeper than 4:1, the sod shall be held in place with pegs driven flush with the surface of the sod. The pegs shall be not more than 1 foot apart, and not less than 2 pegs shall be

used for each strip of sod. The sod shall be pressed into the underlying soil by thorough tamping and rolling, after which a thin layer of topsoil, and 5-10-5 fertilizer applied at the rate of 600 pounds per acre, shall be spread evenly over all sodded areas and raked to a smooth, uniform surface. Then the sodded areas shall be thoroughly watered.

The finished surface shall be smooth, even and to the prescribed lines and contour. The sod shall be kept moist until growth is established. Sod showing evidence of dying or other defects before acceptance of the Project shall be replaced.

7. 8. 4. Quantity and Payment.

The quantity of Sodding for which payment will be made will be the actual area sodded in accordance with the Plans and Specifications or as directed by the Engineer.

Payment for Sodding will be made for the quantity as above determined, measured in square yards, at the price per square yard bid for the item SODDING in the Proposal, which price shall include the cost of furnishing and placing topsoil, sod and fertilizer; pegging; watering; all materials, labor, equipment and all else necessary therefor and incidental thereto.

SECTION 9

Mulching

7. 9. 1. Description.

Mulching shall include the furnishing, spreading and binding of hay and salt hay on areas prescribed respectively therefor.

7. 9. 2. Materials.

Hay, salt hay and binder of asphaltic oil, Grade RC-2, for mulching shall conform to the requirements specified respectively therefor in Art. 8. 3. 6.

7. 9. 3. Methods of Construction.

All seeded areas shall be mulched with hay uniformly spread in a layer 1 to 1½ inches thick, loose measurement. Hay shall be blown on in its natural length. Chopped hay shall not be used. No seeded areas shall remain unmulched longer than 7 days.

Ground cover areas and trees and shrubs within such areas shall be mulched with salt hay uniformly spread in a layer 3 to 3½ inches thick, loose measurement. The salt hay for tree and shrub mulching shall be spread and bound after the planting.

All mulch shall be bound in place with one application of the binder applied at a temperature of 145° F. to 155° F. After the

hay mulch for seeded areas has been spread, the binder shall be applied at the rate of 0.04 gallons per square yard on slopes less than 8 feet high and 0.075 gallons per square yard over the entire area of slopes 8 feet or more in height. The salt hay mulch for ground cover areas, trees and shrubs shall receive the binder at the rate of 0.075 gallons per square yard.

If, prior to final acceptance of the Project, any salt hay mulch be displaced, or if any hay mulch be displaced before the grass has made a growth of 1½ inches, it shall be replaced and rebound without additional compensation.

All mulch shall be left in place and allowed to disintegrate except that excessive amounts of hay shall be removed when directed by the Engineer.

7. 9. 4. Quantity and Payment.

The quantity of Mulching for which payment will be made will be the areas mulched with hay and with salt hay in accordance with the Plans and Specifications and as directed by the Engineer.

Payment for Mulching will be made for the quantities as above determined, measured in square yards, at the unit prices bid in the Proposal for the items HAY MULCHING and SALT HAY MULCHING, respectively, which prices shall include the cost of furnishing, placing and anchoring the mulch with binder, removing and disposing of excess mulch, and all else necessary therefor and incidental thereto.

SECTION 10

Planting

7. 10. 1. Description.

Planting consists of the furnishing and planting of trees, shrubs, vines, perennials and other plant material, and incidental work.

7. 10. 2. Materials.

Materials for planting shall conform to the requirements specified in the various Articles as follows:

Fertilizer, 10-6-4 commercial designation	Art. 8. 3. 1
Ground limestone	Art. 8. 3. 3
Manure	Art. 8. 3. 4
Miscellaneous materials	Art. 8. 3. 5
Mulch	Art. 8. 3. 6
Peat	Art. 8. 3. 7
Peat moss	Art. 8. 3. 8
Plant materials	Art. 8. 3. 9
Topsoil	Art. 8. 3. 12

7. 10. 3. Methods of Construction.

All plant material shall be carefully handled and packed in accordance with good nursery practice to prevent injuries during transit. The roots of all plants shall be properly protected with wet straw, moss or other suitable material until planted. If not planted on the day of delivery, all bare root material shall be heeled in and well watered, and the plants shall be kept shaded or covered, in a manner acceptable to the Engineer, until planted. The Contractor shall coordinate his work to prevent delays in planting that may expose the roots of plant materials to the air, sun, or freezing conditions. The Contractor shall perform all planting in accordance with approved nursery practice.

Time of Planting. Broadleaf and coniferous evergreen trees, shrubs, vines, and ground covers shall be planted between August 15 and September 15 and between April 15 and May 15. Deciduous trees, shrubs, vines and perennials shall be planted between October 15 and November 15 and between March 15 and May 15. These planting seasons may be extended or shortened according to prevailing weather and soil conditions, as directed by the Engineer.

For all planting during an extension of the spring planting season, the plant material shall be moved with roots balled; the trunk, branches and foliage shall be sprayed with an antidesiccant which shall be mixed and applied according to the directions of the manufacturer; and the trees and shrubs shall be trimmed and thinned to reduce the amount of foliage and help balance the loss of roots due to transplanting.

The Contractor shall assume all extra risk or cost of planting when it is performed out of the regular prescribed seasons.

Planting Beds. All planting beds, except those on steep slopes, shall be cultivated to a depth of 6 inches. All grass, sod and weeds shall be completely removed from the planting beds or thoroughly turned under and entirely covered with soil. The planting beds shall be raked to an even surface and neatly edged.

Planting Pits. The minimum planting pit sizes for bare root plant materials shall be as follows:

Height of plant, feet	1-4	4-5	5-6	6-8	8-10	10-12	12-14
Diameter of pit, inches	25	27	28	30	33	36	44
Depth of pit, inches	16	17	18	19	20	22	26

Planting pits for B & B plant materials shall provide a space for not less than 6 inches of backfill below and around the ball. Planting pits for potted plant material shall provide space for not less than 4 inches of topsoil below and around the root-earth clump. If topsoil from the excavation of planting pits is of good quality, as determined by the Engineer, it shall be saved and re-used.

PLANTING

Planting pits for vines, ground covers and perennials shall be not less than 12 inches in diameter and 12 inches deep.

Backfilling. Backfill shall be composed of peat and topsoil thoroughly mixed together in the proportion, by volume, of one part peat to three parts topsoil. When manure is specified, it shall be added to the backfill in the form of rotted horse or cow manure at the rate of 18 pounds for each tree, 6 pounds for each shrub and 3 pounds for each vine.

The roots of bare root plant materials shall be placed in their natural arrangement and the backfilling shall be carefully performed to prevent damage to the plant's root system. Broken or bruised roots shall be pruned immediately with a clean cut. The backfill mixture shall be placed in the bottom of the planting pit and shall be worked around the roots and thoroughly compacted as the backfilling proceeds.

For balled materials, the backfill mixture shall be placed in the bottom of the pits and around the balls. When the planting pits are backfilled, the burlap shall be cut away from the upper half of the balls and the remainder adjusted to prevent the formation of air pockets. Then the backfilling shall be completed and tamped firm.

Potted plant material shall not be removed from the pots until immediately before planting. The plants shall be set on 4 inches of the backfill mixture which has been placed in the planting pits. Additional backfill mixture shall be compacted about the roots of the plants in a manner that will not damage the root-earth clumps.

Where the ground is level or on a slight slope, a shallow basin with a diameter equal to that of the planting pit shall be left around each plant. On steeper slopes the backfill shall be formed into a dam that will catch and hold water around the plant. All plants shall be thoroughly watered the day they are planted.

Fertilizing Plants. Plants shall be fertilized before they are mulched except that trees and shrubs not fertilized before June 1 shall be mulched but not fertilized until after October 1 of the same year. Fertilizer shall be applied at the following rates:

Trees: 1½ pounds per inch of caliper.
Shrubs: ¼ pound per foot of height.
Vines, ground covers and perennials: ¼ pound per plant.

Mulching Plants. All plant materials shall be mulched with peat moss within 2 days after planting. The peat moss mulch shall completely cover the area of the planting bed, or planting pit when not contained in a bed, to a depth of 2 inches, loose measurement, except where otherwise prescribed.

Pruning of Plants. Deciduous trees and shrubs shall be pruned to remove one-third to one-half of the previous season's

growth, or more as may be directed by the Engineer. The plants shall be carefully pruned to preserve their natural appearance.

Wrapping Trees. All deciduous trees more than 2 inches in caliper shall be wrapped except when otherwise designated. Burlap wrapping material shall overlap 3 inches. Paper wrapping material shall overlap 1½ inches. The wrapping material shall be wound from the ground line to a height of 24 inches above the lowest main branches. The wrapping shall be tied at the bottom and the top and at 24-inch intervals between the bottom and the top. The wrapping shall be extended over the larger branches when directed by the Engineer and it shall be tied throughout the branch wrapping. The trees shall be wrapped within 4 days after planting, but not before the condition of the trunks of the trees has been inspected and approved by the Engineer.

Supporting Trees. All trees 1 inch or more in caliper or more than 5 feet high shall be staked or guyed immediately after planting.

The following trees shall be staked with one white cedar post placed, where possible, on the side of the tree away from the road and set not less than 24 inches in the ground and 9 inches from the tree trunk:

Deciduous trees, bare root, 1 to 2½ inches caliper, inclusive.

Deciduous trees, balled and burlapped, 1 to 1½ inches caliper, inclusive.

Columnar evergreen trees, 4 to 7 feet high, inclusive.

The following trees shall be staked with two white cedar posts, placed on opposite sides of the trees and set not less than 24 inches in the ground. The posts shall be placed at the perimeter of the ball.

Deciduous trees, balled and burlapped, over 1½ inches to 2½ inches caliper, inclusive.

Columnar evergreen trees, over 7 to 9 feet high, inclusive.

The following trees shall be guyed with three guys arranged evenly about each tree and attached securely to wood stakes driven firmly into the ground. The stakes shall be notched to receive the guy wire and shall extend not more than 8 inches out of the ground. Each guy shall be made of two strands of wire twisted together.

Deciduous trees over 2½ inches to 4 inches caliper.

Bushy evergreen trees 5 feet and higher up to 4 inches caliper.

Columnar evergreen trees over 9 feet high to 4 inches caliper.

Deciduous and evergreen trees over 4 inches to 8 inches caliper shall be guyed with three wire rope guys spaced around the tree and each guy anchored to a log or timber dead man buried not less than 2 feet in the ground.

Guys shall be attached to the trees above the lowest main branches or as directed by the Engineer and shall slope at an angle of approximately 45 degrees with the tree trunk.

The wire or wire rope for staking and guying shall pass through a piece of hose around the trees to prevent contact with them. The hose shall be long enough to prevent the wire or wire rope from cutting or rubbing the bark.

Maintenance. All plants shall be watered thoroughly on the day they are planted. Until final acceptance of the Project the Contractor shall properly care for all planting. He shall water, weed, spray with insecticide or fungicide, cultivate and perform other ordinary maintenance work as shall be necessary to keep the plants in a live and healty condition. At the time of acceptance of the Project all planting areas shall be free from weeds and in a cultivated condition, and all plant materials shall be alive and healthy.

During the guarantee period the Contractor shall water the plants as often as necessary to maintain them in a healthy growing condition.

Replacement Planting. All plants that are not alive and healthy at the end of one year after the date of final acceptance of a separate landscaping project, or after the date of approval by the Engineer of the completed landscape planting included in contracts for other work, shall be replaced by the Contractor with material as originally specified, without additional compensation. The Engineer shall determine which plants are not acceptable and shall designate the time for planting the replacements.

Replacement of evergreen material shall not be made between May 1 and August 15. Replacement of deciduous material shall not be made between May 1 and October 15.

On separate landscaping projects, when it is necessary to defer a portion of the landscape planting because of the work of other contractors, or for other reasons beyond the control of the Contractor, except weather conditions, the Engineer may approve the completed portion of the landscape planting and the guarantee period of one year for such completed portion shall begin on the date of such approval. The foregoing provision shall apply only when, at the time of such deferment, the completed portion of the planting amounts to more than 50 per cent of the total amount of the Contract and provided that, by reason of such deferment, the normal guarantee period would extend the guarantee period for the completed portion of the planting into an additional replacement planting season.

Before a semifinal or final payment for a separate landscaping project is made as provided in Article 1. 8. 5, the Contractor shall furnish a separate surety corporation bond, in addition to the 5 per cent guaranty bond specified in Art. 1. 8. 7, satisfactory to the Commissioner, conditioned for the faithful performance of the foregoing provisions relating to replacement planting and in the sum of 10 per cent of the total amount of the Contract.

When landscape work is included in a contract for other work, and it is necessary to defer a portion of the landscape planting because of the work of contractors other than the Contractor or his subcontractors, or for other reasons except weather conditions, that are beyond the control of the Contractor or his subcontractors, the Engineer may approve the completed portion of the landscape planting and the guarantee period of one year for the completed portion of planting shall begin on the date of such approval. The foregoing provision shall apply only when, at the time of such deferment, the completed portion of the planting amounts to more than 50 per cent of the value of all the landscape work in the Contract and provided that, by reason of such deferment, the normal guarantee period would extend the guarantee period for the completed portion of the planting into an additional replacement planting season.

When landscape work is included in a contract for other work, a semifinal certificate will not be issued solely for landscape work. Before semifinal or final payment is made, as provided in Art. 1. 8. 5, on such a contract, the Contractor shall furnish a separate surety corporation bond, in addition to the 5 per cent guaranty bond specified in Art. 1. 8. 7, satisfactory to the Commissioner, conditioned for the faithful performance of the foregoing provisions and in the sum of 10 per cent of the total amount of the landscape work included in the Contract.

7. 10. 4. Quantity and Payment.

The quantities of planting for which payment will be made will be the number of the various kinds of plant materials actually planted in accordance with the Plans and Specifications or as directed by the Engineer.

Payment for planting will be made for the quantities of each kind of plant material as above determined, at the price per unit bid for each plant in the Proposal, which price shall include the cost of furnishing the plant material and protection thereof before planting, excavation of holes, planting, mixing and placing backfill material, fertilizing, pruning tops and roots, supporting trees, wrapping, furnishing and applying antidesiccant or fungicide, repairing ground surface, disposal of excess excavated and waste materials, watering, maintenance, replacements, all materials, labor,

equipment and all else necessary therefor and incidental thereto except that the cost of furnishing topsoil, manure, peat and peat moss for planting shall be paid for separately as hereinafter specified.

The quantity of Topsoil for which payment will be made will be the quantity of topsoil actually placed in accordance with the Plans and Specifications and as directed by the Engineer. Topsoil will be measured by truck load volume at the time of delivery.

The quantity of Manure for which payment will be made will be the number of tons of manure actually used in accordance with the Plans and Specifications and as directed by the Engineer.

The quantity of Peat Moss for which payment will be made will be the quantity actually placed in accordance with the Plans and Specifications or as directed by the Engineer.

The quantity of Peat for which payment will be made will be the number of tons of cultivated peat or 75 per cent of the number of tons of raw peat, delivered to the job and incorporated with the soil in accordance with the Plans and Specifications and as directed by the Engineer.

Payment for Topsoil used for planting will be made for the quantity as determined above, measured in cubic yards, at the price per cubic yard bid for the item TOPSOIL, in the Proposal, which price shall include the furnishing of topsoil, as directed by the Engineer, furnishing all labor and equipment, and all other work in connection therewith and incidental thereto.

Payment for Manure will be made for the quantity as determined above, at the price per ton bid for the item MANURE in the Proposal, which price shall include the cost of furnishing and incorporating manure with the backfill, furnishing all labor and equipment, and all other work in connection therewith and incidental thereto.

Payment for Peat Moss will be made for the quantity as determined above, measured in standard bales, at the price per bale bid for the item PEAT MOSS in the Proposal, which price shall include the furnishing of peat moss, placing it in accordance with the Specifications or as directed by the Engineer, furnishing all labor and equipment, and all other work in connection therewith and incidental thereto.

Payment for Peat will be made for the quantity as determined above, at the price per ton bid for the item PEAT in the Proposal, which price shall include the cost of furnishing peat, furnishing and incorporating ground limestone with the peat as required, furnishing all labor and equipment, and all other work in connection therewith and incidental thereto.

SECTION 11

Mowing

7. 11. 1. Description.

Mowing consists of the mowing of seeded areas, and abandoned pastures and meadows which will remain within the right of way, at such locations as may be designated on the Plans or by the Engineer.

7. 11. 2. Materials.

No materials are required.

7. 11. 3. Methods of Construction.

The Engineer shall determine which areas require mowing and when it shall be done. The grass shall be mowed with a rotary type mower at a height of 3 to 4 inches. Mowing equipment and mowing operations which the Engineer may consider dangerous or injurious to the completed work or work under construction will not be permitted.

7. 11. 4. Quantity and Payment.

The quantity of Mowing for which payment will be made will be the number of acres actually mowed in areas designated on the Plans or by the Engineer.

Payment for Mowing will be made for the quantity as above determined, measured in acres, at the price per acre bid for the item MOWING in the Proposal, which price shall include mowing, the furnishing of all labor and equipment, and all else necessary therefor and incidental thereto.

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DIVISION 8

Materials

SECTION 1

Bituminous Materials

8. 1. 1. General Requirements.

Bituminous materials shall conform to the requirements therefor as specified in this Section except that those for use in waterproofing and dampproofing shall be as specified under that heading in Art. 4. 1. 3. All materials shall be homogeneous, free from foreign materials, and ready for use as furnished, unless otherwise specifically provided. The uses for various bituminous materials in certain types of construction and repairs are shown in Table 18.

8. 1. 2. Asphalt Cement for Paving.

Asphalt cement shall be prepared by the distillation of asphaltic petroleum, shall be homogeneous, free from water, tar and tar products and shall not foam when heated to a temperature of 347° F. It shall conform to the penetration grade or grades prescribed for specific uses. The various penetration grades shall conform to the requirements given in Table 8.

Table 8.—Asphalt Cement for Paving

Penetration Grade	60-70	70-85	85-100	100-120	120-150
Tests					
Specific Gravity, 77° F./77° F., min.	1	1	1	1	1
Flash Point, deg. F., min. (C. O. C.)	450	450	450	425	425
Loss on Heating, %, max.	1	1	1	1	1
Penetration of Residue from Loss on Heating, compared to penetration before heating, %, min.	80	75	75	75	75
*Ductility at 77° F./77° F., 5 cm. per min., cm., min.	100	100	100	100	100
Total Bitumen, Soluble in 100% Benzol, %, min.	99.5	99.5	99.5	99.5	99.5
Proportion of Bitumen Soluble in Carbon Tetrachloride, %, min.	99	99	99	99	99
Inorganic Matter or Ash, %, max.	1	1	1	1	1

* The ductility for all grades shall be determined at 50 penetration. The material shall be reduced to 50 penetration in accordance with current A.S.T.M. Designation D 243, and the ductility determined on this residue the penetration of which shall be not more than 60 nor less than 40. There shall be added to or subtracted from the ductility secured, 1 cm. for each point in penetration below or above 50, as a correction when the penetration is not exactly 50 when reduced.

8. 1. 3. Asphalt Cement for Corrugated Metal Pipe.

Asphalt cement for the coating and paved invert of corrugated metal pipe shall be prepared by distillation, or by distillation and blowing, of suitable bituminous material to produce asphalt cement conforming to the requirements shown in Table 9.

Table 9.—Asphalt Cement for Corrugated Metal Pipe

Water, %, max.	0
Specific Gravity, 77° F./77° F., min.	0.97
Penetration, 115° F, 50 gms., 5 secs., max.	80
Penetration, 77° F., 100 gms., 5 secs.	30-50
Penetration, 32° F., 200 gms., 60 secs., min.	25
Loss on Heating, 325° F., 50 gms., 5 hrs., %, max.	1
Penetration of Residue, 77° F., % of original, min.	85
Total Bitumen soluble in CCl_4, %, min.	99.5
Flash Point, C. O. C., deg. F., min.	347
Softening Point (Ball & Ring), deg. F.	190-230

In addition to conformance with the above requirements, the asphalt coating after application to the pipe shall conform to the following test requirements:

Stability Test. The asphalt coating shall not lose its stability when subjected to the highest summer temperature as indicated by successfully withstanding the following test:

Parallel lines shall be drawn along the crest of the corrugations and the specimen placed on end in a constant temperature oven with the line of corrugations horizontal. The temperature of the specimen shall be maintained within 2 degrees of 150° F. for a period of 4 hours. At the end of this period, no part of any line shall have dropped more than ¼ inch.

Impermeability Test. The asphalt coating shall be impermeable to moisture as indicated by the following test:

A 25% solution of sulphuric acid or a 25% solution of sodium hydroxide or a saturated salt solution (sodium chloride) shall be maintained in the valleys of the corrugations for a period of 48 hours, during which time no loosening or separation of the coating from the galvanizing shall have taken place.

8. 1. 4. Asphalt Cement for Undersealing Rigid Pavements.

Asphalt cement for undersealing rigid pavements shall be homogeneous, free from water, and shall not foam when heated to 400° F. It shall conform to the requirements shown in Table 10.

Table 10.—Asphalt Cement for Undersealing Rigid Pavements

Water, %, max.	0
Flash Point, C. O. C., deg. F., min.	475
Softening Point (Ball & Ring), deg. F., min.	180
Penetration at 115° F., 50 gms., 5 secs., max.	60
Penetration at 77° F., 100 gms., 5 secs.	15-30
Penetration at 32° F., 200 gms., 60 secs., min.	10
Evaporation Loss at 325° F., 50 gms., 5 hrs., %, max.	0.5
Penetration of Residue, 77° F., % of original, min.	70
Ductility at 77° F., cms., min.	2
Soluble in Carbon Disulphide, %, min.	99

8. 1. 5. Asphalt, Emulsified.

Emulsified asphalt, Types RS-1, RS-2, MS-1, MS-2, MS-3, MS-4 and SS-1 shall conform to the requirements of current A. A. S. H. O. Designation M 140 except that Type RS-1 may be used also for tack coat. Type SS-2 shall conform to the requirements specified for Type SS-1 in current A. A. S. H. O. Designation M 140 except that Penetration on the Residue, 77° F., gm., 5 sec., shall be 40-90.

8. 1. 6. Asphalt, Inverted Emulsified Cutback.

Rapid Curing Type. Inverted emulsified cutback asphalt, Rapid Curing Type, shall be prepared using a suitable grade of asphaltic oil, Grade RC, conforming to the requirements specified therefor in Art. 8. 1. 7, with the necessary water and emulsifier required. It shall be homogeneous at all times and shall conform to the requirements shown in Table 11.

Table 11.—Inverted Emulsified Cutback Asphalt, Rapid Curing Type

Grades	IE-RC-0	IE-RC-1	IE-RC-2	IE-RC-3	IE-RC-4*	IE-RC-5
Tests						
Miscibility (all grades)	Not Miscible					
Settlement, %, max.	1	1	1	1	1	1
Freezing (all grades)	Shall remain homogeneous					
Viscosity, Saybolt Furol, at 77° F.,	75-150					
at 122° F.,		75-150				
at 140° F.,			100-200	250-450	450-850	
at 180° F.,						300-600
Distillation a. Asphalt Content, % by wt., min.	50	60	65	67	75	78
b. Water, % by wt.	3-12	3-12	3-12	3-12	3-12	3-12
c. Naphtha (by difference) % by wt.	20-45	25-40	18-31	12-26	8-21	6 min.
Residue from Distillation a. Specific Gravity at 60° F./60° F., min.	1	1	1	1	1	1
b. Penetration at 77° F./77° F.	80-150	80-150	80-150	80-150	80-150	80-150
c. Ductility at 77° F., 5 cm. per min., cm., min.	100	100	100	100	100	100
d. Solubility in Carbon Tetrachloride, %, min.	98	98	98	98	98	98
e. Ash, % by wt., max.	1	1	1	1	1	1

* The purchaser reserves the right to require that this grade shall be furnished ready for application, with a viscosity range of either 450-650 or 650-850, depending upon the atmospheric temperature, road, traffic and other conditions encountered on the Project.

Medium Curing Type. Inverted emulsified cutback asphalt Medium Curing Type, shall be prepared using a suitable grade of asphaltic oil, Grade MC, conforming to the requirements specified therefor in Art. 8. 1. 7, with the necessary water and emulsifier required. It shall be homogeneous at all times and shall comply with the requirements shown in Table 12.

Table 12.—Inverted Emulsified Cutback Asphalt, Medium Curing

Grades	IE-MC-0	IE-MC-1	IE-MC-2	IE-MC-3	IE-MC-4	IE-MC-5
Tests						
Miscibility (all grades)	Not Miscible					
Settlement, %, max.	1	1	1	1	1	1
Freezing (all grades)	Shall remain homogeneous					
Viscosity, Saybolt Furol, at 77° F.,	75-150					
at 122° F.,		75-150				
at 140° F.,			100-200	250-500		
at 180° F.,					125-250	300-600
Distillation Asphalt Content, % by wt., min.	45	60	65	67	70	73
Water, % by wt.	3-12	3-12	3-12	3-12	3-12	3-12
Solvent (by difference), by wt., min.	25	20	15	12	8	6
Residue from Distillation Specific Gravity at 60° F./60° F., min.	1	1	1	1	1	1
Penetration at 77° F./77° F., 100 g., 5 sec.	120-300	120-300	120-300	120-300	120-300	120-300
Ductility at 77° F., 5 cm. per min. reduced to 50 Penet., cm., min.	100	100	100	100	100	100
Solubility in Carbon Tetrachloride, % by wt., min.	98	98	98	98	98	98
Ash, % by wt., max.	1	1	1	1	1	1

The properties shown in Tables 11 and 12 shall be determined in accordance with current A. A. S. H. O. Designation T 59 except that the asphalt content, per cent by weight, shall be determined in accordance with the "Method of Test for Determination of Asphalt Content of Inverted Emulsified Cutback Asphalt" as specified in Art. 9. 1. 1 herein.

8. 1. 7. Asphaltic Oil.

Asphaltic oil shall be a liquid petroleum product composed of suitable naphtha and petroleum asphalt. Residual asphaltic oil shall be made only from petroleum classified as having an asphaltic or semiasphaltic base. The various types and grades of asphaltic oil shall conform to the requirements given in Tables 13, 14 and 15.

Table 13.—Asphaltic Oil, Rapid Curing Type

Grades	RC-0	RC-1	RC-2	RC-3	RC-4	RC-5
Tests						
Furol Viscosity at 77° F.	75-150					
122° F.		75-150				
140° F.			100-200	250-500		
180° F.					125-250	300-600
Ductility at 50 Penetration, 5 cm. per minute, cm., min.	80	80	80	80	80	80
Distillation (% by volume of total distillate to 680° F.) up to 320° F., min.	20	15	10	5	3	
374° F., min.	55	45	40	30	25	15
437° F., min.	75	65	60	55	50	45
500° F., min.	85	80	75	70	65	55
600° F., min.	90	88	87	85	83	80
Residue from Distillation to 680° F., volume % by difference, min.	45	60	70	74	78	82
Tests on Residue from Distillation, Penetration, 77° F., 100 g., 5 secs.	80-120	80-120	80-120	80-120	80-120	80-120
% Soluble in CCl_4, min.	99.5	99.5	99.5	99.5	99.5	99.5

Table 14.—Asphaltic Oil, Medium Curing Type

Grades	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
Tests						
Flash Point, Tag. Open Cup, deg. F., min.	100	100	150	150	150	150
Furol Viscosity at 77° F.	75-150					
122° F.		75-150				
140° F.			100-200	250-500		
180° F.					125-250	300-600
Ductility at 50 Penetration, cm., min.	80	80	80	80	80	80
Distillation (% by volume of total distillate to 680° F.) to 437° F., max.	25	20	10	5	0	0
to 500° F.	40-70	25-65	15-55	5-40	max. 30	max. 20
to 600° F.	75-93	70-90	60-87	55-85	40-80	20-75
Residue from Distillation to 680° F., volume % by difference, min.	50	60	67	73	78	82
Tests on Residue from Distillation, Penetration, 77° F., 100 g., 5 secs.	120-300	120-300	120-300	120-300	120-300	120-300
% Soluble in CCl_4, min.	99.5	99.5	99.5	99.5	99.5	99.5

Table 15.—Asphaltic Oil, Slow Curing Type

Grade	SCO
Tests	
Specific Gravity at 60° F./60° F., min.	0.93
Evaporation Loss, 325° F. 5 hrs., 20 g., %, min.	23
Float Test, Residue, 122° F., from Evaporation Loss	90-250
Evaporation Loss, 212° F., 5 hrs., 20 g., %, min.	11
Viscosity, Engler, 104° F. 1st. 50 cc.	350-500
Solubility in C_6 H_6, %, min.	99.5
Ductility at 50 Penetration, cm., min.	60
Bitumen Content, 100 Penetration, %	60-75
Flash Point (Cleveland Open Cup), deg. F., min.	158

8. 1. 8. Asphalt Plank, Premolded.

Premolded asphalt plank shall conform to the requirements of current A. A. S. H. O. Designation M 46.

8. 1. 9. Joint Filler, Preformed.

Bituminous Type. Bituminous type preformed expansion joint filler for concrete shall conform to the requirements of the current A. A. S. H. O. Designation M 33.

Bituminous Cellular Type. Bituminous cellular type premolded joint filler for concrete shall conform to the requirements of current A. A. S. H. O. Designation M 153, Type III.

The above joint filler requirements are identical with those specified in Art. 8. 5. 31 for the same types.

8. 1. 10. Joint Sealer and Fillers, Liquid.

Joint Sealer, Hot-Poured Rubber-Asphalt. Hot-poured rubber-asphalt joint sealer shall be furnished in one grade only, composed of a mixture of materials which will form a resilient and adhesive compound capable of effecting the filling and sealing of joints in concrete pavements against the infiltration of moisture throughout repeated cycles of expansion and contraction with temperature changes, and which will not flow from the joint or be picked up by vehicular tires at summer temperatures. The sealer shall not be damaged when heated to a temperature required for satisfactory pouring.

The sealer shall conform to the following requirements:

Pour Test. The pour point shall be at least 20° F. lower than the safe heating temperature. The safe heating temperature is defined as the highest temperature to which the joint sealing material can be heated and conform to the flow requirements.

Penetration. The penetration at 77° F. with a load of 150 grams shall not exceed 0.90 cms. in 5 seconds.

Flow. The flow at 140° F. shall not exceed 0.5 cms.

Bond. The sealer, when tested at 0° F., shall not develop at any time during the test procedure a crack, separation or other opening which at any point is more than ¼ inch deep in the sealer or between the sealer and the mortar block.

The failure of at least two specimens in the group of three representing a given sample of compound shall be necessary for rejection of the sample on the basis of this requirement.

Packing and Marking. The sealer shall be packed in substantial commercial containers of a size which can be conveniently handled on the Project, and so constructed as to insure safe delivery by common carrier or other carriers to the point of delivery, and so that the covering may be removed readily from the material without waste. The container shall be legibly marked with the description, manufacturer's name and brand, weight, maximum pouring temperature, and batch number.

Sampling and Testing. The joint sealer shall be tested in accordance with current Federal Specification SS-R-406, "Road and Paving Materials, Methods of Sampling and Testing." Arrangements may be made to sample and test the sealer before it is shipped to the Project in which event one sample shall be taken at random from each batch. Where the single sample selected fails to conform to the requirements specified herein, a number of packages shall be selected at random equivalent to the cube root of the total number of packages in the batch.

If not previously inspected and approved, certified copies of the test analysis on the sealer, made either by the producer or an independent laboratory, shall be furnished by the producer with each batch of material shipped. One test analysis shall be included with the shipment and one forwarded to the Department's Laboratory.

When the sealer is not supplied from a tested stock as described above, it shall be sampled and tested after delivery. A separate sample consisting of not less than 10 pounds of the compound shall be cut from a single container. This sample shall not be melted and placed in a container but shall be submitted as cut from the single container. It shall be wrapped in wax paper before being packaged for shipment to the Laboratory.

Joint Sealer, Cold-Poured. Cold-poured joint sealer shall be any suitable material of a cold application consistency.

Material. As delivered to the user, the sealer may be composed of one homogeneous substance, or of two or more substances which are to be mixed prior to application. In the latter case, the substances shall be of such a character that a homogeneous preparation can be readily obtained by combining the separate substances by mechanical or manual stirring without the application of heat above a temperature of 100° F. The sealer shall be a resilient and adhesive material which is capable of sealing joints in concrete effectively against the infiltration of moisture throughout repeated cycles of expansion and contraction and which will not flow from the joint. The material shall pour or extrude readily at a temperature of 70° F. immediately after preparation for use, and shall remain in a suitable condition for sealing joints for at least one hour. The sealer shall not be applied at temperatures below 40° F. In the case of vertical joints, a dam shall be placed over the material for a period of twelve to twenty-four hours.

Adhesion to Concrete. The material shall be of such a nature that it will adhere to dry but dust-free concrete or to damp concrete free from surface moisture.

Bond Test. The sealer shall not fail in adhesion or cohesion, after 5 cycles, when tested in accordance with current Federal Specification SS-R-406C, Road and Paving Materials, such specification being amended to provide that after each extension the specimen shall be immersed in water at room temperature for recovery under water before proceeding with the next cycle.

Flow Test. The sealer shall not flow when subjected to the following test: The sealer as prepared for the bond test shall be poured or troweled into a brass mold 4 cm. wide, 6 cm. long and 0.32 cm. in depth. This mold shall be so placed on a bright tin panel that the completed specimen may be removed intact for the test. The excess shall be struck off with a hot straight edge. Three specimens shall be so prepared and, after 24 hours of curing, they shall be placed on a support at an angle of 75 degrees with the horizontal in an oven maintained at 140° F. ± 2° F. for 5 hours.

Sampling. The material shall be shipped to the supplier or to the Project in batches. Each batch shall be identified by a batch number and shall be accompanied by an analysis certification. The Laboratory also shall receive a certified copy of the analysis made on the material by the producer or an independent laboratory, with a 1-quart sample of the material, or if a 2-component material, a sufficient amount of each component to prepare a quart sample of the finished sealer.

Packaging. The joint sealer shall be furnished in 1-gallon or 5-gallon containers as specified. In the case of two or more com-

ponents, the material shall be furnished in 1-gallon or 5-gallon containers holding in separate compartments thereof the exact amount of each of the materials which are to be combined to prepare the sealer for use.

Marking. The container shall be marked with the name and type of material, the manufacturer's name, the batch number and the quantity contained therein.

Joint Filler, Grade RA. Joint filler, Grade RA, shall conform to the requirements shown in Table 16, shall be made from suitable asphalt cement and other materials as may be required, and shall not crack or shatter at 8° F. when subjected to the Brittleness Test made in accordance with the "Method of Test for Brittleness of Liquid Joint Filler" as specified in Art. 9. 1. 6.

Joint Fillers, Grade BM. Joint fillers, Grade BM, shall be made from asphalt cement and mineral filler. For Grade BM-1, the asphalt cement used shall be Penetration Grade 85-100 and for Grade BM-2, Penetration Grade 60-70. The mineral filler used shall be limestone, dolomite, slate or diatomaceous earth, pulverized so that all shall pass a No. 200 sieve and not less than 95 per cent shall pass a No. 300 sieve. The mineral filler must be capable of being mixed with the asphalt cement so that, after being maintained at 163° C. for 2 hours without agitation, the settlement ratio shall be less than 1.1. The settlement ratio test shall be made in accordance with current A. A. S. H. O. Designation T 109. BM Grades of joint filler shall conform to the requirements shown in Table 16.

Joint Filler, Oil Asphalt. Oil asphalt joint filler shall conform to the requirements specified in the current A. A. S. H. O. Designation M 18. Grade A shall be used for the filler for granite block pavement joints.

Table 16.—Joint Fillers

Grade	RA	BM-1	BM-2
Tests			
Specific Gravity, 15.5° C., min.	0.985		
Penetration at 0° C., 200 gm., 60 sec., min.	40		
Penetration at 25° C., 100 gm., 5 sec.	75-100		
Penetration at 46°C., 50 gm., 5 sec., max.	215		
Softening Point (B & R), deg. C., min.	60	53	56
Evaporation Loss, 163° C., 50 gm., 5 hrs. %, max.	1		
Penetration of Residue at 25° C., 100 gm., 5 sec., min.	55		
Solubility in Benzol, %	99 min.	55-75	45-65
Bitumen Soluble in Ether (Sulphuric U. S. P.), %, min.	72		
Flash Point, deg. C., min.		200	200
Ductility at 0° C., 5 cm. per min., min.	2		
Ductility at 25° C., 5 cm. per min., min.	3		
Bend Test, 50 gm., 5 sec.		45-75	30-45
Flow Test at 51.7° C., cm., max.	6		

The Bend Test shall be as specified in Art. 9. 1. 7, "Method of Test for Deflection or Bend of Liquid Joint Filler."

The Flow Test shall be as specified in Art. 9. 1. 8, "Method of Test for Flow of Liquid Joint Filler."

8. 1. 11. Liquefier.

Liquefier shall be a petroleum distillate free from insoluble matter, lubricating oil, wax and water, shall have no acid or corrosive action and shall conform to the requirements shown in Table 17 when tested in accordance with current A. S. T. M. Designation D 86.

Table 17.—Liquefier

Initial Boiling Point, deg. F.	194-255
End Point, deg. F., max.	400
50% distillate over at, deg. F., max.	293
75% distillate over at, deg. F., max.	320
95% distillate over at, deg. F., max.	374
Distillation Residue, %, max.	2
Gravity (Bé), at 60° F.	50-62

8. 1. 12. Tars.

Tars shall conform to the requirements of current A. A. S. H. O. Designation M 52 including the Sulfonation Index.

8. 1. 13. Tar Base Coating, Cold Application.

General Requirements. Tar base coating shall be a black, self-priming heavy duty protective coating which may be applied easily to steel, concrete or masonry surfaces in thick films without sag. As received, it shall be a heavy paste or plastic-like material which, on stirring, thins out to a brushing or spraying consistency without the use of thinners of any kind.

Composition. The material shall be composed of a tar base pitch blended with selected solvents and an inert inorganic filler to a heavy paste-like consistency. Natural asphalt or petroleum shall not be used as one of the constituents.

The material shall conform to the following requirements when tested by the respective test methods shown below:

	Min.	Max.	Test Method
1. Distillation, % by Weight			
0 - 150° C		None	
0 - 235° C	20	30	ASTM-D 20
Softening Point of Dist. Residue, ° F.	205	240	ASTM-D 36
Penetration on Residue at 77° F., 100 gm., 5 sec.	5	25	ASTM-D 5
2. Ash, % by Weight	15	25	ASTM-D 271
3. Sag Test		No Sag	*

* A coating 3/64 inch thick on a smooth metal plate suspended vertically shall show no appreciable flowing or sagging while still wet.

Table 18.—Uses of Bituminous Materials

Type of Construction	Asphaltic Oil	Tar	Emulsified	
			Asphalt	Cutback
Surface Treatment—New Macadam	Grade	Grade	Grade	Grade
Prime Coat	MC-0 or 1	RT-1 or 2		
Seal Coat	RC-3 or 4	RT-7, 8, 9, 10, 11 or 12	RS-2	IE-RC-2 or 3
Gravel				
Prime Coat	MC-0 or MC-1	RT-1		
Seal Coat (a)	RC-3 or 4	RT-7, 8, 9, 10, 11 or 12	RS-2	IE-MC-1 or 2
Seal Coat (b)	MC-2 or SCO			IE-MC-1 or 2
Surface Retreatment				
Aggregate Size—Grits	RC-2	RT-7, 8, 9, 10, 11 or 12	RS-1	IE-RC-2
⅜″	RC-3 or 4	RT-7, 8, 9, 10, 11 or 12	RS-2	IE-RC-2 or 3
½″	RC-3 or 4	RT-8, 9, 10, 11 or 12	RS-2	IE-RC-2 or 3
Fine Aggregate	MC-0, 1 or 2 or SCO			IE-MC-1 or 2
Boiler Slag		RT-7 or 8		
Mixed-in-Place				
Coarse Aggregate ¾″ or 1″	RC-2 or 3		MS-1	IE-RC-2
Soil-Aggregate, Type 2, Class A or B (Road Gravel)	MC-2 or SCO		SS-1 or SS-2	
Patching, Cold Mix				
¼″ to 1″ Size Aggregate	RC-2, 3 or 4	RTCB-5 or 6	MS-1	
Soil-Aggregate, Type 2, Class A or B (Road Gravel)	MC-2, 3 or 4 or SCO	RT-5 or 6	SS-1	
Sand-Gravel	MC-2, 3 or 4 or SCO	RT-5 or 6	SS-1	
Fine Aggregate	MC-2, 3 or 4 or SCO	RT-5 or 6	SS-1	
Tack Coat				
Cement Concrete	RC-0		RS-1 or SS-1	
Bituminous Concrete or S. A.	RC-0		RS-1 or SS-1	
Bituminous Treated Surface	RC-1		RS-1 or SS-1	

Alternative types of bituminous materials shown in the above table may be used except as otherwise prescribed in the Supplementary Specifications.

Where two or more grades of a given material are indicated, the higher-numbered grade or grades shall be used in warm weather, as directed or approved by the Engineer.

(a) For use with coarse aggregate cover.

(b) For use with fine aggregate cover.

SECTION 2

Electrical Materials

Aluminum alloys shall be as specified in Art. 8. 4. 1.

8. 2. 1. Cable, Electrical.

Electrical cable shall be made up of components conforming to the requirements therefor hereinafter specified.

Duplicate certified copies of the manufacturer's tests on the cable shall be furnished with each shipment of cable.

Series Lighting Cable, Nonarmored.

Conductor. The conductor shall be No. 8 American Wire gauge, 19-wire strand, tinned soft copper conforming to current A. S. T. M. Designation B 8.

Insulation. The insulation shall be 7500-volt, 1⁴⁄₆₄-inch thick, ozone-resistant rubber conforming to the current A. S. T. M. Designation D 574.

Corona Shield. The corona shield shall conform to current A. S. T. M. Designation D 27, with a 0.005-inch thick, tinned copper shielding tape.

Jacket. The jacket shall be ⁴⁄₆₄-inch neoprene conforming to current A. S. T. M. Designation D 752.

Series Lighting Cable, Armored.

Conductor. The conductor shall be No. 8 American Wire gauge, 19-wire strand, tinned soft copper conforming to the current A. S. T. M. Designation B 8.

Insulation. The insulation shall be 7500-volt, 1⁴⁄₆₄-inch thick, ozone-resistant rubber conforming to the current A. S. T. M. Designation D 574.

Corona Shield. The corona shield shall conform to the current A. S. T. M. Designation D 27, with a 0.005-inch thick, tinned copper shielding tape.

Jacket. The jacket shall be ⁴⁄₆₄-inch neoprene conforming to current A. S. T. M. Designation D 752.

Bedding. Bedding shall be saturated jute conforming to the current Specification of the I. P. C. E. A., Part 6, Section 6.4. 1. 4.

Armor. Armor shall be two galvanized flat steel tapes conforming to the current Specification of the I. P. C. E. A., Part 6, Section 6. 4. 1. 4.

Covering. The covering shall be jute serving over-all covering conforming to the current Specification of the I. P. C. E. A., Part 6, Section 6. 4. 1. 8.

8. 2. 2. Conduits and Fittings.

Conduits used as a raceway for the installation of wires and cables, and the fittings therefor, shall conform to the requirements hereinafter specified.

Asbestos-Cement Conduit and Fittings. Asbestos-cement conduit and fittings shall conform to Federal Specification for Conduit and Fittings; Asbestos-Cement (Electrical Purposes) W-C-571, dated April 3, 1942, and amendments thereto.

Bituminized Fiber Conduit and Fittings. Bituminized fiber conduit and fittings shall conform to the Federal Specification for Conduit and Fittings; Fiber, Bituminized (Electrical Purposes) W-C-581, dated August 1, 1939, and amendments thereto.

Rigid Metallic Conduit and Fittings. *Rigid metallic conduit and fittings* for installation above ground shall conform to the standards therefor as set forth in Bulletin UL6, Rigid Metal Conduit, of the Underwriters' Laboratories, Inc.

Rigid metallic conduit and fittings for underground installation shall be hot-galvanized and shall be wrought iron pipe conforming to the requirements hereinafter specified or shall be of a ferrous metal having a corrosion resistance not less than that of wrought iron.

Wrought iron pipe shall be standard wall wrought iron pipe conforming to current A. S. T. M. Designation A-72, Welded Wrought Iron Pipe, and shall be galvanized inside and outside by the hot-dip process. The weight of zinc coating shall be not less than two ounces per square foot.

Threads and couplings shall conform to the provisions of Table I, Appendix IV of A. S. T. M. Designation A 53, Basic Threading Data for Pipe. Each length of pipe shall be plugged or drifted and each end reamed to insure that the interior is free of obstructions and the ends smooth.

8. 2. 3. Controllers and Controller Housings.

Controllers and controller housing shall conform to the requirements of current A. S. A. Specification D-13. 1 and U. D. C.-656. 054, as may be amended in the Plans or Supplementary Specifications.

8. 2. 4. Detectors.

Detectors shall conform to the requirements of current A. S. A. Specification D-13. 1 and U. D. C.-656. 054, as may be amended in the Plans or Supplementary Specifications.

8. 2. 5. Signal Heads.

Signal heads shall conform to the requirements of current A. S. A. Specification D-10. 1 and U. D. C-656. 054, as may be amended in the Plans or Supplementary Specifications.

8. 2. 6. Wire, Electrical.

Electrical wire shall conform to the requirements specified in Table 19 for the uses indicated. All wire shall be single conductor, 7-strand with 600-volt insulation.

Table 19.—Electrical Wire

Use	Trade Designation	Current A. S. T. M. Specification	
	Wire Type	Wire	Insulation
Highway Lighting			
Multiple Lighting Wire	R. R.	B 8	D 754
Utility Service Wire	R. R.	B 8	D 754
Pole & Bracket Wire	R. R.	B 8	D 754
Electric Signs			
Circuit Wire	R. R.	B 8	D 754
Utility Service Wire	R. R.	B 8	D 754
Traffic Signals			
Signal Wire	T. W.	N. E. C.*	
Utility Service Wire	R. R.	B 8	D 754

* National Electric Code

Ground Wire. Ground wire shall be No. 8 American Wire gauge, bare soft drawn copper, tinned, 7-wire strand, conforming to the requirements of current A. S. T. M. Designation B 8.

Grounding Rods. Grounding rods shall be galvanized steel rods ⅝ inch in diameter, 10 feet long, and galvanized malleable iron ground clamps. Galvanizing shall conform to the requirements of current A. S. T. M. Designation A 153.

SECTION 3

Landscaping Materials

8. 3. 1. Fertilizer.

Each ton of fertilizer shall conform to the requirements shown therefor in Table 20. The commercial designation required shall be as prescribed in the Plans or Supplementary Specifications.

Table 20.—Fertilizer

Commercial Designation	5-10-5	10-20-10	10-6-4	12-12-12
Components	Weight in Pounds Per Ton			
Nitrate of Soda (16%N), min.	200	...	475	...
Ammonium Nitrate (33.5%N), min.	...	225	...	285
Sulphate of Ammonia (20.5%N), min.	330	400	485	705
Urea, min.	...	100	...	...
Tankage (10%N), min.	...	...	250	...
Superphosphate (20%P), min.	1000	...	600	...
Triple Superphosphate (46%P), min.	...	870	...	520
Muriate of Potash (50%K), min.	150	400	160	480
Sul-Po-Mag (25%K), min.	100	...	...	...
Borax, min.	10	...	10	...
Manganese Sulphate, min.	10	...	10	...
Filler, max.	200	5	10	10

Shipment. Each delivery of fertilizer shall be accompanied by a delivery slip indicating the number of bags and the weight. A chemical analysis of the composition of the fertilizer, certified by the manufacturer, shall appear on each bag or on the delivery slip. The delivery slip shall be furnished to the Engineer at the time of delivery.

8. 3. 2. Lime, Hydrated.

Hydrated lime shall be composed of not less than 70 per cent calcium and magnesium oxides. Its gradation shall be as shown in Table 21.

Table 21.—Hydrated Lime, Gradation

Sieve Size	Total Per Cent Passing min.	max.
No. 20	95	100
No. 60	85	90
No. 100	75	77

Each delivery of hydrated lime shall be accompanied by a delivery slip indicating the weight, and a certified analysis of its chemical composition and gradation, which shall be furnished to the Engineer at the time of delivery.

8. 3. 3. Limestone, Ground.

Ground limestone shall be composed of not less than 85 per cent calcium and magnesium carbonates equivalent to not less than 50 per cent of calcium and magnesium oxides. Its gradation shall be as shown in Table 22.

Table 22.—Ground Limestone, Gradation

Sieve Size	Total Per Cent Passing min.	max.
No. 20	95	98
No. 60	75	80
No. 100	65	70
No. 200	45	50

Each delivery of ground limestone shall be accompanied by a delivery slip indicating the weight, and a certified analysis of its chemical composition and gradation, which shall be furnished to the Engineer at the time of delivery.

8. 3. 4. Manure.

Horse or Cow Manure. Horse or cow manure, or a mixture thereof, together with bedding of straw, peanut shells or other approved materials, shall be thoroughly rotted but not more than two years old. The manure shall contain a total of not more than 5 per cent, by volume, of wood shavings, corn stalks or other foreign materials, not more than 60 per cent, by weight, of water, and shall be subject to approval of the Engineer before delivery.

Dehydrated Horse and Cow Manure. Dehydrated horse and cow manure shall conform to the requirements specified above for horse or cow manure except that it shall be fresh manure properly processed and dehydrated to the extent that approximately 7,600 pounds shall have been reduced to a weight of 2,000 pounds. The dehydrated product shall contain not more than 8 per cent, by weight, of moisture and shall contain as available mineral elements, by weight, not less than 2 per cent of nitrogen, 1 per cent of phosphoric acid and 1 per cent of potash.

Poultry Manure. Poultry manure shall contain not more than 50 per cent, by weight, of approved litter. It shall have been

handled in the best possible manner to preserve its organic and chemical content and to promote rapid drying prior to storage. Poultry manure which has not been handled to promote rapid air drying, or which has been stored out-of-door or other places where it may become wet, will not be accepted. All poultry manure shall be subject to approval by the Engineer before delivery.

Dehydrated Poultry Manure. Dehydrated poultry manure shall conform to the requirements specified above for poultry manure except that it shall be properly processed and dehydrated to the extent that 6,000 pounds of poultry manure shall have been reduced to a weight of 2,000 pounds. The dehydrated product shall contain not more than 8 per cent, by weight, of moisture and shall contain as available mineral elements, by weight, not less than 2 per cent of nitrogen, 1 per cent of phosphoric acid and 1 per cent of potash.

Shipment. Each shipment of manure shall be accompanied by a certified weight slip and, in the case of dehydrated manure, the chemical analysis certified by the manufacturer. Both shall be furnished to the Engineer at the time of delivery.

8. 3. 5. Miscellaneous Landscaping Materials.

Antidesiccant. Antidesiccant shall be of the polyvinyl type.

Cedar Posts. Cedar posts shall be of white cedar, 8 feet long and not less than 2 inches nor more than 3 inches in diameter at the thinner end.

Guy Wire. Guy wire shall be 14-gauge galvanized steel wire.

Herbicides. Herbicides shall be ammonium sulfamate, 2-4-D, 2-4-5T, or equivalent products approved by the Engineer, in concentrations and mixtures recommended for the control of the particular species of plants.

Log or Timber Deadman. Log or timber deadman for anchoring wire rope guys shall be 2 feet long and 6 to 8 inches in diameter.

Pegs. Pegs for fastening sod on slopes shall be of wood lath not less than 9 inches long, or similar pieces of wood.

Rubber Hose. Rubber hose shall be ¾ inch corded hose.

Slope Boards and Stakes. Slope boards shall be 1-inch by 6-inch boards of sound, unsplit wood with no defects that may impair their usefulness.

Stakes shall be 2 inches by 4 inches, with a minimum length of 24 inches, of sound, unsplit wood with no defects that may impair their usefulness.

Wood Guy Stakes. Wood guy stakes shall be new 2" x 2" x 24" stakes of southern yellow pine, or 2½ inch diameter, 24 inches long, of white cedar. The diameter of the cedar stakes shall be measured at the thinner end. The stakes shall be pointed on the thicker end and notched 4 inches from the other end for fastening the wire guys.

Tree Paint. Tree paint shall be an asphaltic base paint prepared for tree surgery.

Twine. Twine to be used to secure wrapping material shall be 2-ply jute twine.

Wire Rope. Wire rope for guying trees shall be ⅜-inch galvanized wire rope. Each guy shall be supplied with one galvanized iron turnbuckle.

Wrapping Material. Wrapping material for trees shall be natural-colored 8-ounce burlap strips, 6 inches wide, or 30-30-30 Krinkle Kraft, or equal, paper strips 4 inches wide.

8. 3. 6. Mulch.

Hay. Hay shall be of timothy, red top or native grasses approved by the Engineer.

Salt Hay. Salt hay shall be of salt meadow grasses approved by the Engineer.

Binder. Asphaltic oil, Grade RC-2, for mulch binder shall conform to the requirements specified therefor in Art. 8. 1. 7.

8. 3. 7. Peat.

Peat (known as sedge or reed peat) shall consist of incompletely decomposed plant residues resulting from anaerobic activity in water-saturated areas. Peat shall not contain gravel, debris or toxic compounds. The average water content of the peat shall not exceed 65 per cent, by weight. Peat with pH value of less than 4 will not be accepted. Samples of peat will be taken by the Department at the source and shall be approved before any deliveries are made.

Cultivated Peat. Cultivated peat shall be peat that has been cultivated with green cover crops which have been turned under and allowed sufficient aging to decompose and produce a peat of relatively stable organic content. Hyperhumus or equal is a cultivated peat.

Raw Peat. Raw peat shall be a peat that has not been cultivated and aged. The organic content of such peat is subject to considerable reduction after its application. It shall be shredded to resemble the texture of cultivated peat.

Organic Content. Peat, cultivated or raw, shall have a minimum organic content of 75 per cent, by weight. The inorganic material shall consist only of sand, silt and clay. The pH (hydrogen-ion concentration), organic content and moisture content shall be determined by the "Method of Test for Peat" as specified in Art. 9. 1. 15.

Shipments. All shipments of peat shall be accompanied by delivery slips with certified weight and name of supplier indicated, which shall be furnished to the Engineer at the time of delivery.

8. 3. 8. Peat Moss.

Peat moss shall be a sphagnum peat moss with a minimum water absorbing capacity of 20 times its dry weight. A bale containing 7½ cubic feet of compressed peat moss which expands to approximately 15 cubic feet of thoroughly loosened material shall be considered a standard bale.

8. 3. 9. Plant Materials.

General. Plant materials shall be trees, shrubs, vines and plants of all descriptions, required for the Project. All plant materials shall conform to the current A. S. N. S. sponsored by the A. A. N. They shall be healthy and vigorous, with well developed branch and root systems, and shall be free from disfiguring knots and gall, sun scald injuries, bark abrasions and other objectionable disfigurements. Plant materials that are weak or thin, or which have been cut back from larger grades to meet certain specified requirements, will not be accepted. All plant materials shall conform to State and Federal laws relating to inspection for diseases and infestation, and inspection certificates shall be filed with the Engineer. The current S. P. N. shall be the authority for all plant names. All plant materials specified on the Plans as "in variety" shall be labeled with the correct botanical name.

Trees, Deciduous. Deciduous trees shall be of the large-growing species such as Quercus borealis maxima and Acer saccharum which lose their foliage in the fall.

Trees, Evergreen. Evergreen trees shall be coniferous or broadleaf trees which retain foliage throughout the year.

Trees, Small and Flowering. Small and flowering trees shall be trees of the smaller-growing deciduous species such as Betula populifolia, Cornus florida and Malus arnoldiana.

Shrubs. Shrubs shall be multiple-stemmed or bushy deciduous and broadleaf evergreen plants such as Berberis thunbergi, Forsythia intermedia, Myrica pennsylvanica, Rhododendron catawbiense and Kalmia latifolia.

Vines and Ground Covers. Vines and ground covers shall be creeping, spreading or climbing plants such as Pachysandra

terminalis, Vinca minor, Celastrus scandens and Parthenocissus tricuspidata veitchi.

Perennials. Perennials shall be herbaceous plants with hardy roots that live for a period of at least three years.

Inspection. Plant materials may be inspected first where they are growing. Certain items selected shall be marked with a seal furnished by the Engineer. The plant materials will again be inspected upon arrival at the site of the Project. The Contractor shall give the Engineer not less than 24 hours written notice of the date he proposes to have the material on the Project. Materials arriving with broken seals, broken or loose balls, insufficient protection, or which have been damaged in transit or do not conform to the Specifications, will not be accepted. The Contractor shall give the Inspector all necessary assistance when inspections are made.

Plant Types.

Type 1. Spreading Conifers and Broadleaf Evergreens: Juniperus pfitzeriana, Taxus baccata repandens, Cotoneaster horizontalis, Rhododendron maximum, Azalea ledifolia.

Type 2. Broad Coniferous and Broadleaf Evergreens: Chamaecyparis (fast-growing upright varieties), picea abies, Tsuga canadensis, Pinus strobus, Magnolia grandiflora.

Type 3. Columnar Coniferous and Broadleaf Evergreens: Thuja, Juniperus and Taxus (upright varieties), Ilex opaca.

Type 4. Shrubs, Small Trees and Ornamental Grasses: Viburnum dentatum, Cornus alba, Prunus glandulosa, Crataegus crusgalli.

Type 5. Standard Shade Trees (Deciduous and Evergreen): Acer rubrum, Quercus palustris, Platanus orientalis.

Ball Sizes, Nursery Grown. The ball sizes of nursery grown trees and shrubs shall be as shown in Table 23.

Table 23.—Minimum Ball Sizes for Nursery Grown Trees and Shrubs

Type 1		Type 2		Type 3		Type 4		Type 5	
Height, Ft.	Diam., In. (min.)	Height, Ft.	Diam., In. (min.)	Height, Ft.	Diam., In. (min.)	Height, Ft.	Diam., In. (min.)	Caliper, In.	Diam., In. (min.)
1½–2	11	1½–2	11	1½–2	11	1½–2	10	1¼–1½	18
2–2½	13	2–3	13	2–3	12	2–3	12	1½–1¾	20
2½–3	15	3–4	15	3–4	13	3–4	13	1¾–2	22
3–3½	16	4–5	17	4–5	14	4–5	15	2–2½	24
3½–4	18	5–6	19	5–6	16	5–6	16	2½–3	28
4–5	21	6–7	21	6–7	18	6–7	18	3–3½	32
5–6	24	7–8	24	7–8	20	7–8	20	3½–4	36
6–7	28	8–9	27	8–9	22	8–9	22	4–4½	40
7–8	32	9–10	30	9–10	24	9–10	24	4½–5	44
8–9	36	10–12	33	10–12	27	10–12	26	5–5½	48
		12–14	36	12–14	30				
		14–16	40	14–16	33				
		16–18	44	16–18	36				
		18–20	48	18–20	40				

Ball Sizes, Collected. The ball sizes of collected trees and shrubs shall be as shown in Table 24.

Table 24.—Minimum Ball Sizes for Collected Trees and Shrubs

Type 1		Type 2		Type 3		Type 4		Type 5	
Height, Ft.	Diam., In. (min.)	Height, Ft.	Diam., In. (min.)	Height, Ft.	Diam., In. (min.)	Height, Ft.	Diam., In. (min.)	Caliper, In.	Diam., In. (min.)
1½–2	13	1½–2	13	1½–2	13	1½–2	13	1¼–1½	22
2–2½	15	2–3	15	2–3	14	2–3	15	1½–1¾	24
2½–3	19	3–4	19	3–4	15	3–4	16	1¾–2	26
3–3½	20	4–5	21	4–5	18	4–5	20	2–2½	28
3½–4	22	5–6	23	5–6	20	5–6	21	2½–3	32
4–5	25	6–7	25	6–7	22	6–7	23	3–3½	36
5–6	28	7–8	28	7–8	24	7–8	30	3½–4	42
6–7	34	8–9	31	8–9	26	8–9	32	4–4½	46
7–8	38	9–10	34	9–10	28	9–10	38	4½–5	50
8–9	42	10–12	39	10–12	31	10–12	40	5–5½	54
		12–14	42	12–14	34				
		14–16	46	14–16	39				
		16–18	50	16–18	42				
		18–20	54	18–20	46				

Ball Depths. Balls shall be of sufficient depth to encompass the fibrous and feeding root system necessary for the full recovery of the plant and shall conform to the following minimum requirements:

Diameter of ball, inches	Up to 20	over 20 to 30	over 30 to 48
Minimum depth of ball, percentage of diameter	75	67	60

These dimensions may vary according to site and type of plant material as provided in the current A. S. N. S.

Vines. All pot grown vines shall be pot bound and in a vigorous growing condition.

Collected Plant Material. Collected or salvaged plant material shall be confined to specific items as indicated on the Plans or approved by the Engineer.

Shipment. All bare root materials shall be completely dormant when they are dug. Immediately before shipment, plant materials shall be dug with skill and care to prevent injury to fibrous roots. Plant material marked B & B in the Proposal shall be balled and burlapped.

Railroad shipments shall be made in adequately ventilated box cars. Each shipment shall be accompanied by an invoice giving the date and origin of shipment, the botanical names, sizes, grades and quantities of plants. A copy of the invoice shall be furnished to the Engineer at the time of delivery.

8. 3. 10. Seed Mixtures.

Grass seed mixtures shall be as shown in Tables 25 and 26.

Table 25.—Type A Grass Seed Mixture for General Purposes

Kind of Seed	Minimum Purity, per cent	Minimum Germination, per cent	Per Cent of Total Weight of Mixture
Kentucky Bluegrass	85	75	20
Red Fescues (Creeping or Chewings)	95	80	35
Kentucky 31	95	80	20
Redtop	92	85	10
Perennial Ryegrass	98	85	10
White Clover	97	90	5

Table 26.—Type B Grass Seed Mixture for Sandy Dry Soils Occasionally Subject to Salt Water

Kind of Seed	Minimum Purity, per cent	Minimum Germination, per cent	Per Cent of Total Weight of Mixture
Redtop	92	85	10
Red Fescues (Creeping or Chewings)	95	80	40
Seaside Bent	95	90	10
Reed Canary Grass	96	80	10
Weeping Love Grass	95	85	10
Perennial Rye	98	85	5
Kentucky 31	95	80	15

Grain Seed. Grain seed shall be rye or oat grain seed of standard purity and germination.

Crown Vetch Seed. Crown Vetch seed shall be of standard purity and germination.

Immediately before adding to the grass seed mixtures and sowing, Crown Vetch seed shall be inoculated according to the directions of the producer of the grass seed or manufacturer of the inoculant except when seeding hydraulically the inoculant shall be added at a rate three times that specified by such producer or manufacturer for inoculating Crown Vetch when sown dry. The Contractor shall notify the Engineer of the time and place the inoculating is to be done sufficiently in advance to allow an inspector to be present during the inoculation process. Crown Vetch seed which has not been inoculated in the presence of an inspector will not be accepted.

After inoculation, Crown Vetch seed shall be added to the grass seed mixtures in the amount of 10 pounds per 100 pounds of Type A grass seed mixture and 15 pounds per 100 pounds of Type B grass seed mixture.

Shipment. Each shipment of grass seed mixture and Crown Vetch seed shall be accompanied by a certified weight slip, and an analysis of the composition, purity and germination of the seed mixture, and the purity and germination of the Crown Vetch seed, certified by the seed house and furnished to the Engineer at the time of delivery.

Sampling and Testing. The Engineer reserves the right to have the certified seed mixtures sampled and tested, after delivery

to the Project. Such sampling and testing shall be done in accordance with the New Jersey State Seed Law, Chap. 189, P. L. 1948, and with the Rules and Regulations for Testing Seeds adopted by the Association of Official Seed Analysts.

8. 3. 11. Sod.

Sod shall be of good quality upland meadow grass, free from noxious weeds and objectionable grasses. It shall contain all the dense root system of the grass and shall not be less than 1½ inches thick. Before removing the sod, the grass shall be cut to a height of 2 inches and its surface shall be raked clean of all debris. It shall be cut with suitable tools in uniform strips not less than 12 inches wide.

Sod shall be taken from approved sources in the locality of the work where the soil is of such character that it will not break up or crumble during cutting, transportation or laying.

8. 3. 12. Topsoil.

Topsoil obtained from stripping within the limits of the Project or furnished from outside the Project shall contain no stones, lumps, roots or similar objects larger than 2 inches in any dimension, and shall have a pH value of not less than 5.8 nor more than 6.5. When the pH value of the topsoil is less than 5.8 it shall be increased by applying ground limestone at a rate necessary to attain a pH value of 6.5.

Topsoil furnished from sources outside the limits of the Project shall have a minimum organic content of not less than 2.75 per cent by weight. When the organic content of the topsoil furnished from sources outside the limits of the Project is less than 2.75 per cent it shall be increased by adding peat at a rate necessary to attain this minimum organic content. The organic content of soils shall be determined by the Laboratory using the chromic acid titration method as described in the United States Department of Agriculture's Circular 757.

The gradation of the topsoil furnished from sources outside the limits of the Project shall be determined by the Laboratory using the Bouyoucos Hydrometer Analysis conforming to the requirements of current A. A. S. H. O. Designation T 88. The gradation of the topsoil shall be within the following ranges:

Sand	(2.000 mm. to 0.050 mm.)	40% to 80%
Silt	(0.050 mm. to 0.005 mm.)	10% to 30%
Clay	(0.005 mm. and smaller)	10% to 30%

except that when one-half of the sand content is larger than 0.500 mm. the maximum sand content shall be 75 per cent and the minimum clay content shall be 15 per cent.

SECTION 4

Metals

8. 4. 1. Aluminum Alloys.

Aluminum alloys shall conform to the requirements shown in Table 27.

Table 27.—Aluminum Alloys

Materials	Current A.S.T.M. Specification	Alloy		Temper
		A.S.T.M. Designation	Trade Designation	
Castings, Permanent Mold	B 108	SG 70 B	A356	T 6
Castings, Sand	B 26	SG 70 A	356	T 6
Extruded Bars, Rods and Shapes	B 221	GS 11 A	6061	T 6
Pipe	B 241	GS 11 A	6061	T 6
Pipe (alternative)	B 241	GS 10 A	6063	T 6
Plates and Sheets	B 209	GS 11 A	6061	T 6
Rolled Shapes, Rods and Bars	B 211	GS 11 A	6061	T 6
Shim Material made of Sheet or Plate	B 209	990 A	1100	0
Tube, Drawn	B 210	GS 11 A	6061	T 6
Tube, Extruded	B 235	GS 11 A	6061	T 6
Tube, Extruded (alternative)	B 235	GS 10 A	6063	T 6
Washers, made of Sheet, Alloy Clad	B 209	CG 42 A	2024	T 4

Bolts, nuts, set screws and pins (2024-T 4 Temper with No. 205 Alumilite Finish) shall be made from rods conforming to the current A. S. T. M. Designation B 211, Alloy CG 42 A. Bolt heads and nuts shall be American Standard, Regular Series, hexagon, semifinished, conforming to the current A. S. A. Specification B 18. 2. Threads shall be American Standard, Coarse Series, Class 2 Fit, conforming to the current A. S. A. Specification B 1. 1. The finished bolts and nuts shall be heat treated to a T 4 temper and given an anodic coating of not less than 0.0002 inch thickness and shall be chromate sealed.

Post Castings, Permanent Mold.

*Tensile Properties.*** The tension test specimens representing the castings shall conform to the following requirements:

*Tensile Strength**		*Elongation in 4 X Diameter**	
Min., psi	Typical, psi	Min., %	Typical, %
25,000	30,000	6	8

* Minimum tensile properties based on separately-cast test bars are 32,000 psi tensile strength and 10% elongation.

** For the purposes of design in the tension test, specimens shall be capable of meeting a minimum yield strength of 18,000 psi (acceptance testing for this property not required).

Test Specimens. The tension test specimens shall be machined from integrally cast test coupons extending from one side of the base of the posts, sufficiently large to permit obtaining a 0.350-inch diameter test specimen as defined in ASTM Test Method Designation E8.

Number of Tests. A minimum of one per cent of the posts in any lot, but not less than one post, shall be sampled for tensile testing. For the purpose of sampling, a lot shall consist of not more than 1,000 pounds of clean castings when produced from a batch-type furnace charged with one heat of ingot of known analysis, or of not more than 2,000 pounds of clean castings when produced from one continuous furnace in not more than eight consecutive hours.

Retests. If the results of any tensile test do not conform to the requirements prescribed, two additional tests shall be taken from the same group of castings, and the average of the three tests must meet the requirements.

Workmanship. The castings shall be produced under radiographic control. This shall consist of radiographic examination of castings until proper foundry technique which will produce castings commercially free from harmful internal defects is established for each mold, and of production of castings as necessary to insure maintenance of satisfactory quality.

8. 4. 2. Bearing and Expansion Plates.

Bronze Bearing and Expansion Plates. Cast bronze bearing and expansion plates shall conform to the requirements of current A. S. T. M. Designation B 22. Alloy B shall be furnished.

Rolled Copper-Alloy Bearing and Expansion Plates. Rolled copper-alloy bearing and expansion plates shall conform to the requirements of current A. S. T. M. Designation B 100. Alloy No. 1 shall be furnished.

8. 4. 3. Castings, Steel.

Medium-Strength Carbon Steel Castings. Medium-strength carbon steel castings shall conform to the requirements of the current A. A. S. H. O. Designation M 103. Grade 65-35 shall be furnished.

High-Strength Steel Castings. High-strength steel castings shall conform to the requirements of the current A. S. T. M. Designation A 148. The grade required shall be as prescribed in the Plans or Supplementary Specifications.

8. 4. 4. Castings, Gray Iron and Malleable Iron.

Gray iron castings and malleable iron castings shall be true to pattern in form and dimensions, free from pouring faults, sponginess, cracks, blowholes, and other defects in composition affecting their strength and value for the service intended. The castings shall be boldly filleted at angles and the arrises shall be sharp and perfect. The surface shall have a workmanlike finish. All castings shall be sand blasted or otherwise effectively cleaned of scale and sand so as to present a smooth, clean and uniform surface.

Gray iron castings shall conform to the requirements of current A. A. S. H. O. Designation M 105. Class 30 shall be furnished.

Malleable iron castings shall conform to the requirements of current A. A. S. H. O. Designation M 106. Grade No. 35018 shall be furnished.

8. 4. 5. Copper Flashing.

Copper for flashing shall weigh 16 ounces per square foot and shall conform to the requirements of current A. S. T. M. Designation B 152, Type E. T. P.

8. 4. 6. Forgings, Steel.

Steel forgings shall conform to the requirements of the current A. A. S. H. O. Designation M 102. The forgings shall be thoroughly annealed before being machined. Class C 1 forgings shall be furnished.

8. 4. 7. Lead, Sheet.

Sheet lead shall conform to the requirements for Type A common desilverized lead of the current A. S. T. M. Designation B 29.

8. 4. 8. Steel Bolts, Corrosion-Resistant.

Corrosion-resistant steel bolts shall be of an alloy steel, containing approximately 18 per cent of chromium and 8 per cent of

nickel, conforming to the requirements of current A. S. T. M. Designation A 276, Type 302.

8. 4. 9. Steel Bolts, High-Strength.

High-strength steel bolts, nuts and washers shall conform to the requirements of the current A. S. T. M. Designation A 325.

8. 4. 10. Steel, Copper-Bearing.

Copper-bearing steel shall conform to the requirements of current A. S. T. M. Designation A 7.

8. 4. 11. Steel, Eye Bar.

Eye bar steel shall conform to the requirements of current A. S. T. M. Designation A 7.

8. 4. 12. Steel, Grid Floor.

Steel for grid floors shall conform to the requirements of the current A. S. T. M. Designation A 7. Unless the material is galvanized, it shall have a copper content of 0.2 per cent.

8. 4. 13. Steel, Joint.

Dowels for transverse joints shall be carbon steel dowels part of the length of which shall be encased in stainless steel or monel metal tubing, or infused with chromium, or shall be solid stainless steel dowels. The carbon steel dowels may be of any grade of carbon steel. Stainless steel and monel metal tubing, solid stainless steel dowels, and the chromium infusion of steel dowels, shall conform to the requirements prescribed therefor in the Plans or Supplementary Specifications.

8. 4. 14. Steel, High-Strength, Low-Alloy.

Structural high-strength low-alloy steel shall conform to the requirements of current A. S. T. M. Designation A 242.

8. 4. 15. Steel, Pile.

Steel for H-piles shall conform to the requirements of current A. S. T. M. Designation A 7.

8. 4. 16. Steel Posts for Beam Guard Rail.

Steel posts for beam guard rail shall be fabricated of structural steel conforming to the requirements of current A. S. T. M. Designation A 7.

8. 4. 17. Steel Rail Element for Beam Guard Rail.

The rail element for standard beam guard rail shall be Steel Plate Beam Guard, Class B, 3-inch Minimum Corrugation, Non-galvanized, conforming to the requirements therefor prescribed in the 1951 A. A. S. H. O. Specifications for Highway Guards, Section 3. 2. 6-a except as follows: The minimum tensile strength when tested in conjunction with splices and end connections shall be 80,000 pounds, and the bolts attaching the rail element to posts shall be 5/8 inch in diameter.

Splices and end connections shall be as shown on the Plans and shall conform to the requirements of Section 3. 4 of the 1951 A. A. S. H. O. Specifications for Highway Guards except that the minimum tensile strength of the splice and end connection assemblies shall be 80,000 pounds.

8. 4. 18. Steel, Reinforcement, for Pavement.

Reinforcement steel for pavements may be either deformed steel bars, plain steel bars or cold drawn steel wire, but only one of these types shall be used in the Project unless otherwise approved by the Engineer. Hot or cold twisted bars shall not be used.

Reinforcement steel shall be sampled and inspected at the place where fabricated, or at a dealer's warehouse, and shall not be shipped to the Project until approved. Proper appliances shall be used for bending, and the dimensions of a bent bar shall be measured outside to outside. The tolerance for the specified dimensions of bent bars shall not exceed plus or minus one-half inch for No. 7 bars or smaller, and plus or minus one inch for bars larger than No. 7. Bars showing injurious defects when received will be rejected. When placed, reinforcement steel shall be clean, free from scale and excessive rust, straight and true to form. Except for such additional reinforcement as may be specified, reinforcement steel shall be assembled into mats before being placed in the pavement.

Deformed Bar Mats. Deformed bar mats shall be assembled by being clipped and shall conform to the requirements of current A. S. T. M. Designation A 184. The deformed bars shall be rolled from new billet steel made by the open-hearth or electric-furnace process conforming to the requirements of current A. A. S. H. O. Designation M 31, or from axle steel conforming to the requirements of current A. A. S. H. O. Designation M 53. The bars shall be size No. 3. All bars shall have the tensile requirement of intermediate or hard grade. The number of bars and spacing thereof shall be as shown on the Plans.

Plain Bar Mats. Plain bar mats shall be assembled by welding and shall conform to the requirements of current A. S.

T. M. Designation A 184. The plain bars shall be rolled from new billet steel made by the open-hearth or electric-furnace process conforming to the requirements of current A. A. S. H. O. Designation M 31, or from axle steel conforming to the requirements of current A. A. S. H. O. Designation M 53. All bars shall have the tensile requirements of intermediate or hard grade. Unless otherwise specified, all bars shall be size No. 3. The number of bars and the spacing thereof shall be as shown on the Plans.

Welded Steel Wire Fabric. Welded steel wire fabric shall conform to the requirements of current A. S. T. M. Designation A 185 and shall be of steel made by the open-hearth or the electric furnace process. The size of the mat shall be as shown on the Plans. The longitudinal wires shall be No. 00 gauge spaced 6 inches on centers and the transverse wires shall be No. 3 gauge spaced 12 inches on centers.

8. 4. 19. Steel, Reinforcement, for Structures.

Reinforcement steel for structures shall be plain or deformed bars as shown on the Plans or prescribed in the Supplementary Specifications. Cold or hot twisted bars shall not be used. The bars shall be rolled from new billet steel made by the open-hearth or electric-furnace process conforming to the requirements of current A. A. S. H. O. Designation M 31, or from axle steel conforming to the requirements of current A. A. S. H. O. Designation M 53. All bars shall have the tensile requirements of intermediate grade.

The bars shall be sampled and inspected at the place where fabricated, or at a dealer's warehouse, and shall not be shipped to the Project until approved. Bars showing injurious defects when received will be rejected. Proper appliances shall be used for bending and the dimensions of a bent bar shall be measured outside to outside of bar. The tolerance for the specified dimensions of bent bars shall not exceed one-half inch plus or minus for No. 7 bars or smaller, and one inch plus or minus for larger bars. For a truss bar, the height dimension shall be not more than one-half inch less than that specified. The diameter of column spirals, ties or stirrups shall be measured outside to outside and shall be not more than one bar thickness plus or minus the specified diameter. However, in no case shall the diameter be more than one-half inch plus or minus the specified diameter. When placed, reinforcement steel shall be clean, free from scale and rust and true to form.

Wire, wire mesh, metal caging and other kinds of reinforcement shall be of a type and quality approved by the Engineer. Structural shapes used for reinforcement shall conform to the requirements for Structural Carbon Steel specified in Art. 8. 4. 23.

8. 4. 20. Steel, Reinforcement. Post-Tensioning Strands, Post-Tensioning Tendons and High-Tensile Alloy Bars for Prestressed Concrete Construction.

Post-Tensioning Strands. All wires shall be cold-drawn. The strands shall have the following physical properties based on gross area:

Minimum ultimate tensile strength 220,000 p. s. i. for uncoated strands.

Minimum ultimate tensile strength 200,000 p. s. i. for galvanized strands.

Minimum modulus of elasticity 24,000,000 p. s. i.

Post-Tensioning Tendons. Cables for post-tensioning shall consist of bright cold-drawn stress-relieved wires.

The physical properties of the wires shall conform to the following requirements:

Wire Diameter (In.)	Area (Sq. In.)	Minimum Ultimate Strength (Lbs.)
0.196	0.03017	7,540
0.250	0.04909	11,780
0.276	0.05983	14,120

The minimum yield strength measured by the 0.2 per cent offset method shall be not less than 80 per cent of the specified minimum ultimate strength.

The average modulus of elasticity shall be approximately 28,500,000 pounds per square inch.

The elongation of the wire shall be not less than 4% in 10 inches.

High-Tensile Alloy Bars. Bars for post-tensioning shall have the following physical properties:

Minimum ultimate tensile strength ..... 145,000 p. s. i.

Minimum 0.2% proof stress during manufacture ..... 130,000 p. s. i.

Modulus of elasticity, approximately .....25,000,000 p. s. i.

minimum elongation at rupture .....4% in 20 diameters

8. 4. 21. Steel, Reinforcement. Pretensioning Strands for Prestressed Concrete Construction.

The manufacture of the steel wire and strand shall be conducted in accordance with the best current practice for high quality hard drawn wire.

All strands shall be of the 7-wire type, having one center wire and six outside wires. The center wire shall be sufficiently larger

than the outside wires to guarantee that each of the outside wires will bear on the center wire. In the finished strand, the six outer wires shall have a uniform pitch of not less than 12 and not more than 16 times the nominal diameter of the strand. All strands shall be stressed-relieved as a unit after the wires have been formed into a strand. The strands shall be free from oil or lubricants.

The wires shall be of carbon steel conforming to the following analysis:

Carbon	—0.70 to 0.85%
Manganese	—0.40 to 0.90%
Phosphorus	—0.045% max.
Sulphur	—0.050% max.

Strand properties shall conform to the following requirements:

Strand Diameter	Approximate Area, Square Inches	Minimum Ultimate Strength, Lbs.
¼"	.0356	9,000
5/16"	.0578	14,500
⅜"	.0799	20,000
7/16"	.1089	27,000
½"	.1438	36,000

The minimum yield strength, measured by the 0.2 per cent offset method, shall be not less than 85 per cent of the specified minimum ultimate strength.

The average modulus of elasticity shall be approximately 27,000,000 pounds per square inch.

The elongation of the strand shall be not less than 4 per cent in 24 inches.

8. 4. 22. Steel Sheet Piling.

Steel sheet piling shall conform to the requirements therefor specified in current A. S. T. M. Designation A 328.

8. 4. 23. Steel, Structural Carbon.

Structural carbon steel shall conform to the requirements of current A. S.T. M. Designation A 7.

8. 4. 24. Steel, Structural, for Welded Members.

Structural steel for members which are to be welded shall conform to current A. S. T. M. Designation A 373.

8. 4. 25. Steel, Structural Nickel.

Structural nickel steel shall conform to the requirements of current A. S. T. M. Designation A 8.

8. 4. 26. Steel, Structural Rivet.

Structural rivet steel shall conform to the requirements of current A. S. T. M. Designation A 141.

8. 4. 27. Steel, Structural Rivet, High-Strength.

High-strength structural rivet steel shall conform to the requirements of current A. S. T. M. Designation A 195.

8. 4. 28. Steel, Structural Silicon.

Structural silicon steel shall conform to the requirements of current A. S. T. M. Designation A 94.

8. 4. 29. Steel, Studs, Automatic End-Welded.

Welding studs shall be manufactured from low-carbon steel having the following properties:

Carbon	— Max. 0.23%
Manganese	— Max. 0.60%
Phosphorus	— Max. 0.04%
Sulphur	— Max. 0.05%

The material used for flux in welding points of solid-fluxed steel studs shall be commercially pure aluminum. The fluxing material to be used in filling the welding points of granular-fluxed studs shall be a mixture of granulated aluminum and cast iron filings or granulated aluminum and steel filings.

8. 4. 30. Wire Rope and Fittings for Highway Guard Rail.

Wire rope and fittings for highway guard rail shall conform to the requirements of current A. A. S. H. O. Designation M 30. ¾-inch Class A wire rope shall be furnished.

8. 4. 31. Wrought Iron Plates.

Wrought iron plates shall conform to the requirements of current A. S. T. M. Designation A 42.

8. 4. 32. Wrought Iron Rolled Shapes and Bars.

Rolled wrought iron shapes and bars shall conform to the requirements of current A. S. T. M. Designation A 207.

8. 4. 33. Zinc Coating, Hot-Galvanized, on Steel.

Hot-galvanized zinc coating, applied on products fabricated from rolled, pressed and forged steel strips, plates and bars, shall conform to the requirements of current A. S. T. M. Designation A 123.

8. 4. 34. Zinc, Sheet.

Sheet zinc shall conform to the requirements of current A. S. T. M. Designation B 69 for Type II.

8. 4. 35. Metallic Sealing Compound.

Metallic sealing compound shall be composed of finely ground aluminum powder and silicon in a vinyl base and shall be installed as shown on the contract drawings.

The compound used shall be nonpermeable, shall be compatible with aluminum alloys, shall provide a good bond of adequate strength, shall harden after setting and not shrink away from contacting metal, and shall be approved by the Engineer.

SECTION 5

Nonmetallic Materials

8. 5. 1. Air-entraining Additives for Portland Cement.

The air-entraining additive used in the manufacture of air-entraining portland cement shall conform to the requirements of current A. S. T. M. Designation C 226.

8. 5. 2. Air-entraining Admixtures for Concrete.

Evidence based on tests made in a recognized testing laboratory shall be submitted to show that air-entraining admixtures for concrete conform to the requirements of the current A. A. S. H. O. Specification M 154 for 7 and 28-day compressive and flexural strengths and resistance of freezing and thawing, except as provided in the following paragraph. Tests for bleeding, bond strength and volume change will not be required. A recognized testing laboratory is any State highway, Bureau of Public Roads or other cement and concrete testing laboratory regularly inspected by the Cement Reference Laboratory of the National Bureau of Standards. Tests may be made upon samples taken from a quantity submitted by the Contractor for use on the Project or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied.

An exception to the requirements in the preceding paragraph is an admixture which is manufactured by neutralizing vinsol resin with caustic soda (sodium hydroxide). When the Contractor proposes to use such an admixture he shall submit a certification concerning the admixture in the following form:

"This is to certify that the product (trade name) as manufactured and sold by the (company) is an aqueous solution of vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to vinsol resin is one part of sodium hydroxide to (number) parts of vinsol resin. The percentage of

solids based on the residue dried at 105° C. is (number). No other admixture or chemical agent is present in this solution."

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same as another previously approved material, with only minor differences in concentration, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Either prior to or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. When so tested, 7-day compressive strength of concrete, made with the cement and aggregates in the proportions to be used in the work and containing the admixture under test in an amount sufficient to produce from 3 to 6 per cent entrained air in the plastic concrete, shall be not less than 85 per cent of the strength of concrete made with the same materials and with the same cement content and consistency but without the admixture.

The percentage reduction in strength shall be calculated from the average strength of at least 5 standard 6" x 12" cylinders of each type of concrete. Specimens shall be made and cured in the laboratory in accordance with the requirements of current A. A. S. H. O. Designation T 126 (A. S. T. M. C 192) and shall be tested in accordance with the requirements of current A. A. S. H. O. Designation T 22 (A. S. T. M. C 39). The percentage of entrained air shall be determined in accordance with the requirements of current A. A. S. H. O. Designation T 152 (A. S. T. M. C 231).

Admixtures failing to meet the above requirements may be rejected.

8. 5. 3. Aggregates, General.

Coarse and fine aggregates shall be kept clean and free from foreign matter until used. Aggregates found segregated when about to be used will be rejected unless and until segregation is eliminated by mixing.

Aggregates which require washing shall not be used sooner than 24 hours after washing nor until the surplus water has disappeared and the material has a uniform moisture content. Shipments of aggregate appearing defective will be held until sampled, tested and approved. Rejected materials shall be removed.

The base area on which stockpiles are to be placed shall be firm and reasonably level, but well drained, and shall be clean and free from all foreign material. Aggregates shall not be removed from the stockpile within 2 feet of the ground until final clean up of the work, at which time inspection and approval will be required for this 2-foot layer. When required by the Engineer, stockpiles

of aggregates shall be placed on bases of ample size consisting of 2-inch planks or other suitable approved material.

The aggregates shall be placed in the stockpile in layers not more than 3 feet deep. The use of a bulldozer or other similar equipment will not be permitted in placing aggregates in stockpiles or storage, or in moving them to other locations.

Aggregates from different sources and of different gradings shall not be stockpiled together, and durable partitions of sufficient height shall be provided to prevent mixing.

8. 5. 4. Aggregate, Coarse.

Coarse aggregate shall be broken stone, washed gravel, blast furnace slag, and boiler slag (for cover material), conforming to the requirements therefor as hereinafter specified and shall be graded as shown in Table 28. The particular types of coarse aggregate, and the kinds of each type, for various uses shall be as specified for each type of construction.

Only one type of coarse aggregate from a specific source, and only one kind of that type, shall be used in any one project unless otherwise approved by the Engineer.

Table 28.—Coarse Aggregate, Gradation

Aggregate Size	Total Per Cent Passing										
	Screens With Round Openings								Sieves		
	3½"	3"	2¼"	1½"	1¼"	¾"	½"	¼"	No. 10	No. 30	No. 200
2½"	100	85–100	0–45		0–5						
1½"			100		0–30	0–5		0–2			
1"				100	95–100	20–50	0–15	0–5			
¾"					100	45–75	25–45	0–10	0–2		
⅝"					100	95–100	30–50	0–10	0–2		
½"						100	60–85	15–35	0–5	0–2	
⅜"						100	95–100	20–50	0–5	0–2	
¼"							100	85–100	0–25	0–10	
Grits							100	90–100		0–20	0–2
Screenings						100		40–100		25–65	5–20
Shoulder Aggregate, Top Course					100	70–100		45–65			5–20
Shoulder Aggregate, Bottom Course	100					0–25					

8. 5. 5. Broken Stone.

Broken stone shall conform to the requirements specified hereinabove in Art. 8. 5. 3 and 8. 5. 4 and to the following requirements:

The broken stone shall be free from pieces coated with clay, caked stone dust and other objectionable materials. It shall contain not more than 5 per cent of weathered and decomposed rock, not more than 5 per cent of stone of types other than the type being used in accordance with the Specifications, and not more than 7 per cent, by weight, of flat or elongated pieces. A flat piece shall be one in which the ratio of the width to thickness of its circumscribing rectangular prism is greater than 5 to 1, and an elongated piece shall be one in which the ratio of the length to width of its circumscribing rectangular prism is greater than 5 to 1.

The percentage of wear shall be determined in accordance with A. A. S. H. O. Designation T 3.

Dolomite. Dolomite shall mean a rock consisting principally of calcium-magnesium carbonate. It shall contain not less than 30 per cent of magnesium carbonate and not less than 80 per cent of combined calcium and magnesium carbonates. It shall be uniform in texture and quality and have a percentage of wear of not more than 4. 5. It shall not be affected noticeably by 5 immersions in a saturated solution of sodium sulphate with proper dehydration after each immersion.

Gneiss. Gneiss shall mean a metamorphic rock consisting principally of quartz and feldspar. It shall have a dense structure and shall not break in thin pieces at lines of stratification and shall have a uniform distribution of the minerals. It shall have a percentage of wear of not more than 4. 5.

Granite. Granite shall mean an igneous rock consisting principally of quartz and feldspar. It shall be of medium or fine grain texture, shall have an even distribution of the constituent materials, shall be uniform in quality and structure, and shall have a percentage of wear of not more than 4. 5.

Granite for use in white concrete shall conform to the foregoing requirements, shall be light-colored, free from dirt and discoloring matter and shall be approved by the Laboratory. It shall be washed before being used when so ordered by the Engineer.

Limestone. Limestone shall mean a rock consisting principally of calcium carbonate. It shall contain not less than 55 per cent of calcium carbonate and not less than 80 per cent of combined calcium and magnesium carbonates. It shall be uniform in texture and quality and have a percentage of wear of not more than 4. 5. It shall not be affected noticeably by 5 immersions in a saturated

solution of sodium sulphate with proper dehydration after each immersion.

Trap Rock. Trap rock shall mean a basic igneous rock consisting principally of augite and plagioclase. It shall have an even distribution of constituent minerals, be of uniform quality and color, and the percentage of wear shall be not more than 4. 5.

8. 5. 6. Gravel, Washed.

Washed gravel shall conform to the requirements specified in Art. 8. 5. 3 and 8. 5. 4 and to the following requirements:

Washed gravel shall be either crushed or uncrushed. It shall contain not more than 5 per cent of soft fragments as determined by current A. S. T. M. Designation C 235, not more than a total of 0.5 per cent of clay lumps, coal, organic and other foreign matter, and shall be practically free from sea salt and other deleterious matter.

It shall contain not more than 7 per cent, by weight, of flat or elongated pieces as defined in Art. 8. 5. 5. Before being loaded for shipment, it shall have been washed so that the surfaces are clean and free from coatings of foreign matter. Crushed gravel shall be artificially crushed with at least 90 per cent of all fragments containing at least one face resulting from fracture. Nicked gravel shall not be considered as crushed.

Washed gravel for use in white concrete shall be light-colored quartz gravel conforming to the foregoing requirements except that it shall be free from dirt and discoloring matter and shall be approved by the Laboratory. The gravel shall be rewashed before delivery, when so directed by the Engineer.

8. 5. 7. Slag, Blast Furnace.

Blast furnace slag shall conform to the requirements of Art. 8. 5. 3 and 8. 5. 4. It shall be air-cooled and shall be obtained as a by-product of the production of pig iron. It shall consist of tough, durable, angular fragments reasonably uniform in density and quality, free from flux stone, dirt or other objectionable matter, and shall contain not more than 7 per cent, by weight, of flat or elongated pieces as defined in Art. 8. 5. 5. The slag also shall conform to the following requirements:

Percentage of wear, Los Angeles test, maximum	35
Weight per cubic foot, dry loose measure, minimum ...	65 lbs.
Coal, or coal and coke, percentage by weight, maximum	1
Iron (FeO), percentage by weight, maximum	1
Glassy particles, percentage by weight, maximum	4

The method of determining the unit weight shall be as specified in Art. 9. 1. 2, "Method of Test for Unit Weight of Coarse Aggregate (Dry Loose Measure)."

The Los Angeles test shall be made in accordance with current A. A. S. H. O. Designation T 96.

8. 5. 8. Slag, Boiler.

Boiler slag shall conform to the requirements of Art. 8. 5. 3 and 8. 5. 4 and to the following requirements:

Boiler slag shall be the fused water-cooled residue from the combustion of pulverized or powdered coal used in electric generating plants, the color of which shall be nearly black.

It shall weigh not less than 95 pounds per cubic foot, loose measure, as determined by the "Method of Test for Unit Weight of Coarse Aggregate (Dry Loose Measure)" specified in Art 9. 1. 2.

It shall have a specific gravity of not less than 2.95 and shall conform to the grading requirements specified for Grits size in Table 28.

8. 5. 9. Aggregate, Fine.

Fine aggregate for concrete and mortar shall be washed and processed material composed of clean particles of quartz, or other hard, durable rock, moderately sharp and reasonably free from soft particles, clay, loam, cemented particles, mica, salt, and other foreign matter, except that for white concrete and mortar the fine aggregate shall be as hereinafter specified in Art. 8. 5. 11. The measurement of the mortar-making properties of the fine aggregate shall be determined by the "Method of Test for Mortar-Making Properties of Fine Aggregates" as specified in Art. 9. 1. 3.

8. 5. 10. Aggregate, Fine, for Portland Cement Concrete and Mortar.

The fine aggregate for portland cement concrete and mortar shall conform to the requirements of Art. 8. 5. 3 and 8. 5. 9. The gradation shall be as shown in Table 29. The mortar-making properties shall be not less than 100 per cent of those of standard ottawa sand.

Table 29.—Fine Aggregate for Concrete and Mortar, Gradation

Passing	Retained on	Min. %	Max. %
⅜" Sieve		100	
⅜" Sieve	No. 4 Sieve	0	5
Material Passing No. 4 Sieve			
No. 4 Sieve	No. 10 Sieve	0	20
No. 10 Sieve	No. 30 Sieve	20	60
No. 30 Sieve	No. 50 Sieve	20	50
No. 50 Sieve	No. 200 Sieve	12	25
No. 200 Sieve		0	5

8. 5. 11. Aggregate, Fine, for White Portland Cement Concrete and Mortar.

The fine aggregate for white portland cement concrete and mortar shall conform to the requirements of Art. 8. 5. 3 and 8. 5. 9 and to the following requirements:

The fine aggregate shall be a crushed white marble or calcite free from dirt and discoloring matter. It shall contain not less than 85 per cent of calcium carbonate ($CaCO_3$) and not more than 0.75 per cent of iron and aluminum ($Al_2O_3 + Fe_2O_3$). Its mortar-making properties shall be not less than 90 per cent of those of standard ottawa sand.

The fine aggregate shall have a reflectance value of not less than 75 per cent which shall be determined as specified in Art. 9. 1. 4, "Method of Test to Determine Reflectance Value of Fine Aggregate for White Concrete and Mortar."

The gradation requirements shall conform to those shown in Table 30.

Table 30.—Fine Aggregate for White Concrete and Mortar, Gradation

Passing	Retained on	Min. %	Max. %
⅜" Sieve		100	
⅜" Sieve	No. 4 Sieve	0	5
Material Passing No. 4 Sieve			
No. 4 Sieve	No. 10 Sieve	0	20
No. 10 Sieve	No. 30 Sieve	20	60
No. 30 Sieve	No. 50 Sieve	20	50
No. 50 Sieve	No. 200 Sieve	12	30
No. 200 Sieve		0	10

8. 5. 12. Aggregate, Fine, for Bituminous Concrete and Sheet Asphalt.

Fine aggregate for hot mixed bituminous concrete and sheet asphalt shall be stone sand conforming to the quality requirements prescribed in Art. 8. 5. 5, natural bank sand, washed sand, or a combination thereof, and shall be free from lumps of clay, loam, organic matter or other foreign matter. Except for use in Type SM-1 and SM-2 Top, it shall conform to the grading shown in Table 31 when tested by means of Laboratory sieves. For use in Type SM-1 and SM-2 Top, it shall be of such grading that when combined with other specified ingredients, it will produce a mixture conforming to the requirements shown for Mixture No. V in Table 3, Art. 3. 10. 2. However, it shall contain not more than 15 per cent of material passing the No. 200 sieve.

Table 31.—Fine Aggregate for Hot Mixed Bituminous Concrete and Sheet Asphalt, Gradation

Passing	Retained on	Min. %	Max. %
No. 4 Sieve	No. 10 Sieve	0	5
No. 10 Sieve	No. 30 Sieve	6	30
No. 30 Sieve	No. 50 Sieve	15	42
No. 50 Sieve	No. 80 Sieve	20	40
No. 80 Sieve	No. 200 Sieve	12	35
No. 200 Sieve		0	6

Fine aggregate for cold mixed bituminous concrete shall be stone sand as specified above for hot mixed bituminous concrete except that it shall be of such grading that, when combined with other specified ingredients, it will produce mixtures conforming to the requirements specified in Table 5, Art. 3. 11. 2, and shall contain not more than 20 per cent of material passing the No. 200 sieve.

8. 5. 13. Aggregate, Fine, for Cover Material for Bituminous Surface Treatment.

Fine aggregate for use as a cover material for bituminous surface treatment shall be composed of sand and hard durable pebbles to be mixed in such proportions that the material will conform to the grading requirements specified in Table 32.

Table 32.—Fine Aggregate Cover Material for Bituminous Surface Treatment, Gradation

Passing	Retained on	Min. %	Max. %
1" Screen	½" Screen	0	20
½" Screen	¼" Screen	0	20
¼" Screen	No. 10 Sieve	3	30*
No. 10 Sieve	No. 30 Sieve	15	60
No. 30 Sieve	No. 50 Sieve	10	45
No. 50 Sieve	No. 80 Sieve	2	20
No. 80 Sieve	No. 200 Sieve	0	7
No. 200 Sieve		0	7

* Provided that the total amount passing the 1-inch screen and retained on the No. 10 sieve shall not exceed 40 per cent.

8. 5. 14. Aggregate, Fine, for Portland Cement Grout.

Fine aggregate for portland cement grout shall conform to the requirements of Art. 8. 5. 10 except that it shall be graded so that all will pass a No. 10 sieve and the mortar prepared therewith shall have a strength of not less than 75 per cent of the strength of mortar prepared similarly with standard ottawa sand.

8. 5. 15. Block, Concrete, for Inlets, Catch Basins and Manholes.

Concrete blocks for inlets, catch basins and manholes shall be solid, precast segmental concrete masonry units. They shall be made from portland cement conforming to the requirements of current A. S. T. M. Designation C 150 or C 175, fine aggregate conforming to the requirements of Art. 8. 5. 10, and coarse aggregate of broken stone or washed gravel conforming to the requirements of Art. 8. 5. 5 and 8. 5. 6, respectively. Broken stone shall be of trap rock, granite or gneiss.

The blocks shall be either rectangular in shape, or curved blocks with the inside and outside surfaces curved to the required

radii, whichever is appropriate for the shape of the structure. The over-all length shall be not less than 12 inches and not more than 18 inches. The height shall be not less than 5 inches and not more than 8 inches. The width shall be not less than 6 inches. The blocks shall be so manufactured that they can be placed in position in the structure with joints not less than ¼ and not more than ½ inch in width. Compressive strength and absorption tests shall be made on three blocks. The compressive strength at a twenty-eight day age shall average not less than 5,000 pounds per square inch with a minimum of 4,500 pounds per square inch for any individual specimen. The maximum absorption for any individual specimen shall not exceed 7 per cent.

For the reduction of the cross sectional area of the structure, blocks intended for use in the cones, or tops, of manholes, inlets or other structures may be of special shapes and heights so that the head casting of the structure will be set at the elevation required on a mortar bed not more than ½ inch thick without cutting the block. The maximum absorption for any individual specimen shall not exceed 7 per cent.

All blocks shall have an approved type of joint at the ends so that the units may be interlocked to form a strong, rigid structure and shall be sound and free from cracks or other defects that would interfere with the proper placing of the unit.

At the place of manufacture, the blocks shall be stocked in such a manner as to provide proper facilities to inspect and sample the units. Blocks shall be sampled and tested in accordance with current A. S. T. M. Designation C 140.

8. 5. 16. Block, Concrete, for Slope Protection.

Concrete blocks for slope protection shall be new solid concrete units 16 inches long, 8 inches wide and 4 inches thick, within a tolerance of plus or minus ⅜ inch. All faces shall be true to shape, true in relation to each other and each shall have a dense uniform surface. They shall be made from portland cement conforming to the requirements of current A. S. T. M. Designation C 150 or C 175, fine aggregate conforming to the requirements of Art. 8. 5. 10 and coarse aggregate of broken stone or washed gravel conforming to the requirements specified respectively therefor in Art. 8. 5. 5 and 8. 5. 6. Broken stone shall be of trap rock, granite or gneiss.

Compressive strength and absorption tests shall be made on three blocks. The blocks tested shall have a minimum compressive strength of 2500 pounds per square inch at twenty-eight day age, and the maximum water absorption for any individual specimen shall not exceed 8 per cent.

At the place of manufacture the blocks shall be stocked in such a manner as to provide proper facilities to inspect and sample the

units. Blocks shall be sampled and tested in accordance with current A. S. T. M. Designation C 140.

8. 5. 17. Block, Granite Paving.

Granite paving blocks shall conform to the requirements of current A. S. T. M. Designation D 59 except that they shall be dressed for ⅜-inch wide joints.

8. 5. 18. Brick, Construction.

Clay or Shale Brick. Clay or shale brick shall be new and shall conform to the requirements of current A. S. T. M. Designation C 32, Grade MA, with the following modifications:

The maximum water absorption, by five hour boiling, shall be 14 per cent based on the average of 5 bricks, and 16 per cent for individual bricks.

The size of brick shall conform to the following:

	Minimum, inches	Maximum, inches
Depth	2.10	2.38
Width	3.50	3.88
Length	7.75	8.25

Sampling and testing shall be as specified except that samples may also be selected by a competent person appointed by the purchaser at the point of use.

Concrete Brick. Concrete brick shall conform to the requirements for Concrete Block for Inlets, Catch Basins and Manholes, as specified in Art. 8. 5. 15 except that the size shall be as specified above for clay or shale brick.

8. 5. 19. Calcium Chloride.

Calcium chloride shall conform to the requirements of current A. A. S. H. O. Designation M 144 and shall be of the pellet or flake type as may be specified.

8. 5. 20. Carbon Black.

Emulsified carbon black for use in air-entrained concrete or air-entraining cement shall be a uniform colloidal dispersion of standard carbon black in a liquid medium. By addition of 2 per cent of the dispersed black, the air content of the concrete shall not be changed by more than 10 per cent. At least 25 per cent, by weight, of the commercial product shall be carbon black. The ash content shall not exceed 3 per cent, by weight, of the finished product.

The carbon black emulsion shall be stable and shall have the same effect on the air entrainment, after standing for a period of twenty-eight days, as specified above.

Portland cement, Type III, containing 2 per cent, by weight, of emulsified carbon black shall be used with standard ottawa sand to prepare 1:3 mortar briquettes. The tensile strength of these briquettes at the age of one day and thereafter shall be not less than 85 per cent of the strength of similar briquettes with no pigment added. The method of test shall conform to the requirements of current A. S. T. M. Designation C 190. The color produced on the broken surface after a 24-hour drying period shall be equal to that produced by a previously established standard of color.

The emulsified carbon black shall show uniform dispersion in mortar and concrete when used in concentrations necessary to produce the desired pigmentation.

8. 5. 21. Cement, Portland.

Portland cement shall be of the type or types specified for each construction item. It shall be of a standard brand and, at the place of manufacture, shall be taken from storage bins containing cement which has been inspected and approved by the Engineer.

8. 5. 22. Cement, Standard Portland.

Standard portland cement shall conform to the requirements of Art. 8. 5. 21 and to the requirements of current A. S. T. M. Designation C 150 except that for Type II the autoclave expansion shall not exceed 0.2 per cent.

8. 5. 23. Cement, Air-Entraining Portland.

Air-entraining portland cement shall conform to the requirements of Art. 8. 5. 21 and to the requirements of current A. S. T. M. Designation C 175 except that for Type IIA the autoclave expansion shall not exceed 0.2 per cent.

8. 5. 24. Cement, White Portland.

White portland cement shall conform to the requirements of Art. 8. 5. 21 and to the requirements of current A. S. T. M. Designation C 150 for Type I Standard Portland Cement except that it shall contain not more than 0.55 per cent, by weight, of ferric oxide (Fe_2O_3).

8. 5. 25. Cement, Air-Entraining White Portland.

Air-entraining white portland cement shall conform to the requirements of Art. 8. 5. 21 and to the requirements of current

A. S. T. M. Designation C 175 for Type IA Standard Portland Cement except that it shall contain not more than 0.55 per cent, by weight, of ferric oxide (Fe_2O_3).

8. 5. 26. Cinders.

Cinders shall be hard, clean, vitreous clinker weighing not less than 42 pounds per cubic foot, loose measure, with a gradation as prescribed or approved by the Engineer.

8. 5. 27. Crib Members, Concrete.

Concrete crib members shall be of the design and dimensions shown on the Plans. The concrete shall be Class A conforming to the requirements of Art. 4. 1. 2 and shall be prepared with portland cement, fine aggregate and coarse aggregate conforming to the requirements specified respectively therefor in Art. 8. 5. 15 for Concrete Block. At a twenty-eight day age, the concrete shall have a compressive strength of not less than 4500 pounds per square inch. Unless otherwise shown on the Plans, the crib members shall be reinforced with No. 3 deformed steel bars conforming to the requirements therefor specified in Art. 8. 4. 19. The number and spacing of the reinforcement bars shall be as shown on the Plans. A tolerance of ¼ inch, plus or minus, will be allowed in the over-all dimensions of crib members.

8. 5. 28. Curbs and Headers, Granite.

Granite for curbs and headers shall be medium grained with uniform texture and distribution of minerals, unstratified, unlaminated and free from seams and evidence of weathering. The percentage of wear shall be not more than 4.5. All curb or header stones furnished for the Project shall be from one quarry and of the same color and texture.

Quarry-split stone for curbs and headers shall have the top face machine-finished or dressed to an even surface without depressions or projections of more than ⅜ inch below or above the plane of the face. Edges shall be straight and even, and the ends shall be cut square for the entire depth of exposed curb face shown on the Plans and for a depth of 4 inches for header stones. Curb stones shall be so dressed that joints can be made not more than ⅜ inch wide from top to gutter line and not more than 1 inch wide below the gutter line.

Dressed stone for curbs shall be dressed to an even, smooth finish on the top face, on the front face for the entire depth of the exposed curb face shown on the Plans, on the back face to a depth of 2 inches, and on the ends to a depth of 1 inch. The projections

and depressions on the various faces shall be not greater than specified below:

Top and dressed part of fronts and ends	Depression ¼"	Projection ¼"
Front, undressed part	Depression 1½"	Projection ½"
Back, dressed part	Depression ½"	Projection ½"
Back, undressed part	Depression 1½"	Projection 1½"
Ends, rough-dressed part	Depression ½"	Projection ¼"
Ends, undressed part	Depression 1½"	Projection ¼"

The rough-dressed part of end faces shall extend 1 inch below the gutter line. The back edge of the top shall be parallel to the front face. When so indicated, the top and front faces shall be sloped, and the front edge shall be rounded as shown on the Plans. The stones shall have the width specified at the top, and the bottom width shall be not less than 1 and not more than 3 inches greater than the top width. The stones shall be furnished in lengths of not less than 4 and not more than 8 feet. Straight-cut stone may be used for curved curb having a radius of not less than 50 feet, but shall be dressed to true radius after being set in place. For smaller radii the stone shall be cut to the required radius, and the ends shall be cut so that the joints can be made not more than ¼ inch wide for the full depth.

Granite headers shall comply in general with the requirements specified for granite curbs.

8. 5. 29. Curing Materials for Concrete.

Burlap. Burlap, when dry, shall weigh not less than 12 ounces per 10 square feet and shall have a length, after shrinkage, of not less than the width of the pavement slab. Clean burlap reclaimed from previous use may be used again if it meets the foregoing requirements.

Cotton Mats. Cotton mats shall conform to current A. A. S. H. O. Designation M 73.

Liquid Compound, Clear or Translucent. Clear or translucent liquid curing compound shall consist of a blend of resins and other suitable materials held in solution in a volatile solvent. It shall not separate on standing, shall be nontoxic, and shall become dry to touch within 4 hours after being applied to the concrete under ordinary conditions. Acceptance for continued use also will be based upon satisfactory field performance.

Consistency. The consistency of the compound shall be such that it can be applied to the concrete in the amount specified, as a fine spray, by means of an atomizing nozzle.

Character of Film. The compound shall adhere to damp, vertical or horizontal concrete surfaces forming a continuous co-

herent film when applied at the specified rate. When dry, the film shall not be tacky or track off the concrete when walked upon, nor impart a slippery condition to the surface.

Color. The compound shall produce no darkening or changing of the color of the concrete to which it is applied. It shall, however, be of such a nature or so treated that the film will be distinctively visible for at least 4 hours after application. Any coloring matter added to the compound shall be a fugitive organic dye of a color approved by the Engineer. All traces of this color shall be indistinct 30 days after application.

Reaction with Concrete. The compound shall not react deleteriously with the wet concrete and shall form a superficial layer over the surface thereof.

Moisture Retention. When tested in accordance with current A. S. T. M. Designation C 156, the moisture loss shall be not more than 0.055 gram per square centimeter of the mortar specimen surface, based on the amount of water in the mortar at the time the curing material is applied.

Liquid Compound, White Pigmented. The compound shall consist of finely ground white pigment, resin and vehicle, ready-mixed for immediate use without alteration. The pigment shall not settle out badly or cake in the container, and the compound shall not thicken in storage to a consistency that will prevent proper application. The compound shall be such that it can be used with safety under properly controlled conditions and shall conform to the following requirements:

Consistency. The consistency of the compound shall be such that it can be applied to the concrete in the amount specified, as a fine spray, by means of an atomizing nozzle.

Adhesion. The compound, when applied to a moist concrete surface at the specified rate, either prior to or subsequent to the time at which the concrete has attained its initial set, shall adhere firmly to the concrete surface for at least 7 days.

Color. The compound, when applied to moist concrete as specified above under the heading Adhesion, shall present a uniformly white appearance and shall effectively obscure the original color of the concrete. After the compound has dried, it shall have an apparent daylight reflectance of not less than 70 per cent relative to magnesium oxide as determined on samples of mortar prepared in the same manner as required for the Moisture Retention test hereinafter specified. The apparatus used for making this determination shall be as specified in current A. S. T. M. Designation E 97.

Drying Properties. The compound shall become dry to touch within 4 hours when applied to concrete under ordinary conditions,

and shall not be tacky or track off the concrete when walked upon, nor impart a slippery surface to the pavement.

Viscosity. The compound shall be suitable for application at a minimum temperature of 40° F. and shall have a sufficiently low viscosity to form an even, uniform coating when applied as specified.

Nonvolatile Matter. The nonvolatile matter in the compound shall be not less than 60 per cent, by weight, as determined by the current A. S. T. M. Designation D 154.

Reaction with Concrete. There shall be no evidence of reaction between the compound and the concrete surface to which it has been applied, either at the time of application or thereafter.

Moisture Retention. When tested in accordance with current A. S. T. M. Designation C 156, the moisture loss shall be not more than 0.055 gram per square centimeter of the mortar specimen surface, based on the amount of water in the mortar at the time the curing material is applied.

Weathering. The compound when applied at the specified rate on a moist concrete surface and exposed to atmospheric conditions shall remain a continuous unbroken film that provides an effective moisture seal for at least 3 days after application, without noticeable darkening or yellowing of the film. Test specimens prepared in the same manner as required for the Moisture Retention test shall conform to the requirements specified under the heading Color, above, when exposed to ultraviolet light for a period of 30 minutes.

Packing and Marking. The compound shall be delivered to the Project only in the manufacturer's original containers which shall be legibly marked with the manufacturer's name, trade name and batch number. One batch number shall be used to represent not more than one formula. Containers shall be clean steel drums equipped with mechanical agitators for thoroughly stirring the compound to a uniform consistency immediately before use.

Polyethylene Sheeting, White. White polyethylene sheeting shall consist of a single sheet manufactured from virgin resin with no scrap or additives other than pigments. The sheeting shall be white, furnished in rolls, shall be free of visible defects and shall have a uniform appearance. It shall be sufficiently strong and tough to permit its use under the conditions existing on highway and structural work without tearing or otherwise becoming unfit for the specific use for which it is intended.

Moisture Retention. When tested for water retention, the polyethylene film shall restrict the moisture loss to not more than 0.055 gram per square centimeter of the mortar specimen surface, based on the amount of water in the mortar at the time the curing medium is applied.

Reflectance, Apparent Daylight. The sheeting shall have an apparent daylight reflectance of not less than 70 per cent relative to magnesium oxide.

Dimensions. The sheeting shall have a length of not less than 100 feet and not more than 300 feet, a normal thickness of not less than 4 mils (.004") with a tolerance of —15% for individual measurements, and a width of not less than 14 feet unless otherwise specified.

Tensile Strength. The sheeting shall conform to the following requirements for tensile strength at 77 degrees Fahrenheit:

Longitudinal direction, lbs. per sq. in., min.	1,700
Transverse direction, lbs. per sq. in., min.	1,200

Elongation. The sheeting shall conform to the following requirements for elongation at 77 degrees Fahrenheit:

Longitudinal direction, per cent, min.	225
Transverse direction, per cent, min.	350

Certificate of Analysis. The manufacturer shall furnish with each shipment a certified analysis giving the results of tests required by these specifications.

Methods of Testing. (a) Moisture Retention: Standard Method of Test for Water-Retention Efficiency of Liquid Membrane-Forming Compounds and Impermeable Sheet Materials for Curing Concrete, A. A. S. H. O. Designation T 155.

(b) Reflectance: Standard Method of Test for 45-degree, 0-degree Directional Reflectance of Opaque Specimens by Filter Photometry, A. S. T. M. Designation E 97.

(c) Dimension: Method of Test for Thickness of Solid Electrical Insulation, current A. S. T. M. Designation D 374.

(d) Tensile Strength and Elongation: Methods of Tests for Tensile Properties of Thin Plastic Sheets and Films, current A. S. T. M. Designation D 882.

Salt Hay. Salt hay shall be of salt meadow grasses, shall be free from decayed matter and from organic matter soluble in water, and shall be approved by the Engineer.

Waterproof Paper. Waterproof paper shall conform to the requirements of current A. A. S. H. O. Designation M 139.

8. 5. 30. Fly Ash.

Fly Ash shall consist of the finely divided residue from the combustion of pulverized coal that is removed from the flue gases by electrical or mechanical means. It shall be free from lumps and foreign materials and shall conform to the requirements hereinafter prescribed for specific uses.

Fly Ash for Mineral Filler.	Min. %	Max. %
Chemical Requirements:		
Carbon	...	15
Sulphur anhydride (SO_3)	...	2.5
Physical Requirements:		
Fineness:		
Retained on No. 100 sieve	...	5
" " No. 200 sieve	...	15

Fly Ash for Soil Stabilization (Used with lime) shall conform to the requirements of current ASTM Designation C 379.

8. 5. 31. Joint Filler, Preformed.

Bituminous Type. Preformed bituminous type joint filler for concrete shall conform to the requirements of current A. A. S. H. O. Designation M 33.

Bituminous Cellular Type. Preformed bituminous cellular type joint filler for concrete shall conform to the requirements of current A. A. S. H. O. Designation M 153, Type III.

Cork Joint Material. Cork joint material shall conform to requirements of current AASHO Designation M 153, Type I.

8. 5. 32. Lignin Binder.

Lignin binder shall be liquid extracts from the manufacture of wood pulp. It shall be free from animal, vegetable or mineral oils, asphalt, tars and free carbon and shall be uniform and homogeneous in composition. There shall be no evidence of fermentation at the time of use.

During concentration, the material shall not be heated above 235° F. The standard evaporation method shall be used, with the liquid being exposed progressively to lower temperatures.

Lignin binder shall conform to requirements of Table 33.

Table 33.—Lignin Binder

Solubility in hot or cold water	Min.	99.5%
Evaporation loss at 212° F. to constant weight	Max.	55 %
Ash content	Max.	8 %
Free acids	Max.	0.5%
Sulphur dioxide (SO_2) content as sulphite	Max.	1 %
Total sulphur content as SO_3	Min.	3.5%
Calcium oxide (CaO)	Max.	6.5%
Magnesium oxide (MgO)	Max.	0.3%
Ferric oxide (Fe_2O_3)	Max.	0.25%
Specific gravity at 60° F / 60° F.	Min.	1.25

The properties shown in Table 33 will be determined by the "Methods of Test for Lignin Binder" as specified in Art. 9. 1. 9.

8. 5. 33. Lime, Hydrated.

Hydrated lime for cold mixed bituminous concrete shall conform to the requirements of current A. S. T. M. Designation C 6.

Hydrated lime for landscape work (soil treatment) shall be as specified in Art. 8. 3. 2.

Hydrated lime for soil stabilization, used with fly ash, shall be standard hydrated dolomitic lime conforming to the requirements of current A. S. T. M. Designation C 207, Type N.

8. 5. 34. Mineral Filler.

Mineral filler for bituminous concrete and sheet asphalt shall be limestone, dolomite, trap rock, fly ash or other inert mineral matter from sources approved by the Laboratory, free from lumps and foreign materials, and shall be of the quality and fineness hereinafter specified.

Not less than 95 per cent shall pass a No. 100 sieve and not less than 85 per cent shall pass a No. 200 sieve.

Limestone, dolomite and trap rock shall conform to the quality requirements as specified in Art. 8. 5. 5. Fly ash shall conform to the requirements of Art. 8. 5. 30.

8. 5. 35. Rubble Stones.

Rubble stones shall consist of trap rock, granite, gneiss or other approved hard, durable, tough rock. They shall be sound, free from weathered or decomposed pieces, shattered ends, structural defects and shall be approved by the Engineer.

For gutters, the stones shall be not less than 6 and not more than 8 inches in thickness, not less than 2 and not more than 5 inches in width, and not less than 6 and not more than 10 inches in length. The upper surface shall be practically flat.

For mortar rubble and dry rubble masonry walls, the face stones shall be not less than 8 inches thick. The width shall be not less than 1.5 times the thickness and the length not more than 3 times the thickness and not less than 1.5 times the width.

For rubble riprap walls, the rubble stones shall be as specified above for rubble masonry walls except that they may be of random size within a range appropriate for the construction of walls of the design cross sections shown on the Plans.

For tree wells, the face stones shall be not less than 4 and not more than 12 inches thick. The width shall be not less than 8 inches and the length not less than 1½ and not more than 3 times the thickness. Sixty-five to seventy-five per cent of the stones shall be 4 to 8 inches thick and twenty-five to thirty-five per cent shall be 8 to 12 inches thick.

8. 5. 36. Sodium Chloride (Rock Salt).

Sodium chloride shall be in the form of rock salt containing, at the time of delivery, not more than 0.5 per cent moisture when dried at 105° C (221° F) to constant weight.

Chemical Composition.

Sodium chloride (rock salt), when dried to constant weight as specified above, shall conform to the following requirements:

Sodium chloride (NaCl), min., per cent	97.0
Solubility in boiling distilled water, min., per cent	99.0

Grading.

Sodium chloride (rock salt), when dried as specified above, shall conform to the following requirements as determined by Laboratory sieves:

Sieve	Total Per Cent Passing Min.	Max.
½ inch	100	...
No. 3	90	100
No. 8	5	35
No. 30	0	5

The sieve analysis shall be in accordance with the applicable provisions of current A. A. S. H. O. Designation T 27.

Evaporated salt shall not be furnished in lieu of rock salt.

8. 5. 37. Tiles.

Tiles shall be frostproof faience of selected grade with plastic clay body and of the required color and texture equivalent to samples on file in the Department. The tiles shall be free from warp and other defects and shall be subject to the approval of the Engineer.

8. 5. 38. Water.

Water for use with cement in mortar and concrete shall be subject to the approval of the Engineer. It shall not be salty or brackish and shall be reasonably clear and free from oil, acid, injurious alkali or vegetable matter. When required by the Engineer, the quality of the mixing water shall be determined in conformance with current A. A. S. H. O. Designation T 26.

8. 5. 39. Waterproofing Protection, Insulation Board.

Insulation board used for protection of waterproofing, as an alternative for mortar protection course, shall be composed of vegetable fiber or fiberglas as specified hereinbelow and shall have a thickness of not less than ½ inch. The widths and lengths of the board shall be subject to the approval of the Engineer.

Vegetable fiber insulation board shall be impregnated in the process of manufacture with an arsenical compound producing an As_2O_3 content of 0.1 to 0.15 per cent, by weight, in the finished board. The Contractor shall submit a certificate, in duplicate, signed by the manufacturer of the insulating board, stating that the insulating board furnished has been treated as specified, and stating the actual amount of the arsenical compound in the finished board.

Mineral fiber insulation board shall be composed of mineral fibers bonded together with a phenolic resin and covered on one side with a waterproof kraft paper facing. The board shall conform to the requirements of the current Federal Specification HH-I-526.

SECTION 6

Paints

8. 6. 1. General.

Except as hereinafter provided, ready mixed paint shall consist of pigments ground to the required consistency in a ball, pebble or roller mill, or by other methods approved by the Engineer, with linseed oil, forming a paste to which shall be added other ingredients that may be required.

The paint shall be well ground and shall not settle badly or cake in the container to the extent that it cannot be readily broken up with a paddle to a smooth, uniform paint of good brushing consistency. The paint when brushed on a smooth, vertical, metallic surface shall dry hard and elastic to full oil gloss within the specified period, without running, streaking, or sagging.

The percentages of all materials required are in terms of net weight. The shade or tint of the finished paint shall meet with the approval of the Engineer. The paint and ingredients shall conform to the requirements hereinafter specified for each kind of paint.

The ready mixed paint and paint materials shall be analyzed in accordance with the methods given therefor in the current Federal Specification TT-P-141.

The paint shall be shipped in substantial containers plainly marked with the name or kind, net weight and volume of the contents, and shall show the name, address and lot or batch number of the manufacturer, together with the Department's lot number and date of approval if the paint has been inspected at the source of manufacture by the Department. All containers must conform to the current Federal Specification TT-P-143.

8. 6. 2. Aluminum Paint.

Aluminum point shall conform to the requirements of current A. A. S. H. O. Designation M 69.

8. 6. 3. Concrete Paint.

This specification covers a paint for application on exposed concrete surfaces.

The mixing vehicle for the paint shall be a solution of potassium silicate having an approximate specific gravity of 1.18 and molecular ratio of 1 part K_2O to 3.3 parts SiO_2.

The pigments for use with the silicate vehicle shall be alkali resistant and of such color or combinations of color that will produce paint with a color or tint approved by the Engineer.

The paint shall be prepared for use just prior to application by thoroughly mixing the pigment with the mixing vehicle. For brush application, it shall be mixed in the proportion of approximately 6.33 pounds of pigment to 1 gallon of vehicle. For spray application, the paint may be diluted to the desired consistency with the addition of more vehicle. The paint shall be delivered in substantial two-compartment containers. The proper quantity of pigment and vehicle, when mixed together, shall result in 1 or 5 gallons or such other quantities of mixed paint as may be specified. The vehicle and pigments will be tested in accordance with Art. 9. 1. 10, "Method of Test for Concrete Paint."

8. 6. 4. Foliage Green Paint.

Foliage green paint shall conform to the requirements hereinafter specified.

PAINTS

Materials.

Alkyd resin solution—Federal Specification TT-R-266, Type I, Class A or B.

Chrome oxide green—A. S. T. M. Designation D 263.

Driers—A. S. T. M. Designation D 600, Class B, with proper metals to produce the required drying characteristics of the paint.

Linseed oil, heat bodied—Federal Specification TT-O-367, Type I.

Linseed oil, raw—A. S. T. M. Designation D 234.

Thinner, mineral spirits—A. S. T. M. Designation D 235, or Turpentine—A. S. T. M. Designation D 13, or a combination of both.

White lead basic carbonate—A. S. T. M. Designation D 81.

Pigment Composition.	Min.	Max.
Basic carbonate white lead, %	81	83
Chrome oxide, green, %	17	19

Vehicle Composition.	Min.	Max.
Linseed oil, % (1)	52	59
Pale heat bodied linseed oil, %	0	7
Resin solution, alkyd, %	28	30
Phthalic anhydride, % (2)	5	7
Thinner and drier, %	0	13
Vehicle solids, %	79	..

(1) Shall conform to the requirements of current A. S. T. M. Designation D 234 except that a maximum acid number of 8 shall be allowed. A mixture of acid refined linseed oil and raw linseed oil may be used.

(2) Based on nonvolatile content of vehicle.

Paint Composition.	Min.	Max.
Pigment, %	65.5	67.5
Vehicle, %	32.5	34.5
Weight per gallon, lbs.	17	..
Dry through, hours	..	24
Viscosity, K. U.	77	90
Fineness of grind	3	..

8. 6. 5. Graphite Paint, Black.

Black graphite paint shall conform to the requirements of current Federal Specification TT-P-27, Type I. When two coats of graphite paint are specified, the first coat shall contain no carbon black or lamp black pigment.

8. 6. 6. Green Enamel Paint.

Green enamel paint shall conform to the requirements of current Federal Specification TT-E-489b, Class A Air Drying Enamel; Gloss, Synthetic (For Exterior and Interior Surfaces). The tint shall match the gloss-green Standard Color Chip No. 14062, Table VI, as shown in current Federal Specification TT-C-595, Color (For Ready Mixed Paint).

8. 6. 7. Red Lead Paint.

Red lead paint for shop coat and field coat shall conform to the requirements of current A. A. S. H. O. Designation M 72, Type I or II, with the following exception:

Extracted raw linseed oil may be used, in whole or in part, as a replacement of the raw linseed oil and shall conform to the following requirements:

	Min.	Max.
Specific gravity at 20° C.	0.934	0.938
Acid number	..	1
Color (Gardner)	..	9
Iodine number (Wijs)	195	..
Viscosity at 25° C (poises)	0.35	0.45
Foots (heated and chilled oil), %..	..	0
Moisture, %	..	0
Unsaponifiable matter, %	..	0
Appearance at 65° C.	Clear and Transparent	

8. 6. 8. Red Lead-Graphite Paint.

The pigment shall be prepared from red lead, natural crystalline flake graphite and siliceous matter, and red iron oxide. Natural crystalline flake graphite and siliceous matter shall conform to the requirements of Federal Specification TT-P-27, Type I. Red lead shall conform to the requirements of current A. A. S. H. O. Designation M 71. Red iron oxide shall be a siliceous type of red iron oxide free from calcium sulphate and shall contain not less than 85 per cent of ferric oxide (Fe_2O_3). The total prepared pigment shall contain not less than 22.5 per cent of graphite carbon. The linseed oil, driers and thinners shall conform to those specified above for red lead paint in Art. 8. 6. 7.

The shop and field coat paints shall conform to the requirements hereinafter specified.

Shop Coat.

Paint Composition.

	Min.	Max.
Graphite, %	20.5	23
Red lead, %	16.5	17.5
Iron oxide, %	9.5	10.5
Liquid (containing not less than 80% of boiled linseed oil), %	48.5	53
Water, %	..	0.5
Coarse particles and skins (total residue retained on No. 325 sieve, based on pigment), %	..	2
Weight per gallon, lbs.	11	..
Viscosity, K. U.	68	..

Drying Time. The paint when brushed on a smooth, vertical metal surface shall dry at room temperature within 24 hours to a smooth, semigloss finish without streaking, running or sagging.

Field Coat.

Paint Composition.

	Min.	Max.
Graphite, %	23.5	25.5
Red lead, %	23.5	25.5
Liquid (containing not less than 80% of boiled linseed oil), %	48.5	53
Water, %	..	0.5
Coarse particles and skins (total residue retained on No. 325 sieve, based on pigment), %	..	2
Weight per gallon, lbs.	11.5	..
Viscosity, K. U.	68	..

Drying Time. The paint when brushed on a smooth, vertical metal surface shall dry at room temperature within 24 hours to a smooth, semigloss finish without streaking, running or sagging.

8. 6. 9. Rust-Inhibitive Primer.

Rust-inhibitive primer shall be fast drying and shall be thoroughly dry with a tough and durable surface before the materials or parts painted therewith are handled or packed for shipment. Formulas used for primers shall have been demonstrated as capable of withstanding at least 200 hours exposure in a weatherometer test conducted in accordance with current A. S. T. M. Designation D 822, with no evidence of cracking, blistering, rusting, checking, peeling, scaling or loss of adhesion.

8. 6. 10. Tar Paint.

Tar paint shall be made from refined coal tar or water gas tar and a tar distillate, shall be free from water and petroleum distillates, and shall conform to the following requirements:

	Min.	Max.
Viscosity, 25° C., first 50 cc. (Engler), sec.	100	400
Solubility in CS_2, %	82	96
Distillation, oil up to 170° C., %	5	20
Distillation, oil up to 235° C., %	15	35
Distillation, oil up to 270° C., %	25	41
Distillation, oil up to 300° C., %	30	46
Softening point of distillation residue (B & R), degrees C.	55	75

8. 6. 11. White Paint.

White paint shall conform to the requirements of current Federal Specification TT-P-103.

8. 6. 12. Zinc Chromate-Iron Oxide Paint.

Zinc chromate-iron oxide paint shall conform to the requirements of current A. A. S. H. O. Designation M 142.

8. 6.13. Zinc Dust-Zinc Oxide Paint Primer.

Zinc dust-zinc oxide paint primer shall conform to the current Federal Specification TT-P-64lb. Type I, II or III may be used.

8. 6. 14. White Traffic Paint.

Scope.

1. These specifications cover three types of ready mixed white paint as follows:

Type I. Vegetable Oil Modified Alkyd Resin Vehicle.
Type II. Phenolic Modified Pentaerythritol Resin Vehicle.
Type III. Pure Drying Alkyd—Chlorinated Rubber Vehicle.

General.

2. The paint shall be such of the above-mentioned types as may be specified or shown on the Plans. The pigment and vehicle shall be so prepared and blended that the resulting paint shall be uniform in composition and of the required consistency. The pigment shall not settle badly or cake in the container nor shall the paint skim or thicken in storage sufficiently to cause undesirable change in consistency. The paint at the time of use shall be such that it can be readily broken up with a paddle to a smooth uniform condition, capable of proper application with a mechanical distributor of the type used by the Department.

The paint shall be packaged in 5-gallon steel containers and shall be well sealed. The containers shall be labeled in accordance with the requirements of the purchaser, and shall comply with the Specifications for Single Trip Metal Drums and Kits, Interstate Commerce Commission current Specification 37D, 11-20-53.

Detail Requirements and Tests for All Types.

3. *(a) Preparation of Paint.* The titanium-calcium, magnesium silicate and calcium carbonate are ground in a sufficient amount of the vehicle. The remainder of the vehicle, additional thinners and pumice, when required, are then stirred into the paint. The purchaser reserves the right to eliminate the use of calcium carbonate and in its place use an equal weight of pumice (current A. S. T. M. D867).

(b) Consistency. Forty-eight hours after the paint has been prepared and placed in the containers it shall have a consistency of 72 to 78 K. U. for use in spray type equipment, and a consistency of 78 to 84 K. U. for use in a sleigh or gravity type equipment. (The pigment for sleigh or gravity type equipment shall contain an equal weight of pumice in place of the calcium carbonate specified.) All consistencies shall be determined by the Stormer Viscosimeter with paddle type rotor at 25° C.

(c) Drying Time. The paints shall have the following no-pick-up drying time when tested at .015" wet film thickness:

Type I — 1 hour max.
Type II — 15 minutes max.
Type III — 15 minutes max.

(d) Light Resistance. A think film of paint spread on a glass plate and allowed to thoroughly dry shall not darken or show any discoloration when subjected to ultra violet rays for a period of five minutes.

(e) Flexibility and Adhesion. A paint film of .015" wet film thickness shall be applied to a 3" x 5" tin panel weighing 0.39 to 0.51 pounds per square foot previously cleaned with benzol and lightly buffed with steel wool. After drying in a horizontal posi-

tion at room temperature (70 to 80° F.) for eighteen hours, the panel shall be baked in an oven at 122° ± 4° F. for two hours, removed and allowed to cool to room temperature. It shall then be bent rapidly, with the painted surface uppermost, over a ½" mandrel and examined without magnification. The paint shall adhere firmly to the panel and any evidence of cracking or flaking of the film shall be cause for rejection of the paint.

(f) Water Resistance. The paint shall show no softening nor blistering when tested as specified in Art. 9. 1. 13 herein.

(g) Fineness of Grind. The pigment shall be so ground as to indicate a fineness of 2 to 3 as determined on a Hegman Grind Gauge.

Type I. Vegetable Oil Modified Alkyd Resin Vehicle.

4. *(a) Composition of Paint.*

Pigment	61-63%
Vehicle	37-39%
Weight per gallon, Min.	12.6 lbs.

(b) Composition of Pigment.

Titanium-calcium, Rutile	79-81%
Magnesium silicate	9-11%
Calcium carbonate	9-11%

(c) Composition of the Vehicle. The vehicle shall be of a medium length drying oil alkyd solution and shall be thinned with V. M. & P. naphtha to produce the consistency desired. The resin solids shall contain an oil acid content of at least 50% and show a phthalic anhydride content of at least 30%. The alkyd resin shall have a maximum color of 6 (Gardner). No rosin will be tolerated. The oil fatty acids shall be of vegetable origin, either alkali refined soya bean oil or the fatty acids of soya bean oil having an iodine number between 115-130. No recovered oil or soya food fatty acid derivatives shall be used. The vehicle as separated from the pigment shall show a nonvolatile content of at least 42%.

(d) Note: Soya lecithin in an amount of 1.0% based on the weight of the pigment, shall be added during the grinding of the pigment and vehicle.

Type II. Phenolic Modified Pentaerythritol Resin Vehicle (quick drying).

5. *(a) Composition of the Paint.*

Pigment	— 61-63%
Vehicle	— 37-39%
Weight per gallon, Min.	— 13.2 lbs.

(b) Composition of the Pigment.

Titanium Calcium, Rutile	—	79-81%
Magnesium Silicate	—	9-11%
Calcium Carbonate	—	9-11%

(c) Composition of the Vehicle. The vehicle shall consist of raw tung oil, phenolic modified pentaerythritol resin, chlorinated rubber, toluene and benzene. Benzene shall be used for thinning the paint to the consistency required.

The vehicle, as separated from the pigment, shall show a non-volatile content of at least 42%.

The varnish shall be composed of 25 gallons of raw tung oil per 100 pounds of phenolic modified pentaerythritol resin reduced to 75% solids with toluene. The resin and oil shall be heated to 400° F. in one hour, held for 2¼ hours, cooled to 250° F. and reduced. Four-tenths per cent (0.4%) lead and five-hundredths per cent (.05%) cobalt by weight of the varnish solids shall be added as driers.

The chlorinated rubber solution shall consist of 40% by weight of 20 centipoise type chlorinated rubber in benzene. Two per cent, by weight, of propylene oxide or epichlorhydrin, based on the chlorinated rubber, shall be added as a stabilizer.

Based on their solid contents, 4 parts, by weight, of varnish and 1 part, by weight, of chlorinated rubber solution shall be used in the vehicle.

(d) Resin. The resin shall be Hercules Pentalyn 802A or equal and shall have the following properties:

Acid Number	25 Max.
Color (Standard Rosin Types)	I Max.
Softening Point (Hercules Drop Method)	160°-170° C.
Viscosity (Gardner-Holdt-50% by Weight in Toluene)	C-G

(e) Chlorinated Rubber. Chlorinated rubber shall have the following properties:

Chlorine	66-69%
Color (Gardner-20% by weight in Toluene)	4 Max.
Viscosity (20% by weight in Toluene)	15-23 centipoises

(f) Note: Soya lecithin in an amount of 1%, based on the weight of the pigment, shall be added during the grinding of the pigment and vehicle.

Type III—Pure Drying Alkyd-Chlorinated Rubber Vehicle.

6. *(a) Composition of Paint.*

Pigment	58-60%
Vehicle	40-42%
Weight per gallon, Min.	13.2 lbs.

(b) Composition of Pigment.

Titanium-calcium, Rutile	79-81%
Magnesium Silicate	9-11%
Calcium Carbonate	9-11%

(c) Composition of Vehicle. The vehicle shall consist of a medium phthalic drying oil alkyd resin, chlorinated rubber, toluene and benzene. Benzene shall be used for thinning the paint to the consistency required.

The vehicle, as separated from the pigment, shall show a non-volatile content of at least 39.5%. The volatile portion of the vehicle may be modified with a small amount of high-boiling aromatic thinner (boiling range—350°-400° F. Kauri butanol value—83 min.) at the discretion of the purchaser.

The alkyd resin shall be a medium phthalic drying oil alkyd containing a minimum of 30% phthalic anhydride and a minimum of 50% oil acids based on the solids. The oil fatty acids shall be of vegetable origin, either alkali refined soya bean oil or the fatty acids of soya bean oil having an iodine number between 115 and 130. No recovered oil or soya food fatty acid derivatives shall be used. The alkyd resin shall have a maximum color of 6 (Gardner).

The alkyd supplied shall be 60% nonvolatile in toluene. The resin shall be Beckosol P819 (Reichold Chemicals) or equal.

The chlorinated rubber solution shall consist of 40% by weight of 20 centipoise type chlorinated rubber in benzene. Two per cent, by weight, of propylene oxide or epichlorhydrin, base on the chlorinated rubber, shall be added as a stabilizer.

Based on their solid contents, 4 parts, by weight, of the alkyd resin solution and 1 part, by weight, of chlorinated rubber solution shall be used in the vehicle.

(d) Chlorinated Rubber. Chlorinated rubber shall have the following properties:

Chlorine	66-69%
Color (Gardner-20% by weight in Toluene)	4 Max.
Viscosity (20% by weight in Toluene)	15-23 centipoises

(e) Note: Soya lecithin in an amount of 1%, based on the weight of the pigment, shall be added during the grinding of the pigment and vehicle.

Methods of Tests.

7. The paint and ingredients shall be tested in accordance with the following methods:

Consistency	Current A. S. T. M. D 562
Drying Time	Current A. S. T. M. D 711
Water Resistance	As specified in Art. 9. 1. 13 herein
Fineness of Grind	Fed. Spec. TT-P-141b—Method 441. 1
Pigment Content	Fed. Spec. TT-P-141b—Method 402. 1
Nonvolatile Content	Fed. Spec. TT-P-141b—Method 403. 1
Weight per gallon	Fed. Spec. TT-P-141b—Method 401. 1
Titanium-Calcium, Rutile	Current A. S. T. M. D 476
Magnesium Silicate	Current A. S. T. M. D 605
Calcium Carbonate	Current A. S. T. M. D 1199, Type GC, Grade I
Pumice	Current A. S. T. M. D 867
Phthalic Anhydride	Fed. Spec. TT-P-141b—Method 702. 1, Procedure A
Rosin	Fed. Spec. TT-P-141b—Method 503. 1
Iodine No. of Fatty Acids	Fed. Spec. TT-P-141b—Method 506. 1
Oil Acid Content	Fed. Spec. TT-P-141b—Method 703.1

Resin.

Acid Number	Fed. Spec. TT-P-141b—Method 507. 2
Color (Standard Rosin Type)	Fed. Spec. TT-P-141b—Method 451. 1
Softening Point (Hercules Drop Method)	As specified in Art. 9. 1. 11 herein
Viscosity (Gardner-Holdt —50% by weight in Toluene)	Fed. Spec. TT-P-141b—Method 427. 1

Chlorinated Rubber.

Chlorine	As specified in Art 9. 1. 12 herein
Color (Gardner—20% by weight in Toluene)	Fed. Spec. TT-P-141b—Method 424.8
Viscosity (20% by weight in Toluene)	Current A. S. T. M. D 115
Raw Tung Oil	Current A. S. T. M. D 12
Benzene	Current A. S. T. M. D 361
Toluene	Current A. S. T. M. D 362

8. 6. 15. Glass Beads for Reflectorizing Traffic Paint.

Scope.

1. This specification is intended to cover glass beads for application on traffic paint for the production of a reflective surface to improve the night visibility of the paint film.

General.

2. The beads shall be manufactured from glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

3. The beads shall be packaged in 50-pound moisture-resistant bags.

Detailed Requirements.

Spherical Particles.

4. The beads shall contain not less than 70% spherical particles. They shall be essentially free from sharp angular particles, and particles showing milkiness or surface scoring or scratching.

Daylight 45°-0° Reflectance.

5. The beads shall be free of tint or color and have a daylight 45°-0° reflectance, in bulk, of not less than 55%.

Grading.

6. The beads shall meet the following grading requirements:

U. S. Standard Sieve No.		
Passing	Retained on	% by Weight
....	# 16	0
# 16	# 20	0-2
# 20	# 30	5-28
# 30	# 50	35-65
# 50	# 100	15-40
# 100	....	0-5

Index of Refraction.

7. The beads when tested by the Liquid Immersion Method at 25° C. shall show an index of refraction within the range of 1.50 to 1.65.

Chemical Stability.

8. Beads which show any tendency toward decomposition, including surface etching, when exposed to atmospheric conditions, moisture, dilute acids or alkalies or paint film constituents, shall be rejected.

Methods of Tests.

9. The glass beads shall be tested as specified in Art. 9. 1. 14 herein.

SECTION 7

Pipe

8. 7. 1. Asbestos-Cement Pressure Pipe.

Asbestos-cement pressure pipe shall conform to the requirements of the current A. S. T. M. Designation C 296. Class 150 shall be used.

8. 7. 2. Cast Iron Culvert Pipe.

Cast iron culvert pipe shall conform to the requirements of current A. A. S. H. O. Designation M 64.

8. 7. 3. Cast Iron Water Pipe.

Cast iron water pipe shall conform to the requirements of the current A. S. A. Specification A 21. 2, Cast Iron Pit Cast Pipe for Water or Other Liquids; A 21. 6, Cast Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids; or A 21.8, Cast Iron Pipe Centrifugally Cast in Sand-Lined Molds, for Water or Other Liquids; as may be prescribed in the Supplementary Specifications. All pipe flanges and fittings shall conform to the requirements of current A. S. A. Specification B 16b, Cast Iron Flanges and Fittings, Class 250.

8. 7. 4. Clay Pipe.

Standard strength, extra strength, standard strength perforated, and cradle invert clay pipe shall conform to the requirements specified respectively therefor in current A. A. S. H. O. Designation M 65.

8. 7. 5. Concrete Pipe.

Nonreinforced Concrete Sewer Pipe. Nonreinforced concrete sewer pipe shall be of the bell and spigot type and shall conform to the requirements of current A. A. S. H. O. Designation M 86 with the following exceptions:

Fine aggregate shall conform to the requirements of Art. 8. 5. 10. Coarse aggregate shall be washed gravel, or broken stone of trap rock, granite or gneiss, conforming to the requirements of Art. 8. 5. 6 and 8. 5. 5, respectively.

Perforated Concrete Pipe. Perforated concrete pipe, nonreinforced, shall conform to the requirements of current A. S. T. M. Designation C 59 with the following exceptions:

Fine aggregate shall conform to the requirements of Art. 8. 5. 10. Coarse aggregate shall be washed gravel, or broken stone of trap rock, granite or gneiss, conforming to the requirements of 8. 5. 6 and 8. 5. 5 respectively.

Reinforced Concrete Culvert, Storm Drain and Sewer Pipe. Reinforced Concrete Culvert, Storm Drain and Sewer Pipe shall conform to the requirements of current A. A. S. H. O. Designation M 170 amended as follows:

Fine aggregate shall comply with requirements of Art. 8. 5. 10. Coarse aggregate shall be washed gravel, or broken stone of trap rock, granite or gneiss, conforming to the requirements of Art. 8. 5. 6 and 8. 5. 5, respectively. Elliptical reinforcing will not be permitted in circular pipe. Unless otherwise specifically provided, Class III, Wall B shall be used for standard strength and Class IV, Wall B shall be used for extra strength reinforced concrete culvert pipe. Pipe of 30-inch diameter and smaller shall be bell

and spigot type and shall comply with the following additional requirements:

The socket shall have a thickness of not less than three-fourths of the wall thickness. The depth of the socket shall equal the wall thickness, but shall be not less than 2½ inches. The annular space between the outside diameter of the barrel and the inside diameter of the socket, at its base, shall be not less than ⅛ inch and not more than ¼ inch. The annular space between the outside diameter of the barrel and the inside diameter of the socket, at its mouth, shall be not less than ½ inch and not more than ⅝ inch. The area of circular reinforcing steel in the socket shall be not less than the requirements for the barrel, and shall have the same longitudinal spacing. At least one line of circular reinforcing in the socket shall overlap one line of circular reinforcing in the barrel. The spigot shall be plain and shall in all respects correspond to the dimensions of the barrel.

Porous Concrete Pipe. Porous concrete pipe shall be manufactured of portland cement, fine aggregate, coarse aggregate and water. Portland cement shall conform to the requirements of current A. S. T. M. Designation C 150. Fine aggregate shall conform to the requirements of Art. 8. 5. 10. Coarse aggregate shall be washed gravel, or broken stone of trap rock, granite or gneiss, conforming to the requirements of Art. 8. 5. 6 and 8. 5. 5, respectively. Water shall conform to the requirements of Art. 8. 5. 38.

Pipe sizes shall be designated by their internal diameters and the interior cross sections shall be approximately circular.

The pipe shall conform to the requirements shown in Table 34.

Table 34.—Porous Concrete Pipe

Nominal Internal Diameter, inches	Minimum Wall Thickness, inches	Average Strength, 3-Edge Bearing, lbs. per linear foot
4	1.00	1,000
6	1.00	1,100
8	1.25	1,300
10	1.375	1,400
12	1.50	1,500
15	1.75	1,750
18	2.00	2,000
21	2.25	2,200
24	2.50	2,400

The pipe shall have a laying length of not less than 24 and not more than 36 inches.

The joints of porous concrete pipe shall be formed of solid nonporous concrete to provide maximum strength. Such concrete shall extend into the barrel of the pipe to a depth of approximately one inch at each end. All joints shall be of the slip joint type.

The rate of infiltration for all sizes shall be not less than one gallon per minute per inch of internal diameter per foot of pipe, as determined by the "Method of Test for Rate of Infiltration for Porous Concrete Pipe" specified in Art. 9. 1. 16.

The finished pipe shall be straight, free from cracks, checks or other physical defects that may impair its strength, durability and serviceability. All pipe shall be reasonably uniform in texture.

8. 7. 6. Corrugated Metal Pipe.

Corrugated metal culvert pipe shall conform to the requirements of current A. A. S. H. O. Designation M 36.

The pipe and connecting bands shall be fully and uniformly shop-coated with bituminous material, inside and outside, to a minimum thickness of 0.05 inches, measured on the crest of the corrugations. Bituminous material for the coating shall be asphalt cement conforming to the requirements therefor specified in Art. 8. 1. 3.

When a paved invert is prescribed, it shall be provided in the pipe before shipment from the factory by placing bituminous material on the inside of the pipe in such a manner that a smooth pavement will be formed in the invert (bottom of the pipe when installed), which shall fill all the corrugations for one-quarter of the circumference of the pipe. The invert pavement, except where its upper edges intersect the corrugations, shall have a minimum thickness of ⅛ inch above the crest of the corrugations. Bituminous material for the paved invert shall be the same as specified above for the pipe coating.

Corrugated metal pipe for underdrains shall conform to the current A. A. S. H. O. Designation M 136 and may be any one of the types designated therein. The pipe shall be perforated and, unless otherwise specified, it shall be coated with bituminous material as hereinabove specified for coating corrugated metal culvert pipe.

Inspection and Tests. For testing coated pipe, a section of pipe of the specified diameter and length shall be furnished by the Contractor upon the request of the Engineer.

The fabricator of the pipe, upon request of the Engineer, shall furnish the purchaser a one-quart sample of bituminous material used for the coating and paved invert, said sample to be taken from the tank during the process of coating the pipe. When in-

spection of the coated pipe is made at its destination, approximately 8 ounces of the bituminous material used for the coating shall be removed from the top of the pipe upon request of the Engineer. Any bituminous coating and invert paving damaged in shipment or during installation, and that which is removed for test, shall be replaced by the Contractor with a brush coat of bituminous material of the same kind as used for the original coating of the pipe, to the satisfaction of the Engineer.

A certified statement shall accompany each shipment which shall include information required by the Department the nature of which will be designated by the Department upon request.

8. 7. 7. Corrugated Metal Pipe-Arches.

Corrugated metal pipe-arches shall consist of corrugated metal pipes which have been reformed to multi-centered pipes having arch-shaped tops with a slightly curved, integral bottom. They shall be fabricated from standard length culvert sheets and factory-riveted to form a continuous length pipe-arch. When the length of the pipe-arch required for a complete structure is longer than can be handled conveniently in one piece, band couplers shall be used to make the field connections.

The requirements for Base Metal, Spelter Coating, Rivets, Sampling, Testing, Brands, Corrugations, End Finish, Bands, Workmanship and Finish, shall conform to the requirements specified respectively therefor in current A. A. S. H. O. Designation M 36.

Dimensions, tolerances, areas, weights and gauges shall be as shown in Table 35.

Table 35.—Corrugated Metal Pipe-Arches

Span, in.	Rise, in.	Gauge, Pipe	Area, sq. ft.	"T" in.	"B" in.	Gauge, Bands
18	11	16	1.1	6½	4½	16
22	13	16	1.6	8¼	4¾	16
25	16	16	2.2	10¾	5¼	16
29	18	14	2.8	12½	5½	16
36	22	14	4.4	15¾	6¼	16
43	27	12	6.4	20	7	14
50	31	12	8.7	23	8	14
58	36	10	11.4	26¾	9¼	12
65	40	10	14.3	29½	10½	12
72	44	8	17.6	32¼	11¾	12

All dimensions are measured from the inside crests of the corrugations. A tolerance of plus or minus 1 inch will be permissible in span and rise. The rise is the sum of dimensions "T" and "B", measured vertically from a horizontal line drawn across the widest portion of the arch. The dimension "T" is the distance from this horizontal line to the highest point of the intrados of the arch. The dimension "B" is the distance from this horizontal line to the lowest portion of the base. The minimum radius of curvature of any part of the pipe arch section shall be 4 inches. The lapped longitudinal seams shall be factory riveted and shall be staggered so as to alternate on each side of the center of the top of the arch by approximately 15 per cent of the periphery.

The pipe-arches shall be bituminous coated as specified above for corrugated metal culvert pipe. When a paved invert is specified, the paved section on the inside bottom of the pipe-arch and the bituminous material therefor shall be as hereinabove specified for the paved invert of corrugated metal culvert pipe except that the invert paving shall cover not less than 40 per cent of the periphery of the pipe arch.

Inspection and Tests. Inspection and tests shall conform to the requirements specified therefor in Art. 8. 7. 6.

8. 7. 8. Structural Plate Pipe, Pipe-Arches and Arches.

Structural plate pipe, structural plate pipe-arches, and structural plate arches shall conform to the requirements specified respectively therefor in current A. A. S. H. O. Specifications for Highway Bridges.

The plates for structural plate pipe, structural plate pipe-arches and structural plate arches shall be bituminous shop-coated as hereinabove specified for the bituminous coating of corrugated metal culvert pipe.

8. 7. 9. Seamless Steel Pipe, For Railing and Posts.

Seamless steel pipe shall conform to the requirements of current A. S. T. M. Designation A 53 or A 120.

8. 7. 10. Tile, Drain.

Drain tile shall conform to the requirements of current A. A. S. H. O. Designation M 66. It shall be extra quality drain tile conforming to either Shale and Fire Clay Tile or Concrete Tile.

8. 7. 11. Wrought Iron Pipe, Welded.

Welded wrought iron pipe shall conform to the requirements of current A. A. S. H. O. Designation M 101. It shall be standard weight, and shall be galvanized as specified in Art. 8. 4. 33. Fittings

not manufactured of wrought iron shall be malleable iron conforming to Art. 8. 4. 4. Each length of pipe shall be marked with the manufacturer's name, identifying mark and year of manufacture.

SECTION 8

Soil Aggregates

8. 8. 1. Soil Aggregates.

Description. Soil aggregates shall be natural or prepared mixtures consisting predominantly of hard durable particles or fragments of stone, slag, gravel or sand and containing some silt-clay or stone dust, conforming to the requirements therefor as hereinafter specified.

Definitions of Constituent Materials. *Stone* shall be crushed or naturally angular particles of rock, a natural solid mineral matter occurring in large masses or fragments, which will pass a 2-inch sieve and be retained on a No. 10 sieve. The stone shall conform to the requirements of Article 8. 5. 5.

Slag shall be blast furnace slag conforming to the requirements of Article 8. 5. 7 except that the gradation shown in Table 28 does not apply.

Gravel shall be rounded particles of rock which will pass a 4-inch sieve and be retained on a No. 10 sieve.

Sand shall be granular material resulting from disintegration, grinding or crushing of rock and which will pass a No. 10 sieve and be retained on the No. 200 Sieve.

Silt-clay shall be fine soil particles which will pass the No. 200 sieve.

Stone dust shall be fine soil or mineral particles, or both, which will pass the No. 200 sieve.

All sieve sizes specified herein for soil aggregates and their constituent materials are based on square openings.

Types and Composition of Soil Aggregates. The following types of soil aggregates are intended to include only materials having normal or average specific gravity, absorption and gradation characteristics. The composite mixture of any type of soil aggregate specified herein shall be free from elements or chemicals which, in the presence of water, would produce detrimental effects to pavements, structures, or utility lines, and free from organic matter, wood, garbage, metal, debris or lumps or balls of clay. Soil aggregates containing shale and similar soft materials, except as hereinafter specified under Type 2, which break up so that

they do not conform to the specified grading requirements when tested in accordance with the provisions of Art. 9. 1. 18, "Methods of Tests for Determining the Breakup in Sizes of Soil Aggregates," shall not be used.

Types 1 and 4. Types 1 and 4 shall consist of bank-run sand and gravel, commercial sand and gravel combined, or blast furnace slag.

Type 2. Type 2 shall be hard, durable gravel mixed with sand and silt-clay so that it can be compacted into a hard, dense mass. The composite mixture of gravel, sand and silt-clay shall contain, by weight, a total of not more than 25 per cent of shale, slate, schist, and soft and decomposed aggregate, as determined by the "Method of Test for Shale, Schist, Slate and Soft and Decomposed Particles in Soil Aggregate" specified in Art. 9. 1. 17. If the total of shale, slate, schist and soft and decomposed aggregate be 5 per cent or less, the schist and soft and decomposed aggregate be 5 per cent or less, the quantity passing the No. 200 sieve shall be not less than 4.5 per cent and not more than 12 per cent. If the total of shale, slate, schist and soft and decomposed aggregate be more than 5 per cent but not more than 25 per cent, the quantity passing the No. 200 sieve shall be not less than 4 per cent and not more than 9 per cent.

Type 3. Type 3 shall consist of clean, free draining sand and gravel. For Type 3B, the grading limits specified for material passing the No. 4 sieve are based on the portion passing the No. 4 sieve.

Type 5. Type 5 shall consist of quarry-processed stone or blast furnace slag conforming to the requirements therefor hereinabove specified and to the grading of Type 5, Class A soil aggregate shown in Table 36. The portion passing the No. 40 sieve shall be nonplastic when tested in accordance with A. A. S. H. O. Designation T 91. The material passing the No. 4 sieve may consist entirely or in part of natural or processed sand.

Combining and Mixing. If bank-run or other materials conforming to the requirements specified hereinabove are not available, materials that will conform thereto may be produced by combining and mixing, and by washing if necessary. Materials may be combined and mixed on the grade only with the approval of the Engineer. The blending on the grade shall be performed by a traveling high speed rotor mixer capable of cutting and thoroughly mixing to a minimum depth of 6 inches.

Gradation. Soil aggregates shall be graded as shown in Table 36 for the various types and classes. The gradation requirements shall be based on the dry weight of the total sample, when tested in accordance with A. A. S. H. O. Designation T 27 and washed as specified in current A. S. T. M. Designation C 117, and

shall apply to the material after it has been placed and compacted on the Project. Where compaction is not prescribed, the requirements for any given type shall apply to the material at the time it is placed.

Table 36.—Soil Aggregates, Gradation

Types	1			2		3			4					5
Class	A	B	C	A	B	A	B	C	A	B	C	D	E	A
Sieve Size	Percentage By Weight Passing Square Mesh Sieves													
4"	100		100					100	100	100	100	100	100	
2½"							100							
2"	70–100	100		100	100	100				80–100	80–100			100
1"						95–100								
¾"	50–95	65–100	60–100	70–100	70–100					60–100	60–100			55–90
½"						80–100	65–100						100	
No. 4	30–60	40–75	30–100	35–75	30–80					40–100	40–100		95–100	25–60
No. 10						40–100	30–100							
No. 30						20–80	20–100						20–55	
No. 40	10–30	10–35	5–40	15–30	10–40				5–40	10–40	10–100			15–30
No. 50						0–20					0–75		5–25	
No. 80							0–15	0–20						
No. 100						0–3	0–5							
No. 200	0–7	0–7	0–5	See text	See text		0–2	0–5	0–8	0–8	0–8	0–5	0–5	5–12

For Type 3, Class B, the gradation shown above for material passing the No. 4 sieve is based on the portion passing the No. 4 sieve.

SECTION 9

Timber, Timber Piles and Timber Preservatives

8. 9. 1. Timber for Guard Rail Posts and Struts.

Timber for guard rail posts and struts shall conform to the requirements for Structural Timber, and its grading to the requirements for the Grading of Solid Sawn Structural Timber, specified in the current A. A. S. H. O. Standard Specifications for Highway Bridges.

8. 9. 2. Timber Bearing Piles.

Timber piles shall conform to the requirements therefor of the current A. A. S. H. O. Standard Specifications for Highway Bridges except that untreated foundation piles having smooth, tight bark need not be peeled.

8. 9. 3. Timber Sheet Piles.

Timber sheet piles shall conform to the requirements of the current A. A. S. H. O. Standard Specifications for Highway Bridges and to the following requirements:

Sheet piles shall be dressed on 4 sides and shall be tongue and grooved or grooved for splines, as shown on the Plans.

8. 9. 4. Timber Connectors.

Timber connectors shall conform to the requirements of the current A. A. S. H. O. Standard Specifications for Highway Bridges.

8. 9. 5. Timber for Structures.

Timber for structures shall conform to the requirements of the current A. A. S. H. O. Standard Specifications for Highway Bridges except as follows:

Timber that is to be painted shall be surfaced 4 sides.

8. 9. 6. Timber Preservatives.

Timber preservatives shall conform to the following requirements:

a. Coal tar creosote and solutions containing creosote shall conform to the requirements of current A. A. S. H. O. Designation M 133.

b. Water-Borne Preservatives.	Federal Specification
Acid Copper Chromate (Celcure)	TT-W-546 a
Ammoniacal Copper Arsenite (Chemonite)	TT-W-549 a
Chromated Copper Arsenate (Greensalt)	TT-W-550
Chromated Zinc Chloride	TT-W-551
Chromated Zinc Arsenate (Boliden Salt)	TT-W-538
Copperized Chromated Zinc Chloride	TT-W-562
Osmosar	TT-W-569
Tanalith (Wolman Salts)	TT-W-573

c. Oil-Borne Preservatives.

Pentachlorophenol Solution in Petroleum—5% Pentachlorophenol, shall conform to the requirements of current A. A. S. H. O. Designation M 133.

Copper Naphthenate Solution in Petroleum—equivalent to 0.5% Copper, shall conform to the requirements of current A. A. S. H. O. Designation M 133.

The petroleum solvent used for preparing the solutions of pentachlorophenol and copper naphthenate shall be light petroleum solvent conforming to the requirements therefor specified in current A. A. S. H. O. Designation M 133.

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DIVISION 9

Methods of Tests and Temperature-Volume Correction Factors

SECTION 1

Methods of Tests

Section 1 consists of certain methods of tests which have been adopted and are currently in use by the Department Laboratory.

9. 1. 1. Method of Test for Determination of Asphalt Content of Inverted Emulsified Cutback Asphalt.

Scope.

1. This method of test determines the asphalt content of inverted emulsified cutback asphalt.

The inverted emulsified cutback asphalt shall first be dehydrated and then distilled in accordance with current A. A. S. H. O. Designation T 78, "Standard Method of Test for Distillation of Cutback Asphaltic Products."

Apparatus.

2. Copper Beaker—one liter capacity—A. A. S. H. O. Designation T 78 Distillation Apparatus.

Procedure.

3. Weigh 200 grams of the material into a tared copper beaker of one liter capacity. Heat, with constant stirring, to a temperature of 350 degrees Fahrenheit. This temperature shall be attained within 20 to 30 minutes. Weigh the residue.

150 grams of the dehydrated material shall be weighed into a tared flask and distilled in accordance with method prescribed above. Weigh the residue in the 8-ounce tin box and also the emptied distillation flask. When the dehydration does not yield sufficient residue for 150 gram distillation charge, or when such residue foams excessively in the flask on distillation, an approximate charge of 125 grams may be used.

The asphalt content, per cent by weight, shall be calculated by the following formula:

$$\frac{A\,(B + C)}{2D}$$

Where A = Weight in grams of residue in copper beaker after open evaporation to 350 degrees Fahrenheit.
B = Weight in grams of residue in 8-ounce tin box.
C = Weight in grams of residue in distillation flask.
D = Weight in grams of residue from open evaporation taken for distillation test. This weight is normally 150 grams as specified above.

9. 1. 2. Method of Test for Unit Weight of Coarse Aggregate (Dry Loose Measure).

Scope.

1. This method of test determines the unit weight of coarse aggregate by dry loose measure in accordance with the current requirements of A. A. S. H. O. Designation T 19, with the following exceptions:

Apparatus.

2. *(a)* The one cubic foot measure shall have an inside diameter of 10.5 inches and an inside height of 20 inches.

(b) The 8-cubic foot mseaure shall be cubical with inside dimensions of 2 x 2 x 2 feet and so constructed as to retain its form under rough usage.

(c) A special tail gate fitted to a 1½-ton (nominal capacity) lift body truck. There shall be attached to the center of the tail gate a trunk and flexible boot with an over-all length of approximately 30 inches, constructed in a manner that, when the truck body is lifted, the sample will flow from the truck through the trunk and boot into the 8-cubic foot measure.

Procedure.

3. *(a)* The unit weight of coarse aggregate with a specified maximum size larger than 1¼ inches shall be determined in the 8-cubic foot measure.

(b) The 1-cubic foot measure shall be filled by allowing the material to slide from the end of the shovel when held at an elevation approximately two inches from the top of the measure. Succeeding shovels full shall be added from all sides of the measure to prevent segregation.

(c) When the 8-cubic foot measure is filled from a truck with the use of the special tail gate, trunk and flexible boot, the boot

shall be manipulated so that the material fills the measure, with a continuous flow preventing segregation due to piling or coning of the coarse aggregate.

9. 1. 3. Method of Test for Mortar-Making Properties of Fine Aggregates.

Scope.

1. This method of test is intended to determine the mortar-making properties of fine aggregate by tensile strength at the age of 7 and 28 days when compared to Standard Ottawa mortar.

Procedure.

2. *(a)* The Standard Ottawa mortar shall be prepared and tested in accordance with the current requirements of A. A. S. H. O. Designation T 132.

(b) The fine aggregate sample mortar shall be prepared and tested in accordance with 2 *(a)* above by replacing the Standard Ottawa sand with the same weight of fine aggregate sample and using sufficient mixing water to produce the same consistency as obtained with the Standard Ottawa mortar.

Report.

3. The strength of the fine aggregate sample shall be reported as a percentage of the Standard Ottawa mortar at ages of 7 and 28 days.

9. 1. 4. Method of Test to Determine Reflectance Value of Fine Aggregate for White Concrete or Mortar.

Scope.

1. This method of test covers a procedure for daylight 45-deg., 0-deg., luminous directional reflectance of fine aggregate for white concrete or mortar.

Apparatus.

2. The apparatus shall conform to the current requirements of A. S. T. M. Designation E-97.

The receptacle in which the sample of sand to be tested is placed for making this determination shall be a flat bottom dish or lid having a depth of at least ¼ inch and a diameter of 3 to 4 inches.

Procedure.

3. Fill the receptacle to overflowing with a representative sample of the fine aggregate.

Place a flat, clean, ⅛ inch glass plate, approximately 4 inches square, on the fine aggregate in the receptacle and rotate and press down at the same time, back and forth, until the surface of the fine aggregate is even with the top edge of the receptacle.

Standardize the reflectometer through the glass plate placed on top of the reflectance standard selected for use with the sample being tested. Then place the glass plate on top of the above prepared sample and determine the reflectance of the fine aggregate.

For each measurement, it is recommended that the available working standard closest in daylight 45-deg., 0-deg. directional reflectance to the sample be chosen.

Report.

4. Values of reflectance shall be reported to the nearest 1 per cent which shall be an average of at least three readings.

9. 1. 5. Method of Test for Unit Weight of Fine Aggregate (Dry Loose Measure).

Scope.

1. This method of test determines the unit weight of fine aggregate by dry loose measure in accordance with the current requirements of A. A. S. H. O. Designation T-19 with the following exceptions:

Apparatus.

2. *(a)* The 1-cubic foot measure shall have an inside diameter of 10.5 inches and an inside height of 20 inches.

(b) An inverted, truncated cone with bottom diameter of 1¼ inches, top diameter of 10 inches and height of 10¾ inches, supported so that the vertical axis of the cone and measure coincide with the small diameter of the cone 2 inches higher than the top of the measure.

Procedure.

3. The cubic foot measure shall be filled by allowing the material to run continuously and freely through the cone which has been stoppered until the cone is initially full and by maintaining the cone filled until the measure overflows.

9. 1. 6. Method of Test for Brittleness of Liquid Joint Filler.

Scope.

1. This method of test determines the Brittleness of liquid joint filler.

Apparatus.

2. *(a)* The apparatus used to form the specimen required for test is shown in Fig. 1. This forms a 1½-inch x 2½-inch specimen of the material for test on 26-gauge black iron.

(b) A 1-inch mandrel.

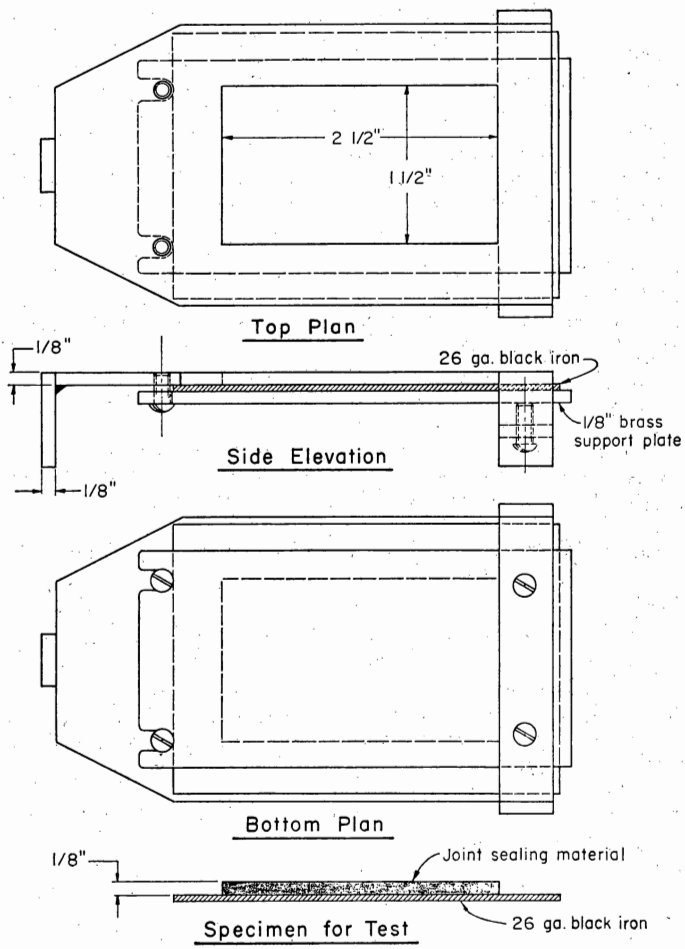


Fig. 1
PLAN OF APPARATUS FOR USE IN FORMING SPECIMEN

Preparation of Sample.

3. The sample of material to be tested shall be heated upon a hot plate to 300° F. and maintained at this temperature while being uniformly and homogeneously mixed throughout by stirring.

Procedure.

4. After being heated and mixed as specified above, the material shall be poured into the opening shown in Fig. 1 until the opening is slightly more than filled. After being poured, it shall be allowed to cool for a period of 30 minutes, after which the excess material shall be cut off with a broad putty knife, until the surface of the material is flush with the top of the mold. After being cut off, the material on the iron sheet shall be removed from the mold without disturbing the specimen in any way. The specimen on the iron sheet, and the mandrel, shall then be placed in a suitable container which shall be maintained at a temperature of 8° F. (± 1° F.) for a period of 2 hours. The specimen on the iron sheet shall then be bent over the mandrel in 3 seconds. When making the bend, the black iron sheet with the specimen resting upon it shall be placed and centered on the mandrel along the 1½-inch dimension. During the bending, the specimen shall be maintained at the temperature specified above.

Report.

5. Five specimens shall be poured for each sample tested. If the material shows any sign of a crack, it shall be considered as not complying with the requirements of the Specifications.

9. 1. 7. Method of Test for Deflection or Bend of Liquid Joint Filler.

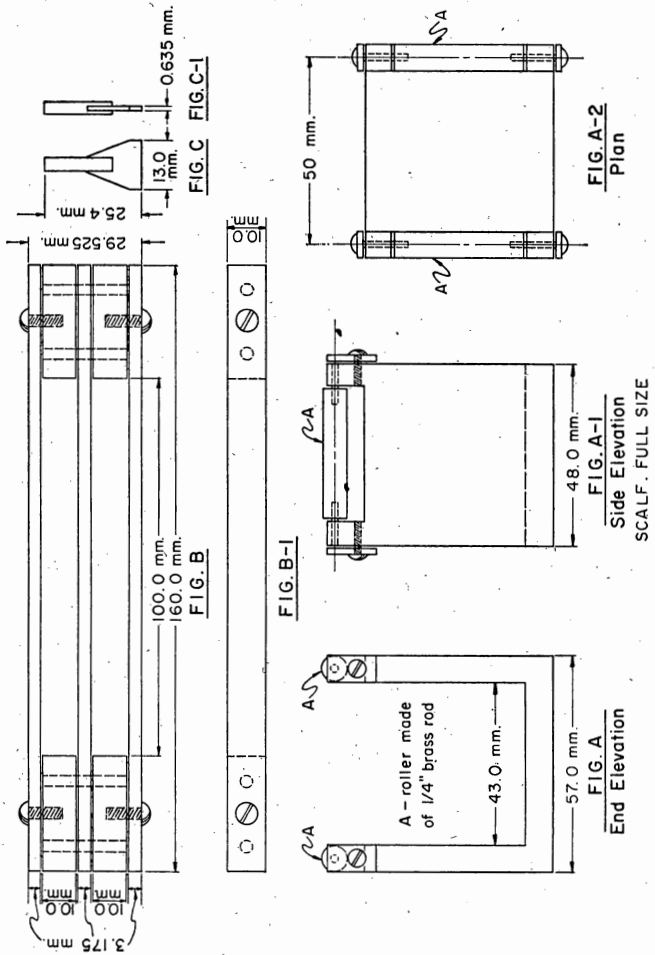
Scope.

1. This method of test determines the deflection or bend of liquid joint filler.

Deflection or bend is defined as the distance that a given size beam will be deflected or bent by a given load applied for a definite length of time at a given temperature. When the conditions of test are not specifically mentioned, the load, time, and temperature are understood to be 50 grams, 5 seconds, and 25° C. (77° F.), respectively, and the units of Deflection or Bend to indicate hundredths of a centimeter.

Apparatus.

2. *(a) Deflectometer.* Any apparatus which will allow the application of the load specified without appreciable friction, and which is accurately calibrated to yield results in accordance with the definition of Deflection or Bend, will be acceptable. The weight of the bearing head is included in the load specified.



(b) Mold. A brass mold that will form a sample of the material having a cross section of 1 cm. square by 10 cms. long shall be used. The mold shall be so designed and constructed that the sample can be removed easily therefrom without injury or distortion (See Figure B).

(c) Support. The support and all parts thereof, upon which rests the sample of material for test, shall be made of brass and have the shape and dimensions as shown on the drawing. The rollers shall work freely without moving back and forth, be parallel and 5 cms. from center to center (See Figure A).

(d) Bearing Head. The bearing head, through which the load is applied to the sample of material, shall be made of brass and be 13 mm. (approximately ½-inch) wide by 0.635 mm. (.025 inch or 24 gauge) thick (See Figure C).

(e) Water Bath. All tests shall be made with the sample fully submerged in water.

The water bath shall be made of sheet copper 5 inches wide by 5¼ inches long by 3½ inches deep. The support, as shown in Figure A on the attached drawing, shall rest on the bottom of the water bath, approximately in the center thereof.

Care shall be taken that the support rests firmly on the bottom of the water bath in such a manner that when the sample rests on the rollers thereof the specimen will be perpendicular to the bearing head.

The volume of water in the bath shall be such that the top of the sample will be submerged at least ½ inch below the level of the water. The water in this bath shall be maintained at a temperature of 25° C. (77° F.) while the test is being made.

Preparation of Sample.

3. The sample shall be completely melted at the lowest possible temperature and stirred thoroughly until it is homogeneous and free from air bubbles.

Procedure.

4. *(a)* After the sample has been prepared, as specified above, it shall be poured into the mold. The interior surfaces of the sides and ends of the mold shall be thoroughly amalgamated. The mold shall be assembled on a brass plate, the surface of which is thoroughly amalgamated. In filling, the material shall be poured in a thin stream back and forth from end to end of the mold until it is more than level full. It shall then be left to cool in the air at a temperature not lower than 15.5° C. (60° F.) for 1 hour, after which the sample and the mold shall be placed in ice water maintained at approximately 5° C. (41° F.) for a period of 15 minutes, after which time they shall be taken from the bath and the excess material cut off by means of a hot putty knife or spatula so that

the mold is level full. The sides of the mold then shall be taken off and the remaining portion of the mold and the sample contained therein shall be placed in a water bath for 1 hour and 15 minutes at a temperature of 25° C. (77° F.).

(b) After the mold containing the material for test has been in the water the specified length of time, the sample shall be removed from the mold without distortion, and the test then made on the material.

(c) The sample shall be placed in the center of the rolls of the support so that 2.5 cms. extend out over the side of each roller. The load specified shall then be so adjusted that the center of the bearing head makes contact with the surface of the sample in the center thereof. The outer edges of the bearing head shall be equidistant from the side of the sample. The recording hand of the dial shall be brought to zero. The load then shall be released for the specified period of time, after which the deflectometer shall be adjusted to measure the distance deflected.

Report.

5. Ten specimens shall be tested for each sample of material and the average result of these tests, whose values shall not differ from the average by more than 5, shall be reported as the Bend.

9. 1. 8. Method of Test for Flow of Liquid Joint Filler.

Scope.

1. This method of test determines the flow of liquid joint filler.

Apparatus.

2. The apparatus shall consist of the following:

(a) Flow Table. The flow table shall be as shown in Figure 1.

(b) Oven. Any type of oven may be used in which the flow table and thermometer can be placed as required, and the specified temperature maintained for the prescribed period.

(c) Mold. Any suitable mold, in which a sample can be formed of the size required and be removed therefrom without deformation, may be used.

(d) Thermometer. Any thermometer, which will indicate the temperature required and which can be read during the time of the test at the outside top of the oven, may be used. The scale error of the thermometer at any point, when standardized, shall not exceed 1° F.

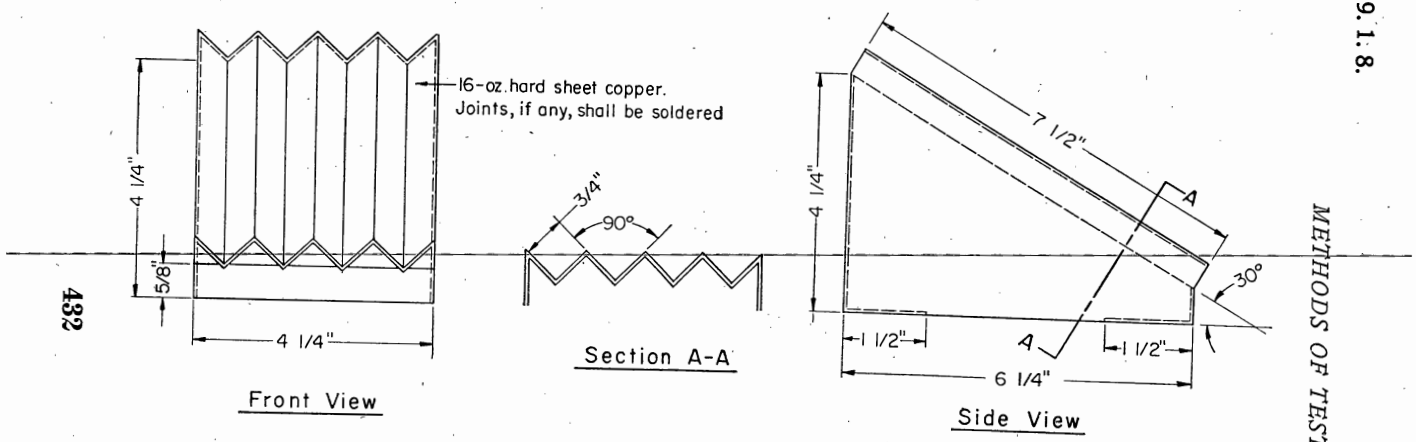


Fig. 1

FLOW TEST TABLE FOR LIQUID JOINT FILLERS

Preparation of Sample.

3. The sample of bituminous joint filler shall be heated on a hot plate to a temperature of 300° F. and uniformly and homogeneously mixed without overheating.

Procedure.

4. The filler shall then be poured into a mold of the proper design to form a specimen 2½ cms. long, 1 cm. wide, and 1 cm. deep. The mold shall be poured slightly more than full and allowed to cool for a period of 30 minutes. After this period, the excess material shall be cut off, with a slightly heated putty knife or other suitable instrument, even with the top of the mold, care being taken not to cause any depression in the surface. The specimen shall be removed from the mold and placed in a 90-degree groove of the flow table so that it fits squarely into the groove, with the lower face thereof even with the starting line which shall be 1½ inches from the top of the groove. The flow table shall be placed in the oven immediately and shall remain there for a period of 5 hours, with the temperature maintained at 125° F. ± 2° F. The thermometer shall be inserted through the top of the oven so that the bulb is at the same level in the oven as the specimen on the flow table. After the 5-hour period, the apparatus shall be removed and the increase in length of the specimen over its original length shall be recorded in terms of cms.

Report.

5. Two specimens of each sample shall be run at one time and the average of the increase in length, in cms., of the two specimens reported as the result.

9. 1. 9. Methods of Test for Lignin Binder.

Scope.

1. These methods of test are intended for the examination of lignin binder.

Specific Gravity.

2. The gravity is taken with a Baumé hydrometer at the temperature it is received, and for every 4 degrees difference between 60° F. and the temperature of the sample 0.1 degree Baume is added to the Baumé reading. Refer to a conversion table for the specific gravity reading.

Solubility in Cold Water.

3. Five grams of the sample are dissolved in cold water, filtered through a Gooch crucible. The residue in the Gooch crucible is washed with cold water and the crucible dried and weighed. The increase in weight of the Gooch crucible is matter insoluble in cold water.

Formula:

$$\frac{\text{Weight of sample—insoluble}}{5} \times 100 = \%\ \text{solubility}$$

Solubility in Hot Water.

4. This test is carried out the same as No. 3 with the exception that hot water is used instead of cold water.

Evaporation Loss at 100° C.

5. Two grams of the sample are weighed on a watch glass and dried in an oven at 105°-110° C. to constant weight.

Formula:

$$\frac{\text{Loss of weight of sample}}{2} \times 100 = \%\ \text{evaporation loss}$$

Ash Content.

6. Five grams of the sample are weighed in a porcelain dish, dried over a Bunsen burner, and ignited to constant weight in a muffle furnace.

Formula:

$$\frac{\text{Weight of ash}}{5} \times 100 = \%\ \text{ash}$$

Free Acids.

7. Five grams of the sample are dissolved in 250 ml. of water. Fifty ml. of this solution, representing a 1-gram sample, are diluted with water to 800 ml. and then titrated with a N/10 solution of sodium hydroxide using phenolphthalein indicator. One ml. of N/10 sodium hydroxide is equivalent to .0032 gram of SO_2.

Formula:

$$\text{Ml. N/10 sodium hydroxide} \times .0032 \times 100 = \%\ \text{free acids}$$

SO_2 Content as Sulphite.

8. Three grams of the sample, or 150 ml. of the solution as prepared under No. 6, are taken for this test. Dilute to 600 ml. with water, add an excess of N/10 iodine solution, add starch indicator and titrate back with N/10 sodium thiosulphate solution. Each ml. of N/10 iodine solution consumed represents .0032 gram of SO_2. From this result, which is the total SO_2 content in the sample, must be deducted the percentage of free acids determined under No. 7.

Formula:

$$\frac{\text{Ml. N/10 iodine consumed} \times .0032 \times 100}{3} = \%\ \text{total } SO_2$$

content.

% total SO_2 content minus % free acids = % SO_2 content as sulphite.

Ferric Oxide Content.

9. Dissolve the ash obtained under No. 6 in a small amount of diluted hydrochloric acid, then dilute with water. If the solution is not clear, filter. To the clear solution, add a slight excess of ammonium hydroxide, boil, filter, ignite and weigh.

Formula:

$$\frac{\text{Weight of ignited precipitate}}{5} \times 100 = \%\ \text{ferric oxide content.}$$

Calcium Oxide.

10. To the filtrate from the ferric oxide determination, add sufficient ammonium oxalate solution to precipitate the calcium oxide. After the precipitate has settled, filter and determine the calcium oxide content by dissolving the precipitate in dilute sulphuric acid, titrating with one-half normal potassium permanganate solution.

Formula:

$$\frac{\text{Ml. N/2 } KMnO_4 \times .01402}{5} \times 100 = \%\ CaO$$

Magnesium Oxide.

11. To the filtrate from the calcium oxide determination, add ammonium hydroxide and sodium ammonium phosphate solution in sufficient quantity to precipitate the magnesium oxide. After standing overnight, filter, ignite and weigh as $Mg_2P_2O_7$.

Formula:

$$\frac{\text{Weight of ignited precipitate} \times .362}{5} \times 100 = \%\ MgO$$

Totai Sulphur as SO_3.*

12. Weigh 1 gram of the sample in a porcelain crucible (25 ml. or larger), add 0.5 ml. of concentrated NaOH solution and

Reference:

* Sulphur Determination in Sulfite Waste Liquor and Organic Compounds. By R. N. Pollock & A. M. Partansky Industrial & Engineering Chemistry 9-15-34.

10 ml. of saturated $KMnO_4$ solution, and mix with a glass rod, washing the material on the glass rod into the crucible. Evaporate to dryness on the water bath or in the oven, ignite ½ hour in muffle furnace or over a burner at 500° C. (ignite thoroughly). The cooled melt is moistened with dilute $KMnO_4$ solution to oxidize any sulfides which may have formed, then add dilute HCl carefully. After CO^2 evolution more HCl is added (total of 5 ml. 12N or equivalent) and warmed on the steam bath until MnO_2 is converted to $MnCl_2$. Add hot water and filter. Wash thoroughly with hot water, dilute and precipitate with $BaCl^2$. Filter, ignite and weigh.

Formula:

Weight of $BaSO_4$ x .343 x 100 = % SO_3

9. 1. 10. Method of Test for Concrete Paint.

Scope.

1. This method of test is intended for a paint for application on exposed concrete surfaces.

General Requirements.

2. The mixing vehicle for this paint shall be a solution of potassium silicate having an approximate specific gravity of 1.18 and a molecular ratio of 1 part K_2O to 3.3 parts of SiO_2.

Detail Requirements.

3. *(a) Specific Gravity.*

HYDROMETER METHOD. The mixing vehicle is placed in a hydrometer cylinder and brought to a temperature of 60° F. The hydrometer is immersed in the vehicle and, when it comes to rest, a reading is taken on the graduated stem of the instrument. In case the hydrometer sinks slowly, give it sufficient time to come to a definite resting point. Check this point by raising the hydrometer and letting it sink a second time. The reading is then noted. Care should be taken that the hydrometer does not touch the sides or bottom of the cylinder when the reading is taken, also that the surface of the liquid is free from froth or bubbles.

(b) Alkali and Silica Content.

POTASSIUM OXIDE.

The potassium oxide is determined by titrating with 0.1 N acid and phenolphthalein indicator. Take an aliquot of 50 ml. corresponding to 1.000 gram, dilute to 500 ml. with water free from CO_2, and titrate until the pink color of the phenolphthalein just disappears. Calculate to K_2O.

1 ml. 0.1 N acid = .00856 gm. K_2O.

SILICA.

Ten grams of the sample are placed in a platinum dish, acidified with hydrochloric acid, and evaporated to dryness on a steam bath. The treatment is repeated with additional hydrochloric, and then the residue is taken up with 5 ml. of hydrochloric and 200 ml. of water. The residue is digested to dissolve the soluble salts, filtered, washed and ignited in a platinum crucible. Silica is determined by loss of weight by volatilization of the silica with hydrofluoric acid and sulfuric acid. Report the result as SiO_2.

9. 1. 11. Method of Test for Determining the Softening Point (Hercules Drop Method) of Resins.

Scope.

1. This method of test is intended to measure the softening point of a resin to the temperature at which it will soften under arbitrarily selected and carefully controlled conditions.

Apparatus.

2. *Test tubes.* These shall be 7 to 8 inches long and ⅞ inch (± 1/16 inch) outside diameter.

Thermometers. These shall have a bulb length of ⅝ inch (± 1/32 inch) and a bulb diameter of ¼ inch (± 1/64 inch).

Heating Bath. 800 or 1,000 ml. beaker filled to a depth of about 4 inches with glycerin, nujol or wesson oil.

Light-duty Laboratory Stirrer.

General.

3. The following method consists of determining the temperature at which a given weight of resin will begin to drop from the bulb of a standard thermometer contained in a test tube and immersed in a constant temperature bath.

It is desirable to have the temperature of the bath not less than 9° C. nor more than 14° C. above the softening point of the sample.

Procedure.

4. Place 15-25 grams of the sample in a 50 ml. beaker and heat on a hot plate until it becomes soft enough to mold on the thermometer bulb. *It is important that the sample be not heated hotter nor longer than necessary.*

Tare the thermometer to the nearest 0.01 gram and warm over a hot plate until it is heated to 15 or 20 C. degrees above the expected softening point of the sample. Dip the thermometer into the melted sample and rotate it in order to form a film of molten resin on the bulb. Quickly place on the balance and weigh. The weight of the sample on the thermometer bulb shall be between

0.50 and 0.55 gram. When the correct weight has been obtained, mold the sample uniformly over the bulb by rolling on the palm of the hand. *It is important that the sample be of uniform thickness over the bulb and that it not extend up on the thermometer stem.* If the film be not uniform when cooled, it shall be removed from the bulb and a new one applied. Do not reheat the film and try to remold. Allow the film and thermometer to cool approximately to room temperature. Usually 15 minutes are required.

Certain high softening point materials have relatively high coefficients of expansion and crack or "check" on the thermometer bulb upon cooling to room temperature. While this has been found to have little effect on the softening point, it is advisable to cool such samples down to only about 50° C. below the expected softening point.

Adjust the bath to within ± 1° C. of the temperature specified for the resin under test. Insert the thermometer in the test tube, supporting it with a notched cork stopper so that the lower end of the bulb is about 1 inch from the bottom of the tube. Then place it in the bath so that the bottom of the thermometer bulb is 2 inches above the bottom of the beaker and the top of the bulb about 1 or 1½ inches below the level of the liquid bath. Stir the bath in order to keep the temperature uniform throughout the bath and maintain the initial temperature.

Observe the thermometer carrying the sample inside the test tube, and record as the softening point its reading when the elongation drop on the end of the bulb first becomes constricted.

5. In the case of new resins or resins of unknown softening range, it is necessary to make a pilot determination as follows:

Prepare the sample and thermometer in the usual way. Adjust the bath 10° C. above the expected sotfening point and insert the test tube carrying the sample thermometer. Maintain the bath at this themperature.

Bath Temperature Too Low. If the sample thermometer rise to 10° C. below the bath temperature before the softening point is reached, start heating the bath maintaining a differential of 10° C. between the sample thermometer and the bath thermometer until the softening point is reached. Record this value as a pilot determination, readjust the bath temperature 14° C. above this point and repeat the determination.

EXAMPLE. If a softening point of 132° C. be obtained on the pilot determination, a bath temperature of 145° C. shall be selected (132 + 14 = 146 or 145 which is the nearest multiple of 5). Usually the softening point thus obtained will fall within 9° to 14° C. below the bath temperature selected in this way.

Bath Temperature Too High. Should the bath temperature in the pilot determination be more than 14° C. above the pilot softening

point, readjust it 9° C. above the pilot value and repeat the determination.

EXAMPLE. If a softening point of 123° C. be obtained with a bath set at 140° C. in the pilot determination, the bath temperature shall be readjusted to 130° C. (123 + 9 = 132 or 130 which is the nearest figure which ends in 0° or 5°). The bath temperature thus selected is usually within the desired range.

Selected Bath Temperature Too High or Too Low. Should the bath temperature selected in either of the above cases not be within the range of 9° to 14° C. of the softening point found, it shall again be adjusted and the determination repeated.

As a general rule, the final bath temperature should be on the high side, that is, preferably nearer to 14° C. above. The bath temperature should be a multiple of 5°, that is, it should end in either 0 or 5.

Control Tests on New Resins. For control tests on a new resin adjust the bath temperature about 15° C. above the desired softening point (which is usually a minimum specification) and hold it at this temperature for all control samples. If this temperature be not within the range of 9° to 14° C. above the softening point obtained on the final sample, readjust as described above and retest the final sample.

Prior to establishing a softening point specification on a new resin, several (10-20) representative batches shall be run at different bath temperatures to insure proper standardization of the bath temperature.

Note: When once decided upon and approved, it is important that the bath temperature selected for a particular resin be strictly adhered to for all subsequent tests on this resin unless special permission for deviation is obtained, otherwise the results will not be directly comparable.

9. 1. 12. Method of Test for Determination of Chlorine in Chlorinated Rubber.

Scope.

1. This method of test covers the procedure based on the insolubility of silver chloride in dilute nitric acid solution.

Reagents.

2. Anhydrous sodium carbonate, reagent.
Calcium oxide, reagent.
Silver nitrate (5% solution).
Dilute nitric acid (1:1).

Procedure.

3. 0.1 gram substance is weighed into a small porcelain crucible and the remainder of the vessel is completely filled

with a mixture of 1 part anhydrous sodium carbonate and 4 parts of calcium oxide. The crucible is placed in an inverted position in a larger crucible, which is then filled with the same mixture, so that the smaller crucible is completely covered.

Heat in a large bunsen flame to redness, and the mixture is treated with water when cold. Make acid with nitric acid, care being taken that the temperature does not rise to any great extent. Filter the cold solution, add silver nitrate solution (5 per cent), and warm the mixture. Let settle, filter the silver halide on a weighed gooch, wash with distilled water containing one ml. of nitric acid per 100 ml. of distilled water. Dry in oven at 105° C. Heat over a flame until the edge of the precipitate begins to turn brown. Cool in a desiccator. Weigh as silver chloride. Calculate the per cent of chlorine from the weight of sample taken.

$$\text{Ag Cl} \times 0.2474 = \text{Cl}$$

Report.

4. Report the results of the test as percentage chlorine based on the weight of the sample taken.

9. 1. 13. Method of Test for Determining Water Resistance of Traffic Paint.

Scope.

1. This method of test is intended for determining the water resistance of traffic paint.

Apparatus.

2. Glass panels 4" x 8".
Suitable solvent.

Procedure.

3. The glass panels used in this test shall be thoroughly cleaned with a suitable solvent to remove the presence of any grease, then with hot soapy water, rinsed with clear warm water, and allowed to dry before the paint is applied.

The paint shall be applied to the panels to a wet film thickness of .015 inch. Allow the paint film to dry in a horizontal position at room temperature (70°-80°) for 72 hours, protecting it against the accumulation of dust, then immerse the paint film on the glass panels in distilled water at room temperature for 18 hours. Allow to air-dry for two hours and then examine.

The paint shall show no softening nor blistering, when examined after the removal of the panel from the distilled water.

9. 1. 14. Methods of Tests for Glass Beads.

Scope.

1. These methods cover procedures for testing glass beads for their suitability for reflectorizing traffic paint.

Sampling.

2. Bags selected at random are split by a sample splitter to about 3 lbs. (one quart). The number of bags selected shall be the nearest cube root of the number of bags in the lot or shipment. Each sample shall again be split to such a size that a combined sample of approximately one quart shall be obtained for the tests.

For determining the per cent spheres, grading, and daylight 45°—0° reflectance, the combined sample is split to such amounts as required for the particular tests.

Spherical Particles.

3. *(a) General.* The spherical particles are separated by rolling the beads down an 11″ x 14″ glass plate which is supported on a wooden platform, the supporting surface of which is inclined at an angle to the horizontal. The wooden platform has a 10″ x 10″ square base and one of the vertical sides is ⅜″ higher than the opposite side. This gives the top of the platform a slope of approximately 2° (2° 9′) to the horizontal.

The spherical particles roll into a pan at the bottom of the incline. Irregular beads remaining on the glass plate are brushed off the side of the glass plate into a separate pan.

The test shall be made in a room having a temperature of 75° F. (± 2° F.) and a relative humidity of 50 ± 4%.

(b) Procedure. A sample weighing 80-100 grams is dried overnight at 105° C. When dry, the beads are separated into different sizes by sieving through 30, 40, 50 and 80-mesh sieves.

Roll the beads retained on the 30, 40 and 50-mesh sieves down the 11″ face of the glass plate inclined at an angle of approximately 2° (platform as is). The beads are dropped on the glass plate at its upper end from a height of one inch at such a rate that they will not "bunch up." While the beads are being dropped on the glass plate, the glass plate is tapped with the tip of the wooden handle of a 2″ bristle brush. The spheres roll down the incline into a pan and the irregular beads remaining on the plate are brushed off the edge into another pan. When all the spherical beads of any one size have rolled into the pan at the bottom of the incline, rerun the spherical particles twice again down the glass plate as before. Weigh the spheres.

Beads retained on the 80-mesh sieve and those passing the 80-mesh sieve are separated into spheres and irregulars in the same manner described above, except that the back of the platform

is raised by one ¼" shim so that the glass plate is inclined at approximately 3½° from the horizontal for the beads retained on the 80-mesh sieve, and the back of the platform is raised by three ¼" shims so that the glass plate is inclined at approximately 6½° from the horizontal for beads passing the 80-mesh sieve.

$$\frac{\text{Total weight of spheres}}{\text{Weight of sample}} \times 100 = \% \text{ spheres}$$

Daylight 45°—0° Reflectance.

4. Fill a one-quart friction top lid to overflowing with glass beads. Place a 4" x 4" glass plate on the beads in the lid and press down evenly.

Standardize a 45°—0° reflectometer through a 4" x 4" glass plate against a reflectance standard. Place the glass plate, through which the reflectometer has been standardized, on the sample of glass beads contained in the friction top lid and determine the reflectance of the beads.

Index of Refraction.

5. *(a) General.*

All transparent or translucent objects when immersed in liquids yield images in the microscope, which are bounded by dark shadow outlines or halos.

As the index of refraction of the solid approaches closer and closer to that of the liquid the dark shadow outlines decrease in prominence, and just disappear when both object and liquid have the same refractive index.

(b) Procedure.

LIQUID IMMERSION METHOD AT 25° C.

The crushed particles of glass beads are placed on a clean glass slide and covered with a small fragment of cover glass. (Small pieces of cover glass are advantageous because less sample and liquid need be used, and the crystals are more easily found.) A drop of liquid of known refractive index is introduced, and the specimen examined under the microscope.

When the solid possesses a higher index than that of the liquid, the contours are usually dark and well defined with a halo or band of light within the black bands; as the microscope tube is raised this band of light will appear to move inward, i.e., toward the center of the solid. If, on the other hand, the solid possesses a lower index of refraction, the black contours are relatively weak, with the bright halo outside the black bands, and upon raising the objectives the band of light or bright halo appears to move outward or away from the center.

Given a series of liquids of known refractive index, if a solid of unknown index be immersed in these, one after another, until the black contours bounding the image just disappears, the index of this particular liquid is the index sought of this solid.

Grading.

6. Approximately 100 grams of glass beads are separated by mechanical sieving into a series of U. S. standard sieves and the following determinations made: Per cent Passing 16, 20, 30, 50 and 100-mesh sieve, and Per cent Retained on 16, 20, 30, 50 and 100-mesh sieve.

Chemical Stability.

7. Samples of beads when subjected to each of the following tests shall show no tendency toward decomposition or surface etching:

(a) Resistance to Hot Water Attack. 25 grams of beads are run with 250 ml. of distilled water and subjected to 90 hours continuous running in a Soxhlet Extraction Apparatus.

(b) Resistance to Attack Comparable to that of Normal Soil Acidity (pH 5 to pH 6). 25 grams of beads are soaked for 90 hours in 500 ml. of buffered solution (pH 5 to pH 6) at room temperature. The solution is then decanted and the beads rinsed with 100 ml. of distilled water.

(c) Resistance to Lime Water Attack (encountered on portland cement concrete highways). 25 grams of beads are boiled for two hours in 1,000 ml. of saturated lime water solution. Solution is then decanted and beads are rinsed with 100 ml. of distilled water.

(d) Resistance to Attack by Salt Solution (encountered in winter with treated sands, etc.). 25 grams of beads are boiled for three hours in 500 ml. of a 1.0 normal solution of calcium chloride. Solution is then decanted and beads are rinsed with 100 ml. of distilled water.

9. 1. 15. Method of Test for Peat.

Scope.

1. This method of test consists of determining the pH (hydrogen-ion concentration) by means of the Beckman pH meter, and the organic content of peat by the Ignition Loss method, to determine its fitness for agricultural purposes.

Determination of pH (Hydrogen-ion Concentration).

2. Weigh 20 grams of peat into a 250-ml. beaker. Add sufficient distilled water to make a slurry and stir the suspension several times at regular intervals for about one hour.

Using a Beckman pH meter, measure the pH of the peat suspension by immersing both the glass electrode and calomel electrode attachments deep into the thoroughly stirred suspension.

The pH is obtained by pressing the button on the center of the knob, and turning the knob until the meter needle indicates the pH of the suspension on the dial, which is calibrated in pH units over a range of 0 to 13.

Determination of Moisture Content.

3. Weigh 250 grams of peat in a tared dish, and dry in an oven at 105° to 110° C. to constant weight.

Loss of weight of sample X 100 = % moisture

Determination of Organic Content.

4. Weigh one gram of the oven dried peat into a porcelain crucible and ignite to constant weight.

Loss of weight of sample X 100 = % organic content.

9. 1. 16. Method of Test for Rate of Water Infiltration for Porous Concrete Pipe.

Scope.

1. This method of test is intended to measure the rate of free infiltration of water into porous concrete pipe.

Apparatus.

2. *(a)* A stop watch or similar timing device with minimum reading of one second, and accuracy of one second in sixty.

(b) A calibrated measuring tank of at least 20 gallons capacity to receive and measure the amount of infiltrated water; or a metering device capable of measuring water with a head pressure of not more than 5 feet and a rate of flow from 8 to 100 gallons per minute with an accuracy of ± 1%.

(c) A suitable tank or container of sufficient size to accommodate a specimen of pipe not less than 12 inches long and of full circular section. The tank or container shall be watertight. This apparatus shall accommodate the pipe specimen to be tested so that the specimen shall be exposed to unobstructed and uninterrupted water infiltration during the full testing procedure. One end of the specimen shall have a watertight closure and the other end shall be fitted with a device for drawing off the infiltrated water at a rate of not less than the specified rate for the nominal diameter and length of the test section. This draw-off device may be a weir or valve capable of quick opening and closing and adjustable to the rate of infiltration of the specimen under test.

Procedure.

3. *(a)* The pipe specimen to be tested shall be free from obvious defects and shall be selected as being representative of not more than 2000 linear feet laying length of pipe of the same type and size.

(b) The specimen may be tested full size, or a section at least twelve inches long may be cut from the barrel of the pipe providing the ends are plane, parallel and capable of being made watertight when mounted in the testing apparatus.

(c) The test specimen shall be placed in the calibrated tank with one end stopped against the entrance of water and the other end making a watertight seal against the draw-off device.

(d) Water shall be run into the apparatus until the specimen is filled by infiltration and sufficient additional water shall be added above the specimen to more than equal the amount of infiltration at the specified rate for the particular specimen being tested for an infiltration period of not less than 15 seconds.

(e) The rate of infiltration shall be determined by measuring the runoff of water from the barrel of the specimen, or by measuring the depletion of the water in the apparatus above the specimen during a period of not less than 15 seconds.

Report.

4. The rate of infiltration shall be reported in gallons per minute.

9. 1. 17. Method of Test for Shale, Schist, Slate and Soft and Decomposed Particles in Soil Aggregate.

Scope.

1. This method of test covers the procedure for the determination of the percentage of shale, schist, slate and soft and decomposed particles in soil aggregates.

Apparatus.

2. The apparatus shall be in accordance with the current requirements of A. A. S. H. O. Designation T-27 with the following additions:

(a) Drying Oven. The drying oven shall be of the forced convection type capable of maintaining a temperature of 105 ± 5° C.

(b) Brass Rod. The brass rod shall be in accordance with the current requirements of A. S. T. M. Designation C-235.

(c) Reading Glass. The reading glass shall be 4X, mounted on a suitable stand.

Samples.

3. Sample for test shall weigh, after drying, not less than 2500 grams nor more than 3500 grams obtained by use of a sample splitter or the quartering method.

Procedure.

4. *(a) Gradation.* The sample shall be separated by use of 2", ¾", #4 and #200 sieves and the particle size distribution determined in accordance with current requirements of A. A. S. H. O. Designation T-27.

(b) Determination of Shale, Schist, Slate, and Soft and Decomposed Particles. The portions of the sample passing the 2" sieve and retained on the ¾" sieve, and passing the ¾" sieve and retained on the #4 sieve shall be examined for shale, schist, slate, and soft and decomposed particles by:

(1) The scratch-hardness test in accordance with current requirements of A. S. T. M. Designation C-235.

(2) Lithological examination, or

(3) A combination of *(1)* and *(2)*.

(c) Separation and Weighing. Particles determined to be shale, schist, slate, and soft and decomposed particles in accordance with 4 *(b)* shall be separated from their respective sample fractions and weighed.

Calculation and Report.

5. The report shall include the following:

(a) The per cent of particle distribution from Item 4 *(a)* for the entire sample.

(b) Percentage of shale, schist, slate, and soft and decomposed particles for each size larger than the #4 sieve as determined by the above procedure.

(c) Total weighted per cent of shale, schist, slate, and soft and decomposed particles for the entire sample. For the purpose of calculating the test results, the material finer than #4 sieve shall be considered to contain the same percentage of shale, schist, slate, and soft and decomposed particles as the next larger size.

9. 1. 18. Methods of Tests for Determining the Breakup in Sizes of Soil Aggregates.

Scope.

1. These tests ascertain the amount a soil aggregate breaks up into finer sizes (1) by compaction, (2) by alternate freezing and thawing, and (3) by alternate wetting and drying.

Apparatus.

2. Six split cylinder molds of 6 inches inside diameter and 12 inches high with detachable base plates.

Preparation of Sample.

3. *(a)* A sample of approximately 180 pounds is air-dried and thoroughly mixed.

(b) A mechanical and hydrometer analysis is run on 2 samples of approximately 12 pounds each, obtained from the above sample by quartering.

(c) The density at optimum moisture content is obtained from another representative portion of the sample according to the "Moisture-Density Relations of Soils, Method C, of current A. S. T. M. Designation D 698."

(d) From the remaining sample, material at optimum moisture content is compacted in the 6 cylinders by use of the Universal Testing Machine to the density obtained at optimum moisture content in *(c)* above.

(e) The 6 cylinders are placed on suitable carriers in the moist room for a period of 7 days, care being taken to protect them from free water.

Procedure.

By Compaction Test:

4. Perform a mechanical analysis, including hydrometer analysis on the material compacted in 3 *(c)* above.

By Freezing and Thawing Test:

5. *(a)* Three cylinders are removed from the moist room, water saturated felt pads, blotters or similar absorptive materials are placed between them and the carriers, and the assemblies are placed in a refrigerator having a constant temperature not warmer than minus 23° C. (minus 10° F.) for a period of 22 hours.

(b) The assemblies are returned to the moist room for a period of 22 hours during which time free water is made available to the absorbent pads under the samples to permit capillary absorption to take place.

(c) The above procedure is repeated eleven times for a total of 12 cycles.

(d) A mechanical analysis, including hydrometer analysis, is performed on the material in the 3 cylinders.

By Wetting and Drying Test:

6. *(a)* Three cylinders are removed from the moist room and submerged in tap water for a period of 5 hours.

(b) The cylinders are removed and placed in an oven having a constant temperature of approximately 71° C. (160° F.) for a period of 42 hours.

(c) The above procedure is repeated eleven (11) times for a total of twelve (12) cycles.

(d) A mechanical analysis, including hydrometer analysis, is performed on the material in the three (3) cylinders.

Report.

7. *(a)* The results of the following are reported in per cent passing each sieve specified for the grading of the particular type and class of soil aggregate under consideration.

(1) The average of the 2 control samples in 3 *(b)*.

(2) The sample in 4.

(3) The sample in 5 *(d)*.

(4) The sample in 6 *(d)*.

(b) The maximum density at optimum moisture obtained in 3 *(c)*.

SECTION 2

Temperature - Volume Correction Factors

9. 2. 1. Temperature—Volume Correction Factors.

This article includes Tables 37 to 42 showing the temperature-volume correction factors which shall be used to convert the volume of asphalt and tar products and lignin binder at the temperature when measured after delivery to the Project, to the volume at 60° F.

Table 37.—Temperature-Volume Correction Factors for Asphalt Products

For the following materials:

Asphalt Cement, All Grades.
Asphaltic Oil, Grades RC-3, RC-4, RC-5, MC-3, MC-4, MC-5.
Inverted Emulsified Cut-back Asphalt,
Grades IE-RC-3, IE-RC-4, IE-RC-5,
IE-MC-3, IE-MC-4, IE-MC-5.
Joint Fillers, All Grades

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
40	1.0070	70	0.9965	100	0.9861	130	0.9758
41	1.0067	71	0.9962	101	0.9857	131	0.9754
42	1.0063	72	0.9958	102	0.9854	132	0.9751
43	1.0060	73	0.9955	103	0.9851	133	0.9747
44	1.0056	74	0.9951	104	0.9847	134	0.9744
45	1.0053	75	0.9948	105	0.9844	135	0.9740
46	1.0049	76	0.9944	106	0.9840	136	0.9737
47	1.0046	77	0.9941	107	0.9837	137	0.9734
48	1.0042	78	0.9937	108	0.9833	138	0.9730
49	1.0038	79	0.9934	109	0.9830	139	0.9727
50	1.0035	80	0.9930	110	0.9826	140	0.9723
51	1.0031	81	0.9927	111	0.9823	141	0.9720
52	1.0028	82	0.9923	112	0.9819	142	0.9716
53	1.0024	83	0.9920	113	0.9816	143	0.9713
54	1.0021	84	0.9916	114	0.9813	144	0.9710
55	1.0017	85	0.9913	115	0.9809	145	0.9706
56	1.0014	86	0.9909	116	0.9806	146	0.9703
57	1.0010	87	0.9906	117	0.9802	147	0.9699
58	1.0007	88	0.9902	118	0.9799	148	0.9696
59	1.0003	89	0.9899	119	0.9795	149	0.9693
60	1.0000	90	0.9896	120	0.9792	150	0.9689
61	0.9997	91	0.9892	121	0.9788	151	0.9686
62	0.9993	92	0.9889	122	0.9785	152	0.9682
63	0.9990	93	0.9885	123	0.9782	153	0.9679
64	0.9986	94	0.9882	124	0.9778	154	0.9675
65	0.9983	95	0.9878	125	0.9775	155	0.9672
66	0.9979	96	0.9875	126	0.9771	156	0.9669
67	0.9976	97	0.9871	127	0.9768	157	0.9665
68	0.9972	98	0.9868	128	0.9764	158	0.9662
69	0.9969	99	0.9864	129	0.9761	159	0.9658

Table 37.—Continued

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
160	0.9655	200	0.9520	240	0.9385	280	0.9253
161	0.9652	201	0.9516	241	0.9382	281	0.9250
162	0.9648	202	0.9513	242	0.9379	282	0.9246
163	0.9645	203	0.9509	243	0.9375	283	0.9243
164	0.9641	204	0.9506	244	0.9372	284	0.9240
165	0.9638	205	0.9503	245	0.9369	285	0.9236
166	0.9635	206	0.9499	246	0.9365	286	0.9233
167	0.9631	207	0.9496	247	0.9362	287	0.9230
168	0.9628	208	0.9493	248	0.9359	288	0.9227
169	0.9624	209	0.9489	249	0.9356	289	0.9223
170	0.9621	210	0.9486	250	0.9352	290	0.9220
171	0.9618	211	0.9483	251	0.9349	291	0.9217
172	0.9614	212	0.9479	252	0.9346	292	0.9213
173	0.9611	213	0.9476	253	0.9342	293	0.9210
174	0.9607	214	0.9472	254	0.9339	294	0.9207
175	0.9604	215	0.9469	255	0.9336	295	0.9204
176	0.9601	216	0.9466	256	0.9332	296	0.9200
177	0.9597	217	0.9462	257	0.9329	297	0.9197
178	0.9594	218	0.9459	258	0.9326	298	0.9194
179	0.9590	219	0.9456	259	0.9322	299	0.9190
180	0.9587	220	0.9452	260	0.9319	300	0.9187
181	0.9584	221	0.9449	261	0.9316	301	0.9184
182	0.9580	222	0.9446	262	0.9312	302	0.9181
183	0.9577	223	0.9442	263	0.9309	303	0.9177
184	0.9574	224	0.9439	264	0.9306	304	0.9174
185	0.9570	225	0.9436	265	0.9302	305	0.9171
186	0.9567	226	0.9432	266	0.9299	306	0.9167
187	0.9563	227	0.9429	267	0.9296	307	0.9164
188	0.9560	228	0.9426	268	0.9293	308	0.9161
189	0.9557	229	0.9422	269	0.9289	309	0.9158
190	0.9553	230	0.9419	270	0.9286	310	0.9154
191	0.9550	231	0.9416	271	0.9283	311	0.9151
192	0.9547	232	0.9412	272	0.9279	312	0.9148
193	0.9543	233	0.9409	273	0.9276	313	0.9145
194	0.9540	234	0.9405	274	0.9273	314	0.9141
195	0.9536	235	0.9402	275	0.9269	315	0.9138
196	0.9533	236	0.9399	276	0.9266	316	0.9135
197	0.9530	237	0.9395	277	0.9263	317	0.9132
198	0.9526	238	0.9392	278	0.9259	318	0.9128
199	0.9523	239	0.9389	279	0.9256	319	0.9125

Table 37.—Continued

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
320	0.9122	345	0.9040	370	0.8960	395	0.8880
321	0.9118	346	0.9037	371	0.8957	396	0.8876
322	0.9115	347	0.9034	372	0.8953	397	0.8873
323	0.9112	348	0.9031	373	0.8950	398	0.8870
324	0.9109	349	0.9028	374	0.8947	399	0.8867
325	0.9105	350	0.9024	375	0.8944	400	0.8864
326	0.9102	351	0.9021	376	0.8941		
327	0.9099	352	0.9018	377	0.8937		
328	0.9096	353	0.9015	378	0.8934		
329	0.9092	354	0.9011	379	0.8931		
330	0.9089	355	0.9008	380	0.8928		
331	0.9086	356	0.9005	381	0.8924		
332	0.9083	357	0.9002	382	0.8921		
333	0.9079	358	0.8998	383	0.8918		
334	0.9076	359	0.8995	384	0.8915		
335	0.9073	360	0.8992	385	0.8912		
336	0.9070	361	0.8989	386	0.8908		
337	0.9066	362	0.8986	387	0.8905		
338	0.9063	363	0.8982	388	0.8902		
339	0.9060	364	0.8979	389	0.8899		
340	0.9057	365	0.8976	390	0.8896		
341	0.9053	366	0.8973	391	0.8892		
342	0.9050	367	0.8969	392	0.8889		
343	0.9047	368	0.8966	393	0.8886		
344	0.9044	369	0.8963	394	0.8883		

Table 38.—Temperature-Volume Correction Factors for Asphalt Products

For the following materials:

Asphaltic Oils, Grades RC-0, RC-1, RC-2, MC-0, MC-1, MC-2, SCO.

Inverted Emulsified Cut-back Asphalt, Grades IE-RC-0, IE-RC-1, IE-RC-2, IE-MC-0, IE-MC-1, IE-MC-2.

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
40	1.0080	70	0.9960	100	0.9842	130	0.9725
41	1.0076	71	0.9956	101	0.9838	131	0.9721
42	1.0072	72	0.9952	102	0.9834	132	0.9717
43	1.0068	73	0.9948	103	0.9830	133	0.9713
44	1.0064	74	0.9944	104	0.9826	134	0.9709
45	1.0060	75	0.9940	105	0.9822	135	0.9705
46	1.0056	76	0.9936	106	0.9818	136	0.9701
47	1.0052	77	0.9932	107	0.9814	137	0.9697
48	1.0048	78	0.9929	108	0.9810	138	0.9693
49	1.0044	79	0.9925	109	0.9806	139	0.9690
50	1.0040	80	0.9921	110	0.9803	140	0.9686
51	1.0036	81	0.9917	111	0.9799	141	0.9682
52	1.0032	82	0.9913	112	0.9795	142	0.9678
53	1.0028	83	0.9909	113	0.9791	143	0.9674
54	1.0024	84	0.9905	114	0.9787	144	0.9670
55	1.0020	85	0.9901	115	0.9783	145	0.9666
56	1.0016	86	0.9897	116	0.9779	146	0.9662
57	1.0012	87	0.9893	117	0.9775	147	0.9659
58	1.0008	88	0.9889	118	0.9771	148	0.9655
59	1.0004	89	0.9885	119	0.9767	149	0.9651
60	1.0000	90	0.9881	120	0.9763	150	0.9647
61	0.9996	91	0.9877	121	0.9760	151	0.9643
62	0.9992	92	0.9873	122	0.9756	152	0.9639
63	0.9988	93	0.9869	123	0.9752	153	0.9635
64	0.9984	94	0.9865	124	0.9748	154	0.9632
65	0.9980	95	0.9861	125	0.9744	155	0.9628
66	0.9976	96	0.9857	126	0.9740	156	0.9624
67	0.9972	97	0.9854	127	0.9736	157	0.9620
68	0.9968	98	0.9850	128	0.9732	158	0.9616
69	0.9964	99	0.9846	129	0.9728	159	0.9612

Table 38.—Continued

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
160	0.9609	200	0.9456	240	0.9305	280	0.9157
161	0.9605	201	0.9452	241	0.9301	281	0.9153
162	0.9601	202	0.9448	242	0.9298	282	0.9149
163	0.9597	203	0.9444	243	0.9294	283	0.9146
164	0.9593	204	0.9441	244	0.9290	284	0.9142
165	0.9589	205	0.9437	245	0.9286	285	0.9138
166	0.9585	206	0.9433	246	0.9283	286	0.9135
167	0.9582	207	0.9429	247	0.9279	287	0.9131
168	0.9578	208	0.9425	248	0.9275	288	0.9127
169	0.9574	209	0.9422	249	0.9272	289	0.9124
170	0.9570	210	0.9418	250	0.9268	290	0.9120
171	0.9566	211	0.9414	251	0.9264	291	0.9116
172	0.9562	212	0.9410	252	0.9260	292	0.9113
173	0.9559	213	0.9407	253	0.9257	293	0.9109
174	0.9555	214	0.9403	254	0.9253	294	0.9105
175	0.9551	215	0.9399	255	0.9249	295	0.9102
176	0.9547	216	0.9395	256	0.9245	296	0.9098
177	0.9543	217	0.9391	257	0.9242	297	0.9094
178	0.9539	218	0.9388	258	0.9238	298	0.9091
179	0.9536	219	0.9384	259	0.9234	299	0.9087
180	0.9532	220	0.9380	260	0.9231	300	0.9083
181	0.9528	221	0.9376	261	0.9227	301	0.9080
182	0.9524	222	0.9373	262	0.9223	302	0.9076
183	0.9520	223	0.9369	263	0.9219	303	0.9072
184	0.9517	224	0.9365	264	0.9216	304	0.9069
185	0.9513	225	0.9361	265	0.9212	305	0.9065
186	0.9509	226	0.9358	266	0.9208	306	0.9061
187	0.9505	227	0.9354	267	0.9205	307	0.9058
188	0.9501	228	0.9350	268	0.9201	308	0.9054
189	0.9498	229	0.9346	269	0.9197	309	0.9050
190	0.9494	230	0.9343	270	0.9194	310	0.9047
191	0.9490	231	0.9339	271	0.9190	311	0.9043
192	0.9486	232	0.9335	272	0.9186	312	0.9039
193	0.9482	233	0.9331	273	0.9182	313	0.9036
194	0.9478	234	0.9328	274	0.9179	314	0.9032
195	0.9475	235	0.9324	275	0.9175	315	0.9029
196	0.9471	236	0.9320	276	0.9171	316	0.9025
197	0.9467	237	0.9316	277	0.9168	317	0.9021
198	0.9463	238	0.9313	278	0.9164	318	0.9018
199	0.9460	239	0.9309	279	0.9160	319	0.9014

Table 38.—Continued

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
320	0.9010	345	0.8920	370	0.8831	395	0.8742
321	0.9007	346	0.8916	371	0.8827	396	0.8738
322	0.9003	347	0.8913	372	0.8823	397	0.8735
323	0.9000	348	0.8909	373	0.8820	398	0.8731
324	0.8996	349	0.8906	374	0.8816	399	0.8728
325	0.8992	350	0.8902	375	0.8813	400	0.8724
326	0.8989	351	0.8899	376	0.8809		
327	0.8985	352	0.8895	377	0.8806		
328	0.8981	353	0.8891	378	0.8802		
329	0.8978	354	0.8888	379	0.8799		
330	0.8974	355	0.8884	380	0.8795		
331	0.8971	356	0.8881	381	0.8792		
332	0.8967	357	0.8877	382	0.8788		
333	0.8963	358	0.8873	383	0.8784		
334	0.8960	359	0.8870	384	0.8781		
335	0.8956	360	0.8866	385	0.8777		
336	0.8952	361	0.8863	386	0.8774		
337	0.8949	362	0.8859	387	0.8770		
338	0.8945	363	0.8856	388	0.8767		
339	0.8942	364	0.8852	389	0.8763		
340	0.8938	365	0.8848	390	0.8760		
341	0.8934	366	0.8845	391	0.8756		
342	0.8931	367	0.8841	392	0.8753		
343	0.8927	368	0.8838	393	0.8749		
344	0.8924	369	0.8834	394	0.8746		

Table 39.—Temperature-Volume Correction Factors for Tar Products

For the following Grades:

RT-5, RT-6, RT-7, RT-8, RT-9, RT-10, RT-11, RT-12, RTCB-5, RTCB-6.

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
40	1.0060	75	0.9955	110	0.9852	145	0.9751
41	1.0057	76	0.9952	111	0.9849	146	0.9748
42	1.0054	77	0.9949	112	0.9846	147	0.9746
43	1.0051	78	0.9946	113	0.9843	148	0.9743
44	1.0048	79	0.9943	114	0.9841	149	0.9740
45	1.0045	80	0.9940	115	0.9838	150	0.9737
46	1.0042	81	0.9937	116	0.9835	151	0.9734
47	1.0039	82	0.9934	117	0.9832	152	0.9731
48	1.0036	83	0.9931	118	0.9829	153	0.9729
49	1.0033	84	0.9929	119	0.9826	154	0.9726
50	1.0030	85	0.9926	120	0.9823	155	0.9723
51	1.0027	86	0.9923	121	0.9820	156	0.9720
52	1.0024	87	0.9920	122	0.9817	157	0.9717
53	1.0021	88	0.9917	123	0.9815	158	0.9714
54	1.0018	89	0.9914	124	0.9812	159	0.9712
55	1.0015	90	0.9911	125	0.9809	160	0.9709
56	1.0012	91	0.9908	126	0.9806	161	0.9706
57	1.0009	92	0.9905	127	0.9803	162	0.9703
58	1.0006	93	0.9902	128	0.9800	163	0.9700
59	1.0003	94	0.9899	129	0.9797	164	0.9697
60	1.0000	95	0.9896	130	0.9794	165	0.9695
61	0.9997	96	0.9893	131	0.9791	166	0.9692
62	0.9994	97	0.9890	132	0.9789	167	0.9689
63	0.9991	98	0.9887	133	0.9786	168	0.9686
64	0.9988	99	0.9884	134	0.9783	169	0.9683
65	0.9985	100	0.9881	135	0.9780	170	0.9681
66	0.9982	101	0.9878	136	0.9777	171	0.9678
67	0.9979	102	0.9876	137	0.9774	172	0.9675
68	0.9976	103	0.9873	138	0.9771	173	0.9672
69	0.9973	104	0.9870	139	0.9768	174	0.9669
70	0.9970	105	0.9867	140	0.9766	175	0.9667
71	0.9967	106	0.9864	141	0.9763	176	0.9664
72	0.9964	107	0.9861	142	0.9760	177	0.9661
73	0.9961	108	0.9858	143	0.9757	178	0.9658
74	0.9958	109	0.9855	144	0.9754	179	0.9655

Table 39.—Continued

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
180	0.9653	200	0.9597	220	0.9542	240	0.9488
181	0.9650	201	0.9594	221	0.9539	241	0.9485
182	0.9647	202	0.9591	222	0.9537	242	0.9482
183	0.9644	203	0.9589	223	0.9534	243	0.9480
184	0.9641	204	0.9586	224	0.9531	244	0.9477
185	0.9639	205	0.9583	225	0.9528	245	0.9474
186	0.9636	206	0.9580	226	0.9526	246	0.9471
187	0.9633	207	0.9578	227	0.9523	247	0.9469
188	0.9630	208	0.9575	228	0.9520	248	0.9466
189	0.9627	209	0.9572	229	0.9517	249	0.9463
190	0.9625	210	0.9569	230	0.9515		
191	0.9622	211	0.9567	231	0.9512		
192	0.9619	212	0.9564	232	0.9509		
193	0.9616	213	0.9561	233	0.9507		
194	0.9614	214	0.9558	234	0.9504		
195	0.9611	215	0.9556	235	0.9501		
196	0.9608	216	0.9553	236	0.9498		
197	0.9605	217	0.9550	237	0.9496		
198	0.9602	218	0.9547	238	0.9493		
199	0.9600	219	0.9545	239	0.9490		

Table 40.—Temperature-Volume Correction Factors for Tar Products

For the following Grades:
RT-1, RT-2, RT-3, RT-4.

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
40	1.0070	75	0.9948	110	0.9827	145	0.9707
41	1.0067	76	0.9944	111	0.9823	146	0.9704
42	1.0063	77	0.9941	112	0.9820	147	0.9701
43	1.0059	78	0.9938	113	0.9816	148	0.9697
44	1.0056	79	0.9934	114	0.9813	149	0.9694
45	1.0052	80	0.9931	115	0.9809	150	0.9691
46	1.0049	81	0.9927	116	0.9806	151	0.9687
47	1.0045	82	0.9924	117	0.9802	152	0.9684
48	1.0042	83	0.9920	118	0.9799	153	0.9680
49	1.0039	84	0.9917	119	0.9795	154	0.9677
50	1.0035	85	0.9914	120	0.9792	155	0.9674
51	1.0032	86	0.9910	121	0.9789	156	0.9670
52	1.0028	87	0.9907	122	0.9785	157	0.9667
53	1.0025	88	0.9903	123	0.9782	158	0.9664
54	1.0021	89	0.9900	124	0.9779	159	0.9660
55	1.0017	90	0.9896	125	0.9775	160	0.9657
56	1.0014	91	0.9892	126	0.9772	161	0.9654
57	1.0010	92	0.9889	127	0.9768	162	0.9650
58	1.0007	93	0.9886	128	0.9765	163	0.9647
59	1.0003	94	0.9882	129	0.9762	164	0.9643
60	1.0000	95	0.9879	130	0.9758	165	0.9640
61	0.9997	96	0.9876	131	0.9755	166	0.9637
62	0.9993	97	0.9872	132	0.9751	167	0.9633
63	0.9990	98	0.9869	133	0.9748	168	0.9630
64	0.9986	99	0.9865	134	0.9745	169	0.9627
65	0.9982	100	0.9862	135	0.9741	170	0.9623
66	0.9979	101	0.9858	136	0.9738	171	0.9620
67	0.9976	102	0.9855	137	0.9736	172	0.9616
68	0.9972	103	0.9852	138	0.9731	173	0.9613
69	0.9969	104	0.9848	139	0.9728	174	0.9610
70	0.9965	105	0.9844	140	0.9724	175	0.9606
71	0.9962	106	0.9841	141	0.9721	176	0.9603
72	0.9958	107	0.9837	142	0.9718	177	0.9600
73	0.9955	108	0.9834	143	0.9714	178	0.9596
74	0.9952	109	0.9831	144	0.9711	179	0.9593

Table 40.—Continued

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
180	0.9590	200	0.9523	220	0.9458	240	0.9392
181	0.9586	201	0.9520	221	0.9454	241	0.9389
182	0.9583	202	0.9517	222	0.9451	242	0.9386
183	0.9580	203	0.9513	223	0.9448	243	0.9383
184	0.9576	204	0.9510	224	0.9445	244	0.9380
185	0.9573	205	0.9507	225	0.9441	245	0.9376
186	0.9569	206	0.9504	226	0.9438	246	0.9373
187	0.9566	207	0.9500	227	0.9435	247	0.9370
188	0.9563	208	0.9497	228	0.9432	248	0.9367
189	0.9559	209	0.9494	229	0.9428	249	0.9364
190	0.9556	210	0.9490	230	0.9425		
191	0.9553	211	0.9487	231	0.9422		
192	0.9549	212	0.9484	232	0.9419		
193	0.9546	213	0.9481	233	0.9415		
194	0.9543	214	0.9477	234	0.9412		
195	0.9539	215	0.9474	235	0.9409		
196	0.9536	216	0.9471	236	0.9406		
197	0.9533	217	0.9468	237	0.9402		
198	0.9530	218	0.9464	238	0.9399		
199	0.9527	219	0.9461	239	0.9396		

Table 41.—Temperature-Volume Correction Factors for Emulsified Asphalt

For the following Types:
RS-1, RS-2, MS-1, MS-2, MS-3, MS-4, SS-1, SS-2.

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
40	1.0050	75	0.9963	110	0.9876	145	0.9792
41	1.0048	76	0.9960	111	0.9874	146	0.9790
42	1.0045	77	0.9958	112	0.9872	147	0.9787
43	1.0043	78	0.9955	113	0.9869	148	0.9785
44	1.0040	79	0.9953	114	0.9867	149	0.9782
45	1.0038	80	0.9950	115	0.9864	150	0.9780
46	1.0035	81	0.9948	116	0.9862	151	0.9778
47	1.0033	82	0.9945	117	0.9860	152	0.9775
48	1.0030	83	0.9943	118	0.9857	153	0.9773
49	1.0028	84	0.9940	119	0.9855	154	0.9770
50	1.0025	85	0.9938	120	0.9852	155	0.9768
51	1.0023	86	0.9935	121	0.9850	156	0.9766
52	1.0020	87	0.9933	122	0.9847	157	0.9763
53	1.0018	88	0.9930	123	0.9845	158	0.9761
54	1.0015	89	0.9928	124	0.9843	159	0.9758
55	1.0013	90	0.9925	125	0.9840	160	0.9756
56	1.0010	91	0.9923	126	0.9838	161	0.9754
57	1.0008	92	0.9920	127	0.9835	162	0.9751
58	1.0005	93	0.9918	128	0.9833	163	0.9749
59	1.0003	94	0.9915	129	0.9830	164	0.9747
60	1.0000	95	0.9913	130	0.9828	165	0.9744
61	0.9998	96	0.9910	131	0.9826	166	0.9742
62	0.9995	97	0.9908	132	0.9823	167	0.9739
63	0.9993	98	0.9905	133	0.9821	168	0.9737
64	0.9990	99	0.9903	134	0.9818	169	0.9735
65	0.9988	100	0.9901	135	0.9816	170	0.9732
66	0.9985	101	0.9899	136	0.9814	171	0.9730
67	0.9983	102	0.9896	137	0.9811	172	0.9728
68	0.9980	103	0.9894	138	0.9809	173	0.9725
69	0.9978	104	0.9891	139	0.9806	174	0.9723
70	0.9975	105	0.9889	140	0.9804	175	0.9721
71	0.9973	106	0.9886	141	0.9802	176	0.9718
72	0.9970	107	0.9884	142	0.9799	177	0.9716
73	0.9968	108	0.9881	143	0.9797	178	0.9713
74	0.9965	109	0.9879	144	0.9794	179	0.9711

Table 42.—Temperature-Volume Correction Factors for Lignin Binder

Temp.	Factor	Temp.	Factor	Temp.	Factor	Temp.	Factor
40	1.0046	70	0.9977	100	0.9908	130	0.9839
41	1.0044	71	0.9975	101	0.9906	131	0.9837
42	1.0041	72	0.9972	102	0.9903	132	0.9834
43	1.0039	73	0.9970	103	0.9901	133	0.9832
44	1.0037	74	0.9968	104	0.9899	134	0.9830
45	1.0035	75	0.9966	105	0.9897	135	0.9828
46	1.0032	76	0.9963	106	0.9894	136	0.9825
47	1.0030	77	0.9961	107	0.9892	137	0.9823
48	1.0028	78	0.9958	108	0.9890	138	0.9821
49	1.0025	79	0.9956	109	0.9887	139	0.9818
50	1.0023	80	0.9954	110	0.9885	140	0.9816
51	1.0021	81	0.9952	111	0.9883	141	0.9814
52	1.0018	82	0.9949	112	0.9880	142	0.9811
53	1.0016	83	0.9947	113	0.9878	143	0.9809
54	1.0014	84	0.9945	114	0.9876	144	0.9807
55	1.0012	85	0.9943	115	0.9874	145	0.9805
56	1.0009	86	0.9940	116	0.9871	146	0.9802
57	1.0007	87	0.9938	117	0.9869	147	0.9800
58	1.0005	88	0.9936	118	0.9867	148	0.9798
59	1.0002	89	0.9933	119	0.9864	149	0.9795
60	1.0000	90	0.9931	120	0.9862	150	0.9793
61	0.9998	91	0.9929	121	0.9860		
62	0.9995	92	0.9926	122	0.9857		
63	0.9993	93	0.9924	123	0.9855		
64	0.9991	94	0.9922	124	0.9853		
65	0.9989	95	0.9920	125	0.9851		
66	0.9986	96	0.9917	126	0.9848		
67	0.9984	97	0.9915	127	0.9846		
68	0.9982	98	0.9913	128	0.9844		
69	0.9979	99	0.9910	129	0.9841		

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