

CITY OF NEWARK
DELAWARE

STANDARD SPECIFICATIONS

FOR

**ROAD & UTILITY
CONSTRUCTION**

JANUARY 30, 2001

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DIVISION I

SECTION 1

DEFINITIONS AND TERMS

Whenever the following terms are used in these specifications, their intent and meaning shall be interpreted as follows:

1.01 ABBREVIATIONS

Whenever the following abbreviations are used in these specifications or on the plans, they are to be construed the same as the respective expressions represented.

AA	Aluminum Association
AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway Transportation Officials
AED	Associated Equipment Distributors
AIA	American Institute of Architects
ANSI	American National Standards Institute
ARA	American Railway Association
AREA	American Railway Engineering Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
FHWA	Federal Highway Administration

FSS Federal Specifications and Standards, General
Services Administration

SAE Society of Automotive Engineers

1.02 ADVERTISEMENT

The public announcement, as required by law, that the City is inviting proposals covering work to be performed and/or materials to be furnished.

1.03 AUXILIARY LANE

The portion of the roadway adjoining the traveled way for parking, speed change, or for other purposes supplementary to through traffic movement.

1.04 AWARD

The decision of the City to accept the proposal of the lowest responsible bidder for the work, subject to the execution and approval of a satisfactory contract thereof and bond to secure the performance thereof, and to such other conditions as may be specified or otherwise required by law.

1.04A BASE COURSE

The layer or layers of specified material of designed thickness placed on a subbase or a subgrade to support a surface course.

1.05 BIDDER

Any individual, partnership, firm, corporation, or any acceptable combination thereof, or joint venture, submitting a bid for the work advertised.

1.06 CALENDAR DAY

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

1.07 CERTIFIED CHECK

Certified check of the bidder drawn upon some solvent clearing house bank.

1.08 CHANGE ORDER

A written order to the contractor approved by the Director, authorizing a change in the work from that originally shown by the plans and specifications; such change orders, duly signed and executed by the contractor, constitute authorized modifications of the contract. If the work is of a nature involving an adjustment of unit price, a supplemental agreement shall be executed.

1.09 CHANNEL

A natural or artificial water course.

1.10 CITY

The City of Newark.

1.11 CONTRACT

The written agreement executed between the City and the successful bidder, covering their performance of the work and the furnishing of labor and materials in the construction of the project. The contract shall include the proposal, plans, standard specifications, special provisions, and contract bond.

1.12 CONTRACT BOND

The approved form of security executed by the contractor and his surety, or sureties guaranteeing complete execution of the contract and all supplemental agreements pertaining thereto and for the payment of all legal debts pertaining to the construction of the project.

1.13 CONTRACT ITEM (PAY ITEM)

A specifically described unit of work for which a price is provided in the contract.

1.14 CONTRACT TIME OR COMPLETION DATE

The number of working or calendar days shown in the proposal indicating the time allowed for the completion of the work contemplated in the contract, including authorized time extensions.

In case a calendar date of completion is shown in the proposal, in lieu of the number of working or calendar days, such work contemplated shall be completed by the end

of that calendar day.

1.15 CONTRACTOR

The successful bidder or individual, firm or corporation to whom the contract is awarded; party of the second part to the contract; the individual, firm or corporation undertaking the execution of the work under the terms of the contract and acting directly or through his, their, or its agents or employees.

1.16 CONTROL OF ACCESS

The condition where the right of owners or occupants of abutting land or other persons to access, light, air, or view in connection with a street is fully or partially controlled by public authority.

Full control of access means that the authority to control access is exercised to give preference to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

Partial control of access means that the authority to control access is exercised to give preference to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossing at grade and some private driveway connections.

1.17 COUNTY

The county in which the work herein specified is to be done is New Castle County.

1.18 CULVERT

Any structure not classified as a bridge which provides an opening under any roadway.

1.19 DEPARTMENT

Department of Public Works.

1.20 DIRECTOR

The Director of Public Works.

1.21 DIVISION OF HIGHWAYS

That authorized subdivision of the Department of Transportation organized to administer the affairs of the Department relating to highways.

1.22 EASEMENT (RIGHT-OF-WAY)

A right acquired by public authority to use or control property for a designated purpose.

1.23 ENGINEER

The Director of Public Works, acting directly or through his duly authorized representative, such representative acting within the scope of the particular duties assigned to him or the authority given him.

1.24 EQUIPMENT

All machinery and equipment, together with the necessary supplies for upkeep and maintenance, and also tools and apparatus necessary for the proper construction and acceptable completion of the work.

1.25 EXTRA WORK

An item of work not provided for in the contract as awarded but found by the Engineer essential to the satisfactory completion of the contract within its intended scope.

1.26 EXTRA WORK ORDER

A change order concerning the performance of work or furnishing of materials involving extra work. Such extra work may be performed at agreed prices or on a force account basis as provided elsewhere in these specifications.

1.27 HOLIDAYS

In the City of Newark, the following days are presently legal holidays: the first of January, known as New Year's Day; the third Monday in February, known as President's Day; Good Friday; the fourth Monday in May, known as Memorial Day; the fourth of July, known as Independence Day, the first Monday in September, known as Labor Day; the fourth Thursday in November, known as Thanksgiving Day; the day after Thanksgiving; the day before Christmas Day; and the twenty-fifth of December, known as Christmas.

If any of the legal holidays fall on Sunday, the Monday following shall be a legal holiday. If any of the legal holidays fall on Saturday, the Friday preceding shall be a legal holiday.

Except with the written permission of the Engineer and in extreme emergencies, there shall be no contract work performed on Sundays and the Official Holidays.

If work is permitted on legal holidays, the contractor will be charged the premium time of the inspection forces required on that legal holiday.

1.28 INSPECTOR

An authorized representative of the Engineer assigned to inspect any feature of the material or work entering into the contract.

1.29 INVITATION FOR BIDS

The advertisement for proposals for all work and/or materials on which bids are required. Such advertisement will indicate with reasonable accuracy the quantity and location of the work to be done or the character and quantity of the material to be furnished and the time and place of the opening of proposals.

1.30 LABORATORY

The testing Laboratory for Materials and Research designated by the Engineer for testing the materials to be used in the contract.

1.31 MAJOR ITEM

Any item whose total bid value equals or exceeds 15% of the total price bid for the contract.

1.32 MATERIALS

Any substances specified for use in the construction of the project and its appurtenances.

1.33 MEDIAN

The portion of a divided highway separating the traveled ways for traffic in opposite directions.

1.34 NOTICE TO PROCEED

Written notice to the contractor to proceed with the contract work including, when applicable, the date of beginning of contract time.

1.35 OWNERS

Mayor and City Council, Newark, Delaware.

1.36 PLANS

The official approved plans, profiles, typical cross-sections, working drawings, and supplemental drawings, or exact reproductions thereof, which show the location, character, dimensions and details of the work to be done, and which are to be considered as a part of the contract supplementary to these specifications.

1.37 PROFILE GRADE

The trace of a vertical plane intersecting the top surface of the proposed wearing surface, usually along the longitudinal centerline of the roadbed. Profile grade means either elevations or gradient of such trace according to the context.

1.38 PROJECT

The specific section of the City together with all appurtenances and construction to be performed thereon under the contract.

1.39 PROPOSAL

The offer of the bidder, submitted on the prescribed proposal form, to perform the work and to furnish the labor and materials at the prices quoted by the bidder.

1.40 PROPOSAL FORM

The approved form on which the City requires formal bids to be prepared and submitted for the work.

1.41 PROPOSAL GUARANTY

The security furnished by the bidder with his proposal for a project, as guaranty he will enter into a contract for the work if this proposal is accepted.

1.42 QUESTIONNAIRE

The approved form or forms upon which the contractor shall furnish the information as to his ability to perform the work, his experience in similar work, the equipment to be used, and his financial condition as related to his ability to finance the work.

1.43 RAMP

A sloping passage joining different levels.

1.44 RIGHT-OF-WAY

A general term denoting land, property, or interest therein, usually in a strip, acquired for or devoted to a highway or street.

1.45 ROAD

A general term denoting a public way for purposes of vehicular travel within the right-of-way.

1.46 ROADBED

The graded portion of a highway or street within top and side slopes, prepared as a foundation for the pavement structure and shoulder.

1.47 ROADSIDE

A general term denoting the area adjoining the outer edge of the roadway. Extensive areas between the roadways of a divided highway may also be considered roadside.

1.48 ROADWAY

The portion of a highway, including shoulders, for vehicular use. A divided highway has two or more roadways. The portion of a highway within limits of construction.

1.49 SHOULDER

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

1.50 SIDEWALKS

That portion of the right-of-way, primarily for the use of pedestrians.

1.51 SPECIAL PROVISIONS

Special directions, provisions, or requirements, peculiar to the project under consideration and not otherwise thoroughly or satisfactorily detailed or set forth in the Standard Specifications. Special Provisions shall prevail over the Standard Specifications and Supplemental Specifications whenever in conflict therewith and over all plans. They set forth the final contractual intent as to the matter involved.

1.52 STANDARD SPECIFICATIONS

The directions, provisions, and requirements contained herein, and as supplemented by such special provisions as may be necessary, pertaining to the method and manner of performing the work or to the quantities of material to be furnished under the contract.

1.53 SPECIFIED COMPLETION DATE

The date on which the contract work is specified to be completed.

1.54 STANDARD DRAWINGS

Drawings of certain standard details of construction which have been adopted for miscellaneous items of work and are a part of the plans.

1.55 STATE

The State of Delaware.

1.56 STREET

A general term denoting a public way for purposes of vehicular travel within the right-of-way.

1.57 STRUCTURES

Bridges, culverts, catch basins, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, underdrains, foundation drains and other features which may be encountered in the work and not otherwise classed herein.

1.58 SUBCONTRACTOR

Any individual, firm, or corporation who has, with the written approved of the Engineer, contracted with the contractor to execute and perform any part of the contract of which these Specifications as a part.

1.59 SUBBASE

The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course.

1.60 SUBGRADE

The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

1.61 SUBSTRUCTURE

All that part of the structure below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, together with the backwalls, wingwalls and wing protection railings.

1.62 SUPERINTENDENT

The contractor's authorized representative in responsible charge of work.

1.63 SUPERSTRUCTURE

The entire structure except the substructure.

1.64 SUPPLEMENTAL AGREEMENT

A written agreement made and entered into by and between the contractor and the City covering work not otherwise provided for, revisions in or amendments to the terms of the contract, or conditions specifically prescribed in the specifications as requiring supplemental agreements. Such supplemental agreements become a part of the contract when approved and properly executed.

1.65 SURETY

The corporate body bound with and for the contractor for the full and complete performance of the contract, and for the payment of all debts pertaining to the work. When applying to the "proposal guaranty" it refers to the corporate body which

engages to be responsible in the execution by the bidder of a satisfactory contract.

1.66 TITLE (OR HEADINGS)

The titles or headings of the sections and subsections herein are intended for convenience of reference and shall not be considered as having any bearing on their interpretations.

1.67 TON

Short ton of 2,000 pounds.

1.68 CITY OR TOWN

The City of Newark.

1.69 TRAVELED WAY

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

1.70 WORK

Work shall be understood to mean the furnishing of all labor, materials, equipment, and other incidentals necessary or convenient to the successful completion of the project and the carrying out of all the duties and obligations imposed by the contract.

1.71 WORKING DAY

A working day is defined as a calendar day exclusive of Saturday, Sundays, or City legal holidays when the contractor can prosecute the work. Working days will not be charged if the contractor elects to work on Saturdays, but will be charged if he is permitted to work on Sundays or City legal holidays. Time charges in the form of working days will start when the contractor begins actual construction work and in no case later than ten (10) days after the written "notice to proceed" with the work. The "notice to proceed" with the work may be incorporated in the award letter, or may be a subsequent separate notification.

The contractor will be charged one working day whenever work is, or could be performed on the contract for a period of eight hours or more, or as specified hereafter. Fractional parts of a day shall be charged in increments of one-fourth of the basic eight-hour day, and no time will be charged for less than one-fourth day.

If the contractor works on any current operations in accordance with the work schedule on any day in which the weather, conditions of the ground, or other conditions beyond his control make it impossible to prosecute the work with full and normal efficiency, the Engineer may count the day as some fraction of a working day. No allowance will be made for delays or suspension of the prosecution of the work due to the fault of the contractor.

If, in the opinion of the Engineer, the contractor is able to carry on any one or more, but not all, of his principal construction operations as shown on his approved work schedule, and fails to do so, he may, at the discretion of the Engineer, be charged for a full working day.

Working days will not be charged under the following conditions:

1. If the contractor elects not to work, when the condition of the ground, weather conditions, or other conditions beyond the control of the contractor make it impossible to carry on any work in accordance with the work schedule.
2. When operations are suspended due to an act or omission on the part of the Department.
3. The number of working days allowed for the completion of the project are shown in the proposal.

1.72 WORKING HOURS

The City's normal number of working hours per day is 7-1/2, unless otherwise authorized by the Engineer in writing, and it is not contemplated that the contractor will work on Saturdays, Sundays, or holidays.

In case of emergency, or in case the contractor desires to work on Saturdays, Sundays, holidays or hours in excess of 7-1/2 on any one working day, the contractor shall request permission of the Engineer to do so. If, in the opinion of the Engineer, the reason for working is bona fide, he will grant permission to the contractor to work such hours as may be necessary. Also, if in the opinion of the Engineer, a bona fide emergency exists, he may direct the contractor to work such hours as may be necessary, whether the contractor requests permission to do so or not.

In the event that the contractor works in excess of 7-1/2 hours per day, or Saturdays, Sundays, or holidays, the contractor shall be required to pay for engineering services performed during these times. Payment for these additional engineering services shall be made by a reduction in the monthly estimate paid the contractor for the sums of money involved for the period covered by the current estimate.

1.73 WORKING DRAWINGS

Stress sheets, shop drawings, erection plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel, or any other supplementary plans or similar data which the contractor is required to submit to the Engineer for approval.

1.74 WORK ORDER

A written order, signed by the Engineer, of a contractual status requiring performance by the contractor without negotiation of any sort.

1.75 In order to avoid cumbersome and confusing repetition of expressions in these specifications, it is provided that whenever anything is, or is to be, done, if as or when or where "contemplated, required, determined, directed, specified, authorized, ordered, given, designated, indicated, considered necessary, deemed necessary, permitted, reserved, suspended, established, approval, approved, disapproved, acceptable, unacceptable, suitable, accepted, satisfactory, unsatisfactory, sufficient, insufficient, rejected, or condemned, "it shall be understood as if the expression were followed by the words "by the Engineer" or "to the Engineer."

SECTION 2

INSTRUCTION TO BIDDERS

2.01 QUALIFICATION OF BIDDERS

No contract will be awarded to any Bidder who in the judgment of the Owner, is not a responsible bidder, or is not prepared with all the necessary experience, capital, organization and equipment, to conduct and complete the work for which the Bidder proposes to contract, in strict accordance with all the terms and provisions of the Contract Documents. To qualify, a sworn statement shall be submitted as to experience, capital, organization and equipment, to conduct and complete the work for which the Bidder proposes to contract, in strict accordance with all the terms and provisions of the Contract Documents.

Such Bidder shall also furnish such additional information bearing on his qualifications as may be required by the Engineer.

The Owner reserves the right to reject the bid of any Bidder, who fails to furnish promptly and properly all the information called for as aforesaid, when notified to do so.

The Owner also reserves the right to reject any and all bids, or to accept any bid and/or waive technical defects as it may deem best for the interest of the Owner.

Each Bidder shall further qualify as otherwise called for in the Contract Documents.

2.02 CONTENTS OF PROPOSAL FORMS

Prospective Bidders, will be furnished with blank proposal forms. On this form will be shown the location of the project, the type of work, the estimated quantities of the work to be performed, the date, time and place of the opening of proposals, the date of completion or the number of working or calendar days allowed for the completion of the project, the required proposal guarantee, and any special provisions and requirements which modify, revise or add to the Standard Specifications.

All papers bound with or attached to the proposal are a necessary part thereof and shall not be detached or altered.

The plans, specifications, and other Contract Documents designated in the proposal form will be considered a part of the proposal whether attached or not.

2.03 INTERPRETATION OF QUANTITIES IN BID SCHEDULE

The quantities appearing in the bid schedule are approximate only and are prepared for the comparison of bids. Payment to the contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the contract, and it is understood that the scheduled quantities of work to be done and materials to be furnished may each be increased, diminished, or omitted as hereinafter provided.

2.04 EXAMINATION OF PLANS, SPECIFICATIONS, SPECIAL PROVISIONS, AND SITE OF WORK

The Bidder is required to examine carefully the site of the proposal work, the proposal, plans, specifications, special provisions, and contract forms before submitting a proposal. The submission of a bid shall be considered prima facie evidence that the bidder has made such examination and is satisfied as to the conditions to be encountered in performing the work and as to the requirements of the plans, specifications, special provisions, and contract.

The general contractor and each subcontractor will be required to furnish all labor and material within his specialty, reasonably indicated or implied by all drawings, and/or the specifications, unless specifically noted otherwise. For his interest, each subcontractor should examine all drawings carefully and all parts of the specifications as well as those which refer primarily to his own branch or branches of the work.

2.05 PREPARATION OF PROPOSAL

The Bidder shall submit his proposal upon the blank forms furnished by the City. The bidder shall specify a unit price in figures for each pay item for which a quantity is given and shall also show the products of the respective unit prices and quantities written in figures in the column provided for that purpose and the total amount of the proposal obtained by adding the amounts of the several items. All figures shall be in ink or typewritten.

In the event of a conflict or error in extensions from unit prices to total amounts, unit price shall prevail and be taken to be the correct bid figures. Bidders are cautioned to thoroughly review their bid figures for errors.

When an item in the proposal contains a choice to be made by the Bidder, the Bidder shall indicate his choice in accordance with the specifications for that particular item, and thereafter no further choice will be permitted, unless written permission by the Engineer is granted.

The Bidder's proposal must be signed with ink by the individual, by one or more members of the partnership, by one or more members or officers of each firm representing a joint venture, or by one or more officers of a corporation, or by an agent of the contractor legally qualified and acceptable to the City. If the proposal is made by an individual, his name and post office address must be shown; by a partnership, the name and post office of each partnership member must be shown; as a joint venture, the name and post office address of each member or officer of the firm represented by the joint venture must be shown; by a corporation, the name of the corporation and the business address of its corporate officials must be shown.

2.06 IRREGULAR PROPOSALS

Proposals shall be considered irregular and may be rejected and not considered for the following reasons:

- (a) If the proposal form furnished by the City is not used or is altered, amended or any terms are included in addition to the terms set forth in the proposal form.
- (b) If there are any unauthorized additions, interlineations, conditional or alternate bids or irregularities of any kind which may tend to make the proposal incomplete, indefinite or ambiguous as to its meaning, or add any terms or provisions not included in the proposal supplied by the City.
- (c) If the Bidder adds any provisions reserving the right to accept or reject an award, or to enter into a contract pursuant to an award.
- (d) If any unit price contained in the bid schedule does not cover at least the cost of materials for that item or if the unit price is obviously unbalanced either above or below reasonable cost analysis values.
- (e) If the Bidder fails to provide a unit price for every pay item indicated except in the case of authorized alternate pay items.

2.07 PROPOSAL GUARANTY

Each Bidder shall submit with his proposal a guaranty in a sum equal to at least 10% of the total amount of his bid. If a bid bond is submitted, the bond need not be for a specific sum but may be stated to be for a sum equal to 10% of the bid to which it relates and not to exceed a certain stated sum, if said sum is equal to at least 10% of the bid.

The guaranty shall be submitted in the form of good and sufficient bond to the City of Newark for the benefit of the City or a certified check drawn on a reputable banking

institution and made payable to the City. If a bid bond is to be supplied, the Bidder must use the blank form of bond included in the proposal form supplied by the City.

2.08 DELIVERY OF PROPOSALS

Proposals shall be delivered in envelopes to the City for this purpose, sealed, and shall bear on the outside the name and address of the Bidder as well as the designation of the contract. If forwarded by mail, the proposal shall be placed in the standard envelope, sealed, and placed in a second envelope addressed to: City of Newark, Newark Municipal Building, 220 Elkton Road, Newark, Delaware. Mailed proposals will be received by the Purchasing Office by special delivery registered mail at its offices, Newark, Delaware, until the time set in the advertisement, unless otherwise noted therein, and will be publicly opened and read aloud in the Council Chambers shortly thereafter.

Item numbers listed in the Proposal relate to Construction Detail items enumerated in the City of Newark Public Works Standard Specifications.

Only proposals which are signed by the company, corporation, individual, or joint venturer that procured plans and specifications in said company, corporation, individual, or joint venturer name will be accepted.

2.09 WITHDRAWAL OF PROPOSALS

A Bidder may withdraw his proposal unopened after it has been deposited with the City if such a request is made in writing prior to the time set for the opening of the proposal.

When the proposals have been read, any low bidder may withdraw any other unopened proposal which he may have submitted for another contract.

Any Bidder exercising the privilege of so withdrawing his bid or bids waives all claims that may arise should it be found that his opened proposal is irregular or for any reason is unacceptable to the City.

2.10 PUBLIC OPENING OF PROPOSALS

Proposals will be opened publicly and read at the place designated by the City on the date and hour set in the advertisement. Bidders or their authorized representatives are invited to be present. Proposals received after the time set for the public opening will be returned unopened.

2.11 DISQUALIFICATION OF BIDDERS

Any one or more of the following causes may be considered as sufficient for the disqualification of a Bidder and the rejection of his proposal or proposals:

- (a) More than one proposal for the same work from an individual, firm or corporation under the same or different names.
- (b) Evidence of collusion among bidders. Participants in such collusion will receive no recognition as bidders for any future work of the City until any such participant shall have been reinstated as a qualified Bidder.
- (c) Lack of competency and adequate machinery, plant and other equipment as revealed by the financial statement required under Subsection 2.01.
- (d) Uncompleted work which, in the judgment of the City, might hinder or prevent the prompt completion of additional work if awarded.
- (e) Failure to pay, or satisfactorily settle, all bills due for labor and material on former contracts in force at the time of letting.
- (f) Failure to comply with any qualification regulations of the City.
- (g) If the Bidder has defaulted under previous contracts.

The above list of causes for disqualification is not be considered as exhaustive, but merely descriptive of such events as may be determined by the City to warrant the disqualification of any bidder.

2.12 MATERIAL GUARANTEE

The successful Bidder may be required to furnish a complete statement of the origin, composition, and manufacture of any or all materials to be used in the construction of the work together with samples, which samples may be subjected to the tests provided for in these specifications to determine their quality and fitness for the work.

2.13 INTERPRETATIONS BY ADDENDUM

Should any Bidder be in doubt as to the intent and meaning of the drawings and/or project manual, he may make inquiry to the Engineer. The questions and answers will be communicated to all Bidders in a written addendum(a), mailed no later than three days prior to the date set for bid opening. However, Bidders shall bear the entire responsibility for being sure they have received any and all addenda. Questions

received later than four (4) working days before the day bids are due will not be considered. Verbal answers will not be binding. After the bids have been received, no claim that the Bidder did not have complete information will be considered. The owner will not be responsible for any other explanation or interpretations of the proposed Documents.

2.14 SUBSTITUTIONS

The Specifications intend to allow and encourage equal competition. Two (2) or more manufacturers or brands are named wherever possible. Where "Or Approved Substitute," "Or Equal," appears after manufacturers' names, it shall be understood to mean "as approved by the Engineer, in writing, during the bidding period." Other manufacturers wishing to substitute for that specified must submit supporting data with their request. Catalogs and/or samples shall be given to the Engineer to aid him in determining if substitute will be approved. If the substitute material is approved, the Engineer will notify all Bidders in an addendum. No request for approval will be considered if received later than ten (10) working days before the bids are due.

2.15 BIDDERS MEETING

A meeting of representatives of the Owner, Engineer and bidding Contractors will be held to discuss bidders questions. Bidders meeting will be scheduled in the City Manager's Conference Room. Decisions made at the Bidders meeting will be binding on all contractors submitting bids on this project. An addendum containing all decisions made at the meeting will be issued promptly to all bidding general contractors and to all others to whom bidding documents have been sold.

SECTION 3

AWARD AND EXECUTION OF CONTRACT

3.01 CONSIDERATION OF PROPOSALS

After the proposals are opened and read, they will be compared on the basis of the summation of the products of the approximate quantities shown in the bid schedule by the unit bid prices, unless the proposal states a different basis for comparing bids. The results of such comparisons will be immediately available to the public. In the event of a discrepancy between unit bid prices and extensions, the unit bid price shall govern.

Before awarding the contract, a Bidder may be required to show that he has the ability, experience, necessary equipment, experienced personnel and financial resources to successfully carry out the work required by the contract.

The right is reserved to reject any or all proposals, to waive technicalities, to advertise for new proposals, or to proceed to do the work otherwise, if in the judgement of the Mayor and Council the best interest of the City will be promoted thereby.

3.02 AWARD OF CONTRACT

The award of contract, if it be awarded, will be made within 30 calendar days after the opening of proposals to the lowest responsible and qualified Bidder whose proposal complies with all the requirements prescribed. The successful Bidder will be notified by letter mailed to the address shown on his proposal that his bid has been accepted and that he has been awarded the contract.

3.03 CANCELLATION OF AWARD

The City reserves the right to cancel the award of any contract at any time before the execution of said contract by all parties without any liability against the City.

3.04 RETURN TO PROPOSAL GUARANTEE

Upon the execution of a formal contract and bond, the bid bond or certified check deposit shall be returned to the successful bidder. The deposit of the unsuccessful bidders shall be returned to them immediately upon the awarding of the contract or the rejection of all bids, but in no event later than 30 calendar days after the opening of bids.

3.05 EXECUTION OF CONTRACT

The Bidder to whom the award is made shall execute a formal contract and furnish good and sufficient bond within 14 calendar days after date of official notice of the award of the contract.

3.06 PERFORMANCE AND PAYMENT BONDS

Simultaneous with the execution of the formal contract, the successful Bidder shall also execute a good and sufficient bond to the City of Newark, with corporate surety authorized to do business in this State, in a sum equal to 100% of the contract price.

The bond shall be conditioned upon the faithful compliance and performance by the successful Bidder of each and every term and condition of the contract and the proposal and plans and specifications thereof, at the time and in the manner prescribed by the contract and the plans and specifications, including the payment in full to every person furnishing material or performing labor or services in the performance of the contract, of all sums of money due him for such labor, services or material. The bond shall also contain the successful Bidder's guarantee to indemnify and same harmless the City from all costs, damages and expenses growing out of or by reason of the successful Bidder's failure to comply and perform the work and complete the contract in accordance with the contract.

The bond shall provide that every person furnishing materials or performing labor for the successful Bidder under the contract may maintain an action on the bond for his own use in the name of the City in any court of competent jurisdiction, for recovery of such sum or sums of money as may be due the person from the successful Bidder.

3.07 FAILURE TO EXECUTE CONTRACTS

If the successful Bidder fails to execute the required contract and bond as aforesaid within 14 days after the date of official notice of the award of the contract, his proposal guarantee shall immediately become forfeited as liquidated damages. Award will then be made to the next lowest qualified Bidder or the work readvertised, as the City may decide.

3.08 AWARD AS AN ENTIRETY

While bids are asked for by items, the contract will not be awarded by items, but will be awarded as an entirety on the basis of the total proposal, which total must be the aggregate sum of the bids on all the items figures at the unit and lump sum prices bid. Bidders shall bid on all items.

SECTION 4

GENERAL PROVISIONS

4.01 COMPENSATION AND LIABILITY INSURANCE

- (a) Except as otherwise provided by law, the Contractor shall at all times maintain and keep in force such insurance as will protect him from claims under workmen's compensation acts, and also such insurance as will protect him and the Owner from any other claims for damages for personal injuries, including death, which may arise from operations under this contract, whether such operations be by the Contractor or by any Subcontractor or anyone directly or indirectly employed by any of them.
- (b) The Contractor and his Subcontractor's Public Liability and Property Damage Insurance shall provide adequate protection against public liability, property damage, and vehicular liability. As required under the General Conditions, the Contractor's Public Liability Insurance shall be in an amount not less than \$200,000 for Bodily Injury, including accidental death, to any one person and an amount not less than \$500,000 on account of any one occurrence. Property damage insurance in an amount not less than \$100,000 per occurrence and \$200,000 aggregate. Vehicular Liability of \$100,000 for any one person or \$200,000 for each occurrence.
- (c) The Contractor shall either: (a) require each of his subcontractors to procure and to maintain during the life of his subcontract, Subcontractor's Public Liability and Property Damage and Vehicular Liability of the type and in the same amounts as specified in the preceding paragraph, or (b) insure the activities of his subcontractors in his own policy.
- (d) The procuring of any and all insurance as set forth in these specifications or elsewhere shall be in addition to and not in any way in substitution for all the other protection provided under the Contract Documents.
- (e) The Contractor shall submit a copy of the insurance certificate when submitting his bid, if his proposal is to be considered.

4.02 LIABILITY OF CONTRACTOR

Whenever the Contractor is required by an existing State, Federal, Local or Municipal laws, ordinances, rules or regulations or by any State, Federal, Local or Municipal laws, ordinance, rules or regulations that may be enacted hereafter pertaining to the

work to be done under this contract, to secure any permits or licenses to carry on any operation or operations in connection with the performance of the contract and/or to act under the direction or supervision of a City official and/or employee in connection with any such operation or operations, the Contractor shall be solely liable for all suits, actions, costs and damages of every kind and description resulting or which may result, directly or indirectly, from any such operation or operations and shall indemnify and save harmless the owner from any and all suits, actions, costs, and damages of every kind and description arising or which may arise directly or indirectly from the said operation or operations.

4.03 INDEMNIFICATION OF THE OWNER

The Contractor shall pay, indemnify and save harmless the Owner, its agents and employees, from all suits, actions, claims, demands, damages, losses, expenses and/or costs of every kind and description to which the Owner may be subjected or put by reason of injury (including death) to person or property resulting from the manner or method employed by the Contractor, his agents and employee or Subcontractors, or from any neglect or default of the Contractor, his agents and employees, or Subcontractors in the performance of this contract, or any part thereof, or from, by or on account of any act of omission of the Contractor, his agents and employees, or Subcontractors, and whether such suits, actions, claims, demands, damages, losses, expenses and/or costs be against, suffered or sustained by the Owner, its agents and employees, or be against, suffered or sustained by other corporations, and persons to whom the Owner, its agent and employees, may become liable therefore, and the whole, or so much of the monies due to become due the Contractor under the contract as may be considered necessary by the Engineer may be retained by the Owner until such suits or claims for damages shall have been settled or otherwise disposed of and satisfactory evidence to that effect furnished to the Engineer.

4.04 PATENTS

Whenever any article, material, means, appliances, process, composition, combination or things called for by these specifications is covered by Letters Patent, the successful Bidder must secure, before using or employing such article, material, means, appliance, process, composition, combination or things, the assent, in writing, of the Owner or the license of such Letters Patent and file the same with the Engineer.

The said assent is to cover not only the use, employment and incorporation of said article, materials, means, appliances, processes, compositions, combinations or things in the construction and completion of the work, but also the permanent use of said articles, materials, means, appliances, processes, compositions, combination of things, thereafter by or on behalf of the Owner in the operation and maintenance of the

project for the purpose for which it is intended or adapted.

The Contractor shall be responsible for any claim made against the Owner or any of its agents and employees for any actual or alleged infringement of patents by the use of patented articles, materials, means, processes, compositions, appliances, combinations or things, in the construction, completion and use of the work, and shall save harmless and indemnify the Owner and its agents and employees from all costs, expenses and damages, including solicitor's fees, which the Owner may be obligated to pay by reason of any actual or alleged infringement or patents used in the construction, completion, maintenance or operation of the works and project herein specified.

4.05 INTENT OF CONTRACT

The intent of the plans and these specifications is to provide for the construction and completion of the work described, as can best be determined at the time such plans and specifications are drafted.

The contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

4.06 PERMITS, LICENSES AND TAXES

Unless otherwise provided in the Special Provisions, the Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful prosecution of the work.

The Contractor and Subcontractors shall be licensed to do business in the State of Delaware, and shall be registered as a Contractor in the City of Newark prior to start of construction.

Prior to the execution of any contract, the successful Bidder will be required to show that he has satisfied the requirements of Section 2502 and 2503, Chapter 25, Title 30, of the Delaware Code, and if the Bidder is a non-resident corporation that the Bidder has complied with the requirements of Subchapter XIV of Title 8 of the Delaware Code.

4.07 INTERPRETATION OF PLANS, ETC.

On all plans, drawings, etc., the figured dimensions shall govern in the case of discrepancy between the scales and figures. The Contractor shall take no advantage of any error or omission in the plans or of any discrepancy between the plans and

specifications, and the Engineer shall make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the specifications and of the plans as construed by him. In all cases of doubt as to the true meaning of the specifications, plans and/or drawings, the decision of the Engineer will be final and conclusive.

The plans which accompany the Contract Documents are for the purpose of illustrating the general character and extent of the work and are subject to such modifications as may be found necessary or advisable, either before or during the performance of the work, and the Contractor shall conform to and abide by whatever supplementary plans and explanations which may be furnished by the City of Newark for the purpose of illustrating the work in more detail. All work that may be called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, shall be executed and furnished by the Contractor as if described in both ways. Should any incidental work or materials be required which is not denoted in the specifications or plans, either directly or indirectly, but which is nevertheless necessary for the proper carrying out of the intent thereof, the contractor is to understand the same to be implied as required and shall perform all such work and furnish all such materials as fully as if they were specifically delineated or described.

4.08 ALTERATION OF PLANS OR CHARACTER OF WORK

The City reserves the right to make, at any time during the progress of the work, alterations in plans, in the details of construction, or character of the work as may be considered necessary or desirable to complete satisfactorily the proposed construction. Such alterations shall not be considered as a waiver of any conditions of the contract, nor invalidate any of the provisions thereof.

The right is reserved to increase or decrease any or all of the items in the estimate of approximate quantities as shown in the bid schedule.

Whenever the items of the project are increased or decreased and whenever such change or combination of changes result in increasing or decreasing the original contract amount as calculated from the bid quantities and contract unit prices by more than 25%, a supplemental agreement, acceptable to both parties to the contract, shall be executed in advance of performing the affected work.

Unless such alterations and increases or decreases materially change the character of the work to be performed, or the cost thereof, the altered work shall be paid for at the contract unit prices, except as provided above. If, however, the character of the work or the unit costs, or the time required for performance of the work, are materially changed, an equitable adjustment shall be made on such basis as may have been

agreed upon in advance of the performance of such work, or in case no such agreement was made, then an allowance shall be made, either for or against the contractor, in such amount as the City may determine to be fair and equitable.

No claim shall be made by the Contractor for any loss of anticipated profits because of any such alteration, or by reason of any variation between the approximate quantities and the quantities of work as done.

Any adjustment in contract time because of such change or changes covered herein shall be made in accordance with the provisions of Subsection 4.69 and any adjustment in compensation shall be made in accordance with the provisions of Subsection 4.11, 4.13 and 4.14.

In all other cases, the work involved in the changes shall be performed on the basis of the contract unit prices and no supplemental agreement shall be necessary.

4.09 SUPPLEMENTAL AGREEMENTS

When total alterations involve (1) an increase or decrease of more than 25% of the total cost of the work calculated from the original contract price, or (2) an increase or decrease of more than 25% in the quantity of any one major contract item or (3) an extension or shortening of the project of more than 25% of the length shown on the plans, either party to the contract shall be entitled to demand a supplemental agreement on that portion of the work above 125% or below 75% of the quantity stated in the proposal. Alteration involving an increase or decrease of more than 25% in the quantity of any one item not classified as a major item will not require a supplemental agreement.

Before work shall be started on any alteration requiring such supplemental agreement, the agreement setting forth an equitable adjustment of compensation to the Contractor shall be executed by the City and the Contractor, and performance secured by good and sufficient bond.

4.10 COMPENSATION FOR ALTERED QUANTITIES

When the actual quantities of work ordered and performed vary from the corresponding quantities set out in the bid schedule but such variance is within the limits hereinbefore set forth in Subsection 4.08, and whether or not there have been any changes in plans, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract unit prices for the actual quantities of work done. No allowance or other adjustment will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting either directly from such alterations or

indirectly from unbalanced allocation among the contract items of overhead expense on the part of the Bidder and subsequent loss of expected reimbursements therefore or from any other cause save the said payment for the actual quantity done at the original contract unit prices.

Alteration of plans or character of work involving supplemental agreements, as indicated in Subsection 4.09 will be paid for as stipulated in such agreements.

4.11 EXTRA WORK

The Contractor shall perform unforeseen work, for which there is no price included in the contract, whenever it is deemed necessary or desirable in order to complete fully the work as contemplated. Such extra work shall be performed in accordance with the specifications and as directed; provided, however, that before doing any extra work is started, a supplemental agreement shall be entered into or an extra work order issued. (See Subsection 4.12) Payment may also be made as provided for under the Special Provisions.

4.12 PAYMENT FOR EXTRA WORK

Extra work shall be paid for at a unit price or lump sum, which amount will be agreed upon in writing by the Contractor and Engineer before such work begins. Where such prices or sum cannot be agreed upon, or where this method of payment is impractical, the Engineer shall issue a written order to the Contractor to do such work by "force account." Supplemental work will be paid for according to the terms of "supplemental agreement." Any time extension for extra work will be as outlined in these specifications.

4.13 PAYMENT BY FORCE ACCOUNT

All extra work done by "force account" will be paid for in the following manner.

- (a) **Labor.** For all labor and foremen in direct charge of the specific operations, the Contractor shall receive the rate of wage (or scale) agreed upon in writing before beginning work for each and every hour that said labor and foreman are actually engaged in such work.

The Contractor shall receive the actual costs paid to, or in behalf of, workmen by reason of subsistence and travel allowances, health and welfare benefits, pension fund benefits or other benefits, when such amounts are required by collective bargaining agreement or other employment contract generally applicable to the classes of labor employed on the work. An amount equal to 20% of the sum of the above items will also be paid the Contractor.

- (b) **Bond, Insurance, and Tax.** For property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work, the Contractor shall receive the actual cost, to which cost 6% will be added. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance, and tax.
- (c) **Materials.** For materials accepted by the Engineer and used, the Contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid by him (exclusive of machinery rentals as hereinafter set forth), to which cost 15% will be added.
- (d) **Equipment.** For any machinery or special equipment (other than small tools) including fuel and lubricants, plus transportation costs, the use of which has been authorized by the Engineer, the Contractors shall receive the rental rates agreed upon in writing before such work is begun for the actual time that such equipment is in operation on the work, to which rental sum 15% will be added. The Rental Rate Blue Book for Construction Equipment will be used as a guide to determine equipment rental rate.
- (e) **Miscellaneous.** No additional allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.
- (f) **Compensation.** The Contractor's representative and the Engineer shall compare records daily of the cost of work done as ordered on a force account basis.
- (g) **Statements.** No payment will be made for work performed on a force account basis until the Contractor has furnished the Engineer with duplicate itemized statements of the cost of such force account work detailed as follows:
1. Name, classification, date, daily hours, total hours, rate, and extension for each laborer and foreman.
 2. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of machinery and equipment.
 3. Quantities of materials, prices, and extensions.
 4. Transportation of materials.
 5. Cost of property damage, liability and workmen's compensation

insurance premiums, unemployment insurance contributions, and social security tax.

Statements shall be accompanied and supported by invoices for all materials used and transportation charges. However, if materials used on the force account work are not specifically purchased for such work, but are taken from the Contractor's stock, then in lieu of the invoices the Contractor shall furnish an affidavit certifying that such materials were taken from his stock, that the quantity claimed was actually used, and that the price and transportation claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor. If unit measurement is by weight, certified weight slips will be required.

Should the Contractor refuse or fail to prosecute the work as directed or to submit his claim as required, the Engineer may withhold payment of all current estimates until the Contractor complies with these requirements or, after giving the Contractor due notice, the Engineer may make payment for said work on the basis of a reasonable estimate of the value of the work performed.

4.14 ELIMINATED ITEMS

The elimination of any item not classified as a major item will not be considered as a basis for the allowance of additional payment for profits except for such actual work as may have been done, and materials actually purchased by order of the Engineer prior to notification of the elimination of the items will be paid for at the actual cost of the material plus 15%. Such materials shall become the property of the City of Newark.

The omission of any major item will be subject to the conditions outlined in Subsection 4.10, "Compensation for Altered Quantities."

PROSECUTION AND PROGRESS OF WORK

4.15 SUBLETTING OF CONTRACT

The Contractor shall not sublet, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of his right, title, or interest therein, without written consent of the Engineer. In case such consent is given, the Contractor will be permitted to sublet a portion thereof, but shall perform with his own organization, work, amounting to not less than 60% of the total contract bid price, except that any items designated in the contract as "specialty items" may be performed by subcontract and the cost of any such specialty items so performed by subcontract may be deducted from the original total bid price before computing the amount of work required to be performed by the Contractor with his own

organization. If the Contractor to whom a contract is awarded proposed to subcontract any part of the work, the scope and value of the work to be done by the Subcontractor shall be outlined. The cost of the materials to be used by the Subcontractor shall be included in the value of the subcontracted work. The work of the Subcontractor shall be listed as to its value in relation to the entire contract. A subcontractor may not, in turn, subcontract a portion of the work intended to be done by that organization without written permission of the Engineer pursuant to the requirements of this section.

In the event that the Contractor utilizes the services of the employees of another contractor or subcontractor, he must receive the Engineer's approval prior to work being performed. The Contractor may be required to supply the City with information relating to such employment which may include but not be limited to payroll information in summary form as well as a copy of each withholding statement filed with the Federal and State indicating payroll deductions.

As a precedent to payment to the Contractor for any part of the work performed by a Subcontractor or by the personnel and equipment of any other person or organization other than the Contractor, the Engineer may require the Contractor to file with the City a certified copy of the subcontract or agreement he has with such Subcontractor or other persons or organization and/or a certified copy of any agreement that such Subcontractor or other person or organization has with any other person or organization for performing work under the contract.

No subcontracts, or transfer of contract, shall in any case release the Contractor of his liability under the contract and bonds.

4.16 NOTICE TO PROCEED

After the contract has been executed, the Engineer will issue to the Contractor a "Notice to Proceed" which notice will stipulate the date on or before which the Contractor is expected to begin work. The date which will be specified in the notice will be at least fourteen (14) calendar days subsequent to the date of issuance of the "Notice to Proceed." The specified contract time shall begin on the day work actually starts or on the date stipulated in the "Notice to Proceed," whichever is earlier. No work is to be started before receipt of the "Notice to Proceed."

4.17 WORK SCHEDULE AND PROSECUTION OF WORK

The Contractor, prior to the notice to proceed, will be required to submit for the Engineer's approval his proposed work schedule in detail including proposed dates for ordering and receiving construction materials and similar items which will control the items of work. His proposed work schedule shall be based on the number of working

days, calendar days, or other increments as set forth in the contract, that he expects to require in completing the project, recognizing the capabilities of his labor, equipment, arrangements for materials, and other related matters. The submission of a proposed work schedule will not entitle the Contractor to an increase in the contract time.

If the Contractor delays submission or resubmission of his work schedule, list of subcontractors (if anticipated) for approval, or list of material sources, the Engineer reserves the right to issue the notice to proceed (or serve notice) so that working days will commence after fourteen (14) days. Such a notice will contain a warning that required submissions must be made and approved before work may begin.

The accumulative number of working days shall be reviewed, verified, and signed by the Contractor's representative, and the Engineer's Inspector, at the end of each two week period; the accumulative working days also will be shown on the Contractor's estimates for partial and final payments. The Contractor's signature on the estimates will indicate that he is in agreement with the accumulative working days shown thereon.

The Contractor shall start construction operations on that part of the project designated by the Engineer, or set forth in the work schedule and the work shall be conducted in such manner and with sufficient materials, equipment, and labor as are considered necessary to insure its completion in accordance with the plans and specifications as interpreted by the Engineer, within the time set forth in the proposal.

Should the prosecution of the work for any reason be discontinued, the Contractor shall notify the Engineer at least 24 hours in advance of resuming operations.

4.18 LIMITATION OF OPERATIONS

The Contractor shall conduct the work at all times in such a manner and in such sequence as will insure the least interference with traffic. He shall have due regard to the location of detours and to the provisions for handling traffic. He shall not open up work to the prejudice or detriment of work already started, and the Engineer may require the Contractor to finish a section on which work is in progress before work is started on any additional sections.

4.19 CHARACTER OF WORKMEN AND EQUIPMENT

In the construction of all public works for the City, or by persons contracting with the City, preference in employment of laborers, workmen, or mechanics, shall be given to bona fide legal citizens of the State, who have established citizenship by residence of at least 90 days in the State.

If any of these provisions conflict or is inconsistent with any statute, rule or regulation of the Federal government applicable to a project or activity, the cost of which is to be paid or reimbursed in whole or in part, by the Federal Government, and due to such conflict or inconsistency the availability of Federal funds may be jeopardized, such provision shall not apply to such project or activity.

For all contracts which are identified as Federal-aid projects by having a Federal-aid number inserted in the appropriate space on the cover sheet of the proposal, if there is a conflict between the above and Federal Law, the requirements of the above shall not apply.

The Engineer shall give instructions and orders to the superintendent or foreman. The Contractor shall employ only competent and efficient laborers, mechanics, or artisans.

Whenever, in the opinion of the Engineer, any employee is careless or incompetent, obstructs the progress of the work, acts contrary to instructions of the superintendent or foreman, or conducts himself improperly, the Contractor shall, upon the request of the Engineer, discharge him from the work and shall not again employ him on the contract except with the written consent of the Engineer.

All machinery and equipment owned or controlled by the Contractor which is proposed to be used by him on the work, shall be of sufficient size and such mechanical condition as to meet the requirements of the work and to produce a satisfactory quality of work. When in the opinion of the Engineer the equipment used for excavating is disturbing the material on which the subbase is placed so that undercutting or special treatment of the subgrade is required, the Contractor shall remove the equipment when directed and make the necessary corrections in the disturbed area at his expense.

When the methods and equipment to be used by the Contractor in accomplishing the construction are not prescribed in the contract, the Contractor is free to use any methods or equipment that he demonstrates to the satisfaction of the Engineer which will accomplish the contract work in conformity with the requirements of the contract.

When the contract specifies that the construction be performed by the use of certain methods and equipment, such methods and equipment shall be used unless others are authorized by the Engineer. If the Contractor desires to use a method or type of equipment other than those specified in the contract, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the Engineer determines that the work produced does not meet

contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining construction with the specified methods and equipment. The Contractor shall remove the deficient work and replace it with work of specified quality, or take such other corrective action as the Engineer may direct. No change will be made in basis of payment for the construction items involved nor in contract time as a result of authorizing a change in methods or equipment under these provisions.

4.20 LAWS TO BE OBSERVED

The Contractor at all times shall observe and comply with all Federal, State, Local and Municipal Laws, ordinances, rules and regulations in any manner affecting the work, and all such orders or decrees as exist at present and those which may be enacted later, of bodies or tribunals having any jurisdiction or authority over the work, and shall indemnify and save harmless the Owner and all its officers, agents, and servants against any claim or liability arising from or based on the violation of any such law, ordinance, rule, regulation, order or decree, whether such violations be by the Contractor or any Subcontractor or any of their agents and/or employees.

4.21 CONSTRUCTION STAKES

The Engineer will furnish and set control and construction stakes in accordance with the following, unless otherwise specified:

(a) Grading Construction

Stakes locating the right of way limits. Stakes and bench marks establishing horizontal and vertical control including center line curvature reference points, for the length of the project.

(b) Paving Construction

Line and grade stakes indicating elevations, centerline and/or edge of pavement for one edge of one lane only at interval frequency determined by the Engineer.

(c) Bridge Construction

Stakes locating the designated longitudinal reference line common to the roadway and the structure, transverse reference line for each abutment and pier and necessary bench marks.

(d) **Miscellaneous Construction**

All necessary line and grade stakes for storm pipe, catch basins and manholes. Principal stakes for utility relocation work which will be performed by the Contractor.

(e) **Construction for Extra Work**

Stakes establishing lines and grades for Extra Work not shown on the project plans.

The Engineer will furnish the Contractor all necessary information relating to lines, slopes and grades and the stakes and marks mentioned herein shall constitute the reference control by and in accordance with which the Contractor shall establish other necessary field controls and perform the work. To insure accurate control, the Contractor shall employ qualified engineering personnel and shall furnish and set stakes of the quality used by the Department of Public Works for control staking. Rough material stakes may be used by the Contractor to denote top and bottom of slopes, edges of pavement, gutter lines, etc.

The Engineer may check the control of the work as progressed by the Contractor. The Contractor may be informed of results of this check, but the Engineer by so doing in no way relieves the Contractor of his responsibility for accuracy of the field control.

The Contractor shall be held responsible for the preservation of all stakes and marks placed by the Engineer and if any have been destroyed or disturbed, the cost of replacing them may be charged against him and will be deducted from the payment for the work. If directed, the Contractor shall construct protective devices around the City's control points.

Before commencing work, the Contractor must satisfy himself as to the correctness and meaning of all stakes, marks and measurements. No claim will be entertained because of alleged inaccuracies unless the Contractor notifies the Engineer about them in time for the Engineer to check the measurement before work is begun.

4.22 MAINTENANCE DURING CONSTRUCTION

The Contractor shall maintain the work during construction and until the work is finally accepted. This maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces to the end that the roadway or structures, are kept in satisfactory condition at all times.

The operation of equipment of such weight or so loaded as to cause damage to

drainage structures or the roadway or to any other type of construction either being constructed or reconstructed will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed, and in no case shall legal road limits be exceeded unless permitted in writing. No loads will be permitted on a concrete pavement, base or structure before the expiration of the curing period. The Contractor shall be responsible for all damage done by his hauling equipment.

In the case of a contract for the placing of a surface course or courses upon a subgrade previously constructed under a separate contract, the Contractor shall be required to maintain the subgrade ahead of other operations covering the preparation and conditioning of the subgrade.

All cost of maintenance work during construction and before the work is finally accepted shall be included in the unit prices bid on the various pay items and the Contractor will not be aid an additional amount for such work.

In the event that the Contractor's work is ordered shut down for failure to comply with the provisions of the contract, the Contractor shall maintain the roadway and structures as provided herein, and provide such ingress and egress for local residents as may be necessary during the period of suspended work or until the contract has been declared in default.

4.23 FAILURE TO MAINTAIN ROADWAY OR STRUCTURES

Failure on the part of the Contractor, at any time to comply with the provisions of Subsection 4.22 will result in the Engineer immediately notifying the Contractor to comply with the required maintenance provisions. In the event that the Contractor fails to remedy unsatisfactory maintenance within 24 hours after receipt of such notice, the Engineer will immediately proceed with adequate forces and equipment to maintain the project, and the entire cost of this maintenance will be deducted from monies due the Contractor on his contract.

4.24 FEDERAL PARTICIPATION

When the United States Government pays all or any portion of the cost of a project, the Federal Laws authorizing such participation and the rules and regulations made pursuant to such laws must be observed by the Contractor, and the work shall be subject to the inspection of the appropriate Federal agency.

Such inspection shall in no sense make the Federal Government a party to this contract and will in no way interfere with the rights of either party hereunder.

4.25 CONSTRUCTION SAFETY, HEALTH, AND SANITARY STANDARDS

It is a condition of all contracts, and shall be made a condition of each subcontract entered into pursuant to the prime contract that the Contractor and any subcontractor shall not require any laborer or mechanic employed in performance of the contract to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health or safety, as determined under construction safety, and health standards (Title 29, Code of Federal Regulations, Part 1518 - published in the Federal Register on April 17, 1971) promulgated by the United States Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act, (83 Stat. 96).

The Contractor shall provide and maintain, in a neat, sanitary condition, such accommodations for the use of his employees as may be necessary to comply with the requirements of the State and Local Boards of Health, or of other bodies or tribunals having jurisdiction.

4.26 PUBLIC CONVENIENCE AND SAFETY

In carrying on the work, the Contractor shall interfere as little as possible with traffic. The Contractor shall provide and maintain ingress and egress for all residences and places of business located along the construction route. So far as practicable, materials stored upon the highway shall be placed so as to cause as little obstruction to the traveling public as possible. If, as determined by the Engineer, it is necessary to keep the road or any portion of it open to travel during the construction thereof, the Contractor shall so carry on the work and provide such means that travel will not be obstructed or endangered. The Contractor shall provide and maintain in an acceptable condition such temporary roadways and bridges as may be necessary to accommodate the traffic using or diverted from the roadway under construction, and shall provide and maintain in a safe condition temporary approaches to and crossing of intersecting highways. Fire hydrants on or adjacent to the highway shall be kept accessible to fire apparatus at all times and no material or obstruction shall be placed within 15 feet of any such hydrant. All footways, gutters, sewers, inlets, and portions of highways adjoining the roadways under construction shall not be obstructed more than is absolutely necessary. Work closed down for the winter and at all other times shall be left entirely accessible at all points to fire apparatus. The Contractor shall not disturb the surface of an existing road farther in advance of the new construction than can be completed in a reasonable length of time as determined by the Engineer.

4.27 BARRICADES AND WARNING SIGNS

The Contractor shall provide and maintain all traffic control devices that furnish information, protection and safety to the traveling public and such other traffic control devices as are deemed necessary by the Engineer. The use and application of all traffic control devices shall meet the standards as given in the Manual on Delaware Traffic Controls for Street and Highway Construction, Maintenance, Utility and Emergency Operations.

4.28 MAINTENANCE OF TRAFFIC

When the contract provides for the maintenance of traffic, the road while undergoing improvements shall be kept open to all traffic by the Contractor. Where so provided on the plans or in the Special Provisions, the Contractor may by-pass traffic over an approved detour route. The Contractor shall keep the portion of the road being used by public traffic in such condition that traffic will be adequately accommodated. He shall also provide and maintain in a safe condition temporary approaches to crossings, intersections, roads, streets, businesses, parking lots, residences, garages and farm; snow removal will be required of the Contractor.

In addition to the provisions required under Section 4.26 and 4.27 of these Specifications, the Contractor shall also comply with the Manual on Uniform Traffic Controls for Street and Highway Construction, Maintenance, Utility and Emergency Operations.

This manual may be obtained from the Delaware Department of Transportation, Dover, Delaware.

4.29 USE OF EXPLOSIVES

When the use of explosives is necessary for the prosecution of the work, the Contractor shall exercise the utmost care not to endanger life or property, including new work. The contractor shall be responsible for all damage resulting from the use of explosives.

All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. Where no local laws or ordinances apply, storage shall be provided satisfactory to the Director and in general not closer than 1,000 feet from the road or from any building or camping area or place of human occupancy.

The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

The use of explosives will not be permitted within 200 feet of any existing, newly finished, or partly finished structure on a project unless authorized in writing by the Engineer. No explosives shall be stored overnight on the project.

4.30 PROTECTION AND RESTORATION OF PROPERTY

The plans will show as accurately as possible, and the Contractor shall be responsible for the preservation of all public and private property, trees, monuments, etc., along and adjacent to the roadway not designated on the plans for repair, removal or construction. He shall exercise the precautions necessary to prevent damage to pipes, conduits, and other underground structures, and shall protect carefully from disturbance or damage all land monuments and property markers until an authorized representative of the Public Works Department has witnessed or otherwise referenced their location and shall not remove them until so directed. Any land monument and/or property markers shall be located and reset by Registered Land Surveyors. The contractor shall not injure or destroy trees or shrubs outside the limits of the graded roadway section, nor remove or cut them without proper authority. Where any direct or indirect damage is done to public or private property on account of any act, omission, neglect, or misconduct in the execution of the work or in consequence of the nonexecution thereof on the part of the Contractor, such property shall be restored by the Contractor at his expense to a condition similar or equal to that existing before such damage.

In case of the failure on the part of the Contractor to restore such property or make good such damage, the Engineer may upon 48 hours notice proceed to repair, rebuild, or otherwise restore such property as may be deemed necessary, and the cost thereof will be deducted from any monies due or which may come due the Contractor under the contract.

4.31 RESPONSIBILITY FOR DAMAGE CLAIMS

The contractor shall indemnify and save harmless the City, its officers and employees, from all suits, actions, or claims, of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the said contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work or because of any act or omission, neglect or misconduct of said Contractor; or because of any claims or amounts recovered from any infringements of patent,

trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, ordinance, order or decree; and so much of the money due the said Contractor under and by virtue of his contract as may be considered necessary by the City for such purpose may be retained for the use of the City or, in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the City; except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he is adequately protected by public liability and property damage insurance.

4.32 OPENING OF SECTION OF HIGHWAY TO TRAFFIC

The work shall not be opened to traffic until authorized by the Engineer. If any or all of the work is opened to traffic by order of the Engineer prior to final acceptance for the convenience of the traveling public, repairs to damage of any item attributable to traffic shall be compensated for at the unit price bid or at an agreed price, whichever is applicable. Any damage to the highway not attributable to traffic which might occur on such section, shall be repaired by the Contractor at this expense. The Contractor shall at no time use any part of the finished pavement for the transportation or operation of heavy equipment such as tractors, earth-moving equipment, shovels, concrete mixers, etc., except by written permission of the Engineer.

4.33 CONTRACTOR'S RESPONSIBILITY FOR WORK

Until final written acceptance of the work by the Engineer, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof by the action of the elements, or from any other cause whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of governmental authorities.

In case of suspension of work, the Contractor shall be responsible for the project and shall take such precautions as may be necessary to prevent damage to the project, provide for normal drainage and normal traffic operations, and to erect any necessary temporary structures, signs, or other facilities at his expense. during such period of suspension of work, the contractor shall properly and continuously maintain in an

acceptable growing conditions all living material in newly established plantings, seedings, soddings furnished under his contract, and shall take adequate precautions to protect new tree growth and other vegetative growth against injury.

4.34 FURNISHING RIGHT OF WAY

The City will be responsible for the securing of all necessary rights of way in advance of construction. Any exceptions will be indicated in the contract.

4.35 PERSONAL LIABILITY OF PUBLIC OFFICIALS

The City, Director, Engineer or their authorized agents shall incur no personal liability as a result of carrying out any of the provisions of the contract, as the result of exercising any power or authority granted to them thereby, or as the result of any act by the Contractor. In such matters they act as the agents and representatives of the City.

4.36 NO WAIVER OF LEGAL RIGHTS

The City shall not be estopped by estimate or certificate made or given by the Engineer or his agents either before or after the final completion and acceptance of the work and payment therefore from showing the true and correct amount, quality, and character of the work done and materials furnished by the Contractor or any other person under this agreement or from showing at any time that any such estimate or certificate is untrue and incorrect, or improperly made in any particular or that the work or materials, or any part thereof, do not in fact conform to the contract; and the City shall not be estopped, notwithstanding any such estimate or certificate and payment in accordance therewith, from demanding and recovering from the Contractor and surety such damages as it may sustain by reason of his failure to comply with the terms of the contract.

4.37 INSPECTION AND TESTING OF MATERIALS

All materials and equipment used in the construction of the project shall be subject to adequate inspection and testing in accordance with accepted standards. The laboratory or inspection agency shall be selected by the Owner. The Contractor will pay for all laboratory inspection service direct, and not as a part of the contract.

Materials of construction, particularly those upon which the strength and durability of the structure may depend, shall be subject to inspection and testing to establish conformance with specifications and suitability for users intended.

4.38 STORAGE OF MATERIALS

Materials shall be stored or stock-piled so as to insure preservation of their quality and fitness for the work. Unless otherwise permitted, they shall be placed on hard and clean surfaces. Stockpiles of stone, slag or gravel shall be built in horizontal layers not exceeding 3 feet in depth in order to avoid segregation.

The methods of storing and protecting materials must be satisfactory to the Engineer and any materials improperly stored will not be approved for use.

4.39 HANDLING MATERIALS

All materials shall be handled carefully and in such manner as to preserve their quality and fitness for the work. They shall be transported from the storage site to the work in tight vehicles so constructed as to prevent loss or segregation of materials after loading and measuring in order that there may be no inconsistencies in the quantities and quality of materials intended for incorporation in the work, and the quantities as actually received at the place of operations.

4.40 UNACCEPTABLE MATERIALS

All materials not conforming to the requirements of these Standard Specifications shall be considered as defective and whether in place or not shall be rejected and removed from the project. No material which has been rejected, the defects of which have been removed or corrected, shall be used until approval has been given. Should the Contractor fail to remove and properly dispose of rejected material immediately after receiving notice, the Engineer may employ labor to remove such material and may charge the cost to the Contractor.

4.41 EQUAL OR APPROVED EQUAL

Where any article or thing is specified by proprietary name, trade name, and/or manufacturers name, with or without the addition of such expressions as "or equal," or "approved equal" (See Subsection 2.14), it is to be understood that the article named or the equal thereof, is intended, subject to the approval of the Engineer as to the equality thereof, and it is distinctly understood (1) that the Engineer is to use his own judgment in determining, from time to time whether or not any article or thing proposed to be substituted is the equal of any article or thing specified; (2) that the decision of the Engineer on all such questions of equality shall be final; and (3) that in the event of any adverse decision by the Engineer, no claim of any sort shall be made or allowed against the Engineer or the City.

An offer of an article or materials by the Contractor for an article or material specified, will raise the presumption that it is for the purpose of saving money. If, in such case, the article or material is approved, the Owner shall be given credit as follows: the difference in the net cost to the Contractor of the article or material submitted and the price at which he could have obtained the lowest priced article or material specified. For convenience in checking the credit, if any, the Contractor shall submit these figures when the offer is made, and no article or materials will be considered without such figures.

4.42 WATER SUPPLY

The Contractor shall at his own cost and expense provide such quantities of clean water as may be required for any and all purposes under the contract. He shall supply sufficient drinking water to all his employees, but only from such sources as are approved by the Engineer, and no other water shall be used for drinking purposes.

The use of a fire hydrant for obtaining water for any purpose other than extinguishing a fire is strictly prohibited and punishable by fine, as stipulated in Article IV, Section 30-44(b) of the Municipal Code.

4.43 DATUM

The datum, from which all elevations mentioned herein or shown on the drawings are measured, is the datum determined and used by the City of Newark.

4.44 AUTHORITY OF THE ENGINEER

All work shall be done under the supervision of the Engineer and performed to his satisfaction. He shall decide all questions which may arise as to the quality and acceptability of materials furnished and work performed and as to the manner of performance and rate of progress of the work; all questions which may arise as to the interpretation of the plans and specifications; all questions as to the acceptable fulfillment of the contract on the part of the Contractor; all disputes and mutual rights between contractors; and all questions as to compensation. The Engineer will have the authority to suspend the work, wholly or in part, due to the failure of the Contractor to correct conditions unsafe for the workmen or the general public; for failure to carry out provisions of the contract; for failure to carry out orders; for such periods as he may deem necessary due to unsuitable weather; for conditions considered unsuitable for the prosecution of the work or for any other condition or reason deemed to be in the public interest.

4.45**AUTHORITY AND DUTIES OF INSPECTORS**

Inspectors employed by the Department of Public Works are authorized to inspect all work done and all material furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. The inspector is not authorized to revoke, alter or waive any requirements of the specifications. He shall call the attention of the Contractor to any failure of the work or materials to conform to the specifications and the contract. He shall have the authority to reject materials or suspend the work until any questions at issue can be referred to and decided by the Engineer. Such inspection will not relieve the Contractor from his obligation to perform the work in accordance with the requirements of the plans, specifications and contract.

The inspector shall in no case act as foreman or perform other duties for the Contractor, nor interfere with the management of the work by the latter. Any advice which the inspector may give the Contractor shall in no way be construed as binding the Engineer in any way or releasing the Contractor from fulfilling all of the terms of the contract.

If the Contractor refuses to suspend operations on oral order, a written order giving the reason for shutting down the work shall be issued. After placing the order in the hands of the Contractor's representatives in charge, the inspector shall immediately leave the job. Work done during the absence of the inspector will not be accepted or paid for.

4.46**INSPECTION OF WORK**

All materials and each part or detail of the work shall be subject at all times to inspection by the Engineer or his authorized representative. Such inspection may include mill, plant, or shop inspection, and any material furnished under these specifications is subject to such inspection. The Engineer or his representative shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed shall be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed, shall be at the

Contractor's expense.

Any work done or materials used without supervision or inspection by a Department of Public Works representative may be ordered removed and replaced at the Contractor's expense.

When any unit of government or political subdivision or any railroad corporation is to pay a portion of the cost of the work covered by this contract, its respective representatives shall have the right to inspect the work. Such inspection shall in no sense make any unit of government or political subdivision or any railroad corporation a party to this contract, and shall in no way interfere with the rights of either party hereunder.

4.47 REMOVAL OF DEFECTIVE AND UNAUTHORIZED WORK

Defective or unauthorized work shall be removed and disposed of immediately upon rejection. Work done without lines and grades being given or work done beyond the lines and grades shown on plans or any extra work done without written authority will be considered as unauthorized and will not be measured or paid for by the City; work so done may be ordered removed and replaced at the Contractor's expense. Failure of the Contractor to remove and properly dispose of rejected work immediately after receiving formal notice to do so shall be sufficient cause for the termination of the contract, in which case the Engineer pay purchase materials, tools, and equipment, and employ labor, or may contract with any other individual, firm, or corporation to perform the work. All costs and expense incurred thereby shall be charged against the defaulting contractor and the amount thereof deducted from any monies due or which may become due him or shall be charged against the contract bond deposited. Any work performed as described in this Subsection shall not relieve the Contractor in any way from his responsibility for the work performed.

4.48 LOAD RESTRICTIONS

The Contractor shall comply with all legal load restrictions in the hauling of materials or equipment on public roads beyond the limit of the project. A hauling permit or special permit will not relieve the Contractor of liability for damage to public or private property which may result from movement of such loads or equipment.

4.49 PLANS AND WORKING DRAWINGS

Plans, consisting of general drawings and showing such details as are necessary to give a comprehensive idea of the construction contemplated, will be furnished by the Department of Public Works. Roadway plans will show alignment, profile grade and typical cross-sections of the improvements. Structure plans will, in general, show in

detail all dimensions of the work contemplated. When the structure plans do not show all dimensions and details, they will show general features and such details as are necessary to give a comprehensive idea of the structure.

The Contractor shall furnish, on the size sheets required, such working and detail drawings, not furnished by the Department of Public Works, as may be required for any part of the finished structure. These drawings shall be submitted in sufficient time to allow discussion and correction prior to beginning the work they cover. Prior to the approval of these drawings, any work done or materials ordered for the structures involved shall be at the Contractor's risk. One set of these drawings shall be returned to the Contractor approved or marked with corrections to be made; the other sets will be retained by the Engineer.

Working drawings for steel structures shall consist of shop detail, erection, and other working plans showing details, dimensions, sizes of material, and other information necessary for the complete fabrication and erection of the metal work.

Working drawings for concrete structures shall consist of such detailed plans as may be required for the successful prosecution of the work and which are not included in the plans furnished by the Department of Public Works. These may include plans for falsework, bracing, centering and form work and masonry layout diagrams.

Approval by the Engineer of the Contractor's working drawings shall not operate to relieve the Contractor of any of his responsibility under the contract for the successful completion of the work.

The contract price shall include the cost of furnishing all working drawings, and the Contractor will be allowed no extra compensation for such drawings.

4.50 CONFORMITY WITH PLANS AND SPECIFICATIONS

All work performed and all materials furnished shall be in reasonably close conformity with the lines, grades, cross-section, dimensions, and material requirements, including tolerances, shown on the plans or indicated in the specifications.

In the event the Engineer finds the materials or the finished product in which the materials are used not within reasonably close conformity with the plans and specifications but that reasonably acceptable work has been produced, he shall then make a determination if the work shall be accepted and remain in place. In this event, the Engineer will document the basis of acceptance by contract modification which will provide for an appropriate adjustment in the contract price for such work or materials as he deems necessary to conform to his determination based on engineering judgment.

In the event the Engineer finds the materials or the finished product in which the materials are used or the work performed are not in reasonably close conformity with the plans and specifications, and have resulted in an inferior or unsatisfactory product, the work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

4.51 SILENCE OF SPECIFICATIONS

The apparent silence of Specifications, Plans, Special Provision and Supplemental Specifications as to any detail or the apparent omission from them of a detailed description concerning any point shall be regarded as meaning that only the best general practice is to be used. All interpretations of these specifications will be made on the above basis.

4.52 COORDINATION OF PLANS, SPECIFICATIONS, SUPPLEMENTAL SPECIFICATIONS, AND SPECIAL PROVISIONS

These specifications, the supplemental specifications, the plans, special provisions, and all supplementary documents are essential parts of the contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In the event of any discrepancy between the drawings and figures written thereof, the figures, unless obviously incorrect, are to govern over scaled dimensions. In the case of any discrepancy between the plans and specifications, the plans are to govern. If there is a discrepancy between these standard specifications and supplemental specifications, the supplemental specifications are to govern. Special provisions shall govern over specifications, supplemental specifications, and plans.

If, in the progress of the work, the Contractor should discover any errors or omissions in the plans, specifications, or lines and grades furnished by the Department of Public Works, or in the work undertaken and executed by him, he shall immediately notify the Engineer and shall not proceed with the work until corrections shall have been made.

4.53 CLEANING UP

The Contractor shall, at his own expense, keep the sites of his operations clean during construction and remove all rubbish as it accumulates.

Upon failure of the Contractor to keep the sites of his operations clean to the satisfaction of the Engineer, the Owner may, upon twenty-four (24) hours notice to the Contractor, remove any rubbish, materials, earth, etc. which the Engineer may

deem necessary charging the cost thereof to the Contractor and may deduct the amount from any money that may be due him. On or before the completion of the work the Contractor shall, without charge therefor, tear down and remove all his buildings and temporary structures built by him, shall remove all rubbish of all kinds from any grounds which he has occupied, and shall leave the site of the work in a clean and neat condition.

4.54 TEMPORARY SUSPENSION OF WORK

The Engineer shall have the authority to suspend the work wholly or in part, for such period or periods as he may deem necessary, due to unsuitable weather, or such other conditions as are considered unfavorable for the suitable prosecution of the work, or for such time as is necessarily due to the failure on the part of the Contractor to carry out orders given or perform many or all provisions of the contract. If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such manner that they will not obstruct or impede the traveling public unnecessarily nor become damaged in any way, and he shall take every precaution to prevent destruction, damage, or deterioration of the work performed, provide suitable drainage by opening ditches, shoulder drains, etc. and erect temporary structures where necessary. The Contractor shall not suspend the work without authority. Neither the failure of the Engineer to notify the Contractor to suspend work on account of bad weather or other unfavorable conditions, nor permission by the Engineer to continue work during bad weather or other unfavorable conditions, shall be a cause for the acceptance of any work which does not comply in every respect with the contract and specifications.

4.55 ANNULMENT OF CONTRACT

If the Contractor fails to begin the work under the contract within the time specified, or fails to perform the work with sufficient skilled workmen and proper equipment and/or with sufficient proper materials and insure the prompt completion of said work, except in case for which an extension of time is provided, or shall perform the work unsuitably or neglect or refuse to promptly remove materials or again promptly perform such work as shall be rejected as defective or unsuitable, or shall discontinue the prosecution of the work, or if the Contractor shall become insolvent or be declared bankrupt, or commit any act of bankruptcy or insolvency or allow any final judgment to stand against him unsatisfied for a period of forty-eight (48) hours, or shall make an assignment for the benefit of creditors, or shall fail to make prompt payment to all Subcontractors and/or material men for material and/or labor supplied, or shall persistently disregard any State, Federal Local, or Municipal laws, ordinances, rules and regulations pertaining to the work, or shall disregard the instructions of the Engineer, or from any other cause whatsoever shall not carry on the work in an acceptable manner, the Engineer may give notice in writing, mailed to the Contractor

and/or his Surety of such delay, neglect or default, specifying the same, and if the Contractor within a period of three (3) days after such written notice is mailed, shall not proceed in accordance therewith, then the Owner shall upon written certificate from the Engineer of the fact of such delay, neglect or default, and the Contractor's failure to comply with such notice, have full power and authority without prejudice to any of its other rights or remedies and without violating the contract, to terminate the employment of the Contractor and to take the prosecution of the work out of the hands of said Contractor, and to take possession of the premises and to appropriate or use any or all materials, appliances and equipment on the premises, and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in its opinion, shall be deemed expedient and necessary for the completion of said contract in accordance with the plans and specifications. In the event of any of the aforementioned circumstances arising at any time or times, the Owner shall have the right to withhold, without the payment of interest, any such sums of money due or to become due the Contractor until the interests of the Owner have been fully protected to the satisfaction of the Engineer. All costs and expenses incurred by the Owner, together with the costs of completing the work under the contract including the cost of additional managerial and administrative services if any, shall be deducted from any monies due or which may become due said Contractor. In case the expense so incurred by the Owner shall be less than the sum which would have been payable under the contract if it had been completed by said Contractor, then the said Contractor shall be entitled to receive the difference; and in case such expense shall exceed the sum which would have been payable under the contract, the Contractor and/or the Surety shall be liable therefor, and shall pay the amount of the difference to the Owner within ten (10) days after written notice mailed to the Contractor and/or Surety. The expense, loss or damage including the cost of additional managerial and administrative services, if any, incurred by the Owner through the Contractor's default shall be certified by the Engineer, and such certifications shall be conclusive and recognized and accepted as the correct amount of the loss sustained by the Owner by any and all parties concerned.

4.56 MATERIALS AND WORK NOT PAID FOR BY THE CONTRACTOR

When written notice is given to the Engineer, before or within sixty (60) days after the completion and conditional acceptance of the entire work under the contract by persons having done work or furnished materials for such contract, that there is money due and unpaid for said work and materials, the Contractor shall furnish the Engineer with satisfactory evidence (by submission of release of liens) that said money has been fully paid or satisfactorily secured by him. And in case such evidence is not furnished as aforesaid, such amounts as may be necessary to meet the claims of the persons aforesaid may be retained from any money due the Contractor under the contract until the liabilities aforesaid shall be fully discharged or such notices withdrawn. The Owner or the Engineer may also, with the written consent of the

Contractor, use any money retained, due or to become due under the contract, for the purpose of paying or both labor and materials for the work, for which claims have been filed in the office of the Engineer.

4.57 EROSION CONTROL AND WATER POLLUTION

The Contractor shall schedule and conduct his operations to minimize erosion of soils and to prevent silting and muddying of streams, rivers, irrigation systems and impoundments (lakes, reservoirs, etc.). Construction of drainage facilities and performance of other contract work which will contribute to the control of erosion and sedimentation shall be carried out in conjunction with earthwork operations or as soon thereafter as practicable. The area of bare soil exposed at any one time by construction operations shall be kept to a minimum.

Prior to suspension of construction operations for appreciable lengths of time, the Contractor shall shape the earthwork in a manner that will permit storm runoff with a minimum of erosion. Temporary erosion and sediment control measures such as berms, dikes, slope drains, or sedimentation basins deemed necessary by the Engineer shall be provided and maintained until permanent drainage facilities and erosion control features are completed and operative. Unless otherwise provided for in the contract, temporary erosion control measures will not be paid for directly, but will be considered as a subsidiary obligation of the Contractor covered under the various contract items of work.

The Contractor shall also conform to the following practices and controls:

1. When borrow material is obtained from other than commercially operated sources, erosion of the borrow site shall be so controlled both during and after completion of the work that erosion will be minimized and sediment will not enter streams or other bodies of water. Waste or disposal areas and construction roads shall be located and constructed in a manner that will keep sediment from entering streams.
2. Frequent fording of live streams will not be permitted; therefore, temporary bridges or other structures shall be used wherever an appreciable number of stream crossings are necessary. Unless otherwise approved in writing, mechanized equipment shall not be operated in live streams.
3. When work areas or gravel pits are located in or adjacent to live streams, such areas shall be separated from the main stream by a dike or other barrier to keep sediment from entering a flowing stream. Care shall be taken during the construction and removal of such barriers to minimize the muddying of a stream.

4. All waterways shall be cleared as soon as practicable of falsework, piling, debris or other obstructions placed during construction operations and not a part of the finished work.
5. Water from aggregate washing or other operations containing sediment shall be treated by filtration, a settling basin or other means sufficient to reduce the sediment content to not more than that of the stream into which it is discharged.
6. Pollutants such as fuels, lubricants, bitumens, raw sewage and other harmful materials shall not be discharged into or near rivers, streams, and impoundments or into natural or manmade channels leading thereto. Wash water or waste from concrete mixing operations shall not be allowed to enter live streams.
7. All applicable regulations of fish and wildlife agencies and statutes relating to the prevention and abatement of pollution shall be complied with in the performance of the contract.
8. It shall be the responsibility of the Contractor to comply with all applicable regulations regarding any open burning operations carried out during the conduct of this contract.

When it becomes necessary, the Engineer will inform the Contractor of unsatisfactory construction procedures and operations insofar as erosion control and water pollution are concerned. If the unsatisfactory construction procedures and operations are not corrected promptly, the Engineer may suspend the performance of other construction until the unsatisfactory condition has been corrected. There will not be any adjustment of contract time for suspension of other work in the event it is necessary to suspend the other work until correction of unsatisfactory control of erosion and water pollution has been accomplished.

4.58 SOURCE OF SUPPLY AND QUALITY REQUIREMENTS

The material used on the work shall meet all the requirements of the contract. In order to expedite the inspection and testing of material, the Contractor shall promptly notify the Engineer of his proposed sources of material and in no case shall material be incorporated into the project without prior approval. At the option of the Engineer materials may be approved at the source of supply before delivery is started. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources. No material, which after approval has in any way become unfit for use, shall be used

in the work.

The approval of material represented by any sample or samples shall not be considered as an approval of all materials from the same sources, and it shall be understood that all materials delivered on the work are subject to test at any time and will be rejected if they do not meet the requirements of these Standard Specifications.

4.59 SAMPLES, TEST, CITED SPECIFICATIONS

All materials shall be inspected, tested and approved before being incorporated in the work and any work in which materials are used without prior test and approval or written permission of the Engineer shall be performed at the Contractor's risk and may be considered as defective and unauthorized and will not be paid for. Final acceptance of materials will be made at the latest practicable time the Engineer has the opportunity to check compliance prior to or during the incorporation of materials into the work. Tests will be made by and at the expense of the Contractor, unless otherwise noted in the contract. Unless otherwise designated, when a reference is made in the specifications to a specification or test designation either of AASHTO, ASTM, Federal Specifications or any other recognized national organization, it shall mean the specification or test method (including Interim AASHTO and Tentative ASTM) which is current on the date of advertisement for bids. Samples shall be taken by or under the direction of a representative of the Department of Public Works. All materials being used are subject to inspection, test or rejection at any time during the preparation and use.

4.60 PLANT INSPECTION

If the volume of the work, construction progress, and other considerations warrant, the Engineer may undertake the inspection of materials at the source.

Plant inspection will be undertaken only upon condition that:

1. The cooperation and assistance of the Contractor and the producer with whom he has contracted for materials is assured.
2. The representative of the Engineer shall have full entry at all times to such parts of the plant as may concern the manufacture or production of the materials being furnished.
3. The Contractor or producer shall provide a laboratory that will permit the tests necessary to approve the materials.
4. It is understood that the Department of Public Works reserves the right to retest

all materials which have been tested and accepted at the source of supply after the same have been delivered and to reject all materials which, when retested, do not meet the requirements of these specifications.

4.61 CLAIMS FOR ADJUSTMENT AND DISPUTES

In the case where the Contractor believes that extra compensation is due him for work or material not clearly covered in the contract or not ordered by the Engineer as an extra, or the Contractor feels that he has encountered unusual and unforeseen conditions beyond his control, as defined herein, the Contractor shall notify the Engineer in writing of his intention to make claim for such extra compensation before he begins the work on which he bases the claim. If such notification is not given, and the Engineer is not afforded proper facilities by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive the claim for such extra compensation. Such notice by the Contractor, and the fact that the Engineer has kept account of the cost as aforesaid, shall not in any way be construed as proving the validity of the claim. In case the claim, after consideration by the Engineer, is found to be just, it shall be allowed and paid as an extra as provided herein for force account work. Nothing in this article shall be construed as establishing any claim contrary to the terms of Subsection 4.09.

4.62 RESOLUTION OF DISPUTES, DIFFERENCES, CONTROVERSIES CLAIMS AND DEMANDS

All disputes differences, controversies, claims and demands, arising out of, or relating to, the contract, the alleged breach thereof and/or the amount, character, quality, quantity, amount and value of any work done and materials furnished under, pursuant to or by reason of the contract, as well as any other matters in question arising out of, or relative to the contract, shall, in the absence of agreement by the Contractor and the Department of Public Works as to the resolution thereof, and upon the demand of either party delivered in writing to the other, be decided by arbitration in accordance with the Construction Industry Arbitration Rules of the American Arbitration Association then obtaining. This agreement to arbitrate shall be specifically enforceable as provided by and under Chapter 57, Title 10, Delaware Code as the same was enacted as Senate Substitute 2 to Senate Bill 425 by the General Assembly of the State of Delaware and signed by the Governor of the State of Delaware on April 30, 1972 and as the same may be hereafter amended from time to time.

4.63 CONFLICT OF LAW

The Contractor is presumed to know and shall strictly comply with all Federal, State or County laws, ordinances and regulations in any manner affecting the conduct of the work. The contractor shall indemnify and save harmless the City of Newark, the

Department of Public Works, and all officers, agents and servants thereof against any claim or liability arising from or based upon the violation of any such laws, ordinances, regulations, orders, or decrees whether by himself or by his employees.

If the Contractor should discover any provisions in the contract that are contrary to or inconsistent with any law, ordinance, regulation, order, or decree, he shall immediately report it to the Engineer in writing.

4.64 COOPERATION BY CONTRACTOR

The Contractor will be supplied with a minimum of two sets of approved plans and proposal assemblies including special provisions, one set of which the Contractor shall keep available on the work at all times.

Additional copies of the specifications will be supplied to the Contractor at five dollars (\$5.00) per copy and additional blue prints at five (5) cents per square foot.

The Contractor shall give the work the constant attention necessary to facilitate the progress thereof, and shall cooperate with the Engineer, his inspectors, and other contractors in every way possible.

The Contractor shall at all times have on the work, as his agent, a competent superintendent or foreman capable of reading and thoroughly understanding the plans and specifications and thoroughly experienced in the type of work being performed, who shall receive instructions from the Engineer or his representatives. The superintendent or foreman shall have full authority to execute the orders or directions of the Engineer without delay, and to promptly supply such materials, equipment, tools, labor and incidentals as may be required. Such superintendence shall be furnished irrespective of the amount of work sublet.

4.65 COOPERATION BETWEEN CONTRACTORS

The City reserves the right at any time to contract for and perform other or additional work on or near the work covered by the contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct his work so as not to interfere with or hinder the progress or completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other and in case of dispute, the Engineer shall be the referee and his decision shall be final and binding on all.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with his contract and shall protect and save harmless the City from any and all

damages or claims that may arise because of inconvenience, delay, or loss experienced by him because of the presence and operations of other contractors working within the limits of the same project and he shall assume all responsibility for all work not complete or accepted because of the presence and operations of the other contractors.

The Contractor shall as far as possible arrange his work and shall place and dispose of the materials being used so as not to interfere with the operations of the other Contractors within the limits of the same project. He shall join his work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

4.66 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICES

At points where the Contractor's operations are adjacent to properties of railway, telegraph, telephone, and power companies, or are adjacent to other property, damage to which might result in considerable expense, loss, or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made.

The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner and that duplication of rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted.

In the event of interruption to water or utility services as a result of accidental breakage, or as a result of being exposed or unsupported, the Contractor shall promptly notify the proper authority. He shall cooperate with the said authority in the restoration of service as promptly as possible. In no case shall interruption to water service be allowed to exist outside of working hours. No work shall be undertaken around fire hydrants until appropriate plans for continued service have been approved by the local fire authority.

It is the Contractor's responsibility to ascertain the location of all permanent and temporary facilities and appurtenances as shown on the plans or otherwise. The Contractor agrees to save the City harmless according to the terms of these specifications for any damage caused to said installations as a result of work done pursuant to the contract.

4.67**BASIS OF PAYMENT FOR LUMP SUM ITEMS**

When indicated on the plans and/or in the Special Provisions, certain items will be paid for on a lump sum basis. Where this occurs, the method of measurement and basis of payment indicated in these Standard Specifications for such items are deleted.

The Bidder should check the estimates and make his own appraisal of the amount of labor, equipment, and/or material required to complete the work in accordance with the plans and specifications. No allowance will be made or claims considered for any quantities used in completing the work in excess of those given in the proposal unless changes due to conditions encountered during construction become necessary and are authorized in writing by the Engineer. In such cases, additions or deductions will be made to or from the proposal quantities for the actual volume or amounts charged, with payment adjusted in accordance with the bid price of the item.

4.68**SCOPE OF PAYMENTS**

The Contractor shall receive and accept the compensation, as provided in the bid or Proposal, in full payment for furnishing all materials, labor, tools and equipment and for performing all work contemplated and embraced under the contract, also for all loss or damage arising out of the nature of the work, or from the action of the elements, or from any unforeseen difficulties or obstructions, which may arise or be encountered during the prosecution of the work, until its final acceptance by the Owner, and for all risks of every description connected with the prosecution of the work, until its final acceptance by the Owner, and for all risks of every description connected with the prosecution of the work also for all expenses incurred by, or in consequence of the suspension or discontinuance of the prosecution of the work as herein specified, and for any actual or alleged infringement of patent, trademark or copyright and for completing the work and the whole thereof, in an acceptable manner according to the plans and specifications. The payment of any current or final estimate, or of any retained percentage, shall in no way or in no degree prejudice or effect the obligation of the Contractor, at his own cost and expense, to renew, or replace any defects and imperfections in the construction of the work or in the strength of or quality of materials used in or about the construction of the work under contract and its appurtenances, as well as all damage due or attributable to such defects, which defects, imperfections, or damages shall be discovered on or before the final inspection and acceptance of the work, and of which defects, imperfections or damages the Engineer shall be the judge, and the said Contractor shall be liable to the owner for failure to do so.

The Contractor shall promptly make payments to all persons supplying labor and materials for the execution of the contract. The Engineer may require satisfactory evidence to that effect before the payment of any estimate, and such evidence must

be presented before the final acceptance and payment by the City.

4.69 EXTENSION OF TIME

If the Contractor finds that it will be impossible for him to complete the work on or before the time allowed by the contract, he shall, prior to the termination of such time, submit a written request to the Engineer for an extension of time for completion of the contract. He shall set forth fully therein the reasons which he considers would justify the Engineer in granting his request, and if requested by the Engineer shall submit a revised detailed work schedule which will show that the remaining work shall be completed on or before the requested extended completion date. If the Engineer finds that the work was delayed on account of unusual conditions beyond the control of the contractor, or that the quantities of work done or to be done are sufficiently in excess of the estimated quantities to warrant additional time, he will, with or without notice to the Surety, grant an extension of time for completion in such amounts as appears to him to be reasonable and proper. This new completion time shall thereafter be as binding upon the Contractor and Surety as if it appeared in the contract originally.

If any delay is caused to the Contractor by specific orders of the Engineer to stop work except as provided in Subsection 4.45 or by the failure of the Engineer to provide necessary instruction for carrying on the work, such delay will entitle the Contractor to an equivalent extension of time and the equivalent suspension of the liquidated damage charge.

When the satisfactory execution and completion of the contract requires more work or materials in greater amounts than set forth in the contract and such work can be shown to effect the contractor's schedule of progress, the Contractor shall be entitled to an extension of time. When the contractor is delayed by conditions beyond his control, the contract time shall be extended equal to the number of days he has been delayed.

4.70 PARTIAL PAYMENT

The Engineer shall once in each month make an estimate, in writing, of the total amount of work done on the contract and the value thereof to the date of such estimate, after receiving an invoice or request for payment of work completed by the Contractor on the contract.

From the total of the amount so ascertained will be deducted an amount equivalent to five (5) per centum of the whole to be retained by the Owner until after the completion of the entire contract, in an acceptable manner, and the balance or a sum equivalent to ninety-five (95) per centum of the whole, shall be paid to the Contractor by the Owner. The total amount deducted shall be retained until final completion of all

work covered by the contract.

A schedule of values of the various parts of the work to be done under lump sum items, shall be agreed upon by the Contractor and the Engineer, and such schedule shall be the basis for determining the amount allowed the Contractor on account of such lump sum items, on partial estimates or payments under the contract.

Payment on estimates, except final estimates, shall not exceed those shown on the proposal except those authorized in extra work orders. No such estimates or payments shall be required to be made when in the judgment of the Engineer, the work is not proceeding in accordance with the provisions of this contract, or when in his judgment the total value of the work done since the last estimate amounts to less than 3,000 dollars. The Engineer, if he deems expedient to do so, may cause estimates to be made more frequently than one in each month and payments thereon to be made more frequently.

When approved by the Engineer, partial estimates may include the values of tested and acceptable materials of a nonperishable or non-contaminative nature which have been produced or furnished for incorporation as a permanent part of work yet to be completed, provided acceptable provisions have been made for storage. Any allowance made for materials on hand will not exceed the delivered cost of the material as verified by invoices furnished by the Contractor, nor will it exceed the contract bid price for the material complete in place. No partial payment will be made on living plant materials until planted.

Whenever liquidated damages are assessable, such damages shall be deducted from the monthly and final estimate. The payment of any current or final estimate or of any retained percentage shall in no way affect the obligation of the Contractor to repair or renew any defective parts of the construction and to be responsible for all damage due to such defects.

If, at any time, there is evidence of any lien or claim which, if established, the City might become liable, and which is chargeable to the Contractor, the City shall have the right to retain out of any payment then due or to become due an amount sufficient to completely indemnify the City against such lien or the Contractor shall refund to the

City all monies that the City may be compelled to pay in discharging any lien made obligatory in consequence of the Contractor's neglect or default.

4.71 CONDITIONAL ACCEPTANCE

Whenever, in the opinion of the Engineer, the Contractor has completed the work in an acceptable manner in accordance with the terms of the contract, the Engineer shall

make an inspection of the entire work, and upon completion of all repairs or renewals which may appear at the time to be necessary, in the judgment of the Engineer, he shall certify to the Owner in writing as to said completion, and as to the value thereof. The aforesaid certificate shall be held and taken to evidence the conditional acceptance to the entire work by the Owner as of the date thereof. Notwithstanding the issuance of such certificate and the entire work thereunder, the Owner shall continue to reserve and retain the aforesaid then five (5) per centum of the whole value of the work as shown by the said certificate of conditional acceptance, over and above any and all other reservations and/or deductions which the Owner is, by the terms of the Contract Documents or otherwise, entitled or required to make and retain, and shall hold the said five (5) per centum for a period of three (3) months from and after the date of such certificate of conditional acceptance, and the City shall be authorized to apply the whole or any part of said five (5) per centum so retained to any and all costs of repairs and renewals of the work and appurtenances which may become necessary, in the judgment of the Engineer, during such period of three (3) months on account of any failure or defects in said work and appurtenances, due to improper work done or materials furnished by the Contractor, if the Contractor shall fail to make such repairs or renewals within twenty-four (24) hours after receiving notice from the Owner to do so.

4.72 MAINTENANCES, REPAIRS, ETC., AFTER COMPLETION

The Contractor, at his entire cost and expense, shall maintain all portions of the work included in this contract to meet the requirements of these specifications for and during the period three (3) months from and after the date of the conditional acceptance of the entire work by the Owner and in addition shall, at his entire cost and expense, make all repairs and replacements of the work and appurtenances which may become necessary, in the judgment of the Engineer, at any time or times, during said three (3) month period, on account of any failures or defects in said work and appurtenances due to improper work done or materials furnished by the Contractor.

4.73 ACCEPTANCE AND FINAL PAYMENT

Upon the expiration of the aforesaid three (3) months period from and after the date of the conditional acceptance of the work, the Engineer shall make a final inspection of the entire work, and, upon completion of all repairs or renewals which may appear at that time to be necessary in the judgment of the Engineer, he shall certify to the Owner in writing as to the final acceptance of the entire project. The Owner, upon receipt and approval of said certificate, shall pay, or cause to be paid, to the said Contractor, the whole amount of money then due the said Contractor, under the contract, except such sums which have already been paid and except such sum or sums as may have been expended by the Owner under the provisions of the Contract Documents and less any other deductions the Owner may be otherwise entitled to

make.

The last mentioned certificate issued by the Engineer shall be deemed and accepted by all of the parties thereto as evidencing the final completion and acceptance of the entire project, and the payment made by the Owner to the Contractor pursuant to the issuance of said certificate of final completion and acceptance shall be deemed to be and accepted by all of the parties hereto as the final payment to be made by the Owner to the Contractor, all prior certificates or estimates upon which payments may have been made being partial estimates and subject to correction in said final payment.

The acceptance by the Contractor of the last payment, as aforesaid shall operate as and shall be a release to the City of Newark, the Department of Public Works and his agents from all claims of liability under this contract, or for anything done or furnished or relating to the work under this contract, or for any act or neglect of the City of Newark, the Department, the Director, or his agents relating to or connected with the contract.

4.74 NO LIMITATION OF LIABILITY

It is understood and agreed that any and all of the duties, liabilities and/or obligations imposed upon or assumed by the Contractor and the Surety, or either of them, by or under the Contract Documents, shall be taken and construed to be cumulative, and that the mention of any specific duty, liability or obligation imposed upon or assumed by the Contractor and/or the Surety under the Contract Documents shall not be taken or construed as a limitation or restriction upon any or all of the other duties, liabilities, and/or obligations imposed upon or assumed by the Contractor and/or the Surety by or under the Contract Documents.

4.75 REMEDIES CUMULATIVE

All remedies provided in the Contract Documents shall be taken and construed to be cumulative; that is, in addition to any and all other remedies provided therein and to any remedies in law or equity which the City would have in any case.

4.76 LEGAL ADDRESS

The address given in the bid or proposal is hereby designated as the legal address of the Contractor. Such address may be changed at any time by notice in writing delivered to the Engineer. The delivering at such legal address or the depositing in any post office, on a postcard, registered wrapper directed to the above mentioned address of any notice, letter or other communication to the Contractor, shall be and shall be deemed to be a legal and sufficient service thereof upon the Contractor.

The delivering at or the mailing to the Contractor's business address (written notice of which address shall be given to the Engineer), or the delivering to the Contractor in person or to his authorized representative, of any notice, letter or other communication shall also be and shall be deemed to be legal and sufficient service thereof upon the Contractor.

4.77 CONTRACTOR'S EXPENSE

All things required by the Contract Documents to be done, furnished and/or installed shall be done by the Contractor at his entire cost and expense, unless otherwise provided therein.

4.78 NIGHT WORK

No night work between the hours of sundown and sunrise shall be permitted except with the written permission of the Engineer.

4.79 STRIKES, ETC.

The Contractor shall adjust all strikes, or other labor troubles, and no allowance will be made for such delays in the time limit herein named.

4.80 GUARANTEE

The Contractor hereby guarantees all of the work for a period of one (1) year (or as specified in the Contract Documents) after the date of completion and final acceptance thereof by the Owner as follows:

1. Against all faulty or imperfect materials and against all imperfect, careless, and/or unskilled workmanship.
2. That the entire equipment and each and every part thereof shall operate (with proper care and attention) in a satisfactory and efficient manner, and in accordance with the requirements of these Contract Documents.
3. That all structures shall be watertight and leakproof at every point and in every particular.
4. The Contractor agrees to replace with proper workmanship and materials, and to re-execute, correct, or repair, without cost to the Owner, any work which may be found to be improper or imperfect and/or which does not operate in a satisfactory manner or fails to perform as specified.

5. The guarantee obligations assumed by the Contractor under these Contract Documents shall not be held or taken to be in any way impaired because of the specifications, indication or approval by or on behalf of the Owner of any articles, materials, means, combinations of things used or to be used in the construction, performance and completion of the work or any part thereof.
6. No use or acceptance by the Owner of the work or any part thereof, nor any failure to use the same, nor any repairs, adjustments, replacements, or corrections made by the Owner due to the Contractor's failure to comply with any of his obligations under the Contract Documents, shall impair in any way the guarantee obligations assumed by the Contractor under these Contract Documents.

4.81 CONDUCT AND COORDINATION OF WORK

The Contractor shall make all necessary arrangements and so conduct the work that all parts of the same will be carried on simultaneously and harmoniously and so that the work of installing the various sections or items of the same shall not interfere with, or retard the progress of other work.

If it becomes necessary, at any time during the progress of the work, to move materials and/or equipment which have been temporarily located or stored, the Contractor shall move them, or cause them to be moved, at his expense. Care shall be taken that floors are not overloaded at any time.

The Contractor shall furnish all required information to insure continuity between various sections of the work and to avoid delay and to obviate defects on any part of the whole work, all as approved by the Engineer.

Any damage caused by the handling or installation of materials or equipment, or the carrying out of any portions of the work, must also be made good by the Contractor to the satisfaction of the Engineer.

The Contractor shall compare all of the various drawings and shall install the work so as to provide for all clearances and finish indicated thereon. work under each trade, etc. shall be arranged to clear piping, equipment, etc. of all other trades.

The Contractor shall inform himself fully regarding any peculiarities and limitations of the space available for the installation of the material. He shall see that all equipment, such as valves, or any other appliances necessary to be reached from time to time for operation and maintenance are made easily accessible and, if required, shall set them in walls or grounds in small iron boxes with wood or metal covers.

The construction of the work may develop conditions that render impracticable the location of equipment as shown or noted. In such cases, before installing his work, the Contractor shall call the condition to the attention of the Engineer and set the equipment as the latter may direct.

**4.82 CONSTRUCTION WITHIN STATE HIGHWAY DEPARTMENT
RIGHTS-OF-WAY**

The City will obtain the necessary permit for the performance of work under this contract within rights-of-way of the Delaware State Highway Department. The Contractor shall perform all operations in full compliance with all requirements of the State Highway Department without additional compensation over the price bid for the work.

It is hereby agreed by both parties involved in the granting of this Franchise or (Permit) that actual construction within the bounds of the highways or streets under the jurisdiction of the State Highway Department, shall be in accordance with the following construction requirements, as well as in accordance with those requirements regularly found in each Franchise or (Permit) granted:

The construction shall be subject at all times to inspection by an authorized representative of the Chief Engineer of the State Highway Department assigned to inspect any feature of material or work entering into the contract.

The construction shall interfere as little as possible with traffic and the residents along the road or street shall be provided with the necessary access to their properties. The Police Department shall be notified prior to any proposed street or road closing.

Necessary barricades, suitable and sufficient red lights, danger signals and signs shall be provided for the protection of the existing property and the safety of the public.

When it is necessary to open a trench through an existing roadway, shoulder, gutter, curb, sidewalk, or any other existing facility, the materials used in the replacement shall be similar to those as removed or materials approved by the Chief Engineer. Further, the design of the mix and construction methods used in the replacements shall also be approved by the Chief Engineer.

Unless otherwise specifically approved in writing by the Chief Engineer, all trenches shall be opened from the surface of the existing facility to the elevation necessary for the pipe installation.

The material excavated from the trench shall be approved by the Chief Engineer

before it is used as backfill. Should the excavated material be unsatisfactory for use as backfill, because of its poor soil characteristics or its high water content, acceptable material shall be provided and placed as directed.

The material placed as backfill shall be well compacted around and to a height of one (1) foot above the pipe, after which layers not exceeding six (6) inches loose measurement, shall be placed and compacted by mechanical tampers to a density equal to that of the adjacent original material.

When the construction has been completed, all existing roadway, shoulder, gutter, curb, sidewalk or other facility disturbed by such construction shall also be replaced in a manner satisfactory to the Highway Department.

When open cuts are made in any hard surfaced roadway, the material replaced will be under the Delaware State Highway Department Specifications and supervision as stated in the requirements of the State Highway Department under General Information.

4.83 REVISED CODE OF DELAWARE, SECTION 6913, TITLE 29

"According to State Law, any person, company or corporation who violates the requirements of Section 6913, Title 29, of the Delaware Code regarding Preference for Delaware Labor shall pay a penalty to the State Secretary of Finance equal to the amount of compensation paid to any person in violation of this Section. This regulation is waived if it is in conflict with Federal Requirements."

In obedience to the requirements of Title 29, Section 6913, the Contractor and each of his Subcontractors hereby agree to furnish upon written or verbal demand of the City Engineer, a bona fide list of the names and residences of all employees of the Contractor or of each and any Subcontractor.

4.84 LIQUIDATED DAMAGES FOR FAILURE TO COMPLETE WORK WITHIN SPECIFIED WORKING TIME

Unless otherwise specified in the contract, the sum specified in the following schedule shall be deducted from monies due the contractor, not as a penalty, but as liquidated damages for the period that any work shall remain uncompleted after the time specified for the completion of the work covered by the contract. The column indicated in the chart as "Calendar Day" will also be used in the assessment of liquidated damages for contracts with a predetermined completion date.

Saturdays, Sundays, and City legal holidays are excluded from the computations for

the assessment of liquidated damages when the contract is on a working day basis. On all other contracts, Saturdays, Sundays, and City legal holidays shall be included in the computations for the assessment of liquidated damages.

A time allowance, however, may be made by the Engineer at his discretion, for delays caused by conditions over which the Contractor has no control. The Contractor shall become liable for liquidated damages for delays commencing from the date on which the time allowance period shall expire.

If there is a delay of critical materials, such as steel, copper or aluminum, due to defense needs, time credit shall be allowed for such delays. Each case will be independently evaluated to determine if the delays were, in fact, beyond the control of the Contractor or fabricator. Satisfactorily supported time credits shall be made concurrently with the delay and not after the fact.

Requests for time credits shall be subject to review by the Engineer and he shall determine the amount of time credit allowed.

There will be no acceptance of unsupported claims of delays in delivery of material as a basis for item credits. The contractor is presumed to have included in his contract price, allowance for any anticipated delays in procurement of materials, which procurement is his sole responsibility. Unless some unusual market condition such as an industry-wide strike, natural disaster, or area-wide shortage arises after bids are taken and prevents procurement of materials within the allowable time limitations, delays in delivery of such materials do not provide sufficient reason for suspending time charges.

Original Contract Amount		Daily Charge	
From More Than	To and Including	Calendar Day	Work Day
\$ 0	\$ 25,000	\$ 195.00	\$275.00
25,000	50,000	210.00	300.00
50,000	100,000	270.00	395.00
100,000	500,000	500.00	710.00
500,000	1,000,000	580.00	825.00
1,000,000	2,000,000	595.00	850.00
2,000,000	5,000,000	630.00	900.00
5,000,000	10,000,000	665.00	950.00
10,000,000	over	1,200.00	1,500.00

4.85**FAILURE TO COMPLETE WORK ON TIME**

Permitting the Contractor to continue and finish the work or any part of it after the time established in the contract for its completion or after the date to which the time for completion may have been extended shall not operate as a waiver by the City of any of its rights under this contract and shall not relieve the surety from its obligations.

4.86**DEFAULT AND TERMINATION OF CONTRACT**

If the Contractor fails to begin the work under the contract within the time specified in the "notice to proceed," or fails to perform the work with sufficient workmen and equipment or with sufficient materials to ensure the prompt completion of said work, or shall perform the work unsuitably or shall neglect or refuse to remove materials or perform anew such work as shall be rejected as defective and unsuitable, or shall discontinue the prosecution of the work, or shall fail to resume within a reasonable time after notice to do so, work which has been discontinued, or if the contractor shall become insolvent or be declared bankrupt, or commit any act of bankruptcy or insolvency, or allow any final judgment to stand against him unsatisfied for a period of 10 days, or shall make an assignment for the benefit of creditors, or for any other cause whatsoever, shall not carry on the work in an acceptable manner, the Engineer shall give notice in writing to the Contractor and his Surety of such delay, neglect, or default.

If the Contractor or Surety, within a period of 10 days after such notice, shall not proceed in accordance therewith, then the Department shall, upon written notification from the Department of the fact of such delay, neglect or default and the Contractor's failure to comply with such notice, have full power and authority without violating the contract, to take the prosecution of the work out of the hands of the said Contractor. The City may appropriate or use any or all materials and equipment on the ground as may be suitable and acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the Engineer shall be required for the completion of said contract in an acceptable manner.

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

4.87**TERMINATION CLAUSE - NATIONAL EMERGENCY**

The City shall, by written notice, terminate the contract or any portion thereof after determining that the reasons beyond either City or Contractor control, he is prevented from proceeding with or completing the work as originally contracted for, and that termination would, therefore, be in the public interest. Such reasons for termination may include, but need not be necessarily limited to, executive orders of the President of the United States relating to prosecution of war, national defense, or national emergency; and restraining orders or injunctions obtained by third-party citizen action resulting from national or local environmental protection laws or where the issuance of such order or injunction is primarily caused by acts or omissions of persons or agencies other than the Contractor.

When contract, or any portion thereof, are terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract unit price, or as mutually agreed for items of work partially completed or not started. No claim for loss or anticipated profits shall be considered.

Reimbursement for organization of the work (when not otherwise included in the contract) and moving equipment to and from the job will be considered where the volume of work completed is too small to compensate the Contractor for these expenses under the Contract unit prices, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained by the Contractor for the work, that have been inspected, tested, and accepted by the Engineer, and that are not incorporated in the work may, at the option of the Engineer, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the Engineer.

Termination of a contract or a portion thereof shall not relieve the Contractor of his responsibilities for the completed work, nor shall it relieve his Surety of its obligation for and concerning any just claims arising out of the work performed.

4.88**TERMINATION OF CONTRACTOR'S RESPONSIBILITY**

A contract will be considered complete when all work has been completed according to plans and specifications, final inspection made, the work accepted by the Engineer, and all of the obligations of the Contractor have been complied with.

The Contractor will then be released from further obligation except as set forth in the contract bond.

4.89 SUBMISSION OF QUALIFICATIONS

Prior to the award of this contract, the low Bidder shall submit to the Director of Public Works for approval a list of the equipment that he intends to use in the prosecution of this contract. Also, he shall indicate by name the supervisory personnel that he intends to use on this contract.

In the event that the above information is not approved by the Director of Public Works, the Mayor and Council reserve the right to award the contract to the next lowest Bidder, or to reject all proposals, as may best serve the interests of the City of Newark.

4.90 LOCATION OF EXISTING UTILITIES

The Contractor's attention is directed to the fact that the locations of the existing utilities as shown on the contract drawings are only approximate and it shall be the Contractor's responsibility to locate these utilities by test pits in advance of actual construction operations in the vicinity of utilities.

The Contractor shall not begin any construction around or adjacent to utilities without notifying their owners at least two (2) working days, but not more than ten (10) working days in advance, as required by Chapter 8, Title 26, of the Delaware Code.

The failure to show on the contract drawings any existing utilities shall not relieve the contractor of his responsibility of determining the location of these utilities and any damage to the utilities or interruption of services shall be repaired at the Contractor's expense, according to City Specifications. The City shall be notified of any damage to any utilities.

It is understood and agreed that the Contractor has considered in his bid all the permanent and temporary utility appurtenances in their present or relocated positions as shown on the plans or are readily discernible and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them, except the Contractor may be granted an equitable extension of time.

The relocation of any existing utilities which will interfere with the proposed construction may also be in operation simultaneously with the work to be performed under this contract. The Department of Public Works will make every effort to

arrange for utility relocation work in advance of the time or times the Contractor will require the use of the areas in which the utilities to be relocated are presently allocated. However, the Department of Public Works does not guarantee that all such work will be completed in the sequence, or within the periods, most convenient to the Contractor.

4.91 MAINTENANCE OF TRAFFIC

It shall be the Contractor's responsibility to maintain open lanes of traffic at all times within the work area and to provide and maintain, in a safe condition, any temporary approaches to crossings, intersections, roads, streets, businesses, parking lots, residences, driveways and garages.

No lane closure or road closing will be permitted unless authorized by the Engineer. The Newark Police Department and the New Castle County Fire Board shall be notified prior to any proposed street or road closing.

Every precaution must be taken to protect the general public while the work is in progress.

Work shall be completed with as little delay to traffic and the general public as possible.

The Contractor shall also comply with the Manual on Delaware Traffic Controls for Street and Highway Construction, Maintenance, Utility, and Emergency Operations.

4.92 SCOPE OF PAYMENT

The Contractor shall accept the compensation as herein provided as full payment for furnishing all materials, labor, tools, equipment necessary to complete the work, and for performing all work contemplated and embraced by the contract.

This compensation shall also include all loss or damage arising from the nature of the work, action of the elements, unforeseen difficulties which may be encountered during the prosecution of the work, and for all expense incurred in consequence of the suspension or discontinuance of the work under the contract.

The Contractor shall promptly make payments to all persons supplying labor and materials for the execution of the contract. The Engineer may require satisfactory evidence (release of liens) to that effect before the payment of any estimate, and such evidence must be presented before the final acceptance and payment.

4.93 SPECIAL PROVISIONS

Special Provisions are specific clauses setting forth conditions or requirements peculiar to the project under consideration and covering work or materials involved in the proposal and estimate of quantities, but not sufficiently covered by the Standard Specifications. Should any special provisions or requirements conflict with these Standard Specifications, the Special Provisions shall govern.

4.94 SEQUENCE OF CONSTRUCTION

The Contractor shall complete this contract according to a particular sequence of construction if directed by the Engineer. This sequence shall be followed by the Contractor at no additional compensation over the unit prices and lump sum prices bid for the work.

Prior to the start of construction, and at a time to be specified by the Owner, a preconstruction conference shall be called by the Owner. This conference shall be attended by representatives of the Owner, the Architect/Engineer, the Contractor, and each Subcontractor, as appropriate. The purpose of this conference is to discuss the labor standard provisions and other requirements of the contract, and to clarify for the Contractor and Subcontractors the methods by which they must implement such provisions and comply with such requirements. At this conference, the Contractor will present his construction schedule.

4.95 QUANTITIES AND WORK CHANGES

The Contractor's attention is directed to the fact that quantities where indicated are approximate and may be increased or decreased by the Engineer. Further, the City reserves the right to increase or delete any portion of the work presented in the Contract, should it so determine. This increase or decrease of some quantities will in no way alter the unit prices bid.

MEASUREMENT AND PAYMENT

4.96 MEASUREMENT OF QUANTITIES

All work completed under the contract will be measured by the Engineer according to United States standard measure.

Unless stated otherwise, all material that is to be measured by weight, the following shall govern: Each load shall have a ticket, signed by an approved Certified Weighmaster and shall be signed by the Construction Inspector as received and used on the project.

A station when used as a definition or term of measurement will be 100 linear feet.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (such as manholes, utility poles, etc.) having an area of 9 square feet or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the Engineer.

Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.

All items which are measured by linear foot, such as pipe culverts, under drains, etc., will be measured parallel to the base or foundation upon which such structures are placed, unless otherwise shown on the plans.

The term "gauge" when used in connection with the measurement of plates, will mean U.S. Standard Gauge, except that when reference is made to the measurement of metal sheets used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing, the term "gauge" or thickness will mean that specified in AASHTO M 36, M 167, M 196, M 197, or M 219.

When the term "gauge" refers to the measurement of wire, it will mean the wire gauge specified in the AASHTO M 32.

The term "ton" will mean the short ton consisting of 2,000 pounds avoirdupois. All materials which are measured or proportioned by weight shall be weighed on accurate, approved scales by competent, qualified personnel at locations designated by the Engineer. If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material be paid for. However, car weights will not be acceptable for material to be paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the Engineer directs, and each truck shall bear a plainly legible identification mark.

When requested by the Contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard may be weighed and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be

agreed to by the Contractor before such method of measurement of pay quantities is used.

Bituminous materials will be measured by the gallon.

Volumes will be measured at 60 degrees F or will be corrected to the volume at 60 degrees F using ASTM D 1250 for asphalt or ASTM D 633 for tars.

When bituminous materials are shipped by truck or transport, net certified weights or volume subject to correction for loss or foaming, may be used for computing quantities.

Cement will be measured by the hundred weight (CWT). The term, CWT shall mean 100 lbs. of cement.

Timber will be measured by the thousand feet board measure (M.F.B.M.) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.

The term "lump sum" when used in an item of payment will mean complete payment for the work described in the contract.

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

Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the project unless special equipment has been ordered by the Engineer in connection with force account work, in which case travel time and transportation to the project will be measured. If equipment has been ordered held on the job on a standby basis by the Engineer, half time rates for the equipment will be paid. When the use of equipment is continuous, or nearly so, a weekly rate of thirty (30) times the hourly rate shall be paid, at the option of the Engineer. For equipment being rented on a weekly basis, the Contractor shall receive one fortieth (1/40) of the weekly rate for all hours worked in excess of 40 hours in a week.

When standard manufactured items are specified such as fence, wire, plates, rolled shaped, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

DIVISION II

CONSTRUCTION DETAILS

ITEM 1

CLEARING AND GRUBBING

1.01 DESCRIPTION

Clearing and grubbing shall consist of clearing, grubbing, removing and disposing of all vegetation and debris within the limits of the right of way and easement areas, except such objects as are designated to remain or are to be removed in accordance with other sections of these specifications. This work shall also include the preservation from injury or defacement of all vegetation, trees and objects designated to remain.

1.02 CONSTRUCTION METHODS

The Contractor shall perform the work of clearing and grubbing so as to remove only material herein specified and, if he chooses to do such work with mechanical equipment and removes and wastes suitable material required on the project, any suitable material removed with the cleared and grubbed material shall be replaced by the Contractor at his own expense. All materials removed by the clearing and grubbing operation shall be removed from the project or otherwise disposed of as specified or directed. It shall be the responsibility of the Contractor to comply with all applicable regulations regarding any open burning carried out during the conduct of the contract.

1.03 TREES DESIGNATED TO REMAIN

The Engineer shall designate such trees, shrubbery, and plants which are not to be removed and the Contractor shall protect them from any damage. If any such trees, shrubbery, or plants are damaged, they shall be replaced or repaired by a competent tree surgeon at the Contractor's expense. Paint required for cut or scarred surfaces of trees or shrubs selected for retention shall be an approved asphaltum base paint prepared especially for tree surgery. Branches of trees overhanging the roadbed shall be properly trimmed to maintain a clearance height of 20', unless otherwise directed.

1.04 DISPOSAL OF TREES, STUMPS, BRUSH, RUBBISH, ETC.

All trees, timber, stumps, brush, rubbish or other material to be removed from the

highway shall become the property of the Contractor and all materials removed from the highway in accordance with these requirements shall be salvaged, or disposed of out of sight from the highway. Any burning shall be done within the requirements of State or local laws or regulations and be under complete control at all times.

1.05 PREPARATION OF GROUND SURFACE

Grading operations shall not be started in any area until all operations of clearing and grubbing within the area affected have been completed. In areas where excavation is to be made, the ground shall be cleared of all living or dead trees, stumps, brush, or other objectionable material. All embedded stumps, root mats, etc., shall be removed to a depth of not less than 2' below the subgrade or slope surfaces. All depressions made below the subgrade or slope surfaces by the removal of stumps or roots shall be backfilled with approved material and compacted as directed.

In areas where embankment is to be made 5' or more in depth, trees and stumps shall be cut off as close to the ground as is practicable, but not to exceed 6" above the ground surface. Near the toe of embankment slopes, no stump shall extend above a point 1' beneath the slope surface.

Areas where embankment is to be made less than 5' in depth, all trees, stumps, roots, brush, root mat, and debris shall be removed, grubbed, or blasted from the ground, and all these materials shall be grubbed in the manner required where excavation is to be made.

1.06 CLEARING OUTSIDE OF ROADWAY

Unless otherwise directed, all right of way and easement areas shall be cleared, flush with the ground, of all trees, brush, shrubs, down timber, rotten wood, rubbish and other objectionable debris and vegetation. In addition, such live trees as may interfere with sight distance, either vertically or horizontally, shall be cleared from these areas.

1.07 REMOVAL OF OTHER OBSTRUCTIONS

Fences and guard rails upon or within the limits of the project, shall be removed carefully by the contractor, wholly or in part, as specified or directed and disposed of as specified or directed, except that where indicated on the drawings. Buildings and other structures shall be removed by the City of Newark or other responsible authority unless otherwise provided.

1.08 METHOD OF MEASUREMENT

The amount of clearing and grubbing will not be measured; however, the work to be paid for shall be that completed within the limits of the area specified.

1.09 BASIS OF PAYMENT

Clearing and grubbing within the limits of the area specified shall be paid for at the contract lump sum bid for Item 1, Clearing and Grubbing, which price and payment shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 2

EXCAVATION AND EMBANKMENT

2.01 DESCRIPTION

Excavation and embankment shall consist of the removal and final disposal, as further specified, of all materials except those specified under Clearing and Grubbing, Excavation for Structures, Rock Excavation, Muck Excavation and Channel Excavation taken from within the limits of the work contracted for and necessary for the preparation and construction of various elements of the work, to the lines and grades shown on the plans, profiles, and cross-sections or as directed. It shall include the grading and compacting of the embankment, roadway, and shoulders, and the cleaning and sloping of side ditches, embankment and cut slopes to the required lines and grades. Flexible pavements shall be removed under this section.

Excavation also includes the salvaging and stockpiling of topsoil for re-use, the backfilling of areas when unsuitable material has been removed, the final dressing of the slopes, ditches and shoulders, and the removal and disposal of all material not otherwise provided for so that the project will be completed in a neat and workmanlike manner.

Undercutting is defined as removal of unsuitable material below the grade of a proposed subgrade or embankment foundation.

2.02 CONSTRUCTION METHODS

Excavation shall be made in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross-sections shown on the plans or established by the Engineer, and no allowance will be made for materials excavated beyond or below such lines and grades unless it has been so ordered. All suitable material removed as excavation shall be used in the formation of embankments, shoulders and slopes, etc., before securing or hauling any borrow unless specifically approved by the Engineer. No sod, vegetation or unsuitable material of any description will be allowed in the formation of embankments but, shall be deposited in fill areas outside of roadway or shall be wasted if so directed. All slopes of cuts and embankments, ditches, waterways, and all old or new pipes or culverts shall be cleaned and cleared of obstructions and shall be left in a neat and trimmed condition.

2.03 TOPSOIL

Prior to the general grading operation, the Contractor shall remove topsoil from areas as required for each project, and stockpile it for use under Item 30, Topsoiling. Cross-sections shall be taken after the topsoil is excavated in embankment areas to determine the amount removed. Any topsoil over and above the amount required to complete Item 30, shall be placed on embankment slopes, unless otherwise directed. The contractor will be required to use all the topsoil that is excavated and will not be permitted to remove any from the project unless directed otherwise. The payment for the placement of the excess material on the fill slopes shall be incidental to the section of Excavation and Embankment.

2.04 PLACING EMBANKMENTS (EXCLUDING PONDS AND BASINS)

All embankments shall be formed of material meeting the requirements of Item 5, except rock and/or concrete obtained from the excavation may be used if placed in uniform loose layers of 24" or less. Any of these materials which cannot be readily incorporated into a 24" loose layer shall be reduced in size until it can be so incorporated. Individual pieces of rock or broken concrete shall not exceed 36" in any one dimension. No rock or concrete shall be placed within 4' of the top of the embankment. The 24" of rock or concrete shall be compacted with a minimum of 6 passes of an approved roller or as directed by the Engineer.

Rocks, broken concrete, larger than 2-12" sieve shall not be placed in embankment areas where piling is to be placed or driven.

No spongy, wet or frozen material will be permitted in the embankment nor will embankment be allowed to be placed on any wet, unstable, or frozen materials. Under embankments 4' or less, all topsoil shall be removed and the area shall be recompacted satisfactorily.

Where new embankments are to be placed against existing embankments or the existing embankment is to be widened, the existing embankment shall be benched in accordance with the detail shown on the plans or as directed by the Engineer.

Unless shown otherwise on the plans or special provisions, where an embankment of less than 4' below subgrade is to be made, all sod and vegetation shall be removed from the surface upon which the embankment is to be placed, and the cleared surface shall be completely broken up by plowing, scarifying or stepping to a minimum depth of 6 inches. This area shall then be recompacted. Sod not required to be removed shall be thoroughly disced before construction of embankment. Wherever a

compacted road surface containing granular materials lies within 3' of the subgrade, such old road surface shall be scarified to a depth of at least six inches. This scarified material shall be recompacted.

Material shall be placed in successive layer, and each layer shall be placed in a level uniform cross-section not to exceed 8 inches in depth, loose measurement unless otherwise approved by the Engineer. It shall be deposited and spread parallel to the centerline, and the layers shall extend the full width of the embankment. If so required, each layer shall be disced to ensure uniform distribution of moisture and component materials. Each layer shall be properly compacted as hereinafter specified before starting the next layer.

There shall be sufficient equipment of the proper type and weight provided to do the work of grading, leveling, and compacting promptly after depositing the material. When this equipment is inadequate for the rate of compacting, the rate of excavation or placing of embankment shall be reduced to a rate not to exceed the capacity of the grading and compacting equipment.

When a number of embankments are being constructed and are so isolated from one another that one roller cannot compact the fills satisfactorily, additional rollers shall be provided as ordered.

2.05 COMPACTION EQUIPMENT

Compaction shall be attained by approved rollers or compactors. The use of other suitable compaction equipment may be approved for work under this Section provided such equipment is constructed and operated so that the requirements of these specifications are fully met.

2.06 VIBRATORY COMPACTORS

Vibratory compactors may be used provided they are approved by the Engineer and perform satisfactorily on the embankment.

2.07 GRID ROLLER

The use of grid rollers will be subject to approval, upon performance, by the Engineer.

2.08 TAMPING ROLLERS

Tamping roller shall consist of metal rollers, drums, or shells, and shall be equipped with self-cleaning tamping feet projecting not less than 7" from the surface of the roller, drum, or shell. the cross sectional area of each tamping foot shall be not less

than 4 nor more than 12 square inches. The feet shall be uniformly spaced on the surface of the drum. The weight and dimensions of the rolling units, the number, spacing, and dimensions of the tamping feet shall be such that specified compaction may be obtained. The tamping roller shall be operated over the fill until the roller is entirely supported by the tamping feet and no portion of the drum is in contact with the fill.

2.09 COMPACTION PROCEDURE

Compaction or rolling shall start at the edges and progress toward the center of the embankment, and shall continue until each layer is thoroughly and uniformly compacted to the full width of the embankment and to 95% or more of the laboratory maximum density on the same soils.

The ordinary use of trucks, carryalls, scrapers, tractors, or other construction equipment may be considered as rolling, but the traffic of such hauling equipment shall be distributed over the fill in such a manner as to make use of the compaction provided thereby as an addition to compaction by rolling.

Any areas, especially in sharp depressions, trench backfills, and around culverts, bridges, and walls, inaccessible to these methods of compaction shall be built in continuous horizontal layers not more than 8" in thickness, loose measurement, and shall be thoroughly tamped and compacted to the specified density.

2.10 DENSITY AND MOISTURE CONTROL

The determination of compliance with field compaction requirements as specified herein shall be in accordance with the following AASHTO test methods:

- (a) AASHTO T 191, Modified or other approved method: Field density tests will be expressed as a percentage of the maximum density made on the same soils.
- (b) AASHTO T 99, Method C, Modified: Determination of maximum density and optimum moisture content.
- (c) AASHTO T 224, Modified: Coarse particle correction method.

The moisture content of the soil at the time of compaction shall be within 2 percentage points of the optimum moisture content as determined by AASHTO T 99, Method C, Modified. If the moisture content is not within 2 percentage points of optimum, the soil shall either be moistened or dried and thoroughly mixed before compaction.

2.11 OBSTRUCTIONS

All obstructions, not covered under Item 1, within the limits of the highway shall be removed as shown on the plans or as directed. The removal of pipe is included in this section and all existing pipes to be removed under Item 2, Excavation and Embankment, shall be removed with reasonable care from their respective locations. If they are usable, they shall remain the property of the City of Newark, and shall be stored at a suitable location on or adjacent to the project and will be removed as directed by the Engineer.

2.12 PREPARATION OF SUBGRADE

The subgrade shall be properly shaped and uniformly and thoroughly compacted in conformity with the lines and grades as shown on the plans and/or as established in the field before any subbase, base or surfacing material is placed. The subgrade shall be free from boulders, large rocks, muck, vegetation, or other materials that would prove detrimental to the road. Depressions that develop during the rolling shall be filled with suitable material and the subgrade shall be rolled until no depressions develop.

Where excavation to the finished graded section results in a subgrade or slopes of unsuitable soil, the Engineer may require the Contractor to remove the unsuitable materials and backfill to the finished graded section with approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary cross-sectional measurements before the backfill is placed.

2.13 TEST ROLLING

When directed, test rolling shall be performed upon the prepared subgrade prior to the placement of any base or subbase material. The subgrade to be test rolled shall be within 2 percentage points of the optimum moisture content.

Test rolling shall be performed with self-propelled pneumatic tired equipment, which shall be of the size, type and weight that will reveal any soft, yielding, or spongy areas.

The equipment shall be run longitudinally so that there shall not be over 18" of unrolled area between tire strips.

If the test rolling shows the subgrade to be unstable, the Contractor shall scarify, disc, aerate, or add moisture and recompact the subgrade to the extent when retested by the above methods, it will be stable, the cost of which will be at the Contractors expense.

If, in the opinion of the Engineer, there are areas to be removed or undercut, they may be ordered excavated and replaced and paid for under this Section; however, as determined by the Engineer, areas which become soft, or spongy due to the Contractor's methods of operation, they shall be removed and/or repaired at the Contractor's expense.

2.14 DRAINAGE OF SUBGRADE

The subgrade must be maintained in such condition that it will drain. Prior to the formation of the final subgrade or of the cutting of any box section in which the subbase or base will be placed, all side ditches parallel to the centerline of the project shall be cut to their plan gradient. Temporary ditches permitting drainage from box sections to side ditches shall be provided at intervals as required. All facilities necessary for complete drainage of the construction areas shall be provided and maintained by the Contractor.

In no case shall vehicles be allowed to travel in a single track and form ruts in the subgrade, and if any sharp irregularities are formed, the subgrade shall be scarified and recompactd.

2.15 APPROVAL OF SUBGRADES

No subbase or base materials shall be placed until the subgrade has been approved.

2.16 CONSTRUCTION OF SHOULDERS

Shoulders on either side of the travel way shall be constructed of the most suitable material obtainable from the right of way or approved borrow pits. They shall also conform to the section as shown on the plans and for areas that are to be paved or surface treated, the compaction shall be 100%.

On areas that are not to be paved or seeded, the maximum density shall be 95%.

Areas to be seeded shall be compacted as directed.

2.17 UTILITY BACKFILL

Backfill for all utility trenches within the roadway shall be compacted to 95% or more and shall be made with material meeting the requirements of Borrow Type C, Subsection 5.02. If the existing material meets these requirements, it shall be used. Backfill material for all utility trenches outside the roadway shall be made with Borrow Type C, Subsection 5.02 to a height of one foot above the utility, unless directed

otherwise by the Engineer, and shall be compacted to 90% or more. The remainder of the trench shall be backfilled with excavated material unless otherwise directed by the Engineer.

Where the pipes are installed under an existing roadway pavement or shoulder, the trench backfill material shall meet the requirements of Item 8, Graded Aggregate Base Course, Type B (crusher run). Select borrow, Type C, conforming to Subsection 5.02, will be allowed as backfill to a height of 1 foot over sanitary sewer pipes, water pipes, gas pipes, and electrical conduits.

The operation of backfilling utility trenches shall be performed by the utility organizations involved and shall conform to the requirements of Item 2.

Utility companies will be required to remove all excess excavation from the project unless the Engineer directs it to be utilized by the Contractor in the project. If such direction is given, the cost incurred for its utilization shall be incidental to Item 2.

2.18 DISPOSAL OF SURPLUS MATERIAL

All surplus materials excavated and suitable waste of every description shall be used in or to widen embankments, flatten side slopes or be deposited in such places as may be directed; or this material and all other materials not permitted in the embankments, shoulders, etc., shall be hauled from within the limits of the highway and deposited where directed, or if such points are not designated, the Contractor shall secure a place for disposal satisfactory to the Engineer.

2.19 METHOD OF MEASUREMENT

All quantities of excavation will be computed by the method of average end areas and will be measured by cross-sections taken at regular intervals and at breaks in grade. All excavation will be measured in its original condition.

Embankment will not be measured or paid for directly. It will be considered a necessary part of the work paid for as Excavation, Excavation for Structures, or Borrow, as the case may be.

2.20 BASIS OF PAYMENT

Excavation and Embankment will be paid for at the contract unit price per cubic yard bid for Item 2,, Excavation and Embankment which price will include the removal of all obstructions not covered under other sections, pipes within the limits of the work, the formation of embankment as specified under Subsection 2.04, Excavation for Backfilling around Structures, the disposal of all surplus material the preparation of

subgrade and shoulders. All excavation not included under other excavation sections will be paid for under this Section. No additional compensation will be paid for cofferdams, bracing, shoring, pumping, or bailing, or for material necessary on account of water. Undercutting of unsuitable material, as defined herein, shall be paid for at the unit price bid per cubic yard for Item 2, Excavation and Embankment. Test holes and test pits shall be paid for as described on the plans and/or in the Special Provisions.

ITEM 2A

EROSION, SEDIMENT CONTROL, AND WATER POLLUTION CONTROL

2A.01 DESCRIPTION

This work shall consist of temporary or permanent control measures, as shown on the plans or ordered by the Engineer, during the life of the project to control erosion, sediment, and water pollution.

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

2A.02 LEGAL AUTHORITY

The City of Newark is a delegated agency of the Delaware Department of Natural Resources and Environmental Control, as defined in Chapter 40, Title 7 of the Delaware Code, and the Delaware Sediment and Stormwater Regulations. Any construction project shall comply with these laws and regulations at all times until project completion. As a delegated Agency, the City may enforce compliance with these laws and regulations or may refer a project to DNREC for enforcement action.

2A.03 PLAN REVIEW AND APPROVAL

Plans are reviewed by the Engineer to determine that the plans were designed in conformance with the applicable laws and regulations. Once approved and signed by the Engineer, the work shall be completed according to the approved Plans.

Review and approval of the erosion, sediment control, and/or stormwater management plans, or errors or omissions in the Plans shall not relieve the Contractor from its responsibility to comply with the Delaware Sediment and Stormwater Regulations or other applicable laws and regulations.

2A.04 PLAN CHANGES

The Contractor shall not deviate from the Plans without prior review and approval by the Engineer. Revised Plans may be required by the Engineer, as well as any supporting design calculations, before considering any proposed change to the approved Plans.

2A.05 PRECONSTRUCTION MEETING

A preconstruction meeting must be scheduled between the Owner/Developer (or representative), and the Engineer (or Site Reviewer) prior to any land disturbing activity. The following persons should attend the preconstruction meeting:

- 1) Site Reviewer/Engineer (City Personnel)
- 2) Owner/Developer (or Representative)
- 3) Site Construction Supervisor/Responsible Construction Personnel (Blue Card Holder)
- 4) Any Necessary Subcontractors/Builders

Items to be discussed during the preconstruction meeting shall include:

- 1) Lines of communication between all attending parties (addresses, phone number)
- 2) Approved plans must be followed unless changes are Engineer approved
- 3) Limits of disturbance
- 4) Sequence of construction
- 5) Erosion and sediment controls for site
- 6) Stormwater management facility construction
- 7) Contractor responsibility to inspect controls immediately following each rainfall and perform any necessary maintenance promptly. Minutes of the preconstruction meeting will be compiled by the City Site Reviewer/Engineer and sent to all appropriate parties.

2A.06 DESCRIPTION OF WORK

Erosion and sediment control measures shall be applied to erodible earth material exposed by any of the Contractor's land disturbing activities on the Project. The work shall consist of the application of temporary and permanent erosion and sediment control items as provided in the Plans or ordered by the Engineer. The temporary erosion control items shall be coordinated with the permanent erosion control items specified. The items shall include, but are not limited to, the use of berms, dikes, dams, sediment basins, traps, geotextiles, stone check dams, silt fences, phased construction, special land grading methods, mats and nets, aggregates, mulches, grasses, slope drains, chemical binders, tackifiers, and other erosion and sediment control items or approved methods as designated in the Delaware Erosion & Sediment Control Handbook for Development (latest edition.)

2A.07

CONSTRUCTION METHODS

The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface area of erodible earth material exposed by excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut slopes shall be seeded and mulched as the excavation proceeds to the extent considered desirable and practicable.

The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time. The Contractor may be required to partially construct permanent drainage facilities to control erosion temporarily.

Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise temporary erosion control measures may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing, exceed 750,000 square feet without approval by the Engineer.

The Engineer will limit the area of excavation, borrow and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

Under no conditions shall the amount of surface area of erodible earth material exposed at one time by excavation, borrow or fill within the right-of-way exceed 750,000 square feet without prior approval by the Engineer.

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

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

2A.07(a) TEMPORARY STABILIZATION - SEEDING

Seeding shall consist of furnishing and placing seed and soil supplements in accordance with Item 31, Seeding.

2A.07(b) TEMPORARY SEEDING EROSION CONTROL - MULCHING

Mulching shall consist of furnishing, placing, and anchoring mulch over seeded areas in accordance with Item 32, Mulching.

Temporary seeding, when specified without excelsior blanket or jute mesh shall be mulched according to the following seasonal schedule:

February 16 - April 15

1. Wood cellulose fiber, 1500 lbs/acre
2. Or small grain straw, 4000 lbs/acre
Tacked with chemical mulch binder, 40 gals/acre

April 16 - August 15

1. Wood cellulose fiber, 2000 lbs/acre
2. Or wood cellulose fiber, 1500 lbs/acre plus chemical mulch binder, 40 gals/acre
3. Or small grain straw, 4000 lbs/acre
Tacked with chemical mulch binder, 40 gals/acre

August 16 - February 15

1. Small grain straw, 4000 lbs/acre
Tacked with a chemical mulch binder at 50 gals/acre

2A.07(c) CHEMICAL BINDER/TACK

Chemical Binder(s) as specified according to Subsection 31.02 when used alone for temporary erosion protection, shall be applied as instructed by the manufacturer of the approved product.

Chemical Binder (or tack) must be applied to straw mulch as specified in Item 32, Mulching.

2A.07(d) JUTE MESH, EXCELSIOR BLANKETS, AND MULCH NETTINGS

Jute Mesh, Excelsior Blankets, and Mulch Nettings shall be as specified in Subsection 32.02, and installed as specified in SubSection 32.03.

2A.08 TEMPORARY DITCH AND SLOPE EROSION PROTECTION

Temporary ditch erosion protection shall include the shaping of channels on all ditches, furnishing, and applying excelsior blanket or jute mesh, sod, seed, fertilizer, lime, chemical binder, mulch, and water, all in accordance with the plans and these Special Provisions.

Temporary slope erosion protection shall include the furnishing and applying of the specified material on the slopes designated by the Engineer. The engineer will designate the exact areas for each type of work.

2A.09 PREPARATION OF AREAS TO BE TREATED WITH EXCELSIOR BLANKET OR JUTE MESH

The ditch-channel shall be shaped in the same manner as preparing a ditch for sod as provided in Item 33.

During ditch shaping operations, a seedbed shall be provided approximately 3/4" deep. Slope areas to be protected shall be prepared as preparing a seedbed for seeding as provided in Subsection 31.07.

2A.10 WATERING OF TEMPORARY EROSION CONTROL MATERIALS

Following the shaping, seeding, fertilizing, mulching, placement of sod, excelsior blanket or jute mesh, all of the areas except those treated with chemical binder shall be watered sufficiently to saturate the seedbed, and as otherwise directed by the Engineer. Water shall be applied as a spray. Three additional waterings shall be applied at approximately one week intervals at the discretion of the Engineer and subject to local weather conditions. Each additional watering shall moisten the soil to a depth of 2". The construction schedule shall include the watering period. Initial watering of seeded areas shall be done not later than the day following seeding. The cost of watering shall be included in the price bid for the item.

2A.11 COMPLETION OF THE WORK

All phases of this work shall be so coordinated and completed that the Contractor's operation for any phase of the work will not exceed the limitations set forth herein for the amount of surface area of erodible earth material exposed at one time, except with

written permission of the Engineer. All phases of this work shall be completed within the time specified in the erosion control schedule submitted by the Contractor.

2A.12 METHOD OF MEASUREMENT

Measurement of the work items used for Erosion, Sediment Control, and Water Pollution Control will be made as follows:

The items of Mulch Netting, Excelsior Blanket or Jute Mesh in ditches and for slope protection will be measured as follows:

Excelsior Blanket or Jute Mesh will be measured by the number of square yards of surfaces treated, complete in place. Included in the measurement will be the material used for anchor slots, junction slots, check slots, terminal folds, and lap joints. Excelsior blanket or jute mesh shall be measured from the length of material in the rolls and the specified width less any amount remaining at the completion of the project, wasted or otherwise not incorporated into acceptable portions of the work.

The Engineer will compute the actual surface area in square yards complete in place for Temporary Erosion Controls.

The Engineer will compute the total gallons applied and complete in place for Temporary Chemical Erosion Control as specified according to Sub-Section 2A.07.

The excavation required for the construction of temporary ditches, berms, dikes, dams, and sediment basins shall be computed by the method of average end areas and will be measured by cross-sections taken at regular intervals and at breaks in grade. All excavation will be measured in its original position.

Embankment for berms, dikes, and dams will not be measured or paid for directly. It will be considered necessary and incidental to the pertinent items of excavation.

2A.13 BASIS OF PAYMENT

The items of work for Erosion, Sediment Control, and Water Pollution Control will be paid for as follows:

The number of cubic yards of excavation for the construction of temporary ditches, berms, dikes, dams, slope drains, and sediment basins, shall be paid for at the contract unit price bid per cubic yard for "Erosion Control, Excavation and Embankment," all in accordance with Item 2. Included in the item for payment is the removal of all temporary ditches, berms, dikes, dams, and sediment basins, and the restoration of the area as directed by the Engineer. The cost for cleaning sediment

basins, as directed, shall be included for payment in this item. If dikes or dams are needed to construct sediment basins, all work is included as one under this item. When pipe of any type is used to construct a sediment basin, the cost of furnishing and placing the pipe and rip rap at the end of the pipe, shall be included for payment in the item. Payment also includes furnishing and placing materials for slope drains such as pipe, fiber mats, rubble, Portland cement concrete, bituminous concrete, plastic sheets, or other material acceptable to the Engineer that will adequately control erosion.

The number of square yards of excelsior blanket or jute mesh will be paid for at the contract unit price bid per square yard for "Erosion Control, Excelsior Blanket, or Jute Mesh," which price shall include the furnishing, placing, and stapling of the jute mesh or excelsior blanket, the smoothing and shaping of the ditch channels and slopes, filling gullies and/or washes, and all labor, tools, equipment, and any other materials necessary to complete this item.

The number of acres of erosion control seeding will be paid for at the contract unit price bid per acre for "Item 31, Seeding," which price shall include the furnishing, mixing and placing of all seed, lime, fertilizer, and water; preparation of the seed bed; furnishing and placing of straw, hay or wood cellulose fiber mulch, mulch securement, and all labor, tools, equipment, and any other materials necessary to complete this item.

The number of gallons of chemical binder shall be paid for at the contract unit price bid per gallon for "Chemical Erosion Control," which price shall include the furnishing, mixing, and placing of the chemical binder, maximum rate of water, and for all labor, equipment, and incidentals necessary to complete the work.

The quantities listed for the items of work for Erosion, Sediment Control, and Water Pollution Control are approximate only. Measurements will be made and the actual amount of each item of work will be determined by the Engineer upon completion of the project.

Payment at the contract unit prices bid for the various items of work required for Erosion, Sediment Control, and Water Pollution Control shall constitute full compensation for furnishing all materials, tools, labor, equipment and all incidentals necessary to complete the various items of work required, all as directed by the Engineer and in accordance with the Plans and Special Provisions.

Should items of work be required for Erosion, Sediment Control, and Water Pollution Control that are not covered by applicable contract items, the Contractor shall be ordered to perform these items of work in accordance with Measurement and Payment of the Standard Specifications.

In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled, and are ordered by the Engineer, such work shall be performed by the Contractor at his own expense. Temporary erosion and pollution control work required, which is not attributed to the Contractor's negligence, carelessness or failure to install permanent controls, will be performed as ordered by the Engineer.

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

In case of repeated failures on the part of the Contractor to control erosion, pollution, and/or siltation, the Engineer reserves the right to employ outside assistance or to use his own forces to provide the necessary corrective measures. Such incurred direct costs, plus project engineering costs will be charged to the Contractor and appropriate deductions made from the Contractor's monthly progress estimate.

Erosion, Sediment Control, and Water Pollution Control features installed by the Contractor shall be acceptably maintained by the Contractor, as directed, and the work required shall not be paid for separately, but shall be included in the aforementioned erosion, sediment control, and water pollution control items.

ITEM 3

ROCK EXCAVATION

ROADWAY

3.01 DESCRIPTION

Rock excavation consists of hard ledge rock and boulders of more than 1/2 cubic yard in volume, as determined by the Engineer. The classification "Rock Excavation" shall not apply to soft and disintegrated rock, bituminous pavements, gravel, broken stone, shale, concrete pavement, or such materials as are classified under Item 2, Excavation and Embankment. The classification includes only material, which in the opinion of the Engineer, requires drilling and blasting and which cannot be removed by normal dipper-stick hydraulic backhoe with a 3/4 cubic yard capacity.

3.02 CONSTRUCTION METHODS

Rock excavation shall be made in accordance with these Specifications and in conformity with the lines, grades, and typical cross-sections as shown on the plans or otherwise specified below. Excavated rocks shall be used in forming embankment wherever the depth of the fill is sufficient to properly contain the rock removed by excavation, and shall be placed in accordance with the directions given by the Engineer. The Engineer may permit the Contractor to use excavated rock for purposes other than embankments, but if borrow is needed to bring any part of the road to grade, the Contractor shall furnish it at his own expense, and without overhaul charges, an amount of approved borrow equal to the amount of rock used plus 50% and place it in final position on the road.

All material within the limits of the contract, and excavated under this item shall be used in the formation of embankments, shoulders, etc., prior to the hauling of any borrow unless otherwise directed by the Engineer.

Unless otherwise specified, material classified as rock shall be excavated to a minimum depth of 6" below subgrade within the limits of the roadbed, and the excavation backfilled with approved material and compacted to the specifications as designated on the plans, Special Provisions, or by the Engineer.

The Contractor is required to insure the utmost safety during blasting operations. The Contractor shall be responsible for all damage due either directly or indirectly to blasting operations.

3.03 MEASUREMENTS FOR ROADWAY

Rock excavation will be computed by the average end areas or by volume measurement. Allowance will not be made for excavation beyond the lines, grades, and typical cross sections as shown on the plans. Measurement will not be made for material excavated beyond these lines unless it is required in embankment, then it will be measured and paid for as Borrow.

3.04 BASIS OF PAYMENT

Rock Excavation, measured as provided above, will be paid for at the contract unit price per cubic yard bid for Item 3, Rock Excavation for Roadway, which price shall be full compensation for drilling, blasting, pre-splitting, excavation, removal, disposal, and furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

ITEM 3A

ROCK EXCAVATION

STRUCTURES AND TRENCHES

3A.01 DESCRIPTION

Any material shall be considered rock which, in the opinion of the Engineer, cannot be excavated except by drilling and blasting or drilling and wedging. Boulder will also be classified as rock if the volume of each single boulder exceeds 1/3 cubic yards. Pavement and concrete or masonry structures of any character will not be classified as rock. Soft or disintegrated rock which can be removed with a pick, material which can be broken down with hammers, broken stone in rock fills or elsewhere and hardpans will not be allowed as rock even though the Contractor, for reasons of economy, may elect to remove such materials by drilling and blasting or drilling and wedging.

The classification includes only material which, in the opinion of the Engineer, requires drilling and blasting and which cannot be removed by normal dipper-stick hydraulic backhoe with a 3/4 cubic yard capacity.

3A.02 CONSTRUCTION METHODS

Rock excavation shall be made in accordance with these Specifications and in conformity with the lines, grades, and typical cross-sections as shown on the plans or otherwise specified. If borrow is needed to bring any part of the Rock Excavation to grade, the Contractor shall furnish it at his own expense, and without overhaul charges, an amount of approved borrow equal to the amount of rock used plus 50% and place it in final position.

3A.03 EXCAVATION FOR EXTENSIONS

Wherever provisions are made for future extensions of lines built in rock, the required trench shall be excavated for a distance of not less than five (5) feet beyond the end of line being installed and in the direction of the future extension.

3A.04 BLASTING

All blasting operations shall be conducted in strict accordance with the existing ordinances and regulations relative to rock blasting and the storage and use of

explosives. Any rock excavation within five (5) feet of a water or gas main, or electric or telephone conduit or their appurtenances shall be done with very light charge of explosives or, if directed, without blasting. The utmost care shall be exercised to avoid breaking or disturbing the mains or conduits or their appurtenances. No blasting shall be done near any of the above mentioned pipe lines or structures unless a representative of the Utility Company involved be present. It will be the duty of the Contractor to notify the Utility Company of the proposed blasting operations. A Blasting Permit shall be obtained from the Fire Marshal.

3A.05 DAMAGES CAUSED BY BLASTING

The Contractor will be held accountable and responsible for all damage to existing water or gas mains, electric or telephone conduits or their appurtenances or to any other structures of property encountered in the rock excavation or from the effects of the blasting operations. Any damage to such structures, or other property shall be repaired to the satisfaction of the owners, and the cost of such repairs borne by the Contractor.

The Contractor shall also be held responsible for injury to any person caused by the blasting operations.

Where the rock blasting operations are in close proximity to highways, sidewalks, houses or other structures, the charge must be covered with heavy timbers and ropes or heavy fibre blasting mat placed over the timbers to prevent spawls from being blown over the adjacent ground or outside the limits of the trench.

3A.06 EXPOSED STRUCTURES TO BE PROTECTED

All exposed pipelines or other structures shall be carefully protected from the effects of the blasts, any damage done to such structures shall be promptly repaired by the Contractor at his own expense.

3A.07 DEPTH OF TRENCH IN ROCK

The depth of trench in rock shall be six (6) inches below the bottom of the barrel of the pipe.

3A.08 WIDTH OF TRENCH IN ROCK

The required width of trench in rock for pipe shall be such as to give a clearance of six (6) inches on each side of the barrel of the pipe. When appurtenances extend beyond the exterior lines of the trench, the excavation in rock required for the same will be that contained in a prism with vertical sides and a horizontal section one (1) foot wide

on each side than the smallest rectangle which will enclose such appurtenances and its foundation.

3A.09 ROCK STRIPPED

Rock shall be stripped in sections, which unless otherwise permitted, shall be not less than fifty (50) feet in length and the Engineer shall then be notified in order that he may measure the same. Rock excavated or blasted before such measurement is made will not be paid for.

3A.10 BACKFILLING

Backfilling shall be done as promptly as is consistent with no injury to pipe joints, but no backfilling shall be done before the Engineer gives permission.

Backfilling shall conform to the requirements of Paragraph 2.10.

In paved streets and on the shoulder of the road, the backfill shall be tamped mechanically in six (6) inch layers.

3A.11 MEASUREMENTS FOR STRUCTURES AND TRENCHES

Rock excavation for pipe trenches or structures will be measured to a width not to exceed 12" outside of the pipe or structure and a depth not to exceed the bottom of the earth cushion for bedding in rock as shown on the plans. Rock excavation in gutters, if designated for separate payment, will be measured to a depth not to exceed 6" below the bottom surface. Rock excavation for headwalls, culverts, and bridges will be measured to a width of 18" outside the neat lines of the structure, unless otherwise shown on the plans or directed. The elevation of the bottom of structure footings shall be considered as approximate only. The Engineer may, during the period of construction, order, in writing, changes in dimensions or elevations of footings as may be deemed necessary to secure a satisfactory foundation.

3A.12 BASIS OF PAYMENT

Rock excavation, measured as provided above, will be paid for at the contract unit price per cubic yard bid for Item 3A, Rock Excavation for Structures and Trenches which price shall be full compensation for furnishing all equipment, tools, labor, and incidentals necessary to complete the work.

ITEM 4

EXCAVATION AND BACKFILL FOR STRUCTURES

4.01 DESCRIPTION

Excavation for Structures consists of the removal and disposal of all materials except rock excavation, necessary for the construction of box culverts, pipe headwalls, and other structures, including placing and compacting the backfill, disposing of surplus material, and cleaning up the site. This work shall include all necessary clearing, grubbing, and removing old structures or parts thereof, as required by the Engineer, except where the contract includes a separate estimate and unit price for each item or items. It also includes the furnishing and placing of shoring, sheeting, bracing, cofferdams, and pumping or bailing of water from them, unless otherwise specified.

CONSTRUCTION METHODS

4.02 FOUNDATION PITS

Foundation pits shall be excavated to the depth shown on the plans, or to such depths as may be necessary to ensure the stability of the structure to be erected or according to the direction of the Engineer.

4.03 AREA OF EXCAVATION

Excavation shall be sufficient in area to place full widths, thickness, and lengths of footings. Undercutting of edges, ends, corners, and other surfaces will not be permitted. If a sump area is required, it shall be outside the footing line.

When the excavation is completed, the Contractor shall notify the Engineer who will make an inspection of the foundation pit. No concrete shall be placed until after the Engineer has approved the depth and character of the foundation material.

4.04 COFFERDAMS

All sheeting and bracing shall be carried to sufficient depth to obtain, as nearly as possible, a tight cofferdam. The cofferdam shall have ample clearance to allow inspection of the forms for the finished structure and provide sump areas. The forms for concrete masonry may be braced against the cofferdams when approved by the Engineer.

4.05 COFFERDAMS FOR LARGE STRUCTURES

If required for a large structure, a drawing showing the layout and details of the cofferdams shall be submitted for the Engineer for approval insofar as it affects the finished work. Other responsibility for the cofferdam shall rest with the Contractor.

If the Engineer orders bracing and cofferdam sheeting to be left in place, payment will be made for actual cost of materials left in place as estimated by receipted bills.

No timber shall remain in finished concrete structures.

4.06 BACKFILLING

Filling around, back of, and over structures shall be with existing material approved by the Engineer, and shall be compacted in accordance with Item 2. For backfilling over bridges, pipes, culverts, or other structures, no heavy mechanical compacting equipment shall be permitted over such structures until a minimum of 18" of cover has been placed, unless otherwise permitted by the Engineer. If the existing material is unsuitable for use as backfill, the Contractor shall furnish at his own expense, material meeting the requirements of Borrow, Type C, Subsection 5.02.

Filling around arches, rigid frames, single-span timber structures, and other similar type structures shall be brought up level simultaneously at each abutment so that no unbalanced stresses will be introduced.

4.07 METHOD OF MEASUREMENT

The yardage to be paid for, shall be the yardage included between the line of the original surface of the ground and the bottom excavation lines, allowing 1-1/2' outside the neat lines of the vertical face of foundation, unless otherwise designated on the plans, but exclusive of Rock Excavation, which shall be paid for under Item 3A, Rock Excavation for Structures and Trenches.

4.08 MEASUREMENT

The Contractor shall notify the Engineer sufficiently in advance of his beginning excavation for any structures, so that the cross sectional measurements of the existing ground and structure may be taken. Any material removed or excavated before these measurements have been taken will not be paid for. No allowance will be made for excavation in excess of 1-1/2' on either side of the outer limits of the foundation or backing on timber structures, measured vertically therefrom. Where

structure excavation material is permitted for use in the formation of embankments, the placement thereof shall conform to the requirements outlined under Item 2, Excavation and Embankment.

4.09 BASIS OF PAYMENT

All foundation excavation except rock excavation shall be paid for at the contract unit price per cubic yard bid for Item 4, Excavation and Backfill for Structures, which price shall include the removal of all material within the limits of the structures of headwalls, excavation for and backfilling around structures or headwalls, the formation of embankments, and the disposal of surplus materials. No additional compensation shall be paid for cofferdams, bracing, shoring, pumping, bailing, or for additional materials made necessary on account of water conditions.

ITEM 4A

EXCAVATION AND BACKFILL FOR PIPE TRENCHES

4A.01 DESCRIPTION

Excavation and Backfill for Pipe Trenches shall consist of the removal and replacement or disposal of all materials except Rock Excavation and excavation necessary for the placement of individual entrance pipes. This section shall include the placing and compacting of the backfill material.

4A.02 CONSTRUCTION METHODS

Normal excavation will be considered to be the outside pipe dimension plus 12" each side, unless otherwise designated on the plans.

Unsuitable foundation material shall be removed below the normal design elevation as directed and backfilled with material approved by the Engineer.

When a pipe is to be placed either partially or completely in a fill, the embankment shall be compacted to an elevation of one foot above the top of the proposed pipe installation for a minimum of two pipe diameters on each side of the centerline of the pipe. The trench shall then be excavated as herein described.

When rock, hardpan or other unyielding material is encountered, the trench shall be excavated as shown on the plans for bedding in rock and shall be backfilled with material meeting the requirements of Subsection 4A.03.

4A.03 BACKFILLING

Backfilling of the pipe shall be made with material meeting the requirements of Borrow Type C, Subsection 5.02. If the existing material meets these requirements, it shall be used for pipe backfill. The operation of backfilling pipe trenches shall conform to the requirements in Item 2.

Where the pipes are under the roadway pavement or shoulders, the backfill material shall be compacted to 95% or more.

Where the pipes are installed under an existing roadway, pavement, or shoulder, the trench backfill material shall meet the requirements of Item 8, Graded Aggregate Base Course, Type B (crusher run). Select Borrow, Type C, conforming to Subsection

5.02, will be allowed as backfill to a height of 1 foot over sanitary sewer pipes, water pipes, gas pipes, and electrical conduits.

Where pipes are not under the roadway pavement or shoulders, the backfill material shall meet the requirements of Borrow Type C, Subsection 5.02, to a height of one foot above the top of the pipe. If the existing materials meet these requirements, it shall be used for pipe backfill. The remainder of the pipe trench shall be backfilled with excavated material unless otherwise directed by the Engineer. The compaction requirement for all pipe backfill not under roadway pavement or shoulders shall be 90% or more.

4A.04 MEASUREMENT

The amount to be paid for Excavation and Backfill for Pipe Trenches shall be the yardage of excavation included between a line from the bottom of plan excavation to the bottom of the pipe at the time of pipe placement, and a normal horizontal measurement of outside pipe dimension plus 12" each side, unless otherwise designated on the plans, but exclusive of Rock Excavation, which shall be paid for under Item 3A, Rock Excavation for Structures and Trenches. No allowance will be made for excavation or backfill outside the limits established above.

The limits of trench excavation shall extend to the exterior wall of catch basins, manholes, etc. When the trench intercepts a "normal" structure such as a headwall, culvert, etc. (where payment for structure excavation is applicable), the trench payment limit shall terminate at the point where structure excavation begins.

4A.05 BASIS OF PAYMENT

Excavation and Backfill for Pipe Trenches, except Rock Excavation, shall be paid for at the contract unit price per cubic yard bid for Item 4A, Excavation and Backfill for Pipe Trenches, which price shall include the removal of all material from the trench within the limits specified and for placement, and compaction of acceptable material necessary to backfill the trench. It shall include the removal and approved disposal of any unsuitable or surplus material excavated from the trench. The price and payment for Excavation and Backfill for Pipe Trenches shall constitute full compensation for all cribbing, shoring, and sheeting, and for all labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 5

BORROW

5.01 DESCRIPTION

When suitable material available within the right-of-way is not sufficient in quantity to properly form the embankments, additional material shall be obtained, furnished and placed by the contractor from borrow pits or other approved sources. No borrow for the contract shall be excavated within 100' of the right-of-way line except with written permission. This section also includes any clearing or grubbing required in preparing the pit area for cross-sectioning or excavating.

5.02 GENERAL REQUIREMENTS

The uses, classification, characteristics, and definitions of the terms for borrow materials obtained shall be in accordance with the requirements of AASHTO M57, Modified; M145, Modified; M146; and M147, Modified.

Unless otherwise directed, all materials having the following properties shall be excluded for use:

- a) The material has a maximum dry weight less than 90 pounds per cubic foot.
- b) The material has a liquid limit in excess of 50.
- c) Material containing detrimental quantities of frozen material, rubbish, boulders in excess of 6", or organic matter such as leaves, roots, grass, or sewage.

The method of testing materials shall be in accordance with the requirements of AASHTO T 88, Modified; T 89, Modified; T 90, Modified; and T 99, Method C, Modified.

Borrow Type A:

The material shall be bank-run gravel, quarry waste, stone screenings, or other acceptable granular material; the particles of which will be of such size that not more than 5% by dry weight shall be retained on the 2-1/2" sieve and not more than 35% by weight shall pass the No. 200 sieve.

Borrow Type B (Special fill)

Materials used for special fill shall consist of clean sand, crushed or uncrushed gravel or crushed stone and shall be free from frozen material, wood or other extraneous matter. With the approval of the Engineer, blasted or crushed rock and boulders may be used. Such rock shall have a maximum size of 12" and shall have a gradation which is satisfactory to the Engineer. Special fill shall contain not more than 10% by weight passing the No. 200 sieve and 45% by weight passing the No. 100 sieve. Where piles are required for future bridges, the material shall have 100% by weight passing the No. 2-1/2" sieve. Material for special fill shall be sampled, tested and approved prior to its final placement.

Borrow Type C (Backfill)

Material used for backfill shall have a gradation of 85-100% by weight passing the 1" sieve and maximum of 25% by weight passing the No. 200 sieve.

Borrow Type D (Cement Stabilization)

This material shall have 100% passing the 3" sieve and between 8 to 30% passing the No. 200 sieve.

Borrow Type E (Asphalt Stabilization)

This material shall be non-plastic and shall have not more than 20% nor less than 6%, by dry weight passing the No. 200 sieve.

Borrow Type F (Common Borrow)

Material used for embankment construction shall be free from detrimental quantities or organic material, such as leaves, grass, roots and sewage; and shall be subject to the general requirements of Subsection 7.02.

Borrow Type G (Select Borrow)

This material shall meet any of the grading requirements listed in the following table:

TYPE G (*) (SELECT BORROW)							
Sieve Designation		Weight Percent Passing Square Mesh Sieves					
Stand. mm	Altern. Inches	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
50.0	2"	100	100	95-100	95-100	95-100	95-100
25.0	1"	---	75-95	85-100	85-100	85-100	85-100
9.5	3/8"	30-65	40-75	50-85	60-100	---	---
4.75	#4	25-55	30-60	35-65	50-85	55-100	70-100
2.00	#10	15-40	20-45	25-50	40-70	40-100	55-100
0.425	#40	8-20	15-30	15-30	25-45	20-50	30-70
0.075	#200	2-8	5-20	5-15	5-20	6-20	8-25

Note: The fraction passing the No. 200 sieve shall not be greater than two-thirds of the fraction passing the No. 40 sieve. The fraction passing No. 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6, when tested according to AASHTO T 89, Modified, & T 90.

5.03 CONSTRUCTION METHODS**Borrow Pits**

The Contractor shall notify the Engineer in advance of the opening of any borrow pit so that soil samples may be obtained and tested. The material and methods of excavation shall be approved by the Engineer so that elevations and measurements of the existing ground surface may be taken. Before excavation is started, the ground surface shall be cleared and grubbed in the manner described under Item 1, Clearing and Grubbing. The pit shall be stripped of all unsuitable material prior to original measurement and removal of borrow for use in embankments. All borrow pits shall be neatly trimmed and left in such condition as to permit accurate measurement after the excavation is completed, and where practicable, shall be so excavated that water will not collect or stand therein.

5.04 TESTING BY THE CONTRACTOR

The Contractor will assist the City in determining the quality and quantity of material from sources he may propose to use. Soil analysis test on one test hole for each 500 cubic yards of estimated borrow may be required from the Contractor.

5.05 USE OF BORROW

No borrow shall be used until the slopes and ditches have been excavated and all other sources of excavation provided for have been exhausted. If the Contractor places more borrow than is required, causing the waste of excavation, the amount of such waste shall be deducted from the borrow as measured in the borrow pit.

5.06 PLACING AND COMPACTING

All borrow under this section shall be placed and compacted in accordance with the requirements of Item 2, Excavation & Embankment. Placing fill shall be approved by the Engineer.

5.07 METHOD OF MEASUREMENT

The yardage of Borrow to be paid for under this section shall be the yardage of acceptable material excavated as hereinabove prescribed, exclusive of the yardage of over-burden or stripping, measured by cross-sections and computed by the method of average end areas.

When requested by the Contractor and approved by the Engineer in writing, material specified to be measured by cubic yard may be weighed and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and when certified weight slips are used as the method of measurement, 3,200 lbs. shall be considered as equivalent to one cubic yard.

Unless stated otherwise, all material that is to be measured by weight, the following shall govern: Each load shall have a ticket, signed by an approved Certified Weighmaster and shall be signed by the Construction Inspector as received and used on the project.

If the limits of measurement for pay quantities for Borrow are designated on the plans, the quantity of Borrow measured for payment will be the volume in cubic yards of Borrow placed within the payment lines and grades shown on the plans as computed by the methods of average end areas from cross-sections taken after foundation materials have been excavated and after completion of fill. Borrow placed beyond the

payment limits due to over excavation or slides will not be included for payment.

5.08 BASIS OF PAYMENT

The yardage of acceptable borrow measured as provided above shall be paid for at the contract unit price per cubic yard bid for Item 5 Borrow, which price and payment shall be full compensation for the clearing, grubbing, and stripping of borrow pits, furnishing, excavation, and hauling of all material, the formation and compaction of embankments, final cleaning up of the borrow pit, and for the furnishing of all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 6

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

6.01 DESCRIPTION

Removal of Structures and Obstructions shall consist of removal, wholly or in part, and satisfactory disposal of all buildings, fences, structures, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other Items in these specifications.

It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits.

6.02 CONSTRUCTION METHODS

The Contractor shall raze, remove and dispose of all buildings and foundations, structures, fences, and other obstructions, any portions of which are on the right-of-way, except utilities and those for which other provisions have been made for removal. All designated salvageable material shall be removed, without unnecessary damage, in sections or pieces which may be readily transported and stored by the Contractor at a specified place. Basements or cavities left by structure removal shall be filled to the level of the surrounding ground while following the compaction guidelines in Item 2, Excavation and Embankment.

Bridges, culverts, and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic and new construction materials delivered to the site.

Unless otherwise directed, the substructures of existing structures shall be removed down to the natural stream bottom and those parts outside of the stream shall be removed down 1' below natural ground surface. Where such portions of existing structures lie wholly or in part within the limits of a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

All work performed under this item must be completed before work can start on Item 4, Excavation and Backfill for Structures.

Steel bridges and wood bridges as specified shall be carefully dismantled without unnecessary damage. Steel members should be match-marked unless waived by the Engineer.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work.

6.03 METHOD OF MEASUREMENT

When the contract stipulates that payment will be made for removal of obstructions on a lump sum basis, the pay item removal of structures and obstructions will include all structures and obstructions encountered within the right-of-way in accordance with the provisions of this item. Where the proposal stipulates that payment will be made for the removal of specified items on a unit basis, measurement will be made by the unit stipulated in the contract.

6.04 BASIS OF PAYMENT

The accepted quantities of Removal of Structures and Obstructions as provided above, shall be paid for at the contract price bid for Item 6, which shall be full compensation for removing and disposing of the obstructions in accordance with the contract and excavation incidental to their removal. The price shall also include salvage of materials removed, their custody, preservation, storage and disposal as may be directed.

ITEM 7

SELECT BORROW BASE COURSE

7.01 DESCRIPTION

Select Borrow Base Course shall consist of furnishing, placing, and compacting select borrow material on the prepared foundation in accordance with these specifications and in reasonably close conformity in all respects with the lines, grades, thicknesses, and typical cross-sections shown on the plans or as established by the Engineer.

7.02 MATERIALS

The material used for Select Borrow Base Course shall meet the requirements of Item 5, Borrow Type G, (Select Borrow).

7.03 PREPARATION OF FOUNDATION

The foundation shall be properly shaped and thoroughly compacted in conformity with the lines and grades as shown on the plans and/or as established by the Engineer before any base course material is placed. These operations shall be in accordance with Item 2, Excavation and Embankment.

No base course material shall be placed until the foundation has been approved by the Engineer.

7.04 CONSTRUCTION METHODS

Material shall be placed in successive layers with each layer placed in a level, uniform, cross-section not to exceed eight inches (8") in depth, loose measurement, unless otherwise approved by the Engineer. Each layer shall be deposited and spread parallel to the centerline, extending the full plan width.

If a layer does not contain a uniform distribution of moisture and component materials, it shall be disced or processed in a manner to ensure homogeneity. Each layer shall be properly compacted as herein specified before starting the next layer.

Compaction or rolling shall start at the edges and progress toward the center, and shall continue until each layer is thoroughly and uniformly compacted to the full width.

In no case shall vehicles be allowed to travel in a single track or form ruts in the

foundation. If any sharp irregularities are formed, the foundation shall be scarified to a depth of six inches (6") and recompact.

7.05 PERFORMANCE REQUIREMENTS

Compaction shall continue until each layer is thoroughly and uniformly compacted to 100% or more of the laboratory maximum density on representative material.

The moisture content of the material at the time of compaction shall be within two percentage points of the optimum. The material shall either be moistened or dried, as needed, and thoroughly mixed before compaction.

The finished surface of the Select Borrow Base Course shall not vary from that required on the plans by more than one-half inch for the grade to be approved. Deficiencies shall be corrected at the contractor's expense.

7.06 METHOD OF MEASUREMENT

The quantity of Select Borrow Base Course to be paid for under this section shall be the number of cubic yards of Select Borrow Type G measured in its original position by cross-sections and computed by the method of average end areas. The number of cubic yards of borrow measured, as stated above, will not include any overburden or stripping.

When requested by the contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard may be weighed and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer. When certified weight slips are used as a method of measurement, 3,200 lbs. shall be considered as equivalent to one cubic yard.

Unless stated otherwise, each load of borrow measured by weight shall have a ticket, signed by an approved Certified Weighmaster and shall be signed by the Construction Inspector as received and used on the project.

7.07 BASIS OF PAYMENT

The quantity of Select Borrow Base Course measured as provided above shall be paid for at the contract unit price per cubic yard for Select Borrow Base Course complete in place, which price and payment shall be full compensation for furnishing, hauling, placing, and compacting the materials, and for furnishing all tools, labor, work and other items incidental thereto and necessary to complete the work.

ITEM 8

GRADED AGGREGATE BASE COURSE

8.01 DESCRIPTION

Graded Aggregate Base Course shall consist of furnishing, placing, and compacting Graded Aggregate Base Course materials on the prepared foundation in accordance with these specifications and in reasonably close conformity in all respects with lines, grades, thicknesses, and typical cross-sections shown on the plans or established by the Engineer.

8.02 MATERIALS

The material used to complete Graded Aggregate Base Course shall consist of crushed stone, crushed gravel, or crushed slag fragments. The aggregates shall be uniform in quality and consistency, free of silt, clay, decomposed rock, and overburden material.

The Graded Aggregate Material shall meet the following gradation requirements for the appropriate type:

Weight Percentage Passing		
Sieve Size	Type "A" (CR-1)	Type B" (Crusher Run)
2 ½"	100	---
1 ½"	---	100
1"	50-80	---
¾"	---	50-90
#4	20-50	20-50
#10	---	15-40
#20	10-30	---
#100	2-20	2-20

Applicable testing methods are as follows:

AASHTO T2 Sampling Stone, Slag, Gravel and Stone Block for Use as Highway Material.

AASHTO T27 Sieve Analysis of Fine and Course Aggregates.

AASHTO T96 Resistance to Abrasion of Small Size Course Aggregate by Use of the Los Angeles Machine.

8.03 PREPARATION

The foundation shall be properly shaped and thoroughly compacted in conformity with the lines and grades as shown on the plans and/or as established by the Engineer before any base course material is placed. These operations shall be in accordance with Item 2, Excavation and Embankment.

In order to support the edges of the aggregate base course during rolling, the shoulders on each side of the proposed pavement shall be placed and compacted prior to the cutting of the box for the pre-mixed material. The shoulders shall conform to the true grade and cross-section shown on the plans.

After the shoulders have been compacted, the inner edges shall be trimmed so as to permit the placing of the sub-base and base with a definite edge and on the desired alignment.

No base course material shall be placed until the foundation has been approved by the Engineer.

8.04 CONSTRUCTION METHODS

The aggregate shall be placed in successive layers with each layer being placed in a level, uniform, cross-section not to exceed eight inches in depth, loose measurement, unless otherwise approved by the Engineer. It shall be deposited and spread parallel to centerline, extending the full plan width, in a manner so that no segregation of fine and course particles occurs. No more than 1,000 linear feet of material may be spread in advance of compaction operations.

Each layer shall be properly compacted as herein specified before starting the next layer. The material shall be compacted with the aid of water. The water shall be applied in a uniform manner to provide adequate moisture content of the base course prior to compaction efforts.

Compaction or rolling shall start at the edges and progress toward the center, and shall continue until each layer is thoroughly and uniformly compacted to the full width.

After compacting, all voids in the surface of each layer shall be filled with aggregate

meeting the requirements of Delaware Number 10, commonly referred to as stone dust. Water shall be applied to the surface and compaction continued.

In no case shall vehicles be allowed to travel in a single track or form ruts. If any sharp irregularities are formed in the foundation and/or base course material, the affected area shall be scarified to a depth of six inches and compacted to meet the appropriate specifications.

8.05 PERFORMANCE REQUIREMENTS

The moisture content of the base course material at the time of compaction shall be within two percentage points of the optimum moisture content. If the moisture content is not within two percentage points of optimum, the material shall be either moistened or dried, as needed, and thoroughly mixed before compaction.

Compaction of the Graded Aggregate Base Course shall continue until each layer is thoroughly and uniformly compacted to a firm and unyielding surface to the satisfaction of the Engineer. Test rolling shall be performed with self-propelled pneumatic tired equipment of sufficient size, type, and weight that would reveal any soft or yielding areas. No additional materials, of any kind, will be permitted to be placed until the test rolling performance has been passed or accepted by the Engineer.

The finished surface of the Graded Aggregate Base Course shall not vary from that required on the plans by more than one-half inch for the grade to be approved. Any portion of the Graded Aggregate Base Course found deficient shall be corrected at the Contractor's expense.

8.06 METHOD OF MEASUREMENT

The quantity of Graded Aggregate Base Course, Type A or Type B, for which payment shall be made will be the number of square yards measured (per inch of thickness) or tons completed to the width and depth as shown on the plans, with the length being measured along the centerline.

Unless otherwise stated, all material that is to be measured by weight shall have a load ticket for each load received, signed by an approved Certified Weighmaster and signed by the Construction Inspector when received and used on the project.

8.07**BASIS OF PAYMENT**

The quantity of Graded Aggregate Base Course, Type A and/or Type B, shall be paid for at the contract unit price bid per square yard or per ton for Graded Aggregate Base Course complete and in place. The price and payment shall be full compensation for preparation, for furnishing, placing and compacting the materials, and for furnishing all tools, labor, work and other items incidental and necessary to complete the work.

ITEM 8A

QUARRY WASTE BASE COURSE

8A.01 DESCRIPTION

Quarry Waste Base Coarse shall consist of a base course of quarry waste, either stone or blast furnace slag, constructed on a prepared sub-base in accordance with these specifications and in reasonably close conformity to the lines, grades, thickness and typical cross-section shown on the plans. When the cross-section specifies a compacted thickness of more than 6", the quarry waste material shall be placed in two equal layers, unless otherwise approved in writing by the Engineer.

8A.02 MATERIALS

Quarry Waste shall conform to the following requirements when tested according to AASHTO T27:

GRADATION

<u>Sieve</u>	<u>Percent Passing</u>
1-1/2"	100
1"	85-100
1/2"	40-85
#10	10-50
#200	2-25

The fraction passing the #40 sieve shall have a liquid limit not greater than 25 and a plasticity index not exceeding 6, when tested according to AASHTO T89 Modified, and T90.

8A.03 CONSTRUCTION METHODS

- 1) Formation of subgrade shall be completed in accordance with the requirements in Item 2, Excavation and Embankment.
- 2) Formation of shoulders shall be completed in accordance with the requirements of Item 8, Graded Aggregate Base Course.
- 3) Spreading of Quarry Waste Base Course shall be completed in accordance with

the requirements of Item 8, Graded Aggregate Base Course.

- 4) Compaction of Quarry Waste Base Course shall be completed in accordance with the requirements of Item 8, Graded Aggregate Base Course.
- 5) Final grade checking of Quarry Waste Base Course shall be completed in accordance with the requirements of Item 8, Graded Aggregate Base Course.

8A.04 METHOD OF MEASUREMENT

The quantity of Quarry Waste Base Course for which payment shall be made will be the number of square yards measured or tons completed to the width and depth shown on the plans with the length being measured along the centerline.

Unless otherwise stated, all material that is to be measured by weight shall have a load ticket for each load received, signed by an approved Certified Weighmaster and signed by the Construction Inspector when received and used on the project.

8A.05 BASIS OF PAYMENT

The quantity of Quarry Waste Base Course shall be paid for at the contract unit price bid per square yard or per ton for Quarry Waste Base Course complete and in place. The price and payment shall be full compensation for preparation, for furnishing, placing and compacting the materials, and for furnishing all tools, labor, work and other items incidental and necessary to complete the work.

ITEM 8B

SOIL CEMENT BASE COURSE

8B.01 DESCRIPTION

Soil Cement Base Course shall consist of constructing one or more courses of a mixture of soil and Portland cement on a prepared surface in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross-sections shown on the plans or established by the Engineer.

MATERIALS

8B.02 PORTLAND CEMENT

Portland Cement shall meet the requirements and tests of the Standard Specifications for Portland Cement, AASHTO M 85, Type I or Type II and shall be approved prior to use.

Water: The water shall be free from mineral or organic substances deleterious to the soil cement and shall be approved prior to use.

Soil: The soil for the base course shall consist of material existing in the area to be paved or borrow material, or a mixture of both, which has been approved. Borrow material shall meet the requirements of Item 5, Borrow Type D. Any material retained on a 3" sieve and other unsuitable material such as roots, vegetation, etc., shall be removed by acceptable methods. The maximum density and optimum moisture will be determined by AASHTO T 99, Method C, Modified. Field density determinations will be made in accordance with AASHTO T 191 or other approved methods.

Asphalt: The asphalt used as a curing film for the soil cement shall be RC 70, RC 250, TS 1 and RS 2 meeting the requirements of AASHTO M 81 or M 140 respectively and shall be approved prior to use. If approved in writing by the Engineer, water cure may be used in lieu of asphalt.

Fine Aggregate: The fine aggregate used as a cover over the asphaltic curing to protect traffic shall meet the requirements of Paragraph 103, Material Details and shall be approved prior to use.

8B.03 EQUIPMENT

The type, condition, and quantity of equipment furnished shall meet the qualifications necessary for the proper execution of the work within the specified working time. Equipment shall bear the manufacturer's name plate on which shall be stamped the model number. All equipment shall be maintained in good condition, and be subject to approval prior to and during its use in connection with the project. Compaction equipment shall also meet the requirements of Item 2.

8B.04 PRECONSTRUCTION

It shall be the Contractor's responsibility to notify the Department of Public Works at least 8 working days prior to the anticipated processing date in order to determine the required proportions of cement and water for the soil cement mixture. This notification shall be made after a stockpile of soil from an approved source has been formed. This stockpile of soil shall be formed of material representative of the approved source and to the satisfaction of the Engineer.

8B.05 CONSTRUCTION

Mixing of the soil, cement, and water shall be accomplished either by the Mix-in-Place or the Central Mix method.

8B.06 MIX-IN-PLACE

1. **Preparation:** The subgrade shall have been successfully test rolled in accordance with Item 2, prior to the placement of the soil to be stabilized. The area to be paved shall be graded and shaped as required to construct the base course conforming to the grades, lines, thickness, and typical cross-section shown on the plans. Any additional soil needs shall be placed as directed.
2. **Pulverization:** It may be necessary to pulverize and thoroughly mix the soil prior to the application of cement.
3. **Application of Cement:** The percentage of moisture in the soil at the time of cement application shall not exceed the quantity that will permit a uniform and intimate mixture of soil and cement during mixing operations, and it shall not exceed the specified optimum moisture content for the soil cement mixture. The cement shall be uniformly applied by an approved mechanical or pneumatic spreader and shall be applied only to material that can be processed in a continuous operation in daylight hours. Any equipment or traffic traveling over

the spread cement shall be maintained at slow speed and any cement displaced shall be replaced before mixing is started at the Contractor's expense. No cement shall be applied when the soil to be mixed or the foundation soils are frozen. The air temperature shall be at least 40° F, in the shade and rising prior to the application of cement.

4. **Mixing:** After the cement has been applied, it shall be immediately and continuously mixed until the soil and cement are completely blended. After the soil and cement have been blended, water shall be immediately applied uniformly in the quantity and at the rates directed with pressurized distributing equipment. Each application of water shall be incorporated into the mixture by the mixing equipment so as to avoid concentration of water on or near the surface. After the last application of water, mixing shall continue until a uniform and intimate mixture of soil, cement, and water has been obtained and that a minimum of 80% by wet weight passes a #4 sieve, exclusive of stone or gravel retained.

Particular care shall be exercised to insure a satisfactory mixture along the edges. No portion of the mixture shall be left undisturbed for more than 30 minutes.

5. **Compaction:** Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. At the beginning of compaction, which shall immediately follow the mixing operations, the percentage of moisture in the mixture shall be within ± 2 percentage points of the specified optimum moisture content or a moisture content which will not cause an unstable condition in the soil cement mixture. The loose mixture shall, within 2-1/2 hours from the application of cement, be uniformly compacted to not less than 97% of the maximum dry density. Material used to determine the maximum dry density will be sampled at the completion of compaction or within the above time limit, whichever occurs first. Field density tests will be performed on each day's construction. During compacting operations, shaping may be required to obtain uniform compaction and the required grade and cross-section. If, due to rain, the average moisture content exceeds the tolerance given above, the entire section shall be corrected by mixing in an additional amount of cement to be determined by the Engineer. The cement will be paid for at the unit price bid.

8B.07 CENTRAL MIX

1. **Central Mixing Plants:** The plant may be either a batch or continuous flow type equipped with batching or metering devices designed to regulate the specified quantities of the respective materials and which has been inspected and approved prior to use. The plant shall be of a design that will produce a

thorough mixture of soil, cement, and water of proper proportions. The mixer shall be in an approved mechanical condition and shall have a capacity of at least 100 tons per hour. Approval will not be granted for use of a mixer that permits added water to come in contact with the cement before the cement has been mixed with the soil. All controls shall be synchronized so that the water, soil, and cement feeds start and stop simultaneously. The soil must be fed in a manner which will assure as even a flow as possible. There must be adequate and acceptable cement storage, an approved stockpile of soil, and adequate water supply. The plant may be required to demonstrate that it is capable of producing a uniform and intimate mixture of soil, cement and water before approval.

2. **Field Laboratory:** The Contractor and/or producer shall provide suitable quarters at central mixing plants for the purpose of housing laboratory testing equipment. The quarters shall be approximately 8' L. x 8' W. x 8' H., with a work counter approximately 8' L. x 21' W., or other acceptable dimensions. The quarters shall be entirely closed, water and dustproofed, and shall be provided with electricity, water storage, screened windows and entrance with satisfactory locks. The quarters shall be located convenient to the plant. The quarters will be considered part of the central mixing plant and no additional compensation will be made.
3. **Mixing:** Before any soil is processed through the plant, it shall be uniform in texture, tested for conformance to specifications, and approved.

The percentage of moisture in the soil, at the time of cement application, shall not exceed the quantity that will permit a uniform and intimate mixture of soil and cement during the mixing operations, and it shall not exceed the specified optimum moisture content for the soil cement mixture. Mixing operations shall not start when the soil or the foundation soils on which the mixture is to be placed is frozen.

The air temperature shall be at least 40° F, in the shade and rising prior to the start of mixing operations.

4. **Hauling:** The mixture shall be hauled to the roadway in vehicles free of foreign material and covered to protect the mixture from loss of moisture.
5. **Spreading:** The foundation material shall be in a moist condition and free of water puddles prior to the spreading operation. The mixture shall be placed in a uniform layer by an approved spreader. The layer of soil cement shall be uniform in thickness and surface contour. The thickness will be such that the mixture when compacted will conform to the tolerances of the required grade.

and cross-sections. Dumping of the mixture in piles or windrows on the foundation material shall not be permitted without the approval of the Engineer.

Not more than 30 minutes shall elapse between the placement of soil cement in adjacent lanes, unless forms are used to construct longitudinal joints. As an alternate, in lieu of using forms should 30 minutes elapse between placement of soil cement in adjacent lanes, the Contractor shall submit a method of construction and protection of the longitudinal joints to be approved by the Engineer.

6. **Compaction:** Prior to the beginning of compaction, the mixture shall be in a loose condition for its full depth. At the beginning of compaction, the percentage of moisture in the mixture shall be within ± 2 percentage points of the specified optimum moisture content or a moisture content which will not cause an unstable condition in the soil cement mixture. If, due to rain, the average moisture content exceeds the tolerances given above, the entire section shall be corrected at the Contractor's expense by mixing in an additional amount of cement to be determined by the Engineer or by removal and replacement. The loose mixture shall, within 2 hours from the time mixed, be uniformly compacted to not less than 97% of the maximum dry density. Material used to determine the maximum dry density will be sampled at the completion of compaction or within the above time limit, whichever occurs first. Field density tests shall be performed on each day's construction. During compaction operations, shaping may be required to obtain uniform compaction and the required grade and cross-section. Not more than 60 minutes shall elapse between the start of mixing and the start of compaction of the soil cement mixtures. Any mixture of soil, cement, and water that has been spread and not been compacted shall not be left undisturbed for more than 30 minutes.

8B.08 FINISHED

After the mixture has been compacted, the surface of the soil cement shall be shaped, if necessary, to the line, grades and cross-section. During shaping operations, light scarifying with a nail drag, weeder, or similar equipment may be necessary to prevent formation of compaction planes. The surface shall be smoothly and uniformly compacted to the specified density. Broom dragging may be required to supplement the final rolling. The surface material shall be maintained within ± 2 percentage points of the specified optimum moisture content during finishing operations. Surface compacting and finishing may be varied as necessary to produce a smooth, dense surface, free of compaction planes, cracks, ridges, or loose material.

8B.09 CONSTRUCTION JOINTS

The end of each completed section shall be cut back to a point where it meets the line, grade, crown, and specified quality of soil cement mixture and shall be trimmed to a vertical face at right angles to the centerline of roadway for the full width and depth. The trimmed vertical face shall be protected until compacting operations begin on the adjacent section. The use of a wooden bulkhead to construct a true vertical face and cross-section may be required by the Engineer.

8B.10 PROTECTION AND COVER

After the soil cement mixture has been completed as specified herein, it shall be protected against drying by applying RC 70, RC 250, RS 1, or RS 2 asphalt at the minimum rate of 0.15 gallon per square yard. Just prior to the application of asphalt, the soil cement shall be broomed free of all loose and foreign material, and sufficient water added with pressurized distributing equipment to fill the surface voids only. The finished soil cement shall be kept moist until the asphalt is applied. This asphalt shall be applied within 24 hours following the finished operation or as soon as weather conditions permit. If approved in writing by the Engineer, water cure may be used in lieu of asphalt.

To protect traffic and the asphaltic curing film, a cover of fine aggregate meeting the requirements of Paragraph 103, Material Details, shall be used. The asphaltic curing film and cover shall be maintained by the Contractor until the mixture is protected by a subsequent course.

Any finished portion of the soil cement adjacent to construction which is traveled on by equipment used in constructing an adjoining section shall be protected in such a manner as to prevent equipment from marring or damaging the completed work.

At any time when the air temperature may be expected to reach the freezing point during the day or night, sufficient protection shall be given the soil cement to prevent its freezing for 7 days after compacting.

8B.11 TOLERANCES

- a. **Thickness:** The thickness of the soil cement mixture shall be within $\pm 1/2"$ of the plan thickness and shall be determined from the average of a set of measurements taken through holes made through the finished soil cement mixture at intervals not to exceed 500 linear feet per lane. A set of measurements consists of three holes spaced 5' apart in a triangular pattern with the thickness measured to the nearest $1/4"$. Measurements will be made immediately following the finishing operation.

If the average thickness shown by a set of measurements is not within the tolerances specified, additional sets of measurements shall be made at 25' intervals forward and backward until at least two consecutive sets of measurements in each direction are within the tolerance specified. Areas represented by averages exceeding the tolerances specified may be required to be reconstructed at the Contractor's expense.

- b. **Surface:** The surface smoothness of the soil cement mixture during and after the compaction and finishing operations shall be tested with a 10' straightedge laid parallel to the centerline. Any irregularities greater than $\pm 1/2$ shall be satisfactorily corrected at the Contractor's expense.
- c. **Density:** Any portion of the soil cement which shows less than 97% of the maximum dry density may be required to be removed and replaced at the Contractor's expense.
- d. **Time Limitations:** Soil cement in areas where time limitations were not adhered to may be required to be reconstructed at the Contractor's expense.

8B.12 TRAFFIC

Local traffic and construction equipment may be permitted to use completed portions immediately, provided the base course has hardened sufficiently to prevent marring or distorting of the surface by equipment or traffic, and provided the protection and cover as specified is not impaired.

8B.13 MAINTENANCE

The Contractor shall be required, within the limits of his contract, to maintain the entire base course in good condition from the time he first starts work until all work shall have been completed and accepted. Maintenance shall include immediate repairs of any defects that may occur either before or after the cement is applied, which work shall be done by the Contractor at his own expense, and repeated as often as may be necessary to keep the area continuously intact. Repairs are to be made in a manner to insure restoration of a uniform surface and durability of the part repaired. Faulty work shall be remedied by replacing the material for the full depth of treatment rather than adding a thin layer of soil cement to the completed work.

8B.14 METHOD OF MEASUREMENT

Soil Cement Base Course shall be measured by the number of square yards excluding cement, completed and accepted according to plan and cross-section which shall

include the asphalt and fine aggregate cover.

The cement shall be measured by the hundredweight (CWT), the term CWT will mean 100# of cement, for all cement used in the completed and accepted work.

8B.15 BASIS OF PAYMENT

Soil Cement Base Course will be paid for at the contract unit price bid for Item 8B, Soil Cement Base Course. Contract unit price shall be full payment for subgrade preparation, water, cement, mixing, compacting, asphalt, fine aggregate, equipment, tools, labor and incidentals necessary to complete the work and for the carrying out of the maintenance provisions in these specifications.

ITEM 8C

BITUMINOUS CONCRETE BASE COURSE

(DEEP LIFT)

8C.01 DESCRIPTION

Bituminous Concrete Base Course shall consist of constructing one course of plant mixed, hot-laid bituminous concrete base course to the compacted thickness shown on the plans and in accordance with these specifications in reasonably close conformity with the lines, grades, section and width shown on the plans.

8C.02 MATERIALS

Asphalt cement, fine aggregate, and coarse aggregate shall meet the requirements of Item 39.

8C.03 COMPOSITION OF MIXTURE

Composition of mixture shall be within the gradation limits of Item 39 for Type "B" Binder; however, during production of the bituminous mixture, the gradation of the aggregates may vary between the limits specified but such variation shall be gradual. Sudden variation from coarse to fine, or vice versa, on any sieve will not be tolerated.

The asphalt content shall be from 3.0 to 4.5%.

Mix Requirements:

Asphalt Content	3.0 -4.5%
Air Voids	3%-8%
Stability	1,000 lb., Minimum
Flow	8-18

Gradation Requirements:	<u>Sieve Size</u>	<u>% Passing</u>
	1 1/2"	100%
	3/4"	75-100%
	3/8"	48-80%
	#8	20-48%
	#30	10-30%
	#50	7-25%
	#200	3-10%

8C.04 GENERAL

All provisions of Subsection 39.18, 39.19, 39.20, 39.21, 39.24, 39.25, and 39.26 of Item 39, shall apply to this Section.

8C.05 METHOD OF MEASUREMENT

The number of tons of Bituminous Concrete Base Course to be paid for under this section shall be the actual weight of Hot-Mix Asphaltic Concrete placed and accepted.

Each load shall have a ticket signed by an approved Certified Weighmaster showing the net weight of each load and signed by a Construction Inspector as being received and used on the project.

8C.06 BASIS OF PAYMENT

The tonnage measured as provided above shall be paid for at the contract unit price per ton bid for Item 8D, Bituminous Concrete Base Course, which price and payment shall be full compensation for furnishing, preparing, hauling, and placing all materials, including fog coat, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 8D

SLURRY SEAL COAT

8D.01 DESCRIPTION

The work to be performed consists of the placement of an asphalt emulsion slurry seal coat, at the location or locations, to the widths and lengths, all as shown on the plans or in the schedule included herewith, together with all other incidental work provided herein.

8D.02 MATERIALS

The slurry seal shall be prepared from those of the following materials selected by the Engineer, conforming to the requirements as shown below:

- A - Asphalt emulsion shall meet the current specifications of the American Association of State Highway and Transportation Officials for Cationic Emulsified Asphalt, Grade CSS-1h, except that the penetration of the distillation residue shall be 40-100.
- B - Aggregate shall be broken stone meeting the quality requirements for the respective materials and meeting the following gradation:

<u>Sieve Size</u>	<u>Percent Passing</u>
#8	100%
#16	55-85%
#30	35-60%
#50	20-45%
#100	10-30%
#200	5-15%

There shall be no blending of aggregates except those of like character, and then only through a bituminous concrete or other approved plant.

- C - Water to be used in the slurry shall be potable and free from soluble salts.

8D.03 PREPARATION OF SURFACE

The Contractor shall prepare, or cause to be prepared by separate agreement or by a bid item in the proposal, the area to be slurry sealed. This shall include necessary patching and cleaning, the removal of all loose material, silt spots, vegetation and other objectionable material. Seal cracks and repair joints. "Scratch coat" over fine cracks less than 1/4" - large area.

8D.04 TRAFFIC PROTECTION

Vehicular traffic need not be maintained while resurfacing is in progress, nor until the slurry seal has taken its initial set. If provided herein, the Contractor shall protect the project during this period by the use of an adequate number of barricades properly placed, and he shall take all reasonable precautions to guard the newly laid seal coat against traffic damage. Otherwise, such protection shall be provided by the contracting agency. Where practical, parking shall be prohibited until the morning following the Slurry Seal application.

8D.05 PROPORTIONING OF MATERIALS

The materials going into the slurry seal mix shall be proportioned in accordance with the design formula established by a laboratory recognized by the Engineer as competent to prepare such formulas. The formula, or design, shall be based on the materials proposed to be used in the work, and it shall be approved by the Engineer prior to the start of any work. No change in the type or source of any ingredient shall be permitted without the submission and approval of a new design.

A complete laboratory analysis and test report shall be submitted by the Contractor before the job starts.

Samples of materials shall be furnished to the Engineer by the Contractor when required, two (2) weeks before work begins.

8D.06 STOCKPILING

Stockpiling and handling of aggregates shall be in accordance with Section 4.38 of the Standard Specifications.

EQUIPMENT

1. **Slurry Mixing Equipment** - The slurry mixing machine shall be a continuous flow mixing unit capable of delivering accurately a predetermined proportion of aggregate, water and asphalt emulsion to a mixing chamber, and of discharging the thoroughly mixed produce on a continuous basis. The aggregate shall be pre-wetted immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all ingredients together without violent action.

The mixing machine shall be equipped with an approved fines feeder that provides an accurate metering device or method of introducing the predetermined proportion of Portland Cement into the mixer at the same time and location that the balance of the aggregate is fed. It shall also be equipped with a water pressure system and fog type spray bar adequate for complete fogging the surface preceding the slurry spread with a maximum application of 0.05 gallons of water per square yard.

Sufficient machine storage capacity to properly mix and apply a minimum of ten tons of slurry shall be provided. A certified calibration chart of the emulsion tank shall be carried on the machine at all times.

The slurry machine must have been calibrated prior to commencing operations. The amount of each material proposed to be used on the contract - the aggregate, the asphalt emulsion and the mineral filler - shall be separately determined by the calibration, and these quantities must meet the requirements of the approved design formula.

2. **Slurry Spreading Equipment** - Attached to the mixer machine shall be a mechanical type squeegee distributor box having flexible material in contact with the road surface to prevent loss of slurry from the distributor. The box shall be so maintained as to prevent loss of slurry on varying grades and crowns by adjustments to assure uniform spread. There shall be a steering device and a flexible strikeoff. The spreader box shall be designed to apply widths of slurry. It shall be kept clean, and build-up of asphalt on the box shall not be permitted.
3. **Auxiliary Equipment** - Burlap, hand squeegees, shovels and all other necessary tools and equipment shall be provided to perform the work in a proper manner, and they shall be maintained in a clean, satisfactory working condition at all times.

8D.08 APPLICATION OF THE SLURRY SURFACE

1. **Weather Limitations** - Slurry Seal shall be applied only when the existing surface is dry or slightly damp without the existence of any free water, and when the pavement temperature is above 40° F and the atmospheric temperature is above 45° F, and rising, or above 50° F if falling, and when no rain is forecasted to begin before the Slurry Seal will have had sufficient time to cure.
2. **Mixing and Spreading** - The surface shall be fogged with water directly preceding the spreader. The slurry mixture shall be of the proper consistency when deposited on the surface and no additional elements shall be provided. Total mixing time shall not exceed four minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that complete coverage of the pavement is obtained. No lumping, balling or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be allowed. No excessive breaking of the emulsion shall be allowed in the spreader box. The depth of the finished slurry seal shall not be less than one quarter inch (1/4").
3. **Joints** - No excessive build-up or unsightly appearance shall be permitted on either longitudinal or transverse joints.
4. **Hand Work** - Approved squeegees shall be used to spread slurry in areas not accessible to the mixer. Care must be exercised in this operation to make sure no unsightly appearance is created by the hand work.

8D.09 OPENING TO TRAFFIC

It is anticipated that the slurry treated area may be opened to traffic within three (3) hours, but the treatment shall be permitted to cure until such time as the engineer permits its opening.

8D.10 QUANTITY AND PAYMENT

Measurement and payment for Slurry Seal Coat shall be on a square yard basis for each area completed and accepted by the engineer. When required by the engineer, certified tickets must be submitted covering the quantities of emulsion, aggregate and cement as determined by the job formula and as specified above. The bid price shall constitute full compensation for furnishing, delivering, unloading, stocking, hauling, mixing, and spreading, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ASPHALT EMULSION SLURRY SEAL
(Material to be used, as directed by the Engineer)

Materials	Materials Required on This Project	Approx. Rate or %
Residue Asphaltic Content of Emulsion	- - -	Minimum 60%
Quickset Cationic QSKS	- - -	18%
Cationic Emulsion CSS-lh	Cationic Emulsion CSS-lh	12-21
Crushed Stone	Washed Trap Rock	+ 10-15/S.Y.
Portland Cement	Portland Cement	0-3
Water		As per Design Formula

Note: All material requirements are based on dry weight of the aggregate. The percentage of emulsion shown must provide a residual asphalt content between 7.5% and 13.5%.

ITEM 8E

BITUMINOUS SURFACE TREATMENT

8E.01 DESCRIPTION

Bituminous Surface Treatment shall consist of constructing one or more courses with bituminous material and aggregate upon the completed and accepted base course or existing surface in accordance with these specifications and as directed.

MATERIALS

8E.02 ASPHALT

The asphalt for surface treatment shall be RC-70 OR CRS-1 for prime coats and RC-250 or CRS-2 for seal coats. All material shall meet the requirements of Paragraph 106 or 113, Material Details.

The material used shall be applied within the following temperature limits: RC-70, 80-150° F; RC-250, 100-175° F; and CRS-1, 70-140° F; CRS-2, 125-185° F.

8E.03 COARSE AGGREGATE

Coarse Aggregate for this work shall conform to the following requirements:

Coarse aggregate for the initial treatment may consist of crushed slag composed of clean, tough, durable pieces of air-cooled blast-furnace slag, reasonably uniform in density and quality and free from glassy particles, coke, dirt, or other objectionable matter.

Crushed slag in dry condition shall weigh not less than 70 pounds per cubic foot when tested according to AASHTO T 19.

Coarse aggregate for initial treatment may also be crushed stone or crushed gravel weighing not less than 95 pounds per cubic foot when tested according to AASHTO T 19 and meeting the requirements of Paragraph 104, Material Details.

The slag, crushed stone or crushed gravel shall conform to Simplified Practice No. 57 or No. 67 grading requirements as specified in Paragraph 110, Material Details.

Coarse aggregate for the 2 treatments following the initial application shall consist of

crushed chips composed of crushed stone, crushed gravel, or crushed slag, conforming to the requirements of Paragraph 104, Material Details, and meeting grading requirements for size 107, Paragraph 110, Material Details.

EQUIPMENT

8E.04 DISTRIBUTORS

The distributors used for this class of work shall be capable of applying the bituminous material in liquid form in a uniform manner with pressure, volume and temperature under definite control. The distributor shall be equipped with a thermometer of sufficient range to determine the actual temperature of the material. Each distributor shall have an approved calibration chart. Each distributor shall be equipped with an approved sampling device.

Pressure: The pressure shall be furnished by a positive displacement pump or air compressor. The pressure shall be uniform throughout the entire width of spray, and accurate pressure gauges shall be located where necessary. If pressure is furnished by air compressor, automatic controls must be provided to maintain sufficient and even pressure throughout the application of an entire load.

Temperature: The distributor shall be equipped with a heating system whereby the heat is applied uniformly across the width of the tank and facilities shall be provided for circulating or agitating the material while heating whenever necessary. The distributor shall be equipped with a thermometer of sufficient range to determine the actual temperature of the material.

Tachometer: All distributors shall be provided with an approved tachometer recording feet per minutes with a tabulation of feet per load with adjustments. Each load tabulation shall start at zero. There shall be also a totaling tabulation of this instrument.

Volume: The volume shall be under definite control. A tachometer shall give correct readings of the speed, and the volumetric efficiency of the distributor shall be such as to assure correct volume at various speeds. Where necessary, tests shall be required to prove the volumetric efficiency of the distributor under the various speed operations.

Circulating: The pump distributors shall be provided with a circulating system so designed as to maintain a solid liquid column while circulating in the distributor tank. This circulating system shall also be arranged so as to circulate the material in the tank truck before application.

Air distributors shall be provided with facilities for agitating the bituminous material in the tank trucks when necessary.

Tests: Necessary tests shall be made to determine the accuracy of any and all pressure gauges, tachometers, and pump efficiencies. The tests shall be made by the Contractor when and as required.

Spray Bars: Each distributor shall be equipped with spray bars capable of applying material uniformly throughout the entire length of the spray bars when they are extended for applying up to 24' in one operation. Spray bars shall be equipped with a cleaning device and positive shut-off valve to prevent dribbling, dripping or streaking.

Tank Capacity Gauge: A tank capacity gauge shall be furnished to give the gallonage in the tank in not less than 25-gallon units and shall be of the float control or other approved type with adjustments for correction.

Tanks shall have a minimum capacity of 750 gallons. All distributor's equipment shall conform to the Delaware State Law as to weight and clearance limitations.

If, at any time during the performance of the work, the Engineer shall deem the equipment applying the material to be inadequate, or fails to comply with all regulations, he shall order the equipment to be removed from the job and require that another unit be placed on the work. Any demurrage or loss of time caused by such delay shall be at the Contractor's expense.

8E.05 MECHANICAL SPREADER

For the spreading of aggregates, it will be necessary for the Contractor to furnish and operate at least one approved mechanical spreader capable of receiving the material to be spread and which can be accurately gauged and set to distribute the aggregate uniformly to regulated truck speed.

8E.06 BROOM DRAG

A broom drag shall be furnished and used on the initial application of coarse aggregate. Such broom shall be a nonrevolving type, at least 15' in length, and shall have at least 4 rows of brooms. One row must be at each end of the drag.

8E.07 ROLLERS

The Contractor shall furnish and operate at least two power rollers under this section. One power roller shall be rated by the manufacturer to be between 5 and 8 tons and

shall be of the 3-wheel type. One self-propelled rubber-tired roller of approved design and weight shall also be used, unless otherwise directed.

8E.08 SEASONAL AND WEATHER LIMITATIONS

Surface treatment shall not be applied (1) on any wet or frozen surface, (2) when the ambient temperature is below 50° F, or (3) when the weather conditions prevent the proper completion of the work, as determined by the Engineer.

CONSTRUCTION METHODS

8E.09 APPLICATIONS

The bituminous surface treatment completed under these specifications shall be in accordance with the following procedure.

The first application of bituminous material shall not be applied until the moisture content of the base is within 2 percentage points of the optimum moisture content, and the roadway has been properly shaped and approved, an initial application of priming asphalt shall be applied at the rate of approximately 0.5 gallon per square yard. Following the application of priming asphalt, a time period shall elapse as determined by the Engineer before the application of the asphalt and the application of the aggregate. Then approximately 50 pounds of stone or 40 pounds of slag per square yard shall be spread from a mechanical spreader. After the initial treatment, two treatments shall be applied using approximately 0.30 gallon of sealing asphalt and from 17 to 20 pounds of crushed chips each application. If slag is used, approximately 0.35 gallon of sealing asphalt shall be used for each treatment.

8E.10 HEATING AND APPLICATION OF BITUMINOUS MATERIAL

Materials used for each treatment shall be heated in a manner that ensures the even heating of the entire mass under efficient and positive control at all times, and shall be maintained within the specified temperature and pressure range during application. Any material which has been damaged shall be rejected and any section treated with damaged material shall be removed and replaced at the Contractor's expense.

The bituminous material shall be applied at the rates specifies, by means of the pressure distributor for the full width of the treatment at one application, unless otherwise directed.

The nozzles of the spray bar shall be kept cleaned at all times; however, if one or more nozzles should become blocked during the application of bituminous materials, the distributor shall be stopped immediately and the nozzle cleaned. The streak areas

shall be immediately made uniform by use of hand hose or other approved methods.

Joints shall be made by an approved method that will ensure proper function with the preceding application. Any excess bituminous material at the transverse junction between distributor loads shall be removed and corrected in a satisfactory manner.

If the Contractor is unable to keep the application uniform, he shall discontinue the operation until he can provide a more experienced operator or a better distributor, or both, or shall take such other precautions as may be necessary to keep the application within specified limits.

In applying bituminous materials adjacent to structures or curbs, the Contractor shall furnish and use effective means of protecting the structure or curbs from discoloration.

8E.11 SPREADING OF COARSE AGGREGATE

As soon as the bituminous material has been applied, it shall be uniformly covered with the specified amount of coarse aggregate.

Spreading shall be done directly from trucks by means of approved mechanical spreaders. Trucks or spreaders shall not drive on the uncovered bituminous material. Spreading of coarse aggregate shall at all times be kept within the distance of one distributor load of bituminous material.

During the spreading of coarse aggregate, a crew of men equipped with hand brooms shall broom all areas where the aggregate has been unevenly applied. Additional aggregate shall be placed by hand on any area not properly covered. If directed, the surface shall then be dragged with a light broom drag until a smooth and even surface is obtained.

8E.12 ROLLING OF COARSE AGGREGATE

Immediately after brooming and dragging, the coarse aggregate shall be rolled in a longitudinal direction with an approved pneumatic-tired roller or rollers. The rolling shall begin at the outer edges of the treatment and progress toward the center, each trip overlapping the previous trip by one-half the width of the roller. This rolling shall be continuous and enough rollers will be required to complete the rolling operation within one hour after the application of the asphalt. The rolling shall be repeated as often as required to ensure thorough keying of the coarse aggregate into the bituminous material.

8E.13 OPENING TRAFFIC

The roadway shall not be opened to traffic after the application of the treatments until bituminous materials have set and the coarse aggregate has embedded sufficiently to prevent picking up or whipping off by traffic.

Signs, barricades, lights, and other necessary incidentals to detouring of traffic shall be furnished and maintained by the Contractor at his expense.

8E.14 METHOD OF MEASUREMENT

The number of gallons of bituminous material to be paid for under this section shall be the number of gallons of bituminous material applied through calibrated distributors which shall be checked immediately prior to application in order to determine the actual stick gallonage and the actual application temperature, and also immediately following distribution in order to determine the stick gallonage applied to the road at the application temperature.

The actual gallonage distributed, corrected to the corresponding volume at 60° F, shall be determined by the use of conversion tables and noted on the tickets.

The number of tons of coarse aggregate to be paid for under this section, shall be the number of tons conforming with all the requirements and placed in accordance with these specifications, in the completed and accepted work. Each load of coarse aggregate shall have a certified weighmaster's weight slip signed by an Inspector at the time of spreading on the roadway.

8E.15 BASIS OF PAYMENT

The number of gallons of bituminous material measured as provided above, shall be paid for at the contract unit price bid per gallon furnished and applied according to these specifications. The number of tons of coarse aggregate, as determined above will be paid for at the contract unit price per ton bid for this Section. The bid price shall constitute full compensation for furnishing, unloading, stocking, hauling, spreading, broom dragging and rolling, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 8F

RETREATMENT AND SEAL COATS

8F.01 DESCRIPTION

Retreatment and Seal Coats shall consist of one or more applications of bituminous material followed by one or more applications of cover aggregate applied to a surface at the rates directed.

8F.02 CONSTRUCTION METHODS

All provisions of Item 8E shall govern except as follows:

- (a) The bidder shall furnish all equipment, tools, labor and incidentals necessary to prepare the travelway so that it will be free from deposits of dirt, loose stone or other objectionable material before application of the bituminous material. Each surface or section thereof must be approved before application of the bituminous material.
- (b) Prime coats will be omitted.
- (c) The cover aggregate shall be approximately 17 pounds per square yard, but may be varied as directed.
- (d) The bituminous material may be varied as directed.

8F.03 METHOD OF MEASUREMENT AND PAYMENT

Measurement and payment shall be in accordance with Item 8E.

ITEM 9

PORTLAND CEMENT CONCRETE PAVEMENT

9.01 DESCRIPTION

Portland Cement Concrete Pavement, shall consist of constructing a jointed pavement composed of Portland Cement Concrete, with or without reinforcement as specified, constructed on a prepared foundation in accordance with the specifications and in reasonably close conformity with the lines, grades, thicknesses, and typical cross-sections shown on the plans or established by the Engineer. The concrete shall be composed of a mixture of water, Portland Cement, fine aggregate, and 1 size of coarse aggregate.

Concrete for this section may be either Job Mixed, Central Mixed, or Truck Mixed. All concrete shall be certified, air entrained.

MATERIALS

9.02 PORTLAND CEMENT

Portland Cement for this work shall conform with the requirements of Paragraph 100, Material Details.

9.03 WATER

Water used in this work shall conform with the requirements of Paragraph 102, Material Details.

9.04 FINE AGGREGATE

Fine aggregate for this work shall conform with the requirements of Paragraph 103, Material Details.

9.05 COARSE AGGREGATE

Coarse aggregate for this work shall conform with the requirements of Paragraph 104, Material Details, and shall consist of No. 57 stone graded as specified in Paragraph 110, Material Details.

9.06 WIRE MESH REINFORCEMENT AND TIE BARS

Wire mesh reinforcement shall meet the requirements of Paragraph 114, Material Details. Tie bars of the specified size shall meet the requirements of AASHTO M31, Grade 60. Hook bolts may be used in lieu of deformed tie bars on approval of the Engineer.

9.07 DOWELS

Dowel bars should be round, steel bars of the diameter and length shown on the plans with a corrosion resistant coating over a plain steel bar core conforming to ASTM A675, Grade 65. the coating shall conform to AASHTO M254 and may be Type A, 25, $\pm$ 5 mil, multi-layer, low bond plastic coating, or Type B, 7 $\pm$ 2 mil, fusion bonded epoxy coating, requiring graphite lubrication.

9.08 CURING MATERIALS

Curing materials shall conform to Subsections 9.20, 9.21, 9.22, and 9.23 of this item.

9.09 AIR ENTRAINMENT AGENT

An air entrainment agent meeting the requirements of AASHTO M154 shall be introduced into the mixer by an approved automatic dispenser. Air entrainment is required in all concrete mix.

9.10 MATERIAL FOR SEALING JOINTS

This material shall conform with the requirements of Paragraph 107, Material Details.

9.11 COMPOSITION OF MIX

The Engineer shall determine the proportions of materials to be used that will produce a workable, dense, concrete of the desired strength, as indicated on the plans.

Construction Methods

Portland cement concrete intended for use as base course or finished pavement may be constructed by either the fixed-form or slip-form method. Finished pavement shall be constructed to the full pavement width regardless of method used. Finished pavement in excess of 26 feet wide, ramps of variable width, or other finished pavement of non-uniform width shall be constructed in a manner to minimize formation of longitudinal construction joints.

Slip form paving shall conform to Subsections 9A.06 of these Standard Specifications.

9.12 LIMITATIONS OF MIXING

The following requirements shall govern concreting during cold and hot weather:

Concrete may be placed when the air temperature in the shade and away from artificial heat is 35°F and rising.

The contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric conditions.

The concrete shall have a temperature of 70°F (21° C.) plus or minus 20° F (11° C.) at the time of placement unless prior permission has been granted to exceed these tolerances.

In cold weather the water and/or aggregate may be heated to not more than 150°F(66° C.) to maintain the concrete at the requirement temperature. The heating apparatus shall be such that the materials will be heated uniformly and preclude the possibility of overheating any portions of the aggregates. Material containing frost or hardened lumps shall not be used.

When concrete is being placed during cold weather and the air temperature may be expected to drop below 35° F, a sufficient supply of straw, hay, grass, or other suitable blanketing material shall be provided along the line of work to be used at any time when the temperature may be expected to reach the freezing point during the day or night. The material so provided shall be spread over the pavement to a sufficient depth to prevent freezing of the concrete. The insulating material shall be adequately secured to hold it in place on the pavement. The period of time over which such protection shall be maintained shall be not less than five (5) days. A longer period may be required if directed by the Engineer. The contractor shall be responsible for the quality and strength of the concrete laid during cold weather and any concrete injured by frost or freezing action shall be removed and replaced at his/her expense.

In hot weather, when the temperature of the plastic concrete reaches 85° F at the mixing plant, particular attention shall be given to the sprinkling and wetting of the foundation and forms, the maintenance of the coarse aggregate stock in a saturated surface-dry conditions through use of stockpile sprinklers, placing and finishing operations and the prompt starting of curing operation.

When the temperature of the plastic concrete reaches 90° F at the mixing plant, immediate steps shall be taken to cool the mixing water or aggregate, or both, in order

to maintain a plastic concrete temperature of 90° F or less. If such actions are not successful in reducing the concrete temperature, mixing operations shall cease.

Concrete shall not be placed when its temperature exceeds 90° F in the plastic state after mixing.

9.13 PREPARATION OF FOUNDATION

The foundation shall be shaped, rolled, uniformly compacted, and brought to a firm, un-yielding surface as specified under Item 2 and other applicable sections of these Specifications, so there is conformance to the lines and grades plus 2' beyond each edge of the proposed pavement or as shown on the plans before any concrete forms are placed thereon. Any portion inaccessible to the roller shall be thoroughly compacted by the use of hand tampers. All unsuitable, soft, and yielding material shall be removed and backfilled with suitable material and re-compacted until firm and unyielding.

In preparing the foundation, the material excavated shall not be piled outside and along the forms in such a manner as to interfere with the proper operation of finishing tools or machinery.

Ditches and drains shall be provided to drain the foundation and in no case shall concrete be placed on frozen material. Frost crystals or mud caused by freezing and thawing shall be removed and replaced with suitable material.

9.14 CONSTRUCTION EQUIPMENT

The Contractor shall furnish and maintain all fixed-form and/or slip-form equipment as necessary to complete the work. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be thoroughly examined and approved.

9.15 FORMS AND FORM SETTING

Side forms shall be metal of approved design and cross-section, of depth equal to the designed edge thickness of the pavement, and not over 1" more than the designed edge thickness and without horizontal joints. They shall be in lengths of not less than 10' except on curves of 150' radius or less, at which time 5' lengths may be used. Flexible or curved forms of proper radius shall be used for curves of 100' radius or less.

The method of connection between sections shall be such that the joint formed shall be free from play or movement in any direction, and the forms shall be of an approved

section with a base width equal to the depth of the form and so secured as to resist, without spring or settlement, the pressure of the concrete when placed and the impact and vibration of the spreading or finishing machine. The forms shall be straight and free from warp. The top surface of any section shall not deviate from a straight line by more than 1/8".

The grade under the forms shall be hard and cut true to grade so that the form when set upon it will be firmly in contact for its whole length and at the desired grade. Any foundation which, at the form line, is found below established grade shall be filled to grade for a distance of 24" on each side of the base of the form and thoroughly rerolled or tamped. Imperfections and variations above grade shall be corrected by tamping or by cutting as necessary. No settlement or springing of forms under the spreading or finishing machine will be permitted.

Forms shall be accurately set to line and grade, joined and staked by using no less than three 30" x 7/8" pins for each 10' section, except that shorter pins may be allowed for use if 30" are found to be impractical.

Conformity of any alignment and grade elevation of forms with the alignment and grade elevation shown on the plans shall be checked and necessary corrections shall be made by the contractor immediately prior to placing the concrete. Where any form has been disturbed, or any foundation become unstable, the form shall be reset and rechecked after restoration of the required grade.

Where alignment permits, forms shall be set for at least 800' in advance of the point where concrete is being placed and shall remain in place at least 12 hours after the concrete has been placed against them and shall be cleaned and oiled each time they are used.

9.16 PLACING CONCRETE

Before any concrete may be placed, each section of the grade must be checked by the contractor with an approved grade tester, mounted on rollers, wheels or tracks and designed to move backwards and forwards. It shall be adjustable vertically and constructed so that the points may be set not more than 1/8" above the required grade elevation. The 1/8" tolerance as herein provided in the grade tester shall in no way be construed as permitting less than the full thickness of pavement as specified on the plans. Measurement by string line or other methods may be employed if deemed necessary. When the marks or indentations are made by the tester, the grade shall be lowered to the required depth, and the tester again passed over the grade after all high spots are removed. The grade tester must be in place on the forms immediately in advance of the point where the concrete is placed. No loose earth shall be placed on the portion of the grade which lies between the grade tester and

the newly deposited concrete.

The grade shall be in a moist but not muddy condition at the time of placing the concrete. If required, it shall be thoroughly wetted with an approved sprinkling device not less than 6 nor more than 12 hours previous to the placing of the concrete. If it subsequently becomes dry the foundation shall be sprinkled. The method of sprinkling shall not be such as will form mud or pools of water.

No concrete shall be placed adjacent to railway tracks or around manholes, inlets or other structures until they have been brought to the required grade and alignment, and all structures which project through the pavement shall be cleaned thoroughly to permit adhesion of the concrete.

The concrete shall be placed by approved methods, so that the batches will be deposited without segregation, and will be uniformly distributed and spread over the entire width of the required pavement section using a mechanical spreader. The mechanical spreader shall be self-propelled, capable of spreading of the concrete mix to the desired cross-sections and easily adjustable to spread different elevations of concrete.

The concrete shall be deposited on the grade from agitator truck chutes without segregation or non-agitating hauling equipment with means for discharge without segregation through a hopper on the spreader, moving hopper or belt or other approved conveyance. Non-agitating equipment may be used with slip-form paving only, unless otherwise directed. The concrete shall be placed in horizontal layers with each successive batch placed against previously placed concrete. Placing shall be continuous between transverse joints without the use of intermediate bulkheads. Spreading shall be accomplished with a mechanical spreader. Necessary hand spreading shall be done with hand shovels, not rakes. Workers will not be allowed to walk in the freshly mixed concrete with boots or shoes coated with earth or foreign substances.

Where concrete is to be placed adjoining a previously constructed lane of pavement, and mechanical equipment will be operated upon the existing lane of pavement, that lane shall have attained a minimum compressive strength of 3000 psi as determined by representative cylinders. If only finishing equipment is operated on the edge of the existing lane, paving in adjoining lanes may be permitted after a minimum compressive strength of 2000 psi has been achieved.

Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators. Vibrators will not be permitted to come in contact with a joint assembly, the grade, or

side form. In no case shall the vibrator be operated longer than 10 seconds in any one location.

Concrete shall be deposited as near to expansion and contraction joints as possible without disturbing them, but shall not be dumped from the discharge bucket chute or hopper onto a joint assembly unless the hopper is well centered on the joint assembly.

Should any concrete materials fall on or be worked into the surface of a completed slab, they shall be removed immediately by approved methods.

9.17 STRIKE OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT

Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. Bends or kinks in individual wires, or other irregularities, shall be corrected before the sheet is laid in the pavement. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be pre-set on chairs securely fastened to the grade, or it may be placed in plastic concrete, after spreading, by mechanical or vibratory means using approved, mechanical mesh depressing equipment. The pavement reinforcement shall be placed such that the reinforcement in the completed pavement will be at the location shown on the plans with a placement tolerance for individual bars or individual wires of $\pm$ one inch horizontally and vertically.

Reinforcing steel shall be free from dirt, oil, paint, grease, mill scale, and loose or thick rust which could impair bond of the steel with the concrete. All laps between sheets shall be held firmly together by wire or clips spaced not more than 4 feet apart (except when reinforcement is placed by vibration, clips may be omitted with permission of the Engineer).

9.18 CONSOLIDATING AND SCREEDING CONCRETE

As soon as the concrete has been spread, it shall be leveled and then struck off with a finishing machine to such elevation above the finish grade that when properly consolidated, the surface shall conform to the lines and grades shown on the plans.

The finishing machine shall be power driven; designed and operated to strike off, screed, consolidate and travel. It shall be of ample weight and strength to furnish pressure and withstand the requirements of the construction and shall be capable of being adjusted to produce the crown, width, and finish required. It shall have sufficient power and be geared to operate consistently and smoothly, and shall be maintained in first class working order at all times. Each machine shall be equipped with two screeds, and with at least one pair of extra shoes for each screed. Worn shoes shall be removed and replaced as directed. Vibrators, for full width vibration of concrete paving slabs, may be either the surface pan type or the internal type with either immersed tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the joints, load transfer devices, grade, or side forms. The frequency of the surface vibrators shall not be less than 3,500 impulses per minute and the frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and no less than 7,000 impulses per minute for spud vibrators. When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

Where the pavement is used in lieu of a form, the wheels of finishing machines shall be adjusted to provide full bearing on the pavement and extended to prevent breaking the pavement edge.

Segregated particles of coarse aggregate which collect in front of the screeds shall either be thrown outside the forms or thoroughly mixed by hand with the mass of concrete already on the grade. Under no circumstances shall segregated particles be carried forward by the finishing machine and pushed into the grade in front of the concrete. The height of the mass of concrete pushed forward by the finishing machine shall not exceed $\frac{2}{3}$ of the height of the vertical face of the front screed. Care shall be exercised to control the operation of the machine to prevent an excess of mortar and water from being worked to the top. The number of operations of the machine over a given area shall be held to a minimum necessary to secure the required strike-off. While the concrete is being struck off, sufficient workers shall be at work leveling, spading along forms, and shaping the concrete ahead of the machine.

Where it is necessary to complete variable width pavement at a width of less than 10 feet or where the full design width of pavement is less than 12 feet, a mechanical concrete spreader and finishing machine will not be required and the concrete may then be struck-off and consolidated using an approved vibrating screed and hand operated spud vibrators as described herein. A non-vibrating screed shall be provided for striking off the bottom layer of concrete if reinforcement is used. The vibrating screed for the surface shall be at least 2 feet longer than the maximum width of the

slab to be struck-off. It shall be of approved design, sufficiently rigid to retain its shape and be constructed either of metal or of other suitable material shod with metal.

In operation the vibrating screed shall be moved forward on the forms, moving always in the direction in which the work is progressing and so manipulated that neither end is raised from the side forms during the striking off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross-section, and free from porous areas.

After the screeding has been done, all laitance, surplus water, and inert material shall be worked entirely off the pavement and the surface shall be made smooth by scraping or dragging with an approved rigid straightedge 10' in length.

The straightedge shall be placed at the inner edge of the slab with the blade parallel to the centerline and pulled slowly and uniformly to the edge. This operation shall be repeated until the surface of the concrete is free from irregularities and makes contact at all points with the bottom of the straightedge. The straightedge shall then be moved forward 1/2 its length and the operations repeated.

Depressions found in the surface shall be filled with fresh concrete and consolidated by floating with a long handled float not less than 3' in length. This float may also be used to smooth sections of the surface which may have become rough or torn by scraping with the straightedge.

In general, the addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

Directly after the process described above, a second straightedge shall be used in a similar manner. However, at this time the smoothness of the surface will be checked and no more scraping than is absolutely necessary will be done. During this operation, the contact of the straightedge with the concrete shall be uniform over the entire length tested. At the time of this final checking, the surface shall be free from soft mortar and excess water. No floating operation will be permitted following the final straightedge.

All the edges of the new pavement shall be tooled with approved edging tools as specified. The work of tooling edges shall be done by competent workers and in an acceptable manner. All tooled edges and faces shall be smooth with no irregularities, bumps, or depressions remaining in the concrete after the operation of tooling is completed, and shall be perfectly shaped to the radius of the edging tools. The outside edge of the face of the edging tools shall not gouge irregular depressions in the surface of the pavement. On all joints the tools shall be guided in such a manner

that the full width of the face of the tool will make a uniform depression in the surface of the pavement. This depression shall not exceed 1/16" and it shall extend the full length of all joints. All corners, including the intersections of longitudinal joints with transverse joints, shall be molded and tooled into true corners, and the concrete shall be sound and homogeneous in all cases.

When the straightedge and edge tooling operations have been successfully accomplished and all excess moisture has disappeared, the plastic concrete shall be textured transversely for the full width of the pavement by use of a mechanized texturing device. The texturing device shall ride on forms or be guided electronically by string line and shall utilize a wire comb consisting of 3/32" wide flat steel tines, 5 to 6" long and with a 1/2" spacing between tines. The tines shall form rectangular shaped grooves approximately 3/32 to 3/16" in width and approximately 3/16", but not less than 1/8" in depth. The wire comb shall meet the approval of the Engineer. The texture shall be produced by drawing the approved comb across the pavement in a transverse direction in one pass without tearing or dragging the mortar. The concrete shall be dry enough to prevent the plastic concrete from flowing back into the grooves being formed. The method used shall produce a uniform finish and the texturing device shall be kept free of hardened concrete particles. Hand brooms about 4 feet wide and made of wire comb as specified above shall be made available by the contractor for use as required. Payment for texturing will not be made but will be considered incidental to the unit price bid for completion of the work.

During construction of base course concrete, the contractor may elect to use conventional burlap drag texturing in lieu of steel tines. However, waterproofing paper, wet burlap or polyethylene shall be used as the curing method. Liquid membrane curing will only be permitted in combination with the tine texturing.

9.20 CURING OF CONCRETE

As soon as possible after the texturing operations and without marring, the surface of the freshly laid concrete shall be covered with polyethylene sheeting, waterproof paper, or sprayed with membrane curing compound.

As soon as the forms are removed, all honeycombed areas shall be filled with 1:2 mortar and the ends of the transverse joints shall be opened and cleaned to full depth, after which the edges of the pavement shall be properly cured as described herein.

9.21**CURING WITH POLYETHYLENE SHEETING**

Polyethylene sheeting shall conform to the requirements of AASHTO M171.

The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units used shall be lapped at least 18". The sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such dimension that each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 5 days after the concrete has been placed, except for limited removal necessary for joint sawing.

9.22**CURING WITH WATERPROOF PAPER**

Waterproof paper shall conform to the requirements of AASHTO M171. The name of the manufacturer shall be marked or imprinted clearly on the paper for proper identification, and it shall retain a minimum of 90% of the mixing water.

Each cover shall be not less than 20' nor more than 75' in length, and shall be of such width that, when in place, it will extend at least 18" beyond the edges of the slab to be covered. Covers may be furnished in widths corresponding to that of the slab provided supplemental stringer sheets, at least 18" wide, are used, in which case such sheets shall be placed along the edges of the slab under the covers. Covers not manufactured in sizes which will provide the proper width shall be securely sewed or cemented together with minimum laps of 4" so as to produce an air-tight waterproof joint which will not open or separate during the curing period. The covers shall be unrolled from suitable poles or spools and placed in such a manner that the surface of the concrete will not be marred. The covers shall be securely held in place along the edges of the pavement with banks of earth placed just inside the form. When placed, the adjoining covers shall overlap at least 12" and the lap shall be securely weighted down to form a sealed joint. Additional mounds of earth shall be placed at random on the covers as may be necessary to keep the covers in close contact with the surface of the pavement.

Upon removal of the forms, the excess width of cover or the supplemental stringer sheets, as the case may be, shall be pulled over the edges and carried down to the bottom of the pavement and promptly secured with a continuous bank of earth. When the pavement to be cured is adjacent to a previously constructed slab, the cover shall be lapped over the pavement already in place and securely held in position by a bank of earth or other suitable weights which will provide a continuous sealed joint.

In the event that hair-checking develops before the cover can be applied, cover curing method will not be permitted. Such hair-checked areas shall be protected with wet burlap.

All rips or holes occurring in the covers while in use shall be immediately repaired with a sealed patch to render them airtight. Covers which have become damaged or soiled to the extent that they will not provide satisfactory curing or will mar the concrete shall not be used.

Unless otherwise specified, the covering shall be maintained in place for 5 days after the concrete has been placed, except for limited removal necessary for joint sawing.

9.23 CURING WITH LIQUID MEMBRANE COMPOUNDS

Materials

The material shall meet the requirements of AASHTO M 148, for Type 2, Class A or B white pigmented liquid curing compound.

Acceptance for continued use will be based upon satisfactory field performance.

Construction Methods

Application of the material shall be made immediately following final finishing or texturing before any marked dehydration of the concrete or checking of the surface. The curing compound shall be applied to the finished surfaces by means of an approved automatic spraying machine as soon as the free water has disappeared. The spraying machine shall be self-propelled and shall ride on the side forms of previously constructed pavement, straddling the newly paved lanes. The machine shall be equipped with one or more spraying nozzles which can be controlled and operated so as to completely and uniformly cover the pavement surface with the required amount of curing compound. The curing compound in the storage drum being used for the spraying operation shall be thoroughly and continuously agitated during the application. Spraying pressure shall be sufficient to produce a fine spray and cover the surface thoroughly and completely with a uniform film. Spray equipment shall be maintained in first class mechanical condition, and the spray nozzle shall be provided with an adequate wind guard. The curing compound shall be applied with an overlapping coverage which will give a two coat application at a coverage of not more than 200 square feet per gallon for each coat. The application of curing compound by hand operated pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms, as authorized by the Engineer. When application is made by hand operated sprayers, the second coat shall be applied in a direction approximately at right angles to the direction of the first coat.

The compound shall form a uniform, continuous, coherent film that will not check, crack or peel and shall be free from pin holes and other imperfections. If pin holes or other discontinuities exist, an additional coat shall be applied within 30 minutes to the affected areas. Concrete surface which are subjected to heavy rainfall within three hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above, at no additional compensation to the contractor.

Necessary precautions shall be taken to insure that none of the curing compound enters joints which are to be sealed. Rope of moistened paper, fiber, or other suitable material shall be used to seal the top of the joint opening and the concrete in the region of the joint shall be sprayed with curing compound immediately after the rope seal is installed. Other methods of protecting the joints may be used when approved by the Engineer. Approved standby facilities or approved alternate methods for curing concrete pavement shall be provided at a readily accessible location at the site of the work for use in event of mechanical failure of the spraying equipment or any other conditions which may prevent correct application of the membrane curing compound at the proper time. In the event of a failure of the regular spraying equipment, the standby or alternate curing method shall be used only on the remaining portion of the paving already placed and the paving operations shall be suspended. Concrete surfaces to which membrane curing compounds have been applied shall be adequately protected for the duration of the entire curing period from pedestrian and vehicular traffic, except as required for joint sawing operations and surface tests, and from any other cause which will disrupt the continuity of the membrane. The curing compound seal shall be given utmost protection for a minimum of 5 days so that it will not be broken. Any area covered with curing compound which is damaged by subsequent construction operations within the curing paper shall be resprayed.

9.24 PROTECTION AGAINST RAIN

In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 2" and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges and covering material such as burlap or cotton mats, curing paper, or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

9.25**SURFACE TEST**

The finished surface of the pavement shall be within the tolerance of the following surface trueness test.

Finished concrete pavement will be tested by the Engineer for trueness in each wheel lane at the expiration of the required curing or protection period. The surface will be tested by means of a rolling 10 foot straightedge, or a 10 foot straightedge placed parallel to the center line of the pavement, parallel to the grade line and touching the surface. Surface variations of the pavement measured by the 10 foot rolling straightedge or measured from the base of the straightedge to the surface of the pavement shall not exceed 1/8". Surface variations which exceed 1/8" up to and including 1/2" in 10 feet will be marked and shall be removed by an approved grinding tool or a device consisting of multiple saws. The use of a bush hammer or other impact devices will not be permitted. Determination of pavement thickness will be made after the removal of high spots. Required surface corrections shall be at the expense of the contractor.

Areas which vary from the true surface by more than 1/2 inch shall be removed and replaced with pavement of the required quality and smoothness at the entire expense of the contractor. When it is necessary to remove the pavement to eliminate surface variations, the sections removed shall be full lane width or the total width between longitudinal joints of the pavement and shall be not less than 10 feet in length. Pavement to be removed shall be saw-cut full depth along the faces of the patch. Pavement replaced shall conform to this Section in every respect.

9.26**PROTECTION OF CONCRETE**

The contractor shall erect and maintain suitable barricades and employ watchpersons, if required, to exclude traffic from the newly constructed pavement for the period herein prescribed but these barriers shall be so arranged as not in any way to interfere with or impede public traffic on any lane intended to be kept open. Necessary signs and lights shall be maintained by the contractor, clearly indicating the lanes open to the public. When it is necessary to provide for traffic across the pavement, the contractor shall, at his/her expense, construct a suitable and substantial crossing to bridge the concrete. The bridge shall be adequate for traffic and satisfactory to the Engineer. Any part of the pavement damaged prior to its final acceptance shall be repaired or replaced by the contractor at his/her expense and in a satisfactory manner.

The contractor shall protect the pavement against public traffic and the traffic of his/her own employees and agents.

JOINTS

Joints shall be constructed of the type and dimensions and at locations required by the plans or special provisions.

9.27 TRANSVERSE CONTRACTION JOINTS

Transverse contraction joints shall, in general, be spaced at intervals of 45 feet or as directed.

A load transfer device, as shown on the plans, or an approved alternate design shall be placed across each contraction joint. The device shall include positive, rigid means for accurately positioning and adequately supporting the load transferring parts regardless of the nature of the foundation material. The positioning and supporting means shall be capable of resisting all normal forces imposed on joint devices during shipment, handling, installation, and during all the concreting operations. The dowels shall be installed and maintained parallel to each other and parallel to the pavement surface and shall be placed midway in the depth of the pavement.

At least two weeks prior to concrete paving, the contractor shall submit for approval, a representative assembled load transfer device. The representative device shall be complete in all details, including tools, installation equipment, and other appurtenances. When so directed, the contractor shall maintain the approved representative device on the project. All load transfer devices furnished for use on the project shall be at least equivalent to the approved device.

The device shall be so designed that extreme accuracy in locating the saw-cut over the center of the device is not necessary for its proper function.

When the load transfer device is in place on the foundation, it shall act as a rigid unit with each component part securely held in position relative to the other members of the assembly. The entire device shall be held securely in place during placing, consolidating, and finishing of the concrete by means of metal stakes which shall penetrate the foundation at least 12 inches. At least 10 stakes shall be used for each 10, 11, or 12 foot section of assembly. The contractor shall check the horizontal alignment of the dowel bars by an approved means and vertical alignment of each dowel bar by means of a leveling device so constructed that it may be adjusted to the correct grade when set on the side forms. Any deviation from correct alignment greater than 1/8 inch in 12 inches shall be corrected before any concrete is placed.

Care shall be exercised in depositing the concrete at the dowel bar assemblies so that the horizontal and vertical alignment will be retained.

The load transfer device shall be fabricated from corrosion resistant coated dowel bars conforming to AASHTO M 254, Type A or Type B coating. Type B fusion bonded epoxy powder coated dowels shall be lubricated at least 1 hour before concrete is placed around the load transfer device. One-half the length of each dowel bar shall be rendered bondless on one side of the device with a coating of graphite lubricant paste. The paste shall consist of an approved mixture of flake graphite, oil vehicle and dryers. The lubricant shall be applied to the free end of dowels by daubing, mopping, or gloved hand to produce a coating approximately 1/16" thick. Brushes shall not be used.

Unless otherwise specified or directed, all transverse contraction joints shall be sawed. Sawing shall be done with approved sawing equipment. The saw shall be equipped with adequate guides, blades, guards, water cooling system, and a method of controlling the depth of cut. An adequate supply of water and a standby saw in good working condition with an ample supply of blades shall be available at the site of the work during the sawing of contraction joints.

Joints shall be sawed in succession as soon as the saw can be operated on the pavement without damaging the surface or washing the mortar away from the coarse aggregate adjacent to the joint. The sawing shall be progressively regulated so that each joint is sawed at the proper time and shall be continued until all joints in the newly placed concrete are completed. The joints shall be sawed completely from edge to edge of the pavement. This can be accomplished by removing a section of the form and by completing the sawing immediately after the form has been removed where the cut falls. When the membrane curing agent is used, the edge of pavement shall be sprayed with the curing agent upon the completion of the sawing of joints. All transverse joints shall be sawed without delay to prevent uncontrolled random cracking, usually 4 to 24 hours after concrete placement depending on weather. Adequate lighting shall be provided to facilitate sawing operations performed during the night. If the wet sawing method is used, the joint shall be flushed clean with water after the concrete has gained sufficient strength to preclude washing of mortar from the joint faces.

Sawing joints shall have a minimum depth of $T/4 + 1/4"$ where T is the design thickness. When a contractor is given approval to place a greater thickness than that which is designed, the sawed joints shall be a minimum of $T/4 + 1/4"$ and T becomes the actual thickness placed. Joints sawed for initial crack control shall be sawn with a 1/8" minimum width blade to the required depth. The upper portion of the groove shall be widened by sawing to the width and depth specified for the sealant required or as specified on the plans.

A chalk line or other suitable guide shall be used to mark the alignment of joints. The saw cut shall not vary more than 1/2" from true alignment. Where the pavement is built in two or more separately poured lanes, the joints shall be continuous for the full width of pavement.

A rolled crepe tissue paper or approved similar product of suitable width shall be inserted in the joints immediately after the sawing and flushing operations have taken place.

9.28 LONGITUDINAL JOINT

Deformed steel tie bars of specified length, size, spacing, and material shall be placed perpendicular to the longitudinal joints. They shall be placed by approved mechanical equipment or rigidly secured on chairs or other approved supports to prevent displacement. Tie bars shall not be painted or coated with asphalt or other material, or enclosed in tubes or sleeves. When the adjacent lanes of pavement are constructed separately, approved hook bolts, or "W" - bolts, as specified on the plans, shall be used.

Longitudinal sawed joints shall be cut by means of approved concrete saws to the depth, width, and line shown on the plans. Suitable guide lines or devices shall be used to assure cutting the longitudinal joint on the true line as shown on the plans. Sawing of longitudinal joints shall be performed prior to the widening of transverse joints in two stage sawing operations. The longitudinal joint shall be sawed not later than 5 days after the concrete has been placed and before any equipment or vehicles are allowed on the pavement. When multiple lane pavement is being constructed, all required sawing of longitudinal joints shall be performed on the pavement in place before additional lanes are constructed. Sawing of longitudinal joints shall be continuous across all transverse joints. Whenever sawing is discontinued, the cut shall terminate at a transverse joint. The sawed area shall be thoroughly cleaned and, if required, the joint shall immediately be filled with sealer.

9.29 CONSTRUCTION JOINTS

Transverse construction joints shall be constructed when there is an interruption of more than one hour in the concreting operations. Transverse construction joints shall not be constructed within 10 feet of an expansion joint, contraction joint, or transverse plane of weakness. If necessary, an unanticipated construction joint shall be moved back to the last plan joint and the excess concrete removed and disposed of as directed.

Construction joints shall be formed by securing in place a removable bulkhead or header board. The board shall conform to the full cross-section of the pavement and it shall be secured flush with the subbase and parallel to the normal transverse joints. The board shall be slotted or drilled to accommodate reinforcement as required by the plans.

The roll of laitance and grout that usually forms in front of the paver shall not be used adjacent to transverse construction joints. Concrete adjacent to transverse construction joints shall be consolidated full width and depth with mechanical hand type spud vibrators. One auxiliary vibrator shall be available for use in the event of mechanical malfunctions.

The contractor shall furnish work bridges, personnel, string lines, straightedges, lighting, and other equipment and tools necessary to string line and correct variations of the concrete surface within 30 feet on either side of transverse construction joints before the final finish is applied to the concrete. The surface shall be stringlined longitudinally and surface deviations of more than 1/8" in 10', in any direction, shall be corrected while the concrete is in a plastic condition.

Longitudinal construction joints shall be constructed by skilled concrete workers using tooling devices and edging tools while the concrete is in a plastic state. The contractor will use methods and equipment that insure joint reinforcement is properly located and not disrupted during construction.

All construction joints, transverse and longitudinal, shall be tooled with rounded or beveled edges to a radius or length specified on the plans or as directed, to accept the required joint sealant. Any joint of insufficient size, radius, or poor workmanship shall be sawed and sealed as directed. The cost of any such additional work or material shall be at the expense of the contractor.

9.30 SEALING JOINTS

All sawed, formed, or tooled longitudinal and transverse contraction and construction joints shall be sealed before the pavement is opened to traffic, including construction traffic, and as soon after the curing period as feasible. The type of pavement joint seal to be used will be as shown on the plans or specified herein. Prior to sealing, each joint shall be thoroughly cleaned by brushing, oil-free compressed air, sand blasting, or other means to completely remove all traces of laitance, curing compound, saw residue, dirt, and all foreign material and/or in accordance with the recommendations of the sealant manufacturer.

All doveled transverse construction joints shall be sawed to the configuration of a contraction joint and sealed. Transverse construction joints tied with deformed bars

may be tooled or sawed as directed and sealed.

Hot-Poured Joint Sealant

All joints in base course and finished concrete pavements shall be sealed with hot-poured joint sealer conforming to ASTM D 3405, Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements, to the configuration shown on the plans.

All sawed joints shall utilize a polyethylene or urethane foam rod, or other approved bond breaker, sufficiently heat resistant to develop the required parabolic sealant shape and depth.

Construction joints shall be tooled and sealed as shown on the plans. Immediately prior to installation of the backer rod and joint sealant, each joint shall be air blown clean and dry.

Hot-poured joint sealer shall be placed in strict conformance with the manufacturer's recommendations concerning joint cleaning, application and safe heating temperature.

For rounded or beveled joints, sealant shall be installed in a depth of not less than 1/8" nor more than 1/4" below the bottom edge of the rounding or bevel. For joints with vertical sides, sealant shall be installed at a depth of 1/4", plus or minus 1/16" below the level of the pavement surfaces.

The sealant material shall be applied to each joint opening in accordance with the details shown on the plans or as directed. Application shall be done in such a manner that the material will not be spilled on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material as a cover for the seal will not be permitted. Hot-poured joint sealing material shall not be placed when the air temperature in the shade is less than 50° F, unless approved by the Engineer.

Preformed Elastomeric Compression Seals

When specified on the plans, all sawed transverse joints in finished Portland Cement Concrete Pavement shall be sealed with preformed compression seals conforming to the requirements of AASHTO M 220.

Saw cut longitudinal joints and all construction joints shall be sealed with hot-poured joint sealer conforming to ASTM D 3405 as described above.

Detailed design or configurations of the seals will not be specified. The contractor shall submit, for the Engineer's approval, prior to delivery to the job site, the design details of the seal proposed. This approval must be requested in writing. In addition, the contractor shall furnish a 5-foot section of the seal. The manufacturer shall supply all certifications that the seals comply with the specifications. Test data must be included to support the certification.

Sizes of seals shall be:

Transverse 1 1/4" (uncompressed width) in 5/8" joint

Lubricant

The lubricant used to install the preformed elastic joint sealer shall be a one-component polychloroprene compound containing only soluble phenolic resins blended together with anti-oxidants and acid acceptors in aromatic hydrocarbon solvent mixture and shall have the following physical properties:

Average net weight per gallon - 7.84 lbs. + 5%
Solids Content - 22 to 28%, by weight

The viscosity shall be such that the lubricant will perform suitably with the installation equipment.

The lubricant shall remain fluid from 50° F to 120° F.

Film strength (ASTM D 412) - 2,300 p.s.i. minimum tensile strength, 750% minimum elongation before breaking.

The lubricant shall be stored at a temperature of 50° F to 80° F. Any lubricant not used within 270 days of its date of manufacture shall be unacceptable.

Each lot of the lubricant shall be delivered in containers plainly marked with the manufacturer's name or trademark, lot number, and date of manufacture and shall be accompanied by the manufacturer's certification as to conformance to this specification.

Transverse joints may be constructed by stage sawing or by sawing the joint 5/8" wide initially. Sawing transversely should be done as soon as possible without damage to the concrete surface. When transverse joints are constructed in two stages, the second stage sawing will not be permitted until the concrete is 3 days old.

All saw cuts must be made full width of pavement. Decreasing the depth of saw cut at pavement edges to eliminate the need of form removal will not be permitted. In

addition, scoring the area to be sawed with a trowel is also prohibited. Forms, if used, must be removed at location of saw cut.

When transverse joints are constructed by the two stage method, the contractor should be prepared to vary the width of the secondary cut. The additional width of cut required will be equal to the width of the cracked joint below the initial saw cut. The contractor must coordinate his/her final sawing and seal insertion such that a 5/8" minimum width joint results. The contractor will not be permitted to install seals in joints less than 5/8" wide.

The edges of the transverse joints shall be beveled 45°. Permissible tolerances for the bevels are 1/8" to 1/4" measured along the pavement surface.

The joints shall be sealed immediately following the curing period or as soon thereafter as weather conditions permit, and before the pavement is opened to traffic, including construction traffic. At the time of application of the compression seals, the atmospheric and pavement temperature shall be above 40° F, and the sealing can continue as long as the joints do not have water in them.

All the equipment necessary for the proper construction of this work shall be on the project in first-class working condition. The equipment shall be as recommended by the manufacturer of the sealer and approved by the Engineer before construction is permitted to start.

The equipment for cleaning joint openings shall consist of plows, powered and hand brooms or wire brushes, air compressors and, if necessary, joint cleaning and grooving machines as are necessary to produce a satisfactory, clean, and dry joint.

Before sealing the joints, the contractor shall be required to demonstrate that the equipment and procedures for placing the compression seal will provide a satisfactorily sealed joint. The top outer edges of the seal should be in contact with the joint faces. There should be no tendency for the seal to roll towards its center.

Installation of seals manually will not be permitted. Machine installation will be required. The installation equipment for the elastic joint seal shall be fabricated for the purpose and shall be capable of installing the sealer in the joints, with the vertical axis of the sealer being parallel to the joint interfaces, without twisting, curling, or nicking of the seal, and shall insure against the seal being in tension in the joint.

The elastic sealer shall be installed in the joints with the lubricant which shall cover both sides of the sealer over the full area in contact with the sides of the concrete joint. The lubricant may be applied to the concrete or sealer or both. The sealer shall be installed in a compressed condition at a depth of not less than 3/16" but not more

than 5/16" below the surface of the pavement. It is intended that the transverse seal be placed first. For longitudinal joints, the hot-poured joint sealer shall be installed at a depth of 1/4" $\pm$ 1/16" below the level of the pavement surface.

In transverse joints, the minimum length of sealer without cuts or splices shall be equal to the full pavement width. Sealer will not be spliced between adjacent joints or slab edges.

The method of installation shall be such that the joint sealer shall not be stretched more than 5% of the minimum theoretical length. The method of installation shall be checked for stretching, using transverse joint sealer. The check shall consist of installing sealer in five joints or full pavement width and removing the sealer immediately after installation and checking the length. If the measured length of any of these 5 seals is less than 95% of the minimum theoretical length required to seal the joint, the installation method shall be modified so that stretching greater than 5% no longer occurs. Once sealing operations have started, one joint per hundred shall be removed and checked for stretch in excess of 5%. If a stretched condition is detected, the joint sealers on either side shall be removed until the condition disappears and the affected joints, including the check joints, shall be resealed in a satisfactory manner at the sole cost of the contractor.

Low Modulus Silicone Sealant

When specified on the plans, an approved low-modulus silicone rubber sealant shall be used in all finished pavement joints. Joints must be clean and dry and prepared in accordance with the manufacturer's recommendations. An expanded closed cell polyethylene foam backer rod shall be used as a bond breaker in all joints. The sealant shall be tooled to provide the required 1/4" $\pm$ 1/16" recess below the surface of the pavement. Typical sealant dimensions are 1/2" in width and 1/4" in thickness over a 5/8" diameter backer rod. The sealant is not self-leveling and will not position properly in the joint to the desired parabolic shape under its own weight. The sealant shall be tooled or applied in a manner to wet the joint faces. Silicone sealant shall not be placed when the air temperature in the shade is less than 40° F.

9.31 OPENING TO TRAFFIC

The pavement shall be closed to traffic for not less than 10 days after the concrete is placed, or longer if weather conditions make it advisable to extend this time. The pavement may be opened to traffic prior to the expiration of the 10 day period when the compressive strength of representative cores taken by a testing laboratory indicates that the strength of the pavement exceeds 3,500 pounds per square inch.

9.32**TOLERANCE IN PAVEMENT THICKNESS**

For the purpose of establishing an adjusted unit price for pavement, units to be considered separately are defined as 1,000 linear feet of pavement in each traffic lane starting at the end of the pavement bearing the smaller station number. The last unit in each lane shall be the larger station number. The last unit in each lane shall be 1,000 feet plus the fractional part of 1,000 feet remaining. One core will be taken at random by a testing laboratory in each unit. When the measurement of the core from a unit is not deficient more than 0.2" from the plan thickness, full payment will be made. When such measurement is deficient more than 0.2" and not more than 1.0" from the plan thickness, two additional cores at intervals not less than 300' longitudinal, on either side of the short core, will be taken and used in the average thickness for that unit. An adjusted unit price as provided in Subsection 9.44 will be paid for the unit represented.

Other areas such as intersection, entrances, crossovers, ramps, etc., will be considered as one unit, and the thickness of each unit will be determined separately. Small irregular unit areas may be included as part of another unit. At such points as the Engineer may select in each unit, one core will be taken for each 1,000 square yards of pavement, or fraction thereof, in the unit. If the core so taken is not deficient more than 0.2" from the plan thickness, full payment will be made. If the core is deficient in thickness by more than 0.2", but not more than 1.0" from the plan thickness, two additional cores will be taken from the area represented and the average of the three cores determined. If the average measurement of these three cores is not deficient more than 0.2" from the plan thickness, full payment will be made. If the average thickness of the three cores is deficient more than 0.2", but not more than 1.0" from the plan thickness, an adjusted unit price as provided in Subsection 9.44 will be paid for the area represented by these cores.

In calculating the average thickness of the pavement, measurements which are in excess of the specified thickness by more than 0.2" will be considered as the specified thickness plus 0.2", and measurements which are less than the specified thickness by more than 1.0" will not be included in the average.

When the measurement of any core is less than the specified thickness by more than 1.0", the actual thickness of the pavement in this area will be determined by taking additional cores at (not less than) 10 foot intervals parallel to the centerline in each direction from the affected location until in each direction a core is found which is not deficient by more than 1.0". Areas found deficient in thickness by more than 1.0" shall be evaluated by the Engineer and if, in his judgement, the deficient areas warrant removal, they shall be removed and replaced with concrete of the thickness shown on the plans.

9.33**METHOD OF MEASUREMENT**

The yardage to be paid for under this section will be the number of square yards of Portland Cement Concrete Pavement, completed and accepted as measured, complete in place. The width for measurement will be the width of the pavement shown on the typical cross-section of the plans, additional widening where called for, or as

otherwise directed in writing. The length will be measured on the surface along the centerline of each roadway or ramp.

Wire reinforcement, dowels, tie bars, hook bolts, and load transfer devices shall be included in the price bid per square yard.

There will be no separate measurement for cleaning, sawing, tooling, and sealing of joints.

9.34**BASIS OF PAYMENT**

- (a) **General.** The accepted quantities of concrete pavement will be paid for at the contract unit price bid per square yard, which price and payment shall be full compensation for furnishing and placing all materials, cleaning of joints, sawing of joints, furnishing and installing preformed compression seals, tooling, sealing, and other incidentals necessary for the completion of the item, including any dowels and joint material, provided however, that for any payment found deficient in thickness by more than 0.2", but not more than 1.0", only the reduced price stipulated below shall be paid.

No additional payment over the unit contract bid price will be made for any pavement which has an average thickness in excess of that shown on the plans.

- (b) **Price Adjustments.** Where the average thickness of pavement is deficient in thickness by more than 0.2", but not more than 1.0", payment will be made at an adjusted price as specified in the following table:

Concrete Pavement Deficiency

Deficiency in Thickness Determined by Cores Inches	Proportion Part of Contract Price Allowed
0.00 to 0.20	100%
0.21 to 0.30	80%
0.31 to 0.40	72%
0.41 to 0.50	68%
0.51 to 0.75	57%
0.76 to 1.00	50%

When the thickness of pavement is deficient by more than 1" and the judgment of the Engineer is that the area of such deficiency should not be removed and replaced, there will be no payment for the area retained.

ITEM 9A

PORTLAND CEMENT CONCRETE PAVEMENT

CONTINUOUSLY REINFORCED

9A.01 DESCRIPTION

Portland Cement Concrete Pavement, Continuously Reinforced, shall consist of constructing a continuously reinforced finished pavement composed of Portland Cement Concrete and deformed bar reinforcement constructed on a base course in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and topical cross-sections shown on the plans or established by the Engineer.

Concrete for this section may be either Job Mixed, Central Mixed, or Truck Mixed. All concrete shall be certified, air entrained, with the requirements of Subsection 9.09.

9A.02 MATERIALS

Materials shall conform to the requirements of Item 9 of these Standard Specifications.

9A.03 STEEL REINFORCEMENT

Longitudinal reinforcement bars shall conform to ASTM A615 Grade 60 and shall be a minimum of 40 feet in length.

Transverse reinforcement bars and tie bars shall conform to ASTM A615 Grade 40 or 60. Dowel bars shall be corrosion resistant and conform to Item 9. Hook bolts and "W" bolts shall conform to the details on the plans.

9A.04 JOINT SEALER

Joint Sealer shall be hot-poured, conforming to ASTM D-3405 as specified in Subsection 9.30.

9A.05 CONSTRUCTION METHODS - PAVING

The Contractor shall construct this section in accordance with the requirements of Item 9 and 9A and may use either the fixed-form method or the slip-form method.

If the slip-form method for construction is used and the results are unsatisfactory in the opinion of the Engineer, with respect to the standards set by these specifications, the Engineer may require the remaining pavement to be constructed by the fixed-form method.

- A. **Fixed-Form Methods.** The fixed-form method shall be in accordance with applicable subsections of Item 9 and as modified herein.
- B. **Slip-Form Method.** The slip-form method shall be in accordance with the applicable subsections of Item 9 and as described herein.

PAVING EQUIPMENT

9A.06 THE SLIP-FORM PAVER

The concrete shall be placed with a slip-form paver or paving train designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the plans and specifications.

The slip-form paver shall be of the self-propelled type, equipped with crawler type tracks, and designed so that the pavement line and surface elevation are automatically controlled by a sensor contacting a taut string or wire.

The slip-form paver shall be adjustable as to crown and super-elevation and shall shape and compact the concrete to the required cross-section as shown on the plans. Such adjustments shall be readily controllable for accuracy in transitions.

The type of slip-form paver to be used shall be approved by the Engineer prior to the delivery of the paver to the job site. The contractor shall supply the Engineer with a copy of the manufacturer's specifications for the equipment.

No tractive force shall be applied to the machine except that which is controlled from the machine.

The slip-form paver shall be operated with as nearly a continuous forward movement as possible, and all operations of mixing, delivering and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum.

Failure of the contractor to maintain a continuous forward movement and/or a constant uniform height of mix across the face of the screed shall warrant the

Engineer's ordering the contractor to improve, modify or change operations as directed.

9A.07 CONSOLIDATING, SCREEDING, AND FINISHING CONCRETE

The contractor shall employ an adequate number of persons trained in the operation and maintenance of the slip-form paver.

The amount of manipulation of the mix shall be held to the minimum required to bring the concrete to a proper finish.

Sliding forms shall be rigidly held together laterally to prevent spreading of the forms. Sliding forms shall trail behind the paver for such a distance that no appreciable slumping of the concrete will occur.

When an additional lane, or lanes, of pavement is constructed adjacent to pavement placed with the slip-form paver, the edge formed by the slip-form paver shall not slump below true grade in excess of the tolerance stated herein. Deviation from the true grade shall be corrected while the concrete is plastic. The contractor shall have on hand a sufficient quantity of temporary forms to immediately bulkhead the pavement edges should sloughing at the pavement edges occur.

The machine shall vibrate the concrete for the full width and depth of the pavement being placed. Approved vibrating tubes or arms to work in the concrete may be required by the Engineer. Such vibration shall be accomplished with vibrating screed or pan operating on the surface of the concrete. The paver shall be so equipped that when the forward motion is interrupted the vibrators stop.

9A.08 SURFACE TEXTURE

The finished pavement surface shall be textured by machine methods as specified in Item 9.

9A.09 CURING

The method of curing shall conform to Item 9.

Application of liquid membrane curing compound on slip-form pavement shall be with equipment guided by stringline and sensors and designed for use in a slip-form paving train.

9A.10**CONSTRUCTION METHODS - STEEL REINFORCEMENT**

Continuous Steel Reinforcement shall consist of furnishing and placing in Portland cement concrete pavement, reinforcement steel of the quality, type, size and quantity designated, as required by these specifications and as shown on the plans.

The contractor shall note that there are two systems of continuous reinforcement. They are shown on the plans as Method 1 (Bar Reinforcement), and Method 2 (Bar Reinforcement-Longitudinal Steel only).

The contractor has the option of using either method as described, however, only one method shall be used throughout.

Chairs for the support of continuous steel reinforcement shall be rigid and capable of supporting the reinforcement without deflection or penetration into the base course or overturning during the placement of concrete. The height of the chairs shall be sufficient to support the reinforcement at required elevations indicated on the plans during the placing and consolidation of the concrete.

The contractor shall submit to the Engineer for approval a sample of each type of chair and tie bar support he/she intends to use, and a drawing showing the proposed layout of chairs at a spacing not to exceed 3 feet transversely and 4 feet longitudinally or one support for each 12 square feet of pavement. Bar reinforcement shall conform to sizes and dimensions shown on the plans, except that shorter longitudinal bars may be used when necessary for starting or ending the staggered lap pattern shown on the plans.

Regardless of the method of placement used, the horizontal spacing tolerances, plus or minus plan dimensions, shall be 1/2" for longitudinal steel and 2" for transverse steel. These tolerances notwithstanding, the number of longitudinal members for a given width of pavement and the number of transverse members per station shall be as shown on the plans.

The position of the longitudinal and transverse steel (if used) in the vertical direction shall be that shown on the plans, plus or minus 1/2".

Reinforcement that is coated with oil, grease or other material that may inhibit the bond will not be permitted for use. Bar reinforcement with light rust, mill scale or a combination of both will be permitted for use, provided bond will not be inhibited, as determined by the Engineer.

Lap splices in longitudinal bars shall be in strict conformity with the plans. Any deviation therefrom shall be cause for removal and replacement at the contractor's

expense.

If construction Method No. 1 is used, all longitudinal bars along the edges of a 12 foot lane shall be tied or clipped to each transverse bar. Internal longitudinal bars shall be tied or clipped to each alternative transverse bar. All laps shall be tied or clipped. Ties or clips shall prevent movement in any direction. Longitudinal bars shorter than the minimum length shall be tied to each transverse bar. Welding of the longitudinal and transverse bars will not be permitted.

Construction of the pavement by the dual-lift method (where the steel reinforcement is supported by the first lift of concrete) will not be permitted. Under Construction Method 1, all reinforcement shall be pre-set on chairs or other approved devices to provide support and prevent movement of the reinforcement during placement of concrete. All reinforcement shall be in position and approved before placement of concrete. The placement of concrete full depth is a requirement.

The use of longitudinal base only, Method 2, requires self-propelled equipment which shall accurately position and space the reinforcing, as full depth concrete is being placed, through tube feeders, rollers, bar spacers or other machinery specifically designed for placing steel in CRC pavement. Such equipment shall be approved prior to use and shall demonstrate steel placement within the tolerances stated herein.

During placement of the concrete, checks on the position of the steel will be made at 100 foot intervals to verify proper vertical placement of the steel. If these checks show variance from the allowable limits, steps shall be taken to adjust the equipment and the frequency of checks will be increased until the Engineer is satisfied that the steel placement is corrected.

9A.11 TRANSVERSE JOINTS

A construction joint shall be made perpendicular to the centerline of the pavement at the close of each day's work and also when the process of depositing concrete is stopped for a length of time that the concrete will have taken its initial set. This joint shall be formed by using a clean plank, the cross-section of which shall be equal to the cross-section of the pavement under construction. The plank shall be cut true to the crown of the finished pavement and shall be accurately set and held in place in a vertical plane.

The longitudinal reinforcing steel shall extend through the headerboard and shall be properly supported from the base course beyond the headerboard to prevent deflection or displacement of the embedded reinforcement during paving operations. The exposed reinforcement in the area beyond the headerboard shall be protected

from concrete spillage by tarpaulins, plywood panels, building paper or other such material as the Engineer may approve.

All lap splices of bar reinforcement occurring within an area from 8 ft. beyond to 3' behind the construction joint in the direction of paving shall be strengthened by splicing in symmetrically with the lap one 6 foot length of #5 bar per longitudinal bar. Additional tie steel will be required at each construction joint. Deformed bar size, length and spacing shall be in accordance with the plans or Standard Drawings. Any excess mortar or laitance accumulated at the front of the paver shall be wasted and not incorporated into the pavement at the joint. Hand spud vibrators shall be on site at all times and shall be used to consolidate the concrete at the joint. A minimum of 12 hours shall elapse before paving is resumed at the joint. The headerboards shall be removed and all concrete, mortar or other debris removed from the joint face and base. The fresh concrete shall be deposited directly against the joint face and compacted with hand vibrators along the entire length of the joints.

The finished surface of the pavement shall conform to the planned shape and crown at the joint. When tested with a 10-foot straightedge, the surface across the joint shall not vary more than 1/8 of an inch. Transverse construction joints require no seal.

9A.12 LONGITUDINAL JOINTS

Longitudinal joints, with the specified tie bar reinforcing, shall be placed as shown on the plans and constructed as specified in Item 9. Finished pavement shall be constructed to the full pavement width whether formed or slip-formed. The formation of longitudinal construction joints shall result from variable width paving only or as noted on the plans. Joint sealing shall be in accordance with Item 9 and as shown on the plans.

9A.13 TERMINAL CONSTRUCTION JOINT

Terminal Construction Joint shall consist of constructing a galvanized steel wide-flange beam joint between continuously reinforced concrete pavements and conventionally jointed standard reinforced concrete pavements having expansion joints with load transfer devices, at the locations and as shown on the plans and/or the Standard Drawings.

Materials. All materials shall be as shown on the plans and/or as follows:

- (a) End plates on beams shall conform to the requirements of ASTM A 36.
- (b) Hot poured joint sealer shall conform to the requirements of ASTM D 3406.

- (c) Load transfer devices shall be corrosion resistant type as described in Item 9 and shown on the plans.

Construction Methods. End plates shall be shop welded to the ends of the WF beam as shown on the plans and in accordance with the requirements of the current edition of the American Welding Society Specifications for Welded Highway and Railroad Bridges.

The finish on the "Sleeper Slab" shall be free from fins, ridges and pockmarks, and shall be a true plane surface so as to minimize friction and ensure a proper slippage plane.

The beams shall be set perpendicular to the edge of the pavement and perpendicular to the pavement surface, and shall be of a length, including end plates, equal to the total width of the pavement.

The contractor shall note that when the terminal construction joints are located in superelevated sections of the roadway, he/she shall compensate for the change in length caused by such superelevation when ordering the beams.

The beam shall be supported above the grade prior to the placement of concrete in the "Sleeper Slab" in a manner approved by the Engineer. Such approval shall in no way relieve the contractor of his/her responsibility under the contract, and any subsidence in elevation of the beam shall be cause for removal and replacement by the contractor at his/her own expense.

For each terminal construction joint constructed, an expansion joint or joints shall be constructed as shown on the plans.

9A.14 SURFACE TEST

The surface of the completed pavement shall be within the tolerance specified in Subsection 9.25 with the exception that a tolerance will be permitted for edge slump, exclusive of edge rounding. Edge slump will be measured by placing a 10 foot straightedge perpendicular to the centerline of pavement and taking the vertical measurement at the edge of the completed pavement where the normal edge rounding begins. The straightedge shall be supplied and maintained by the contractor.

- (a) Edge slump of the concrete pavement, exclusive of edge rounding, may vary up to 1/2" at locations where no additional concrete work is to be constructed immediately adjacent to the pavement being placed. Edge slump will be tested as soon as practical after paving operations begin. Any edge slump in excess of 1/2 inch shall be corrected before the concrete has hardened. When edge

slump excess of 1/2 inch persists, paving will be suspended and operational corrections shall be made before the Engineer will permit the resumption of paving.

- (b) Edge slump of the concrete pavement in excess of 1/4 inch will not be allowed at locations where additional concrete work (widening, ramps, additional lanes, curb and gutter, etc.) is to be constructed immediately adjacent to the pavement being placed. The contractor shall correct any edge slump in these areas before the concrete has hardened. If the concrete has hardened, the edge slump shall be corrected for the full length of the defective pavement to the satisfaction of the Engineer at the contractor's expense.
- (c) Deviation of the edge of pavement from specified horizontal alignment shall not exceed a distance of 0.15 foot. Any changes in horizontal alignment must be made at a rate not to exceed 1 in 50.

If the contractor consistently fails to construct pavement within these specified tolerances, the use of slip form methods will be discontinued and the pavement shall be placed by means of conventional forms.

9A.15 METHOD OF MEASUREMENT

The yardage of Portland Cement Concrete Pavement, Continuously Reinforced, to be paid for under this section shall be the number of square yards of cement concrete pavement, complete in place and accepted. The width for measurement shall be the width shown on the plans and additional widening where called for and the length will be the actual length measured along the centerline. The thickness shall be the designated thickness as adjusted in accordance with Subsection 9.34.

The measurement of Terminal Joints shall be made separately per each joint constructed on a lump sum basis.

9A.16 BASIS OF PAYMENT

The yardage of Portland Cement Concrete Pavement, Continuously Reinforced, measured as provided above, shall be paid at the contract unit price bid per square yard for Portland Cement Concrete Pavement, Continuously Reinforced, which price and payment shall be full compensation for furnishing, preparing, hauling, and placing all materials, including all sawed joints, joint sealing, continuous steel reinforcement, chairs, splice bars, tie bars, tie wire, clips, and all labor, equipment, tools, and incidentals necessary to complete the section.

Payment for the Terminal Joint shall be made separately per each joint constructed.

Payment shall be full compensation for furnishing all materials and labor associated with construction of the reinforced Portland cement concrete sleeper slab and wide-flange beam joint. Conventional reinforced concrete pavement, including the load transfer devices with the expansion joints, abutting the terminal joint, shall be measured and paid for as Item 9.

ITEM 10

PATCHING PORTLAND CEMENT

CONCRETE PAVEMENT

10.01 DESCRIPTION

Patching Portland Cement Concrete Pavement shall consist of cutting out old pavement and replacing it with a Portland cement concrete pavement in accordance with these specifications and in reasonably close conformity with the thicknesses shown on the plans or established by the Engineer. The areas of old pavement to be patched will be indicated on the plans, and as directed.

The limits of the areas where the pavement is to be removed and patched will be painted on the existing pavement by the Construction Inspector.

10.02 MATERIALS

All materials used in this section shall conform to the requirements of materials in Item 9.

10.03 COMPOSITION OF MIX

The requirements for this Item are as specified in Paragraph 108, Material Details, Class A or Class B.

Class A concrete will be used in combination with strength accelerating and/or other admixtures:

Either

A combination of 16 to 48 ounces per sack of cement Type E, Water Reducing - set Accelerating Admixture and 3 to 5 ounces per sack of cement Type A, Water Reducing Admixture.

Or

A combination of 16 to 48 ounces per sack of cement Type E, Water Reducing - Set Accelerating Admixture and 3 to 5 ounces per sack of cement Type D, Water Reducing - Set Retarding Admixture.

The actual combination type and rates of dosage shall be as required by field conditions, ambient temperature, humidity, and wind, and as specified by the Department of Public Works. The design minimum concrete strength is 2000 pounds per square inch (psi) in 18 hours and 4500 (psi) in 28 days.

Class B concrete shall be used for conventional concrete patching when early opening to traffic is not specified or required.

Class A and Class B Concrete shall meet the following requirements:

- (a) Air content - 5% plus or minus 2%
- (b) Slump - 2 to 4 inches

10.04 CONSISTENCY

The requirements for this Item are as specified in Paragraph 108, Material Details.

10.05 CONSTRUCTION METHODS - CONVENTIONAL CONCRETE PAVEMENT

The minimum length of the area to be repaired, measured along the centerline of pavement, shall be not less than 6'. The pavement slab adjacent to the section being repaired shall be cut to a true neat line, with straight edges, perpendicular to the longitudinal centerline of pavement and perpendicular to the plane of the finished subgrade. An approved concrete cutting saw shall be used in severing the patch area from the old pavement. The first operation in removing the old pavement shall involve sawing the slab along the lines of the extremities of the area to be patched with an approved mechanical saw, to a vertical cut of 3" in depth and in such manner as will produce a definite plane of weakness and ensure a straight, clean, vertical break. The concrete in the patch area shall be broken by an approved mechanical pavement breaking machine. In removing the old pavement the subgrade shall be undisturbed insofar as practicable below the elevation of the bottom of the new concrete patch. The broken concrete shall become the property of the contractor and shall be disposed of in a satisfactory manner.

10.06 SUBGRADE PREPARATION

The subgrade shall be cut to the desired elevation so as to eliminate the necessity for backfilling. It shall then be properly shaped, compacted, and brought to a firm and unyielding surface by tamping or by other approved methods. If the subgrade material is found unsatisfactory upon removing the old pavement, the Engineer may direct that the unsuitable material be removed and replaced with approved material, placed and compacted as required under Item 2.

The subgrade shall be sprinkled so as to be moist, but not muddy at the time of placing concrete.

10.07 PLACING CONCRETE

The requirements of Item 9 shall prevail for the placing of concrete. The concrete shall be deposited directly on the foundation and shall be uniformly distributed and spread.

Side forms are required in any areas where existing conditions will not provide a completed patch with smooth vertical sides.

10.08 CONSOLIDATING AND FINISHING CONCRETE

Experienced concrete finishers shall be employed in finishing the surface of the concrete. It is intended that the amount of manipulation be held to the minimum required to bring the concrete to a proper finish. Short patches that are generally less than 12 feet can be screeded either transversely or longitudinally. If a pavement is rutted, screeding in the longitudinal direction (placing the screed parallel to the centerline) may be directed by the Engineer so the patch will match the existing cross-section of the pavement. For patches over 12 feet in length, the screed shall be placed perpendicular to the centerline.

As soon as the concrete has been deposited, it shall be leveled and immediately struck off by means of vibratory screed or templates. The first or forward screed shall not be less than 10" in width, from 1 1/2' to 2' longer than the width of the pavement and shall be constructed of a channel iron weighing not less than 25 pounds per linear foot or other approved design. The second or follow up screed shall not be less than 8" in width, of the same length and construction as the first screed and shall weigh not less than 18 pounds per linear foot or other approved design. These screeds shall be shaped to the approved cross-sections and shall be of sufficient strength to retain their shape under all working conditions. During operation, the second shall follow the first at a reasonable distance as determined by the Engineer. The screed shall be moved forward with a combined longitudinal and crosswise motion. If necessary, the screeds shall be used a second time or until a true surface is obtained. While the concrete is being struck off, at least 2 workers shall be at work leveling, spading, and tamping the concrete directly in front of the screed.

Hand spud vibrators shall be available and shall be used by experienced workmen to facilitate consolidation of the concrete.

10.09

JOINTS

On one transverse side of the patch, 3/4" thick cork or rubber filler material conforming to the requirements of AASHTO M 153 shall be placed directly against the face of the existing concrete; it shall extend across the full width of the transverse joint and from the bottom of the existing slab to within 3/4" of the top surface of the slab, or as needed by the sealant system requirements.

When specified on the plans, all transverse joints shall have deformed bar tie steel and corrosion resistant dowel bars installed as shown in the plan details. Deformed steel bars, conforming to the requirements of AASHTO M 31, Grade 40 or 60, with dimensions of 5/8" diameter and 18" long shall be used. Dowel bars shall conform to Item 9 and shall be 1 1/4 inch in diameter and 18 long, placed as shown in the plan details. Tie bars and dowel bars shall be drilled into the face of the existing pavement by approved methods. It is critical that each tie bar and dowel is placed parallel with the centerline of slab, both vertically and horizontally. It is recommended that a guide be used during the drilling of the holes into the existing slab to guarantee conformance to this requirement. Use of an approved adhesive anchor system is recommended over a procedure involving grouting the dowels in place. The end of the dowel that will be within the new concrete shall be coated with grease or graphite paste in order to prevent any possible bonding to the new concrete.

No tie steel is required to adjacent concrete pavement slabs at longitudinal joints, except where less than full slab width removal is required. A bond breaker shall be placed on any concrete face along the longitudinal joints exposed within the patch. A coat of approved latex paint or an approved alternate system may be used such that bonding between the new and existing concrete will be prevented along this place.

For patches longer than 16' in the longitudinal direction, steel wire mesh reinforcement, conforming to the requirements of AASHTO M 32 or M 55, of longitudinal #2 wire spaced at 6" on center and transverse #4 wire spaced at 12" on center shall be used. The mesh shall be placed to result in 3" to 4" of concrete cover to the surface and sides of the patch.

The surface edges of all patches adjacent to the existing concrete shall be tooled, formed, sawed and cleaned to result in a properly dimensioned reservoir for sealant. All joints so constructed and to be overlayed with hot-mix shall be sealed with hot-poured joint sealer conforming to ASTM D 3405 within 5 working days. All other joints to remain exposed as part of the existing concrete pavement, shall be sealed with low modulus silicone sealant in accordance with requirements of Subsection 9.30.

10.10 FINISHED SURFACE

The cross section of the patch shall be finished to match the existing cross section of the roadway (any existing rutting will be continued through the patch for the first 10' length in the direction of travel). A broomed texture, or tining as applicable to match the existing concrete surface, is required. Surface variations greater than 1/4" in a

10' interval along the longitudinal direction will render the work defective. Grinding at the expense of the contractor is an acceptable patch surface correction procedure.

10.11 CURING

Curing shall conform to Item 9. When a liquid membrane curing compound is used, it shall be applied uniformly, immediately upon completion of the patch texturing, at a rate of 1 gallon per 150 square feet.

10.12 OPENING TO TRAFFIC

The pavement shall be opened to traffic when directed, but shall not be opened in less than 72 hours after placing Class B concrete or until the concrete has achieved a minimum compressive strength of 2000 psi as determined by testing representative cylinders.

10.13 CONTINUOUSLY REINFORCED CONCRETE PAVEMENT

Item 9A, the applicable methods of Item 10 and the following requirements shall govern the patching of continuously reinforced concrete pavement.

The pavement shall be patched in such a manner that the continuity of the pavement is preserved. Repairs shall be made for the full width of the slab. If possible, patches shall be placed during stable weather conditions when the daily temperature cycle is small.

Patching shall be done as follows:

- (a) The minimum length of patch shall be 10'.
- (b) The patch shall be placed on a 1 to 4 skew across the pavement to avoid both wheels of an axle crossing the construction joint simultaneously.
- (c) A groove shall be cut 1" deep at each boundary of the patch without cutting the reinforcement.

- (d) Saw two cuts parallel to and 3'-0" and 3'-6" respectively inside of each of the cuts which define the patch boundaries.
- (e) Chip the concrete from between each pair of cuts down to the reinforcement and cut the steel with a torch or bolt cutter.
- (f) Remove all the concrete between patch boundaries with an air hammer, being careful not to unduly injure the stabilized foundation course, and leaving 3' of reinforcement steel exposed at each end of the patch area.
- (g) Repair the stabilized foundation course as prescribed in the plans and specifications.
- (h) Splice-in deformed bars with each member of reinforcement which extends into the patch area from the ends of the existing pavement. The reinforcement shall be lapped 36". The laps shall be secured with wire ties. Welding will not be permitted. If movement of the pavement ends causes the reinforcement to buckle, such buckling shall be corrected just prior to placing concrete by removing and replacing the wire ties at the laps.
- (i) Provide supplementary bars to increase the area of longitudinal steel by 50 percent. The splice bars and the supplementary reinforcement shall be firmly supported at the proper elevation above the foundation course by approved metal chairs.
- (j) Place concrete in the patch area, using extreme care to consolidate so as to avoid any honeycomb. This is particularly important because of the close spacing of the steel.
- (k) Finish the surface of the patch similar to the existing pavement. The patch shall be cured as prescribed in Item 9, and shall not be opened to traffic until the concrete has attained a compressive strength of 2,000 psi.

10.14 METHOD OF MEASUREMENT

The yardage of Patching Portland Cement Concrete Pavement to be paid for under this section shall be the actual number of square yards of concrete patching, of the thickness specified, constructed in accordance with these requirements, complete in place and accepted. The width for measurement will be the width from outside of the completed patches as constructed and the length shall be the actual length measured along the centerline of pavement.

10.15 BASIS OF PAYMENT

The number of square yards of Patching Portland Cement Concrete Pavement, determined as provided above, will be paid for at the contract unit price per square yard bid for Item 10, Patching Portland Cement Concrete Pavement, which price and payment shall be full compensation for furnishing, hauling, and placing all materials, for the removal and disposal of old concrete for preparing the subgrade and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 11

PORTLAND CEMENT CONCRETE MASONRY

11.01 DESCRIPTION

Portland Cement Concrete Masonry shall consist of the construction of bridges, culverts, end walls of pipe culverts and drains, run-offs, retaining walls, steps, intakes for corrugated metal shoulder pipe and other incidental structures constructed of Portland cement concrete as herein specified and as shown on the plans. The Portland cement concrete shall consist of Portland cement, fine aggregate, coarse aggregate, and water, each measured separately and incorporated in accordance with the design and method prescribed, or as directed. Steel bar reinforcement conforming with the requirements of these specifications, shall be used as required on the plans. Cement concrete for this section may be Job Mixed, Central Mixed, or Truck Mixed.

MATERIALS

11.02 PORTLAND CEMENT

Portland cement for this section shall conform with all the requirements of Paragraph 100, Material Details.

11.03 WATER

Water used in mixing concrete for this section shall conform with all the requirements of Paragraph 102, Material Details.

11.04 FINE AGGREGATE

Fine aggregate for use in this section shall conform with all the requirements of Paragraph 103, Material Details.

11.05 COARSE AGGREGATE

Coarse aggregate for use in this section shall conform with the requirements of Paragraph 104, Material Details, and at the time it is proportioned shall be graded as set forth in Paragraph 110, for size No. 57.

11.06 STOCK PILES

The requirements for stock piles for this section shall be the same as those specified

in Material Details, Paragraph 108.

11.07 PIPE FOR WEEP HOLES

Cast iron soil pipe for weepholes shall conform to the requirements of ASTM A 74. Plastic pipe shall conform to ASTM D 2665, Polyvinyl Chloride (PVC), Plastic Drain, Waste, and Vent Pipe.

11.08 SHEET METAL FOR FLASHING, WATER STOPS, ETC.

Sheet copper shall conform to AASHTO B 370, sheet copper for construction.

Sheet lead shall conform to the requirements for Common Desilverized Lead, ASTM B 29.

Sheet zinc shall conform to the requirements for Rolled Zinc, ASTM B 69.

11.09 CONCRETE CURING AGENTS

Concrete curing agents shall be as specified in Item 9.

11.10 FORM OIL FOR CONCRETE FORMWORK

Form oil shall be a non-staining petroleum distillate free from water, asphaltic, and other insoluble residue or equivalent product.

11.11 PREFORMED EXPANSION JOINT FILLERS

Unless otherwise specified on the plans or in the special provisions, preformed expansion joint fillers will meet the requirements of AASHTO M 153, Type III, self-expanding cork.

11.12 CONCRETE JOINT SEALERS

Joint sealer type shall be as specified on the plan.

- (a) Preformed Compression Seal. Elastomeric preformed compression seals shall be composed of open cell polychloroprene and conform to AASHTO M 220.
- (b) Rubber Joint Sealant. The sealant shall be a multi-part chemically curing polyurethane or polysulfide sealant which meets or exceeds the curing requirements of Federal Specification TT-S-00227D, (1) Type 1 (Flow Type) and Type II (non-sag Type), Class A, (Compounds resistant to 50% total joint

movement). The color shall be gray to match concrete.

A primer shall be used as recommended by the sealant manufacturer. A bond breaker such as masking tape, polyethylene film, or backing rod as supplied by the manufacturer shall be used at the bottom of the joint.

Sealant Surface Preparation. The surfaces of the joints or recesses must be clean, dry, and free of corrosion, scale, rust, oil, wax, tar paint, and other contamination. Masonry joints shall be sandblasted to remove contamination. Metal surfaces shall be given a commercial sandblast.

Sealant Applicant. Apply masking tape along the edges of the joint where required. Prime joint faces in accordance with sealant manufacturer's instructions. Place sealant following manufacturer's instructions regarding mixing and application. Do not apply sealant on wet or frosty surfaces or when the surface temperatures are less than 40° F or above 130° F. Clean adjacent surfaces free of sealant with mechanical action or solvent as necessary. Leave finished work in a neat and clean condition.

- (c) Bituminous Joint Sealant. Bituminous joint sealers may be hot applied conforming to AASHTO M 173 or equivalent, or cold applied elastomeric sealant conforming to Federal Specification SS-S-200D, Type H.
- (d) Epoxy Bonding Compound. When bonding fresh concrete to hardened concrete, or hardened concrete or steel to hardened concrete, an epoxy bonding compound conforming to ASTM C 881 shall be used. Surface preparation, mixing and application requirements and limitations as specified by the manufacturer shall be strictly followed. Bonding compounds shall be approved prior to use.

The contractor shall schedule his/her concreting operations so that it shall be placed while the epoxy bonding compound is still uncured and tacky. If, in the opinion of the Engineer, the bonding compound has begun to cure, no concrete shall be placed until a new film of bonding compound has been applied to the required areas, at the expense of the Contractor.

11.13 BAR REINFORCEMENT

Steel reinforcement bars shall conform to Item 13.

11.14 COMPOSITION OF MIX

The requirements of this section are to be as specified on the plans or by the Engineer.

11.15 FORMS

Except where indicated elsewhere in these specifications, forms shall be designed and constructed so they can be removed without injuring the concrete. Forms shall be designed for strength and deflection to resist all loads and pressures of the wet concrete, the weight of the forms, the rate of pour, the affect of vibration, the time of setting, and an addition of 50 lbs. per square foot of construction live load applied to all horizontal surfaces.

For removable forms no member shall have a deflection under total load, in excess of $1/360$ of its span length, and in no case shall the deflection exceed $1/4"$, except that deflections of form surfaces for concrete floor slabs where such forms are supported by beams, stringers or girders may be $1/180$ of the span length but not exceed $1/2"$. Where the design of the forms requires deflection in excess of these amounts the forms shall be cambered.

Concrete shall be assumed to weigh 150 lbs. per cubic foot. Lumber in forms shall be assumed to weigh 4 lbs. per board foot. For material other than lumber the unit weight of the material shall be used.

Form work plywood (without backing) shall be used with the face plies running parallel to the span (or perpendicular to supports) for maximum working strength and minimum deflection.

The contractor shall prepare, and submit for approval complete detailed plans of all form work to be constructed and he shall not proceed with formwork construction until his plans have been approved. However, approval of these plans shall not relieve the contractor of complete responsibility for the safety and adequacy of all formwork.

The form drawings, shall show all major design values and loading conditions. These include assumed values of live and dead load, rate of placement, temperature of concrete, height of drop, weight of moving equipment which may be operating on formwork, foundation pressures, design stresses, deflection and camber diagrams, and other pertinent applicable information. In addition to specifying types of materials, size lengths, and connection details, formwork drawings shall provide for applicable details such as: (1) Anchors, shores, and braces; (2) field adjustment of the form during placing of concrete; (3) waterstops, keyways and inserts; (4) working scaffolds and runways; (5) weepholes or vibrator holes where required; (6) screed and grade

strips; (7) crush plates or wrecking plates; (8) removal of spreaders or temporary blocking; (9) cleanout holes; (10) construction control and expansion joints; (11) chafer strips; (12) notes to cover conduits and pipes to be embedded; (13) details on shoring, reshoring or leaving original shores in place as forms are stripped.

The material to be used for forms for exposed surfaces shall be either heavy plywood, metal in which all bolt and rivet holes are countersunk, fiber, or other approved material. In any case, a plain smooth surface of the desired contour must be obtained. For surfaces to be given a rubbed finish the material shall be heavy plywood unless otherwise specifically approved. For curved or special surfaces the above requirements may be modified.

The form material shall be placed so a smooth surface free from irregularities is obtained. Sheets of material shall be placed so that joints are in regular and true horizontal and vertical lines. Full sized plywood sheets shall be used except where a single smaller piece will cover an entire area. Where form lining is used, it will be used in pieces as large as possible. All joints shall be solidly backed, butted tight together and sealed with white lead paste or other approved crack fillers. All holes shall be filled as well as depressions or hammer marks so that the completed surface is as smooth as possible. When steel forms are used, the panels shall be as large as practical and of sufficient gauge to prevent surface irregularities. Panels shall be assembled in uniform patterns and firmly locked and braced together to form a smooth surface. Bent or irregular panels will not be used. Round fiber column forms shall be furnished full height and shall be fitted with circular wooden templates at top and bottom and with wooden collars at intermediate points. Fiber forms shall be removed not later than 10 days after pouring.

Moldings, fluting, rustification, and other ornamental details shall be formed of material specifically manufactured for the job. Samples or details of the material shall be submitted for approval by the Engineer prior to use.

All lumber shall be free from knotholes, loose knots, cracks, splits, warps, or other defects impairing the strength or the appearance of the finished structure.

When necessary because of thin wall construction, forms shall be daylighted at intervals not greater than 10' vertically, the openings being sufficient to permit free access to the forms for the purpose of inspecting, working, and vibrating the concrete.

The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar tight and, to close cracks due to shrinkage, shall be thoroughly soaked with water.

Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled, greased, or soaped to ensure non-adhesion of mortar. Form plywood and/or lumber which is used a second time shall be free from bulge, warp or damage and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete and any defects shall be remedied and all dirt, sawdust, shavings, or other debris within the forms shall be removed.

Blocks and bracing shall be removed with the forms and in no case shall any portions of the wood forms be left in the concrete. Special attention shall be paid to the ties and bracing and when forms appear to be insufficiently braced or unsatisfactorily built, either before or during construction, the work will be ordered stopped until the defects have been corrected. The forms shall be so constructed that the finished concrete shall be of the form and dimensions shown on the plans and true to line and grade.

Forms shall be so constructed that any metal supports or ties shall be removable to within 1-1/2" from all exposed faces.

On the structures having cement concrete masonry decks, supported by beams and girders, the forms for the deck slabs shall be so constructed that under full dead load, the slabs will be of the required thickness shown on the plans and the surface of the roadway will accurately conform to the profile grades, cross-sections and alignment shown on the plans. Allowance shall be made for the camber of the beams and stringer as fabricated and erected and also for the additional deflections due to dead load. The depth of haunches between the top of the stringers and the bottom of the slab as shown on the plans, is theoretical, and due to variations in obtainable camber in the stringers and to usual inaccuracies of fabrication and erection, the depths of haunches to be constructed may vary considerably from the theoretical. The form work shall be constructed so as to provide for any and all necessary variations in actual depths of haunches required.

PERMANENT STEEL BRIDGE DECK FORMS FOR CONCRETE DECK SLABS OF BRIDGES

General. Permanent steel bridge deck forms for concrete deck slabs of bridges shall be used when shown on the contract plans, except that such forms may be used when approved by the Engineer in a change order agreed to after award of contract. The pay quantity of concrete in the floor slabs shall be computed from the dimensions shown on the plans with no allowance for form deflection.

Materials. Permanent steel bridge deck forms and supports shall be fabricated from steel conforming to ASTM Specification A446 (Grades A through E) having a coating

of G165 according to ASTM Specification A525.

Design. The following criteria shall govern the design of permanent steel bridge deck forms:

The steel forms shall be designed on the basis of dead load of form, reinforcement and plastic concrete plus 50 pounds per square foot for construction loads. The unit working stress in the steel sheet shall be not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 pounds per square inch.

Deflection under the weight of the forms, the plastic concrete and reinforcement shall not exceed $1/180$ of the form span or $1/2$ " whichever is less, but in no case shall this loading be less than 120 PSF total.

The permissible form camber shall be based on the actual dead load condition. Camber shall not be used to compensate for deflection in excess of the foregoing limits.

The design span of the form sheets shall be the clear span of the form plus 2" measured parallel to the form flutes.

Physical design properties shall be computed in accordance with requirements of the American Iron and Steel Institute Specifications for the Design of Cold Formed Steel Structural Members, latest published edition.

All reinforcement shall have minimum concrete cover of 2".

The plan dimensions of both layers of primary deck reinforcement from the top surface of the concrete deck shall be maintained.

Permanent steel bridge deck forms shall not be considered as lateral bracing for compression flanges of supporting structural members.

Permanent steel bridge deck forms shall not be used in panels where longitudinal deck construction joints are located between stringers.

Welding shall not be permitted to flanges in tension or to structural steel bridge elements fabricated from non-weldable grades of steel.

Fabricators shop and erection drawings shall be submitted to the Engineer for approval. These plans shall indicate the grade of steel, the physical and section properties for all permanent steel bridge deck form sheets, and a clean indication of

locations where the forms are supported by steel beam flanges subject to tensile stresses.

CONSTRUCTION FOR PERMANENT STEEL BRIDGE DECK FORMS

All forms shall be installed in accordance with approved fabrication and erection plans.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1" at each end. Form supports shall be placed in direct contact with the flange of stringer or floor beam. All attachments shall be made by permissible welds, bolts, clips, or other approved means. However, welding of form supports to flanges of steels not considered weldable and to portions of a flange subject to tensile stresses shall not be permitted. Welding and welds shall be in accordance with the provisions of AWS D2.0 pertaining to fillet welds, except that 1/8" fillet welds will be permitted.

Any permanently exposed form metal where the galvanized coating has been damaged shall be thoroughly cleaned, wire brushed, and painted with two coats of zinc oxide-zinc dust primer. Federal Specification TT-P-64Id, Type II, no color added, to the satisfaction of the Engineer. Minor heat discoloration in areas of welds need not be touched up.

Transverse construction joints shall be located at the bottom of a flute and 1/4" weep holes shall be field drilled at not less than 12" on center along the line of the joint.

PLACING OF CONCRETE FOR PERMANENT STEEL BRIDGE DECK FORMS

Concrete shall be placed in accordance with the contract specifications. Particular emphasis should be placed on proper vibration of the concrete to avoid honeycomb and voids, especially at construction joints, expansion joints, and valleys and ends of form sheets. Pouring sequences, procedures and mixes shall be approved by the Engineer. Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete laced on permanent steel bridge deck forms.

INSPECTION FOR PERMANENT STEEL BRIDGE DECK FORMS

The contractor's method of construction should be carefully observed during all phases of the construction of the bridge deck slab. These phases include installation of the metal forms; location and fastening of the reinforcement; composition of concrete items; mixing procedures, concrete placement and vibration; and finishing of the bridge deck. Should the Engineer determine that the procedures used during the placement of the concrete warrant inspection of the underside of the deck, the

contractor shall remove at least one section of the forms at a location and time selected by the Engineer for each span in the contract. This should be done as soon after placing the concrete as practicable in order to provide visual evidence that the concrete mix and the contractor's procedures are obtaining the desired results. An additional section shall be removed if the Engineer determines that there has been any change in the concrete mix or in the contractor's procedures warranting additional inspection.

After the deck concrete has been in place for a minimum period of two days, the concrete shall be tested for soundness and bonding of the forms by sounding with a hammer as directed by the Engineer. If areas of doubtful soundness are disclosed by this procedure, the contractor will be required to remove the forms from such areas for visual inspection after the pour has attained adequate strength. This removal of the permanent steel bridge deck forms shall be at no cost to the project.

At locations where sections of the forms are removed, the contractor will not be required to replace the forms, but the adjacent metal forms and supports shall be repaired to present a neat appearance and assure their satisfactory retention. As soon as the form is removed, the concrete surfaces will be examined for cavities, honeycombing and other defects. If irregularities are found, and it is determined by the Engineer that these irregularities do not justify rejection of the work, the concrete shall be repaired as the Engineer may direct and shall be given an Ordinary Surface Finish, in accordance with the contract specifications. If the concrete where the form is removed is unsatisfactory, additional forms, as necessary, shall be removed to insect and repair the slab, and the contractor's methods of construction shall be modified as required to obtain satisfactory concrete in the slab. All unsatisfactory concrete shall be removed or repaired as directed by the Engineer.

The amount of sounding and form removal may be moderated, at the Engineer's discretion after a substantial amount of slab has been constructed and inspected, if the contractors methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained throughout the slabs.

The contractor shall provide all facilities as are reasonably required for the safe and convenient conduct of the Engineer's inspection procedures.

11.16 FALSEWORK

Falsework shall be built on a firm foundation to carry the anticipated loads without appreciable deformation and shall be of sufficient strength to carry the loads safely without exceeding the deflections as specified in Subsection 11.15 Forms. It shall be constructed so as to provide the camber shown on the plans for the completed structure. Proper allowance shall be made for takeup in timbers and probable

falsework settlement. A "telltale" or other approved type indicator shall be attached to the forms in a manner to indicate any settlement, movement, or deflections in the forms of falsework. If any of them is in excess of the prescribed tolerance(s), the work shall be stopped and the Contractor shall be required to rectify the problem to the full satisfaction of the Engineer at the Contractor's expense.

The Contractor shall engage a Professional Engineer registered in Delaware to design the falsework separately for every bridge on the project with his seal imprinted and signature on the working drawings. It is the Contractor's responsibility to obtain approval of the working drawings from the Engineer prior to the construction of the falsework. Such approval, when given by the Engineer, shall not relieve the Contractor from the responsibility of the adequacy and satisfactory performance of the falsework.

Falsework systems shall be designed to handle all vertical and horizontal loadings and should contain enough redundancy to prevent a failure in the entire system. Vertical loading and differential settlement forces, and horizontal lateral and longitudinal forces shall also be taken into account for design of the falsework.

After placement of the falsework, the Contractor's Professional Engineer shall certify that the falsework system has been assembled according to the approved falsework drawing prior to placing loads on the falsework. When falsework installations are to be erected adjacent to a highway, special design considerations and protection shall be taken to ensure that falsework system is not disturbed by errant highway vehicles or by the vibration forces caused by the passing vehicles.

In the event falsework is moved from one bridge to another, the falsework shall be thoroughly inspected and approved by the Contractor's Professional Engineer prior to its use for structural damage and plumbness to ensure that all members are in place and properly aligned and connected.

11.17 HANDLING, MEASURING AND BATCHING MATERIALS

The requirements of this section is as specified in the Material Details, Paragraph 108.

11.18 CONSISTENCY

The requirements of this section is as specified in Material Details, Paragraph 108.

11.19 MIXING

The requirements of this section is as specified in Material Details, Paragraph 108.

11.20 PLACING CONCRETE DURING COLD WEATHER

The following requirements shall govern the placing of concrete during cold weather:

General

No concrete shall be placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35° F without permission of the Engineer. When such permission is granted, the aggregates and/or water shall be uniformly heated to a temperature not higher than 150° F. The temperature of the heated concrete shall not be less than 55° F and not more than 80° F at the time it is placed in the forms.

The aggregates shall be free from ice, frost, and frozen particles, and concrete shall not be placed on frozen foundation material.

The contractor shall protect all concrete by means of heated enclosures or by insulation whenever any of the following conditions occur:

- (a) The Concrete has been placed when the air temperature, measured at the location of the concreting operation in the shade away from artificial heat, is below 35° F.
- (b) The air temperature, measured at the location of the freshly placed concrete in the shade away from artificial heat, is below 35° F and the concrete has not yet attained an age of 72 hours.

The contractor shall provide and place at locations directed by the Engineer a sufficient number of maximum-minimum recording thermometers to provide an accurate record of the temperature surrounding the concrete during the entire protection period.

The contractor shall assume all risks connected with the placing of concrete under the cold weather conditions referred to herein. Permission given by the Engineer to place concrete when the temperature is below 35° F and the subsequent protection of the concrete as required herein shall not relieve the contractor in any way of the responsibility for obtaining the required results.

Heated Enclosures

Portland cement concrete, that is placed when the air temperature is below 35° F and Portland cement concrete that has not yet attained an age of 72 hours before the air

temperature falls below 35° F, shall be immediately enclosed with a housing consisting of canvas or other approved material supported by an open framework or with an equally satisfactory housing, and the air surrounding the concrete shall be maintained at a temperature of not less than 50° F nor more than 90° F for the remainder of the 72 hour period. The air surrounding the concrete shall be maintained at temperatures above 32° F for not less than 48 hours immediately thereafter. The time periods referred to above shall not begin until the manipulation of each separate mass of concrete has been completed.

The contractor shall provide such heating apparatus as stoves, salamanders, or steam equipment, and the necessary fuel.

When dry heat is used, means of preventing loss of moisture from the concrete shall be provided.

Insulation

Protection of concrete by the use of approved insulated forms or insulation blankets will be permitted in lieu of the heated enclosure. Insulation will be required under the same conditions that heated enclosures are required, and shall be placed on the concrete as soon as initial set will permit.

Insulating materials shall have a minimum thickness of 1". The thermal conductivity of the insulation shall not exceed 0.27 BTU per hour square foot for a thermal gradient of one degree F per inch as determined by ASTM C 177. Results of tests conducted in accordance with ASTM C 177 by an acceptable commercial testing laboratory shall be furnished to the Engineer for approval. Such approval shall be secured prior to use of the material. Insulating blankets shall be faced or covered, top and bottom, with polyethylene or similar waterproofing material. Blankets shall be placed on the concrete in such a manner that they form a waterproof surface for the concrete being protected. When the anticipated low temperature expected to occur during the protection period is less than 10° F, 2 inches of insulation will be required.

Blanket insulation mats shall overlap at the edges by at least 6 inches. Rigid type insulation sheets shall be tightly butted together and sealed. Particular care shall be taken to provide effective protection of curbs, corners, and around protruding reinforcing steel. Overhang forms shall be insulated both on the outside vertical faces and on the underside with a 1" minimum thickness of either rigid or blanket type insulation.

Should the air under the insulation fall below 50° F during the protection period, the contractor will be required to immediately cover the concrete with canvas and framework or other satisfactory housing and apply heat uniformly at a rate such that

the air surrounding the concrete is not less than 50° F for the remainder of the protection period.

11.21 PLACING CONCRETE

No concrete shall be placed until the depth of the excavation and character of the foundation material, the adequacy of the forms and falsework, and the placing of reinforcement and other embedded items have been inspected and approved by the Engineer.

Concrete shall be placed in daylight unless an adequate lighting system meeting the approval of the Engineer is provided.

In preparation for the placing of concrete all sawdust, chips, and other construction debris and extraneous matter shall be removed from the interior of forms. Hardened concrete and foreign matter shall be removed from tools, screeds, and conveying equipment.

The temperature of the concrete shall not be greater than 90° F, nor less than 50° F at the time of placing, except where other temperatures are required by these specifications. The temperature of concrete for bridge decks shall not exceed 85° F. During hot weather, the contractor may be required to chill the mixing water, incorporate ice into the concrete mixture as part of the mixing water to maintain concrete temperatures below the specified maximum temperatures. In addition, any combination of wind velocity, high air temperatures and low relative humidity, which, in the opinion of the Engineer, will impair the quality of fresh or hardened concrete due to rapid concrete moisture evaporation shall be sufficient cause to discontinue or prohibit concrete placement. The ACI Recommended Practice for Hot Weather Concreting will be used as a guide in assessing the hazards of hot weather.

No concrete shall be used which does not reach its final position in forms within the time stipulated in Paragraph 108, Material Details.

Surfaces other than foundations on which concrete is to be placed shall be thoroughly cleaned and wetted immediately before placing concrete in order to facilitate bonding.

Placing of concrete shall be so regulated that the pressures caused by the wet concrete shall not exceed those used in the design of the forms.

The external surface of all concrete shall be thoroughly worked during the placing by means of tools of an approved type. During the placing of concrete, care shall be taken that the methods of compaction used will result in a surface of even texture free from voids, water, or air pockets, and that the coarse aggregate is forced away from

the forms in order to leave a mortar surface.

Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement. Concrete may be placed with the aid of buckets, chutes, troughs, pipes or conveyors. Open troughs or chutes shall be metal or metal lined and extend as nearly as possible to the point of deposit. Aluminum will not be permitted as the contact surface for concrete placed through any conveyance.

Chutes on steep slopes shall be equipped with baffle boards or be in short lengths that reverse the direction of concrete movement. Chutes shall not slope greater than 1 to 2 or less than 1 to 3 (vertical to horizontal). Concrete placed with chutes over 25 feet long or not meeting these slope standards shall discharge into a hopper before distribution unless otherwise directed.

All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the structure.

Dropping the concrete a distance of more than 5 feet or depositing a large quantity at any point and running or working it along the forms will not be permitted, except that the 5 foot limitation will not apply to the dropping of concrete into the forms for the walls of box culverts, or retaining walls unless directed by the Engineer.

Care shall be taken to fill each part of the form by depositing the concrete as near its final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the projecting reinforcement or other items embedded in the concrete, except where unavoidable on structures being widened under traffic.

Concrete shall be laced in continuous horizontal layers, the thickness of which generally shall not exceed 10" to 12". However, slabs shall be laced in a single layer. When it is necessary in an emergency to place less than a complete horizontal layer in one operation, such layer shall terminate in a vertical bulkhead. In any given layer, the separate batches shall follow each other so closely that each one shall be placed and consolidated before the preceding one has taken initial set in order that the fresh concrete shall not be injured and there shall be no lines of separation between the batches. Each layer of concrete shall generally be left somewhat rough to secure efficient bonding with the next layer above. A succeeding layer placed before the underlying layer has become set shall be consolidated in a manner that will entirely break up and obliterate the tendency to produce a construction joint between layers.

Layers completing a day's work or placed prior to temporarily discontinuing operations shall be cleaned of all laitance and other objectional material as soon as the surface has become sufficiently firm to retain its form. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be finished being smoothed with a trowel.

Horizontal layers so located as to produce a construction joint at a location wherein a feather edge might be produced in the succeeding layer shall be so formed by inset formwork that the succeeding layer will end in a body of concrete having a thickness of not less than 6".

In no case shall the work on any section or layer be stopped to temporarily discontinued within 18" below the top of any face, unless the details of the work provide for a coping having a thickness of less than 18" in which case at the option of the Engineer, the construction joint may be made at the underside of the coping.

Care shall be exercised during the placement of concrete to minimize the coating of reinforcing steel, structural steel, forms, and other items which extend into areas involved in a subsequent placement. In the event coating of the steel does occur, no attempt shall be made to remove the mortar until after the concrete steel bond of the earlier placement has developed sufficiently to withstand a cleaning operation. Any coating of mortar on deformed bars which cannot be removed by hand brushing with a wire bristle brush, or by a light chipping action, will not have to be removed.

The method and manner of placing concrete shall be so regulated as to place all construction joints across regions of low shearing stress and in such locations as will be hidden from view to the greatest possible extent.

The operations of depositing and consolidating the concrete shall, in general, be conducted so as to form a compact, dense, impervious mass of uniform texture which will show smooth faces on exposed surfaces. Any section of concrete found to be defective shall be removed or repaired as directed by the Engineer.

If concrete operations are permitted to extend into the night, the work shall be brightly lighted so that all operations are plainly visible.

11.21A PUMPING CONCRETE

Placement of concrete by pumping will be permitted only when approved by the Engineer. However, prior to starting the pumping operation, the contractor shall get a method approved by the Engineer for maintaining continuous placement of concrete in case of breakdown of the pumping operation. Pumping equipment shall be suitable and adequate in capacity for the work, and shall be located so that no vibrations result

which might damage the freshly placed concrete. Pumping equipment, including the conduit system shall not contain any aluminum or aluminum alloy in contact with the concrete. The conduit system shall consist of 5" I.D. minimum diameter rigid or flexible pipe.

Grout used to lubricate the inner surfaces of the conduit system shall be wasted. Operation of the pump shall be such that a continuous stream of concrete without air pockets is delivered. When pumping is completed, any concrete remaining in the pipeline which is to be used in the work shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

Samples of concrete to be used for test purposes shall be taken from the discharge end of the conduit system.

11.22 CONSOLIDATION OF CONCRETE BY VIBRATION

Concrete, except that placed under water, and/or as otherwise approved, shall be compacted during and immediately after depositing by means of approved mechanical vibrating equipment.

Internal mechanical vibrators shall be of sturdy construction, with a cutoff switch at the vibrator, adequately powered and capable of transmitting vibrations to the concrete in frequencies of not less than 5,000 impulses per minute and shall produce a vibration of sufficient intensity and amplitude to cause settlement of the concrete into place without a separation of the aggregates.

In using internal vibrators, the vibratory element shall be inserted into the concrete at the point of deposit and in the areas of freshly-placed concrete. The time of vibration shall be long enough to accomplish thorough consolidation of the concrete and complete embedment of the reinforcement, to produce smooth surfaces free from honeycombing and air bubbles, and to work the concrete into all angled and corners of the forms. However, over-vibration shall be avoided. Vibration shall continue in a spot only until the concrete has become plastic and shall not continue to the extent that pools of grout are formed. The correct length of time of vibration will depend upon the frequency of the vibration impulses per minutes, the size of vibrators and the slump of the concrete.

Internal vibrators shall be applied at points uniformly spaced, not farther apart than the radius over which the vibration is visibly effective and shall be applied close enough to the forms to effectively vibrate the surface concrete. The vibration shall not be dissipated in lateral motion but shall be concentrated in vertical settlement in consolidating the concrete.

The vibrating element shall be inserted in the concrete mass a sufficient depth to vibrate the bottom of each layer effectively and in as nearly a vertical position as practicable. It shall be withdrawn completely from the concrete before being advanced to the next point of application.

To secure even and dense surfaces free from aggregate pockets or honeycomb, vibration shall be supplemented by working or spading by hand in the corners or angles of the forms and along form surfaces while the concrete is plastic under the vibratory action.

A sufficient number of vibrators shall be employed so that at the required rate of placement thorough consolidation is secured throughout the entire volume of each layer of concrete. Extra vibrators shall be on hand for emergency use and for use when other vibrators are being serviced.

The use of surface vibrators to supplement internal vibration will be permitted only when satisfactory surfaces cannot be obtained by internal vibration alone, and only upon approval. Surface vibrators shall be applied only long enough to embed the coarse aggregate and to bring enough mortar to the surface for satisfactory finishing.

The use of approved form vibrators will be permitted only when it is impossible to use internal or surface vibrators. When permitted, they shall be attached to or held on the forms in such manner as to effectively transmit the vibration to the concrete and so that the principal paths or motion of the vibration are in a horizontal plane.

It is intended that the operation of compacting the concrete shall produce a compact, dense, impervious mass, which shall show a smooth face on exposed surfaces. Porous, plastered, or defective concrete shall be removed and replaced at the contractor's expense.

11.23 DEPOSITING CONCRETE IN WATER

No concrete shall be deposited in water unless shown on the plans or called for by special provisions without approval.

11.24 CONSTRUCTION JOINTS

Construction joints shall be made only where located on the plans or shown in the placing schedule, unless otherwise approved by the Engineer.

If not detailed on the plans, or in the case of emergency, construction joints shall be placed as directed by the Engineer. Shear keys or inclined reinforcement shall be used where necessary to transmit shear or bond the two sections together. Joints shall be

so constructed that featheredging does not occur.

For construction joints in deck slabs, a 2" by 1 1/2" shear key shall be provided between the mats of reinforcing steel.

In construction joints exposed to view or in other construction joints where seepage of water is particularly objectionable, or where specified on the plans, an approved waterstop shall be inserted. The waterstop shall be placed not less than 3" from the face of the concrete and shall extend into each section of the concrete a distance of not less than 2" or as specified on the plans.

When longitudinal joints are specified or permitted, they shall be spaced so that each placement of concrete will be not less than 10' in width. Transverse joints shall be placed at the centerlines of piers or as specified on the plans. Concrete shall be placed in one continuous operation between construction joints. The minimum volume of concrete in any one placement shall be not less than the volume of concrete in one end span. The falsework under all spans from edge to edge of slab or from edge of the slab to an open joint shall remain in place until the concrete in the entire slab has attained the minimum 28-day design compressive strength required for the mix.

11.24A BONDING CONSTRUCTION JOINTS

If joining fresh concrete to concrete that has already set, the work already in place shall have its surface roughened thoroughly with a suitable tool and all shavings, sawdust or other loose and foreign material shall be removed. The surface shall be washed and scrubbed with wire brooms when necessary to remove substances that will interfere with bond. The concrete of the preceding placement shall be thoroughly wetted prior to the placement of the next unit of fresh concrete.

For construction joints in deck slabs, the vertical face shall be epoxy coated prior to placement of adjoining concrete with Epoxy Bonding Compound.

In order to bond successive course, suitable keys shall be formed at the top of the upper layer of each day's work and at other levels where work is interrupted. These keys shall be formed by the insertion and subsequent removal of beveled wood strips which shall be saturated thoroughly with water to induce swell prior to insertion in the fresh concrete. Rough stone or steel dowels may, at the discretion of the Engineer, be used in lieu of keys. Dowels shall extend an equal distance on each side of the construction joint. Prior to inserting or driving of dowels into predrilled or preformed holes, the holes shall be filled with Portland cement grout in the proportion of one part of cement to 2 parts of sand. The size and spacing of keys and dowels shall be determined by the Engineer.

11.25 CURING

All exposed surfaces shall be cured by one of the methods outlined in Item 9 except as follows:

Roadway surfaces of bridge decks or other structures shall be spray cured first by membrane curing compounds applied as soon as possible after the concrete is placed, and shall also be covered within 24 hours with waterproof covers as set forth in Item 9. The waterproof covers shall remain in place for not less than 7 days. Extreme care shall be taken to protect adjacent reinforcing steel from the membrane curing compounds.

11.26

**REMOVAL OF FORMS, FALSEWORK CENTERING, SETTING OF FORMS
AND PLACING OF CONCRETE FOR SUPERIMPOSED ELEMENTS, ETC.**

The minimum period during which forms and supports for concrete structures must remain in place are listed in Table 11.A and are defined either by the "Time" or the "Cylinder Strength" requirements.

TABLE 11.A

Structural Element	Removal of Formwork		Setting Forms for Superimposed Elements		Placing Concrete in Superimposed Elements	
	Time, Days	Strength, % of C*	Time, Days	Strength, % of C*	Time, Days	Strength, % of C*
Arch (Centering)	14	85	18	90	21	95
T-beam (Centering) Girders, Etc.	14	85	18	90	21	95
T-Beam (Side Forms)	2	30	--	--	--	--
Deck Slab	7	60	10	70	14	85
Wall Carrying Load **	7	60	10	70	14	85
Column Carrying Load **	7	60	10	70	14	85
Footing	None	--	3	40	5	50
Pier or Abutment Cap	7	60	10	70	14	85
Carrying Load	2	30	--	--	--	--

* Design minimum compressive strength specified.

** The "load" referred to is the immediate load which will be transmitted to the structural element as a result of the removal of falsework, etc., not the load which will eventually be placed on the structural element.

Vertical surface forms for beams, walls and other members not subject to direct stress

may be removed after a minimum period of twelve (12) hours, provided that the concrete has sufficiently hardened to preclude surface damage resulting from form removal. During cold weather, (less than 40°) these forms shall remain in place for five (5) days. Upon removal of forms, all surface cavity repairs, as well as the finishing and curing of the exposed areas shall begin immediately.

Except during cold weather, the forms for rubbed surfaces shall be removed prior to 48 hours after placing of the concrete.

In the determination of "Time" requirements for the removal of forms and the construction of superimposed elements, consideration shall be given to the location and character, the weather and other conditions influencing the setting of the concrete and the material used in the mix. The use of retarders or special cements requires special attention.

The attained strengths of concrete listed in Table 11.A., shall provide a guide, when and where field operations are controlled by the "Cylinder Strength and approved by the Engineer. The Contractor shall give notice to the Engineer in writing, forty eight (48) hours prior to pouring of any concrete, that all construction procedure control for the form removal operations will depend on the "Cylinder Strength" reaching the values indicated. However, the cylinders shall be cured under conditions which are not more favorable than the most unfavorable conditions for the portions of the concrete which the cylinders represent.

In field operations not controlled by the "Cylinder Strength" the "Time" requirements given in Table 11.A. for the removal of forms and the construction of superimposed structural elements are exclusive of days when the temperature is less than 40 degrees F in the shade. The "Time" required to remove forms and all subsequent operations during cold weather curing shall be lengthened as directed by the Engineer.

These "Strength and Time" requirements as listed are intended only for the construction operations indicated and shall not apply to the use of equipment or other live loads on the structure. Stockpiling of material and the use of unauthorized equipment on the structure will not be permitted.

The exception are power-operated concrete buggies, which may be permitted to cross a load-bearing bridge or culvert slab or any other structure 5 days after concrete has been placed, provided the concrete has attained the minimum strengths as listed in Table 11.A.

Truck mixers, dump trucks, cranes, and other heavy construction equipment will not be permitted to cross or to be parked on a completed structure, nor will the structure be opened to construction or public traffic until so authorized by the Engineer. The

"Cylinder Strength" must have attained full design compressive strength (f_j') before this authorization will be given. The earliest time at which such an authorization may be given to utilize a structure fully is fourteen (14) days after the last concrete has been placed.

The backfilling behind abutment backwalls, retaining walls, at box culverts and arches may begin 10 days after completion of concrete placement. However, this operation should not be permitted until the compressive strength f_j' to be specified on plans or in special provisions, is reached or until the "Cylinder Strength" requirement is fulfilled and verified by the Engineer. In the case where field operations depend on the "Cylinder Strength" requirement, the minimum compressive strength shall be not less than $(.85 f_j')$ when backfilling operations commence.

Methods of form removal likely to cause overstressing of the concrete shall not be used. Forms and their supports shall not be removed without the approval of the Engineer.

Supports shall be removed in such a manner as to permit the concrete to take, uniformly and gradually, the stresses due to its own weight.

Forms for columns shall be removed before shores are taken from beneath the beams or girder, in order to determine the condition of column concrete.

Falsework under all spans shall be completely released before forms are constructed and concrete is placed in railings or rail bases.

Forms for pipe and walls may be removed after the concrete has been in place for a period of twenty-four (24) hours, unless it is necessary to protect the concrete against cold weather, in which case, either the forms remain in place for the entire protection period or an alternate procedure will be approved by the Engineer.

Forms for footings constructed within cofferdams or cribs may be left in place, when, in the opinion of the Engineer, their removal would endanger the safety of the cofferdam or crib, and when the forms so left intact will not be exposed to view in the finished structure.

The forms supporting the roadway slab of box girder type structures shall be supported on wales or similar supports fastened, as nearly as possible, to the top of web walls, and may be left in place. The forms supporting the roadway slab shall not be shored to or supported on the bottom slab.

All other forms shall be removed whether above or below the ground line or water level.

When and where inside forms of hollow piers, box girders, abutments, etc. have to be removed, necessary openings shall be provided for that purpose.

The forms for concrete exposed to sea water or to alkaline water or soil shall be left in place thirty (30) days.

Centers of arches shall be gradually and uniformly lowered in such a manner as to avoid injurious stresses in any part of the structure. In arch structures of two or more spans, the sequence of striking centers shall be specified or approved by the Engineer.

For filled spandrel arches, such portions of the spandrel walls shall be left for construction subsequent to the strikings of centers, as may be necessary to avoid jamming of the expansion joints.

As soon as the forms are removed, all projecting wires or other metal devices used for holding the forms in place, and which pass through the body of the concrete, shall be cut at least 1 1/2" beneath the surface of the concrete, and the holes, and depressions thus made, and all other holes, depressions, and small voids, which show upon the removal of the forms, shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the work.

The work shall be so planned and executed that form removal and specified finishing is performed within the required limits; otherwise, subsequent placement of concrete in other parts of the structure or structures shall be ordered stopped.

11.27 FINISHING CONCRETE SURFACES

All concrete surfaces shall be true, even, and free from open or rough places, depressions, or projections. The concrete in all bridge seats, parapets, sidewalks, curbs, railing, and walls shall be brought flush with the finished top surface and shall be struck off with a template and floated to a finish free from irregularities and true to line and grade. All masonry bearing areas shall be placed to the final elevation called for.

They may be bush-hammered down to within 1/4" of the final elevation and ground with an approved device to a smooth level true plain surface which must be within 1/8" of the prescribed bearing elevation. The concrete in the bearing area shall be poured high enough so that no part of the bearing area, after bush-hammering, will be lower than the surrounding bridge seating surface.

Unless otherwise specified on the plans only the roadway side surfaces of curbs, parapets and barrier rails shall be given a rubbed finish. All other surfaces shall be

given an ordinary surface finish unless after form removal they are in such a condition that they cannot be repaired to the satisfaction of the Engineer. In these cases, the entire structural unit shall be given a rubbed finish.

Portland cement concrete for deck slabs on bridges or structures shall be finished in accordance with Item 9 except as herein altered:

Unless otherwise specifically approved, the screeding shall be done with motorized mechanical equipment. The screed must be long enough and shall satisfactorily operate from two end supports only to produce the desired concrete surface plane from gutter line to construction joint or from gutter to gutter, whichever is applicable and it shall be adjustable so that the desired plane can be maintained. The proposed supporting longitudinal screed templates shall be approved prior to use and shall be designed to give unyielding support to the screed which is selected and approved. The screeding operation, in general, will progress up grade and the screed will be normal or radial to the center line of the roadway, unless longitudinal screeding is being performed.

In the finishing operation workmen will not be permitted to walk in the wet concrete and walk bridges must be provided as necessary.

A sufficient number of concrete finishers thoroughly experienced in finishing of bridge decks shall be employed for this work.

Finishing of the concrete for the roadway slab shall be in accordance with Item 9 but the scraping straight edge operation and the checking straight edge operation therein described, shall be performed also in transverse position covering the entire area and width, in order to produce the desired cross slope and plan as indicated on the plans. All straight edging operations, both longitudinal and transverse, shall begin and finish by checking with one half the 10' length of the tool on all adjacent surfaces, including steel expansion joints, bulkheads and previously placed slabs. The exception to this method of adjacent checking shall be at down-spout intakes and certain longitudinal parallel slabs, which are not intended to produce a straight slope to each other, or as otherwise determined. At longitudinal construction joints the edge of the one slab shall not be finished above or below the other edge, and shall be checked for proof using a short straight tool placed across the joints.

Edging shall be done, by approved edging tools, when shown on the plans or as directed.

Following the burlap drag, the deck surfaces shall be given a final finish by pulling a lightweight bristle broom gently and squarely across the width of the slab, normal or

radial to the center line of roadway, with not more than one stroke per width of broom, to remove laitance and other surface blemishes and to produce uniform corrugations not more than 1/8" deep.

When finishing has been completed and the concrete has hardened, the surface will be tested and corrected if necessary in accordance with Subsection 9.25.

Safety curbs, or sidewalks on bridges, or other structures shall be finished and cured in accordance with Item 9.

11.28 ORDINARY SURFACE FINISH

Immediately following the removal of forms, all fins and irregular projections shall be removed from surfaces. On all surfaces the cavities produced by form ties and all other holes, honeycombs, spots, broken corners or edges, and other defects, shall be thoroughly cleaned and shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the concrete being finished. Mortar used in pointing shall be not more than 1 hour old. The mortar patches shall be cured as specified under Subsection 11.25, Curing. All construction and expansion joints in the completed work shall be left carefully tooled and free to all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

The resulting surfaces shall be true and uniform. All surfaces which cannot be repaired to the satisfaction of the Engineer shall be given a rubbed finish.

11.29 RUBBED SURFACE FINISH

As soon as the mortar used for the pointing and other repairs to the surface defects, as noted under Ordinary Surface Finish, has set sufficiently, the entire surface shall be thoroughly wetted and rubbed with a No. 16 carborundum stone, or an abrasive of equal quality bringing the surface to a paste. The rubbing shall be continued sufficiently to removal all form marks and projections, producing a smooth, dense surface without its or irregularities. The paste produced by this rubbing will appear as swirls, is not to be brushed or wiped out, but shall be left in place at this time and allowed to reset.

The first rubbing operation, as just described, shall be completed within 12 hours of the time that the forms are first removed and the concrete exposed to air. Curing shall continue as described in Subsection 11.25.

After all concrete in a structure, or in a complete unit of a structure, has been cast and rubbed as specified above, the final finish shall be obtained by wetting and

thoroughly rubbing with a No. 30 carborundum stone or an abrasive of equal quality. This rubbing shall continue until the entire surface is of a smooth texture and of uniform color.

11.30 TOOLED FINISH

A tooled finish shall be made on the surfaces previously spaded by cutting into the body of the concrete with a pointing tool or bush-hammer as indicated on the plans.

11.31 EXPANSION JOINTS

Expansion joints shall be provided as shown on the plans. They shall be made by building keyed faces and are to be covered with bituminous expansion felt or other approved material to prevent leakage and the adhesion of the concrete faces. Roofing paper will not be considered as expansion material.

11.32 DRAINAGE AND WEEP HOLES

Drainage openings and weep holes shall be constructed in the manner and at locations indicated on the plans, or as directed and no additional payment will be made for such work. No deductions in the computed yardage of concrete masonry, except for openings in pipe headwalls, will be made.

At the intake end of each weep hole a minimum of 2.5 cubic feet of coarse aggregate, size No. 3, Paragraph 110, Material Details shall be placed immediately around the end of the pipe.

11.33 PLACING PIPE AND CONDUITS

Pipes and conduits which are to be encased in the concrete, as shown on the plans, shall be placed by the contractor during construction. Such pipes and conduits shall be furnished and placed by the contractor unless otherwise stated on the plans. No compensation will be made for placing such pipes, conduits, etc., except that no deduction will be made for the volume occupied by the same.

11.34 PLACING ANCHORS, BOLTS, GRILLS, ETC.

Anchors, bolts, grills, etc. which are to be placed in the concrete as indicated on the plans, shall be furnished and placed by the contractor during construction. No compensation will be made for furnishing such anchors, bolts, grills, etc., except no deduction will be made for the volume of concrete occupied by any of the materials specified above.

11.35 PROTECTIVE COATING FOR PORTLAND CEMENT CONCRETE MASONRY

The work to be performed under this section includes, but is not limited to the furnishing of all materials, labor, tools, equipment, and incidentals required for the application of a protective coating to the exposed surfaces of the Portland cement concrete roadway, curbs, gutters, sidewalks, crossable median; and to the structure slabs, curbs, sidewalks, and horizontal surfaces of abutments and piers or as ordered by the Engineer.

The contractor shall note that 3 types of thinners are specified herein; kerosene, spirits of turpentine, and petroleum spirits. The contractor shall have the option of furnishing any of the above types of thinners, but only 1 type of thinner. Where Portland cement concrete is to receive protective coating, membrane curing shall not be used.

MATERIALS

1. The protective coating shall be composed of a mixture of 50% boiled linseed oil and 50% thinner by volume.
2. The boiled linseed oil shall conform to the requirements of ASTM D 260.
3. The thinners shall conform to the following requirements:

Kerosene-Federal Specification VV-K-211

Spirits of Turpentine-ASTM D 13

Petroleum Spirits-ASTM D 235 (Mineral Spirits)

CONSTRUCTION METHODS

All surfaces shall be clean, reasonably dry, and free of deicers at the time the protective coating is applied. A pavement and/or bridge deck temperature of 40° F or above, unless otherwise directed, is required in order to obtain proper penetration and drying.

Concrete surfaces shall be treated before being exposed to deicers, but if this is not possible, due to the lateness of the season, and other unavoidable circumstances, the deicers shall be removed, either by natural rainfall or by artificial flushing before application of the protective coating.

The protective coating shall be applied as a 50-50 mixture by volume of boiled linseed oil and a thinner (mineral spirits, kerosene, or turpentine) in two applications; the first

application at the rate of 1 gallon of the mixture per 40 s.y., and the second at the rate of 1 gallon of the mixture per 67 s.y. The thoroughly mixed linseed oil and thinner shall be applied by an approved distributor. An asphalt distributor may be used but must be cleaned and approved before use. The application of the second coat shall be delayed until after the first coat has been completely absorbed and the concrete has regained its dry appearance. If on inspection it is found that the oil applied at the rate designated above is not sufficiently absorbed after 3 or 4 hours to permit opening to traffic, the rate shall be decreased accordingly. On the other hand, if the adsorptiveness of the concrete is such that the second coat is absorbed rapidly, greater protection shall be afforded by using more mixture.

In the case of curbs, sidewalks and inside faces of bridge parapets, application may be made by means of medium pressure hydraulic spray equipment or by hand-operated single spray pressure equipment subject to the Engineer's approval.

11.36 BACKFILL

All spaces which have been excavated, the volume of which is not occupied by the concrete structure, shall be backfilled with approved material placed and compacted in accordance with Item 4.

Backfill shall not be made against a concrete structure until the concrete has been in place 14 days, unless otherwise directed in writing.

11.37 DEFECTIVE WORK

Any defective work discovered after the forms have been removed shall be immediately removed and replaced. If the surface of the concrete is bulged or uneven, or shows honeycombing, which cannot be repaired satisfactorily, the entire section shall be removed and replaced. No compensation will be allowed for this work.

11.38 METHOD OF MEASUREMENT

The number of cubic yards or square yards of Portland Cement Concrete Masonry to be paid for under this section is the number of cubic yards or square yards of concrete complete in place and accepted.

11.39 BASIS OF PAYMENT

The yardage of Portland Cement Concrete Masonry measured as described above shall be paid for at the contract unit price bid per cubic yard or square yard for Item 11, Portland Cement Concrete Masonry, which price and payment shall be full

compensation for furnishing all materials, forms, falsework, cold weather protection, protective coating, and for all equipment, tools, labor and incidentals necessary to complete the work.

ITEM 12

SUPERFICIAL WATERPROOFING

12.01 DESCRIPTION

Superficial Waterproofing shall consist of furnishing and placing of waterproofing materials consisting of an asphaltic or tar primer followed by a second coat of asphaltic or tar seal on all concrete surfaces above the top of footings of headwalls, walls, wings, and decks which will be in contact with when all construction is complete and all embankment fill is in place or on other surfaces as may be directed.

12.02 MATERIALS

The bituminous material for both primer and seal shall conform with the requirements of Paragraph 112, Material Details, of these Specifications. All waterproofing materials shall be tested before shipment. All materials shall be delivered on the project in the original containers plainly marked with the manufacturer's brand and label.

CONSTRUCTION METHODS

12.03 CONDITIONS FOR APPLICATION

Waterproofing shall not be applied in wet weather, or when the air temperature is below 35° F, without permission. Surfaces to be waterproofed shall be dry and clean.

12.04 APPLICATION

Both asphalt and tar to be used as waterproofing may be applied cold; however, the amount of bitumen for each coat shall be not less than 4-1/2 gallons for each 100 square feet of surface. Should it be necessary to heat any application, the bitumen shall be stirred frequently while being heated. Asphalt shall not be heated over 350° F, and tars over 250° F.

Each coat shall be applied uniformly and in such a manner that it will completely cover all pores and thoroughly bond with the wall surface. Application of prime coat shall not commence until the work specified in Item II is approved.

12.05 METHOD OF MEASUREMENT

The yardage of Superficial Waterproofing to be paid for under this Section shall be the number of square yards measured on the surface of the concrete, complete in place according to the requirements of these specifications and as shown on the plans.

12.06 BASIS OF PAYMENT

The number of square yards of Superficial Waterproofing, measured as provided above shall be paid for at the contract unit price per square yard bid for Item 12, Superficial Waterproofing, which price and payment shall be full compensation for waterproofing complete in place and shall include all materials, tools, equipment, and labor necessary to complete the work.

ITEM 12A

MEMBRANE WATERPROOFING

12A.01 DESCRIPTION

Membrane Waterproofing shall consist of the furnishing of all materials and the application of membrane waterproofing to all contraction and construction joints in concrete structures below grade, and as shown on the plans and as specified herein.

12A.02 MATERIALS

This section shall consist of membrane waterproofing conforming to the requirements of Item 12.

Fabric for membrane waterproofing shall conform to the requirements of AASHTO M 117 for either asphalt or tar depending upon the material selected for use in the membrane system.

12A.03 CONSTRUCTION METHODS

The concrete surfaces to be waterproofed shall be cleaned of all dust loose dirt and foreign materials. concrete surfaces shall be dry before any waterproofing material is applied. When necessary, the surface may be ordered scrubbed with water and a stiff brush, after which the surface shall be allowed to dry before application of the primer.

The surfaces shall be brushed or spray painted with 1 coat of primer material, applied at a rate of not less than 1/8 gallon per square yard. Primer shall not be heated. The prime coat shall be applied approximately 24 hours prior to the application of any mop coats, and shall be allowed to become thoroughly dry before the first mopping is applied.

Mop coat material shall be heated to a temperature between 300° F and 350° F, for tar with frequent stirring to avoid local overheating. Heating kettles shall be equipped with thermometers.

Waterproofing shall begin at the low point of the surface in all cases so that water will run over, and not against or along laps in the finished work. The completed waterproofing shall be a firmly bonded membrane composed at all points of 2 plies of fabric and 3 mop coats of waterproofing material.

Mop coats on concrete shall cover the surface so that no grey spots appear, and on fabric shall be sufficiently heavy to cover the weave of the fabric. On horizontal surfaces, not less than 12 gallons of tar or asphalt shall be used for each 100 square feet of finished work, and on vertical surfaces not less than 15 gallons shall be used per 100 square feet of finished work.

Special care shall be taken to see that all edges and laps are thoroughly sealed down. The work shall be so regulated that at the end of a day's work, all fabric that is laid shall have received the final mop coat.

Care shall be taken to prevent injury to the finished membrane during subsequent work and placement of backfill. Any damage which may occur shall be repaired by patching. Patches shall extend at least 12" beyond the outermost damaged portion and successive plies shall overlap the previously placed plies by at least 3".

No waterproofing shall be done when the atmospheric temperature is 35° F or lower.

12A.04 METHOD OF MEASUREMENT

The yardage of Membrane Waterproofing to be paid for under this section shall be the number of square yards of Membrane Waterproofing measured on the surface of the concrete, complete in place according to the requirements of these specifications, and as shown on the plans.

12A.05 BASIS OF PAYMENT

The number of square yards of Membrane Waterproofing measured as provided above shall be paid for at the contract unit price per square yard bid for Item 12A, Membrane Waterproofing, which price and payment shall be full compensation for waterproofing complete in place and shall include all materials, tools, equipment, and labor necessary to complete the work.

ITEM 13

BAR REINFORCEMENT

13.01 DESCRIPTION

Bar reinforcement shall consist of furnishing and placing in concrete, reinforcement steel of the quality, type, size, and quantity designated, as required by these specifications and as shown on the plans.

13.02 MATERIALS

Reinforcement bars shall meet the requirements for Deformed Billet-Steel Bars for Concrete Reinforcement, AASHTO M 31, Grade 40 or Grade 60, as specified on the plans.

13.03 STORAGE

When stored at the project site, reinforcement steel shall be placed on wooden platforms or other hard and clean surfaces and not on the earth and shall be placed under cover as directed or approved by the Engineer.

13.04 PLACING

When placed, all reinforcement steel shall be free from dirt, oil, paint, grease, mill scale, loose or thick rust. When bending is required, it shall be accurately done without the use of heat, and bars having cracks or splits at the bends shall be rejected. All reinforcement steel shall be placed in the exact position shown on the plans and shall be so securely held in position by wiring and blocking from the forms and by wiring together at intersections that it will not be displaced during the placing and compacting of the concrete. Bars shall be tied at all intersections except where spacing is less than 1' in each direction, in which case alternate intersections shall be tied. Welding of reinforcement steel shall be done only if detailed on the plans, the approved working drawings, or if authorized in writing. Welding shall conform to the current specifications for Welded Highway and Railway Bridges of the American Welding Society, and welds produced shall be of the required size and length, and this workmanship shall be such that no burning or reduction of section of the reinforcement occurs and all welds shall be approved by the Engineer as to methods and results. Precast concrete blocks for holding reinforcement from contact with the forms shall be used where applicable. The use of pebbles, brick, broken stone, metal

and wooden blocks, for blocking or other unapproved material is prohibited.

13.05 WORKING DRAWINGS

The Contractor shall furnish complete detail working drawings, bar lists, and bending diagrams for all reinforcement steel he proposes to furnish. It shall be the Contractor's responsibility to check all bar lists and details shown on the plans for accuracy as to the number, size, length, and dimensions before ordering bars from these lists. Working drawings shall be submitted in triplicate for checking, after which 1 print will be returned to the Contractor with approval or corrections noted. All drawings not fully approved shall be corrected by the Contractor and resubmitted until final approval is given.

13.06 SPLICING REINFORCEMENT

No splices of reinforcement shall be made except as shown on the design drawings, or as authorized by the Engineer. Except as provided herein, all welding shall conform to Structural Welding Code, Reinforcing Steel, AWS D1.4 of the American Welding Society.

Lapped splices in reinforcement in which the critical design stress is tensile shall not be used for bar sizes larger than No. 11.

Tensile reinforcing shall not be spliced at points of maximum stress. The length of lap for deformed bars shall not be less than 24 and 30 bar diameters for specified yield strengths of 40,000 and 50,000 psi, respectively, nor less than 12". For plain bars the minimum length of lap shall be twice that for deformed bars.

Where lapped splices are used in reinforcement in which the critical design stress is compressive, the minimum amount of lap shall be: with concrete having a strength of 3000 or more, the length of lap for deformed bars shall be 20 bar diameters for specified yield strengths of 50,000 psi and under, but not less than 12". For plain bars, the minimum amount of lap shall be twice that specified for deformed bars.

Welded splices or other positive connections may be used instead of lapped splices. Where the bar size exceeds No. 11, welded splices or other positive connections shall preferably be used. In bars required for compression only, the compressive stress may be transmitted by bearing of square-cut ends held in concentric contact by a suitably welded sleeve or mechanical device.

An approved welded splice is one in which the bars are butted and welded so as to develop in tension at least 125% of the specified yield strength of the reinforcing bar. Approved positive connections for bars designed to carry critical tension or

compression shall be equivalent in strength to an approved welded splice.

13.07 METHOD OF MEASUREMENT

The weight of Bar Reinforcement steel to be paid for shall be the theoretical weight of the steel placed as shown on the plans and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars, as the case may be, of equal nominal size, placed as shown on the plans or approved working drawings and accepted.

For purposes of computing theoretical weight of reinforcing steel, the following table shall be used.

DEFORMED BAR DESIGNATION NUMBERS AND UNIT WEIGHTS

<u>Bar Designation</u>	<u>Unit Weight Lb. Per. Ft.</u>
3	0.376
4	0.668
5	1.043
6	1.502
7	2.044
8	2.670
9	3.400
10	4.303
11	5.313

13.08 BASIS OF PAYMENT

The weight of Bar Reinforcement, determined as provided above, shall be paid for at the contract unit price bid per pound for Item 13, Bar Reinforcement, which price and payment shall be full compensation for furnishing and placing all material, and for all labor, equipment, tools, and incidentals necessary to complete the work. No compensation will be made for the clips, wire, separators, or other materials used for fastening the reinforcement steel in place.

ITEM 14

PORTLAND CEMENT RUBBLE MASONRY

14.01 DESCRIPTION

Portland Cement Rubble Masonry shall consist of constructing Portland cement rubble masonry, composed of approved stones laid in mortar beds, in accordance with these specifications and in reasonably close conformity with the form, dimensions, and design shown on the plans or established by the Engineer.

MATERIALS

14.02 PORTLAND CEMENT

Portland cement for this section shall conform to all requirements of Paragraph 100, Material Details.

14.03 FINE AGGREGATE

Fine aggregate for use in this section shall conform with all the requirements of Paragraph 103, Material Details.

14.04 WATER

Water for use in this section shall conform with all the requirements of Paragraph 102, Material Details.

14.05 STONE

Stone for rubble masonry shall be sound and durable, properly quarried, free from rifts, seams, laminations and minerals which by weathering would cause deterioration or discoloration. All stone shall be furnished from approved quarries. The individual stones shall be satisfactory and shall be hammer dressed to give horizontal beds and joints of the thickness specified. Stones for the face of the wall, except for leveling up, shall have a thickness of not less than 4" and a width of not less than 1-1/2 times the thickness. No stone, except headers, shall have a length of less than 1-1/2 times its width.

14.06 HYDRATED LIME

Hydrated lime for use in this section shall conform with the requirements of Paragraph 101, Material Details.

CONSTRUCTION METHODS

14.07 PLACING STONE

All rubble masonry shall be constructed by experienced stone masons. Selected stone, squared and pitched to line, shall be used at all angles, and ends of walls. All stones shall be laid on horizontal beds, but no horizontal joint shall have a continuous length of more than 5'. End joints of stones shall vary from the vertical to suit the stone being used.

One-fifth of the end joints shall vary from the vertical by from 10° to 30°. The largest stones shall be selected for the bottom course and the stones shall graduate in size from the bottom to the top course of the work. All stones shall be thoroughly wetted prior to laying and shall be fully bedded in Portland cement mortar.

The interior of the walls shall be built up so that the stones of which it is composed will be bonded and so that no open spaces will be left. Horizontal joints in the face shall not exceed 3/4" in thickness and vertical joints shall not exceed 1-1/2" in width. Walls shall be provided with weep holes wherever called for on the plans, constructed in accordance with Subsection 11.32. If a stone is loosened after the mortar has set, it shall be removed, the mortar cleaned off, and the stone re-laid. Stone shall be laid so that any joint shall be broken by a minimum of 6".

14.08 MORTAR

Portland cement mortar shall be mixed in the proportion of 1 part cement to 3 parts of fine aggregate, to which shall be added hydrated lime in the amount of 10% of the total volume. The mortar shall be so placed to form a firm bond. Mortar which is not used within 30 minutes after water has been added shall be wasted. Retempering of mortar will not be permitted. The fine aggregate, cement, and lime shall first be mixed dry in an approved manner until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains such consistency as can be easily handled and spread with a trowel.

14.09 HEADERS

Headers shall be distributed uniformly through the walls of the structure so as to form at least 1/5 of the exposed faces. They shall be of such lengths as to extend through the face wall into the backing at least 12", and where a wall is less than 18" in thickness, the header shall extend entirely through from the front to the back face.

14.10 COPING AND POINTING

This class of masonry shall be finished with a top course or coping, as shown on the plans. Stone for coping shall be from 2' to 5' in length and wide enough to cover the top of the wall. Vertical joints shall be at right angles to the face and shall be true for the full width of the stones. Coping stones shall be set in full mortar beds and the vertical joints shall be completely filled with mortar.

After the stone is all laid as specified above, the face joints shall be thoroughly raked and cleaned of all mortar to a depth of 1". The joints shall then be wetted and pointed with Portland cement mortar mixed in the proportions of 1 part Portland cement to 1 part fine aggregate. No pointing shall be done in freezing weather, and any work damaged by frost shall be removed and replaced.

In hot or dry weather, the pointed masonry shall be satisfactorily protected from the sun and kept wet for a period of 3 days after completion.

No masonry shall be laid in freezing weather. No backfill shall be made prior to approval.

14.11 METHOD OF MEASUREMENT

The yardage of Portland Cement Rubble Masonry to be paid for under this section shall be the number of square yards of Portland Cement Rubble Masonry, complete in place and accepted. In computing the yardage for payment, the dimensions used shall be those shown on the plans or ordered in writing. The volume of the coping will be included in the measurements. The average height will be used in measuring the volume of the coping.

14.12 BASIS OF PAYMENT

The yardage of Portland Rubble Masonry, measured as provided above shall be paid for at the price bid per square yard for Item 14, Portland Cement Rubble Masonry, which price and payment shall be full compensation for furnishing and placing all materials, including the stone coping, curing, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 15

DRY RUBBLE MASONRY

15.01 DESCRIPTION

This item consists of dry rubble masonry composed of approved stones laid without mortar and constructed in accordance with these specifications and of the form, dimensions, and design shown on the plans, or as directed by the Engineer.

15.02 STONE

The stones shall be sound, durable, free from structural defects and shall be free from rounded or worn surfaces and clean of earth, clay or other foreign substances. Except as noted below, no stone shall be used which has a minimum thickness of less than 5", a minimum width of less than 12", or which is less than 1/2 cubic foot in volume. In the lower course of the rubble masonry wall, no stone shall be used which has a volume of less than 1 cubic foot. Small stones may be used for pinning and filling interstices in the heart of the wall.

15.03 CONSTRUCTION METHODS

All dry rubble masonry shall be constructed by experienced stone masons. The stones shall be roughly dressed on beds and joints and laid on natural beds, being well bonded and breaking joints at least 6". Walls need not be built in courses, but shall be so constructed that no part is materially in advance of the other. In all cases, the base thickness of dry walls shall be at least 1/2 the height, which shall not exceed 8'. Headers shall be distributed uniformly throughout the wall, so as to form 1/5 of the exposed faces, and shall extend through the face wall and into the backing at least 12". Where a wall is less than 18" in thickness, the headers shall either be built up so as to leave no appreciable open spaces and only sufficient spalls shall be used to wedge the larger stones in place.

Masonry of this class shall be finished with a top course consisting of roughly shaped stones not less than 6" thick, from 1-1/2' to 4' long and wide enough to cover the top of the wall carefully laid in solid beds.

15.04 METHODS OF MEASUREMENT

The yardage to be paid for under this item shall be the number of square yards of dry rubble masonry complete in place and accepted. In computing the masonry yardage for payment, the dimensions used shall be those shown on the plans, or ordered in

writing by the Engineer. The volume of the coping will be included in the measurements.

15.05 BASIS OF PAYMENT

The yardage, measured as provided above, shall be paid for at the contract unit price per square yard bid for Item 15, Dry Rubble Masonry, which price and payment shall be full compensation for furnishing and placing all materials, including the coping and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 16

BRICK MASONRY

16.01 DESCRIPTION

Brick Masonry shall consist of constructing brick masonry, composed of approved bricks laid in mortar beds, in accordance with these specifications and in reasonably close conformity with the form, dimensions and design shown on the plans or established by the Engineer.

MATERIAL

16.02 PORTLAND CEMENT

Portland cement for this section shall conform to all the requirements of Paragraph 100, Material Details.

16.03 FINE AGGREGATE

Fine aggregate for mortar shall conform to the requirements of Paragraph 103, Material Details.

16.04 WATER

Water used in mixing the mortar for brick masonry shall conform to the requirements of Paragraph 102, Material Details.

16.05 BRICK

Brick shall be new, whole brick of best quality, of uniform and dense structure, free from lumps of lime, laminations, cracks, checks, soluble salt or other defects which in any way impair their strength, durability, appearance, or usefulness for the purpose intended. All brick shall meet all requirements of AASHTO M 114 for Grade SW brick. Contractor must submit samples for approval when the masonry is exposed to general view.

16.06 MORTAR

Mortar shall be composed of 1 part Portland cement and 3 parts sand by dry loose volume, to which shall be added hydrated lime, meeting the requirements of Paragraph 101, Material Details, and not to exceed 10% of the cement by weight.

CONSTRUCTION METHODS

16.07 EXCAVATION

Excavation shall be made to the required depth when necessary, to expose the foundation on which the brick masonry is to be placed.

16.08 MIXING

For mortar, the fine aggregate, lime, and cement shall first be mixed dry in an approved manner until the mixture assumes a uniform color, after which water shall be added as the mixing continues until the mortar attains such consistency as can be easily handled and spread with a trowel. Mortar that is not used within 30 minutes after water has been added, shall be wasted. Retempering of mortar will not be permitted.

16.09 PLACING

Bricks shall be laid by means of the shove-joint method so as to thoroughly blend them into mortar. Buttered or plastered joints will not be permitted. All brick headers and stretchers shall be so arranged as to thoroughly bond the mass with alternate courses breaking joints. All joints shall be completely filled with mortar and shall be finished properly as the work progresses. Joints shall be not less than 1/4" and not more than 1/2" in thickness. No spalls or bats shall be used except for shaping irregular openings or when unavoidable to finish out a course, in which case, full bricks shall be placed at the corners; the bats being placed in the interior of the course. Competent bricklayers shall be employed on work of this class.

16.10 BACKFILLING

The excavated areas which are not occupied by the brick masonry shall be backfilled to the required elevation with suitable material which shall be tamped in layers of not more than 6", until firm and solid. No backfill shall be made prior to approval.

16.11 CLEANING

Brick masonry which is to be exposed after completion of the structure, shall be thoroughly cleaned of all mortar, scars, or spots, and shall present a surface showing the natural color of the bricks. Efflorescence may be partly removed by water, but where special treatment is necessary, the wall shall be first washed down with water, then treated with a solution of 3 parts hydrochloric acid to 100 parts of water, and finally washed thoroughly again with water.

16.12 METHOD OF MEASUREMENT

The amount of Brick Masonry to be paid for under this section shall be the lump sum bid for brick masonry as shown on the plans, complete in place and accepted.

16.13 BASIS OF PAYMENT

The lump sum bid for Brick Masonry as provided above shall be paid for at the contract lump sum price bid for Item 16, Brick Masonry, which price and payment shall be full compensation for furnishing and placing all materials, for necessary excavation, backfilling, and tamping, for the disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 17

REINFORCED CONCRETE PIPE

17.01 DESCRIPTION

Reinforced Concrete Pipe shall consist of furnishing and installing reinforced concrete pipe of the size and dimensions required in accordance with these specifications and in reasonably close conformity with the lines, grades, and at such places shown on the plans or established by the Engineer. This section also includes the construction of connections to existing catch basins, manholes, etc., as may be required to complete the work.

17.02 BASIS OF ACCEPTANCE

Reinforced concrete pipe shall meet the requirements of AASHTO M 170.

17.03 DESIGN AND CLASS

1. Standard Strength Reinforced Concrete Pipe shall meet the requirements for AASHTO M 170M for Class III pipe.
2. Extra Strength Reinforced Concrete Pipe shall meet the requirements for AASHTO M 170M, for Class IV pipe.

17.04 FINAL INSPECTION

No pipe shall be shipped from the plant to the project until the requirements of AASHTO M 170 are met. The manufacturer shall have clearly marked on the pipe the following information before inspection:

1. Pipe Class
2. Date of Manufacture
3. Name or Trade Mark of the Manufacturer
4. One end of each section of pipe with elliptical reinforcement shall be clearly marked during the process of manufacture or immediately thereafter, on the inside and the outside of the opposite walls along the minor axis of the elliptical reinforcement.

All pipe inspected and approved at the manufacturing plant shall be subject to inspection at the site of the work and no previous stamp or approval shall bar rejection if the pipe is found to be defective or damaged.

CONSTRUCTION METHODS

17.05 BEDDING OF PIPE

1. The trench in which the pipe is laid shall be excavated and backfilled in accordance with Item 4A.
2. The trench shall be excavated to the required depth and the bottom of the trench shall be shaped to provide the required class of bedding. Unless noted otherwise, all pipes shall receive a Class C bedding. Class C bedding shall consist of bedding the pipe in a trench carefully shaped to conform to the outside circumference of the pipe for a depth not less than 10% of the outside diameter of the pipe. Shaping of the bed to conform to the shape of the pipe at joints will also be required.
3. Where rock is encountered, the trench shall be excavated in the depth to the bottom of the earth cushion as shown on the plans for bedding in rock. and for a width of 12" on each side of the pipe. This depth and width shall be backfilled with approved material and thoroughly tamped.

Where pipe is not laid in a trench, a uniformly firm bed, in contact with at least 1/4 of the circumference of the pipe, shall be made.

4. The pipe shall be laid with the lowest point of the inside diameter conforming with the flow line shown on the plans.
5. All pipe shall be carefully laid with the groove ends upgrade and tongue ends fully entered into the adjoining groove and true to the lines and grades given.

17.06 JOINTS

A rubber gasket meeting the requirements of ASTM C443M shall be used to seal the joints between successive sections of pipe. The spigot and bell ends of the pipe shall be suitably designed to accommodate the rubber gasket and provide an acceptable seal.

Construction Methods for Rubber Gasket Sealer

Before laying the pipe in the trench, attach the rubber gasket to the spigot end of each pipe joint, setting it firmly against the shoulder around the entire circumference of the pipe joint. A lubricant, specified by the gasket manufacturer, may be applied to the gasket for ease of installation.

Pipe handling after the plastic gasket has been affixed shall be carefully controlled to avoid bumping the gasket and thus displacing it or covering it with dirt or other foreign material. Any gaskets so disturbed shall be removed and replaced if damaged and repositioned if displaced. Sufficient pressure shall be applied in making the joint to assure that the joint is tight.

During cold weather operations, the gasket material shall be stored at a temperature that will maintain the gasket material in a flexible state for ease of application.

Pipe lift holes shall not be permitted. Pipe placement shall be accomplished through use of slings or in a manner acceptable to the Engineer.

Any pipe which is not in true alignment, or which shows any settlement after laying, shall be taken up and relaid without extra compensation. Any cribbing or foundation treatment necessary to prevent settlement shall be placed at the contractor's expense, unless otherwise directed. Unsuitable material encountered below the flow line of the pipe shall be removed to a depth as directed. Payment for this excavation shall be as provided for under Item 4A. Excavation and Backfill for Pipe Trenches.

17.07 BACKFILL

Pipe backfill material shall meet the requirements of Borrow Type C, Subsection 5.02. If the existing material meets these requirements, it shall be used for pipe backfill.

The compaction requirements for the pipe backfill shall conform to the 2nd and 3rd paragraphs of Subsection 4A.03, except that where heavy construction equipment travels over the pipe, a cover of material shall be placed to a minimum depth of 4'.

17.08 METHOD OF MEASUREMENT

The number of feet of Reinforced Concrete Pipe to be paid for under this section shall be the number of linear feet of reinforced concrete pipe installed in place complete and accepted, measured from end to end of pipe, including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot placed shall be doubled.

17.09 BASIS OF PAYMENT

The number of linear feet of Reinforced Concrete Pipe measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 17, Reinforced Concrete Pipe, which price and payment shall constitute full compensation for all cribbing, shoring and sheeting, for furnishing, hauling, and installing pipe and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 18

POLYVINYL CHLORIDE (PVC) PLASTIC

GRAVITY STORM SEWER PIPE & FITTINGS

(Nominal Diameter 18-27 Inches)

18.01 DESCRIPTION

PVC pipe shall consist of furnishing and installing PVC pipe of nominal diameter (18-27 inch) in accordance with these specifications and within reasonably close conformity with the lines, grades, and at such places shown on the plans or established by the Engineer. This section also includes the construction of connections to existing catch basins, manholes, etc., as may be required to complete the work.

18.02 BASIS OF ACCEPTANCE

- (a) The plastics nomenclature used in the specifications is in accordance with definitions given in ASTM Nomenclature D-883 and F-412, unless other indicated.
- (b) Certification: As the basis of the acceptance of the material, the Contractor will furnish manufacturer's certificate of conformance of these specifications upon request. Other conformance certification in the form of affidavit of conformance, test results, or copies of test reports, shall be provided when requested by the Engineer.

18.03 REQUIREMENTS

- (a) **Pipe and Fittings:** The pipe shall be made of PVC plastic having a minimum cell classification of 12354-B as defined in ASTM Specification D-1784. The fittings shall be made of PVC plastic having a minimum cell classification of 12354-B as defined in ASTM Specification D-1784. Compounds that have different cell classifications because one or more properties are superior to those of the specified compounds are also acceptable. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of the specifications.

- (b) **Gaskets:** Rubber gaskets shall comply in all respects with the physical requirements specified in the non-pressure requirements in ASTM Specification F-477.
- (c) **Lubricants:** The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe.
- (d) **Workmanship:** The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties.
- (e) **Dimensions:**
 - 1. **Pipe Diameter:** The average outside diameter of the pipe shall meet the requirements given in Table I when measured in accordance with Section 18.04 (a).
 - 2. **Pipe Wall Thickness:** Pipe wall thickness shall meet the requirements of Table I when measured in accordance with Section 18.04 (a). The wall thickness of the integral bell shall be considered satisfactory if it was formed from pipe meeting the above requirements.
 - 3. **Fitting Dimensions:** Fittings such as couplings, wyes, tees, adaptors, etc. for use in laying PVC gravity sewer pipe shall have dimension as recommended by the manufacturer.

18.04 MATERIAL AND TESTING

- (a) **Conditioning:** The test shall be run at $23^{\circ} + 2^{\circ} \text{ C}$ ($73.4^{\circ} \pm 3.6^{\circ} \text{ F}$). Care should be taken to condition the specimens to the test temperature when they are taken directly from an extrusion or molding operation. In cases of disagreement, specimens shall be conditioned utilizing Procedure A of ASTM Methods D-618.
- (b) **Sampling:** The selection of the sample or samples of pipe shall be as agreed upon by the purchaser and manufacturer. In case of no prior agreement, any sample selected by the manufacturer shall be deemed adequate.

TEST METHODS

- (a) **Dimensions:** All measurements shall be made in accordance with ASTM Specification D-2122.

- (b) **Flattening:** Three specimens of pipe, 6 inches long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 minutes. Remove the load, and examine the specimens for splitting, cracking or breaking. There shall be no evidence of splitting, cracking or breaking when the pipe is tested as illustrated.
- (c) **Extrusions Quality:** This test shall be conducted in accordance with ASTM Specification D 2152. This procedure is used for determining the extrusion quality of extruded PVC plastic pipe as indicated by reaction to immersion in anhydrous acetone. It is applicable only for distinguishing between unfused and properly fused PVC. The pipe shall not disintegrate or flake when tested in accordance with this item for quality control purposes.
- (d) **Pipe Stiffness:** The pipe stiffness shall be determined at 5 percent deflection datum under ASTM Specification D 2412. Three specimens, each 6 inches long, shall be tested and the average pipe stiffness determined at 5 percent deflection in accordance with 9.1.9 of ASTM Specification D 2412. The pipe stiffness shall equal or exceed the minimum value listed in Table I.

Note: To determine pipe stiffness, the test requires the pipe to be deflected. A deflection of 5 percent has been arbitrarily selected. This deflection is not a limiting field performance requirement.

18.05 JOINTS AND INSTALLATION

- (a) **Joints:** The integral bell gasketed joint is designed so that when assembled, the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in accordance with the manufacturer's recommendations. All joints made with pipe and fittings shall conform to the non-pressure application requirements of UNI-B-1 of ASTM Specification D 3212 when laboratory tested.
- (b) **Gaskets:** All gaskets shall be molded into a circular form or extruded to the proper section and then spliced into circular form.
- (c) **Backfill Material:** Pipe backfill material shall meet the requirements of Borrow Type C, Subsection 5.02. If the existing material meets these requirements, it shall be used for pipe backfill. The compaction requirement for the pipe backfill shall conform to Section 4A.03.

TABLE I

Nominal Pipe Size (In.)	Average OD (In.)	Average OD (mm)	Tolerance On Average OD (Inches)	Minimum Wall Thickness*(in.)			Minimum Pipe Stiffness (lbs/in.-in.)
				M-1	M-2	M-3	
18"	18.700	475	±.028	.536	.520	.499	46
21"	22.047	560	±.033	.632	.613	.588	46
24"	24.803	630	±.037	.711	.689	.661	46
27"	27.956	710	±.042	.801	.777	.745	46

*Note: M-1 = 400,000 psi minimum modulus
M-2 = 440,000 psi minimum modulus
M-3 = 500,000 psi minimum modulus

18.06 METHOD OF MEASUREMENT

The number of feet of PVC pipe to be paid for under this section shall be the number of linear feet of PVC pipe installed in place completed and accepted, including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot placed shall be doubled.

18.07 BASIS OF PAYMENT

The number of linear feet of PVC pipe measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 18, PVC Pipe, which price and payment shall constitute full compensation for furnishing, hauling and installing pipe, for all cribbing, shoring and sheeting, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 19

POLYVINYL CHLORIDE (PVC) PIPE

(Nominal Diameters Smaller Than 18")

19.01 DESCRIPTION, BASIS AND ACCEPTANCE

PVC pipe shall consist of furnishing and installing PVC pipe of nominal diameter (< 18 inch) in accordance with these specifications and within reasonably close conformity with the lines, grades, and at such places shown on the plans or established by the Engineer. This section also includes the construction of connections to existing catch basins, manholes, etc., as may be required to complete the work.

19.02 METHOD OF MEASUREMENT

Polyvinyl Chloride (PVC) pipe suitable for non pressure drainage shall conform to ASTM Designation: D 3033, Type PSP or D 3034, Type PSM. the SDR number which expresses the ratio of pipe diameter to wall thickness is acceptable in SDR-35, SDR-41, and SDR-42. The pipe and fitting shall be made of PVC plastic. The two joining systems are:

1. Solvent Cement Joints: The pipe spigot wedges into the tapered socket and the surfaces fuse together.
2. Elastomeric Gasket Joints: Assembly shall be in accordance with pipe manufacturer's recommendations.

19.03 CONSTRUCTION METHODS

All pipe shall be laid in accordance with subsections 4A.02 and 4A.03.

19.04 METHOD OF MEASUREMENT

The number of feet of PVC pipe to be paid for under this section shall be the number of linear feet of PVC pipe installed in place completed and accepted.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot placed shall be doubled.

19.05**BASIS OF PAYMENT**

The number of linear feet of PVC pipe measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 19, PVC pipe, which price and payment shall constitute full compensation for furnishing, hauling, and installing pipe, for all cribbing, shoring and sheeting, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 20

REINFORCED CONCRETE ELLIPTICAL PIPE

20.01 DESCRIPTION

Reinforced Concrete Elliptical Pipe shall consist of furnishing and installing reinforced concrete elliptical pipe of the sizes and dimensions required in accordance with these specifications and in reasonably close conformity with the lines, grades and at such places shown on the plans or established by the Engineer. This section also includes the construction of connections to existing catch basins, manholes, etc., as may be required to complete the work.

Pipe designed for placement with the major axis horizontal shall be designated as Horizontal Elliptical Pipe (HE). Pipe designed for placement with the major axis vertical shall be designated as Vertical Elliptical Pipe (VE).

20.02 BASIS OF ACCEPTANCE

Reinforced Concrete Elliptical Pipe shall meet all requirements of AASHTO M 207.

20.03 DESIGN AND CLASS

1. Standard Strength Reinforcement Concrete Elliptical Pipe (HE or VE) shall meet the requirements for Class HE III Pipe, AASHTO M 207.
2. Extra Strength Reinforced Concrete Elliptical Pipe (HE or VE) shall meet the requirements for Class HE IV Pipe, AASHTO M 207.

20.04 FINAL INSPECTION

No pipe shall be shipped from the plant to the project until the requirements of AASHTO M 207 are met. The manufacturer shall have clearly marked on the pipe the following information before inspection is made:

1. Pipe Class and Type (HE or VE)
2. Date of Manufacture
3. Name or Trade Mark of the Manufacturer

All pipe inspected and approved at the manufacturing plant shall be subject to

inspection at the site of the work and no previous stamp or approval shall bar rejection of the pipe if found to be defective or damaged.

CONSTRUCTION METHODS

20.05 BEDDING OF PIPE

1. The trench in which the pipe is laid shall be excavated and backfilled in accordance with Item 4A.
2. The trench shall be excavated to the required depth and the bottom of the trench shall be shaped to provide the required class of bedding. Unless noted otherwise, all pipes shall receive a Class C bedding. Class C bedding shall consist of bedding the pipe in a trench carefully shaped to conform to the outside circumference of the pipe for a depth not less than 10% of the outside horizontal diameter of the pipe. Shaping of the bed to conform to the shape of the pipe at joints will also be required.
3. Where rock is encountered, the trench shall be excavated in depth to the bottom of the earth cushion as shown on the plans for bedding in rock, and for a width of 12" on each side of the pipe. This depth and width shall be backfilled with approved material and thoroughly tamped.
4. The pipe shall be laid with the lowest point of the inside diameter conforming to the flow line shown on the plans.
5. All pipe shall be carefully laid with the groove end up and tongue ends fully entered into the adjoining groove and true to the lines and grades given.

20.06 JOINTS

Requirements of Item 17, shall apply for this section.

20.07 BACKFILL

Materials and placement shall conform to Subsection 4A.03.

20.08 METHOD OF MEASUREMENT

The number of feet of Reinforced Concrete Elliptical Pipe to be paid for under this section shall be the number of linear feet of reinforced concrete elliptical pipe installed in place complete and accepted, measured from end to end of pipe including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot placed shall be doubled.

20.09 BASIS OF PAYMENT

The number of linear feet of Reinforced Concrete Elliptical Pipe measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 20, Reinforced Concrete Elliptical Pipe, which price and payment shall constitute full compensation for all cribbing, shoring and sheeting, for furnishing, hauling, and installing pipe and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 21

GALVANIZED CORRUGATED STEEL PIPE

21.01 DESCRIPTION

Galvanized Corrugated Steel Pipe shall consist of furnishing corrugated galvanized steel pipe conforming to these specifications, of the sizes, dimensions and gauges required on the plans, and in reasonably close conformity with the line and grades given. This section also includes the furnishing and construction of such joints and connections to existing pipes, catch basins, endwalls, etc., as may be required to complete the work as indicated on the plans, or as directed.

MATERIALS

21.02 BITUMINOUS COATING AND/OR PAVING

When bituminous coating and/or paving is called for, it shall meet the requirements of AASHTO M 190.

21.03 PIPE AND BANDS

All corrugated metal pipe shall be furnished in lengths specified on the plans. If any specified length of pipe is divided into shorter sections for convenience, approved connecting bands shall be furnished for field joints. The pipe and coupling bands shall conform to AASHTO M 36/M 36M.

Bands shall be constructed so as to lap an equal portion of each of the pipe sections to be connected. Bands shall be fastened at the ends by galvanized angles having minimum dimensions of 2" x 2" x 3/16". Other equally effective methods of fastening the bands may be used if approved.

21.04 CONSTRUCTION METHODS

All pipe shall be carefully handled during unloading and placing in position. Dragging the pipe over the ground or over timbers or planks will not be permitted. Utmost care shall be taken to prevent damage to the bituminous coating. Any exposed metal, damaged coating or paving, not exceeding 50 square inches, shall be covered with an approved bituminous material properly built up, before placing the backfill. Pipe with damaged areas exceeding 50 square inches may be rejected.

The pipe shall be bedded according to Item 17 or 20, whichever applies.

Pipes of large diameter shall be strutted if shown on the plans. The struts shall be placed before the embankment is placed and shall be removed when ordered.

Where the pipe sections are joined on the project, the ends shall be joined with a standard band, bolted firmly in place.

Any pipe which is not in true alignment or which shows any detrimental settlement after laying shall be taken up and relayed with no extra compensation.

21.05 BACKFILL

Pipe backfill material shall meet the requirements of Borrow Type C, Subsection 5.02. If the existing material meets these requirements, it shall be used for pipe backfill.

The compaction requirements for the pipe backfill shall conform to the 2nd and 3rd paragraphs of Subsection 4A.03.

Care shall be taken to avoid striking the pipe with tamping tools.

21.06 METHOD OF MEASUREMENT

The number of feet of Galvanized Corrugated Steel Pipe to be paid for under this section shall be the number of linear feet of corrugated metal pipe installed in place complete and accepted, measured from end to end of pipe including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot placed shall be doubled.

21.07 BASIS OF PAYMENT

The number of linear feet of Galvanized Corrugated Steel Pipe measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 21, Galvanized Corrugated Steel Pipe (Plain) or Galvanized Corrugated Steel Pipe, (Coated and/or Paved) which price and payment shall constitute shoring and sheeting, for coating and/or paving if required, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 21A

CORRUGATED ALUMINUM PIPE

21A.01 DESCRIPTION

Corrugated Aluminum Pipe shall consist of furnishing corrugated aluminum pipe conforming to these specifications, of the sizes and dimensions required on the plans, and installing such pipe at places designated on the plans and in reasonably close conformity with the lines and grades given. This section also includes the furnishing and construction of such joints and connections to existing pipes, catch basins, endwalls, etc., as may be required to complete the work as indicated on the plans, or as directed.

21A.02 MATERIALS

Pipe furnished under this section shall meet the requirements of AASHTO M 196/M 196M.

Bituminous coating and/or paving, when specified, shall meet the requirements of AASHTO M 190.

21A.03 CONSTRUCTION METHODS

Pipe shall be installed in accordance with Item 21.

Backfill materials and placement shall conform to Subsection 4A.03.

21A.04 METHOD OF MEASUREMENT

The number of feet of Corrugated Aluminum Pipe to be paid for under this section shall be the number of linear feet of corrugated aluminum pipe installed in place complete and accepted, measured from end to end of pipe including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of coupling bands, each actual linear foot placed shall be doubled.

21A.05 BASIS OF PAYMENT

The number of linear feet of Corrugated Aluminum Pipe measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 21A, Corrugated Aluminum Pipe, which price and payment shall constitute full compensation for

furnishing, hauling, and installing pipe, for all cribbing shoring and sheeting, for coating and paving if required, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 21B

CORRUGATED POLYETHYLENE PIPE

(Nominal Diameters 12 - 24 Inches)

21B.01 DESCRIPTION

Corrugated Polyethylene Pipe shall consist of furnishing corrugated polyethylene pipe conforming to these specifications, of the sizes, dimensions, and gauges required on the plans, and installing such pipe at locations designated on the plans, and in includes the furnishing and construction of such joints and connections existing pipes, catch basins, end walls, etc., as may be required to complete the work as indicated on the plans or as directed by the Engineer.

21B.02 MATERIALS

Corrugated Polyethylene Pipe furnished under this section shall meet the requirements of AASHTO M294. Interior wall of pipe, whether corrugated or smooth, shall be determined by the Engineer.

21B.03 COUPLINGS

Joints shall be made using split-couplings, corrugated to match the pipe corrugations, and in width shall not be less than one-half the diameter of the pipe. The couplings must be locked around the pipe joint by the use of quick ties supplied by the manufacturer. A neoprene gasket shall be utilized with the coupling to provide a more soil-tight joint.

21B.04 CONSTRUCTION METHODS

Pipe shall be utilized in accordance with Item 17. Backfilling of pipe shall conform to Subsection 4A.03.

21B.05 METHOD OF MEASUREMENT

The number of linear feet of Corrugated Polyethylene Pipe to be paid for under this section shall be the number of linear feet of Corrugated Polyethylene Pipe installed in place complete and accepted, measured from end to end of pipe including structure wall thickness, but excluding structure interior.

In measuring lengths of special manufactured connections, exclusive of couplings, each actual linear foot placed shall be doubled.

21B.06 BASIS OF PAYMENT

The number of linear feet of Corrugated Polyethylene Pipe measured, as provided above, shall be paid for at the contract unit price per linear foot bid for Item 21B, Corrugated Polyethylene Pipe, which price and payment shall constitute full compensation for furnishing, hauling and installing of pipe, for all cribbing, shoring, sheeting, and for all material, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 21C

FLARED END SECTIONS

21C.01 DESCRIPTION

Flared End Sections shall consist of furnishing and installing flared end sections for corrugated metal pipe (asphalt coated and non-coated), corrugated polyethylene pipe, corrugated aluminum pipe, or reinforced concrete pipe in conformance with the details, dimensions, and notes shown on the standard sheet and at the locations shown on the plans.

21C.02 MATERIALS

Materials shall conform to the requirements of Item 17, 20, 21, 21A, or 21B, whichever applicable.

21C.03 BASIS OF PAYMENT

The Flared End Sections shall be paid for at the contract unit price bid per each for Item 21C, Flared End Sections, complete in place, which price and payment shall constitute full compensation for furnishing, hauling, installing; for cribbing, shoring, sheeting, coating and paving, bar reinforcement and for all material, labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 21D

PERFORATED PIPE UNDERDRAINS

21D.01 DESCRIPTION

Perforated Pipe Underdrains shall consist of furnishing and placing corrugated metal pipe (S.M.P.), perforated polyvinyl chloride (P.V.C.) pipe, or perforated corrugated polyethylene tubing (C.P.T.), furnishing and placing filter fabric and DE NO. 57 stone in accordance with the locations and details shown on the plans, or as directed by the Engineer.

21D.02 MATERIALS

1. Perforated Polyvinyl Chloride (P.V.C.) pipe shall conform to the requirements of ASTM 2729.
2. Perforated Corrugated Polyethylene Tubing (C.P.T.) shall conform to the requirements of AASHTO M 252.
3. Perforated corrugated metal pipe (C.M.P.) shall meet the requirements of AASHTO M 36.
4. Filter fabric shall conform to the requirements of AASHTO M 288.
5. Stone for backfill shall conform to the requirements of DE NO. 57.

21D.02 GENERAL

The underdrain shall be constructed in accordance with the details shown on the Plans or the Standard Details and at the locations shown on the Plans. The pipe shall be placed as directed by the Engineer. Lateral connections to the pipe shall be made with connectors recommended by the manufacturer. Stone backfill shall be placed in 6 inch lifts and compacted with a vibratory plate tamp to the satisfaction of the Engineer.

21D.04 METHOD OF MEASUREMENT

The quantity of perforated pipe underdrains will be measured from end to end in linear feet of pipe completed and accepted.

21D.05**BASIS OF PAYMENT**

The quantity of perforated pipe underdrains will be paid for at the contract unit price per linear foot. Price and payment will constitute full compensation for furnishing and installing all materials, including perforated pipe, connectors, stone backfill, and filter fabric; for excavating, backfilling, compacting, and for all labor, tools, equipment, and incidentals required to complete the work.

ITEM 21E

ROOF DRAINS

21E.01 DESCRIPTION

Roof Drains shall consist of furnishing pipe for outlets, roof drains, etc., conforming with these specifications, of the material, sizes, and dimensions required on the plans, or as directed, and in reasonably close conformity with the lines and grades given. This item includes the furnishing and constructing of such connections to pipes, catch basins, endwalls, etc., as may be required to complete the work as indicated on the plans or as directed.

21E.02 MATERIALS

Polyvinyl Chloride Pipe (P.V.C.) - P.V.C. pipe shall meet the requirements of subsection 19.01 of these specifications.

21E.03 CONSTRUCTION METHODS

All pipe shall be laid in accordance with subsection 17.05 of these specifications.

21E.04 METHOD OF MEASUREMENT

The number of feet of Roof Drains to be paid for under this item shall be the number of linear feet of pipe (including specially manufactured connections), installed in place, complete and accepted, measured end to end of pipe, excluding structures

21E.05 BASIS OF PAYMENT

The number of linear feet of Roof Drains, measured as provided above, shall be paid for at the contract unit per linear foot bid for Item 21E, Roof Drains, which price and payment shall constitute full compensation for furnishing, hauling, and installing pipe; excavation and backfill of trenches, and for all materials, labor, equipment tools, and incidentals necessary to complete the work.

ITEM 22

DUCTILE IRON WATER PIPE, FITTINGS, AND APPURTENANCES

22.01 DESCRIPTION

This item consists of furnishing ductile iron pipe conforming to these specifications of the size and dimensions required on the plans and installing such pipe at the places designated on the plans, or by the Engineer, in conformity with the lines and grades given.

22.02 MATERIALS

Ductile iron pipe for use in this item, unless otherwise specified, shall be centrifugally cast in lengths not less than 12 feet nor more than 20 feet, conforming ANSI/AWWA C151/A21.51-81. Ductile iron pipe shall be cement lined in accordance with the requirements of ANSI/AWWA C104/121.4-80. A bituminous seal coating shall be applied to the interior and exterior as soon as the cement lining has sufficiently dried.

22.03 DUCTILE IRON FITTINGS

All ductile iron fittings and specials for pipe 12 inches in diameter and less shall be furnished in accordance with the requirements of ANSI/AWWA C153/A21.53-84 for compact (short body) ductile iron fittings, with a 350 p.s.i pressure rating.

All fittings and specials shall be provided with standardized mechanical joints in accordance with ANSI/AWWA C111/A21.11-80.

All fittings shall be cement lined and bituminous coated.

22.04 PIPE CLASS AND DIMENSION

The minimum class designation and wall thickness of ductile iron for each diameter of pipe shall conform to the following table:

DIAMETER OF PIPE INCHES	AWWA THICKNESS CLASS	WALL THICKNESS INCHES	OUTSIDE DIAMETER INCHES
4	52	0.29	4.80
6	52	0.31	6.90
8	52	0.33	9.05
10	52	0.35	11.10
12	52	0.37	13.20
14	52	0.39	15.30
16	52	0.40	17.40

22.05 FITTINGS, GATE VALVES, VALVE BOXES, FIRE HYDRANT AND APPURTENANCES

Fittings, gate valves, and valve boxes shall be placed along the water mains where shown on the drawings or where designated by the Engineer.

A blow-off shall be installed on all dead-end water mains. Size of the blow-off shall be determined by the Water Department.

A valve box shall be carefully placed over the bonnet of each gate valve with the top adjusted to the finished grade elevation at that location or at such other elevation as directed by the Engineer. The valve box shall be set plumb and special care shall be taken while backfilling and tamping to ensure that the box remains plumb and is firmly supported to avoid settlement. Any valve box which is found out of plum or not firmly supported, shall be dug up and reset in a satisfactory manner at the contractor's expense.

All bends shall be concrete buttressed or utilize locking gaskets.

Main gate valves shall be Mueller H-2370-20, open left and A-2360.

Tapping valves shall be Mueller H-687, open left.

Tapping sleeves shall be Mueller H-615.

Valves boxes shall be Mueller H-10360, or equal.

Fire hydrants shall be Mueller A-423 on a 6 inch ductile iron pipe lateral with mechanical joint connections. A 6 inch gate valve with valve box shall be installed on the lateral anchoring restraint tee. The hydrant valve with a 5¼ inch opening shall open left. Fire hydrants must be rodded and braced with a concrete buttress.

Fire hydrants shall be equipped with one 4½ inch outlet and two 2½ inch outlets with National Standard Threads. The 4½ inch outlet must be facing directly to the street. All operating nuts shall be 1½ inch pentagon shaped nuts.

Fire hydrants shall be firmly set in a bed of screened gravel, or crushed stones (DEL No. 57) which shall extend 1 foot below the bottom of the hydrant, and total not less than 1/3 of a cubic yard of gravel or stone around the bleed holes of the hydrant. Lay plastic on top of stone before backfilling.

All fire hydrants must be installed at a distance no closer than 3 feet nor farther than 9 feet from the face of curb to the top operating nut of the hydrant.

Curb stops shall be ¾ inch Mueller H-15201 or H-15209, ¼ turn to stop.

Curb boxes shall be Mueller H-10350 or approved equal.

Corporation stops shall be ¾ inch Mueller H-15010 tapped on upper 1/3 of main.

House services shall be ¾ inch soft copper tubing, Type K, minimum depth of cover is 42 inches.

Meter yokes shall be Mueller H-1412.

The developer will be responsible for installing a conduit, if necessary, and fish the remote wire through the conduit, leaving enough slack on either end for the connection to the water meter and remote reader. The Water Department will supply the remote wire.

22.06 JOINTING STANDARD TYTON JOINT (PUSH ON) DUCTILE IRON PIPE

Tyton joints shall be effected as follows:

1. Remove all foreign material in the gasket seat of the bell socket and wipe gasket clean.
2. Flex gasket and place it in bell socket with the large round end entering first so that it is seated evenly and completely around the inside of the bell socket with the groove fitted over the bead.
3. Apply a thin film of the manufacturer's specified lubricant to the exposed surface of the gasket which will contact the spigot end to the next pipe.
4. Align said spigot end into the bell socket, and force the pipes together until the second strip on the spigot end is flush with the bell face. Any method which does not damage the pipe may be used to accomplish this assembly.

22.07 JOINTING STANDARD MECHANICAL JOINT DUCTILE IRON PIPE AND FITTINGS

Before any joint is made, the contractor shall exercise particular care to ensure the outside of the spigot and the inside of the bell are entirely free of oil, tar, and greasy substance to ensure a tight bond.

The mechanical joint shall consist of a rubber or composition tapered gasket, a ductile iron gland ring, and t-head bolts with nuts. The joint shall be effected in the following manner:

1. Remove all dirt, oil, tar or greasy substance from the gland, gasket, inside of bell and outside of spigot end.
2. Slip gland on spigot end with lip extension of the gland toward the joint.
3. Wet the inside of the bell and the outside of spigot with soapy water.
4. Slip gasket on pipe with its thick edge toward the gland and wet thoroughly with soapy water.
5. Push spigot end to its seat in the bell and press gasket into place within the bell. Gasket must be evenly set all around joint.
6. Move gland into position for bolting, insert all bolts, and tighten nuts evenly

with fingers. Special care shall be exercised to prevent the gland from riding the pipe at any point.

7. Bolts 180° apart should be tightened alternately in order to bring up gland evenly all around, i.e., first bolt to be tightened should be at the bottom of the joint, second should be at the top of the joint, etc. All bolts shall be tightened with a torque wrench set between a minimum of 50 pounds and a maximum of 60 pounds.

22.08 LAYING THE PIPE

Pipe, fittings, and valves shall be carefully handled and lowered into the trench. The ends of the pipe shall abut each other in such a manner that there should be no shoulder or unevenness on the inside of the main.

Whenever directed, the contractor shall lay pipe upon an artificial foundation which he shall construct. Such foundation may consist of gravel, sills, wedges, planks, or other timber foundation, or of concrete, all to be of formed-end dimensions, and placed in the manner required by the Engineer. All necessary excavation for the construction of artificial foundations shall be made by the contractor.

All water main pipe shall be installed to a depth of no less than 42 inches from finished grade at top of the trench to the elevation of the top of newly installed pipe. Backfilling shall be in accordance with utility backfill in Item 2, Excavation.

Proper and suitable tools and appliances for the safe and convenient handling and laying of pipes and fittings shall be used. Great care should be taken to prevent the pipe lining and coating from being damaged. Any pipe with lining or coating damage may be rejected for use.

The pipes and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the of the completed work. At the close of each work day the end of the pipe line shall be tightly closed with an expansion type stopper so that no dirt or other foreign substance may enter the line. This stopper shall be kept in place until pipe laying is again resumed.

Whenever a pipe requires cutting to fit in the line to bring it to the required location, the work shall be done in a satisfactory manner so as to leave a smooth end and without additional compensation.

No springing of bell and spigot joints to effect a change in direction will be allowed, except by permission or as directed or shown on the plans.

When directed by the Engineer, ductile iron pipe fittings and valves shall be secured in place by suitable braces and/or concrete foundation, buttress, or thrust block.

22.09 AIR VALVE MANHOLES (PRE-CAST)

Air valve manholes shall be installed at such points on the pipe lines, and of such form and dimension as are shown on the drawings or as may be directed.

A Simplex air valve, or approved equal, will be installed on the water main. The valve will be connected to a corporation tap installed on the top of the water main. On mains 12 inch or less, a 1 inch corporation tap must be used and on mains larger than 12 inch, a 2 inch corporation tap must be used.

22.10 DEFECTS TO BE MADE GOOD

If at any time before the completion of the contract any damages or defects are found in the water mains, or in any of their appurtenances, the contractor shall cause the same to be removed and replaced with proper material and workmanship, without extra compensation for the labor and material required, even though such damages or defects may not have been due to any act, default, or negligence on the part of the contractor. It shall be the contractors responsibility to carefully examine all materials for damages or defects just before installation, and any materials found defective shall not be installed.

22.11 TESTING

The contractor shall hydrostatically test all water mains (with all services to curb stops installed) at a pressure of 150 p.s.i., maintained for a period of not less than 4 hours. The maximum rate of leakage shall not exceed 50 gallons per diameter inch per mile in 24 hours. The contractor shall furnish all labor, materials, tools and equipment necessary to perform the test as directed by the Water Department.

22.12 DISINFECTING WATER MAINS

All newly installed water mains shall be disinfected in accordance with the applicable section of AWWA Standard C601-81.

During the installation of the water main, 5 gram calcium hypochlorite tablets shall be placed in each section of pipe, with the numbers of tablets to be determined from the following table:

NUMBER OF 5 GRAM CALCIUM HYPOCHLORITE TABLETS REQUIRED

PIPE DIAMETER	LENGTH OF PIPE SECTION, LINEAR FEET		
	13 L.F. OR LESS	18 L.F.	20 L.F.
4 INCH	1	1	1
6 INCH	1	1	1
8 INCH	1	2	2
10 INCH	2	3	3
12 INCH	3	4	4
16 INCH	4	6	7

The calcium hypochlorite tablets shall be attached to the top inside of each pipe with Permatex No. 1 adhesive or other approved equal. One tablet shall be placed in each hydrant, hydrant branch, or other appurtenance.

Upon the completion of the water main installation, the main shall be filled with water slowly. After the main has been completely filled, this water shall remain in the pipe for at least 24 hours, before being blown-off or flushed prior to being put into service.

22.13 BACKFILLING

Backfilling of the pipe shall be as specified under Utility Backfill in Item 2, Excavation.

22.14 BASIS OF PAYMENT

The number of linear feet measured shall be paid for at the contract price per linear foot bid for Item 22, Ductile Iron Water Pipe, Fittings, and Appurtenances, which price and payment shall constitute full compensation for the necessary excavation and backfilling, for all cribbing, shoring or sheeting, for furnishing, hauling, and installing pipe and for all materials, labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 22A

ADJUSTING EXISTING VALVE BOXES

22A.01 DESCRIPTION

This work shall consist of raising or lowering the valve boxes to accommodate any planned construction. The extensions and the boxes shall be adjusted so as to be perpendicular and also shall be adjusted so that a key will easily fit in the valve nut.

The excavation done in preparation shall be considered spoil and shall be replaced with concrete to within 1-1/2" or 2" of the top of the valve box.

22A.02 MATERIALS

Portland cement concrete shall conform to the requirements of Item 9. The composition of the mix shall be determined as defined in Paragraph 108, Material Details.

Any replacements for defective or broken parts will be furnished by the City and installed by the contractor, provided the parts are not broken by the contractor, in which case the contractor will be back charged for same.

22A.03 METHOD OF MEASUREMENT

The number of valve boxes adjusted to be paid for under this section shall be the actual number of valve boxes adjusted, complete, and accepted.

22A.04 BASIS OF PAYMENT

The number of valve boxes adjusted as provided above shall be paid for at the contract unit price bid for Item 22A, Adjusting Existing Valve Boxes, which price and payment shall constitute full compensation for excavation, removing the valve box resetting the valve box to proper grade, furnishing and placing materials, backfilling, labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 23

SANITARY SEWER PIPE AND FITTINGS **POLYVINYL CHLORINE (PVC) AND DUCTILE IRON PIPE**

23.01 DESCRIPTION

This item consists of furnishing PVC and/or ductile iron sanitary sewer pipe and fittings conforming to these specifications, of the sizes and dimensions required on the plans and installing such pipe at such places designated on the plans or by the engineer, in conformity with the lines and grades given while providing all labor, tools, equipment, and services necessary for or incidental to the acceptable installation of the sanitary sewer as approved by the Engineer.

23.02 MATERIAL REQUIREMENTS

PVC PIPE AND FITTINGS

The pipe and fittings in this item shall conform to the requirements of ASTM D 3034 (SDR 35) - Standard Specifications for PVC Sewer Pipe and Fittings for sizes 4 inch through 15 inch. The pipe shall be manufactured with an integral bell and jointed by a bell and spigot rubber gasketed joint conforming to ASTM D 3212 - Standard Specifications for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals. All fittings shall be joined to the pipe using a rubber gasketed joint. Lubricant specified by the pipe manufacturer shall be furnished in sufficient amounts used to facilitate the coupling of all joints.

DUCTILE IRON PIPE AND FITTINGS

When required, ductile iron pipe for use in this item shall be Class 52 pipe, unless otherwise specified, and shall be centrifugally cast in lengths not less than 12 feet nor more than 20 feet, conforming to ANSI/AWWA C151/A21.51-81. Ductile iron pipe shall be cement lined in accordance with the requirements of ANSI/AWWA C104/A21.4-80. A bituminous seal coating shall be applied to the interior (and exterior) as soon as the cement lining has sufficiently dried.

All ductile iron fittings shall meet the requirements of ANSI/AWWA C153/A21.53-84 for compact (short body) ductile iron fittings and have a 350 p.s.i. pressure rating. All fittings shall be provided with standardized mechanical joints in accordance with ANSI/AWWA C111/A21.11-80. All fittings shall be cement lined on the interior and bituminous coated on the interior and exterior.

23.03 INSTALLATIONS

MAINS

All PVC pipe for sanitary sewer mains shall be manufactured by Johns-Manville or CertainTeed Corporation, and the mains minimum size shall be 8 inches in diameter.

All PVC sanitary sewer mains shall be encased with 6 inches of 3500 p.s.i. concrete where one foot or less of vertical separation exists between the sanitary sewer main and the crossing utility. The encasement length shall be 10 feet and shall be divided equally on either side of the crossing utility. Encasements are also required when the sanitary sewer main crosses any waterway in the City.

No PVC sanitary sewer main will be permitted to be installed at depth greater than 20 feet nor less than 4 feet. Ductile iron pipe may be used as an alternative when approved by the Engineer.

Backfilling of the pipe shall be as specified under Utility Backfill in Item No. 2, Excavation and Embankment. Main sanitary pipes shall be installed on a 4 to 6 inch bed of washed gravel or crushed stone (DEL No. 57). Backfilling with the same type of stone to 4 to 6 inch over the pipe. This stone encasement will extend from manhole to manhole.

LATERALS

All sanitary sewer laterals shall be a minimum of 4 inches diameter and consist of SDR 35 (Rubber Gasketed Joints) or Schedule 40 (Solvent Weld) pipe, or which no lateral shall be installed at a depth greater than 20 feet nor shallower than 4 feet.

All combination clean-outs shall be constructed by installing a 45° wye in the lateral with a 45° elbow turned up, and a riser pipe with a clean-out adapter and screw in cleanout plug (MPT) on top, extending to finished grade or 1 inch below finished grade in grassed areas. All fittings in the combination cleanout shall be manufactured by Johns-Manville.

All sanitary sewer cleanouts shall be installed on the property line. If the cleanout is located in any driveway or sidewalk area the screw cap shall be a Genco or equal cast iron to PVC bell with a brass lid flush with concrete. Asphalt paved area's shall be cast iron lamphole frame and cover mounted in a concrete footer to grade.

Backfilling of the lateral shall be as specified under Utility Backfill in Item 2, Excavation and Embankment. Lateral pipes shall be installed on 4 inches of washed gravel or crushed stone (DEL No. 57) backfilling with the same type of stone 4 inches over pipe. This stone encasement will extend from main tie-in to clean out. Special care must be taken while backfilling the cleanout riser pipe to ensure that the riser pipe remains perpendicular to the lateral.

23.04 LAYING THE PIPE

Pipe shall be laid only during dry weather and under conditions which in the opinion of the Engineer are suitable for proper jointing.

All pipe and fittings shall be thoroughly cleaned before installation. The joint shall be made in such a manner as to eliminate a shoulder or unevenness on the inside of the main.

The pipe must be laid on a stable stone bed and provide uniform support for the full length of the pipe. Bell holes in the trench bottom must be provided to permit the joint to be made properly and support the pipe joint uniformly. No blocking, sills, or wedges of any kind will be allowed to be used to bring the pipe to grade.

If at any time the contractor encounters significant ground water or rock in the trench, additional trench undercut excavation may be required and shall be the full width and length of the unsuitable trench. Additional trench excavation and stone bedding shall be at the expense of the contractor.

Whenever a pipe requires cutting to fit into the line, the cutting shall be accomplished accurately and smoothly; otherwise the pipe may be rejected.

If any defects are detected due to settlement, the Contractor shall make the necessary repairs to correct the defect at his own expense.

In order to keep the completed portions of the sewer clean until the work is accepted, the last pipe length installed shall be sealed with a tight fitting stopper or plug at all times when pipe laying is not in progress.

23.05 JOINTING THE PIPE

PVC PIPE (SLIP JOINT)

1. Remove all foreign material in front of the bell socket.
2. Make sure the gasket is clean and evenly seated in the groove.

3. Apply a thin film of the manufacturer's specified lubricant to the exposed surface of the gasket and the spigot end of the next pipe.
4. Align spigot end into the bell socket and force the pipes together fully. Any method which does not damage the pipes may be used to accomplish this assembly.

DUCTILE IRON PIPE (SLIP JOINT)

1. Remove all foreign material in the gasket seat of the bell socket and wipe gasket clean.
2. Flex gasket and place it in bell socket with the large round end entering first so that it is seated evenly and completely around the inside of the bell socket with the groove fitted over the bead.
3. Apply a thin film of the manufacturer's specified lubricant to the exposed surface of the gasket and the spigot end to the next pipe.
4. Align spigot end into the bell socket and force the pipes together fully. Any method which does not damage the pipes may be used to accomplish this assembly.

SCHEDULE 40 (SOLVENT WELD) - LATERAL USE ONLY

1. End of pipe must be cut square and beveled at an angle (10°-15°) between one-sixteenth and three-thirty seconds of an inch from the end of the pipe.
2. Use a clean rag to wipe the pipe surface and fitting socket to remove all dirt, moisture, and grease.
3. Check "dry fit" of pipe and fitting. Pipe should enter fitting about 1/3 to 3/4 in depth.
4. Use the pipe manufacturer's suggested primer to dissolve and penetrate the surface of the pipe and fitting. Repeated applications of primer may be necessary to ensure the surfaces are well penetrated.
5. Apply a liberal coat of the pipe manufacturer's recommended solvent cement to both the pipe and the fitting.

6. With both surfaces still wet, insert pipe with a ¼ turn twisting motion while exerting pressure to ensure that the pipe fits snug to the bottom of the socket. The cementing procedure should be completed in less than one minute.

23.06 TESTING SANITARY SEWER MAINS

Sanitary sewer mains shall be air tested after all laterals, with complete cleanouts, have been installed. The Contractor shall furnish all labor, materials, tools and equipment necessary to perform all test as directed by, or under the directed by, or under the direction of the Engineer. The Contractor shall repair or replace all sections of sanitary sewer failing to meet testing requirements.

The sanitary sewer shall be air tested holding 5 p.s.i. for 15 minutes with no allowable leakage.

Sanitary force mains shall be air tested holding 50 p.s.i. for 5 minutes with no allowable leakage, or may be determined by the Engineer.

23.07 DEFECTS TO BE MADE GOOD

If at any time before completion of the contract any damages or defects are found in the sewers or in any of their appurtenances, the Contractor shall cause the same to be removed and replaced by proper material and workmanship without extra compensation for labor and materials required, even though damages or defects may not have been due to any act, default, or negligence on the part of the Contractor. All materials shall be carefully inspected by the Contractor for defects just before installation. Any defective or damaged materials shall not be installed.

23.08 BACKFILLING

Backfilling of the sanitary sewer mains and laterals shall be completed as specified under Utility Backfill in Item 2, Excavation and Embankment.

23.09 METHOD OF MEASUREMENT

The number of linear feet measured of sanitary sewer pipe (PVC or DIP) to be paid for under this item shall be the actual number of linear feet of pipe installed in place and accepted, measured from end to end of pipe, excluding structures. Wye branches to be paid for in addition to the number of linear feet measured and paid for.

23.10 BASIS OF PAYMENT

The number of linear feet measured, shall be paid for at the contract unit price per linear foot bid, which price and payment shall constitute full compensation for excavating and backfilling, shoring and sheeting, for furnishing, hauling and installing pipe, and for all materials, labor, tools, equipment and incidentals necessary to complete the item.

ITEM 24

PORTLAND CEMENT REINFORCED

CONCRETE VALLEY GUTTER

24.01 DESCRIPTION

Portland Cement Reinforced Concrete Valley Gutter shall consist of a cement concrete gutter constructed in 1 course on a prepared subgrade in reasonably close conformity with the dimensions indicated on the plans and in accordance with these specifications. Unless otherwise specified, it shall be 8" in thickness. Concrete for this section may be either Job Mixed, Central Mixed, or Truck Mixed.

This item shall consist of 4' and 8' valley gutter made of Portland cement concrete, constructed in accordance with these specifications and of the form, dimensions, and designs shown on the plans in the Standard Detail Book, or as directed by the Engineer.

MATERIALS

24.02 PORTLAND CEMENT

Portland cement for this section shall conform to the requirements of Paragraph 100, Material Details.

24.03 WATER

Water for use in mixing concrete for this section shall conform to the requirements of Paragraph 102, Material Details.

24.04 FINE AGGREGATE

Fine Aggregate for use in this section shall conform to the requirements of Paragraph 103, Material Details.

24.05 COURSE AGGREGATE

Coarse Aggregate for use in this section shall conform to the requirements of Paragraph 104, Material Details.

24.06 GRADATION

Coarse aggregate at the time it is proportioned shall be graded between the limits specified for size No. 57 of Paragraph 110, Material Details.

24.07 COMPOSITION

The composition of the mix shall conform to Paragraph 108, Material Details.

24.08 WIRE MESH REINFORCEMENT

This item shall conform to the requirements of Paragraph 114, Material Details. The mesh shall consist of wires so spaced and of such gauges as called for on the plans or in the Detail Standards.

24.09 PREFORMED EXPANSION JOINT MATERIAL

Expansion joint material for this item shall consist of preformed strips which have been formed from clean, granulated cork particles securely bound together by a synthetic resin of an insoluble nature. For this item, it shall be 1/2" thick and shall conform to all the requirements of this material as specified in AASHTO M 153, "Preformed Expansion Joint Fillers for Concrete." Premoulded expansion joint material of other types may be approved provided they meet the latest requirements of AASHTO "Preformed Expansion Joint Fillers for Concrete", and are approved by the Engineer.

CONSTRUCTION METHODS

24.10 PREPARATION OF SUBGRADE

The subgrade shall be formed at the required depth below the finished surface of the gutter, in accordance with the dimensions and design shown on the plans for the bottom of the gutter. All soft and yielding or other unsuitable material shall be removed and replaced with suitable materials. The subgrade shall then be compacted to 95% of the maximum density as determined by Subsection 2.12 of these specifications. Where rock is encountered, the grade shall be excavated to 6" below the bottom of the gutter and this depth shall be backfilled with suitable material and thoroughly compacted.

24.11 FORMS

Forms shall be of wood or metal, straight, and of sufficient strength, when staked, to resist the pressure of the concrete without springing. They shall be approved as to section and condition. All forms shall be cleaned thoroughly and oiled before concrete is placed against them. Forms that have become worn, bent, or damaged shall not be used. The concrete shall be batched, mixed, and handled as specified under Item 9.

24.12 PLACING THE CONCRETE

The concrete shall be placed on a moist foundation between the forms and agitated sufficiently to bring mortar to the surface, after which it shall be struck off to the required contour and finished smooth and even by means of an approved wooden float or magnesium float.

24.13 CONSTRUCTION OF THE GUTTER

The concrete gutter shall be constructed in accordance with the Standard Detail section or as shown on the drawings with such modifications thereof as the Engineer may deem necessary to satisfactorily meet conditions.

24.14 FINISHING

The surface of the gutter shall receive a hair broom finish. The forms shall not be removed for at least 12 hours. Minor defects exposed after stripping forms shall be filled with mortar composed of 1 part of Portland cement to 2 parts of fine aggregate. Plastering will not be permitted and all rejected gutter shall be removed and replaced without additional compensation.

24.15 CHECKING GUTTER

Before the concrete is given the final finish, the surface on the gutter shall be checked with a 10' straightedge and any irregularities of more than 1/45" in 10' shall be corrected.

24.16 SEALING THE JOINTS

All transverse joints shall be sealed and all longitudinal joints formed in concrete gutters adjacent to rigid pavements, base course, header curbs, and rigid structures, shall be sealed with bituminous joint filler conforming to requirements of Paragraph 113, Material Details, after the gutter has been satisfactorily completed and prior to final acceptance.

24.17 CURING

Immediately after the surface has been finished, it shall be cured according to the requirements of Item 9. If burlap is used, it shall be left in place and kept thoroughly saturated for at least 72 hours. If curing paper or approved curing covers is used, it shall be left in place 5 days.

After the concrete has hardened sufficiently, the space adjacent to the gutter shall be backfilled with acceptable material in layers of not more than 4" in depth. Each layer shall be thoroughly compacted to the required elevation and cross-section.

24.18 METHOD OF MEASUREMENT

The yardage of Portland Cement Reinforced Concrete Valley Gutter to be paid for under this section shall be the actual number of square yards of Portland cement reinforced concrete valley gutter measured complete in place and accepted. Measurements will be taken parallel to and along the surface of the finished gutter.

24.19 BASIS OF PAYMENT

The yardage of Portland Cement Reinforced Concrete Valley Gutter, measured as provided above, shall be paid for at the contract unit price per square yard bid for Item 24, Portland Cement Reinforced Concrete Valley Gutter, which price and payment shall constitute full compensation for furnishing all materials, for excavation below the finished grade of the gutter, backfilling, tamping, and disposing of surplus materials, for filling joints, and for all labor, equipment, tools and incidentals necessary to complete the item.

ITEM 25

INTEGRAL-VERTICAL-ROLLED

PORTLAND CEMENT CONCRETE CURB AND GUTTER

25.01 DESCRIPTION

Portland Cement Concrete curb shall consist of constructing a Portland cement concrete curb on a prepared subgrade in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and designs shown on the plans or established by the Engineer.

25.02 PORTLAND CEMENT

Portland Cement for this section shall conform to the requirements of Paragraph 100, Material Details.

25.03 WATER

Water for use in this section shall conform to the requirements of Paragraph 102, Material Details.

25.04 FINE AGGREGATE

Fine aggregate for use in this section shall conform to the requirements of Paragraph 103, Material Details.

25.05 COARSE AGGREGATE

Coarse aggregate for use in this section shall conform to the requirements of Paragraph 104, Material Details.

25.06 GRADATION

Coarse aggregate at the time it is proportioned shall be graded between the limits specified for size No. 57 of Paragraph 110, Material Details.

25.07 COMPOSITION OF MIX

The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

25.08 PREFORMED EXPANSION JOINT MATERIAL

Expansion joint material for this section shall consist of preformed strips which have been formed from clean, granulated cork particles securely bound together by a synthetic resin of an insoluble nature or other types that may be approved. For this section, it shall be ½" thick and shall conform with all the requirements as specified in AASHTO M 153 "Preformed Expansion Joint Fillers for concrete". Premolded expansion joint material of other types may be approved provided they meet the requirements of AASHTO "Preformed Expansion Joint Fillers for Concrete".

CONSTRUCTION METHODS

25.09 SUBGRADE

Excavation shall be made to the required depth and the subgrade or base upon which the curb is to be set shall be compacted to a firm, even, surface. The subgrade shall then be compacted to 95% of the maximum density as determined by Subsection 2.12 of these specifications.

25.10 FORMS

All forms shall be set true to line and grade and held rigidly in position so as to prevent leakage of mortar. They shall be either of metal or of acceptable planed and matched lumber, straight, free from warp, and of sufficient strength to resist springing when the concrete is deposited against them. If of wood, they shall be of 2" surfaced plant; if of metal, they shall be of approved section and shall have a flat surface on top. For short radii, form material shall be approved. Forms shall be cleaned and oiled each time they are used. The tops of forms shall be set to the finished line and grade of the curb.

25.11 PLACING CONCRETE

The materials shall be measured and the concrete mixed as required under Paragraph 108, Material Details, and shall be placed in the forms to the depth specified and tamped and spaded until mortar entirely covers its surface. The top of the curb shall be floated smooth and the edges rounded to the radii shown on the plans.

25.12 CONSTRUCTION OF SECTIONS

The curb shall be constructed in uniform sections 10' in length except where shorter sections are necessary for closures, but no section shall be less than 4'. These sections shall be separated by sheet-steel templates set perpendicular to the face and top of the curb. These templates shall be 1/8" in thickness. The templates shall be

set carefully and held firmly during the placing of the concrete and shall be allowed to remain in place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place.

25.13 JOINTS

Expansion joints shall be formed in the curb at intervals of 40'. When a curb is placed adjacent to concrete pavement, the location and thickness of joints in the curb shall coincide with the joints in the pavement when practicable. When a curb is installed next to a structure or sidewalk, expansion joint material shall be used to separate curb from the structure or sidewalk.

25.14 FINISHING

The front forms may be removed after the concrete has hardened sufficiently. The rear forms shall not be removed for at least 12 hours. Minor defects shall be filled with mortar composed of 1 part of Portland cement to 2 parts of fine aggregate. Alignments of curbs shall be in reasonably close conformity to the lines shown on the plans. Irregularities in grade or alignment of exposed surfaces shall not exceed 3/8" in 10'. Vertical alignment shall be sufficiently uniform and regular to insure complete drainage.

Plastering will not be permitted on the face of the curb and all rejected curb shall be removed and replaced without additional compensation. The exposed surfaces of the curb shall be finished while the concrete is still green on the same day of placement, by wetting a wooden float and rubbing the surfaces until they are smooth and conform to the planned section. This shall be followed by a steel trowel operation, which is intended to give the finished curb a hard smooth texture. These operations shall be followed immediately with a soft dampened brush longitudinally along the surface of the rubbed curb.

Where the curb is constructed in advance of the pavement surfacing course, the face of the curb shall be finished as described above from the top to a point 2" below the proposed surface elevation.

Alignment of curbs shall be in reasonably close conformity to the lines shown on the plans. Irregularities in grade or alignment of exposed surfaces shall not exceed 3/8" in 10'. Vertical alignment shall be sufficiently uniform and regular to insure complete drainage.

25.15 CURING

Curb shall be cured according to Subsection 9.20, Item 9.

25.16 BACKFILLING

Immediately after the concrete has set sufficiently, the spaces in front and back of the curb shall be backfilled to the required elevation with suitable material which shall be tamped in layers of not more than 4", until firm and solid.

25.17 METHOD OF MEASUREMENT

The footage of Portland Cement Concrete Curb to be paid for under this section shall be the number of linear feet of concrete curb constructed in accordance with these specifications, measured in place along the face of the curb, completed and accepted. No deduction will be made where the curb is depressed for entrances.

25.18 BASIS OF PAYMENT

The footage, of Portland Cement Curb measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 25, Portland Cement Concrete Curb, which price and payment shall constitute full compensation for furnishing and placing all material, including joints, forms, drainage openings, excavation and backfilling, tamping, disposal of surplus material, and for all labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 25A

HOT-MIX, HOT LAID BITUMINOUS CONCRETE CURB

25A.01 DESCRIPTION

Hot-Mix, Hot Laid Asphaltic Concrete Curb shall consist of constructing a machine laid hot-mix, hot laid asphaltic concrete curb on an approved surface in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and designs shown on the plans or established by the Engineer.

25A.02 MATERIALS

All materials used in this section shall conform to the requirements of Item 39, except that from 1% to 3% of the total mix weight of an approved fiber shall be added.

25A.03 GRADATION

The gradation, asphalt cement, and temperature shall meet the requirements of Item 39, Subsection 39.16, Hot-Mix, Hot Laid Bituminous Concrete Pavement Type E.

25A.04

Job mix formula, mixing plant, and transportation and delivery of mixture shall conform to the requirements of Item 39.

CONSTRUCTION METHODS

25A.05 GENERAL

Hot-mix, hot laid bituminous concrete curb shall be constructed by machine methods on an approved surface where shown on the plans or ordered by the Engineer.

The surface where the curb is to be placed shall be kept clean and free from dust until the curb has been placed. If directed, a fog coat of approved bitumen shall be sprayed prior to placing of the curb.

25A.06 CURBING MACHINE

The curbing machine shall form the curb to the dimensions as shown on the plans, or as ordered by the Engineer, by a process of extrusion producing a homogeneous stable curb, free from honeycomb, and which will require no further compaction. The laying temperature and the percentage of bitumen shall be varied within their specified

ranges to produce a mixture that will pass through the mold without tearing and still be stable enough to resist sloughing. The curbing machine shall be operated in an uphill direction whenever practicable, as an aid in compaction.

25A.07 CURB CONSTRUCTION

Curb construction shall be a continuous operation between concrete intake aprons and other concrete structures so as to eliminate curb joints at other locations.

Hand spreading will be permitted only immediately adjacent to the concrete structures and at ends of runs of curb, and shall be performed in accordance with the pertinent provisions of Item 39. Contact surfaces of the concrete structures shall be painted with a thin uniform coat of hot bitumen just before the mixture is placed against them.

25A.08 INSPECTION

Hot-mix, hot laid bituminous concrete curb not constructed true to the required lines, grades, or cross-sections, or curb planes when the mixture is too hot or too cold, and curb otherwise unsatisfactory, shall be removed and replaced with satisfactory curbing at the expense of the contractor.

25A.09 METHOD OF MEASUREMENT

The footage of Hot-Mix, Hot Laid Bituminous Concrete Curb to be paid for under this section shall be the number of linear feet in place and accepted, measured along the curb from end to end, with appropriate deductions for concrete intake aprons.

25A.10 BASIS OF PAYMENT

The number of linear feet, measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 25A, Hot-Mix, Hot Laid Bituminous Concrete Curb, which price and payment shall constitute full compensation for furnishing all materials, for placing and compacting the curb, and for all equipment, labor, tools, and incidentals necessary to complete the section.

ITEM 25B

PORTLAND CEMENT CONCRETE PARKWAY CURB

25B.01 DESCRIPTION

Portland Cement Concrete Parkway Curb shall consist of constructing a Portland cement concrete curb on a prepared subgrade in accordance with these specification and in reasonably close conformity with the lines, grades, dimensions, and designs shown on the plans or established by the Engineer.

MATERIALS

25B.02 PORTLAND CEMENT

Portland cement for use in this section shall be light in color, of a standard brand of Portland cement, and shall conform to the requirements of Paragraph 100, Material Details.

25B.03 WATER

Water for use in mixing concrete for this section shall conform to the requirements of Paragraph 102, Material Details.

25B.04 FINE AGGREGATE

Fine aggregate for use in this section shall be light in color and conform to the requirement of Paragraph 103, Material Details.

25B.05 COARSE AGGREGATE

Coarse aggregate for this section shall consist of clean, sound, durable, well graded, uniformly mixed, crushed stone or gravel, light in color and shall conform to the requirements of Paragraph 104, Material Details.

25B.06 GRADATION

Coarse aggregate, at the time it is proportioned, shall be graded between the limits specified for size No. 57 of Paragraph 110, Material Details.

25B.07 PREFORMED EXPANSION JOINT MATERIAL

Expansion joint material for this section shall conform to the requirements of Subsection 25.08.

25B.08 COMPOSITION OF MIX

The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

25B.09 SUBGRADE

Subgrade shall meet the requirements of Subsection 25.09.

25B.10 FORMS

Side forms of parkway curb shall be made of metal or wood, free from warps, bends, or kinks. Forms shall be set accurately and rigidly to line and grade and shall be staked and braced at intervals not to exceed 3' for each 10' section of forms.

25B.11 PLACING CONCRETE

The concrete shall be batched, mixed, and handled as required under Paragraph 108, Material Details, of these specifications and shall be placed in the forms to the depth specified, and tamped and spaded until mortar entirely covers its surface. The surface of the curb shall be finished smooth and even with a steel float. The longitudinal and transverse edges of each curb section shall be finished to the radii shown on the plans.

25B.12 CONSTRUCTION OF SECTIONS

Construction of sections shall meet the requirements of Subsection 25.12.

25B.13 JOINTS

Expansion joints shall be installed in the curb at intervals of 40'. The joint material shall be placed flush with the edges of the curb and $\frac{1}{4}$ " below the top surface. When the curb is placed adjacent to the concrete pavement, the location of the joint in the curb shall coincide with the joints in the pavement.

25B.14 CURING

Curb shall be cured according to Subsection 9.20, Item 9.

25B.15 FINISHING

The side forms shall be removed at the end of 24 hours and any superficial honeycombed areas shall be immediately filled with mortar composed of 1 part of Portland cement to 2 parts of fine aggregate. Plastering will not be permitted on the face of the parkway curb and all rejected parkway curb shall be removed and replaced without additional compensation. Alignment of curbs shall be in reasonably close conformity to the lines shown on the plans. Irregularities in grade or alignment of the exposed surfaces shall not exceed 3/8" in 10'. Vertical alignment shall be sufficiently uniform and regular to ensure complete drainage.

25B.15 BACKFILLING

After the concrete has set sufficiently, the area in back of the curb shall be backfilled with approved materials placed in 4" layers and thoroughly tamped.

25B.17 METHOD OF MEASUREMENT

The number of linear feet of Portland Cement Concrete Parkway Curb to be paid for shall be the actual number of linear feet of curb constructed in accordance with these specifications complete and accepted. Measurement for pay length shall be taken along the roadway face of the finished curb.

25B.18 BASIS OF PAYMENT

The footage of Portland Cement Concrete Parkway Curb measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 25B, Portland Cement Concrete Parkway Curb, which price and payment shall constitute full compensation for furnishing and placing all materials including joints, for forms, drainage, openings, excavation and backfilling, tamping and disposal of surplus material and for all labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 26

PORTLAND CEMENT CONCRETE SIDEWALK

26.01 DESCRIPTION

Portland Cement Concrete Sidewalk shall consist of constructing a Portland cement concrete sidewalk on a prepared subgrade in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions, and designs shown on the plans or established by the Engineer.

MATERIALS

26.02 PORTLAND CEMENT

Portland cement for use in this section shall conform to the requirements of Paragraph 100, Material Details.

26.03 WATER

Water for use in mixing concrete for this section shall conform to the requirements of Paragraph 102, Material Details.

26.04 FINE AGGREGATE

Fine aggregate for use in this section shall conform to the requirements of Paragraph 103, Material Details.

26.05 COURSE AGGREGATE

Coarse aggregate for use in this section shall conform to the requirements of Paragraph 104, Material Details.

26.06 GRADATION

Coarse aggregate shall be graded as specified for size No. 57 of Paragraph 110, Material Details.

26.07 PREFORMED EXPANSION JOINT MATERIAL

Expansion joint material for this section shall conform to the requirements of Item 24, Section 24.09.

26.08 COMPOSITION OF MIX

The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

CONSTRUCTION METHODS

26.09 SUBGRADE

The foundation shall be formed at the required grade to accommodate dimensions and design shown on the plans for the bottom of the sidewalk. Where the sidewalk foundation is to be existing undisturbed soil of suitable quality, the foundation shall be firm and unyielding. All soft, yielding, or unsuitable foundation material shall be removed to a sufficient depth, replaced with quarry waste, crusher run, or CR-1 stone base and compacted to provide a firm and unyielding base.

In all cases where the sidewalk foundation could not be considered existing undisturbed soil of suitable quality, the foundation shall be construction of compacted quarry waste, crusher run, or CR-1 stone base with a minimum thickness of 4". The quarry waste, crusher run, or CR-1 stone base shall have been compacted sufficiently with approved tampers to provide a firm and unyielding base.

26.10 FORMS

Forms of approved design shall be used. They must at all times be held rigidly to line and grade by stakes and braces. Forms shall be cleaned and oiled before placing concrete against them. The forms shall be straight and free from warp. the maximum vertical deviation of the top surface of sidewalk forms when in place shall not exceed 1/8" in 10'.

26.11 CONCRETE THICKNESS AND WIDTH

<u>Residential</u>		<u>Business</u>	
<u>Thickness</u>	<u>Width</u>	<u>Thickness</u>	<u>Width</u>
Sidewalk 4"	4'	4"	5' minimum
Driveway 6"	4'	6"*	5' "

* Wire mesh reinforcement required

26.12 CONSISTENCY

The slump of the concrete when determined in accordance with AASHTO T 119 shall be between 2" and 4".

26.13 CHECKING SUBGRADE

Immediately before placing the concrete, the subgrade shall be checked with an approved template, provided by the Contractor, and shall be brought to true grade. If loose earth is added to bring the surface to grade, it shall be thoroughly tamped with an acceptable tamper.

26.14 PLACING AND FINISHING CONCRETE

Concrete shall be distributed to the required depth and for the entire width of the slab by shoveling, or an approved method which will preserve the integrity of the mixture. Concrete shall be thoroughly spaded along all joints and on the inside of the forms for its entire depth.

The concrete shall be leveled and immediately struck off by means of an approved screed, of sufficient strength to retain its shape under all working conditions.

While the concrete is still moist, it shall be floated with a 3' approved float of either wood or metal to insure that all irregularities or depressions are filled. As soon as the excess water has disappeared, the final finish shall be obtained by either a wood float or hair broom of commercial type.

26.15 MARKING

Sidewalks shall be marked into 4 foot square blocks in residential areas. In business areas, the width of sidewalks and hence the size of blocks shall be as designated by the Engineer. Block marks shall be achieved by scoring the concrete, when sufficiently set to hold its shape, to a ½" minimum depth with an approved jointing tool. Other approved means of achieving block marks may be used. In all cases, the sidewalk markings shall be continued through driveway aprons. Concrete next to forms shall be rounded with ¼" radius edging tool.

26.16 EXPANSION JOINTS

Expansion joints shall extend from the surface to the subbase and must be at right angles to the sidewalk surface. A ½" expansion joint, conforming to the requirements of these specifications, shall be placed across the walk every 20 ft. This distance may be adjusted slightly to match existing joints in previously placed concrete work. Where sidewalk is "locked in" on all sides and ends by other rigid structures such as buildings, pavements, adjoins or intersects a curb, etc., expansion material shall be placed as directed.

26.17 CURING

Concrete shall be cured as provided for under Item 9, for a period of 5 days. The sidewalk shall not be opened to traffic until the end of the curing period.

26.18 COLD WEATHER CONCRETING

If concrete is permitted to be placed during cold weather, it shall be placed in accordance with Item 9.

26.19 BACKFILL

Where the concrete sidewalk is not adjacent to curb or other structures, suitable approved material shall be used to form a shoulder for the sidewalk for a width of 18". This material shall be placed immediately at the end of the curing period.

26.20 METHOD OF MEASUREMENT

The area of Portland Cement Concrete Sidewalk to be paid for under this section shall be the number of square feet, measured upon the surface of the sidewalk, of cement concrete sidewalk constructed in accordance with these specifications and as shown on the plans, complete in place and accepted.

26.21 BASIS OF PAYMENT

The number of square feet of Portland Cement Concrete Sidewalk measured as provided above shall be paid for at the contract unit price per square foot bid for Item 26, Portland Cement Concrete Sidewalk, which price and payment shall constitute full compensation for furnishing, hauling, and placing all materials, preparing the subgrade and shaping the shoulders, and for all labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 26A

HOT-MIX, HOT LAID ASPHALTIC CONCRETE SIDEWALKS

26A.01 DESCRIPTION

This item consists of asphaltic concrete wearing course laid upon a prepared base approved by the City Engineer. The sidewalk constructed to the lines and grades, compacted thickness, and typical section shown on the plans or Detail Standards.

26A.02 MATERIALS

All materials for this item shall conform to the requirements of Item 39.

CONSTRUCTION METHODS

26A.03 GENERAL

The methods employed in performing the work and all equipment, tools, and machinery 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, shall be changed or improved as required by the Engineer. All equipment, tools, and machinery used must be maintained in a satisfactory working condition.

26A.04 SUBBASE

The foundation shall be formed at the required grade to accommodate dimensions and design shown on the plans for the bottom of the sidewalk.

The Subbase Material May Be Either:

- A) 4" of compacted CR-1 (GABC Type A)
- B) 5" of compacted Crusher Run (GABC Type B)
- C) 7" of compacted Quarry Waste

The subbase material must be compacted to provide a firm and unyielding foundation for the sidewalk, and must be approved by the Engineer.

26A.05 PLACING ASPHALT

Before placing asphalt, Ryerson Steel Edging (4" x 3/16") or approved equal must be installed as forms on each side of the properly constructed subbase. This edging must be held rigidly to line and grade by stakes, pins, and/or braces. The maximum vertical deviation of the top surface of the edging when in place shall not exceed " in 10'.

The minimum compacted thickness of asphaltic concrete sidewalk is 2".

Asphalt shall be placed between the edging at a sufficient height so that when properly compacted by approved methods, the asphalt sidewalk will remain flush with the edging. Any deviation from the lines and grades greater than 1/4" shall be considered unacceptable and shall be removed and replaced by the Contractor at his own expense.

26A.06 METHOD OF MEASUREMENT

The sidewalk to be paid for under this item shall be the number of square feet, measured along the surface, constructed in accordance with these specifications and as shown on the drawings, complete in place and accepted.

26A.07 BASIS OF PAYMENT

The number of square feet, measured as provided above, shall be paid for at the contract unit price per square foot bid for this item, which price and payment shall constitute full compensation for furnishing, hauling and placing all materials, for the preparation of all materials, for shaping the subbase and shoulders, and for all materials, labor, equipment, tools, and incidentals necessary to complete the item.

ITEM 27

CATCH BASINS

27.01 DESCRIPTION

Catch basins shall consist of the construction of catch basins of Portland cement concrete masonry with reinforcement, brick or block masonry, including the installation of metal frames and covers or gratings in reasonably close conformity with the Detail Standards, as modified on the plans, and in accordance with these specifications.

Furnishing all materials and construction of pre-cast catch basins conforming to the dimensions shown in the Detail Standards, as modified on the plans, and as directed by the Engineer, may be included as an alternate.

The catch basins shall be constructed to the dimensions specified, and carried to the proper elevation to permit framing outlet pipe connections at the elevations shown on the plans, or as directed.

All catch basins 4' or more in depth, measured from the top of the grate to the invert of the lowest pipe shall have standard steps installed as shown in the Detail Standards.

MATERIALS

27.02 CONCRETE

The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

27.03 BRICK

Brick for use in this section shall conform to the requirements of Item 16 or concrete brick conforming to the requirements of ASTM C 139, except absorption which shall have a maximum value of 15 lbs. per cubic foot.

27.04 CONCRETE BLOCK

Concrete block shall meet the requirements of Paragraph 118, Material Details.

27.05 CASTINGS

Castings for frames and grates shall conform to AASHTO M 105, Class 30.

Castings shall be boldly filleted at angles and the arrises shall be sharp and perfect.

Castings shall be true to pattern in form and dimensions free from pouring faults, sponginess, cracks, blowholes, and other defects impairing their strength and value for the service intended.

27.06 GRATINGS

Gratings shall be fabricated as shown on the standard drawings from ASTM A 36 steel. Following fabrication, the entire assembly shall be hot dipped galvanized in accordance with AASHTO M 111, with a minimum of 2 ounces per square foot of zinc coating.

CONSTRUCTION METHODS

27.07 EXCAVATION

Excavation shall be made to the required depth and the subgrade or base upon which the concrete floor of the catch basin is to be set shall be compacted to a firm, even surface.

27.08 CONCRETE CONSTRUCTION

If the catch basin is to be constructed of cement masonry, all of the requirements for Construction Methods under Item 11, shall be followed insofar as they are applicable. Materials and composition of the mix shall conform with the requirements of Paragraph 108, Material Details.

Pre-cast reinforced concrete catch basins and curb bonnets conforming to the dimensions and designs indicated in the Detail Standards may be used when approved by the Engineer.

27.09 BRICK OR BLOCK CONSTRUCTION

If the catch basins are to be constructed of brick masonry, all the requirements for Construction Methods under Item 16, Brick Masonry, shall be followed insofar as they are applicable. Solid concrete block may be used, provided it meets the requirements of Item 118, Material Details.

27.10 FRAMES OF CASTINGS

Frames of castings shall be set in full mortar beds composed of 1 part of Portland cement and 2 parts of fine aggregate, conforming to the requirements of these specifications.

27.11 INLET AND OUTLET PIPES

Inlet and outlet pipes shall be of the size and kind as the connecting pipes shown on the plans, and shall extend through the walls for a distance beyond the outside surface sufficient for the intended connections, and the brick masonry shall be constructed around them so as to prevent leakage. The inlet and outlet pipes shall be flush with the inside of the wall.

If the ends of reinforced concrete pipes are cut off as for framing a skewed outlet pipe, the ends of the pipes shall be cleanly cut and finished smooth with mortar, so that no reinforcing steel remains exposed.

Any modifications necessary to achieve satisfactory inverts or top of grate elevations shall be done at the contractor's expense.

27.12 BACKFILL

The excavated areas which are not occupied by masonry will be backfilled to the required elevation with suitable material which shall be tamped in layers of not more than 6" until firm and solid. No backfill shall be made prior to approval.

27.13 METHOD OF MEASUREMENT

The number of catch basins to be paid for under this section shall be the actual number of catch basins called for on the plans and installed according to these specifications complete in place and accepted. Inlet and outlet pipes will not be measured or paid for under this section, but will be measured with the adjoining pipe and paid for at the contract unit price per linear foot bid for that particular size and kind of pipe.

27.14 BASIS OF PAYMENT

The number of catch basins as determined above shall be paid for at the contract unit price bid for Item 27, Catch Basins, complete in place, which price and payment shall constitute full compensation for furnishing and placing all materials, for any necessary

fittings, metal frames, gratings, covers, excavation, and backfilling around the structure, the disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 27A

ADJUSTING AND REPAIRING EXISTING CATCH BASINS

27A.01 DESCRIPTION

Adjusting and repairing existing catch basins shall consist of adjusting and repairing existing catch basins as indicated on the plans or where directed.

MATERIALS

27A.02 CONCRETE

Portland cement concrete masonry shall conform to the requirements of Item 11. The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

27A.03 BRICK

Brick and mortar used in any brick work under this section shall conform to the requirements of Item 16.

27A.04 BACKFILL

Select borrow used under this section as backfill shall conform to the requirements of Item 5, Type G.

27A.05 CONSTRUCTION METHODS

Catch basins shall be adjusted to grade and shall be repaired as necessary. Covers of catch basins shall be removed and all masonry found to be in poor condition shall be rebuilt using materials conforming to the original structure. The exterior walls of the catch basin shall be plastered with a ½" coat of cement mortar, which shall be sufficiently dried before backfilling.

27A.06 EXCAVATION

The materials necessary to be excavated under this section shall be removed from the site. All such excavations shall be backfilled with select borrow by methods conforming to Subsection 4.06.

27A.07 METHOD OF MEASUREMENT

The number of catch basins adjusted and/or repaired to be paid for under this section shall be the actual number of catch basins complete and accepted.

27A.08 BASIS OF PAYMENT

The number of catch basins adjusted and repaired, as provided above, shall be paid for at the contract unit price bid for Item 27A, Adjusting and Repairing Existing Catch Basins, which price and payment shall constitute full compensation for excavating, removing the covers and portions of structures, furnishing and placing all materials, backfilling, resetting the covers to proper grades, labor, equipment, tools and incidentals necessary to complete the work.

ITEM 28

MANHOLES

28.01 DESCRIPTION

Manholes shall consist of the construction of manholes of Portland cement concrete masonry with reinforcement when and where required, or brick or block masonry, including the installation of metal frames and covers, in reasonably close conformity with the details shown on the standard drawings and in accordance with these specifications.

Manholes shall be constructed to the dimensions specified and carried to the proper elevation to permit framing outlet pipe connections at the elevations shown on the plans, or as directed.

All manholes 4' or more in depth, measured from the top of cover to the invert of the lowest pipe shall have standard steps installed as shown on the Detail Standards.

MATERIALS

28.02 CONCRETE

Portland cement, water, fine aggregate, coarse aggregate, reinforcement except the composition of the mix used in this section shall conform to the requirements of Item 11. The composition of the mix shall be determined as defined in Paragraph 108, Material Details.

28.03 BRICK

Brick for use in this section shall conform to the requirements of Item 16 or concrete brick conforming to the requirements of ASTM C 139, except absorption which shall have a maximum value of 15 lbs. per cubic foot.

28.04 CONCRETE BLOCK

Concrete block shall meet the requirements of Paragraph 118, Material Details.

28.05 CASTINGS

Castings for frames and covers shall conform to the requirements of Item 27.

CONSTRUCTION METHODS

28.06 EXCAVATION

Excavation shall be made to the required depth and the subgrade or base upon which the concrete floor of the manhole is to be set shall be compacted to a firm, even surface.

28.07 CONCRETE CONSTRUCTION

If the manhole is to be constructed of concrete masonry all the requirements for Construction Methods under Item 11, shall be following insofar as they are applicable. Materials and composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

28.08 BRICK OR BLOCK CONSTRUCTION

If the manhole is to be constructed of brick masonry, all the requirements for Construction Methods under Item 16, Brick Masonry, shall be followed insofar as they are applicable. Solid concrete block may be used provided it meets the requirements of Paragraph 118, Material Details.

28.09 FRAMES AND COVERS

1. Sanitary sewer and storm sewer manhole frames and covers meeting the requirements of the Detail Standards shall be furnished and installed by the contractor. Frames shall be set to grade in a bed of mortar composed of 1 part Portland cement and 2 parts of fine aggregate conforming to the requirements of these specifications. Adjustment of the frame to finished grade shall be accomplished using brick masonry construction methods, or pre-cast concrete adjustment collars and mortar, as directed.
2. Sanitary sewer manhole frames and cover shall be watertight as directed by the Water & Waste Water Department.

28.10 PRE-CAST REINFORCED CONCRETE MANHOLES

Pre-cast reinforced concrete manholes shall conform to ASTM C478-90b and shall be constructed in accordance with the specified dimensions and designs as shown in the Detail Standards.

A watertight joint between manhole sections shall be effected by using a rubber gasket conforming to the specifications of ASTM C443-85a.

All benches and channels inside the manhole shall be constructed of poured concrete. The strength of the concrete used shall be 3500 p.s.i. or greater.

An approved bituminous seal coat shall be applied to the exterior of all sanitary sewer manholes.

28.11 INLET AND OUTLET PIPES

All sanitary sewer inlet and outlet pipes shall enter and exit through the pre-cast manhole wall through a watertight rubber boot-type gasket that was inserted into the manhole wall during the manhole manufacturing process. This rubber boot-type gasket shall conform to the specifications of ASTM C923.

All storm sewer inlet and outlet pipes shall conform to Subsection 27.11 of these specifications.

28.12 PARGING EXTERIOR MANHOLE WALLS

Prior to backfilling, the exterior walls of the storm sewer manhole must be plastered with a ½" coat of cement mortar. The excavated areas, which are not occupied by the structure, shall be backfilled to the required elevation with suitable approved material which shall be placed and compacted in layers no greater than 6".

Parging of pre-cast manhole exterior walls may be omitted, however, all interior joints in pre-cast sections shall be plastered with mortar to ensure a watertight seal.

28.13 METHOD OF MEASUREMENTS

The number of Manholes to be paid for under this section shall be the actual number of manholes constructed according to these specifications, complete in place and accepted. Inlet and outlet pipe will not be measured or paid for under this section, but will be measured with the adjoining pipe and paid for at the contract unit price per linear foot bid for that particular size and kind of pipe.

The depth of manholes will be measured from the invert of the channel at the center of the manhole to the underside of the cast iron manhole frame.

28.14 BASIS OF PAYMENT

The number of Manholes as determined above shall be paid for at the contract unit price bid for Item 28. Manholes, complete in place, which price and payment shall

constitute full compensation for furnishing and placing all materials, for any necessary fittings, frames, and castings, excavation and backfilling around the structure, the disposal of surplus materials, and for all labor, equipment, tools and incidentals necessary to complete the section.

ITEM 28A

ADJUSTING AND REPAIRING

EXISTING MANHOLES

28A.01 DESCRIPTION

Adjusting and Repairing Existing Manholes shall consist of adjusting and repairing existing manholes as indicated on the plans or where directed.

This work shall consist of raising or lowering the manhole frames and covers to the proper elevation to accommodate any hot mix overlay, concrete patching, or any patching that may be done during any new construction.

Any excavation done in preparation of adjusting manhole frames will be considered a spoil item and shall be replaced with concrete to within 1 ½" or 2" of top cover.

MATERIALS

28A.02 CONCRETE

Portland cement concrete masonry shall conform to the requirements of Item 11. The composition of the mix shall be determined as defined in Paragraph 108, Material Details.

28A.03 BRICKWORK

Brick and mortar used in any brick work under this section shall conform to the requirements of Item 16.

28A.04 CONSTRUCTION METHODS

Manholes shall be adjusted to grade and shall be repaired as necessary prior to the paving operations. Covers of manholes shall be removed and all masonry found to be in poor condition shall be rebuilt using materials conforming to the original structure.

The materials necessary to be excavated under this section shall be removed from the site. All such excavations shall be backfilled with suitable approved materials and compacted thoroughly.

28A.05 METHOD OF MEASUREMENT

The number of manholes adjusted and/or repaired to be paid for under this section shall be the actual number of manholes complete and accepted.

28A.06 BASIS OF PAYMENT

The number of Manholes adjusted and repaired, as provided above shall be paid for at the contract unit price bid for Item 28A, Adjusting and Repairing Existing Manholes which price and payment shall constitute full compensation for excavating, removing the covers and portions of structures, furnishing and placing all materials, backfilling, resetting the covers to proper grades, labor, equipment, tools and incidentals necessary to complete the work.

ITEM 29

TOPSOIL

29.01 DESCRIPTION

Topsoil shall consist of furnishing and placing topsoil and fertilizer for planting. Topsoil shall be a rich, friable soil conforming to the requirements of these specifications, and obtained from locations indicated on the plans, or as approved. Topsoil shall be placed at the locations and to a minimum 4" depth indicated on the plans or as directed, and in conformity with the requirements of these specifications.

29.02 MATERIALS

Topsoil for planting shall be original surface friable loam topsoil of good, rich, uniform, quality, free from heavy clay, coarse sand, stones over 2" lumps, frozen clods, plants, roots, sticks and foreign materials harmful to plant growth.

Topsoil shall be reasonably free from noxious perennial weeds or woody vegetation and completely void of Johnsongrass (*Sorghum halapense*) as determined through prior inspection by an authorized representative of the Department of Public Works.

The topsoil shall have an acidity range of pH 6.0 to pH 7.5 and, if necessary, lime shall be applied as directed by the Engineer and incorporated with the furnished topsoil.

Topsoil shall contain not less than 2.0% nor more than 30% organic matter as determined by loss through ignition of samples oven dried to constant weight at 212° F $\pm$ 5°.

Topsoil shall meet the following analysis as determined by the AASHTO Designation T-88, Standard Hydrometer Test. Sand, silt and clay are as defined by AASHTO Designation M-146.

Grading Analysis:

<u>MINIMUM</u> <u>% PASSING</u>	<u>SIEVE</u>
100	2"
90	No. 4
80	No. 10

	<u>MINIMUM PERCENT</u>	<u>MAXIMUM PERCENT</u>
--	------------------------	------------------------

Sand	15	65
Silt	10	60
Clay	5	40

Topsoil shall not be delivered until samples have been approved by the Engineer.

29.03 FERTILIZER

Fertilizer for this item shall be a recognized commercial fertilizer with an analysis of 5% total nitrogen, 10% available phosphoric acid and 5% total potash (5-10-5). Ground limestone will be used in additional.

29.04 AREAS FROM WHICH OBTAINED

Topsoil shall be secured from areas from which topsoil has not been previously removed either by erosion or mechanical methods, and it shall not be removed to a depth in excess of the depth approved.

The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage, and other characteristics as to offer assurance that when removed in commercial quantities, the product will be homogeneous in nature and will conform to the requirements of these specifications.

CONSTRUCTION METHODS

29.05 CLEARING THE AREA

All areas from which topsoil is to be secured shall be cleaned of all brush, sticks, weeds, stones, bricks, ashes and other refuse which will hinder or prevent growth.

29.05 APPROVAL OF MATERIAL

In securing topsoil from an approved source, should strata or seams of materials be encountered which do not qualify as topsoil, such materials shall be removed from the topsoil, or, if required, the source shall be abandoned.

29.07 PLACING

Before placing or depositing topsoil upon any section as shown on the plans, the foundation upon which the topsoil is to be placed shall be approved.

Topsoil shall be spread on these areas to a 4" minimum depth or sufficiently greater than that specified on the plans that after natural settlement has taken place, the work will be in reasonably close conformity with the lines, grades, and elevations shown on the plans.

29.08 MAINTAINING THE TOPSOIL

The Contractor shall maintain the topsoil at his own expense until final completion and acceptance of the contract. Maintenance shall consist of preserving, protecting, replacing, and such other work as may be necessary to keep the topsoil in a satisfactory condition.

29.09 FINAL CLEANING

Upon the completion of this section, final cleaning shall be done within the limits of the project, and shall consist of completely cleaning the project of excess material, sweeping pavements and structures of dirt and rubbish, and the removal of any unused material which will mar the appearance of the contract.

29.10 METHOD OF MEASUREMENT

The yardage of Topsoil to be paid for under this section shall be the actual number of square yards of topsoil and fertilizer complete in place and accepted. In computing the topsoil yardage for payment, the areas to be measured shall be those shown on the plans, or as ordered. Measurement will be made on the surface of the completed area topsoiled.

29.11 BASIS OF PAYMENT

The yardage of Topsoil determined as provided above shall be paid for at the contract unit price per square yard bid for Item 29, Topsoil, which price and payment shall be full compensation for preparation of the grade, furnishing, hauling, and placing all materials (including fertilizer and lime), and for all labor, equipment, tools and incidentals necessary to complete the work.

ITEM 30

TOPSOILING

30.01 DESCRIPTION

Topsoiling shall consist of placing the topsoil which has been salvaged and stock-piled under Item 2. Topsoiling under this section shall be placed in the locations and to the depths shown on the plans, and shall conform to the requirements of Item 29.

30.02 MATERIALS

All topsoil used in the work of this section shall conform to Item 29.

30.03 CONSTRUCTION METHODS

The work of placing all topsoil under this section shall conform to Item 29.

30.04 METHOD OF MEASUREMENT

The yardage of Topsoiling to be paid for under this section shall be the actual number of square yards of topsoil in place complete and accepted. In computing the topsoiling yardage for payment, the areas to be measured shall be those shown on the plans, or as ordered. Measurements shall be made on the surfaces of the completed topsoiling areas.

30.05 BASIS OF PAYMENT

The yardage of Topsoiling determined as provided above shall be paid for at the contract unit price per square yard bid for Item 30, Topsoiling, which price and payment shall constitute full compensation for preparation of the grade, hauling, and placing all topsoil salvaged under Item 2, furnishing, hauling, and placing additional topsoil in accordance with Item 29 at the Contractor's expense if sufficient topsoil has not been reserved to complete the section of Topsoiling, unless otherwise indicated on the plans and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 31

SEEDING

31.01 DESCRIPTION

Seeding shall consist of furnishing and placing seed and soil supplements on topsoiled areas and at any other locations indicated on the plans or ordered by the Engineer in accordance with these specifications.

MATERIALS

31.02 SOIL SUPPLEMENTS

Limestone shall be ground agricultural limestone and shall contain not less than 85% calcium and magnesium carbonates. Dolomitic lime or magnesium lime shall contain at least 10% magnesium oxide. The ground limestone shall be ground to meet the following gradation:

No. 10 sieve -----	100% passing
No. 20 sieve -----	90% passing
No. 100 sieve -----	50% passing

The fertilizer mix requirements for permanent roadside seeding and suburban development seeding per acre are as follows:

Standard Seeding Mix:

70 lbs. nitrogen (N), 50% by weight of the nitrogen content shall be available from ureaformaldehyde.

42 lbs. available phosphoric acid (P_2O_5)

28 lbs. water soluble potash (K_2O)

Crownvetch Mix:

152 lbs. nitrogen (N), 100% by weight of the nitrogen content shall be available from ureaformaldehyde.

100 lbs. available phosphoric acid (P_2O_5)

100 lbs. water soluble potash (K₂O)

Commercial fertilizer shall be furnished in containers plainly marked with the chemical analysis of the product or, if provided in bulk, a certificate guaranteeing the fertilizer analysis must accompany each delivery to the project. No fertilizer shall be used which has not been marketed in accordance with State and Federal laws.

The ureaformaldehyde specified above shall meet the following requirements:

Total nitrogen (TN) cold water insoluble --	38.0% Minimum
Nitrogen (IN25 deg.) -----	25.0% Minimum
Activity index (AI) -----	45.0% Minimum
Urea nitrogen -----	3.5% Minimum

Chemical Binder. The chemical binder shall be 50% solids in water emulsion containing or composed of Polyalkyleneoxide Modified Vinylolefin.

The chemical binder shall be miscible with all normally available water. After an adequate drying period of two to six hours, the chemical binder shall no longer be soluble or dispersible in water.

The chemical binder shall be physiologically harmless, shall not inhibit seed germination and shall be entirely safe for existing vegetation, as well as for wild and marine life.

31.03 GRASS AND AGRICULTURAL SEEDS

All seed shall be fresh, clean, from new crop seed, and delivered to the site unopened in original packages which have affixed to the packages the dated guaranteed analysis in accordance with the Delaware Code.

All seed shall display an inspection tag affixed at the time of mixing. All seed mixed for use on projects shall be used within 9 months of the date of certification.

Permanent Roadside Mix (per acre):

Quantity	Type	Min % <u>Purity</u>	Min % <u>Germination</u>	Max % <u>Weed Seed</u>
40 lbs.	Festuca Elatior Arundinacea (Dwarf Tall fescue - mowless blend)	98	85	.5
20 lbs.	Festuca Ovina Var. Duriuscula (Hard Fescue - SR 3000)	98	85	.5
20 lbs.	Festuca Rubra Var. Commutata (Chewings Fescue SR 5000)	98	85	.5
25 lbs.	Festuca Rubra (Red Fescue: Pennlawn)	98	85	.5
5 lbs.	Lolium Perenne (Perennial Ryegrass SR 4200)	98	90	.25
30 lbs.	Secale Cereale* (Cereal Rye)	97	90	.75

* To be added to mix if seeding accomplished between October 20 and March 1.

Permanent Suburban Development Mix (Per Acre):

Quantity	Type	Min % <u>Purity</u>	Min % <u>Germination</u>	Max % <u>Weed Seed</u>
65 lbs.	Festuca Elatior Arundinacea (Dwarf Tall Fescue-Mowless Blend)	98	85	.5
30 lbs.	Festuca Rubra (Red Fescue: Pennlawn)	98	85	.25
5 lbs.	Lolium Perenne (Perennial Ryegrass SR4200)	98	90	.25

Crownvetch Mix (Per Acre):

Quantity	Type	Min % Purity	Min % Germination	Max % Weed Seed
30 lbs.	Coronilla Varia (Crownvetch: Penngift)	99	70*	.35
30 lbs.	Lolium Multiform (Annual Ryegrass)	95	90	.15
5 lbs.	Lespedeza Stipulacea (Korean Lespedeza)	98	85**	.75

* Germination shall include a total of 35% (Min.) quick germination plus hard seed.

** Germination shall include a total of 55% (Min.) quick germination plus hard seed.
Lespedeza shall be hulled and scarified.

31.04 SEED INOCULANT

The inoculant for crownvetch seeding shall be a pure culture of nitrogen fixing bacteria selected for maximum vitality and for the ability to transform nitrogen from the air into soluble nitrates and deposit them in the soil. Inoculants shall consist of pure bred cultures and shall not be used later than the date indicated on the container. Four times the normal amount of inoculant as indicated on packaging shall be used for wet application. Temperatures above 75°-80°F, will weaken the bacteria and the Contractor shall take every precaution possible while handling the inoculant.

CONSTRUCTION METHODS

31.05 GENERAL

This item shall consist of preparing the ground, furnishing and placing all lime, fertilizer and seed on the area indicated on the plans and as specified by the Engineer. This work will include, in addition to the lime, fertilizer and seed, the specified quantity of inoculant and mulch required in the seeding slurry when placing crownvetch. The Engineer reserves the right to stop seeding operations whenever conditions are determined to be unfavorable. All materials used on this contract shall be obtained by the Contractor from a dealer or manufacturer whose product is shown by analysis to fulfill the guarantee claimed by the producer.

Seeding Periods:

Seeding operations for Permanent Roadside Mix and Permanent Suburban Development Mix, as specified in Subsection 31.03, shall be carried out between March 1 and May 15 and between August 15 and October 20. All requests by the Contractor to seed at a time other than as specified above shall be submitted in writing.

Seeding operations for Crownvetch Mix as specified in Subsection 31.04 shall be carried out anytime during the year except October and November.

31.06 SEEDING FLAT AREAS (4:1 SLOPES OR LESS)

General. All topsoil placement and grading shall be completed before seeding.

Seedbed Preparation. The area to be seeded shall be thoroughly loosened to a depth of not less than 4", and if just prior to seeding, the top 2" of soil is loose, friable and free of large clods, rocks, or other extraneous matter 3" or more in diameter measured at the widest dimension; and if shaped to the prescribed grade, it shall be a satisfactory seedbed and require no further work.

However, when that area to be seeded is partially sodded, barren, weedy, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily removed; and the soil shall then be scarified or otherwise loosened to a depth of not less than 4". Clods and lumps shall be broken, rubbish, rocks and other extraneous matter removed clear of the site; and the upper 2" or 3" shall be disced or otherwise worked into a satisfactory seedbed.

Quantities of Material. The quantity of limestone as specified according to Subsection 31.02 shall be applied at the rate of 3,000 pounds per acre.

The quantity of seed as specified according to Subsection 31.03, Standard Roadside Mix, shall be applied at the rate of 110 pounds per acre.

Fertilizer shall be applied according to the quantities of actual plant food per acre required as specified according to Subsection 31.02, Standard Roadside Mix.

Spraying Equipment. The seeding applicator shall have a water tank equipped with a liquid level gauge calibrated to read increments not greater than 50 gallons over the entire range of the tank capacity, and the gauge shall be mounted and visible to the nozzle operator. The tank shall also be equipped with an agitation system capable of keeping all the solids in a state of complete suspension at all times during the seeding operation.

Wet Application of Lime, Fertilizer and Seed. The Contractor shall apply the seed, lime, fertilizer and, when appropriate, the inoculant, by mixing them in an aqueous solution and spraying them on a previously prepared seedbed as specified in Subsection 31.06 above.

The limestone, fertilizer, seed and, when appropriate, the inoculant, shall be added to the seeding applicator after the unit has been completely filled with water. A minimum of 1,000 gallons of water shall be required per acre. When wood cellulose fiber as specified according to Subsection 32.02 is chosen as the mulch for placement over seeded areas, it shall be applied through wet application equipment at the rate of 1,800 pounds per acre. The Contractor may choose to incorporate the wood cellulose fiber as an integral part of the slurry or separately as specified according to Subsection 32.03, Construction Methods. In the event he chooses to apply the wood cellulose fiber as a part of the seed slurry, the mulch shall be added after the seed, fertilizer and lime are thoroughly mixed in the spraying applicator. Where areas of less than one acre are involved, the seed, limestone (wood cellulose fiber when included in slurry) and fertilizer shall be mixed together in the relative proportions specified above with not more than 300 pounds of these combined materials mixed with each 100 gallons of water.

Where the use of a chemical binder is specified, the chemical binder shall be diluted in a minimum of 1,500 gallons of water per acre when applied on rain wet soil; and in a minimum of 2,500 gallons when applied on dry soil. Both the application rate of the chemical binder and of the dilution water may be varied by the Engineer, in accordance with the construction site and particular soil requirements. The limestone, fertilizer, seed, wood cellulose fiber and chemical binder shall comprise the seeding slurry to be applied with wet application equipment as described above. The quantities of limestone, seed, and fertilizer shall be applied at the rates specified according to Subsection 31.06 above. The chemical binder shall be applied at a minimum rate as determined by the Manufacturer. The wood cellulose fiber shall be applied at the rate of 600 lbs. per acre. The seeding slurry shall not be applied during heavy rainfall or at temperatures below 34°F. Following the final application, all surfaces consolidated shall not be disturbed in any manner by vehicular, pedestrian, or other traffic.

All water used shall meet the requirements of Paragraph 102, Material Details.

Particular care shall be taken to insure complete and accurate coverage at the prescribed rates. Proper predetermined quantities of mixture in accordance with the specifications shall be used to cover specified sections of known surface area.

Seeding operations shall not be carried out during periods of high wind.

Responsibility for Treated Areas. Until the project is finally accepted, the Contractor shall be required to mow and maintain vegetation between 4" and 10" in height. Also, the Contractor will be required to repair or replace any seeding or mulching that is defective or becomes damaged.

When seeding is approved and accomplished out of season and all other work on the contract has been satisfactorily completed, but a determination cannot be made as to whether or not an established stand of grass has or may result, payment for the areas seeded out of season will be withheld until such time as this requirement has been met.

A satisfactory stand of grass as determined by the Engineer shall be required. To be acceptable, a stand must have at least a uniform count of 80 to 100 plants per square foot.

31.07 SEEDING SLOPES (3:1 SLOPES OR GREATER)

General. Crownvetch seeding and mulching shall be completed on all slopes 3:1 or greater as shown on the plans. Topsoil, except in highly urbanized areas, shall not be required when applying the crownvetch mix and mulch.

Seedbed Preparation. All slopes shall be tilled and scarified across the slope to prevent gully and sheet erosion to the satisfaction of the Engineer.

Spraying Equipment. The seeding applicator shall have a water tank equipped with a liquid level gauge calibrated to read increments not greater than 50 gallons over the entire range of the tank capacity, and the gauge shall be mounted and visible to the nozzle operator. The tank shall also be equipped with an agitation system capable of keeping all the solids in a state of complete suspension at all times during the seeding operation.

Quantities of Material. The quantities of limestone, fertilizer, crownvetch, inoculant, companion grass seed and mulch listed below shall be mixed into the applicator and applied directly to one acre as described under Wet Application Procedure.

The quantity of limestone as specified according to Subsection 31.02 shall be applied at the rate of 3,000 pounds per acre.

The quantity of seed as specified according to Subsection 31.03, Crownvetch Mix, shall be applied at the rate of 65 pounds per acre. The inoculant required for crownvetch seed shall be applied as specified according to Section 31.04, Seed Inoculant.

Fertilizer shall be applied according to the quantities of actual plant food per acre required as specified according to Subsection 31.02, Crownvetch Mix.

The mulch required during and after the seeding operation shall be wood cellulose fiber as specified according to Subsection 32.02, at the combined total rate of 1,800 pounds per acre. Straw or hay may be used for mulch after seeding as specified according to Subsection 32.02 at the rate of 2½ tons per acre.

Wet Application Procedure

Step 1: To 1,000 gallons of water in the tank, add the limestone, fertilizer, seed, inoculant and 300 pounds per acre of wood cellulose fiber. The Contractor shall see that the slurry of material is continuously stirred during application.

Where areas of less than one acre are involved, the lime, fertilizer, crownvetch seed, inoculant, companion grass and wood cellulose fiber shall be mixed together in the relative proportions specified above with not more than 300 pounds of these combined materials mixed with each 100 gallons of water.

Step 2: The Contractor shall immediately apply the mulch to offset the drying effects of the sun and wind. Mulch may be wood cellulose fiber at the rate of 1,500 pounds per acre. Hay or straw may also be used at the rate of 2½ tons per acre and tacked with a chemical binder at a minimum rate of 45 gallons per acre as determined by the Engineer.

Watering Following the shaping, seeding, fertilizing and mulching, the area shall be watered sufficiently to saturate the seedbed, unless otherwise directed by the Engineer. Water shall be applied as a spray. Three additional waterings shall be applied at approximately one-week intervals at the discretion of the Engineer subject to local weather conditions. Each additional watering shall moisten the soil to a depth of 2". The initial watering of seeded areas shall be done not later than the day following seeding. The cost of watering shall be included in the price bid for the item.

Responsibility for Treated Areas The Contractors responsibility for treated areas until the project is finally accepted, shall be as specified in Subsection 31.06. A satisfactory crownvetch cover, as determined by the Engineer, shall display uniform establishment.

31.08 METHOD OF MEASUREMENT

The quantity of Seeding for which payment will be made shall be the total number of square yards of surface area actually seeded in accordance with the plans or as directed by the Engineer. Measurements will be made on the ground surface of individual seeded areas.

The quantity of Crownvetch Seeding and Mulching for which payment will be made shall be the total number of square yards of surface area actually seeded and mulched in accordance with the plans or as directed by the Engineer. Measurements will be made on the ground surface of individual seeded areas.

31.09 BASIS OF PAYMENT

The surface area of Seeding as described above shall be paid for at the contract unit price bid per square yard for "Seeding," which price and payment shall be full compensation for preparing the ground, furnishing and placing all seed, water, fertilizer, lime, maintenance as described above, and for all labor, equipment and incidentals necessary to complete the work.

Where wood cellulose fiber is used by the Contractor for mulching and is either applied with the spray applicator separately or mixed with the seeding slurry, it shall be paid for separately under Item 32, Mulching.

The surface area of Crownvetch Seeding and Mulching as determined above shall be paid for at the contract unit price bid per square yard for "Crownvetch Seeding and Mulching," which price and payment shall be full compensation for preparing the ground, furnishing and placing all seed, watering, fertilizer, lime, inoculant and mulch, chemical binders, maintenance as described above, and for all labor, equipment and incidentals necessary to complete the work.

ITEM 32

MULCHING

32.01 DESCRIPTION

Mulching shall consist of furnishing, placing, and anchoring mulch over seeded areas on slopes and other areas as indicated on the plans or as directed by the Engineer.

MATERIALS

32.02 MULCH

- (a) **Small Grain Straw**. Straw for mulching shall be from oats, wheat, rye or other approved grain crops which are free from noxious weeds, mold or other objectionable material. Straw mulch shall be in an air-dry condition and suitable for placing with mulch blower equipment.
- (b) **Wood Cellulose Fiber or Approved Equal**. Wood cellulose fiber shall consist of specially prepared wood cellulose processed into a uniform fibrous physical state. Wood cellulose fiber shall contain a green dye that will provide for easy visual inspection for uniformity of the spread slurry.

The wood cellulose fiber, including dye, shall contain no germination or growth inhibiting properties. The material shall be manufactured and processed in such a manner that the wood cellulose fiber will remain in uniform suspension in water under agitation and will blend with seed, fertilizer and other additives to form a homogeneous slurry. The wood cellulose fiber shall perform satisfactorily in hydraulic seeding equipment without clogging or damaging the system.

The manufacturer shall certify that the wood cellulose fiber shall not exceed 2.0% ash content determined in accordance with ASTM D 586.

The material shall be delivered in packages of uniform weight which shall not exceed 75 pounds net weight and shall bear the name of the manufacturer, the net weight and supplemental statement of the net weight content in the form of certification.

- (c) **Jute Mesh.** Jute mesh shall be of a uniform, plain weave with warp and weft yarns of approximately the same size.

The physical requirements shall be:

Width - variable

78 warp ends per width minimum

41 weft ends per yard minimum

Range in weight of cloth: 1.80 lbs. (average) per running yard with a 5% minimum tolerance to 1.22 lbs. (average) per running yard with a 5% minimum tolerance at standard atmospheric conditions.

Dry: Warp and Fill 6 pounds, minimum

Wet Tensile: 50% of the above dry tensile, minimum

- (d) **Mulch Netting or Approved Equal.** Erosion control netting shall be an extruded rectangular mesh plastic.

Weight: 3 lbs. minimum/1,000 s.f.

Color: Clear, green or black or other earth colors

Width: 5' minimum width

Mesh Opening: 2" x 2" maximum

- (e) **Excelsior Blankets or Approved Equal.** Excelsior blankets shall be made smolder resistant without the use of chemical additives.

Blanket: variable

Fiber Dimensions: .021" x .042" $\pm$ 10% per s.y.

Weight: 0.8 lbs. $\pm$ 10% per s.y.

Length and Condition: All material must be new and unused.

The length shall be marked on each roll.

The excelsior blanket shall consist of a machine produced mat of curled wood excelsior of 80% 6" or longer fiber length with consistent thickness and the fiber evenly distributed over the entire area of the blanket.

The top side of each excelsior blanket shall be covered with a 3" x 1" weave of twisted kraft paper having a high wet strength of a 2" x 1" biodegradable extruded plastic mesh.

- (f) **Soil Reinforcing Mat or Approved Equal.** Soil reinforcing mat when specified for ditch lining and slope wall protection shall consist of a bulky structure of entangled nylon monofilaments, melt-bonded at their intersections, forming a

stable mat of suitable weight and configuration. The mat shall be resilient, permeable and highly resistant to environmental deteriorations and ultraviolet degradation. The color of the mat shall be black and comply with the following physical and chemical properties:

Material Type: Nylon 6 plus a minimum content of 0.5% by weight of carbon black.

Filament diameter: 0.40 mm, min. 0.0157 in., min

Weight: $405 \pm 7\%$ g/m² 0.7466 lb./s.y.

Thickness of mat: 18 mm, min. 0.7086 in., min.

Width: $97 \pm 3\%$ cm 38.189 in.

Roll length: 100 ± 3 m 109 yards

Tensile properties: ASTM D 1682 strip test procedure modified to obtain filament bond strength of indicated tensile properties

Strength:	Kg/m	Lb/in
Length direction	140	7.84
Width direction	80	4.48
Elongation:		
Length direction	50% min.	
Width direction	50% min.	

Resiliency - Compression load cycling of 100 psi (689.47kPa) on a 2" x 2" sample size, crosshead speed of 2 inches per minute
30 minutes recovery, 80% min.
(3 cycles)

Certification - The manufacturer shall furnish certification with each shipment of mat stating that the material complies with the requirements of the specifications for the number of rolls furnished in this shipment.

Wood Stakes - Wood stakes used in conjunction with soil reinforcing mat shall be sound, rough sawn hardwood measuring 1" x 3" with a length of 9"-12" and tapered to a point.

- (g) **Chemical Mulch Tack of Approved Equal.** Chemical mulch tack shall consist of free flowing silicate granules to which hydrophilic polymers, reclaimed biodegradable cellulose fibers, and coloring agents are added.

In addition, the following specifications apply:

1. pH 6-7
2. Viscosity 1% suspension - 1650 centipoise on a Brookfield viscometer with a #3 spindle at 70°F. One hour viscosity of 1900 cps under same conditions.
3. Particle Size: Silicate granules: 96% less than 44 microns.
Polymers: Maximum 20% 325 mesh screen.
4. Coloring Agent: Basic green dye, cationic in nature, non-toxic to all life, color dissipates upon exposure to sunlight.

Mulch tackifiers shall be capable of effectively binding mulch for retention after application. Mulch tackifiers shall not inhibit seed germination and plant growth. Tackifiers shall be harmless and safe for human, marine, plant and wildlife.

The chemical mulch tackifiers shall be miscible with all normally available water. After adequate drying (2-6 hours), the tackifier shall no longer be water soluble or be dispersible in water. It shall remain green in appearance but will upon application gradually dissipate upon exposure to sunlight.

32.03 CONSTRUCTION METHODS

Excelsior blanket, or its approved equal mulch, shall be utilized to stabilize ditchlines up to a maximum design velocity of 5.0 fps. Soil reinforcing mat, or its approved equal mulch, shall be utilized to stabilize ditchlines up to a maximum design velocity of 12.0 fps. Stabilization, where the ditchline velocity exceeds 12.0 fps, will vary according to specific project requirements and will be identified in the Plans.

Mulch for use in stabilization of sheet flow requirements (all exposed sites/areas other than ditchlines) shall be in accordance with the following:

1. **Mulch for Use on All Seeding.** (3:1) or Flatter Sheet Flow):

Small grain straw at 4,000 pounds per acre secured with chemical mulch binder in accordance with Subsection 32.02.

2. **Mulch for Use on All Seeding.** (Sheet Flow Steeper than 3:1)

Excelsior blankets secured in accordance with Subsection 32.04 or small grain

straw at 4,000 pounds per acre secured by crimping as required in Subsection 32.04.

- (a) **Small Grain Straw Mulch.** Small grain straw mulch, as specified according to Subsection 32.02(a) shall be uniformly and evenly applied after the seeding has been completed or on any portions of the total area completed on a daily basis.

A mechanical blower may be used to apply the mulch material, provided the machine has been designed and approved for that purpose. At least 90% of the small grain straw mulch as placed shall be in pieces 6" or larger.

Wood cellulose fiber, as specified according to Subsection 32.02(b) shall be uniformly and evenly applied with or immediately after the seeding operation as specified in accordance with Item 31, Seeding.

- (b) **Jute Mesh or Approved Equal.** Jute Mesh, as specified according to Subsection 32.02(c) shall be placed when specified for use according to the standard drawings showing details for the installation of jute mesh over small grain straw mulch only.

During ditch shaping operations, a seedbed shall be provided approximately $\frac{3}{4}$ " deep. Seedbeds on slope areas to be protected with jute mesh shall be prepared as provided in Item 31, Seeding.

All rocks or clods over 1½" in diameter and all sticks or other foreign material which will prevent contact of the jute mesh with the seedbed will be removed.

Ditch-channel and adjacent slope seedbeds shall then be fertilized, limed and seeded according to Subsection 31.06, Seeding Flat Area (4:1 slopes or flatter).

Small grain straw shall be applied at the rate of 1,500 pounds per acre to the seeded area prior to laying the jute mesh.

Jute mesh shall then be applied in the direction of the flow of water. Where more than one strip is required, the lap joint shall be lapped not less than 2".

The anchor slot on the top edge of the jute mesh shall be buried from 6" to 12" perpendicular to mesh placement as designated by the standard sheets or as directed by the Engineer.

On junction slots, the upslope end of each strip of jute mesh shall be buried 6" to 12" perpendicular to the slope or as designated by the Engineer, with the soil firmly tamped. The ends of jute mesh shall overlap at least 16" with the end folded under approximately 4" and stapled with the upgrade section on top. Rolls of jute mesh containing splices that are not securely sewn by machine shall be separated and junction slots installed.

Check slots, approximately 45" wide, shall be constructed by placing a tight fold from 6" to 12" vertically into the soil, as designated by the Engineer. The jute mesh shall be tamped and stapled into place. All check slots must be placed at right angles to the direction of water flow before the jute mesh is applied to the area specified. Check slots on ditch channels must be spaced so that one check slot occurs within each 100 feet on adjacent slopes 4:1 or less. On adjacent slopes 3:1 to 4:1, check slots must be spaced so that one slot occurs within each 50 feet. Check slots on slopes steeper than 3:1 shall be spaced so that one check slot occurs each 30 feet.

The terminal fold at the bottom end of the jute mesh shall be folded under approximately 4" and stapled.

- (c) **Mulch Netting.** Mulch netting, as specified according to Subsection 32.02(d), shall be placed when specified for use according to the standard drawings showing details for the installation of erosion control netting over small grain straw only.

During ditch shaping operations, a seedbed shall be provided approximately $\frac{3}{4}$ " deep. Seedbeds on slope areas to be protected with erosion control netting shall be prepared as provided in Item 31, Seeding.

All rocks or clods over 1½" in diameter and all sticks or other foreign material which will prevent contact of the jute mesh with the seedbed shall be removed.

Ditch-channel and adjacent slope seedbeds shall then be fertilized, limed and seeded according to Subsection 31.06, Seeding Flat Area (4:1 slopes or flatter).

Small grain straw shall be applied at the rate of 1,500 pounds per acre to the seeded area prior to laying the erosion control netting.

When specified for installation in ditchlines, erosion control netting shall be

applied in the direction of the water flow. It is essential to extend the netting 4"-6" over the top edge of the ditch. Overlap ends of netting 2"-4" with upstream netting blanket on top.

Using square top staples as specified by the manufacturer, insert one every 1'-2' along end of netting and at every overlap strip. Insert staples every 4'-5' on each edge and down center of netting to form an X-shaped pattern.

First, staple the end of netting starting in the middle and continuing down the center of the netting. Next, staple towards the outside edge applying interior staples first. Last, apply staples on the outside edge.

Where two or more netting steps must be utilized to cover a ditch, overlap at least 4" and staple all overlap at 1'-2' intervals.

When specified for installation on slopes, netting shall be unrolled from the top to the bottom of the slope overlapping the adjacent net 2"-4" with the net on the upstream side of any lateral water flow on the surface. Utilizing square top staples, insert one staple every 1'-2' along the top and bottom ends. Also insert staples every 4'-5' on each edge and down the center of the net to form an X-shaped pattern.

Staple the top end of the mulch first, starting in the center of the net and working toward the outside edges. Staples shall always be installed moving from the center out and down the slope.

- (d) **Excelsior Blankets.** Excelsior blankets, as specified according to Subsection 32.02(e) shall be placed when specified for use according to the standard drawings showing details for the installation of excelsior blankets for seedbed protection in conjunction with wood cellulose fiber mulch.

During ditch shaping operations, a seedbed shall be provided approximately $\frac{3}{4}$ " deep. Seedbeds on slope areas to be protected with jute mesh shall be prepared as provided in Item 31, Seeding.

All rocks or clods over 1½" in diameter and all sticks or other foreign material which will prevent contact of the excelsior blanket with the seedbed shall be removed.

Ditch-channel and adjacent slope seedbeds shall then be fertilized, limed and seeded according to Subsection 31.06, Seeding Flat Areas (4:1 slopes or flatter).

When the excelsior blanket is unrolled, the netting shall be on top of the fibers in contact with the soil over the entire area. In ditches, the blankets shall be applied in the direction of the flow of water, butted snugly at ends and sides and stapled.

On slopes, the blankets shall be applied either horizontally or vertically to the slope. Ends and sides shall be overlapped and stapled. It shall not be necessary to dig check slots, anchor ditches or bury the ends of the blankets. On slopes 6:1 through 2:1, the blankets shall be placed as above but stapled every two (2) linear yards for each strip, with one row of staples along each edge and one alternating parallel to row in the center.

- (e) **Soil Reinforcing Mat or Approved Equal.** Soil reinforcing mat, as specified according to Subsection 32.02(f), shall be placed when specified for use according to the standard drawings showing details for the installation of soil reinforcing mat for ditchline or swale stabilization, or in lieu of riprap slope protection or concrete gutter.

All surfaces to be protected with nylon erosion control mat shall be graded, shaped and finished so that the surfaces are stable, firm and free of rock or obstructions which prevent the mat from lying in direct contact with the soil surface.

Installation of Mat. The terminal ends of the mat shall be buried at least 12" vertically in an anchor slot dug into the soil. The mat shall be secured in the anchor slot by stakes at intervals of 3' or less prior to backfill of the slot. The backfilled soil shall be firmly compacted in the anchor slot. The ends of each mat shall be overlapped 36" with the upslope mat on top. The lapped joint shall be stacked at intervals of 3 feet or less. Check slots 6" deep shall be installed every 25' and extend up the side of slopes of the ditch a minimum of 6". The outer edges of the mat shall be buried in 4" slots, staked at 3' intervals and backfilled to prevent water from undercutting at the edges. The mat shall be firmly anchored by stakes along the entire mat surface on a minimum 3' x 3' spacing.

Seeding. After the mat has been placed and approved, the mat area shall be uniformly seeded at the rates specified in Item 31. Seed shall be sown on the designated areas by hydraulic, broadcast or handseeding methods allowing the seed to drop to the soil through openings in the mat.

Mulch Application. Wood cellulose fiber mulch shall be applied hydraulically to the seeded area within 48 hours after seeding. The mulch shall be applied uniformly at the rate of 320 pounds per 1,000 square yards.

The mulching operation shall be a separate work operation and shall not be incorporated as part of the seeding application.

32.04 MULCH SECUREMENT

- (a) Small grain straw, as placed to Subsection 32.03(a), shall be secured by crimping utilizing a cleat tracked vehicle as approved by the Engineer on all slopes 1½:1 to 4:1. Slopes flatter than 4:1 and all other sites mulched with straw shall be secured utilizing chemical mulch binder specified according to Subsection 32.02(g), or with a crimping device as approved by the Engineer.

On all slopes 1½:1 to 4:1 which are cleat tracked, an angle not to exceed 10° from the vertical plane is the limit for all work performed where a deviation is required from the vertical due to obstacles or structures which may interfere with the cleat tracking operation.

Silt fence damaged or requiring replacement as a result of crimping or tracking operations will be replaced at the contractor's expense.

- (b) **Jute Mesh.** Jute mesh, as placed according to Subsection 32.03(b), shall be secured by the following methods:

For all anchor slots, junction slots, check slots and terminal folds, suitable wire "U" shaped staples shall be used. In sandy areas, wire staples with a minimum length of 12" will be required. In other soils, wire staples with a minimum length of 6" will be required. Wire staples shall be driven without objectional bending. The minimum diameter of staples shall be of 11 gauge, but for some soil conditions, wire of 13 gauge will be accepted if driving is demonstrated to be satisfactory.

The lap joints which run parallel to the direction of flow in channel bottoms shall be stapled on 2' intervals. Outside edges, centers and overlaps on banks should be stapled on 2' intervals. Each width of cloth will have a row of staples down the center as well as along each edge. Check slots and junctions of new rolls shall be stapled across the channel on 6" intervals. On soft or sandy soil or windy areas, apply staples in alternating slanting position and space at closer intervals of 12" to 18".

On extremely hard soil or swale areas, a sharp pointed hardened steel 3" fence staple shall be used.

Alternate Stapling. Hog rings, 1 1/4", can be used for added protection on lengthwise overlaps for steep slopes, windy areas, soft or sandy soil. Hog rings should be spaced 8" apart between each staple. Where hog rings are used along lengthwise overlaps, staples shall be placed 4' apart.

- (c) **Excelsior Blankets.** Excelsior blankets as placed according to Subsection 32.03 shall be secured by the following methods:

Suitable wire "U" shaped staples shall be used. In sandy areas, wire staples with a minimum length of 12" will be required. In other soils, wire staples with a minimum length of 6" will be required. Wire staples shall be driven without objectionable bending. The minimum diameter of staples shall be of 11 gauge, but, for some soil conditions, wire of 13 gauge will be accepted if driving is demonstrated to be satisfactory.

On slopes, the blankets shall be stapled every four linear feet for each strip, with one row of staples along each edge and one alternating parallel row in the center.

On ditch channels, the blankets shall be stapled every two linear feet for each strip with one row of staples along each edge and one alternating parallel row in the center.

On soft, sandy and/or windy areas, staples shall be applied in an alternating pattern as described above and spaced at intervals ranging from 12 to 18 inches, as determined by the Engineer.

- (d) **Mulch Netting.** Erosion control netting, as placed according to Subsection 32.03(c) shall be secured with adherence to the following wire staple requirements:

For all crosshatch, diagonal, terminal and overlap stapling requirements, a "U" shaped wire staple, at least 8" in length and with a minimum 2" opening, shall be required.

Wire staples shall be driven without objectional bending. The minimum diameter of staples shall be of 11 gauge, but for some soil conditions, wire of 13 gauge shall be accepted if driving is demonstrated to be satisfactory.

- (e) **Soil Reinforcing Mat/Mat Securement.** Wooden stakes for anchoring, as specified according to Subsection 32.02(f), shall be driven to within 3" of being flush with the soil surface.

32.05 METHOD OF MEASUREMENT

The number of square yards of Mulching to be paid for shall be the number of square yards of actual surface mulched, as measured along the surface of the treated area. No measurement for overlap fabric materials of any kind, as specified herein, will be allowed.

Chemical Mulch Tack, and the use of a Mulch Crimper or tiller, as described in accordance with Subsection 32.04, Mulch Securement, shall be incidental to the Mulching item.

32.06 BASIS OF PAYMENT

The quantity of Mulching shall be paid for at the contract unit price per square yard.

Excelsior blanket, erosion control net, jute mesh and soil reinforcing mat shall be paid for at the unit price bid per square yard for each item where specified for use.

The cost of excelsior blanket when required for use with wood cellulose fiber under seasonable limitations in accordance with Subsection 32.03, Construction Methods, shall be included in the unit price bid per square yard for Mulching.

The contract unit price bid for each item of excelsior blanket, erosion control net, jute mesh, soil reinforcing mat and mulching, as specified separately, shall constitute full compensation for furnishing and applying the item, to include all labor, all methods of anchorage and/or securement as described herein, equipment, tools and incidentals necessary to complete the described work.

ITEM 33

SODDING

33.01 DESCRIPTION

Sodding shall consist of preparing the ground area, furnishing, and placing approved sod at such locations as may be indicated on the plans, or as directed and in reasonably close conformity with the requirements of these specifications.

33.02 SOD

Sod shall be well rooted from high quality seed of known origin and native to the locality of the work. No sod shall be removed until a sample has been approved by an authorized representative of the Department of Public Works. Sod shall be stripped, delivered and laid within a period of 36 hours. Sod stripped and/or delivered but not laid within this period shall be reinspected and approved by the Engineer prior to its use.

Tall Fescue-Bluegrass Sod. Shall contain not less than 97% dwarf or semi-dwarf Tall Fescue (*Fescue elatior arundinacea*) with no more than 3% common Kentucky Blue Grass (*Poa pratensis*) by weight of seed in the blend. The varietal makeup of the Tall Fescue/Blue Grass Sod must be submitted for prior approval to the project Engineer.

Sod shall be free of objectionable grassy and broadleaf weeds. Sod shall be considered free of such weeds if less than 5 such plants are found per 100 square feet of area. Sod shall not be acceptable if it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel and brome grass.

Sod shall be reasonably free of thatch, diseases, nematodes and soil borne insects. All sod entering the project inter-state must display inspection tags affixed at the sod source. The same shall apply to all sod shipped intra-state with prior inspection and tagging through the Delaware State Department of Agriculture.

33.03 CUTTING SOD

Before stripping, sod shall be mowed uniformly at a height of 1 to 2½". Sod shall be machine cut at a uniform soil thickness of 5/8" plus or minus ¼", at the time of cutting. Measurement for thickness shall exclude top growth and thatch. The sod pad size shall be cut to a minimum uniform width of 12" and a minimum length of 12".

CONSTRUCTION METHODS

33.04 PLACING

Sod shall be placed only when the soil is moist and favorable to growth. In areas where soil is not favorable to growth, a minimum of 2" of topsoil shall be placed in accordance with Item 29. Sod shall not be placed between November 1 and April 1, unless weather and soil conditions are considered favorable and permission is granted.

33.05 PREPARATION OF GRADE

The area to be sodded shall be shaped and finished to the lines and grades indicated on the plans and the surface loosened prior to placing the sod. The Contractor shall water the area before the sod is placed.

33.06 LAYING THE SOD

The sod shall be placed on the prepared surface with the edges in close contact and, as far as possible, in a position to break joints. Each strip or section of sod laid shall be fitted and tamped into place with hand tampers of not less than 100 square inches in area.

After slopes of either cuts or fills have been shaped to conform to the finished grade and cross-section shown on the plans, the shoulders and toes of the slope shall be rounded off to a 5' radius, or as otherwise indicated in the plans.

On slopes 3:1 or less, the sod shall then be placed on the slopes beginning at the outer edge of the toe and working upward, or, if furnished in rolls, it may be placed from the top down.

On slopes 2:1 and steeper, sod shall be laid with the long edges parallel to the contour starting at the bottom of the slope. Successive strips shall be neatly matched and all joints staggered or broken. When placing sod in drainage ditches, the length of the strip shall be laid parallel to the direction of the flow of the water. Where replacing it, workmen shall work from ladders or treated planks to prevent further displacement.

Each strip or section of sod placed on slopes 2:1 and steeper, surface drainage V-shaped or flat bottom ditches or gutters shall be staked securely with at least two stakes or pins spaces not more than 2' apart with the flat side against the slope. Stakes may be wood wedges and shall be ½' x 1" x 6" to ½" x 1" x 12" as required by soil condition, driven so that the last 1" remains above the top of the sod, or T-shaped pins, machine bent from 15" pieces of 8-gauge low carbon bright steel with an 8" leg, a 4" head, and a 1" secondary drive. Wire pins shall be driven flush

with the top of the sod.

When sodding adjacent to a sidewalk, curb, pavements, or retaining walls, sufficient allowance shall be made in grading for the thickness of the sod, so that when placed the sod shall be flush with the tops of such structures. The sod shall be tamped to insure tight joints and a smooth level surface. As the top of the slope is reached, the sod shall be trimmed to a line placed a fixed distance from the break of the bank and along the entire length of the cut or fill. The top of the bank shall have been previously graded, so that the sod, when applied, shall come flush with the average level of the top of the bank. All surfaces shall be uniform in appearance and reasonably true to line and grade.

The Contractor shall water the sod immediately after placement to a depth sufficient that the underside of the new sod pad(s) and soil immediately below the sod are thoroughly wet and it shall be kept moist until growth is established. All sod in which shrinking, burning, or turning brown occurs shall be rejected, removed and replaced.

A satisfactory stand of grass from sod as determined by the Engineer shall be required. To be acceptable, a stand of grass from sod must display an even flush of growth and show evidence of solid surface contact and minimal undermining or erosion.

33.07 METHOD OF MEASUREMENT

The quantity of sodding to be paid for under this section shall be the number of square yards of sod placed conforming with all the requirements of these specifications, complete and accepted. Measurement will be made along the surface of the completed area sodded.

33.08 BASIS OF PAYMENT

The yardage of Sodding measured as provided above, will be paid for at the contract unit price per square yard bid for Item 33. Sodding, which price and payment shall be full compensation for grading, rounding the shoulders and toes of slopes, furnishing the sod, hauling, laying, tamping, watering, replacement, and for all labor, equipment, tools, and incidentals necessary to complete the section.

ITEM 34

PLANTING

34.01 DESCRIPTION

This item consists of furnishing specified plants, shrubs and trees and their proper planting by approved methods, as hereinafter specified in the locations shown on the plans or as directed, and the replacement and cultural care of the material as outlined herein.

MATERIALS

34.02 PLANT MATERIAL

Quality. All plants shall be true to type and nomenclature and typical of their species or variety. They shall have a normal habit of growth with well-developed branch systems and vigorous root systems. They shall be sound, healthy and vigorous plants, free from defects, disfiguration, injury, disease of any kind, insect eggs, borers and any infestation. All plants shall be nursery grown. They shall have been growing under similar climatic conditions to those of the locality of this project for at least 2 years prior to planting. All plant material shall have been grown in a soil that is similar to this area, and shall not have been grown in a muck type soil or other foreign type. It will be the responsibility of the contractor to inspect the plants before removal from the nursery where they have been grown to make sure that the plants meet this requirement. All plants shall be freshly dug and no heeled nor cold storage plants will be accepted, with the exception of plant material delivered prior to planting as outlined under Digging and Handling.

Measurements. All plants shall conform to all sizes and measurements specified in the Plant List. Plants that meet the requirements specified in the Plant List but do not have a normal balance between height and spread will not be accepted. Where any requirements or exact measurement is omitted, the plants furnished shall be normal for the species and variety as published by the American Association of Nurserymen, Inc. Plants for use where symmetry is required shall be matched as close as possible. All plants shall be measured for height and spread with the branches in their normal position. The caliper of all trees shall be taken 6" above the ground level up to and including 4" caliper size and 12" above the ground level for larger sizes. The height of the branches on the tree trunks need not be as specified if the required height can be obtained by pruning the lower branches without leaving unsightly scars and damaging the trunk. No pruning of branches for this effect will be done before delivery to the site unless approved. Plants larger in size than specified may be used if approved in

writing, but using larger plants shall not increase the contract price. If the use of larger plants is approved, the earth ball or spread of roots shall be increased proportionally in accordance with the 1972 Edition of "USA Standards for Nursery Stock," published by American Association of Nurserymen, Inc.

Inspection. The contractor shall be responsible for all certificates of inspection of plant materials that may be required by Federal, State, or other authorities to accompany shipment of plants.

The successful bidder shall furnish complete information as to the location of all plants which he intends to supply and use. The right is reserved to inspect, tag and approve all plants at the source of supply. This inspection and tagging shall not in any way eliminate the right of rejection at the site. All plants must be inspected and approved before they are planted. Any plants placed without prior inspection at the site will be rejected at the discretion of the Engineer.

The contractor shall furnish a complete listing of the locations and confirmation in writing on all types at that location and in what quantity for all plant material he intends to use on the project. Plant materials shall be protected according to best horticultural practice while in transit in such a way as to prevent the drying or possible desiccation of plant tissue. Also, any plant material arriving at the site with broken or loose balls, dry or insufficiently developed roots or which are weak or thin, or damaged or defective or which do not comply with the specifications, will not be accepted. The Engineer reserves the right to reject all stock that is found to be unsatisfactory. All plant material determined as unsatisfactory by the Engineer shall not be planted under any circumstances, and shall be removed from the project site by the close of the working day. Failure on the part of the contractor to comply with any of the above procedures will require immediate suspension of all work.

Nomenclature. Plants shall conform to the nomenclature of "Standard Plant Names" as accepted by the American Joint Commission of Horticulture Nomenclature 1942 Edition. Names of varieties not included shall conform to names accepted in Nursery trade. Size and grading shall conform to those of the American Association of Nurserymen, Inc. as published in "USA Standards for Nursery Stock." No substitution shall be permitted except by written permission of the Engineer.

34.03 TREES

Trees shall have straight trunks according to their habit of growth and shall be well branched and rooted. Shade trees of standard variety shall have a single leader and shall be branched at 6' to 8' height unless otherwise directed.

34.04 SHRUBS

Shrubs shall be well branched, with full and compact growth and have ample well branched root systems capable of sustaining vigorous plant growth.

34.05 GROUND COVER, HERBACEOUS PERENNIALS AND WILDFLOWERS

Ground cover shall be 1 year old, container grown plants, unless otherwise approved or specified in the contract documents and shall have been growing for at least 6 months in the size specified as verified by the City's inspection representative.

Herbaceous perennials shall be 6 months old, container grown plants and shall have been growing for at least 3 months in the size specified as verified by the City's inspection representative.

Wildflowers shall be native annual, biennial or perennial forms at least 3 months old, container grown plants and shall have been growing for at least 1½ months in the size specified as verified by the City's inspection representative.

34.06 TOPSOIL

Planting topsoil shall consist of natural surface soil from well drained areas from which no topsoil has previously been stripped. The topsoil shall be free of subsoil, heavy clay, hard clods, weeds, roots, sticks, toxic substances or any other extraneous material. The topsoil shall have a pH range of from 5.5 to 6.8 and contain not less than 2% nor more than 10% organic matter. The topsoil shall exhibit the following grading analysis:

<u>Sieve</u>	<u>Minimum Percent Passing</u>
2"	100
No. 4	90
No. 10	80

The contractor shall take the necessary action at his expense to insure that the topsoil meets the sieve analysis, acidity and organic matter requirements. A certificate of analysis of soil samples shall be provided the Engineer and approved prior to topsoil being delivered to the project site.

34.07 PEAT MOSS, PEAT HUMUS, COMPOSTED SEWAGE SLUDGE AND CO-COMPOSTED MUNICIPAL WASTE

Peat Moss. Peat Moss shall be from sphagnum peat bogs. All peat moss shall be shredded, not dusty and free of twigs, stones, hard lumps, roots, or any other

undesirable materials. All peat moss must be moistened before using, however, not watered to a saturated or puddled unworkable condition. Peat Moss shall show an acid reaction of 3.5pH and 5.5pH. The contractor shall provide written certification from the manufacturer that the peat moss was obtained from sphagnum peat bogs.

Peat Humus. Peat humus shall be a natural peat or peat humus from fresh water saturated areas, consisting of sedge, sphagnum or reed peat and be of such physical condition that it will pass through a ½" mesh screen. The humus shall be free from sticks, stones, roots and other objectionable materials.

Composted Sewage Sludge. Anaerobically digested sewage sludge shall be dewatered and mixed with wood chips at a 1-to-2 ratio (V/V). The mixture shall then be Environmental Protection Agency certified as to composting duration and pathogen reduction. The composted material shall also pass through a 3/8" or smaller screen. Environmental Protection Agency certification must be supplied with the product as to the above described requirements.

Random samples taken shall have the following analysis:

Typical Properties: Particle size 3/8" or smaller
Bulk Density: Approximately 1,000 lbs. per cubic yard
Moisture Content: 40% to 50%
Organic Matter Content: 50%
PH: 6.5 to 7.5
Water Holding Capacity: Approximately 50% of dry weight.

Heavy Metals and Toxic Compounds (Based on Sewage Sludge Content).

MAXIMUM PPM

Cadmium	50
Chromium	1000
Copper	1000
Lead	1000
Nickel	200
Zinc	2000
PCB's	10

Co-Composted Municipal Waste. Anaerobically digested sewage sludge shall be dewatered and mixed with municipal solid waste at a 1 to 1 ratio (V/V). Municipal solid waste shall be comprised of the organic fraction of solid waste minus glass, plastic and metal. The mixture shall then be E.P.A. certified as to composting duration and pathogen reduction. The composted material shall also pass through a ¼"

screen.

Random samples taken shall have the following analysis:

Typical Properties: Particle size $\frac{1}{4}$ "
Bulk Density: 700 to 800 pounds per cubic yard
Moisture Content: 30% to 40%
Organic Matter Content: Approximately 50%
PH: 6.5 to 7.2

Water Holding Capacity: 100% (or higher) by dry weight
Composted sewage sludge or co-composted municipal waste
in the amount of 4.0 cubic yards respectively may be substituted for the peat
moss or peat humus.

34.08 FERTILIZER

The fertilizer shall be a 20-10-5 analysis or approved equal in accordance with the following minimum guaranteed analysis:

Total Nitrogen (N)	20.00%
Derived from urea-formaldehyde	
7.0% Water Soluble Nitrogen	
13.0% Water Insoluble Nitrogen	
Available Phosphoric Acid (P_2O_5)	10.00%
Derived from calcium phosphate	
Soluble Potash (K_2O)	5.00%
Derived from potassium sulfate	
Combined Calcium (Ca)	2.60%
Derived from calcium phosphates	
Combined Sulfur (S)	1.60%
Derived from ferrous and Potassium sulfates	
Iron (expressed as elemental Fe)	0.35%
Derived from ferrous sulfate	

The fertilizer shall be formulated in tablet form weighing a minimum of 20 grams per tablet.

The fertilizer shall conform to all State and Federal Regulations. The Engineer shall require the Contractor to furnish an affidavit from the vendor or a testing laboratory as to the available nutrients contained therein.

Fertilizer shall be furnished in new, clean, sealed and properly labeled packages or containers. Fertilizer failing to meet the specified analysis may be used as determined by the Engineer, providing sufficient materials are applied to comply with the specified nutrients per unit of measure without additional cost to the City.

34.09 MULCHING MATERIALS

Mulching materials shall be commercially prepared type, either chopped pine bark, licorice root, or tan bark, or an approved equal accepted by the Engineer. All mulching materials shall be visually inspected by the Engineer prior to delivery at the planting site and shall conform to the following requirements:

1. Chopped pine bark shall be freshly prepared so as not to be decomposed or in any condition that may shorten its lifetime as an effective mulch. It shall be free of stones, sticks, weed seeds, pieces of wood or bark that measure 4" in their longest dimension and not contain any toxic or foreign materials. The mulch shall contain no more than 50% of material passing through a $\frac{3}{4}$ " sieve.
2. Licorice root shall be the by-product of the licorice extraction process. It shall be fibrous material free from all foreign and toxic substances.
3. Tan bark shall be a by-product of the tanning process. It shall be fibrous and free of foreign and toxic substances.
4. Shredded hardwood bark shall be from a deciduous hardwood source and be mechanically ground to a maximum size of six (6) inches. In addition, the bark shall be relatively free of bark fines dust and shall exclude all foreign and toxic substances.
5. Wood chips must be stockpiled for at least one (1) year prior to placement as verified by the City's inspection representative and shall not contain leaves, twigs, wood shavings and sawdust, and all foreign and toxic substances. In addition, fertilizer in accordance with Subsection 34.08 shall be applied at the rate of eight (8) ounces per square yard prior to wood chip placement.

Only one of the above mulches will be selected and approved for use throughout the entire project and written certification for the above listed requirements of the mulch shall be submitted by the contractor.

34.10 STAKES, GUYS AND RELATED MATERIALS

Guy Wire. Guy wire shall be No. 12 or No. 14 gauge annealed galvanized steel wire, free of bends or kinks.

Turnbuckles. Turnbuckles shall be galvanized with 4½" openings and 5/16" threaded ends with screw eyes. Zinc coating when tested shall meet ASTM A153 for galvanization.

Tree Stakes. Tree stakes shall be hardwood stakes at least 2" x 2" rough sawed to the length required. The lower half of each stake shall be given a flow coat of 5% pentachlorophenol solution or otherwise treated with an approved material and method. The contractor shall submit manufacturer's written certification for any stake treatment and accomplish such work in the presence of the Engineer.

Rubber Hose. Rubber hose shall be new, 2-ply rubber (reinforced) hose at least 5/8" in diameter.

Wrapping Materials. Wrapping material shall be clean new burlap 7 or 8 ounce weight per square yard, in strips 4" to 6" wide or horticulturally approved waterproof wrapping paper 30-30-30 ratings in 4" strips. The contractor shall provide in writing manufacturer's certification for the above-mentioned wrapping material requirements.

Twine. The tying material used to secure the tree wrap shall be at least 2-ply jute twine.

Anchors. Anchors for guy wire shall be 4" malleable iron ground anchors, one pound each, 3,000 pounds holding strength, triangular in shape with hoops or slots for attaching guy wires, stem for receiving driving rods. The anchor assembly shall have preloading capacity so that it will rise 2" to 6", and this movement shall occur as the anchor turns in the ground to its permanent position of approximately a 90° angle to the line of force applied. Anchors shall be pre-loaded and installed in the ground with the use of driving rods. Follow manufacturers specifications recommended for installing the ground anchors.

Tree Wound Dressing. Dressing for treating tree wounds or cuts shall be:

- (1) An approved black asphaltum base antiseptic paint.
- (2) An approved black paint consisting of Bordeaux Mixture, raw linseed oil, and lamp black.
- (3) An approved black paint consisting of zinc oxide, raw linseed oil and lamp black.

34.11 WATER

All water for plants shall be obtained from fresh water sources and shall be free from toxic substances and chemicals which may be injurious to plant life.

34.12 PLANTING TREES

All plant material shall be planted during the following planting periods, with the exceptions as noted:

Balled or Burlapped and Potted or Container Grown Material

March 1 to December 1

- (1) All planting of broadleaf evergreens during the fall season shall be completed by November 1.
- (2) All bare root material shall be planted between October 15 and May 15.
- (3) All material planted from May 30 to August 30 must be treated with an approved antitranspirant in a manner recommended by the manufacturer and written approval for moving plants within this period must first be obtained from the Engineer.

The above mentioned periods may be extended or reduced according weather and soil conditions at the time and at the discretion of the Engineer. The Engineer reserves the right to stop planting operations at any time he deems it necessary.

The contractor shall not plant when weather conditions are unfavorable for proper work or when the soil is in a wet, soggy or frozen condition.

The contractor shall be charged working days while engaged in actual planting and directly related work such as plant pit excavation, staking, wrapping, and mulching. The contractor shall not be charged time for indirectly related work such as watering, weed control, pruning, and other responsibilities as described under Plant Establishment, Subsection 34.18.

34.13 SOIL MIXTURE

Soil mixtures for the various plantings shall consist of the following:

- (a) Soil mix for all plants except ericaceous material: 6-7½ cubic feet bales of peat moss, or approved equal to 12 yards of planting topsoil.

- (b) Soil mix for ericaceous plants: 6-7½ cubic feet bales of peat moss, or approved equal, to 10 yards of planting topsoil.

If peat humus is furnished in lieu of peat moss in the above mix, it shall be used in the proportion of ½ cubic yard of peat humus for each 7½ cubic feet bale of peat moss specified for the above soil mix. Other approved equal materials will be mixed according to the manufacturer's printed recommendations which shall be submitted to the Engineer for written approval.

The above soil mixtures shall be mixed as specified in an area approved by the Engineer. No mix shall be prepared prior to notification of the Engineer at least 48 hours in advance of the mixing operation. When groundcovers or herbaceous perennials are specified, the soil mix may be mixed in place providing the existing topsoil meets the requirements of Item 29, Topsoil.

The fertilizer, as specified in accordance with Subsection 34.08, shall be placed according to the following:

- (a) Bare root, balled and burlaped, or container stock: Position the plant in the hole and backfill no higher than halfway up the root ball. Place the recommended number of tablets evenly around the perimeter of and immediately adjacent to the root ball.

Complete the backfilling, tamping and watering.

- (b) Small groundcover plants and herbaceous perennials: Position the plant in the hole and backfill halfway and no more. Place the tablet immediately adjacent to the root ball.

Complete the backfilling, tamping and watering.

- (c) Trees - Use 1 - 20 gram tablet for each ½" of tree trunk caliper based on size specified for planting.
- (d) Shrubs - Use 1 - 20 gram tablet for each foot of height or spread based on size specified for planting.
- (e) Groundcover and Herbaceous Perennials - Use 1 - 20 gram tablet for each plant.

No backfill shall be placed in any pit until the excavation has been inspected. Excess excavated material shall be removed from the project site at the contractor's expense.

34.14 DIGGING AND HANDLING

All precautions customary in good trade practice shall be taken in preparing plants for transplanting. Plants transplanted with workmanship that fails to meet the highest standards will be rejected. All plants shall have firm, natural balls of earth of ample proportions and diameter not less than as specified in the "USA Standard for Nursery Stock." Plants with cracked, broken or crushed balls which occur either before or during planting operations, will be rejected and shall be removed from the site immediately. Dig bare root (BR) plants with sufficient spread and depth of roots as to insure full and prompt recovery and development of the plants. Avoid bruises and injury to roots. All plants shall be handled so that roots are adequately protected and moist at all times. Material that cannot be planted immediately after delivery shall be adequately protected by covering with canvas, wet straw, burlap, moss or other suitable material and kept covered until ready to be planted. Trees should not be planted with frozen earth balls.

34.15 LOCATION OF PLANTS

Plants shall be located as indicated on the drawings, but may be shifted to avoid utilities subject to the approval of the Engineer. In all mass planting areas, the plants shall be evenly spaced to give uniform cover in the planting bed area. No excavation shall commence until locations are approved.

34.16 PLANTING

All trees and shrubs shall be planted in pits as detailed in the drawings. Excavate pits with vertical sides. They shall be of such a depth that when planted and settled, the crown of the plant shall bear the same relation to finished grade as it did to soil surface in its place of growth. All backfill top soil shall be covered with a water-proof material after mixing. Backfill pits with specified soil mix and compact firmly, especially under ball of roots to establish a firm foundation. Plants shall be set in the center of pits in a vertical position so that the crown of the plant is level with the finished grade after allowing for watering and settling of soil. The "Soil Mixture" shall be carefully and firmly worked and tamped under and around the base of the ball to fill all voids. When partially backfilled and compacted, the burlap shall be removed from the sides and tops of the balls and cut away to prevent air pockets, but no burlap shall be pulled from under the balls. A ring of earth shall be formed around the plant to produce a dish for watering. All plants shall be thoroughly watered immediately after planting as directed by the Engineer. This shall mean complete saturation of all backfill in the pits and beds during the same day of planting. Care shall be taken during all planting operations to insure that no excavated material is dumped on any grassed area unless a suitable type of matting or protective underlay is used. The

contractor will be responsible for all damage to any grassed, planted or other landscape area, caused by his operations and shall repair any damage so caused in a manner satisfactory to the Engineer at the contractor's own expense.

Prepare ground cover and herbaceous perennial areas by rototilling to a minimum depth of 10". The mixing of peat moss, peat humus or approved equal may be performed separately in order to obtain the proportion of ground cover or herbaceous perennial soil mixture as specified.

If dead or unhealthy plants are discovered, they shall be removed and replaced within 10 days after notification. Plants requiring replacement between planting seasons shall be immediately removed from the project and replacement made during the next proper planting period.

Pruning. All plants shall be pruned immediately after planting or transplanting to remove all injured or dead wood. The overall heights after pruning shall be as specified under the plant material tabulation chart on the construction drawings. All trees inspected and tagged at the nursery will conform to A.A.N. Standards and any subsequent pruning by the Contractor shall in no way alter the natural habit or shape of the plant. All pruning shall be done by men skilled in this operation with sharp tools. All cuts shall be made flush, leaving no stubs. On all cuts over $\frac{3}{4}$ " in diameter and bruises or scars on the bark, the injured cambium shall be traced back to living tissue and removed; wounds shall be smoothed and shaped so as not to retain water; and the treated area shall be coated with an approved tree wound paint.

Initial Watering. The initial watering will be included in cost of planting. The Contractor will be required to water all plants as described under Subsection 34.17.

Mulching. Trees, shrubs and ground cover shall be mulched with at least a 4" cover of mulch. Mulch shall be placed the same day of planting.

Wrapping. All trees shall be wrapped with the wrapping material overlapping 1½", wound from the lowest main branches to the base of the tree. The wrapping shall be tied at the top and bottom and at 1" intervals along the trunk with twine.

Staking and Guying. Unless approved by the Engineer, all staking and guying specified shall be completed the same day as planting and mulching.

Cleaning Up. Throughout the course of planting, excess and waste materials shall be immediately removed from the site, seeded areas kept clean, and all precautions taken to avoid damage to existing structures, trees, shrubs, plants, and grass. When planting in an area that has been otherwise completed, the area shall, upon completion of the planting be immediately and thoroughly cleared of all debris,

rubbish, subsoil, and all waste materials removed from the site. All ground surfaces shall be raked smooth. All sodded areas disturbed as a result of construction will be repaired by the contractor.

34.17 SUBSEQUENT WATERING

The Contractor shall water all plant pits with the following minimum quantities of water for each watering:

Major Trees (Over 2" caliper)	20 Gallons Per Pit
Minor Trees (2" caliper or less)	10 Gallons Per Pit
Evergreen Trees	15 Gallons Per Pit
Shrubs Over 18"	2.5 Gallons Per Pit
Shrubs Under 18"	1 Gallon Per Pit
Ground Cover, Herbaceous Perennials	1 Gallon Per Pit

The Contractor will be required to continue watering the plantings to insure their proper growth and health.

34.18 PLANT ESTABLISHMENT

The plant establishment period for all planting shall begin immediately after all planting and replacements (as specified under Planting) are complete and acceptable to the Engineer. The plant establishment period will consist of one full growing season, during which time the Contractor shall be responsible for all work necessary to keep the plants in a live and healthy condition. If the Contractor completes all planting and/or transplanting and replacements (as specified under Planting) by May 1, the semi-final inspection shall be held on or about October 1 of that year. In the event the Contractor does not complete all planting and/or transplanting and replacements by May 1, the semi-final inspection will be held on or about October 1 of the following year. All replacement plant material determined to be necessary at the semi-final inspection must then be approved at the replacement plant source by October 15. At this time, the Engineer will direct the Contractor to replace those plants determined to be dead or unhealthy by December 1. The contractor will notify the Engineer in writing that all replacement planting has been accomplished. The Engineer will conduct a final inspection within 15 days after notification to determine the acceptability of the replacements. All replacement plant material must be guaranteed for a period of one year from date of planting.

All planting areas shall be kept free of weeds and grasses during the life of the contract. As requested in writing by the Engineer, it shall be the duty of the contractor to weed the areas planted. The Contractor may request and use, as approved by the Engineer, herbicides for weed and grass control. The contractor shall

prune and spray plants as required, repair or replace stakes, and repair washouts caused by work on this contract when and specified by the Engineer.

Any plants that settle below or rise above the desired finished grades shall be reset at the proper grades. All replacements shall be plants of the same kind, size and quality as originally specified in the contract and they shall be furnished, planted, mulched, guyed, watered, etc., as specified herein for new plant material.

If dead or unhealthy plants are discovered, they shall be removed and replaced within 10 days after notification. Plants requiring replacement between planting seasons shall be immediately removed from the project and replacement made during the next proper planting period. Plants requiring replacement between planting seasons shall be immediately removed from the project and replacement made during the next proper planting period.

If, upon written request, the Contractor fails to proceed within one week with the above requirements, the Engineer may arrange for and proceed with adequate labor, equipment and material to perform the work requested. The entire cost of such work shall be deducted from any monies due the contractor.

The Department shall not be responsible for any damage incurred to plant material, tree protection, wire or staking as a result of fire, theft, vehicular damage or acts of vandalism.

34.19 METHOD OF MEASUREMENT

The quantities of planting for which payment will be made will be the total number of the various species of new plants of each designated height, spread, caliper, etc., actually planted as specified in this contract.

Replacement plants will be made at no added cost to the City.

The cost of responsibilities outlined under Plant Establishment, including subsequent watering, shall be included in the unit prices bid for plants.

34.20 BASIS OF PAYMENT

Payment for Planting shall be for the various items of planting scheduled in the proposal, which prices shall include the cost of furnishing and planting all plant materials, protection of plants after digging and prior to planting, staking, excavating plant pits, furnishing soil mixes, mulch, watering, pruning, wrapping, guying, the cultural care of the plants until the completion and acceptance of all landscape work, disposal of excess and waste materials, replacement planting, and all materials, labor,

equipment and incidentals necessary to complete the project. There will be no partial payments on this item of the contract.

ITEM 34A

TRANSPLANTING

34A.01 DESCRIPTION

The work to be included under this item shall consist of transplanting trees and shrubs from one site to another within the limits of the contract area as shown on the construction plans.

34A.02 MATERIALS

Existing Plants to be transplanted with appropriate ball diameters as specified on the construction plans.

Hydraulic spades shall be used for all transplanting work.

34A.03 CONSTRUCTION METHODS

The root structure of large plants shall be transplanted as a conically shaped earthen core cut on a 60° angle by the hydraulically operated cutter blades. The spade shall be located so the hydraulically operated cutter blades are positioned equidistantly from the trunk(s) or stem(s) of the plant being transplanted. The core excavated at the new planting site shall be 2" to 4" larger than the minimum ball diameter specified so that the plant, when placed, will be slightly below finished grade. All trees or shrubs transplanted shall be tamped lightly around the edge of the ball and approved topsoil added where required by the Engineer to fill any small cracks or voids formed during the transplanting operation. Guying, staking, mulching, and wrapping will be required on all trees and shrubs transplanted as described under the construction methods.

34A.04 METHOD OF MEASUREMENT

The quantity of transplanting for which payment shall be made will be the total number of the various species of trees and/or shrubs of each designated height, spread, caliber, etc., actually transplanted as specified in this contract.

Replacement trees and shrubs will be planted at no cost to the City.

The cost of responsibilities outlined under Subsection 34.18, Plant Establishment, shall be included in the unit price bid to transplant trees and/or shrubs.

34A.05 BASIS OF PAYMENT

Payment for transplanting shall be for the various items of work scheduled in the proposal, which prices shall include the cost of transplanting all plant materials, furnishing soil mixes, mulch, watering, pruning, guying, the cultural care of the plants until the completion and acceptance of all landscape work, disposal of excess and waste materials, replacement planting, and all materials, labor, equipment and incidentals necessary to complete the project. There will be no partial payments on this item of the contract.

ITEM 35

CALCIUM CHLORIDE FOR DUST CONTROL

35.01 DESCRIPTION

Calcium Chloride for Dust Control shall consist of furnishing and applying flake calcium chloride, lightly and evenly over the subgrade for dust preventive purpose at such locations throughout the project as may be designated.

35.02 MATERIALS

Material used for this section shall conform to the provisions of Paragraph 105, Material Details.

35.03 METHOD OF MEASUREMENT

Certified weight slips will be accepted for showing the number of tons of Calcium Chloride for Dust Control used on the project.

35.04 BASIS OF PAYMENT

The price per ton bid for Item 36, Calcium Chloride, shall constitute full compensation for furnishing, hauling, and spreading all material, for any necessary preparation of the grade, all labor, materials, equipment, tools and incidentals necessary to complete the work.

ITEM 36

GABIONS

36.01 DESCRIPTION

Gabions shall consist of furnishing, assembling, tying, and filling open mesh wire baskets with approved stones, constructed in accordance with these specifications and placed in conformity with the lines, grades, and dimensions shown on the plans or as required by the Engineer.

36.02 MATERIALS

GABION STONE

- (a) The baskets shall be filled with approved stone ranging in size from a minimum of four inches to a maximum of 13 inches, both measured in the greatest dimension. The dry weight of the stone in air shall weigh not less than 150 pounds per solid cubic foot.
- (b) The stone shall be approved by the Engineer. The Department of Public Works reserves the right to reject any source failing either of the following tests:
 - (1) Freeze - Thaw Test - A maximum 10% loss by weight, after 25 cycles of freezing and thawing.
 - (2) Magnesium Sulfate Soundness Test - A maximum 10% loss, by weight after 10 cycles of the magnesium sulfate soundness test.

WIRE MATTRESS UNITS

- (a) **Dimensions.** Wire mattress units shall be supplied, as specified, in various lengths and widths. The thickness shall be either 6 inches or 9 inches, or as directed. The horizontal width shall be not less than six feet. However, all mattress units furnished by a manufacturer shall be of a uniform width. Dimensions for thicknesses, lengths, and widths are subject to a tolerance of $\pm$ 3 percent of the manufacturer's stated sizes.
- (b) **Fabrication.** Wire mattress units shall be fabricated in such a manner so that the base, sides, and lids can be assembled at the construction site into a rectangular unit of the specified size. The mattress units shall be manufactured such that the base, lids, ends, and sides, shall be either woven into a single unit or one edge of these members will be woven in a manner such that the strength and flexibility at the point

of connection is at least equal to that of the mesh.

The mattress units shall be subdivided into compartments two feet long extending over the full width of the mattress unit by the insertion of partitions made of the same mesh as the rest of the mattress unit. The partitions shall be secured in proper position on the base in a manner such that no additional tying at this junction will be necessary.

All perimeter edges of the mesh forming the mattress unit shall be securely selvaged or bound so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

(c) **Prefabricated**. Wire ties or connecting wire shall be supplied in sufficient quantity to fasten securely all edges of the mattress unit and its partitions. The wire ties or connecting wire shall meet or exceed the same specifications as the wire used in the mesh. The maximum linear dimension of the mesh opening shall not exceed 3½ inches and the area of the mesh opening shall not exceed 6 square inches.

(d) **Base Metal**. The wire mesh shall be made of galvanized steel wire having a minimum size of U.S. Steel Wire Gauge No. 14. The tensile strength of the wire shall be in the range of 60,000 to 85,000 psi. The minimum zinc coating of the wire shall be 0.80 ounces per square foot of uncoated wire surface and shall be applied in accordance with ASTM Designation A 90.

(e) **Test**. The wire mesh shall have sufficient elasticity to permit elongation of the mesh equivalent to a minimum of 10 percent of the length of the section of the mesh under test without reducing the gauge or tensile strength of individual wires to values less than those for similar wire one gauge smaller in diameter.

An uncut section of the mesh not less than six feet long and not less than three feet wide, after first being subjected to the elongation test described above, shall withstand a load test of 4,000 pounds applied to an area of one square foot located approximately in the center of the section under test.

The wire mesh shall be fabricated in such a manner as to be nonravelling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh then subjected to the load test described in the elasticity test above.

The tensile strength test shall be conducted in accordance with details described in ASTM A 392.

(f) **Certification.** Each shipment of wire mesh mattress to a job site shall be accompanied by a certification which states that the material conforms to the requirements of these specifications. A shipment shall consist of all material arriving at the job site at approximately the same time. The certification shall be on company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

WIRE BOXES

(a) **Dimensions.** Gabions shall be supplied as specified, in various lengths, heights, and widths. The horizontal width shall not be less than 36 inches. However, all gabions furnished by a manufacturer shall be of uniform width. Dimensions for heights, lengths, and widths are subject to a tolerance limit of $\pm 3\%$ of manufacturer's stated sizes.

(b) **Fabrication.** Gabions shall be fabricated in such a manner that the sides, ends, lids, and diaphragms can be assembled at the construction site into a rectangular basket of the specified sizes. Gabions shall be of single unit construction - the base, lid, ends, and sides shall be either woven into a single unit or one edge of these members connected to the base sections of the gabion in such a manner that strength and flexibility at the point of connection is at least equal to that of the mesh.

Where the length of the gabion exceeds its horizontal width, the gabion shall be equally divided by diaphragms, of the same mesh and gauge as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabions shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary.

All perimeter edges of the mesh forming the gabion shall be securely selvaged so that the joints formed by tying the selvages have at least the same strength as the body of the mesh.

The wire or connecting wire shall be supplied in sufficient quantity for securely fastening all edges of the gabion and diaphragms and to provide for four internal connecting wires in each cell one-half unit high and 8 internal wires in each cell one unit high. The tie wire is to meet the specifications as the wire used in the mesh except that it may not be more than two gauges smaller. The maximum linear dimension of the mesh opening shall not exceed $4\frac{1}{2}$ inches and the area of the mesh opening shall not exceed 8 square inches.

(c) **Base Metal.** The wire mesh shall be made of galvanized steel wire having a minimum size of U.S. Steel Wire Gauge No. 11. The tensile strength of the wire shall be in the range of 60,000 to 85,000 psi. The minimum zinc coating of the wire shall

be 0.80 oz./s.f. of uncoated wire surface and shall be applied in accordance with ASTM Designation A-90.

(d) **Testing.** The wire mesh shall have sufficient elasticity to permit elongation of the mesh under test without reducing the gauge or tensile strength of individual wires to values less than those for similar wire one gauge smaller in diameter.

A section of the mesh 6 feet long and not less than 3 feet wide, after first being subjected to the elongation test described above, shall withstand a load test of 6,000 pounds applied to an area of one square foot approximately in the center of the section under test.

The wire mesh shall be fabricated in such a manner as to be nonravelling. This is defined as the ability to resist pulling apart at any of the twists or connections forming the mesh when a single wire in a section of mesh is cut and the section of mesh then subjected to the load test described in the elasticity test above.

(e) **Certification.** Each shipment of gabions to a job site shall be accompanied by a certification which states that the material conforms to the requirements of this specification. A shipment shall consist of all material arriving at the job site at substantially the same time. The certification shall be on company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

36.03 CONSTRUCTION METHODS

(a) **Assembling.** Each gabion unit shall be assembled by binding together all vertical edges with wire ties on approximately six inch spacing or by a continuous piece of connecting wire stitched around the vertical edges with a coil about every four inches. Empty gabion units shall be set to line and grade as shown on the plans. Wire ties or connecting wire shall be used to join the units together in the same manner as described above for assembling. Internal tie wires shall be uniformly spaced and securely fastened in each outside cell of the structure or where ordered by the Engineer. When gabions are being placed as slope protection, the cross-connecting wires may be deleted if ordered by the Engineer.

(b) **Tensioning.** A standard fence stretcher, chain fall, or iron rod may be used to stretch the wire baskets and hold alignment.

(c) **Filling.** The gabions shall be filled with stone carefully placed by hand or machine to assure alignment and avoid bulges with a minimum of voids. After a gabion has been filled, the lid shall be bent over until it meets the sides and edges. The lid shall then be secured to the sides, ends and diaphragms with the wire ties or connecting

wire in the manner described above for assembling.

(d) **Special Fitting**. When a complete mattress unit cannot be installed on the slope because of space limitations, the unit shall be cut to fit in the manner indicated on the plans.

36.04 METHOD OF MEASUREMENT

Gabions will be measured on the basis of the number of cubic yards actually placed. Linear dimensions will be taken in not less than three directions and of sufficient number so that averages can be obtained and the product of the averages shall be the volume considered for payment.

36.05 BASIS OF PAYMENT

Gabions described above will be paid for on the basis of the unit price bid per cubic yard. The cost of furnishing and placing stone-filled gabion mattresses or boxes, including all labor, materials, excavation, backfilled and incidentals such as clearing and grubbing, bushes or tree removal; filling with clean soil, and protecting live trees within the work area, etc., shall be included in the contract unit price bid for the item.

ITEM 37

RIPRAP

37.01 DESCRIPTION

Riprap shall consist of furnishing, setting, and placing of plain or grouted riprap on a prepared bed in accordance with these specifications and in reasonably close conformity with the lines, grades, dimensions and locations shown on the plans or established by the Engineer.

MATERIALS

37.02 STONE

Stone for this section shall be hard, durable stone, of which 60% of the pieces shall weigh 100 pounds or more. The weight, dry, per solid cubic foot shall weigh not less than 150 pounds in air.

37.03 BROKEN CONCRETE

Broken concrete for this section shall conform to the size and requirements specified for stone. Concrete shall be solid and dense and free from major cracks and flaws.

The minimum thickness of riprap pieces shall be 6".

37.04 GROUT

Grout for this section shall be composed of 1 part Portland Cement and 4 parts of sand, measured in dry, loose volume and mixed thoroughly with water to make a grout of a thick, creamy consistency.

Materials shall conform to the requirements of Paragraphs 100, 102, and 103, Material Details.

37.05 GEOTEXTILE

Geotextile for this item shall conform to Subsection 47.05.

37.06 CONSTRUCTION METHODS

The pieces shall be laid on an approved geotextile over the compacted finished bedding areas; the larger pieces being placed in the low areas and in the lower courses of bank slopes, and the smaller pieces placed in the upper courses and areas. The pieces shall be laid in close contact, so as to break joints, and in such a manner that the weight of each piece is carried by the earth, and not by the adjoining pieces. The spaces between the larger pieces shall be filled with spalls, securely rammed into place. The finished work shall present a tight surface conforming to the required contour.

In the case of grouted riprap, the following additional requirements and provisions will apply:

Care shall be taken to prevent earth or sand from filling the voids in the riprap.

Immediately before pouring the grout, the riprap shall be thoroughly wetted.

Grout shall be carefully poured into the voids between the pieces, beginning with the lowest elevation and progressing upward, so as to maintain the upper surface of the grout in an appropriate horizontal line. Broadcasting, sloping, or spilling the grout over the surface of the riprap will not be permitted. Progress shall be sufficiently slow to prevent the grout from being forced out of the voids in the lower courses and flowing over the surface of the riprap.

Not less than 12 hours after the grouting operation has been completed satisfactorily, the riprap surface shall be covered with wet burlap, wet cotton mats, and kept continually soaked with water for a period of not less than 72 hours, after which the covering shall be removed.

No riprap shall be grouted during freezing weather, or when the riprap pieces contain frost.

37.07 METHOD OF MEASUREMENT

The number of square yards of Riprap to be paid for under this section shall be the actual number of square yards of riprap complete in place and accepted, as determined by computation based on field measurements taken on and along the completed finished surfaces (no horizontal projection).

37.08 BASIS OF PAYMENT

The number of square yards of Riprap, measured as provided for above, shall be paid for at the contract unit price per square yard bid for Item 37, Riprap, Plain or Grouted. This price and payment shall constitute full compensation for preparation of bedding areas, geotextile placement, for furnishing and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 37A

SACKED CONCRETE RIPRAP

37A.01 DESCRIPTION

Sacked Concrete Riprap shall consist of placing sacked concrete riprap on slopes for protection as shown on the plans or as designated.

37A.02 MATERIALS

The Portland cement, aggregates and mixing shall be the same as that specified for in Item 9. The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

Sacks for the concrete shall be of cotton or jute material possessing sufficient strength to contain the concrete without failure during filling, moving and placing. The sacks shall be approximately 16" x 25" measured inside the seams when the sack is laid flat, and shall have a capacity of 1.00 cubic foot. The Contractor shall furnish sample sacks of the type proposed for use in the work, and he shall not proceed with the work until the sacks proposed for use have received approval.

37A.03 CONSTRUCTION METHODS

The sacks shall be filled with approximately one half full and the top shall be folded down sufficiently to retain the concrete during placing. Tying of sacks to form a knot will not be permitted.

Immediately after filling with concrete, the sacks shall be placed and lightly tramped into place to cause them to conform to the prepared slope and to adjacent sacks in place.

The sacks shall be placed to conform as near as possible to the slopes shown on the plans and as directed. The first course shall consist of a double row of stretchers laid in a neatly trimmed trench to form a toe wall. When placed at pipe ends, this first course should extend completely under the bottom of the pipe. Sacks in the remaining courses shall be placed as headers.

The second course shall be placed directly on the bottom course and the remaining courses shall be stepped back to conform to the required slope. Joints in succeeding courses shall be staggered. The sacks will be placed so the folded end is in toward the bank. All dirt and debris shall be removed from the top of the sacks before the

next course is placed.

Every effort shall be made to avoid disturbing the placed sacks during the time the concrete is obtaining its set. During hot and dry weather, the sacked concrete shall be hosed down as directed. No other special curing effort is required.

37A.04 METHOD OF MEASUREMENT

The number of cubic yards of Sacked Concrete Riprap to be paid for shall be the actual number of cubic yards of concrete placed in the sacks at the mixer.

37A.05 BASIS OF PAYMENT

The number of cubic yards of Sacked Concrete Riprap measured as described above, and incorporated into the finished construction, shall be paid for at the contract unit price per cubic yard bid for Item 37A, Sacked Concrete Riprap, which price and payment shall constitute full compensation for furnishing, preparing and placing of all materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 38

REMOVAL AND REPLACEMENT OF EXISTING

VALLEY GUTTER

38.01 DESCRIPTION

This item consists of the removal, replacement, and disposition of existing gutters, etc., to the bottom of the roadway box, necessary to construct the new facility. It shall also include all excavation normally removed under Item 2, Excavation.

38.02 MATERIALS FOR REPLACEMENT

All materials for the replacement of gutters shall conform to the requirements of Item 24, Portland Cement Reinforced Concrete Gutter.

38.03 CONSTRUCTION METHODS

The material to be removed shall be broken by an approved power breaking machine. The ball type breaker will not be permitted. Extreme care shall be exercised by the Contractor in the operation to insure that no damage occurs to any existing buried, surface, or aerial utility. The broken concrete materials will become the property of the Contractor and shall be removed from the project or otherwise disposed of in a manner satisfactory to the Engineer.

38.04 REPLACEMENT OF GUTTER

Replacement shall be in accordance with the requirements of Item 24, Portland Cement Reinforced concrete Valley Gutter.

The Contractor's attention is called to the fact that 4' and 8' reinforced concrete valley gutter is eight (8) inches of concrete, conforming to Item 9.

38.05 METHOD OF MEASUREMENT

The valley gutter replaced as provided above shall be the number of linear feet or square yards, removed and replaced from the specified area, measured along the surface of the pavement.

38.06

BASIS OF PAYMENT

Removed and replaced gutter measured as provided above shall be paid for at the contract unit price bid per linear foot or square yards for Item 38, which price and payment shall constitute full compensation for removing, replacing new gutter and disposing of all materials as herein provided, for all equipment, tools, labor and incidentals necessary to complete the item.

ITEM 39

HOT MIX, HOT LAID BITUMINOUS

CONCRETE PAVEMENT

39.01 DESCRIPTION

Hot-Mix, Hot Laid Bituminous Concrete Pavement shall consist of constructing hot-mix, hot-laid bituminous concrete base binder, and/or wearing courses on a prepared base in accordance with these specifications and in reasonably close conformity with the lines, grades, thickness, and typical cross-sections shown on the plans or established by the Engineer.

MATERIALS

39.02 ASPHALT CEMENT

The asphalt cement shall be AC 20 viscosity grade conforming with the requirements of Paragraph 115, Material Details. Asphalt cement delivered in tank trucks shall be equipped with an approved sampling device and delivery temperature of the material shall not exceed the maximum mixing temperature.

39.03 FINE AGGREGATE

Fine aggregate is defined as all material passing the No. 8 sieve, and for this item it shall consist of clean, hard, durable crushed stone or crushed gravel.

In Types B, C, and D up to 15% of the fine aggregate may be washed concrete sand, meeting the requirements of Paragraph 103, Material Details. If the stability as determined by the Laboratory Marshall Method (AASHTO T245) is less than 1,000 lbs., the fine aggregate sand percent shall be reduced or excluded.

39.04 COARSE AGGREGATE

Coarse aggregate is all material retained on the No. 8 sieve, and for this item, it shall meet the requirements of Paragraph 104, Material Details. Carbonate and serpentine aggregate shall be prohibited in the final roadway wearing surface course on any roadway having a minimum average daily traffic volume (ADT) of 8,000 vehicles and a posted speed of 40 mph or greater.

39.05 FIBER

An approved fiber shall be used in mixture Type E, Bituminous Concrete Curb Mix. The fiber shall not ball or melt during mixing and shall provide sufficient mix cohesion to prevent slumping or breaking of the extruded curb during placement.

39.06 ANTI-STRIP ADDITIVE

When specified for use by the Engineer to improve asphalt-aggregate coating or when the bituminous mixture fails to maintain 95% coating during a boiling stripping test, a heat-stable anti-stripping chemical additive shall be blended with the asphalt cement and conform to the following requirements:

- (a) The material shall contain no ingredient harmful to asphalt cement and shall not appreciably alter the characteristics thereof when added in the recommended proportions.
- (b) It shall be capable of thorough dispersion in the asphalt cement at the temperature of use and shall be capable of remaining in asphalt cement in storage at the normal storage temperature without detrimentally affecting the asphalt cement. The additive shall remain effective as an anti-stripping compound when stored in the asphalt cement.

39.07 SOURCE OF SUPPLY

Written approval of all materials shall be obtained prior to delivery. Samples of each source shall be submitted as directed.

39.08 LABORATORY

At all batching and/or mixing plants, the contractor and/or producer, shall provide a building suitable for a field laboratory in which to house and use the equipment necessary to carry on the various tests required, including bituminous extractions and gradations.

The building shall be for the use of the Engineer and inspectors for testing and recording purposes and shall be so located that details of the plant are plainly visible from one window of the building.

The building shall have a minimum of 200 square feet of floor space and be of acceptable dimensions. It shall be weatherproof. It shall have at least two windows and a door, all equipped with acceptable latches and lock and shall be maintained to the satisfaction of the Engineer. Satisfactory lighting, heating and air-conditioning

shall be supplied.

The contractor and/or producer shall furnish all water, including drinking water, fuel, telephone, heat, and power to conduct all necessary tests. Tables, desks, chairs, and work tables shall be provided and maintained as required. Approved sanitary facilities shall be furnished and maintained.

If approved, the laboratory may be a part of another building, in which case it shall be completely partitioned off from the remainder of the building.

Separate payment for a field laboratory will not be made but will be considered incidental to the unit price bid for completion of the work.

39.09 TESTING EQUIPMENT

All plants shall be equipped with an approved type extractor, approved sieve shaker and all equipment necessary to determine the bitumen content of the mixture and gradation of the aggregate for verification of the design formula.

The plant shall also provide all equipment, of approved make and design, for developing the design and conducting the control tests, in accordance with the specifications and the Delaware Modified Marshall Method Tests. In addition, the plant shall supply all thermometers for temperature control.

The plant shall provide all thermometers used by City personnel for measurement of mix temperature. A minimum of three (3) thermometers shall be available for use at all times. Thermometers submitted for this purpose shall be stainless steel, 50° to 500°F range (5° F increments). Thermometers must meet the approval of the Engineer.

Approval of the plant will be contingent upon meeting the requirements of Subsection 39.07 and 39.08.

39.10 INSPECTION OF PAVING PLANT OPERATIONS

The Engineer or his agent shall have access at any time to all parts of the paving plant for checking the adequacy of the equipment in use, inspecting the conditions and operation of the plant, for the verification of weights or proportions and character of materials and for the determination and checking of temperatures being maintained in the preparation of the mixtures.

MIXING PLANT

39.11 BATCH TYPE

Bituminous concrete plants will not be approved unless they are automated.

The automatic batch plant shall be controlled by means of an approved automatic batch selector set to control and deliver accurately, and in proper sequence, the designated weight or volume of bituminous material and aggregates required for the bituminous concrete mixture and for automatically timing the mixing operation. The batch selector controls shall be locked or sealed during the operation and no changes in selector control or setting shall be made except in the presence of the Engineer's representative.

(a) **Interlocks**. The plant shall be equipped with interlocking cut-off circuits to interrupt and stop the automatic cycling of the operation at any time an error in weighing or proportioning occurs or when there is a malfunction of any portion of the control system.

(b) **Equipment Failure**. If at any time the automatic proportioning devices become inoperative, the plant may be permitted to batch and mix bituminous materials for a period of not more than 48 hours from the time of the breakdown if the operation is not impaired due to the breakdown and if approved by the Engineer. Written permission of the Engineer shall be required for periods of operation longer than 48 hours without automatic proportioning.

39.12 PLANT AND MACHINERY

The mixing plant used by the Contractor in preparation of the asphaltic material shall be capable of producing a minimum of 75 tons per operating hours and shall comply with the following requirements:

(a) **Cold Feed**. The plant shall be provided with a separate cold bin or tunnel opening for each size and type of mineral aggregate used in the mix. In addition, each cold bin or tunnel opening shall be equipped with a calibrated gate and mechanical feed to provide a uniform and concurrent flow of aggregates prior to their introduction into the drier.

(b) **Drier**. The drier shall be of rotating cylinder type suitably designed to heat and dry the aggregates, and shall continually agitate the aggregates during heating. The drier shall be capable of preparing aggregate to the full rated capacity of the paving plant.

(c) **Burner.** The burner shall be of an approved design and be automatically controlled.

(d) **Sieves.** All plant sieves shall be designed, constructed and operated so that all aggregates are sieved to their specified sizes and proportions, and shall have a capacity, when operated at normal speed, slightly in excess of the maximum capacity of the mixer.

(e) **Bins.** The plant shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Bins shall be arranged to assure separate and adequate storage and appropriate fractions of the mineral aggregates. Separate dry storage shall be provided for filler or hydrated lime when used and the plant shall be equipped to feed such material into the mixer. Each bin shall be provided with overflow pipes, of such size and at such location as to prevent backing up of material into other compartments or bins. Each compartment shall be provided with its individual outlet gate, constructed so that when closed, there shall be no leakage. The gates shall cut off quickly and completely. Bins shall be so constructed that samples can be readily obtained. Bins for continuous mix plants shall be equipped with adequate telltale devices to indicate the position of the aggregates in the bins at the lower quarter points. They shall be constructed so that samples may be properly taken. Each compartment shall be designed so as to prevent overflow of material into other bins.

(f) **Weigh Box or Hopper.** The plants shall have a weigh box of sufficient capacity to hold the maximum amount of the aggregate material for one batch. The weigh box or hopper shall be supported on fulcrums and knife edges, so constructed that they will not be easily thrown out of alignment or adjustment. Weighing hoppers must be free from contact with all edges, ends, or sides, or with any supporting rods or columns or other equipment that will in any way effect its proper functioning. In addition, there must be sufficient clearance between the hopper and supporting devices so that foreign materials will not accumulate. The discharge gate of the weigh box shall be so suspended that the aggregates will not be segregated when dumped in the mixer. If necessary to correct any such tendency, baffles shall be inserted or other means provided to discharge the materials in a blended condition.

(g) **Aggregate Scales.** Scales for the weighing of aggregate shall be springless dial types and shall be of standard make and design, accurate to 0.5% throughout their range.

Dial scales shall be of a standard make and of sufficient size and positioned so that the numerals on the dial can be read at a reasonable distance. The dials shall be of the compounding type having a full compliment of index pointers. Any pointer so placed as to give excessive parallax errors shall not be used. They shall be

substantially constructed, and scales of this type which easily get out of adjustment shall be replaced with other makes when so ordered. Proper provisions shall be made to prevent dirt from collecting in and around the dial mechanism. The dial face shall be of a material which is not affected by moisture, and it shall be kept clean at all times.

The value of the graduations of scales weighing 5,000 pounds or less shall not be greater than 5 pounds. The value of the graduations of scales used in weighing over 5,000 pounds shall not be greater than 0.1% of the rate capacity of the scale.

All scales shall be so located that they will be in plain view of the operator and inspector. No weighing of aggregates shall be permitted where vibration from plant mechanisms or any other source prevents accurate reading of the scales.

All working parts of the scales shall be protected to prevent any material from falling on or against them. Knife edges shall be kept clean at all times. Where a dashpot is used, the oil shall be kept clean and at the proper consistency at all times to give the dampening effect desired. Proper alignment of all parts of the scales shall be maintained.

(h) **Bitumen Scales.** The indicator dial shall have a capacity of at least 15% in excess of the quantity of bituminous material used in a batch. The controls shall be constructed so that they may be locked at any dial setting and will automatically reset to that reading after the addition of bituminous material to each batch. The dial shall be in full view of the mixer operator and shall be graduated in increments not greater than 1 lb. The flow of bituminous material shall be automatically controlled. All of the bituminous material required for one batch shall be discharged in not more than 20 seconds after the flow has started. The size and spacing of the spray bar openings shall provide a uniform application of bituminous material the full length of the mixer. The section of the bituminous line between the charging valve and the spray bar shall be provided with a valve and outlet for checking the meter when a metering device is substituted for a bituminous material bucket.

The equipment used to measure the bituminous material shall be accurate to plus or minus 0.5%. The bituminous material bucket shall be a non-tilting type with a loose sheet metal cover. The length of the discharge opening or spray bar shall be not less than $\frac{3}{4}$ the length of the mixer and it shall discharge directly into the mixer. The bituminous material bucket, its discharge valve or valves and spray bar shall be adequately heated. Steam jackets, if used, shall be efficiently drained and all connections shall be so constructed that they will not interfere with the efficient operation of the bituminous scales. The capacity of the bituminous material bucket shall be at least 15% in excess of the weight of bituminous material required in any batch. The plant shall have an adequately heated quick-acting, non-drip, charging valve located directly over the bituminous material bucket.

(i) **Test Weights.** The Contractor shall provide and have at hand twenty 50-pound standard calibrated test weights for frequent testing of all scales.

The weighing equipment, in addition to complying with the above requirements, must have adjusting devices which will provide for the readjustment of any part which, being out of adjustment or balance, prevents the scale from functioning properly.

(j) **Asphalt Control System.** Satisfactory means, either by weighing or metering shall be provided to obtain the proper amount of bituminous material in the mix within the tolerance specified for the job mix.

Heating of asphalt cement shall be by steam coil, hot oil or other approved methods. Under no circumstances will a direct flame from oil or other fuel be permitted to come in direct contact with the heating tanks. The asphalt circulating system shall be constructed of a size adequate to give the proper and continual circulation of asphalt cement throughout the operating periods.

(k) **Thermometric Equipment.** An armored thermometer reading within the ranges used shall be fixed in the asphalt line at a suitable location near the weigh bucket discharge valve.

The plant shall also be equipped with an approved mercury actuated dial scale thermometer and an electric pyrometer or other approved thermometric instrument so placed at the discharge chute of the drier as to automatically register and record the temperature of the heated aggregates. This device shall also be in full view of the burner controller or the head feeder.

The Engineer reserves the right to judge the efficiency of the above instrument and, for better regulation of temperature of the aggregates, direct the replacement of the instrument by some approved temperature recording apparatus, and further, may require daily charts of said regulator to be filled with the Engineer.

(l) **Mixer Unit.** The mixer shall be a heat-jacketed, insulated or otherwise equipped batch mixer of the standard pugmill type; or an approved heat-jacketed insulated or otherwise equipped rotary, drum type mixer equipped with a sufficient number of paddles or blades and set in proper position to produce properly mixed batches of any material required under these specifications. When the clearance in the twin pugmill exceeds 1", either the shortened blades or the work liners (or both) shall be replaced to reduce the clearance to less than the allowable 1" maximum. The mixers shall be provided with an approved, accurate time lock that will lock the discharge gates until the specified time has elapsed. In no case shall the rated capacity of the mixer as specified on the manufacturers name plate be exceeded. If sufficient mixing and

coating is not secured, the right is reserved to increase the required mixing time, as may be judged necessary.

Deviations in size of batches will be permitted to provide for mixing batches 25% below, or 15% above, the rated capacity of the mixer. When slag coarse aggregate is used, no increase will be permitted in the size of the batch above the rated capacity of the mixer.

(m) **Dust Collector.** All plants shall be equipped with an approved dust collector system. Provisions shall be made to waste the material so collected or to return it uniformly to the aggregate mixture as directed. All State and local regulations and/or ordinances shall be followed.

(n) **Safety Requirements.** An adequate and safe stairway 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, and this space shall be kept free of drippings from the mixing platform. A platform shall be so located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. The platform and steps shall have safety hand rails. Easy and safe access shall be provided to the location above the mixer where samples of the aggregate in the bins are to be procured. Adequate overhead protection shall be provided where necessary. All other State or local safety requirements shall be followed.

(o) **Platform Truck Scales.** All plants shall be required to be equipped with platform truck scales to weigh empty and loaded trucks. Truck scales shall be of approved design and kept in good condition. Scales shall be mounted in a concrete foundation that will insure their remaining level and plumb and weigh the entire truck. Each platform truck scales shall be approved by the appropriate Sealer of Weights and Measures and have their seal attached at the beginning of each season or at such other times as may be deemed necessary. Manufacturers Certified Scale Checks may be accepted. Split weighing will not be approved.

39.13 CONTINUOUS MIXING TYPE

The use of continuous mixing plants will be permitted for the preparation of hot-mix bituminous concrete provided such plants conform to the requirements listed below as well as the general requirements for all plants.

(a) **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 one dimension adjustable by positive mechanical means and provided with a lock. Indicators shall be provided in 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 shall be obtained.

(b) **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, each compartment material 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.

(c) **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 other positive method of accurate control.

(d) **Mixer Unit Continuous Method.** The plant shall include a continuous mixer of an approved twin pugmill type, heat-jacketed, and capable of producing a uniform mixture within the permissible variations from the job mix specifications. The paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of the mix. 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 and also giving the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by weight method under the following formula. The weights shall be determined for the job by tests made by the Engineer.

$$\text{Mixing Time in Seconds} = \frac{\text{Pugmill Dead Capacity in Pounds}}{\text{Pugmill Output in Pounds Per Sec.}}$$

The production capacity of the continuous mix plant shall be not less than 75 tons per hour.

(e) **Discharge Hopper.** The discharge end of the pugmill shall be equipped with a hopper, or other approved device for loading into the truck, that will eliminate segregation of the mixed material.

39.14 PREPARATION OF ASPHALT CEMENT

The asphalt cement shall be heated to a temperature of 250° to 350° F in the tanks to secure uniform heating of the entire contents. Asphalt shall be maintained within the limits specified.

39.15 PREPARATION OF MINERAL AGGREGATES

The aggregates for the mixture shall be dried and heated at the mixing plant before entering the mixer to a temperature, not to exceed 375° F (except for recycled mixes) as determined on the mixing platform. Flames used for drying and heating shall be properly adjusted to avoid injury to the aggregate.

The aggregates immediately after heating shall be screened into separate bins, ready for batching and mixing with asphalt cement.

39.16 PREPARATION OF THE MIXTURE

Each size of hot aggregate and the asphalt cement shall be weighed separately and accurately to the proportions in which they are to be mixed. Temperatures at which the mixture shall be mixed will be given for the type of material being produced.

The mixture shall consist of coarse aggregate, fine aggregate, filler (if required), and asphalt cement conforming to Paragraph 115, Material Details. The exact proportions within the limits specified shall be regulated to produce a satisfactory mixture in which all the particles are coated with bitumen, but in which balling shall not occur.

The hot fine and coarse aggregate shall be introduced into the twin pugmill after which the asphalt cement shall be added in an even sheet the full width of the mixing chamber. After the asphalt cement is added, mixing shall be continued for 30 seconds or until aggregates are coated and well mixed.

The bituminous concrete mixture may be processed through and held in a storage system.

The plant shall be specifically designed for dryer-drum mixing and shall be capable of satisfactorily heating, drying, and mixing the bituminous mixtures. The aggregate shall enter the drum from the same end the burner is located and shall travel parallel to the flame and exhaust air stream. The system shall be equipped with automatic burner controls, and heating shall be controlled to prevent damage to the aggregate or the asphalt cement. The temperature of the mixture when discharged from the mixer shall be within the range specified for the type mix being produced. The rate of flow through the drum shall be controlled in order that the bituminous material and aggregate shall be mixed until a homogeneous mixture with all particles uniformly coated is obtained and in no case shall the quantity of mixture produced exceed the manufacturers rated capacity.

Each cold feed bin shall have an adjustable gate with an indicator provided to reference the opening setting. On each of the aggregate feeders, a device shall be installed to indicate when the flow of material from the bin is below the point where accurate proportioning through the feeder gates can be accomplished. These indicators shall be positive in action and shall actuate a clearly visible or audible signal to the plant operator or stop the flow of materials to the drum when the level of material in the bin is too low for accurate proportioning. In addition, for those particular cold bins in which aggregate material tends to either bridge or lump together causing temporary interruptions in feeds, a vibrator or other suitable means shall be provided to insure uniform flow. The order of aggregate feed onto the composite cold feed belt shall be from coarse to fine. A scalping screen mounted independent of other proportioning or weighing equipment shall be required if directed by the Engineer.

Asphalt cement shall be introduced through a continuously registering cumulative indicating meter by a pump specifically designed for dryer-drum plants. The meter shall be located in the asphalt line so that it will continuously register the asphalt discharge to the mixer and so that the discharge through the meter can be readily diverted into a container for measurement. The meter shall be equipped with a nonsetback register and shall have an accuracy within 1 percent by weight of the material actually being measured in any given period of time. The accuracy of the pump and meter shall be verified at periodic intervals as designated by the Engineer.

The aggregate feed system and the asphalt flow shall be interlocked by a blending system, which will automatically regulate the asphalt flow and cause immediate correction for variations in aggregate flow. The system shall provide positive weight measurement of the combined cold aggregate feed by use of belt scales. The combined cold aggregate feed shall be continuously recorded on a nonsetback register. Feed of material to the belt scale shall be controlled too insure at normal

operation that the combined aggregate flow is between 50% and 100% of the rated capacity of the scales. The plant shall be equipped so that the proportion of each aggregate can be individually varied. The plant shall also be equipped so that the total aggregate rate can be varied without affecting the proportions. The plant shall be equipped with a moisture compensating device in the control panel to automatically correct for the moisture in the aggregate passing over the belt scale.

Moisture determinations on the combined aggregate will be made periodically during each day's operation. The plant shall also be equipped with a device in the control panel to automatically correct for the specific gravity of the asphalt.

Safe, adequate, and convenient facilities shall be provided for obtaining representative asphalt and aggregate samples. The plant shall be equipped with a sampling device capable of providing a sample of sufficient size from the full width of the combined aggregate cold feed flow. It shall be designed so that samples may be taken while the plant is operating at normal production rates. Safe, adequate, and convenient facilities shall be provided for calibrating the asphalt flow and the aggregate flow. The manufacturer's recommendations shall be followed for calibration. To calibrate the aggregate flow system, means shall be provided to permit a positive and uniform diversion of the aggregate in sufficient quantity for accurate time/weight checks. To calibrate the asphalt metering system for proper proportioning, an asphalt distributor or other equipment approved by the Engineer shall be made available so that an accurate tare, gross, and net weight may be obtained of the diverted asphalt discharge. If necessary, manual overrides of the electronic timing equipment shall be provided for testing and calibration purposes. The rate of flow of the total aggregate and asphalt flow shall not vary by more than 2.0% by weight from the required quantity of each.

The drum dryer-mixer shall be capable of simultaneously heating and mixing the introduced aggregate with asphalt to an acceptable thoroughly coated mix meeting the required temperature and mix designs. Pyrometers or other thermometric instruments shall be located at the discharge chute of the dryer-mixer to automatically register the temperature of the mix.

Prior to mixing of hot-mix bituminous concrete in drum plants, the gradation of all stockpiled aggregate material shall be checked for grading requirements in conformance with Paragraph 110, Material Details, and shall be approved prior to use.

Aggregate from the approved stockpile shall be selected on a percentage basis of various stockpile sizes to meet the appropriate job mix formula gradation in accordance with Subsection 39.21. Samples from the cold feed conveyor shall be obtained to ascertain that proper gradation requirements are being obtained prior to the addition of asphalt for production of hot-mix.

39.18 ANTI-STRIP ADDITIVE BLENDING - ALL PLANTS

Blending of the additive and asphalt cement shall be accomplished at the asphalt cement source of supply or at the bituminous concrete production plant through use of an approved in-line metering and blending system, storage tank metering and blending system, or other blending system which provides uniform and complete dispersion of the required additive in the asphalt cement to the satisfaction of the Engineer. Blending/metering systems shall be designed to provide accurate metering of the additive and shall be calibrated and approved prior to use.

39.19 STORAGE SYSTEMS - ALL PLANTS

The system shall be capable of conveying the hot-mixture from the plant to the storage bins and storing the hot mixture without loss of temperature, segregation of the mix or oxidation with all specified quality requirements.

The conveyor system may be a continuous type or skip bucket type. The continuous type shall be enclosed and heated for effective control of mix temperature. The skip bucket type must be of sufficient capacity to transport an entire batch and mass dump into the bins.

The storage bins shall be designed to prevent segregation of the mix during discharge from the conveyor into the bins. The bin discharge gates shall be designed to prevent segregation of the hot-mixture while loading into trucks.

Approval for the use of storage bins may be withdrawn when there is an excessive heat gain or heat loss, uneven heat, segregation of the aggregate and/or migration or oxidation of the asphalt due to the operation or use of storage bins. Mixtures may be retained in heated storage bins for 24 hours provided material and mixture quality is maintained.

39.20 JOB MIX FORMULA

The general composition limits prescribed herein are master ranges of tolerance to govern mixtures made from any raw materials meeting specifications. The composition limits are maximum and minimum in all cases. A closer control appropriate to the job materials may be required for the specific project in accordance with the job mix formula. No work shall be started on the contract nor any mixture accepted for it until the proposed job mix formula has been approved. The contractor shall submit a written proposal indicating the single definite percentage for each sieve fraction of aggregate and for the asphalt which he/she chooses as the fixed means in each instance, and also the temperature at which he/she proposed to furnish the mixture at the plant. The approval of such job mix formula shall bind the contractor to

furnish paving mixtures not only within the master ranges, but also meeting the exact formula set up for the project within the allowable tolerances.

MIXTURE REQUIREMENTS

39.21 GRADATION

Sieve Size	Type A %	Type B %	Type C %	Types D & E %	Job Mix Tolerance %
2½"	100.0	-	-	-	±7
2"	90-100	-	-	-	±7
1½"	60-90	-	-	-	±7
1¼"	-	100.0	-	-	±7
1"	40-75	95-100	-	-	±7
¾"	-	75-95	-	-	±7
½"	30-65	50-80	100.0	-	±7
⅜"	-	45-70	85-100	100.00	±7
#4	20-45	30-50	50-75	80-100	±7
#8	-	22-38	33-59	70-90	±4
#30	-	9-23	14-32	30-55	±4
#50	-	6-18	7-26	15-40	±4
#200	2-10	3-10	3-10	5-15	±2
A.C. %	2.0-4.0	3.5-5.5	4.5-6.5	6.0-8.5	±0.4
Temp° F	225-275	275-325	275-325	275-325	±20° F

The percentages for aggregates are based on the total weight of aggregate and the percentages for asphalt cement are based on the total weight of the mix.

39.22**MARSHALL PROPERTIES**

	Mix Type	Mix Type	Mix Type	Mix Type
Specification Requirements	A	B	C	D & E
Air Voids, % (Compacted Specimen)	-	3-6	3-5	3-5
Stability, lbs. (Minimum)	750	1000	1000	1000
Flow	8-20	8-20	8-20	8-20
Voids in Mineral Aggregate (VMA)% (Minimum)	11.5	13	16	18

39.23**APPLICABLE TESTING METHODS**

The following standards shall be used to test the qualities of the mixture:

- AASHTO T 164, Method A - Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
- AASHTO T 166 - Bulk Specific Gravity of Compacted Bituminous Mixtures
- AASHTO T 209 - Maximum Specific Gravity of Bituminous Paving Mixtures
- AASHTO T 245 - Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- AASHTO T 269 - Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

Samples of the actual mixture in use will be taken as many times daily as required and the mixture must be maintained uniform throughout the project within the above tolerances. Should the mix produced not meet the above requirements or project field performance needs, changes in the mix design or mixing procedure shall be made immediately in a manner approved by the Engineer.

If an additional source of supply for materials is approved, the job mix formula will be readjusted as necessary. Any job mix formula submitted but found unacceptable shall be readjusted to the satisfaction of the Engineer.

39.24 RESTRICTED PERFORMANCE SPECIFICATIONS

DelDOT is currently developing restricted performance specifications governing production and construction of bituminous concrete pavements. These specifications will require process control sampling and testing operations to be the responsibility of the contractor at both the production facility and the project. Acceptance sampling and testing will be the responsibility of DelDOT and will be statistically based. Performance and acceptance parameters to be evaluated will be gradation, asphalt content and pavement density.

39.25 RECLAIMED ASPHALT PAVEMENT (RAP)

This material shall consist of an existing asphalt cement concrete pavement removed by cold milling or removed and processed such that 100% will pass the 2" sieve and 90% will pass the 1" sieve. If the contractor has a supply of RAP meeting the approval of the Engineer, a percentage of this material may be substituted for the new materials required to produce bituminous base binder, and/or dense surface courses as recycled asphalt concrete mixtures.

The stockpile of RAP shall be free of topsoil, debris, foreign matter and other contaminants.

39.26 RECYCLED ASPHALT CONCRETE MIXTURE

The recycled mixture shall be an intimate blend of RAP, new aggregate and asphalt cement conforming to the mixture requirements of Item 39 for the type mix specified. The new aggregate shall conform to the applicable provisions of Item 39. The new asphalt shall conform to the provisions of Paragraph 115, Material Details, Asphalt Cement. The percentage of new aggregate is not fixed by this specification. However, limitations are placed on the RAP percentage permitted in the recycled mix. A job-mix formula must be submitted to the Engineer and approved prior to initiation of work and for any subsequent changes in the blend of the mixture. The approved RAP - new aggregate ratio and percentage of new asphalt cement required to be incorporated into the recycled asphalt concrete mixture will be based on laboratory tests performed on representative samples of stockpiled RAP and new aggregate.

The physical properties of the RAP asphalt cement will be determined by extraction, recovery and testing and generally will govern the percentage of RAP permitted in the recycling mix. Usually, the harder the RAP asphalt, the smaller the RAP percentage permitted in the recycled mix. In any mixture type, the contribution of the RAP asphalt shall not exceed 50% of the design asphalt content for the recycled mix.

In addition, the following plant limitations shall apply to all recycled mixtures:

PLANT TYPE	Maximum RAP% Mixtures	Maximum RAP% Mixtures	Maximum RAP% Mixtures
	Deep Lift	Type B	Type C
Dryer Drum	20%	10%	10%
Batch Plant	20%	10%	10%

Results of single extractions and sieve tests shall not be used as the sole basis for acceptance of the mixture. Any variation from the job-mix formula in the grading of the aggregate or in the asphalt content greater than the tolerances noted below shall be investigated and the conditions causing the variations corrected.

The following tolerances for the job mix formula will be allowed per single test:

<u>Passing Sieve</u>	<u>Percent</u>
½" and larger	±8
¾" and No. 4	±7
No. 8 to No. 100 (inclusive)	±5
No. 200	±3
Asphalt content, weight percent of total mixture	±0.4

39.27 RECYCLED MIX PRODUCTION

Recycled mixtures may be produced in Batch or Dryer Drum type plants. Batch plants shall use the heat transfer method by introducing the RAP into the plant weigh box at stockpile-ambient temperature. The uncoated, virgin aggregate is super-heated in the dryer and transfers its heat to the cold RAP in the plant mixer. A conveying system shall be used to introduce the proper amount of RAP per batch into the weigh box in sequence with the superheated aggregates from the plant hot bins. A 15 second minimum dry-mix cycle shall be incorporated into the mixing cycle prior to introduction of the hot asphalt cement. The mixture produced shall be of uniform, specified temperature, evenly coated, without segregation and shall have all the characteristics typical of a virgin aggregate-asphalt mixture for the type mix produced.

Dryer drum plants used in the production of recycled mixtures shall have specific design and equipment features provided by the manufacturer to accomplish entrance of the RAP material into the drum with subsequent heating and mixing with new aggregate and asphalt without direct flame contact, excessive asphalt hardening or violation of air quality standards. The mixture produced shall be of uniform, specified

temperature, evenly coated, without segregation and shall have all the characteristics typical of a virgin aggregate-asphalt mixture for the type mix produced.

39.28 USE OF RECYCLED MIXTURES

Unless prohibited by the contract, the use of recycled mixture for the mix types specified by the contract shall be at the option of the contractor. All provisions of Item 39, except as modified herein, shall govern materials, production, storage, transportation, spreading, finishing and compaction of recycled materials for the appropriate mix type provided.

39.29 GENERAL USES OF MIXES

- Type A - Open plant mix base course
- Type B - Dense graded base and binder course
- Type C - Dense graded surface course
- Type D - Fine, dense graded surface course
- Type E - Curb mix

39.30 DELIVERY OF MIXTURE

The mixture shall be delivered at the spreader with a loss not greater than 20° F from the temperature determined at the plant by the Engineer.

A minimum of 75 tons of hot-mix concrete per hour shall be delivered to the project unless otherwise directed.

39.31 HAULING EQUIPMENT

Trucks used for hauling bituminous concrete shall have tight, clean, smooth, metal beds which have been thinly coated with an emulsified oil, soap solution or other approved release agent to prevent adherence of the bituminous mixture to the beds. Each truck shall have a securely fastened cover of canvas or other suitable material of such size as to protect the mixture from the weather and prevent heat loss. In addition, each year after September 30, truck body sides shall be insulated for the remainder of the construction season. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight unless approval for nighttime paving has been granted by the Engineer.

CONSTRUCTION EQUIPMENT

39.32 PAVERS

Bituminous pavers shall be self-contained units, provided with an activated screed or strike-off assembly, heated, and capable of spreading and finishing asphaltic concrete in lane widths applicable to the specified typical section and thickness shown on the plans. The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The front of the screed or strike-off assembly shall be equipped with an automatic control device as required herein and shall effectively produce a finished surface of the required evenness and texture without segregation, tearing, shoving, or gouging the mixture. The paver shall be capable of operation at forward speeds consistent with satisfactory laying of the mixture. Equipment used for shoulders and similar construction shall be capable of spreading and finishing the courses in widths shown on the plans.

The screed of the mechanical spreading and finishing machine shall be regulated by an automatically controlled grade leveling and slope control device approved by the Engineer. The device shall be of a standard commercial quality adapted to the type of paver used and shall provide control for producing a uniform surface to the established grade, and a cross slope conforming to the requirements of the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope throughout superelevated curves. Grade control shall be accomplished by use of a sensor following a traveling reference plane not less than 30 feet in length and/or a joint matching shoe referencing to an adjacent mat.

39.33 ROLLERS

Rollers shall be of the steel wheel, static or vibratory type and shall be in satisfactory working condition. All rollers shall be capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each wheel or roller. The rollers shall be operated with the drive wheels nearest the paver and at speeds slow enough to avoid displacement of the mixture. The number and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. The use of equipment which results in excessive crushing of the aggregate or marring of the pavement surface will not be permitted.

All rollers shall be approved prior to use and shall be continuously maintained in a satisfactory working condition and shall bear the manufacturer's name plate on which shall be stamped the model number and the weight without ballast.

39.34 APPLICATION OF TACK COAT

A tack coat of CSS-1-h asphalt (diluted with 50% water) meeting the requirements of AASHTO M 208 shall be applied on all concrete pavement and bituminous pavement surfaces. The surfaces shall be dry and broomed clean. Tack coat shall be applied at a rate of 0.05 gal./S.Y. to 0.15 gal./S.Y., and at a temperature of 70-160° F. Tack coat shall be applied only as far in advance of the hot mix operation as is anticipated for the current day's operation.

With the approval of the Engineer, the contractor may substitute RS-1 (undiluted) meeting the requirements of AASHTO M140 for the CSS-1-h at an application rate of 0.03 to 0.08 gal./S.Y. However, the use of CSS-1-h (as a tack coat) shall be required in all urban paving.

Asphalt for this purpose shall not be a separate bid item, but shall be incidental to the price per ton bid for Item 39, Hot-Mix, Hot-Laid Bituminous Concrete.

39.35 PLACING BITUMINOUS MIXTURES

Prior to the delivery of the mixtures on the job, the underlying course shall have been brought to line, grade, and cross-section, and all excess patching material, joint material, dirt, or foreign material shall be removed. The mixtures shall be placed only upon a surface which is dry, and only when weather conditions are suitable.

Upon arrival, the mixture shall be dumped into the approved mechanical spreader and immediately spread thereby and struck off in a uniform layer to the full width required, and of such depth that when the work is completed, it will have the thickness shown on the plans and will conform to the grade and surface contour required. Machine methods of spreading and screeding will be required unless otherwise permitted.

Should unevenness of texture, tearing, or shoving occur during the paving operation due to unsatisfactory material, methods or equipment, the contractor shall immediately take such action as may be necessary to correct such unsatisfactory work.

The outside edges of the pavement being laid shall be in true alignment and parallel to the centerline of the roadway. On projects requiring multiple lifts or courses, the width of the individual lifts shall be arranged such that the longitudinal joints of each successive lift are offset from the previous lift a minimum of 6 inches but not greater than 12 inches. The longitudinal joint in the surface course shall be at the lane line.

When placing adjacent lanes of the same course, pavers shall be equipped with a joint matching device which will automatically provide control of the depth of the mixture

being placed so that, when compacted, it will match the depth of the adjacent lane.

The placement of roadway bituminous concrete shall be as continuous as possible. Intersections and irregular areas shall be paved after the adjacent roadway has been paved. Hand spreading with lutes will be permitted where irregularities or obstacles make the use of pavers impractical. The use of garden rakes will not be permitted.

No bituminous concrete shall be placed when the ambient (air) temperature at the location of the paving operation is below 50° F for any surface course 1 inch or less in thickness, or below 40° F for any surface, binder, or base course 2 inches or less in thickness. The minimum ambient temperature for base mix placement in excess of 2 inch thickness shall be 32° F. No bituminous concrete shall be placed on any frozen surface or when weather conditions, such as wind and low temperatures, prevent proper spreading, finishing and compaction of the mixture in the opinion of the Engineer. Subsequent lifts or course shall not be placed over another lift or course placed on the same day while the temperature of the previously placed mix is 140° F or greater. Traffic shall be kept off the bituminous concrete until the mat temperature is less than 140° F.

The contractor shall fill low places in the base with a leveling material which consists of binder course or surface material of hot-mix bituminous concrete. The locations along the base course to receive this leveling course material, the type of material to be used, and the method to be employed in each case shall be as directed. Hot-mix bituminous concrete shall be placed as directed around all manholes, catch basins, valves, etc., when they are adjusted to the proposed grade. This material shall be removed if directed and such removal shall be incidental to the item.

The contact surface of curbing, gutters, manholes, etc. shall be painted with a thin uniform coat of hot asphalt cement or other approved bituminous material just before the mixture is placed against them.

After the hot-mix bituminous concrete base/binder course is placed, it shall not lay exposed for a period longer than 10 days. If, due to conditions of emergency, more than 10 days elapsed, a fog coat of RS-1 or CSS-1-h may be required to be sprayed uniformly on the base/binder course so exposed before placing the wearing course of hot-mix bituminous concrete. There will be no additional compensation for the fog coat. In addition, the contractor shall plan his/her paving operation so that no bituminous base course or binder course remains unsurfaced after the "winter shutdown" unless authorized by the Engineer.

Unless otherwise permitted, a single lane of any course shall not be constructed to a length which cannot be completed to a full width of the pavement the following day. All hot-mix resurfacing operations shall be properly signed at the contractor's expense with notice of "Pavement Drop-Off" or "Uneven Pavement".

At locations where the hot-mix is tapered to meet an existing roadway, a tack coat of bituminous material shall be uniformly applied on the tapered area at the rate of approximately 0.15 gallon per square yard. There will be no separate payment for the tack coat. The cost shall be incidental to this item.

39.36 COMPACTION

Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving. Delays in rolling freshly spread mixtures will not be permitted. Each roller shall be operated by a competent and experienced roller operator. All rollers shall be kept in good condition. The number, weight and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. The sequence of rolling operations and the selection of roller types shall provide the specified pavement density. All rollers shall be approved prior to use and shall be continuously maintained in a satisfactory working condition and shall bear the manufacturer's name plate on which shall be stamped the model number and the weight without ballast.

Rollers shall move at a slow but uniform speed with the drive roller or wheels nearest the paver. Rolling shall start longitudinally at the sides, parallel to and proceed toward the center of the work, overlapping on successive trips by at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. When paving an abutting previously placed lane, the longitudinal joint shall be rolled first, followed by the regular rolling procedure. On superelevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the center line.

The bituminous mixture shall be compacted to a mean density of at least 98% of target density. The density shall be sufficiently uniform that individual test results will be at least 96% of target density. If any individual test result falls below 96% of target density, the mixture represented by the test will be considered defective and the contractor shall further compact the subplot. After further compaction, the original test site and one other randomly selected site within the subplot will be tested. The average of the two test results will be included in the mean density for that production day. The original test result will not be included.

To determine target density, a control strip shall be constructed at the beginning of work on each pavement course. Each control strip is to remain in place and become a section of the completed roadway. A control strip shall have an area of approximately 400 square yards and shall be of the same depth specified for the pavement course

which it represents.

The materials used in the construction of the control strip shall conform to the requirements of the approved job mix formula. They shall be furnished from the same source and shall be of the same type used in the remainder of the pavement course represented by the control strip. The prepared base upon which a control strip is to be constructed shall have the prior approval of the Engineer.

The equipment used in the construction of the control strip shall be approved by the Engineer and shall be of the same type and weight to be used on the remainder of the pavement course represented by the control strip.

Compaction of control strips shall commence as soon as possible after the mixture has been spread to the desired thickness, and shall be continuous and uniform over the entire surface. Compaction of the control strip shall be continued until no appreciable increase of density can be obtained by additional roller coverages.

Upon completion of the rolling, the mean density of the control strip will be determined by averaging the results of ten nuclear density tests taken at randomly selected sites within the control strip. The mean density of the control strip shall be the target density for the remainder of the pavement course which it represents.

Compaction shall be expressed as a percentage of the target density:

$$\% \text{ Compaction} = \frac{\text{Nuclear Pavement Density} \times 100}{\text{Control Strip Target Density}}$$

If the mean density of the control strip as determined by cored samples taken in accordance with AASHTO T 230, Method B, is less than 95% of the density of laboratory compacted specimens for surface mixtures, or 90% for base/binder mixtures, the Engineer may order the construction of another control strip.

A new control strip may also be ordered by the Engineer or requested by the contractor when:

- (a) A change in job mix formula is made.
- (b) A change in the material from the same source is observed.
- (c) There is reason to believe that a control strip density is not representative of the bituminous mixture being placed.

If the densities are not obtained, additional rolling or more approved rollers, will be

required. All roller marks shall be rolled out.

The motion of the roller at all times shall be slow enough to avoid displacement of the hot mixtures, and any displacement occurring as a result of the reversing of the direction of the roller, or from any other cause, shall at once be corrected by the use of lutes and of fresh mixture when required. To prevent adhesion of the mixture to the wheels of the roller, they shall be kept properly moistened, but excess water will not be permitted.

Along curb, headers, manholes, railroad crossings, and similar structures and at all places not accessible to the roller, thorough compaction must be secured by means of approved tampers. At all contacts of this character the joints between these structures and the mixture must be effectively sealed. Any mixture which becomes loose and broken, mixed with dirt, or in any way defective, shall be removed and replaced with fresh, hot mixture, which shall be immediately compacted to conform with the surrounding area. Areas showing an excess of asphalt cement, as determined by the Engineer shall be removed and replaced at the contractor's expense.

Compaction Testing. Compaction shall be controlled by the following methods at the discretion of the Engineer:

- (a) Bituminous mixtures shall be compacted to a degree of compaction of not less than 95% of the density obtained by laboratory compaction for surface courses and not less than 90% of the density obtained by laboratory compaction for base and binder course. Laboratory compaction is the average density obtained by the Standard Marshall Method (50 blows top and bottom face), AASHTO T 245 and T 166, for the mixtures produced and being placed. The degree of compaction shall be determined through measurement of actual pavement density using a nuclear density gauge in accordance with ASTM D 2950, "Density of Bituminous Concrete in Place by Nuclear Method," and a laboratory compacted specimen density using the Marshall Method and shall be expressed as a percentage:

$$\text{Degree of Compaction} = \frac{\text{Pavement Density} \times 100}{\text{Marshall Density}}$$

- (b) At the option of the Engineer, 4 inch diameter, diamond bit drilled roadway cores may be obtained from the constructed pavement mixtures for pavement density determination in lieu of the nuclear method.
- (c) When Marshall Density values are not immediately available, or, at the option of the Engineer, pavement compaction may be monitored by a nuclear density

gauge and use of a Control Strip Density in lieu of the Marshall Method. The Control Strip Density shall be the average maximum density obtained by rolling a 300 foot test strip of the material on the project at plan thickness until no appreciable increase in density occurs as measured by the nuclear gauge during successive roller passes. Tests will be run at random locations within sublots equal to approximately 400 square yards of pavement and the result will be immediately available to the contractor.

39.37 JOINTS

Placing of bituminous concrete shall be as nearly continuous as possible and the roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint between old and new pavements or between successive days work, the joint shall be made by means of placing a bulkhead or by tapering the course in which case the edge shall be cut back to its full depth and width on a straight line to expose a vertical surface. It is not the intent of these specifications to require an existing (old) pavement to be cut back full depth transversely when the paving work being performed is an overlay tie-in unless such is designated in the special provisions or on the plans. In both methods, all contact surfaces shall be painted with an approved material before placing any fresh mixture against the joint.

Longitudinal joints shall be rolled directly behind the laying operations. The first lane shall be true to line and grade and have a vertical face. The material being placed in the abutting lane shall be tightly compacted against the vertical face of the previously placed lane. The finishing machine shall be positioned so that in spreading, the material overlaps the edge of the lane previously placed by 1" to 2" and shall be left sufficiently high to allow for compaction. Before rolling, the material overlapping the joint shall be carefully moved with a broom or lute onto the surface of the unrolled lane. When the abutting lane is not placed the same day, or the joint is distorted by traffic or other means, the edge shall be carefully trimmed to line and painted with a thin coat of approved bituminous material such as asphalt cement or emulsified asphalt. Cut-back asphalt is not approved. The longitudinal joint in any layer shall offset that in the layer immediately below by approximately 6 inches. However, the joints in the completed surfacing shall be at the lane lines of the travel way.

39.38 SURFACE REQUIREMENTS

After final rolling, the surface will be tested longitudinally by the Engineer using a 10-foot straightedge at locations selected by the Engineer. The variations of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed the following limits:

(a) For Bituminous Base Courses:

Lower courses $\pm 3/8"$
Top courses $\pm 1/4"$

(b) For Binder and Surface Courses:

(1) Multiple course construction: $\pm 3/16"$ for surface course, $\pm 1/4"$ for lower courses

(2) Single course construction: $\pm 1/4"$

Areas found to exceed these tolerances shall be corrected or removed and replaced by the contractor, as directed, to provide conformance to the surface requirements stated herein. The work and materials required in the correction of defective work shall be provided by the contractor at no cost to the City.

The contractor shall have available at all times an approved 10 foot straightedge.

39.39 METHOD OF MEASUREMENT

The number of tons of Hot-Mix, Hot Laid Bituminous Concrete to be paid for under this section shall be the actual weight of Hot-Mix Bituminous Concrete placed and accepted. The tonnage shall be based as follows:

The weight of each load shall be determined by weighing each loaded truck or other approved hauling equipment and then deducting the tare weight of the truck or hauling equipment. The tare weight shall be checked twice daily, or as often as directed by the Engineer and appropriate adjustments made thereafter, in the use of the tare weight (at no cost to the City).

The scale platform shall be of such length and width that it will conveniently accommodate all trucks, or other approved hauling equipment, hauling materials. The entire vehicle load must rest on the scale platform and be weighed as one draft. All scales shall be checked and approved before use. Each load shall have a ticket signed by an approved Certified Weighmaster and shall be signed by the Construction Inspector as received on the project.

39.40 BASIS OF PAYMENT

The tonnage measured as provided above shall be paid for at the contract unit price per ton bid for Item 39, Hot-Mix, Hot Laid Bituminous Concrete, which price and payment shall be full compensation for furnishing, preparing, hauling, and placing all materials and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 39A

HOT-MIX BITUMINOUS CONCRETE AND/OR

COLD LAID BITUMINOUS CONCRETE

(TEMPORARY ROADWAY MATERIAL- TRM)

39A.01 DESCRIPTION

This item consists of furnishing and placing Hot-Mix Bituminous Concrete and or Cold Laid Bituminous Concrete for Temporary Roadway Material as directed by the Engineer and in conformance with the requirements of Item 39 of the Standard Specifications, and as modified by Special Provisions.

39A.02 MATERIAL

Material shall conform to the requirements of applicable subsections of Item 39 and Paragraph 116, Material Details.

39A.03 BASIS OF PAYMENT

Only one unit price bid for the item, Hot-Mix Bituminous Concrete and/or Cold Laid Bituminous Concrete (Temporary Roadway Material), will be paid for the above described work and materials which are to be used for this item, for which payment of the contract unit price bid per ton shall be full compensation for furnishing, preparing, hauling, and placing all materials, including tack coat, and for all labor, equipment, tools, and incidentals to complete the item.

ITEM 39B

PLANT MIX OPEN - GRADED WEARING SURFACE

39B.01 DESCRIPTION

This work shall consist of furnishing all materials and constructing open-graded wearing surface in accordance with the widths and thicknesses shown on the plan and approved by the Engineer.

The pavement shall be constructed in conformity with the requirements of all applicable sections of Item 39.

39B.02 JOB MIX FORMULA

The open-graded wearing surface shall be composed of a mixture of approved aggregate and asphalt cement. Limestone or Serpentine aggregate will not be approved. The use of washed concrete sand in this mix will not be permitted.

At least one month prior to production, the contractor shall submit in writing a job mix formula to the Engineer for approval. At this time, the contractor shall list all sources of materials and provide adequate samples of all aggregates and asphalt in order to verify suitability of the proposed job mix.

Job mix suitability will be determined on the basis of laboratory tests.

Gradation and Mix Requirements

<u>Sieve</u>	<u>Master Range (% of Passing)</u>	<u>Tolerance from Job Mix</u>
1/2"	100	---
3/8"	88 - 98	3%
#4	25 - 42	±5%
#8	5 - 15	±3%
#200	2 - 5	±1.5%

Asphalt Cement 6.0 to 8.0% (to be determined by Laboratory Tests).

An approved heat stable anti-stripping additive shall be added to all asphalt cement used for open-graded surface course. The amount of the additive used shall be 0.25 to 1.0% by weight of the asphalt cement as recommended by the additive

manufacturer and approved by the Engineer.

The additive shall be thoroughly and uniformly blended with the asphalt cement at the hot-mix production plant or at the asphalt cement source of supply by one of the following methods:

- (a) An approved in-line metering and blending system.
- (b) An approved propeller type blade blender in the asphalt storage tank in conjunction with an approved metering device for adding the required anti-stripping additive.

Heat stable anti-stripping additive shall conform to the following requirements:

- (a) The material shall contain no ingredient harmful to asphalt cement and shall not appreciably alter the characteristics thereof when added in the recommended proportions.
- (b) It shall be capable of thorough dispersion of the asphalt cement at the temperature of use and shall be capable of remaining in asphalt cement in storage at the normal storage temperatures without detrimentally affecting the asphalt cement. The additive shall remain effective as an anti-stripping compound when stored in the asphalt cement.

No separate payment will be made for the anti-strip agent. Payment will be included in the unit price bid for Plant Mix Open-Graded Wearing Surface.

The target temperature ($\pm 10^{\circ}$ F) of the mix leaving the mixer shall be established by the Materials and Research Section on the basis of laboratory tests. A target temperature of 240° F $\pm 10^{\circ}$ F is typical.

Should a change in source of material be proposed or should an approved job mix formula prove unsatisfactory, a new job mix formula shall be submitted by the contractor.

Asphalt cement shall conform to the requirements of Paragraph 115 of the Material Details. However, the temperature of the asphalt cement shall not be greater than 310° F at time of introduction into the mixer.

Aggregate shall conform to the requirements of Paragraph 103 and 104 of the Material Details, except slag will not be permitted. The use of limestone aggregate or natural sand, washed or unwashed, is prohibited.

39B.03 PREPARATION OF AGGREGATES

The aggregates for the mixture shall be dried and heated to the required temperature. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid soot on the aggregate.

The temperature of the aggregates as introduced into the mixer shall not exceed a temperature which causes segregation of the asphalt and aggregate during transportation. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

39B.04 MIXING

The dried aggregates and the bituminous material shall be measured and gauged and introduced into the mixer in the proportions specified by the job mix formula.

After the required amount of aggregate and bituminous material have been introduced into the mixer, the materials shall be mixed until a complete and uniform coating of the particles and a thorough distribution of the bituminous material throughout the aggregate is secured.

39B.05 BITUMINOUS MIXING PLANT

The requirements of Subsections 39.10 and 39.11 of these Standard Specifications shall apply.

39B.06 HAULING EQUIPMENT

Requirements of Subsection 39.31 of these Standard Specifications shall apply.

39B.07 PAVERS

Requirements of Subsection 39.32 of these Standard Specifications shall apply.

39B.08 ROLLERS

Rollers shall be in good condition, capable of reversing without backlash. The use of equipment which results in crushing of the aggregate will not be permitted. Rollers shall be steel-wheel capable of exerting a force of not less than 250 pounds per inch of width of compression roll or rolls. Rubber tired rollers will not be permitted on the open-graded wearing surface.

39B.09 SPREADING AND FINISHING

The mix shall be spread and struck off to the grade and elevation established. Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable.

No open-graded wearing surface shall be placed when the ambient temperature is below 65° F.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the mixture may be spread, raked and luted by hand tools.

39B.10 COMPACTION

After the bituminous mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The bituminous mixture shall be rolled in a longitudinal direction, commencing at the outside edge and progressing towards the center. Rolling shall be accomplished with a steel-wheel roller or rollers and shall be conducted in such a manner that shoving, distortion, or stripping will not develop beneath the roller. On superelevated curves, the rolling shall commence on the low side and progress to the high side. The amount of rolling shall be confined to only that necessary for consolidating the bituminous mixture and bonding it to the underlying surface. Excessive rolling shall be avoided.

The completed bituminous mixture shall be protected from all traffic until it has cooled sufficiently to resist distortion, abrasion, or pickup.

The contractor is advised that early breakdown is essential due to rapid temperature loss of the open-graded mix. It is anticipated that two complete passes of the roller will provide adequate compaction. Density tests on the open-graded wearing surface will not be conducted. The contractor will be directed to cease rolling when, in the opinion of the Engineer, maximum density has been achieved. Determination will be by visual means. Over-rolling will result in aggregate fracture which shall be avoided.

39B.11 JOINTS, TRIMMING EDGES AND CLEANUP

Placing of the bituminous mixture shall be as continuous as possible. Rollers shall not pass over the unprotected end of a freshly laid mixture unless authorized by the Engineer. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A brush coat of bituminous material shall be used on contact surfaces of transverse joints just before additional mixture is placed against the previously rolled material.

The exposed edges of the completed mat shall be cut off true to the required lines. Material trimmed from the edge and any other discarded bituminous mixture shall be removed from the roadway and disposed of by the contractor.

39B.12 FINISHED WORK SAMPLES

The engineer may cut samples from the pavement for testing. Samples will be neatly cut by a saw or core drill. The contractor shall supply and place new material to backfill voids left by sampling.

39B.13 METHOD OF MEASUREMENT

The number of tons of bituminous Plant Mix Open-Graded Wearing Surface to be paid for under this Section shall be the actual weight of bituminous Plant Mix Open-graded Wearing Surface placed and accepted. The tonnage shall be based as follows.

The weight of each load shall be determined by weighing each loaded truck or other approved hauling equipment and then deducting the tare weight of the truck or hauling equipment. The tare weight shall be checked twice daily, or as often as directed by the Engineer and appropriate adjustments made thereafter, in the use of the tare weight.

The scale platform shall be of such length and width that it will conveniently accommodate all trucks or other approved hauling equipment. The entire vehicle load must rest on the scale platform and be weighed as one draft. All scales shall be checked and approved before use.

Weight tickets showing a net weight of each load of material delivered to the project shall be signed by the construction inspector.

39B.14 BASIS OF PAYMENT

The tonnage measured as provided above shall be paid for at the contract unit price per ton bid for Item 39B, Plant Mix Open-Graded Wearing Surface, which price and payment shall be full compensation for furnishing all materials, preparing, hauling, and placing all materials, and for all labor, equipment, tools, and incidentals necessary to complete the work.

ITEM 40

REMOVAL AND REPLACEMENT OF EXISTING

INTEGRAL CONCRETE CURB AND GUTTER,

ROLL CURB AND VERTICAL CURB

40.01 DESCRIPTION

This item shall consist of the removal and replacement of existing integral curb and gutter, roll curb and vertical curb made of Portland Cement Concrete, constructed on a prepared subgrade in accordance with these specifications where, and of the form, dimensions, and designs shown on the plans, or as directed by the Engineer.

The linear feet measured as provided for under Item 25, shall be paid for at a unit price per linear foot, which price and payment shall be full compensation for removing old curb and gutter, furnishing and placing of all materials, labor and other preparations incidental to installing this item complete, including restoration of disturbed areas to their original conditions.

40.02 PORTLAND CEMENT

Portland cement for use in this item shall conform to the requirements of Paragraph 100, Material Details.

40.03 WATER

Water for use in mixing concrete for this item shall conform to the requirements of Paragraph 102, Material Details.

40.04 FINE AGGREGATE

Fine aggregate for use in this item shall conform to the requirements of Paragraph 103, Material Details.

40.05 COARSE AGGREGATE

Coarse aggregate for use in this item shall conform to the requirements of Paragraph 104, Material Details.

40.06 GRADATION

Coarse aggregate shall be of one size, graded as specified for size No. 57 of Paragraph 110, Material Details.

40.07 PREFORMED EXPANSION JOINT MATERIAL

Expansion joint material for this item shall conform to the requirements of Subsection 25.08.

40.08 COMPOSITION OF MIX

The composition of the mix shall conform to the requirements of Paragraph 108, Material Details.

40.09 CONSTRUCTION METHODS

The material to be removed shall be broken by an approved power breaking machine. The ball type breaker will not be permitted. Extreme care shall be exercised by the Contractor in the operation to insure that no damage occurs to any existing buried, surface, or aerial utility. The broken concrete materials will become the property of the Contractor and shall be removed from the project or otherwise disposed of in a manner satisfactory to the Engineer.

The methods employed in performing the work and all equipment, tools, and machinery 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, shall be changed or improved as required by the Engineer. All equipment, tools, and machinery used must be maintained in a satisfactory working condition.

40.10 EXCAVATION FOR REMOVAL OF CURBS

Excavation shall be made to the required depth and the subgrade or base upon which the integral curb and gutter, roll curb or vertical curb is to be set, shall be compacted to a firm even surface. All soft and unsuitable material shall be removed and replaced with suitable material and compacted.

40.11 FORMS

Forms shall conform with requirements specified in Subsection 25.10, Item 25, Portland Cement Concrete Curb.

40.12 PLACING CONCRETE

The concrete shall be placed in accordance with Subsection 25.11, Item 25, Portland Cement Concrete Curb.

40.13 CHECKING GUTTER

Before the concrete is given the final finish, the surface on the gutter shall be checked with a 10' straightedge and any irregularities of more than $\frac{1}{4}$ " in 10' shall be corrected.

40.14 CONSTRUCTION OF SECTIONS

The curb and gutter shall be constructed in sections 10' in length in accordance with Subsection 25.12, Item 25, Portland Cement Concrete Curb.

40.15 JOINTS

Expansion joints shall be formed in the curb and gutter at intervals of 40'. When the curb and gutter are placed adjacent to concrete pavement, the location and thickness of expansion joints in the curb and gutter shall coincide with the expansion joints in the pavement, as detailed on the plans.

40.16 FINISHING AND CURING

Finishing shall meet the requirements of Subsection 25.14, Item 25, Portland Cement Concrete Curb.

Curb shall be cured according to Subsection 9.20, Item 9, Portland Cement Concrete Pavement.

40.17 BACKFILLING

Backfilling shall meet the requirements of Subsection 25.16, Item 25, Portland Cement Concrete Curb.

40.18 METHOD OF MEASUREMENT

The linear feet to be paid for under this item shall be the actual linear feet of integral curb and gutter, roll curb or vertical curb, replaced and accepted.

40.19

BASIS OF PAYMENT

The linear feet measured as provided hereto before shall be paid for at contract unit price per lineal foot "Integral Curb and Gutter, Roll Curb or Vertical Curb" which price and payment shall be full compensation for removal, furnishing and replacing of all materials and for the excavating, filling, or other preparations incidental to installing these items complete.

ITEM 41

REINFORCED CONCRETE BLOCK MASONRY

41.01 DESCRIPTION

This item includes the construction of reinforced concrete block walls as herein specified and as shown on the plans. The work under this item shall include the furnishing of all labor, materials and equipment and the completion of all masonry and reinforcement essential for the completion of the construction, as indicated on the plans.

MATERIALS

41.02 PORTLAND CEMENT

Portland Cement for this item shall conform to all the requirements of Paragraph 100, Material Details.

41.03 FINE AGGREGATE

Fine aggregate for mortar shall conform to the requirements of Paragraph 103, Material Details.

41.04 WATER

Water used in mixing the mortar for concrete block masonry shall conform to the requirements of Paragraph 102, Material Details.

41.05 CONCRETE BLOCK

Concrete blocks shall be made in accordance with the Standard Specifications of the National Concrete Products Associations. All blocks shall be hollow masonry units filled solid, meeting the requirements of the ASTM Specifications SS-C-621. All blocks shall be properly cured and shall have a minimum compressive strength of 750 psi.

41.06 MORTAR

Mortar shall be composed of 1 part Portland cement and 3 parts sand by dry loose volume, to which shall be added hydrated lime not to exceed 10% of the cement by weight.

41.07 BAR REINFORCEMENT

Reinforcing steel shall be placed as shown on the plans. All reinforcement in blockwork shall conform to Item 13, Bar Reinforcement.

41.08 BLOCKWORK

Blockwork shall be laid in common bond.

All hollow blocks shall be laid with the cells vertical to the wall and in such manner that the main bearing webs come in proper relation for bearing with those of the blocks below. All vertical or horizontal joints shall be mortared through the walls by buttering the two edges of each block on both horizontal and vertical joints. The reinforcement shall be placed as shown on the plans.

Top of block walls shall be within 1/8" of the final elevation.

41.09 METHOD OF MEASUREMENT

The yardage to be paid for under this item shall be the number of square yards of 8" reinforced blockwork measured on the surface of the wall, complete in place according to the requirements of these specifications, and as shown on the plans.

41.10 BASIS OF PAYMENT

The number of square yards measured as provided above shall be paid for at the contract unit price per square yard bid for Item 41, Reinforced Concrete Block Masonry, which price and payment shall be full compensation for furnishing all materials, including reinforcement, tools, equipment, and labor necessary to complete the item.

ITEM 42

PRESTRESSED PRECAST REINFORCED

CONCRETE MEMBERS

42.01 DESCRIPTION

Prestressed Precast Reinforced Concrete Members shall consist of the furnishing of a complete bridge superstructure or deck of culvert composed of prestressed precast reinforced concrete members and accessories, and the erection of the superstructure on the substructure abutments, in reasonably close conformity with details shown on the contract plans, and or the approved shop or working drawings.

This item includes bearing pads and materials, dowels, tie rods, nuts, and plates, joints and joint materials, scuppers, and all other incidental parts and materials required to complete this section.

Unless otherwise noted on the plans, or in the special provisions, the roadway wearing surface, reinforced concrete sidewalks, curbs, safety curbs, and parapets will not be included for payment in this section.

42.02 PLANS

The contract plans show general details and information pertaining to the prestressed precast concrete members, to serve as an indication of the type of construction acceptable for use. The Contractor will be required to prepare and submit for approval a complete set of detailed shop plans with supporting design computations for the prestressed concrete members he proposes to furnish, and he shall not proceed with the manufacture of the members until the final shop drawings have been approved.

42.03 DESIGN CRITERIA

The design of the prestressed precast reinforced concrete members shall meet the requirements of Section 6 of the Standard Specifications for Highway Bridges of the American Association of State Highway and Transportation Officials.

The design load shall be HS 20-44.

$f' c$ (Compressive strength of concrete at 28 days) shall be 5000 psi minimum.

f' ci (Compressive strength of concrete at time of initial prestress) shall be 4000 psi minimum.

42.04 MATERIALS

Strand. As shown on plans.

Wire. As shown on the plans. Should the Contractor have superior materials available, consideration for their approval will be given.

Bar Reinforcement. All bar reinforcement shall conform to the requirements of Item 13.

Concrete. Concrete for prestressed members shall conform to the following requirements:

The coarse aggregate shall have a grading conforming to size No.57.

The cement factor shall be a least 7.0 bags per cubic yard, but not more than 7.5 bags per cubic yards.

The concrete shall have an entrained air content of $5\% \pm 2\%$.

A mix shall contain at least 40% by specific volume of coarse aggregate and shall have a water-cement ratio of not more than 5:3.

The slump of the concrete shall not exceed 3". Admixture meeting the requirements of ASTM C 494, shall be added to the mix in strict accordance with the manufacturer's recommendation.

The required test cylinder strength of the concrete at the time of transfer of the tensioning load from strand to concrete, (release of prestress) shall be not less than 4000 pounds per square inch (f' ci).

Cylinders shall be initially cured under the same curing conditions as the members.

A total of 6 test cylinders shall be cast for each member and tested as follows: Two cylinders shall be tested to determine when transfer of the tensioning load may be permitted 3 cylinders shall be tested at 28 days; and 1 cylinder shall be held in reserve or tested at shipping date, if necessary. After the release cylinders have been tested, the remainder of the test cylinders shall be moist cured.

Concrete used in the prestressed precast members shall have a minimum 28 day

compressive strength of 5000 pounds per square inch.

Bearing Pad Material. Elastomeric bearings as herein specified shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates) of the size indicated on the plans.

The elastomer portion of the elastomeric compounds shall be 100% virgin polyisoprene (natural rubber) meeting the requirements of Table A or 100% virgin chloroprene (neoprene) meeting the requirements of Table B, as specified by the Engineer. Compounds of nominal hardness between the values shown may be used and the test requirements interpolated. When test specimens are cut from the finished product a 10% variation in "Physical Properties" will be allowed.

Laminates shall be rerolled mild steel sheets conforming to AASHTO M 183 (ASTM A 36) or ASTM A 245, Grade C or D unless otherwise specified by the Engineer.

Manufacturing Requirements. Plain bearings may be molded individually, cut from previously molded strips or slabs or extruded and cut to lengths. Cut edges shall be at least as smooth as ANSI 250 finish. Unless otherwise shown on the plans, all components of a laminated bearing shall be molded together into an integral unit, and all edges of the nonelastic laminations shall be covered by a minimum of 1/8" (3.2 mm) of elastomer except at laminate restraining devices and around holes that will be entirely closed on the finished structure.

Tolerances. Flash tolerance, finish and appearances shall meet the requirements of the latest edition of the Rubber Handbook as published by the Rubber Manufacturers Association, Inc., RMA F3 and T.063 for molded bearings and RMA F2 for extruded bearings.

For both plain and laminated bearings, the permissible variation from the dimensions and configuration required by the plans and these specifications shall be as follows:

	Inches (mm)
(a) Overall Vertical Dimensions	
Average total thickness	
1-1/4"(31.8mm) or less	-0, + 1/8"(-0, + 3.2)
Average Total Thickness	
over 1-1/4"(31.8mm)	-0, + 1/4"(-0, + 6.4)
(b) Overall Horizontal Dimension	
36" and less (.914m)	-0, + 1/4"(-0, + 6.4)
over 36" (.914m)	-0, + 1/2"(-0, + 12.7)

	Inches (mm)
(c) Thickness of Individual Layers of Elastomer (Laminated Bearing Only)	$\pm 1/8"$ (± 3.2)
(d) Variation from a Plane Parallel to the Theoretical Surface (as determined by measure- ments at the edges of the bearings)	
Top	1/8" (3.2)
Sides	1/4" (6.4)
Individual Non-Elastic Laminates	1/8" (3.2)
(e) Position of Exposed Connection Members	1/8" (3.2)
(f) Edge Cover of Embedded Laminates or Connection Members	-0, + 1/8" (-0, + 3.2)
(g) Size of Holes, Slots or Inserts	$\pm 1/8"$ (± 3.2)
(h) Position of Holes, Slots or Inserts	$\pm 1/8"$ (± 3.2)

TABLE A

ASTM STANDARD	PHYSICAL PROPERTIES	50 DURO	60 DURO	70 DURO
D2240 D412	Hardness	50 ± 5	60 ± 5	70 ± 5
	Tensile Strength minimum psi (MPa)	2500 (17.237)	2500 (17.237)	2500 (17.237)
	Ultimate Elongation minimum %	450	400	300
HEAT RESISTANCE				
	Change in durometer hardness, max. points	+10	+10	+10
D573 70 Hrs @158°F	Change in tensile strength, max %	-25	-25	-25
	Change in Ultimate elongation, max %	-25	-25	-25
COMPRESSION SET				
D395 Method B	22 hours @ 158°F (69.9°C), max %	25	25	25
OZONE				
D1149	25 pphm ozone in air by volume, 20% strain 100 $F \pm 2^{\circ}F (37.7^{\circ}C \pm 1^{\circ}C)$, 48 hrs mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
ADHESION				
D429 B	Bond made during Vulcanization, lbs per inch (kg/m)	40 (714)	40 (714)	40 (714)
LOW TEMPERATURE TEST				
D746 Procedure B	Brittleness at -40° F (-40° C)	No Failure	No Failure	No Failure

TABLE B

ASTM STANDARD	PHYSICAL PROPERTIES	50 DURO	60 DURO	70 DURO
D2240 D412	Hardness Tensile Strength minimum psi (MPa) Ultimate Elongation minimum %	50 $\pm$ 5 2500 (17.237) 400	60 $\pm$ 5 2500 (17.237) 350	70 $\pm$ 5 2500 (17.237) 300
HEAT RESISTANCE				
	Change in durometer hardness, max. points	+ 15	+ 15	+ 15
D573 70 Hrs @212° F (100° C)	Change in tensile strength, max % Change in Ultimate elongation, max %	-15 -40	-15 -40	-15 -40
COMPRESSION SET				
D395 Method B	22 hours @ 212° F (100° C), max %	35	35	35
OZONE				
D1149	100 pphm ozone in air by volume, 20% strain 100 F $\pm$ 2° F (37.7° C $\pm$ 1° C), 100 hrs mounting procedure D518, Procedure A	No Cracks	No Cracks	No Cracks
ADHESION				
D429 B	Bond made during Vulcanization, lbs per inch (kg/m)	40 (714)	40 (714)	40 (714)
LOW TEMPERATURE TEST				
D746 Procedure B	Brittleness at - 40° F (-40° C)	No Failure	No Failure	No Failure

42.04 MATERIALS

Quality Assurance. Whenever practical, the mechanical properties of the finished bearing shall be verified by laboratory test.

The following values shall be met under laboratory testing conditions of full size bearings:

- (a) Compressive strain of any layer of an elastomer bearing shall not exceed 7 percent at 800 psi (5.516 MPa) average unit pressure, or at the design dead load plus live load pressure if so indicated on the plans.
- (b) The shear resistance of the bearing shall not exceed 30 psi (.207MPa) for 50 durometer, 40 psi (.276MPa) for 60 durometer or 50 psi (.345MPa) for 70 durometer, Table A compounds; nor 50 psi (.345MPa) for 50 durometer, 75 psi (.517MPa) for durometer or 110 psi (.758MPa) for 70 durometer Table B compounds at 25 percent strain of the total effective rubber thickness after an extended four day ambient temperature of -20° F (-28.9° C).

Non-Shrink Grout. Non-shrink grout shall be composed of the following:

- 1 Sack cement
- 105 Lbs. sand
- 100 Lbs. of approved non-shrink admixture

Structural Steel and Wrought Iron. Structural Steel and wrought iron shall conform to the provisions of the plans and shop drawings.

Protective Coating. Epoxy coal-tar application shall consist of grinding and preparing bridge deck surfaces, applying epoxy coal-tar resin to the prepared surfaces and coating the epoxy with sand as described herein or as directed by the Engineer. This application shall be made to the surfaces indicated on the plans.

42.05 GENERAL

The plant(s) manufacturing prestressed precast reinforced concrete members for contract work shall be inspected and approved before manufacture of the members may be started.

All materials, equipment, processes of manufacturer, and the finished members, including handling, storage, and transportation, shall be subject to inspection and approval. Any defective construction, which may adversely affect the strength of a member or its performance in the bridge deck, shall be cause for rejection. Rejected

members shall be replaced at no expense to the City.

Permissible construction tolerances shall be in accordance with those recommended in the AASHTO publication, "Tentative Standards for Prestressed Concrete Piles, Slabs, I Beams, and Box Beams for Bridges and an Interim Manual for Such Construction."

42.06 FORMS

Forms and centering shall be made and maintained, during their use, true to the shapes and dimensions shown on the approved drawings.

Unless otherwise provided, only metal forms shall be used. They shall be well constructed, carefully aligned, substantial and firm, securely braced and fastened together sufficiently tight to prevent leakage of mortar, and strong enough to withstand the action of mechanical vibrators.

Form ties shall be either of the threaded type or the snap off type, so that no form wires or metal pieces will be left at the surface of the finished concrete. Corners and angles shall be mitered or rounded.

Joints between panel forms shall be made smooth and tight.

42.07 REINFORCEMENT AND PRETENSIONING STRANDS

Bar reinforcement and pretensioning strands shall be free of frost, dirt, oil, paint, mill scale, corrosion, or any foreign material that may prevent bond between the steel and concrete. If an anti-bonding agent is used on the forms to facilitate their removal, every precaution shall be taken to protect the reinforcement and the pretensioning strands against being coated by the anti-bonding agent.

Pretensioning strands, reinforcement, and other embedded fixtures shall be accurately placed as indicated on the drawings, and shall be maintained in their correct position during the manufacture of the members.

Stressing Requirements and Procedures

42.08 PRETENSIONING

The amount of stress to be given each cable or strand shall be shown on the approved working drawings.

All cables or strands to be prestressed in a group shall be brought to a uniform initial tension, prior to being given their full pretensioning. This uniform initial tension of

approximately 500 pounds per strand shall be measured by a dynamometer or other approved means so that its amount can be used as a check against elongations computed and measured.

After this initial tensioning, the group shall be stressed until the required elongation and jacking pressure is attained and reconciled with the following general requirements and provisions.

The stress induced in the cables or strands shall be measured both by jacking gages and elongations of the cables or strands. The results should check each other within close limits.

All jacks shall be equipped with accurate and calibrated gages for registering jacking pressures. Means shall be provided for measuring the elongation of the prestressing strands to at least the nearest 1/32".

The Contractor shall be required to furnish the Department of Public Works with satisfactory, accredited proof that all jacking equipment and gages to be used in the manufacture of the prestressed members have been calibrated by a reputable testing laboratory.

The interpretations and analysis of elongations and jacking pressures shall take into consideration, and make allowance for, all possible slippage or relaxation of the anchorage.

In the event of an apparent discrepancy of as much as 10% between stress determination by jacking pressures and elongation measurements, the entire operation shall be carefully checked, and the source of error determined, before proceeding further.

With the cables or strands stressed in accordance with the plan requirements and foregoing specifications, and with all other reinforcements in place, the concrete shall be placed in the form. The temperature of the concrete shall be between 50° and 85° F. Cable or strand stress shall be maintained between anchorages until the concrete has reached the minimum compressive strength of 4000 pounds per square inch, and the process of transferring the prestress to the member has begun.

Members shall be steam cured under a suitable enclosure to contain the live steam and minimize moisture and heat losses. The initial application of the steam shall be from four to six hours after the final placement of concrete to allow the initial set of the concrete to take place. The steam shall be at 100% relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of

the steam, the ambient air temperature shall increase at a rate not to exceed 40° F, per hour until a maximum temperature of from 140° F to 160° F is reached. The maximum temperature shall be held until the concrete has reached the desired release strength. In discontinuing the steam, the ambient air temperature shall not decrease at a rate to exceed 40° F per hour until a temperature has been reached about 20° F above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to temperature below freezing for six days after casting. Recording charts of steam temperature shall be maintained.

The detensioning shall be done immediately following the curing period while the concrete is still warm and moist. If allowed to dry and/or cool prior to detensioning, dimensional changes take place which may cause cracking or undesirable stresses in the concrete.

In all detensioning operations, the prestressing forces must be kept nearly symmetrical about the vertical axis of the member and must be applied in a manner that will minimize sudden or shock loading. Maximum eccentricity about the vertical axis shall be limited to one strand.

Forms, ties, inserts, hold-downs or other devices that would restrict longitudinal movement of the members along the bed shall be removed, loosened, or alternate detensioning shall be performed in such a manner and sequence that longitudinal movement is precluded.

After completion of the release of prestresses, the strands shall be cut flush with the ends of the member, and painted with either an approved bitumastic compound or waterproofing compound.

42.09 PRODUCTION

The manufacturer's plant and equipment shall be arranged and operated to secure sufficient uniform production of a dense and high grade concrete in all parts of the members, under all working and weather conditions. All operations of mixing, placing, finishing, and curing shall be subject to inspection and approval.

42.10 HANDLING, STORAGE AND SHIPPING

Prestressed members may be handled immediately after cutting of strands or cables. Members shall not be shipped until the minimum 28 day compressive strength has been attained, and in no case less than 3 days after the placing of concrete in the forms. Members shall be handled from pick-up points provided especially for this purpose. They shall be maintained in a horizontal position (as when formed on the casting bed) at all times during handling, moving, storing or shipping.

Members damaged by improper storing, handling, transporting or erecting shall revert to the ownership of the Contractor and shall be removed and replaced at no expense to the City.

Members will be inspected at the project site for possible damage during shipment, and for camber and other dimensions required for satisfactory installation.

The Contractor shall follow the manufacturer's recommended practice for handling and placing the precast members, throughout the entire procedure of transportation from the casting yard to the project site, unloading at the site and final installation of the members complete in place.

42.11 GROUTING BETWEEN PRESTRESSED MEMBERS

After the deck members have been placed and fastened together with tie rods, and the end anchor dowels placed, the longitudinal joints between members shall be filled with a non-shrink grout.

Immediately prior to filling the joints, the keyways shall be cleaned of all debris, and all oil, grease, or other material which may prevent effective bonding. After cleaning, the keyways shall be thoroughly soaked, then tightly caulked below the bottom of the shear key with oakum, or an approved equal, to avoid mortar leaks. The caulking material shall not project more than ½" into the shear key area. In cold weather, the concrete against which the grout will be placed must be in a frost-free conditions.

The grout shall be mixed to consistency necessary to place the material. Traffic, or other loading, shall not be permitted on the bridge deck for at least 24 hours after the grout has been placed, and preferably not until the end of the curing period.

The joints shall be covered with wet burlap, kept wet, and cured for 3 days.

41.12 SCUPPERS

The Contractor shall furnish and install scuppers approved by the Engineer, in the locations indicated on the plans, or as directed.

42.13 ERECTION

The precast units shall be installed by the manufacturer, or under his direct supervision, in level position, making sure that the proper angle to the bearing wall is maintained.

The manufacturer shall cooperate with other trades to permit proper locations of anchors, hangers, etc. Field cutting of openings shall be done by the trade requiring same in the hollow sections of the units. Reinforcing shall not be cut without the approval of the Engineer.

The manufacturer will be required to furnish and install such steel as shown or called for on the drawings.

42.14 BASIS OF PAYMENT

A single lump sum price will be paid for Item 42, Prestressed Precast Reinforced Concrete Members complete in place and accepted, which price and payment shall constitute full compensation for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

ITEM 43

PERFORATED PIPE UNDERDRAINS

43.01 DESCRIPTION

Perforated Pipe Underdrains shall consist of furnishing and placing perforated pipe underdrains, furnishing and placing filter fabric and DE No. 57 stone in accordance with the locations, notes, and details shown on the plans.

MATERIALS

43.02 PIPE

Perforated corrugated metal pipe shall meet requirements of AASHTO M 36.

Perforated Corrugated Polyethylene Tubing shall meet the requirements of AASHTO M 252, and shall be supplied in individual lengths with no length shorter than 10'. Coil pipe will only be permitted in 4" diameter when it is to be machine installed.

43.03 STONE BACKFILL

The stone used for encasing the perforated pipe shall meet the grading requirements of DE No. 57 listed in Paragraph 110 of the Material Details.

43.04 GEOTEXTILES

Geotextile fabric installed to prevent soil infiltration into the stone encasement, shall conform to ASHTO M 288.

43.05 CONSTRUCTION METHODS

The underdrain shall be constructed in accordance with the Detail Standards or Plan Detail approved by the Engineer.

43.06 METHOD OF MEASUREMENT

The number of feet of Perforated Pipe Underdrain to be paid for under this section shall be the actual number of linear feet of perforated pipe underdrain installed in place, complete and accepted, measured from end to end of pipe, excluding structures. In measuring lengths of special manufactured connections exclusive of coupling bands, each actual linear foot placed shall be doubled and payment made

according to the regular bid price for this section.

43.07 BASIS OF PAYMENT

The number of linear feet of Perforated Pipe Underdrain measured as provided above, shall be paid for at the contract unit price per linear foot bid for Item 43, Perforated Pipe Underdrains, which price and payment shall constitute full compensation for necessary excavation and backfilling, for the perforated pipe underdrain, for furnishing, hauling, and installing the pipe, and for all materials including backfill, equipment, tools, and incidentals necessary to complete the work.

ITEM 44

CHAIN LINK FENCE

44.01 DESCRIPTION

Chain link fence shall consist of furnishing and erecting a chain link type fence as indicated on the plans or as ordered by the Engineer.

The Contractor should note that 3 types of fence are specified herein; an aluminum fence, zinc coated steel fence, and an aluminum coated steel fabric fence. The Contractor shall furnish one of the three types of fence, as specified or directed.

All chain link fence shall conform to AASHTO M 181.

It is intended that all work shown on the contract drawings and included in the specifications is to be paid for under the terms listed in the proposal forms. The absence from the proposal forms of bid items specifically described in the standard specifications or shown on the drawings, shall be interpreted as meaning that the cost of any such work contemplated by the contract documents, shall be included in the prices bid for related items for which quantities have been established.

44.02 MATERIALS

Chain link fabric shall be zinc coated steel, aluminum coated steel, or aluminum alloy in conformity with AASHTO M 181. Fabric shall be 2" mesh woven from 9 gauge wire. Top and bottom selvage shall be twisted and barbed. Each roll of fabric shall be tagged showing coating, gauge, and mesh.

Posts, Rails, Gate Frames and Expansion Sleeves. All posts, rails, gate frames and expansion sleeves furnished for use in conjunction with zinc-coated steel and those furnished for use in conjunctions with aluminum alloy fabric shall be of aluminum alloy.

Zinc-Coated Steel Members. The base metal of zinc-coated steel posts, rails, gate frames and expansion sleeves shall be of good commercial quality steel made by the open-hearth, electric furnace, basic oxygen, or acid-Bessemer process, and protected on all surfaces with a zinc-coating applied in conformance to AASHTO M 111.

Aluminum Alloy Members. Aluminum posts, rails, gate frames, and expansion sleeves shall be of aluminum alloy having a minimum tensile strength of 30,000 lbs. per

square inch, a minimum yield strength of 25,000 lbs. per square inch, and a minimum elongation of 8%.

Zinc Coated Steel Posts

Terminal Posts. All end, corner and pull post shall be 2-7/8" O.D. standard weight pipe, weight 5.79 lbs. in steel per linear foot.

Intermediate Posts. Intermediate posts shall be "H" column, nominal weight 3.16 lbs. per foot, minimum tensile strength 75,000 lbs. per square inch.

Galvanized Post		Galvanized
Fence Height		Post - Weight
	Dimensions Inches	Lbs. Per Foot
6' and over	2.25± .0937 x 1.95± .0937	3.16± 5%

Gate Posts. Gate posts for swing gates shall conform to the following gate leaf widths:

Roll Formed Section	Lbs. Per Linear Foot
Up to 6' wide 3-1/2" x 3-12"	5.14

STANDARD WEIGHT PIPE

	Nominal Weight Lbs. per Ft.
Up to 6' wide 2-7/8" O.D.	5.79
Over 6' to 14 4" O.D.	9.11
Over 13' to 18' 6-5/8" O.D.	18.97
Over 18 8-5/8" O.D.	24.70

Top Supports

Round Rails. Outside dimensions of steel rails shall be 1.660 inches, nominal. Nominal weight of steel rails shall be 1.35, 2.27 p/f, or any other weight greater than 1.35 p/f.

Formed Steel. Outside dimensions of formed rails and post braces shall be 1.625 by 1.25 inches, nominal. Nominal weight shall be 1.35 p/f. Thickness of steel sheet shall

be 0.0747 inch nominal.

Pipe Rail Couplings. Pipe rail couplings are to be outside type at least a minimum of 6" in length, one in every five to be equipped with a heavy spring to take up expansion and contraction of the top rail. Roll form rail couplings fit inside and are a minimum of 6" in length. Both couplings are to be placed approximately every 20'. Top rail to pass through intermediate post tops and form a continuous brace from end to end of each stretch of fence. Top rail to be fastened to tubular post by heavy pressed steel connectors.

Tension Wire. Tension wire shall be of the gauge shown on the plans. Tension wire shall be either galvanized to conform to the requirements of ASTM Designation: A116, Class 3 coating, or it shall be coated with aluminum alloy applied at the rate of not less than 0.30 oz. per square foot of wire surface.

Braces. Brace material to be the same material as top rail for round rails. The roll form rail and brace shall be installed 24" apart and the tubular rail and brace shall be installed 30" apart. They shall extend from terminal post to first adjacent line post. Braces to be fastened to post by heavy pressed steel connections, then trussed from line post back to terminal post with round rods.

Posts. Concrete for posts shall conform to Item 9.

Barbed Wire. Barbed wire shall be galvanized steel conforming to the requirements of ASTM A 121 and shall consist of 2 strand 12-1/2 gauge wire with tightly wrapped, sharp, 4 point barbs formed of 14 gauge wire spaced evenly at not more than 5 inch intervals. Class 3 galvanized barbed wire shall be used with galvanized fabric.

Aluminum coated barbed wire with aluminum barbs shall be used with aluminum coated fabric.

Aluminum barbed wire with aluminum barbs shall be used with aluminum alloy fabric.

Extension Arms. Where barbed wire is required, posts shall be equipped with extension arms. Arms to be designed to extend at a 45° angle with lock wire for securely fastening the barbed wire equally spaced with the top strand located 12" above the fabric and 12" out from the fence line. Extension arms shall be capable of supporting a dead load of 200 lbs. at the point of attachment of the outer strand of barbed wire without taking a permanent set.

Post Tops. Tubular post tops to be so designed as to exclude moisture from the posts. All intermediate post tops designed to hold the top rail. Roll section terminal posts do not require post tops.

Aluminum Posts, Rails and Braces. Terminal Posts. (End, pull, and corner posts) 2.875" O.D., weighing 2.004 lbs. per ft. or 3" square weighing 2,002 lbs. per ft. Alloy 6063 - T6 for either round or square posts. Line posts 2.25" x 1.95" "H" Beam,

Alloy 6063 - T6, weighing 1.235 lbs. per ft. Rails and braces 1.66" O.D. Alloy 6063 - T6 weighing 0.786 lbs. per ft.

Gates. Gate frames, if required, shall be made of 1.90" O.D. standard weight pipe, 2.72 lbs. per foot with heavy malleable iron or pressed steel corner fittings securely riveted, or welded at all corners. Welds shall be painted with aluminum base or zinc base paint.

Fabric to match the fence shall be installed in the frame by means of tension bars and hook bolts. Each frame to be equipped with 3/8" diameter adjustable truss rods. Bottom hinges to be ball and socket type designed to carry the weight of the gate on the post footing. Upper hinge to be wrap-around adjustable type. All gates to be equipped with a positive type latching device with provision for padlocking. All drive gates to be provided with center plunger rod, catch and semi-automatic outer catches to secure gates in opened position.

Vehicular-Gates. Vehicular Gates shall consist of gates equipped with approved latches, stops, suitable locking devices and satisfactory provision for padlocking. Means shall be provided for securing and supporting the free ends of vehicular gates in the open position. Hinges shall be of the pivot type, heavy and strong, with large bearing surfaces for clamping onto the posts, or equal. Hinges shall not twist or turn under the action of gates, and shall be so arranged that closed gates cannot be lifted off the hinges to obtain entry. Vehicular gates shall be capable of being operated easily by one person and shall be of the full 180° opening swing type.

The bottom of gates shall be not less than 3" nor more than 5" above the ground by at least 3" at all points in its swing. The Contractor shall modify the existing grade within the area of swing, if necessary, to meet this requirement when directed. Stops with latches, or other approved means for holding gates open, shall be provided and so placed as to prevent damage to the gates or fence by overswing. All gate stops shall be of the type shown on the plans or an alternate as approved by the Engineer and shall be set in concrete as shown on the plans.

Fabric Connections. The chain link fabric shall be securely fastened to all terminal posts by 3/16 x 3/4" tension bars with 11 gauge pressed steel bands spaced approximately 14" apart or woven integrally into lock loops on roll form sections and to the line post with 6 gauge wire clips spaced approximately 14" apart and to the top rail and brace rail with 9 gauge aluminum tie wires on approximately 24' centers.

Wire Ties & Tension Wire. All wire fabric ties, wire ties, hog rings and tension wire furnished for use in conjunction with zinc coated steel fabric or with aluminum coated steel fabric shall be of zinc coated steel or aluminum coated steel and those furnished for use in conjunction with aluminum alloy fabric shall be of aluminum alloy. Hog rings used with aluminum fabric shall be 11 gauge aluminum alloy for fastening tension wire on approximately 24" centers.

Zinc-Coated Wire Ties. The wire used for zinc-coated wire fabric ties, wire ties and hog rings shall be of ductile steel coated with prime western spelter or equal (AASHTO M 120) applied at a rate of not less than 0.7 oz. per square foot of uncoated wire surface.

Zinc-coated and Aluminum-Coated Tension Wire. The base metal of zinc-coated and aluminum coated tension wire shall be steel wire having a minimum tensile strength of 80,000 lbs. per square inch coated (a) with prime western spelter or equal (AASHTO M 120) applied at a rate of not less than 0.8 oz. per square foot of uncoated wire surface, or coated (b) with aluminum alloy applied at the rate of not less than 0.40 oz. per square foot of uncoated wire surface.

Aluminum Alloy Wire Ties and Tension Wire. Wire fabric ties, wire ties, hog rings and tension wire of aluminum shall be of aluminum alloy having a minimum tensile strength of 42,000 lbs. per square inch, a minimum yield strength of 35,000 lbs. per square inch, and a minimum elongation of 10%.

Miscellaneous Fittings and Hardware. All miscellaneous fittings and hardware furnished for use in conjunction with zinc-coated steel fabric or with aluminum coated steel fabric shall be of zinc-coated steel, and those furnished for use in conjunction with aluminum alloy fabric shall be of aluminum alloy.

Zinc-Coated Steel Fittings and Hardware. Miscellaneous steel fittings and hardware shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength and other properties to provide a balanced design when used in conjunction with fabric, posts and wires of the qualities specified herein. All steel fittings and hardware shall be protected with a zinc-coating applied in conformance to AASHTO M 111.

Aluminum Alloy Fittings and Hardware. Miscellaneous aluminum fittings and hardware shall be wrought or cast aluminum alloy.

44.03 FABRICATION

Fabrication of materials furnished under these specifications shall be in conformance to the sizes, shapes, dimensions, and other factors indicated by designs provided by the Department of Public Works, and shall show careful, finished workmanship in all respects.

44.04 TEST SPECIMENS

Test specimens for testing specified shall consist of finished products or portions thereof of suitable size to enable proper performance of the intended tests. If any test specimen shows defects or develops flaws, two additional specimens shall be cut from the remainder of the sample and tested, both of which shall meet the requirements in every respect.

44.05 MARKING

Each roll of fabric shall carry a tag showing the kind of base metal (steel or aluminum alloy number), kind of coating, class of coating, the gauge of the wire, the length of fencing in the roll, and the name or mark of the manufacturers. Posts, wire and other fittings shall be identified as to manufacturer, kind of base metal (steel or aluminum alloy number), class or coating and other pertinent data sufficient for proper identification as to apparent conformance to specified quality requirements.

44.06 INSPECTION

Each product or article furnished under these specifications shall be subject to inspection at the factory, fabricating plant, in laboratories of the City's choosing or other point of delivery.

44.07 METHODS OF TESTING

The testing of chain-link fence materials shall be in accordance with the following standard methods of the American Association of State Highway and Transportation Officials:

Weight of Coating on Galvanized Articles	T65
Uniformity of Coating by Preece Test	T66
Tension Testing of Metallic Materials	T68

Concrete Footings. Concrete footings shall be constructed in accordance with dimensions shown on the plans. Posts shall be centered in the cylindrical concrete footings. The concrete shall be thoroughly compacted around the posts by tamping or vibrating, and shall have a smooth finish slightly higher than the ground line and sloped to drain moisture away from the posts. No attachments shall be placed on the posts, nor shall the posts be disturbed in any manner, within 72 hours after the individual post footing is completed. No hand mixed concrete may be used without special permission of the Engineer. If hand mixing is permitted, the quantity to be mixed shall not exceed $\frac{1}{2}$ cubic yard per batch. Materials and composition of the mix shall conform with the requirements of Paragraph 108, Material Details.

Erection. Height of fence when completed shall be 7 feet from grade to top of strand of barbed wire, or as specified on the plans.

Erection and spacing of posts shall be as follows:

- a) Line posts shall be set not more than 10 feet on centers in the line of fence, and to a depth of 36 inches below finished grade.
- b) Terminal and gate posts shall be set where required or at locations shown on the drawings, and to a depth of 36 inches below finished grade.
- c) All posts shall be set in a cement concrete base, which shall be 6 inches deeper than the bottom end of posts and not less than 12 inches in diameter. The top of the cement-concrete bases shall be finished with a one-inch crown from post to edge of base at finished grade.
- d) The fence post shall be connected with top rail which will run continuously through the openings provided in post-top fittings. The top rail shall be coupled with self-centering, and the ends fastened to the fittings provided with gate and terminal posts.

Should rock be encountered at a depth less than the planned footing depth, a hole 2" larger than the greatest dimension of the posts shall be drilled to a depth of 12". After the posts are set, the remainder of the drilled hole shall be filled with grout, composed of 1 part Portland cement and 2 parts mortar sand. Any remaining space above the rock shall be filled with the concrete in the normal manner for posts set in concrete as described above. All excess excavation from footings shall be disposed of in a manner satisfactory to the Engineer.

All posts shall be plumb, and spaced at 10' centers maximum, with a tolerance of minus 2". Spacing of posts shall be as uniform as practicable under local conditions. Terminal posts shall be installed at all abrupt changes in grade, at changes in line over 15°, and at all ends. In no case shall the distance between terminal posts exceed 500'. Post tops shall fit snugly on posts to prevent moisture penetration.

The top rail shall be continuous, and shall pass through the post tops. The couplings used to join the top rail lengths shall allow for expansion.

Horizontal brace rails, with diagonal truss rods and turnbuckles, shall be installed at all terminal posts. Sufficient braces shall be supplied to allow complete bracing from each terminal post to adjacent line posts.

Fence Construction. The fence shall be erected at the locations indicated on the plans. The fence shall be true to line, taut, and shall comply with the best practice for chain link fence construction. The bottom of the fabric shall be placed a normal distance of 3" above the ground line; however, over irregular ground, a minimum clearance of 1" and a maximum clearance of 6" will be permitted for a horizontal distance not to exceed 8'. Any excavation and backfilling required in order to comply with these provisions shall be made as ordered by the Engineer.

The fence fabric shall be installed on the roadway side of posts, and shall be tied to top rails and brace rails at 2' maximum intervals. Tension bars shall be attached to terminal posts by connectors equally spaced at 16" centers maximum or woven integrally into lock loops on roll form sections. End connectors shall be as close to the ends of the fabric as possible.

At locations of small natural swales or drainage ditches, and where it is not practical to have the fence conform to the general contour of the ground surface, the Contractor shall span the opening below the fence with barbed wire as shown on the plans.

Existing fences shall be permanently fastened to the terminals of the new fence at the location indicated on the plans.

44.09 ELECTRICAL GROUNDS

Electrical grounds shall be constructed where a power line passes over the fence. The ground shall be installed immediately below the point of crossing. The ground shall be accomplished with a copperclad rod 8' long and a minimum of 5/8" in diameter driven vertically until the top is approximately 6" below the top of the ground. A No. 6 solid copper conductor shall be clamped to the rod and to the fence in such a manner that each element of the fence is grounded. Similar grounds shall be installed at a

maximum of every 2,000' length of fence, whether or not there are power line crossings.

44.10 METHOD OF MEASUREMENT

Chain link fence will be measured for payment on a linear foot basis, and the quantity to be paid for will be the number of linear feet of fence actually installed and accepted, measured in place along the line of the fence from center to center of end posts.

44.11 BASIS OF PAYMENT

Payment of Chain Link Fence will be made at the linear foot bid for Item 44, Chain Link Fence, in the proposal, which price and payment shall constitute full compensation for the furnishing of all materials, labor, tools, equipment, hauling, concrete footings, anchors, excavation and backfilling or footings, excavation and backfill under fences necessary to comply with specified clearances, line posts, top rails, chain link fabric, tension wire, barbed wire, stakes, fittings, bolts, galvanizing, and incidentals necessary to complete this item of work.

Payment for furnishing and installing chain link gates shall be paid for at the contract lump sum price per gate installed, which price and payment shall be full compensation for furnishing and placing, labor and other preparations incidental to installing this item complete.

ITEM 45

FLAGPERSON

45.01 DESCRIPTION

Flagperson shall consist of furnishing personnel and necessary equipment for the controlling of traffic through work areas.

Since flagperson's make the greatest number of public contacts of all construction personnel and are responsible for human safety; it is important that well qualified personnel be selected. A flagperson shall possess the following qualifications:

1. Average intelligence.
2. Good physical condition, including sight, and hearing.
3. Mental alertness.
4. Courteous, but firm manner.
5. Neat appearance.
6. Pleasing personality.
7. Sense of responsibility for safety of public and crew.

Flagperson stations shall be located far enough from the work site so that vehicles will have sufficient distance to slow down before entering the project, but not so far that vehicles will tend to speed up into the work site.

Normally, the flagperson will stand either on the shoulder adjacent to the lane of traffic they are controlling or in the barricaded lane. At a spot obstruction, they may have to stand on the shoulder opposite the barricaded section. Under no circumstances, shall they stand in the traffic lane. In rural areas, they shall be clearly visible to the traffic they are controlling for a distance of 500'. For this reason, they must stand alone, never permitting a group of workmen to congregate around them. Flagperson stations must be adequately protected and preceded by proper advance warning signs.

45.02 FLAGGING PROCEDURES

The flagperson shall wear approved orange colored clothing on the upper portions of the body, such as a vest, shirt, or jacket; and shall be required to wear the appropriate orange colored headgear at all times. For night time conditions, the use of similar outside garments or belting, reflectorized, shall be used. In addition, flagperson stations shall be adequately illuminated to attract attention.

The flagperson shall use only a STOP/SLOW paddle for controlling traffic through the work areas, unless otherwise, use of flag is required in emergency situations.

When the sign paddle is used with arm extended, it shall be held stationary in a vertical position supported by a rigid vertical handle 7' high. For further explanation and details, the Contractor shall refer and comply with the requirements of "Delaware Traffic and Maintenance Operations" with latest revisions.

Lights, and/or reflectorized sign paddles shall be used to control traffic at night. To stop traffic, the light shall be waved back and forth across the path of the approaching vehicle. The signal to proceed shall be given verbally or by a hand motion. Adequately reflectorized sign paddles or flags may be used at night provided that the reflectorization is of a type that will retain its brilliance when wet. Daytime flagging procedure shall be followed whenever such paddles or flags are used at night.

Whenever practicable, the flagperson should advise the motorist of the reason for the delay and the approximate period that traffic will be halted. Flagperson and operators of construction machinery or trucks should be made to understand that every reasonable effort must be made to allow the driving public the right of way and prevent excessive delays.

Any flagperson performing duties unsatisfactorily in the opinion of the Engineer, shall immediately be discharged from the project and replaced with an approved flagperson.

ITEM 46

PAVEMENT MILLING

46.01 DESCRIPTION

The item consists of furnishing a pavement-milling machine and milling or planing the existing bituminous concrete pavement at the locations and to the depths shown on the Plans and/or as directed by the Engineer. The pavement-milling machine shall be one with a proven record for use in milling hot-mix pavement. The contractor shall reuse, salvage or dispose of the milled material as called for by the plans.

46.02 METHOD OF MEASUREMENT

The quantity of pavement-milling to be paid for shall be the number of square yards per inch of depth as shown on the Plans. Any additional depth, not approved by the Engineer in writing, will not be included for payment.

46.03 BASIS OF PAYMENT

Pavement-Milling measured as provided above shall be paid for at the contract unit price bid per square yard per inch of depth for Item 46, Pavement Milling, which price and payment shall constitute full compensation for furnishing an accepted pavement-milling machine and operator, for removal and disposal of the milled material, for transporting equipment, for all labor, tools, equipment and incidentals necessary to complete the item.

ITEM 47

GEOTEXTILES

47.01 DESCRIPTION

This material consists of geotextile for use in constructing silt fence; reinforced silt fence; inlet sediment control; sediment trap outlet, riser pipe; riprap ditch; perimeter dike/swale; earth dike; temporary slope drain; stilling well; sump pit; stabilized construction entrance; portable sediment tank; geotextile lined channel diversion; dewatering basin; sediment basin outlet structure, corrugated metal; and other soil sediment and erosion applications.

47.02 SILT FENCE

The geotextile shall be a minimum of 36" wide and shall be a woven fabric consisting of long chain polymeric filaments, or yarns, such as polypropylene, polyethylene, polyester, polyamide, or polyvinylidene - chloride formed into a stable network such that the filaments or yarns retain their relative position to each other. The geotextile shall be inert to commonly encountered chemicals and shall meet the requirements listed in the following table:

<u>Fabric Properties</u>	<u>Minimum Acceptable Value</u>	<u>Test Method</u>
Grab Tensile Strength (lbs)	90	ASTM D 1682
Elongation at Failure (%)	50	ASTM D 1682
Mullen Burst Strength (PSI)	190	ASTM D3786
Puncture Strength (lbs)	40	ASTM D751 (modified)
Slurry Flow Rate(gal/min/sf)	0.3	
Equivalent Opening Size	40-80	US Std. Sieve CW-02215
Ultraviolet Radiation Stability %	90	ASTM G-26

47.03 INLET SEDIMENT CONTROL

The fabric shall meet or exceed the minimum flow rate of the fabrics listed in the following table:

Geotextile Manufacturer	Geotextile Style	Flow Rate
		Gal/Min/Ft ²
Mirafi	140 N	120
	4030 A	145
Amoco	4545	150
	4535	155
Ling	103 EX	140
	125 EX	150

47.04 RISER PIPE ASSEMBLY FOR SEDIMENT BASIN

The fabric shall conform to the requirements of Subsection 47.03.

47.05 RIPRAP

The fabric used under riprap shall be Mirafi 700X or an equal approved by the Engineer.

47.06 STABILIZED CONSTRUCTION ENTRANCE

The fabric shall be a woven or non-woven geotextile and shall conform to the properties of the following table:

<u>Fabric Properties</u>	<u>Light Duty 1/ Roads - Graded Subgrade</u>	<u>Heavy Duty 2/ Haul Roads- Rough Graded</u>	<u>Test Method</u>
Grab Tensile Strength (lbs)	200	220	ASTM D1682
Elongation at Failure (%)	50	220	ASTM D1682

Mullen Burst Strength (lbs)	190	430	ASTM D3786
Puncture Strength (lbs)	40	125	ASTM D751 modified
Equivalent Opening Size	40-80	40-80	US Std Sieve CW-02215
Aggregate Depth (in.)	6	10	-----

1/ Light Duty Road:

Are sites that have been graded to subgrade and where most travel would be single axle vehicles and an occasional multi-axle truck.

Trevira Spunbond 1115, Mirafi 100X, Typar 3401, or equivalent.

2/ Heavy Duty Road:

Are sites with only rough grading, and where most travel would be multi-axle vehicles.

Trevira Spunbond 1135, Mirafi 600X, or equivalent.

47.07 PORTABLE SEDIMENT TANK

The fabric shall conform to the requirements of Subsection 47.03.

47.08 GEOTEXTILE LINED CHANNEL DIVERSION

The fabric shall conform to the requirements of Subsection 47.05.

47.09 METHOD OF MEASUREMENT

The quantity of geotextiles will be measured as the actual number of square yards used in any application described in Item 47, Geotextiles.

47.10**BASIS OF PAYMENT**

The quantity of geotextiles, measured as provided above, shall be paid for at the contract unit price bid per square yard for Item 47, Geotextiles, which price and payment shall constitute full compensation for furnishing and installing the geotextile and all other incidentals necessary to complete the work.

DIVISION III

MATERIAL DETAILS

PARAGRAPH 100 - PORTLAND CEMENT

Portland cement shall conform to the requirements of AASHTO M 85, except "Fineness" shall be measured by the air permeability test, and a maximum specific surface of 420 M. Square/Kg will be permitted. Unless otherwise specified, cement shall be either Type 1 or Type II.

Type I(PM) or Type IP cement, meeting the specifications of AASHTO M 240, will be permitted as an alternate to Type I or Type II cement in all classes of concrete, subject to the following conditions:

- (1) The pozzolan that is blended with the Portland cement, shall conform to Paragraph 111, Fly Ash.
- (2) The pozzolan constituent (Fly Ash), shall not exceed twenty percent (20%) by weight of the Portland cement and Fly Ash total weight.
- (3) The concrete mixture incorporation Type I(PM) or Type IP cement shall meet the requirements applicable to its use.

Reserved bins may be sampled by the Department of Public Works or its authorized representative and all test shall be completed before the cement is accepted. Only pretested and accepted cement shall be allowed for use.

The temperature of the Portland cement at the time of delivery to the paver or mixer shall not exceed 150° F.

Orders for cement shall be placed with the manufacturer at least 10 days before the first shipment is made.

All cement used in any one contract item shall be of a single brand, from a single mill, unless otherwise authorized in writing by the Engineer.

Upon approval of the Engineer, the preceding requirements for reserved bins and sealed shipments may be waived if the cement manufacturer qualifies for inclusion in a program of certification.

A manufacturer may become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by the Department and the manufacturer's testing laboratory and upon approval of production and storage facilities by the Engineer. The manufacturer shall conduct sufficient tests to assure that adequate quality control is maintained and that cement furnished conforms to the specification requirements. The manufacturer shall maintain a record of all test results for review by the Engineer. Samples for tests of any cement may be taken at any time necessary as determined by the Engineer.

Cement manufacturers will be furnished specific details on requirements; however, the Engineer reserves the right to modify the program for all participants as required, or to impose additional or special requirements on manufacturers as considered necessary to maintain control.

A manufacturer who fails to cooperate in a satisfactory manner or cannot furnish cement within the established limits of acceptance will be required to cease participation in the certification program. In such cases, pretesting, reserved bins, and sealed shipments will be required.

PARAGRAPH 101 - NORMAL FINISHING HYDRATED LIME

Normal finishing hydrated lime shall conform to ASTM C206, Type N.

PARAGRAPH 102 - WATER FOR MIXING PORTLAND CEMENT CONCRETE

Water used in mixing, curing, or other designated applications shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Water will be tested in accordance with, and shall meet the suggested requirements of AASHTO T 26. Water known to be of potable quality may be used without testing. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

The water shall conform to the following requirements:

Hydrogen ion concentrations	4.5 to 8.5 pH
Total Solids	5000 ppm
Total Chlorides	300 ppm
Soluble SO ₄	500 ppm
Total alkalis as Na ₂ plus 0.658K ₂ O	500 ppm
Organic content	2000 ppm
Compressive strength, minimum	90% of control
Time of setting, Vicat	±60 minutes from control and within the specifications of AASHTO M 85

PARAGRAPH 103 - FINE AGGREGATE FOR USE IN PORTLAND CEMENT CONCRETE

Fine aggregate for use in Portland cement concrete shall conform with AASHTO M 6, except the grading will be:

<u>Sieve Size</u>	<u>Passing</u>
3/8"	100%
#4	95 - 100%
#50	5-30%
#100	1-10%
#200	0-4%

Fineness Modulus: 2.3 - 3.1

The organic impurities requirement will be waived for fine aggregate specified for uses other than in Portland cement concrete.

PARAGRAPH 104 - COARSE AGGREGATE

Coarse aggregate shall conform to the requirements of AASHTO M 80, except no gravel, crushed gravel, or crushed concrete shall be used. Also the requirements of Section 2.1, Percentage of Wear, Los Angeles test, shall be not more than 45%. If air cooled, blast furnace slag is used, it shall weight not less than .94 tons per cubic yard, when tested according to AASHTO T 19/T 19M.

PARAGRAPH 105 - CALCIUM CHLORIDE

The calcium chloride shall be Type S, Grade A conforming to AASHTO M 144.

PARAGRAPH 106 - EMULSIFIED ASPHALT

Emulsified asphalt shall meet the requirements of AASHTO M 140 (ASTM D 977) for anionic emulsions or AASHTO M 208 (ASTM D 2397) for cationic emulsions.

PARAGRAPH 107 - HOT-POURED JOINT SEALER

Hot poured joint sealant used in sealing formed, tooled, and sawed joints in base course concrete, Portland cement concrete patches and where designated on the plans shall conform to ASTM D 3405, Joint Sealants, Hot-Poured for Concrete and Asphalt Pavement.

Hot-poured joint sealant used in sealing formed, tooled and sawed joints in finished Portland cement concrete pavement and where designated on the plans shall conform to ASTM D 3406, Joint Sealant, Hot-Poured, Elastomeric type, for Concrete Pavement.

PARAGRAPH 108 - PORTLAND CEMENT CONCRETE

Portland cement concrete shall consist of Portland cement, fine aggregate, coarse aggregate, water and admixtures mixed in the specified proportions for the various classes of concrete. It shall conform to the materials, design and control requirements specified herein.

MATERIALS REQUIREMENTS

- (a) **Portland Cement.** Portland cement shall conform with the requirements of Paragraph 100, Material Details.
- (b) **Water.** Water shall conform with the requirements of Paragraph 102, Material Details.
- (c) **Fine Aggregate.** Fine aggregate shall conform with the requirements of Paragraph 103, Material Details.
- (d) **Coarse Aggregate.** Coarse aggregate shall conform with the requirements of Paragraph 104, Material Details.
- (e) **Gradation.** Coarse aggregate shall consist of one size, No. 57, graded as specified in Paragraph 110, Material Details.
- (f) **Air Entrainment Agent.** An air-entrainment agent meeting the requirements of AASHTO M 154 shall be introduced into the mixer by an approved automatic dispenser.
- (g) **Chemical Admixtures.** Chemical admixtures shall comply with the requirements of AASHTO M 194 (ASTM C 494) for the seven types as follows:
 - Type A - Water Reducing
 - Type B - Retarding
 - Type C - Accelerating
 - Type D - Water Reducing and Retarding
 - Type E - Water Reducing and Accelerating
 - Type F - Water Reducing, High Range
 - Type G - Water Reducing, High Range and Retarding
- (h) **Fly Ash.** Fly ash may be used as an additive in concrete in order to promote workability and plasticity. Fly Ash shall conform with the physical and chemical requirements of Paragraph 111, Fly Ash.

Storage, handling, mixing requirements, recommendations, and restrictions are described in related sub-sections of this specification.

- (i) **Samples.** The source of fine aggregate, coarse aggregate, cement, additives, and admixtures shall be submitted to the Engineer prior to any concreting operations in sufficient time so mix design proportions may be determined.

Coarse and fine aggregates for use in Portland cement concrete mixtures shall also be evaluated for potential alkali-silica reactivity using ASTM C 1260 Mortar Bar Method and ASTM C295 - Petrographic Examination. Aggregate sources determined to be reactive with cement alkali shall be permitted in concrete mixtures using either low alkali (0.6% or less) cement or Type I-P cement. Use of high alkali cement will be permitted with these aggregates upon substitution of 40% to 50% of the Portland cement with ground granulated blast furnace slag conforming to ASTM C989 Grade 120 or Fly Ash conforming to Paragraph 111, Material Details. The minimum amount of fly ash shall be 20% by mass of cementitious material.

HANDLING AND STORING MATERIALS

- (a) **Aggregate.** Aggregate stockpiles shall be placed on hard, clean and well drained surfaces. Coarse and fine aggregate shall be kept separate during transportation, handling and storage until batched. If necessary, suitable partitions shall be constructed to prevent mixing of the fine and coarse aggregate.

Aggregate stockpiles shall be constructed in horizontal layers not exceeding 5' in depth in order to avoid segregation. Segregated material shall be removed from stockpiles and disposed of or remixed to the satisfaction of the Engineer.

Fine aggregate shall be stockpiled at the batch plant a minimum of 24 hours prior to batching or longer if required until surplus water has disappeared and the material has a uniform free moisture content. Wet fine aggregate shall not be placed where it becomes mixed with material being used for batching. Batching direct from the washing plant will not be permitted.

- (b) **Cement.** Reclaimed cement or cement that shows evidence of hydration, such as lumps or cakes, shall not be used. All cement shall be stored in suitable weatherproof structures which will protect the cement from dampness.

- (c) **Fly Ash.** Fly Ash which shows evidence of hydration, such as lumps or cakes, shall not be used. All Fly Ash shall be stored in suitable weatherproof structures which will protect the Fly Ash from dampness and other contamination.
- (d) **Admixtures.** Admixtures shall be stored and handled in such a manner that contamination or deterioration will be prevented. Admixtures shall not be used unless thoroughly agitated. The use of admixtures that are partially frozen will not be allowed. When the amount of admixture required to give the specified results deviates appreciably from the manufacturer's recommended dosage, the use of this material shall be discontinued unless conditions justify a change in the dosage.

COMPOSITION OF MIX

The Engineer shall determine the proportions of materials to be used that will produce a workable, dense, concrete conforming with the requirements of Table I herein for the class of concrete specified. ACI design methods will be used as a guide in determining aggregate proportion.

Exceptions to these requirements are:

- (a) The producers of prestressed precast reinforced concrete items complying with these specifications shall determine mix design proportions for concrete proposed for use. The mix design proportions shall be submitted to the Engineer for approval prior to use.
- (b) The contractor/concrete supplier shall submit to the Engineer sources of all materials and mix design proposed for production of Class "D" concrete prior to any work.

Such submission shall be made in sufficient time for preparation of laboratory or field trial mixes and 28 day strength determinations. Field trial mixes shall be made at the concrete supply location and shall consist of 3 cubic yard (minimum) batches of concrete. All materials, equipment and labor required to produce the field trial mixes shall be supplied by the contractor.

- (c) Producers wishing to use Type I (PM) or Type IP cement, shall determine the mix design proportions for the concrete proposed for use. With respect to Table 1, the total blended weight of the Portland cement, and Fly Ash represents "cement content". The use of additional Fly Ash as a partial replacement for Portland cement in mixtures containing Type I (PM) or IP

cement is prohibited. A concrete mixture containing Type I (PM) or Type IP cement is considered as a mix containing Fly Ash, and shall meet the requirements for such mixes.

Producers wishing to use Fly Ash as an additive or a partial replacement for Portland cement, shall determine the mix design proportions for the concrete proposed for use. Fly Ash use as partial replacement for Portland cement in mixtures containing Type I (PM) or IP cement is prohibited. The minimum cement content indicated in Table 1 for each class of concrete may be modified in accordance with the following limitations:

- (1) Fly Ash as a partial replacement for Portland cement shall not be more than a total of twenty (20%) by weight of cement originally required.
- (2) At least 1.0 pound of Class C Fly Ash or at least 1.5 pound of Class F Fly Ash shall be used for each 1 pound of Portland cement replaced in the concrete mix.
- (3) The design must produce a workable, dense concrete, which meets the applicable content, slump, and strength requirements of the class and use specified for the concrete mix.

For mixes containing Fly Ash, laboratory testing (which is the responsibility of the Producer) must have been performed, which documents the design's conformance to all requirements, emphasizing that air entrainment will be of special concern. Identification of the sources of materials, and the mix design proportions, as well as the results of the laboratory testing of the proposed mix design shall be submitted to the Engineer for approval prior to use of the design. The Producer shall supply appropriate samples of the design materials, and should schedule approximately five weeks for evaluation by the Engineer.

When a mix containing Fly Ash is used the Engineer shall perform extra sampling and testing of the concrete mixture, as deemed necessary by the Engineer in order to detect possible harmful variation in the quality of the mix.

When a mix containing Fly Ash is used, the in-place mix must meet the applicable strength requirements before forms and supports are removed, and/or loading is applied. The strength of the in-place mix shall be determined by representative sampling and compression strength testing. This requirement is based on the expectation that mixes which contain Fly

Ash, which has partially replaced Portland cement may gain strength slower than mixes not containing Fly Ash. Delays due to slow strength gain from a Fly Ash mix, shall not be considered for an extension of time allowed for the completion of the project.

When a mix containing Fly Ash is placed after October 30 and before May 1, or when early strength gain is important, additional samples of the material placed shall be made as directed by the Engineer, for strength testing. Samples shall be cured in the same ambient temperature as the placed material, in order to more accurately represent the strength of the placed material. This requirement is based on the expectation of slower strength gain in cooler weather from mixes containing Fly Ash, which has partially replaced Portland cement than from mixes not containing Fly Ash.

(d) Mix requirements for various classes of concrete:

TABLE 1

Class of Concrete	A	B	C	D
Design Compressive Strength, f'_c @28 days (1)	4500 psi	3500 psi	2000 psi	4500 psi
Design Cement Content (min) sacks/cy (lbs/cy)(2)	7½ (705)	6 (564)	4½ (423)	7½ (705)
Design Water Cement Ratio $W/C = \frac{\text{Wt. Water}}{\text{Wt. Cement}}$ (3)	.40	.45	.60	.40
Required Air Content % (4)	5-8	4-7	4-7	5-8
Required Slump (inches) (5)	2-4	2-4	2-4	2-4
Required Admixtures (6) (AASHTO M 194, ASTM C 494)	A,D,E	A,D,E	A,D,E	A,D

Note (1) In addition to meeting the specified f'_c design compressive strength, Class D concrete shall achieve f_{cr} required average strength. The required average strength f_{cr} shall be the minimum strength required for mix approval and shall be in excess of 4500 psi design strength, f'_c . The degree of excess strength necessary shall depend on expected uniformity of concrete production as per criteria established in the A.C.I. (American Concrete Institute) Standard 214. Upon establishment of standard

deviation data, the following A.C.I. 318 required strength values shall govern acceptance of the trial mix proportions:

- f_{cr} = 4900 psi if standard deviation is less than 300 psi
- = 5050 psi if standard deviation is less than 300-400 psi
- = 5200 psi if standard deviation is less than 400-500 psi
- = 5400 psi if standard deviation is less than 500-600 psi

If standard deviation exceeds 600 psi the concrete production facility shall be unacceptable for Class "D" concrete production. A probability of not more than one in ten test falling below the specified strength will be used to compute the required strength. The average 28-day compression strength of two companion molded 6" x 12" or 4" x 8" cylinders prepared from the same batch of concrete shall be considered a "test".

- (2) For Class "D" concrete, the average strength and coefficient of variations shall be computed upon the availability of 28-day strength data comprising a minimum of 15 tests from the concrete production plant. Should these determinations indicate an excessive margin of safety, the concrete mix may be modified to produce a lower average strength as approved by the Engineer, but in no case shall the cement content be reduced to less than 7 sacks/cubic yard (658 lbs/cy). Should determination indicate a lower average strength or a higher coefficient of variation than anticipated, the quality of the concrete will be evaluated and mix productions adjusted as required; however, cement content may not exceed 8 sacks cubic yard (752 lbs/cubic yard).
- (3) Water cement ratio may be expected to vary $\pm 5\%$ depending on varying atmospheric and other related conditions.
- (4) Required air content for Class "A" in Item 10, Portland Cement Concrete Patching shall be 3 to 7%.
- (5) Slump shall be 1"- 2" for slip form concrete operations. Slump of concrete other than slip form work may be increased to 5" when approved by the Engineer for special conditions.
- (6) Water reducing admixtures will be required for all concrete. The quantity and AASHTO type and/or combination of AASHTO types shall be determined by the Engineer depending on the water reduction required, the degree of set retardation or acceleration required and atmospheric conditions.

- (7) The total chloride content of concrete mixtures, when tested in accordance with the requirements of AASHTO T 260 shall not exceed the following:

- a. Prestressed concrete - 0.06%
- b. Conventionally reinforced concrete in a moist environment and exposed to chloride deicing salts or marine conditions -0.10%.
- c. Conventionally reinforced concrete in a moist environment or areas with potential moisture condensation but not exposed to chloride -0.15%.

Limits are expressed as a percent of the total weight of the Portland Cement and Fly Ash in the concrete mix.

The above limits shall not apply to concrete mixtures specifically designed to achieve rapid setting characteristics, such as patching mixtures.

- (8) For mixes containing Fly Ash, the "Design Cement Content" may be modified in accordance with Paragraph (c) in this section of Paragraph 108.
- (9) In calculating the "Water Cement Ratio" for mixes containing Fly Ash, the weight of the Portland cement plus the weight of the Fly Ash represents the weight of "cement".
- (e) **Testing.** Consistency of the mix shall be determined by AASHTO T 119 test methods. Air content shall be determined by AASHTO T 152 (Modified) or T 196 test methods.

MIX TEMPERATURE LIMITATIONS

The contractor shall be responsible for the quality of the concrete placed in any weather or atmospheric conditions.

The concrete shall have a temperature of 70° F (21° C) plus or minus 20° F (11° C) at the time of placement unless prior permission has been granted to exceed these tolerances; however, concrete for bridge decks shall not exceed 85° F (30° C).

In cold weather the water and/or aggregate may be heated to not more than 150° F (66° C) to maintain the concrete at the required temperature. The heating apparatus shall be such that the materials will be heated uniformly and preclude the possibility of overheating any portions of the aggregates. Material containing frost or hardened lumps shall not be used.

In hot weather the water and/or aggregate shall be cooled as necessary to maintain the concrete temperature within the specified limits.

DELIVERY RESTRICTIONS

The time elapsing between the introduction of water to the mix and the placing of the concrete shall be 30 minutes maximum for non-agitating type haul equipment or 60 minutes maximum for agitating type haul equipment. This provision shall apply for central mix and truck mix concrete. Any concrete which has not been placed within this time limit it shall be rejected for use in the work. These delivery time restrictions may be extended 30 minutes when an approved water reducing and set retarding admixture is used, provided the concrete remains workable for the use intended.

The interval between placing successive loads shall be as directed, however, in no case shall exceed 20 minutes in order that concrete in place shall not have become partially hardened prior to placing successive batches, unless approved in writing by the Engineer.

The method and time of delivery shall be controlled by plant slips signed by the plant operator and issued to the truck driver. The slips will indicate the name and location of the plant, the size and proportions of the batch, type of admixture used, and the time the mixer is charged. Upon arrival on the job, each slip shall be delivered to the Engineer and completed to show the time the concrete is discharged from the truck.

The contractor shall notify the Department's project inspectors at least one work day prior to the placement of any concrete so that inspection services can be provided.

PLANT AND EQUIPMENT REQUIREMENTS

- (a) **General Requirements.** All concrete batch plants shall be equipped for automatic batching and proportioning of all cement, aggregates, water and automatic visual insertion of admixtures.

This requirement may be waived with written permission of the Engineer for small isolated projects provided specification concrete is produced.

All currently approved concrete batch plants shall retain approved status, unless the approval is rescinded for failure to comply with the batch plant requirements specified herein and the requirements of the current AASHTO M 157 for concrete batch plants. In this case, reinstatement shall be on the basis of the requirements for automation as specified for approval of plants. The requirements for automatic batch selector may be waived for plants designed to produce only one concrete mix, i.e., paving or masonry; however, the producer will not be permitted to supply more than one type of mix from this type of plant simultaneously.

The batching plant and all equipment and facilities necessary for performing the work shall be inspected and approved by the Engineer as

to design, capacity and condition well in advance of the start of construction. The batching plant shall meet the requirements of AASHTO M 157, except as modified herein.

A laboratory of 150 s.f. minimum shall be provided for the exclusive use of the Engineer at all Portland cement concrete facilities. The producer shall furnish all heat, lights, air conditioning, telephone, electric, water (including drinking water), tables, desk, chairs, file cabinets, and all testing equipment or devices to control the production and quality of the concrete. Approved sanitary facilities shall be furnished and maintained.

Inspection of all equipment incidental to the production and transportation of concrete shall be performed by the Engineer either on an annual basis or prior to commencement of work on a contract. If at any time during construction equipment is not performing satisfactorily, it shall be repaired prior to re-use.

- (1) **Bins and Hopper.** The bins shall be in good condition and have adequate separate compartments for fine aggregates and for each required size of coarse aggregate. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly and shut off with precision.

The hopper and its appurtenances shall be constructed to eliminate the retention of varying tare materials on any of its parts, and operated to ensure a rapid and complete discharge without shaking and jarring the scales.

- (2) **Weighing Equipment.** The scales for weighing material shall be either of the horizontal beam or the springless dial type, and shall be the product of an established manufacturer. They shall be of rugged design and constructed to support the hopper or hoppers and with minimum adjustments consistent with the accuracy required. Scale levers shall be of such design construction, and material to permit frequent handling without damage.

Pivots shall be of steel, sufficiently hardened and tempered to ensure minimum wear under a heavy volume of weighing. They shall be accurately set in substantial mountings which will ensure a permanent spacing of the knife edges under all conditions of loading and which will prevent them from being loosened by the vibration incident to usage.

Multiple weigh beams, on scales to be used for weighing more than one kind of material, shall have as many beams as there are different kinds of

material to be weighed on the scales. All weigh beams shall be horizontal. The trip loop shall allow movement of the weigh beam above and below the horizontal position for proper operations of the telltale dial as hereinafter specified. The free end of the weigh beam shall be equipped with a suitable device for indicating clearly and accurately the horizontal position of the weigh beam.

Provision such as a telltale dial shall be made for indicating to the scale operator that the required load in the weighing hopper is being approached. Such device shall indicate at least the last 200 pounds (90 kilograms) of load.

Poises shall be constructed so they cannot be easily removed from the beam and shall be equipped with a device to hold them firmly in place. Poises and weigh beams shall be made of noncorrosive material and shall be of sufficient hardness to prevent excessive wear.

Graduated dials shall be provided with suitable markers placed outside the glass cover and set closely in front of the dial for use in determining the position of the dial indicator for predetermined loads in the weigh hopper. Provisions shall be made to prevent dirt from collecting in and around the dial mechanism. Means shall be provided for obtaining and maintaining proper alignment between the dial and the part of the scale which transmits the load to the dial. The dial face shall be of a material which is not affected by moisture. The value of the graduations of scales weighing 5000 pounds (2250 kilograms) or less shall not be greater than 5 pounds (2.25 kilograms). The value of the graduations of scales used in weighing over 5000 pounds (2250 kilograms) shall not be greater than 0.1% of the rated capacity of the scales.

Scales shall be so constructed that they may be maintained within a maximum tolerance of 0.5% of the net load in the hopper.

Clearance shall be provided between the scale parts and the hopper or bin structure to prevent displacement of or friction between the scales due to vibration or any other cause.

Each scale installation shall be provided with at least ten 50 pound (22.5 kilogram) calibrated test weights available for use at the plant at all times for checking scale accuracy. These weights shall be checked for true weight at the Engineer's discretion.

The weights shall be made of high quality cast iron and shall be cast and finished in such a manner that foreign material will not adhere to the surface.

All batching controls shall be positioned so as to allow the operator full view of all scales and admixture dispensers.

The weighing equipment, including dials, weigh beams, bins, and operating levers shall be so arranged that a clear and unobstructed view of the weighing operations are provided at all times.

All working parts of the scales, particularly knife edges, shall be protected to prevent any material except windborne material from falling upon or against them. Suitable windbreaks shall be constructed, when necessary, to prevent variation of the scale mechanism by winds. All working parts of the scales shall be readily accessible for inspection and cleaning.

The individual aggregates, as weighed, shall be within 1% of the required weight and the total weight of the aggregates shall be within 1% of the required total weight.

All scales shall be checked regularly as determined by the Engineer.

- (2) **Water Supply.** Water may be measured by volume or by weight. The device for the measurement of water shall be readily adjustable and shall under all operating conditions be accurate within 1% of the quantity of water required for each batch. The device shall be so arranged that the measurements will not be affected by variable pressure in the supply line.

Measuring tanks shall be equipped with outside taps and valves to provide for the calibration unless other means are provided.

- (4) **Admixture Dispensers.** Equipment for dispensing air entrainment or other admixtures shall be of approved design and calibrated prior to being approved. Recalibrations will be made as required by the Engineer.

The flasks and discharge hoses shall be transparent and so arranged that the Engineer has a clear and unobstructed view of the dispensing operation at all times.

- (5) **Automatic Batch Selector.** The automatic batch plant shall be controlled by means of an approved automatic batch selector set to deliver accurately, and in proper sequence, the designated weight of cement, aggregates, the weight or volume of water, and admixtures required for the concrete mixture. The batch selector controls shall be locked or sealed during the operation, and no changes in selector controls or weight settings shall be made except in the presence of the inspector.

For safety reasons, Fly Ash, if used, shall be weighed and added after the Portland cement has been weighed and added.

Provisions may be included to vary the size of the batch without affecting the basic proportions of the concrete mix being produced.

- (6) **Interlocks.** All batching equipment in automatic plants shall be interlocked so that: a new weighing cycle cannot be started until the weigh hopper is empty; the scales are in balance; and the discharge gates and the supply valves included in the system are closed.
- (7) **Mixer.** The mixer shall be of approved design and shall be operated as recommended by the manufacturer. The pickup and throw-over blades shall be replaced or repaired when any part or section is worn 1" (2.54 centimeters) or more below the original height of the manufacturer's design. The mixer shall be kept free from accumulations of hardened concrete inside the mixing drum.

The mixer shall be equipped with an approved timing device or in the case of truck mix concrete, the use of revolution counters or other methods as determined by the Engineer.

(b) **Specific Requirements**

(1) **Central Mixed Portland Cement Concrete**

- a. **Description.** Central Mixed Portland cement concrete shall consist of Portland cement concrete manufactured from previously approved materials, proportioned and mixed in a central mixing plant and transported to the project in approved vehicles.
- b. **Mixing.** Concrete shall be mixed in a batch mixer, as previously described, for a period of not less than 60 seconds for mixers with capacities of 10 cubic yards (7.64 cubic meters) or less. For mixers of greater capacity, the Engineer shall determine the mixing time, based on mixing efficiency. The Engineer reserves the right to adjust the mixing time to any extent necessary to obtain concrete of desired uniformity. Mixing time starts when all the materials, excluding water, are in the mixer. The batch shall be so charged into the drum that some water shall enter in advance of the aggregates and shall continue to flow for a period of not less than 5 nor more than 10 seconds after all aggregates are in the drum. The entire contents shall be removed from the drum before succeeding batches are introduced. Unless otherwise permitted, the maximum batch size shall be the manufacturer's rated capacity for that mixer.

- c. **Moisture Meter.** An automatic electrical moisture meter, equipped with adjustable controls, shall be installed at the Engineer's discretion to measure accurately and continuously the moisture content of the fine aggregate. The meter probe shall be kept cleaned and maintained at all times.

(2) **Truck Mixed Portland Cement Concrete**

- a. **Description.** Truck mixed Portland cement concrete shall be proportioned and dry batched using previously approved materials, with water added for mixing either at the plant or on the job site. Delivery shall be made in approved mixer trucks. Batching and mixing shall be under the supervision of the Engineer.
- b. **Mixer Truck.** Truck mix units shall be designed for both mixing and agitation and shall be equipped with a watertight drum suitably mounted and powered, and fitted with properly designed blades. The mixing unit shall be capable of combining the aggregates into a thoroughly mixed and uniform mass of concrete and of transporting and discharging the concrete without segregation. The pickup and throw-over blades shall be replaced or repaired when any part or section is worn 1" (2.54 centimeters) or more below the original height of the manufacturer's design. The inside of the mixer drum shall be kept free from accumulations of hardened concrete.

Water supply equipment for truck mixers shall include a water storage compartment of sufficient capacity to hold the entire water required for mixing of concrete (in the case of on-site mixing) and wash water required to wash the mixer after depositing concrete in all cases. The equipment shall include an external water gauge calibrated to 1 gallon (3.7852 liter) intervals and suitable cut-off valves to regulate the quantity of water delivered to the mixer. These cut-off valves must be maintained in first class working order. A truck mixer with a leaky valve will not be permitted on the project.

The size of the batch which may be charged into the truck mix unit shall not exceed the manufacturer's rated capacity for the unit when operated as a mixer. If the manufacturer's rating is not stamped on each mixing unit, the rated capacity will be determined by the Engineer. Any mixer which shows a variation in consistency of concrete of more than 1" (2.54 centimeters) slump during the discharge of any single batch shall not be permitted to operate until repaired so as to produce concrete of the required uniformity.

- c. **Mixing.** Each batch of concrete mixed in truck units shall be mixed not less than 70 nor more than 100 revolutions of the mixer and at the rate of rotation specified by the manufacturer as the mixing speed. Additional mixing, more than 100 revolutions, if required shall be done at the rate of rotation specified by the manufacturer as agitation speed.

Immediately prior to the addition of the mixing of water, the drum shall be operated at mixing speed. The mixing period shall be started at the time the mixing water is added to the drum. This operation will be supervised by the Engineer who will indicate on the delivery ticket the time the mix started and also the time that the drum is empty and the entire batch is in place.

- d. **Inspection Platform.** An inspection platform of suitable dimensions shall be provided at the plant for the viewing of truck mix concrete by the Engineer with reasonable access and safety.

(c) **Transportation**

- (1) **Vehicle.** The vehicle in which Portland cement concrete is transported shall be an approved type of agitator truck, equipped with a watertight revolving drum, suitably mounted and powered, and fitted with properly designed blades capable of transporting and discharging the concrete without excessive abrasion and segregation.

The agitator unit shall be so constructed as to insure rapid delivery of the concrete without loss of ingredients and to effect complete discharge of each batch.

Low slump Portland cement concrete as used in slip form paving may also be transported in open trucks designed for that purpose and may be either agitator or non-agitator types, provided that no segregation or loss of water detrimental to the mix, as determined by the Engineer, occurs during transportation, and the concrete on delivery at the project meets the requirements specified.

Either agitator or non-agitator types of truck bodies shall be capable of having the dump end elevated so that the concrete will be discharged at sufficient height to permit chuting without segregation.

- (2) **Size of Batch.** The size of the batch which may be transported in these units shall not exceed the manufacturer's rating for the unit when used as an agitator. If the manufacturer's rating is not stamped on each mixing unit, the rated capacity will be determined by the Engineer.

(d)

Portland Cement Concrete Made by Volumetric Batching and Continuous Mixing:

- (1) **Description.** Portland cement concrete made by volumetric batching and continuous mixing method as hereinafter described is permissible for concrete used in bridge deck overlays utilizing latex concrete, headwalls, steps, utility encasement, manhole and inlet bottoms, gutters, curbs, headers, barrier curbs, sidewalks, island pavements, fence and sign post footings, signals, light standard and meter cabinet footings, junction boxes and other small pour items as may be approved by the Engineer.
- (2) **Mixing on the Project in a Continuous Mixing Type Truck Mixer.** Continuous mix concrete shall be materials accurately proportioned by volumetric measurement from bins on the truck mixer and hydrated and mixed on the truck mixer at the site of the work.

The concrete shall be mixed in an approved type mixing unit which is part of the truck carrying the dry ingredients. The mixing unit shall be an auger type mixer incorporated in the truck's discharge chute or other suitable mixing mechanism approved by the Engineer, and shall produce concrete of uniform consistency and discharge the mix without segregation.

The truck mixer shall have permanently attached thereto in a prominent place a metal plate or plates on which are plainly marked the gross volume of the unit in terms of mixed concrete, operating speed, and the cement constant of the machine in terms of an indicator revolution count required to deliver 94 lbs. (42.3 kilograms) of cement, all as rated by the manufacturer.

The truck mixer shall be equipped with a cement bin of sufficient capacity to store and supply the quantity of dry cement required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. The cement bin shall be free of moisture and contamination at all times.

The truck mixer shall be equipped with aggregate bins of sufficient capacity to store separately the quantities of fine and coarse aggregates required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer. Suitable means, approved by the Engineer, shall be provided to prevent contamination or intermixing of the fine and coarse aggregates during loading and transporting. Aggregate bins may be covered when there exists a possibility of moisture entering the bins.

The truck mixer shall be equipped with water tanks of sufficient capacity to store the quantity of water required to produce the maximum volume concrete capacity of the truck mixer as rated by the manufacturer and at the slump specified for each concrete section.

If concrete additives are to be used in the mix, suitable means, approved by the Engineer, shall be provided for storing the additives on the truck and incorporating them in the mix. Suitable means shall also be provided on the truck mixer to permit the Engineer to check the rate of flow of the additive into the mix.

The truck mixer shall include a feeder unit mounted under the compartment bins to deliver the ingredients to the mixing unit.

Each bin on the truck shall have an accurately controlled individual gate or feeding mechanism to form an orifice for volumetrically measuring the material drawn from each respective bin compartment. The cement bin feeding mechanism shall be set to discharge continuously and at a uniform rate a given volumetric weight equivalent of cement during the concrete mixing operation. The gates of the aggregate bins shall be calibrated at the various openings to discharge the volumetric weight equivalent of aggregate required for various concrete mixes.

The truck mixer shall be so constructed as to allow the Engineer to check the calibration of the gate openings and meters by means of weight test samples.

The calibration of the gate openings, meters, etc., shall be checked and certified either on a semi-annual basis or prior to work on a contract. If at any time during construction a piece of equipment is not performing satisfactorily, it shall be repaired satisfactorily prior to reuse. A copy of the Certification shall accompany the truck mixer at all times.

A $\frac{1}{4}$ yard (0.191 cubic meter) box constructed of suitable rigid materials shall be with the machine at all times for calibration purposes.

Each truck mixer shall be equipped with an accurate revolution counter indicator permitting the reading of the volumetric weight equivalent of cement discharged during the concrete mixing operation.

Each truck shall be equipped with fine and coarse aggregate dials to permit accurate adjustments of the gates of the aggregate bins for

volumetric proportioning of aggregates.

Each truck mixer shall be equipped with a water meter or gauge to register the discharge rate of water by volume entering the mix.

Each truck mixer shall be equipped with positive automatic means of maintaining the operating speed of the proportioning and mixing operation independent of the drive engine of the truck, and within 8% above or below that established by the manufacturer and noted on the aforementioned metal plate as the speed at which the machine will accurately proportion concrete. Such positive automatic means shall automatically shut down the proportioning and mixing operation when the operating speed varies by more than the above tolerance. A tachometer shall be mounted on the unit to indicate the operating speed.

All indicators, dials, meters, tachometer, and controls shall be in full view and near enough to be accurately read or adjusted by the operator while mixing concrete.

Handling, measuring and batching of materials shall conform to the applicable requirements of the Section in which the concrete is being placed.

Cement and aggregates shall be proportioned, measured, and batched by a volumetric weight equivalent method. Separate batching equipment and storage bins will not be required and the materials shall be batched in a continuous mixing truck type mixer.

The concrete will be rejected if there is any evidence of improper batching, mixing, excessive segregation, use of excessive mixing water, or if the amount of entrained air be other than as specified.

Tolerances in proportioning the various ingredients are as follows:

Cement (weight percent)	0 to +4
Fine aggregate (weight percent)	± 2
Coarse aggregate (weight percent)	± 2
Admixtures (weight or volume percent)	± 3
Water (weight or volume percent)	± 3

Each truck load of ingredients shall be accompanied by a sufficient number of delivery tickets such that the operator may supply one copy of the delivery ticket to the Engineer for each project and for each kind of concrete delivered. The delivery tickets shall show the brand name and type of cement, the calibrated cement constant of

the machine in terms of the indicator revolution count, the source of aggregates and the size of the coarse aggregate. The delivery tickets shall be signed by the mixer operator. The mixer operator shall enter on the tickets the name of the project, the name of the contractor, the revolution counter readings indicating the volumetric weight equivalent of cement discharged during that mixing operation, the aggregate dial settings, and the section for which the concrete is delivered. The operator shall sign each completed ticket and furnish one copy to the Engineer.

PARAGRAPH 109 - MORTAR SAND

Mortar sand shall comply with AASHTO M 45 and the following grading:

Sieve Size	Passing
#4	100%
#8	95-100%
#100	0-25%
#200	0-10%

Fineness modulus: 1.6 - 2.5

The organic impurities requirement will be waived for uses other than masonry mortar.

PARAGRAPH 110 - GRADING REQUIREMENTS FOR STONE

MINIMUM AND MAXIMUM PERCENTAGES PASSING

DEL. NO.	SIEVE SIZE (SQUARE OPENINGS) INCHES											SIEVE NO.			
	4	3-1/2	3	2-1/2	2	1-1/2	1	3/4	1/2	3/8		4	8	16	100
1	100	90-100		25-60		0-15		0-5							
2			100	90-100	35-70	0-15		0-5							
3				100	90-100	35-70	0-15		0-5						
57						100	95-100		25-60			0-10	0-5		
67							100	90-100		20-55		0-10	0-5		
8									100	85-100		10-30	0-10	0-5	
10										100		85-100			10-30

SIEVE SIZE (SQUARE OPENINGS) NUMBER					
"RICE"	3/8"	4	10	40	200
	100	70-100	0-20	0-10	0-5

PARAGRAPH 111 - FLY ASH

Fly Ash is a by-product of coal combustion. Fly Ash may be used as a mineral additive in concrete and can be used as a partial replacement for Portland cement within Paragraph 108 and other sections of these specifications.

Fly Ash must conform to the requirements of ASTM C 618, Class C or Class F, as modified herein. The requirements of Table 1, "Chemical Requirements," shall be modified to establish the maximum "Loss on Ignition" at 4.0%. Table 1A, "Supplementary Optional Chemical Requirement" shall apply. Traces of ammonia and oil shall be absent from the Fly Ash.

Transport containers for Fly Ash must be of a design that provide for proper and complete unloading. Dedicated and reserved storage bins of Fly Ash shall be sampled and tested by the Engineer. All tests shall be completed and show that the material conforms with all requirements prior to any use.

Upon approval of the Engineer, the preceding requirement for dedicated and reserved storage bins of Fly Ash may be waived if the Fly Ash supplier is qualified for inclusion in a certification program. The certification program involves acceptable supplier quality control procedures.

For an acceptable Program of Certification the supplier must establish a history of satisfactory quality control of Fly Ash produced as evidenced by the results of tests performed by the Department and the supplier's testing laboratory. The supplier shall conduct sufficient tests to assure that adequate quality is maintained in regard to the material specifications. The supplier must maintain a record of all tests for review by the Engineer. The Engineer reserves the right to modify the program as considered necessary to maintain quality. Samples for tests by the Department may be taken at any time as determined by the Engineer. In addition, the handling and storage facilities must be approved by the Engineer.

PARAGRAPH 112 - BITUMINOUS MATERIAL FOR SUPERFICIAL WATERPROOFING

Bituminous material for use in dampproofing and waterproofing shall conform to the requirements of either asphalt or tar of the type specified below.

ASPHALT

Prime
AASHTO M 116

Asphalt for Damp proofing
and water proofing

Seal
AASHTO M 115 TYPE A

TAR

Prime
AASHTO M 121

Coal-Tar, Pitch for Roofing,
Dampproofing and
Waterproofing

Seal
AASHTO M 118
Type B

PARAGRAPH 113 MATERIAL FOR RESEALING JOINTS & CRACKS

This material shall consist of a blend of asphalt cement and 18% $\pm$ 2% by weight of mixture of recycled, reclaimed crumb rubber.

MATERIALS

Asphalt. The asphalt used shall have a maximum penetration of 150 as determined by AASHTO T 49.

Crumb Rubber. The recycled/reclaimed crumb rubber used in the mixture shall meet the following requirements:

- (a) Shall be produced from an ambient grinding process (crushes, tears, grinds, and/or abrades of the used rubber at or above ordinary room temperature) which produces rubber particles with a very ragged, sponge-like surface. Cryogenically ground rubbers are prohibited.
- (b) Shall contain recycled, vulcanized crumb rubber and/or reclaimed (devulcanized) rubber.
- (c) Shall contain a minimum of 25% natural rubber by weight of the total rubber portion of the mixture.
- (d) Shall contain no more than a trace of fabric.
- (e) Shall be free of wire and other contaminating materials, except that up to 4% calcium carbonate or talc may be included to prevent the rubber particles from sticking together.
- (f) Shall have no rubber particles greater than ¼" in length.
- (g) Shall meet the following gradation requirements:

Sieve Size*	Percent Passing
#10	100%
#16	90-100%
#30	40-80%
#80	0-10%

*Sieves shall comply to AASHTO M 92.

MIXTURE REQUIREMENTS

- (a) Pour Point - shall be at least 20° F (11° C) lower than the safe heating temperature, which is the maximum temperature to which the material may be heated without exceeding the permitted flow.
- (b) Penetration - at 77° F (25° C), 150 g, 5s; shall not exceed 90.
- (c) Flow - at 140° F (60° C) shall not exceed 5mm.
- (d) Bond - the sealant shall be tested at 0° F (-17.8° C) for five complete cycles. The development at any time during the test procedure of a crack, separation or other opening that at any point is over ¼" (6.4 mm) deep in the sealant or between the sealant and mortar block, shall constitute failure of the test specimen. The depth of the crack, separation or opening shall be measured perpendicular to the side of the sealant showing the defect. At least two test specimens in a group of three representing a given sample of sealant shall meet this requirement for bond.
- (e) Packaging - The premixed sealant shall be packaged in unit weighing no more than 30 pounds with a maximum of two 30 pound units per shipping container. The plastic film used in packaging the units shall readily melt at normal application temperatures when placed in the installation equipment. Bonding or sticking of the packaged units to each other or to the shipping container or packaging causing unnecessary contamination of the sealant with staples, fasteners, etc., as determined by the Engineer, shall be sufficient cause for rejection of the material.

PARAGRAPH 114 - WIRE MESH REINFORCEMENT

Wire mesh reinforcement shall meet the requirements of AASHTO M 55, Cold Drawn Steel Wire for Concrete Reinforcement, and as shown on the plans.

PARAGRAPH 115 - ASPHALT CEMENT

Asphalt cement shall be prepared by the refining of crude petroleum using methods standard of the industry.

The asphalt cement shall be homogeneous, free from water, and shall not foam when heated to 350° F, and shall meet the requirements of AASHTO M 226 Viscosity Graded Asphalt Cement, AC-20 grade of Table 2 or AC-10 grade of Table 2 when specified for use in recycled bituminous mixtures. When tested by ignition, the inorganic insoluble residue content of the asphalt cement shall not exceed 0.25% by weight.

Asphalt cement shall maintain aggregate coating integrity when subjected to a boiling strip test. Failure to maintain a minimum 95% coating level of the aggregates intended for use shall require addition of an anti-strip additive to the asphalt cement at a rate of 0.5% to 1.0% by weight of asphalt cement as determined by the Engineer. If upon addition of the anti-strip additive to the asphalt cement, the minimum 95% coating requirement is not achieved, the asphalt cement-aggregate combination shall be rejected for use.

PARAGRAPH 116 - BITUMINOUS COLD MIX-COLD PATCH

Bituminous Cold-Mix Material (Cold Patch) shall be a uniform mixture of compatible mineral aggregate and bituminous material further described herein. The aggregate shall be uniformly coated with no stripping of the bituminous material from the aggregate. The mixture shall be capable of being stored in a stockpile for a period of at least six months without hardening or stripping and shall remain workable during all expected weather conditions during this storage.

Coarse Aggregate shall meet the requirements as outlined in Paragraph 110, "Material Details," of these Standard Specifications.

Fine Aggregate shall be crushed stone screening and up to 25% washed concrete sand meeting the requirements of Paragraph 103, Material Details. The 25% limit is based on the total dry weight of the sand compared to the total dry aggregate weight in the mixture.

Bituminous Material shall be a medium curing cutback conforming to AASHTO M 82. When mixing and stockpiling of Bituminous Cold-Mix occurs during November 1 to March 31, an MC 250 shall be used and during April 1 to October 31, an MC 800 shall be used. At the option of the Contractor, an MC 400 may be used year round and shall conform to the following requirements:

Test	Min.	Max.
Kinematic Viscosity @ 60° C, cs	400	800
Flash point, Tag open cup, ° C	66	---
Water percent	---	0.2
Distillation Test		
Distillate percentage by volume of total distillate to 360° C		
to 225° C	0	7
to 260° C	10	45
to 315° C	55	85
Residue from Distillation to 360° C - volume % of sample by difference	70	---

Tests on Residue	<u>Min.</u>	<u>Max.</u>
Absolute viscosity @ 60° C, poises	300	1200
Ductility 5 cm/min. at 25° C - cm	100	----
Solubility	99.0	----
(Reference AASHTO M 82)		

An anti-stripping additive shall be blended into the bituminous material at the source of supply in accordance with the manufacturer's recommendation. The anti-stripping additive shall be heat stable for a minimum of 96 hours at 185° F.

The producer shall submit a written proposal indicating the single definite percentage of each sieve fraction of aggregate and percentage of asphalt residue. Expected temperature ranges for component materials and the completed mixture shall also be provided with the job mix formula submission.

The job mix formula shall be within the following limits:

Sieve	% Passing	Production Tolerance ($\pm$)
3/8"	100	0
#4	55-90	7
#8	10-40	4
#200	0-3	2

Asphalt residue, including additive, shall be 4.5 to 6.5% of the total aggregate weight. When tested according to procedures described herein, the allowable production tolerance from the approved mix design is 0.4% (plus or minus).

The aggregate shall be heated to a temperature between 185° F and 225° F; the asphalt between 135° F and 175° F. The completed mix shall have a temperature not to exceed 180° F.

Acceptance of the materials and the produced mixture will be based on an evaluation of asphalt-aggregate compatibility using a boiling strip test and coating test, and extraction analysis of the mixture.

PARAGRAPH 117 - CUT BACK ASPHALT

Cut-back asphalt shall conform to AASHTO M 81 for rapid curing (RC) types and AASHTO M 82 for medium curing (MC) types.

PARAGRAPH 118 - SOLID CONCRETE BLOCK

Solid concrete block shall conform to the requirements of ASTM C 139, except absorption which shall have a maximum value of 15 lbs./cubic foot. Units less than

5" in thickness shall have a minimum compressive strength of 2000 psi. A concrete masonry unit may be either a concrete block or what is commonly referred to as a concrete brick.

PARAGRAPH 119 - PAINT FOR STEEL STRUCTURES

I. Inorganic Zinc - Vinyl Topcoat System

This system specifies the use of a two-component organic zinc primer plus a ready mixed vinyl chloride copolymer topcoat. The primer and topcoat shall be supplied by the same manufacturer.

Material Specifications-Primer

(a) Zinc Pigment

The zinc portion shall be a finely divided zinc powder containing a minimum of 94% metallic zinc and 97.5% total zinc by weight (reference ASTM D 520, Type I, modified to permit 0.1% retained on the #100 mesh screen).

(b) Vehicle-Alkyl or Ethyl Silicate, solvent type, self-curing.

% Nonvolatile @ 105° C, by weight	18.0 min.
% Silicon Dioxide, by weight of vehicle	9.0 min.
Weight per gallon, pounds @ 77° F	7.5 min.

(c) Properties of Mixed Paint

Weight per gallon,	21.0 min.
Viscosity, KU @ 77° F	60-90
Percent Zn in the dry film, by weights	75.0 min.
Weight of zinc gallon, pounds	14.6 min.
Dry Time - To touch, minutes	30 max.
To topcoat, hours	24 max.
Pot Life @ 70° F, hours	8 min.

The color of the inorganic zinc primer must be such that a definite contrast between it and the color of the blasted steel is readily apparent. The contractor will be required to submit color samples of the primer to the Engineer for approval.

Materials Specification-Topcoat

The vinyl topcoat shall be a ready mixed vinyl chloride copolymer paint specifically formulated for use on steel structures which have been painted with inorganic zinc primer. To insure compatibility, both the primer and topcoat shall be supplied by the same manufacturer.

Properties of Mixed Paint

Weight per gallon, lbs.	8.5 min.
Viscosity, KU @ 77° F	65-95
% Non, volatile, by weight	35.0 min.
% Pigment, by weight	12.0 min.
Dry Time - To touch, minutes	30 max.
To recoat, hrs.	4 max.
Gloss	Matte
Gloss-Federal Standard No. 595	24172

II. Alkyd System

This system specifies the use of a three-coat alkyd system intended for painting of structural steel and other ferrous metal surfaces.

Prime Coat

The prime coat shall be a basic lead silico chromate base-iron oxide linseed-oil alkyd conforming to AASHTO M 229, Type V (Federal Specification TT-P-615, V) and shall be applied at a minimum dry film thickness of 2.0 mils.

Intermediate Coat

The intermediate coat shall be a basic lead silico chromate base-iron oxide alkyd varnish conforming to AASHTO M 229 Type III (Federal Specification TT-P-615, III) and shall be applied at a minimum dry film thickness of 1.5 mils. The intermediate coat shall be tinted to show a definite contrast in comparison to the prime coat.

Finish Coat

The finish coat shall be an oil modified alkyd varnish applied at a minimum dry film thickness of 2.0 mils and shall conform to the following requirements:

Ingredients

<u>Pigment</u>	<u>Percent by Weight</u>	
	<u>Minimum</u>	<u>Maximum</u>
Basic Lead Silico Chromate	23.0	----
TiO ₂ (Rutile)	23.0	----
Chromium Oxide Green	23.0	----

<u>Vehicle</u>	<u>Min.</u>	<u>Max.</u>
Raw Linseed Oil	5.0	10.0
Alkyd Resin Solids	50.0	----
Volatile Mineral Spirits & Driers	----	45.0

<u>Mixed Paint</u>		
Pigment	38.0	----
Vehicle	----	62.0
Vehicle Solids	55.0	----
Coarse particles and skins (retained on 0.45 mm sieve)		
percent by weight of pigment	----	1.0
weight/gallon, lbs.	10.8	----
consistency, Krebs Units	65	85
fineness of grind	5	----
Drying time, hours	----	16

Finish	dull gloss
Color, Federal Standard 595	#24172 (Green)

APPENDIX I

I - APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	39.370 08	mils	
mm	millimeters	0.039 37	inches	in
m	meters	3.280	feet	ft
m	meters	1.093	yards	yd
km	kilometers	0.621 371 2	miles	mi
AREA				
mm ²	millimeters squared	0.001 155	square inches	in ²
m ²	meters squared	10.763 91	square feet	ft ²
mL	milliliters	0.033 814	fluid ounces	fl oz
m ²	meters squared	1.195 99	square yards	yd ²
ha	hectares	2.471 054	acres	ac
km ²	kilometers squared	0.386	square miles	mi ²
VOLUME				
mL	milliliters	0.033 814	fluid ounces	fl oz
L	liters	0.264 172	gallons	gal
m ³	meters cubed	35.314 662 5	cubic feet	ft ³
m ³	meters cubed	1.307 750	cubic yards	yd ³
MASS				
g	grams	0.035 273 9	ounces	oz
kg	kilograms	2.204 624 4	pounds	lb
t	metric tons	1.102 312 2	short tons (2,000 lb)	T
OTHER				
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
ΔT°C	Change in Celsius	1.8	Change in Fahrenheit	ΔT°F
Pa	pascals	0.000 145 037	pounds per square inch	psi

APPENDIX I

I - APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
	mils	0.025 4	millimeters	mm
in	inches	25.4	millimeters	mm
ft	feet	0.304 8	meters	m
yd	yards	0.914 4	meters	m
mi	miles	1.609 344	kilometers	km
AREA				
in ²	square inches	645.16	millimeters squared	mm ²
ft ²	square feet	0.092 903	meters squared	m ²
fl oz	fluid ounces	29.573 53	milliliters	mL
yd ²	square yards	0.836 127 4	meters squared	m ²
ac	acres	0.404 685 6	hectares	ha
mi ²	square miles	2.59	kilometers squared	km ²
VOLUME				
fl oz	fluid ounces	29.573 53	milliliters	mL
gal	gallons	3.785 412	liters	L
ft ³	cubic feet	0.028 316 85	meters cubed	m ³
yd ³	cubic yards	0.764 555	meters cubed	m ³
NOTE: Volumes greater than 1000 L shall be shown in m ³ .				
MASS				
oz	ounces	28.349 52	grams	g
lb	pounds	0.453 592	kilograms	kg
T	short tons (2000#)	0.907 184	metric tons	t
OTHER				
°F	Fahrenheit temperature	5(F - 32)/9	Celsius temperature	°C
ΔT°F	Change in Fahrenheit Temp.	0.555 556	Change in Celsius Temp.	ΔT°C
psi	pounds per square inch	6 894.757	pascals	Pa