H. L. No. 38-3

WAR DEPARTMENT
United States Engineer Office
Providence, R. I.

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S P E C I F I C A T I O N S

FOR CONSTRUCTION OF FLOOD CONTROL WORKS

ALONG THE CONNECTICUT RIVER

HARTFORD, CONNECTICUT

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February 24, 1938

Revised April 19, 1938

INDEX

GENERAL SPECIFICATIONS

Section 1 Location
2 Work to be done
3 Organization
4 Responsibility of the District Engineer
5 Description of the project
6 Drawings
7 Quantities
8 Transportation facilities
9 Physical data
10 Datum and bench marks
11 Lines, grades, stakes and templates
12 Planimeter
13 Plant organization
14 Responsibility for work
15 Lands, rights of way, damages
16 Removal of existing structures
17 Cold weather restrictions
18 Borrow pits
19 Protection of stored materials
20 Material purchased by the District Engineer
21 Liability and safety requirements
22 Use of explosives
23 Time and manner of doing work
24 Employment of labor
25 Purchase of supplies and materials
26 Quality and inspection of supplies and materials
27 Removal of rubbish
28 Soil classifications
29 Cost accounting

DETAILED SPECIFICATIONS

Item	Designation	Sections
1	Levee Embankment	1.01 to 1.10
2	Removal of Existing Stop-Log Structure	2.01 to 2.04
3	Excavation and backfill for concrete structure	3.01 to 3.05
4	Concrete	4.01 to 4.16
5	Reinforcing steel	5.01 to 5.06

H. L. No. 38-3
February 24, 1938
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WAR DEPARTMENT
UNITED STATES ENGINEER OFFICE
PROVIDENCE, R. I.

APPROPRIATION: Emergency Relief, 1938.

EARTH DIKE AND STOP-LOG STRUCTURE ALONG CONNECTICUT RIVER

HARTFORD, CONNECTICUT.

SPECIFICATIONS

GENERAL SPECIFICATIONS

Section 1. Location. - The site of the work covered by these specifications is located along the existing Clark dike, on the west bank of the Connecticut River, in the south portion of the City of Hartford, Connecticut.

Section 2. Work to be done. - a. The work provided for herein is authorized by the Emergency Relief Appropriation Act of 1937.

b. The work to be done consists in the construction of an earth dike approximately 11,300 feet in length and one concrete stop-log structure to the grade and dimensions and otherwise complete as described in these specifications. It includes furnishing all plant, labor and materials and performing all operations in connection with the following principal items of construction:

(1) Construction of an earth dike between traverse stations 3 + 00 and 116 + 00.

(2) Reconstruction of a concrete stop-log structure at traverse station 5 + 49.90.

Section 3. Organization. - The work described in these specifications will be executed by the Area Engineer whose responsibility shall correspond to that of "contractor" as defined in Article 1, standard construction contract form No. 23. The District Engineer as the officer responsible for the final

accomplishment of the work specified will correspond to the "contracting officer."

Section 4. Responsibility of the District Engineer. - a. The District Engineer will decide all questions which may arise as to performance, quantity and quality, acceptability, fitness and/or materials to be furnished and used, and the rate of progress of the work as described by these specifications and will decide all questions which may arise as to interpretations of the specifications and drawings.

b. Changes which are necessary due to changed conditions in the field and necessitate a change in the specifications and/or drawings will be made in writing by the District Engineer provided that any change involving an estimated increase or decrease of more than $500 will be subject to the final approval of the Division Engineer.

c. Inspection. - The work will be conducted under the general direction of the District Engineer and will be inspected by inspectors appointed by him. The organization of the inspection staff will be entirely separate from the construction organization and will be directly responsible to the District Engineer. It is understood that any instructions given by the District Engineer through an inspector or other authorized employee are to be considered instructions or decisions of the District Engineer in all cases.

Section 5. Description of the project. - The enlargement of that portion of the existing Clark Dike as covered by these specifications will be of the rolled-fill type, top elevation 43.0 ± M.S.L. at the upstream end to 42.5 ± M.S.L. at the downstream end, with an average height of 6.5 feet above the existing dike grade. The existing stop-log structure at station 5 + 49.9 will be removed and reconstructed. The work covered by these specifications will be constructed 6.5 feet above the comprehensive plan design grade.

Section 6. Drawings. - a. The work will conform to drawings marked "Proposed Dike Work, Hartford, Connecticut", comprising five drawings numbered and titled as follows:

Sheet No.	Title	File No.
1	Plan	CT-4-1020
2	Profile and Typical Cross-sections	CT-4-1021
3	Stop-Log Structure Station 5+49.9	CT-4-1022
4	" " " " " " "	CT-4-1023
5	Plan - Clark Dike Wethersfield End	CT-4-1024

all of which form a part of the specifications, and which are filed in the United States Engineer Office at Providence, R. I.

b. The work shall also conform to such other drawings relating thereto used in explanation of details or minor modifications as may be furnished by the District Engineer from time to time during construction.

Section 7. Quantities. - The following estimate of net quantities is given to serve as an indication of the extent of the work covered by these specifications:

Item No.	Designation	Unit	Quantity
1	Levee Embankment	Cu. Yd.	285,700
2	Removal of Existing Stop-Log Structure	Each	One
3	Excavation and backfill for concrete structures	Cu. Yd.	325
4	Concrete	Cu. Yd.	260
5	Reinforcing steel	Lb.	29,500

Section 8. Transportation facilities - a. Railroads. - The New York, New Haven and Hartford Railroad serves the city of Hartford with main line traffic and adequate siding facilities are available in close proximity to the work.

b. Highways. - First-class highways also serve the city and provide reasonable access to all parts of the project.

Section 9. Physical data. - a. The locality is subject to atmospheric temperatures ranging from minus 18 degrees to 101 degrees Fahrenheit. The mean annual precipitation at Hartford is 42.50 inches. The mean monthly precipitation varies from a low of 3.22 inches in June to a high of 4.20 inches in August.

Section 10. Datum and bench marks. - The plane of reference of Mean Sea Level as used in these specifications is that determined by the following bench mark.

Description of Bench Mark
F8 at Hartford

Hartford County on the New York, New Haven and Hartford Railroad, 60 feet west of the station, in Bushnell Park, 15 feet south of the south rail, 10 feet west of Asylum Street, 6 feet south of a high stone retaining wall, and 30 feet lower than the track. A standard U.S.C. & G.S. disk, stamped "F 8 36.98" and set in the top of a concrete post. Elevation 11.222 meters or 36.818 feet.

Section 11. Lines, grades, stakes and templates. - The Government inspector will furnish on request all points and elevations reasonably necessary for the prosecution of the work from lines and grades established by the survey party.

Section 12. Planimeter. - For the estimating of quantities in which computation of area by arithmetic and geometric methods will be comparatively laborious the planimeter shall be considered an instrument of precision adapted to the measurement of such areas. Measurement of quantities in place after compaction will be used for cost keeping data.

Section 13. Plant organization. - a. The Area Engineer shall provide sufficient plant of size suitable to meet the requirements of the work and shall maintain the plant and equipment in such condition to perform the work efficiently and economically within the time specified. An ample force shall be maintained to properly and efficiently conduct the work.

b. No reduction in the capacity of the plant employed on the work shall be made except when approved by the District Engineer. The measure of the "capacity of the plant" shall be its actual performance on the work to which these specifications apply.

Section 14. Responsibility for work. - The Area Engineer shall assume all responsibility for the satisfactory prosecution and completion of the work and take all precautions for preventing injury to persons and property in or about the work.

Section 15. Lands, rights of way, damages. - a. The District Engineer shall designate the lands, rights of way and easements which will be required for the project, and the Area Engineer shall undertake the construction only when approved assurances shall have been obtained from local interests and when local cooperation has been complied with as required by Section 3 of the Flood Control Act (Public No. 738 - 74th Congress).

b. In the pursuance of the work covered by these specifications, no money appropriated for the construction of the project will be expended until the City of Hartford has given assurances satisfactory to the Secretary of War that it will:

(1) Provide without cost to the United States all lands, easements, and rights of way necessary for the construction of the project as defined by these specifications.

(2) Hold and save the United States free from damages owing to the construction works.

(3) Complete the flood protection of the South Meadows area if additional funds are not allotted for same by the United States.

(4) Maintain and operate all works after completion in accordance with regulations prescribed by the Secretary of War.

Section 16. Removal of existing structures. - The removal of existing structures and utilities required to permit the orderly prosecution of the work covered by these specifications shall be accomplished by local agencies in a manner as directed by the Area Engineer and satisfactory to the District Engineer. Whenever a telephone or telegraph pole, pipe line, conduit, sewer or other utility is encountered and must be removed to permit completion of the work, the District Engineer will notify the proper local authorities, who shall take prompt action to have the designated utility expeditiously removed.

Section 17. Cold weather restrictions. - No work shall be done when in the opinion of the District Engineer the weather is such as to interfere with proper construction. No frozen material shall be used in the construction of the earth embankment. No materials shall be placed on surfaces which are frozen or upon foundations or banks which are frozen unless otherwise approved by the District Engineer.

Section 18. Borrow pits. - Borrow pit areas shall be furnished by the local interests without cost to the United States, including rights of way for transportation purposes across property not owned. If sufficient material is not available in the borrow areas provided to complete the work, additional areas shall be furnished without cost to the United States.

Section 19. Protection of stored materials. - All materials and supplies shall be adequately protected against deterioration and damage.

Section 20. Material purchased by the District Engineer. - All orders, shipping bills or memoranda accompanying material purchased by the District Engineer shall clearly indicate weights and shall be so worded or marked that each item, piece or member can be definitely identified on the drawings.

Section 21. Liability and safety requirements. - a. The Area Engineer shall be responsible that his employees strictly observe the laws of the United States affecting all operations at the site under the contract. He shall comply with all applicable Federal and state laws under which he is operating, including those concerning the inspection of boilers, hulls, and other equipment, the licensing of engineers, masters and other employees.

b. The Area Engineer shall conduct the work with due regard to adequate safety and sanitary requirements and shall maintain his plant and equipment in safe condition. He shall conform to current safety engineering practices as set forth in the Manual of Accident Prevention in Construction, publishe by the Associated General Contractors of America; the publications of the National Safety Council, and with all applicable state or local safety and sanitary laws, regulations and ordinances.

c. The District Engineer shall require such safety and sanitary measures to be taken as the nature of the work and the conditions under which it is to be performed, demand. Such measures shall include:

(1) The provision of adequate extinguishers or fire-fighting apparatus in and about all buildings and plant erected or used at the site of the work;

(2) Adequate life-saving equipment.

(3) Adequate illumination during night operations;

(4) Watchmen service at any railroad crossings used by employees for access to the site;

(5) Warning lights between sunset and sunrise and during fogs, on all cofferdams, vessels, range piles and other obst uctions placed in navigable waters during the progress of the work;

(6) Instruction in accident prevention to reach all employees;

(7) Such machinery guards, safe walkways, scaffolds, ladders, bridges, gang planks and other safety devices, equipment and apparel as are necessary to prevent accidents or injuries.

d. The Area Engineer shall promptly report to the District Engineer in form prescribed by him all accidents occurring at the site of the work.

Section 22. Use of explosives. - All blasting shall be done in the most careful manner so as not to endanger life, property, or the work. Explosives use will be of a quality and power approved by the District Engineer. Dynamite in a frozen condition shall not be used. Approved explosives shall be stored before use in a suitable magazine, in an approved location, in compliance with state and local laws and regulations. Detonators shall be kept in a separate magazine not less than 100 feet from the explosives magazine. Magazines shall be plainly marked with large letters "EXPLOSIVES - DANGEROUS" and shall be kept locked. Accurate daily records shall be kept to account for each piece of explosive and detonator from the time of delivery at the magazine until its discharge in use.

Section 23. Time and manner of doing work. - The work covered by these specifications shall be commenced on the date designated by the District Engineer and shall be completed on or before June 30, 1938. In the pursuance of the work covered by these specifications, no money shall be expended on the construction of the project until the state, political subdivisions thereof, or other responsible agencies have given assurances satisfactory to the Secretary of War that the required easements and rights of way have been furnished according to the provisions of Section 15. The work shall be carried on at such localities and in such order of precedence as may be found necessary by the District Engineer. The location and limits of the work to be done shall be plainly indicated by the District Engineer or his agents by stakes or otherwise. The District Engineer may suspend the work wholly or in part for such periods as he

may deem necessary on account of conditions considered unfavorable for the suitable prosecution of the work. Proper lights each night, between the hours of sunset and sunrise, shall be maintained on or about the site of the work as the District Engineer deems necessary for the proper conduct and inspection of the work and the safety of employees when night work is performed. Danger lights and barricades shall be placed, in accordance with the laws of the State of Connecticut, on all intercepted highways and on such obstructions and hazards which encroach on, or are adjacent to, public rights of way.

Section 24. Employment of labor. - The method of employment, rate of wages, and monthly hours of employment for the various classifications of workmen shall be in strict conformity with the schedule (or any authorized revision thereof) furnished by the Works Progress Administration for Hartford. The District Engineer shall report to the Department of Labor monthly within five days after the close of each calendar month on forms to be furnished by the Department of Labor, the number of persons employed on the project, the man-hours worked and the total expenditure for materials. No work shall be done on Sundays or on days declared by Congress as holidays for per diem employees of the United States except in in cases of emergency, and then only with the written consent of the District Engineer. Night work, when necessary, will be permitted to maintain operating schedules upon written approval of the District Engineer.

Section 25. Purchase of supplies and materials. - a. Because the materials listed below, or the materials from which they are manufactured, are not mined, produced, or manufactured, as the case may be, in the United States in sufficient and reasonably available commercial quantities and of a satisfactory quality, their use in the work herein specified (subject to the requirements of the specifications) is authorized without regard to the country of origin:

Platinum	Rubber	Balsa wood
Chromium	Teakwood	English ball clay
Cork	Silk	English china clay
Jute	Sisal	Natural nickel copper alloy (monel metal)
Kauri gum	Tin	
Lac	Asbestos	
Nickel	China wood oil (tung oil)	

Articles, materials, or supplies, manufactured in the United States and containing mercury, antimony, tungsten, or mica of foreign origin may be used (subject to the requirements of the specifications) in the work herein specified because such manufactured articles, materials, or supplies have been manufactured in the United States substantially all from articles, materials, or supplies mined, produced, or manufactured, as the case may be, in the United States.

Section 26. Quality and inspection of supplies and materials. - All materials, supplies and articles used will be, insofar as is practicable, the standard stock products of recognized and reputable manufacturers and will be sufficient in strength, durability, usefulness and convenience for the purpose intended. All materials, parts and equipment shall be of the highest grade, free from defects and imperfections, of recent manufacture and unused. Workmanship shall be of the highest grade and in accordance with best modern practice.

All materials, supplies, and parts and assemblies thereof, purchased for the work covered by these specifications, shall be inspected in conformity with modern approved methods as directed by the District Engineer. Unless waived in writing by the District Engineer, all tests and trials shall be made in the presence of a duly authorized representative of the District Engineer. When the presence of the inspector is so waived, sworn statements, in duplicate, of the tests made and results thereof shall be furnished the District Engineer by the supplier. All costs of all tests and trials excepting the expenses of the Government inspector shall be borne by the supplier and shall be included in the price bid.

Section 27. Removal of rubbish. - Upon completion of the work, all plant, unused materials, rubbish, temporary buildings and other temporary structures erected for use during the prosecution of the work will be promptly removed and the site left in good order and condition.

Section 28. Soil classifications. - a. Soil classifications as referred to in these specifications conform to descriptive terms and limits of classifications as shown on Table No. 1 "Soil Classification" and Plate No. 1 "Diagram Showing Limits of Soil Classes," both of which form a part of these specifications.

b. Table No. 1 - Soil Classification.

(See page 12 for Table No. 1)

c. Plate No. 1 - Diagram Showing Limits of Soil Classes.

(See page 13 for Plate No. 1)

Section 29. Cost Accounting. - a. The Area Engineer shall keep an accurate cost distribution record of all work done and shall submit a monthly cost report to the District Engineer. The cost shall be kept so that proper charges may be made against the items in section 7.

b. A separate account shall be kept of all labor charges in order that employees' compensation insurance may be determined.

c. The cost and expense of inspection and surveys shall be kept separately and not included in the actual cost of performing the work.

d. Prior to the commencement of the work, the Area Engineer shall prepare a Job Estimate Summary sheet (Form No. 18 Costs) in quadruplicate and forward same to the District Engineer, attaching thereto the engineering estimat for performing the work. The engineering estimate shall be prepared in a manner similar to that set forth in paragraphs 734.1, 734.2, and 734.3 of Orders and Regulations. The final cost shall reflect all charges contemplated in the estimate.

e. Nothing in this paragraph shall be construed as changing the metho by which costs are now reported in monthly and annual reports required by the cost keeping manual.

TABLE NO. 1

CLASS	DESCRIPTION OF MATERIAL
1	Relatively Clean Gravel. A material the bulk of which consists of gravel. Contains a small percent of coarse sand but very little, if any, fine sand.
2	Uniform Coarse to Medium Sand. A material the bulk of which consists of coarse to medium sand. Contains little gravel and fine sand.
3	Variable - Gravel and Coarse to Medium Sand. A mixed material of which the controlling part is coarse to medium sand. Contains much gravel and little fine sand.
4	Uniform Medium to Fine Sand. A material the bulk of which consists of medium to fine sand. Contains small percent of grains larger than medium sand and smaller than fine sand.
5	Variable - Medium to Fine Sand. A mixed material of which the controlling part is medium to fine sand. Contains much coarse sand and gravel and little fine silt.
6	Uniform Fine Sand to Coarse Silt. A material the bulk of which consists of fine sand to coarse silt. Contains small percent of grains larger than fine sand and smaller than coarse silt.
7	Variable - Fine Sand to Coarse Silt. A mixed material of which the controlling part is fine sand to coarse silt. Contains much coarser sand and gravel and little fine silt.
8	Uniform Coarse to Medium Silt. A material the bulk of which consists of coarse to medium silt. Contains small percent of grains larger than coarse silt and smaller than medium silt.
9	Variable - Coarse to Medium Silt. A mixed material of which the controlling part is coarse to medium silt. Contains much sand, little gravel and fine silt.
10	Uniform Medium to Fine Silt. A material the bulk of which consists of medium to fine silt. Contains small percent of clay and grains larger than medium silt.
11	Variable - Medium to Fine Silt. A mixed material of which the controlling part is medium to fine silt. Contains much coarser silt, sand and possibly gravel and little clay.
12	Uniform Clay. A material the bulk of which consists of particles ranging from coarse clay to colloidal sizes. Contains a small percent of silt grains.
13	Variable Clay. A material composed of clay and much coarser material ranging in size from silt to coarse sand. Possesses characteristics of clay.

PROVIDENCE DISTRICT SOIL CLASSIFICATION

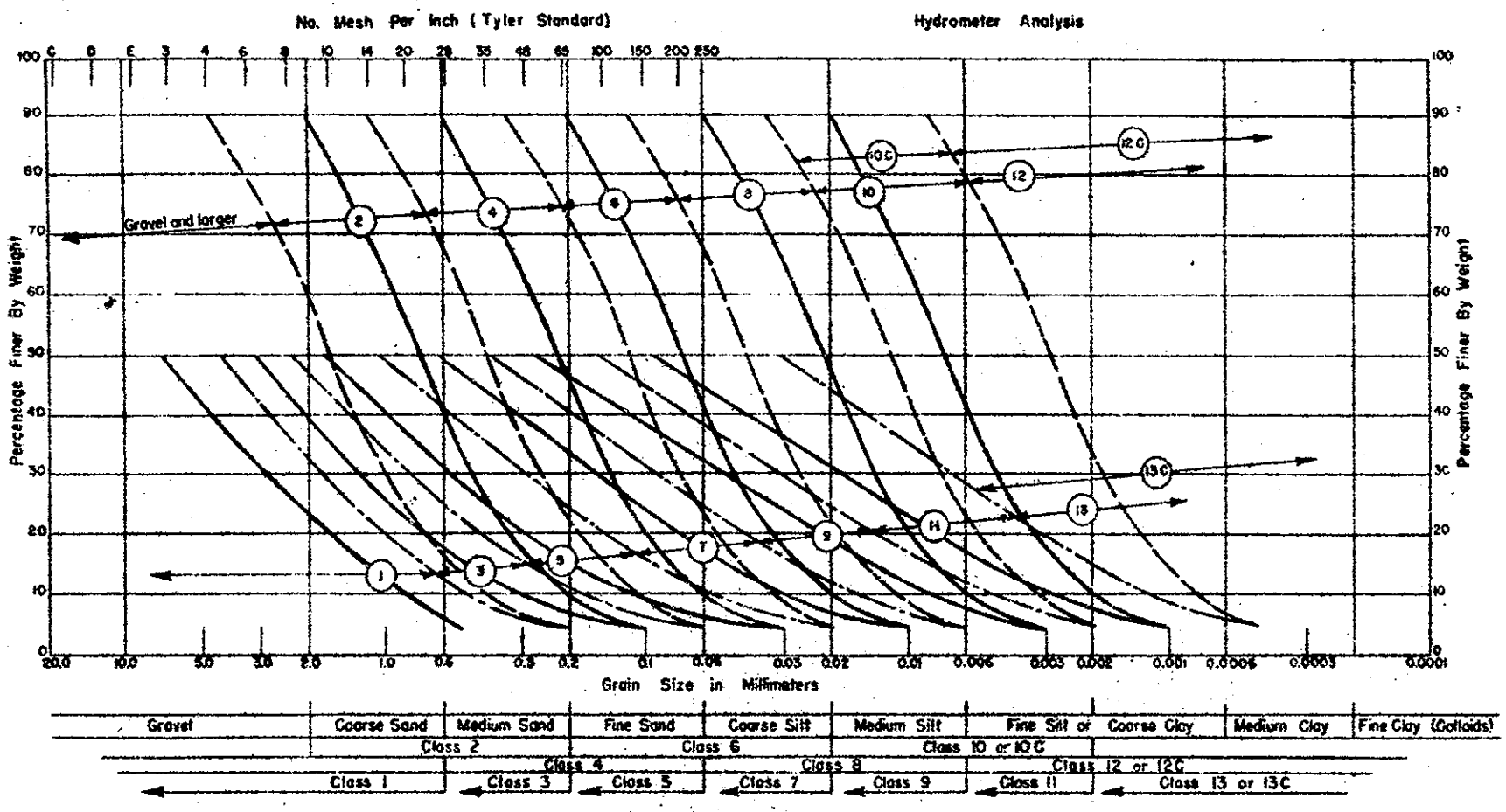

DIAGRAM SHOWING LIMITS OF SOIL CLASSES

DETAILED SPECIFICATIONS

LEVEE EMBANKMENT (Item 1)

Section 1.01. Work included. - Under Item 1, the work included shall be the clearing of the area to be occupied by the dike, borrow pits and any other ordered areas, the stripping and plowing of the area to be occupied by the dike, the loading, the transportation and placement of approved materials in the embankment, the rolling of the embankment, the placing of top soil, and seeding.

Section 1.02. Clearing and grubbing for foundations. - The area to be occupied by the dike as indicated on the drawings, together with strips two feet wide contiguous to the slope line on each side shall be prepared in the following manner:

All trees shall be cut down and removed or destroyed, together with all logs, brush, and debris of every description. The area, together with the two-foot strips, shall then be thoroughly grubbed by the removal of all stumps, roots, buried logs, and other matter that would be objectionable in the foundation for the dike. After inspection and approval the excavations made in connection with the grubbing shall be refilled with approved material.

Section 1.03. Stripping. - In the area to be occupied by the dike as indicated on the drawings all sod, top soil and other objectionable materials shall be removed by standard construction equipment to a minimum depth of one foot or as required by the District Engineer to a depth to which suitable materials for foundation are encountered. After inspection and approval of the excavation made in connection with the stripping, construction of the embankment may proceed as outlined.

Section 1.04. Plowing. - Immediately prior to placement of embankment, the entire foundation for the embankment shall be thoroughly plowed and broken to a depth of not less than six inches by plowing in furrows approximately parallel to the axis of the dike. Any roots or other debris turned up by plowing shall be removed. Plowing will be completed not less than 200 feet in advance of the embankment construction. If for any reason the foundation which is to receive fill becomes compacted before construction reaches it, the foundation shall again be thoroughly broken, as prescribed above.

Section 1.05. Filling excavation and embankment areas. - The excavation for the test pit, stump holes, and all other excavated areas within the limits of embankment, and as otherwise specified and indicated, shall be filled with approved materials. The fill in the stump holes and the test pits shall be placed in six-inch layers and thoroughly compacted.

Section 1.06. Borrow pits. (1) Local interests shall provide without cost to the United States ample and satisfactory material for placement of the embankment. Excavations in borrow pit areas shall be made as specified or directed by the District Engineer. When directed by the District Engineer top soil shall be stored for future use on the embankment. (See Section 1.07j). The borrow pits shall be left in neat and sightly condition. Slopes shall be not greater than 1 on 2 and must blend into the surrounding topography and shall be so graded that all surface water will readily drain from the areas. All top soil and other objectionable material shall be removed and disposed of as directed by the District Engineer.

(2) Borrow may be obtained by hydraulic methods from the river bed in the close proximity of the work when the material is approved by the District Engineer. If river bed material is used it shall be placed in stock piles and sufficiently dried to permit placement in accordance with Section 1.07.

Section 1.07. Embankment. - a. General Provisions. - The embankment shall be constructed to the grade and cross section providing a crown width of fifteen feet, landside slope of 1 vertical on 3 horizontal, riverside slope of 1 vertical on 3 horizontal, except as indicated on the drawings. The height will be increased as may be deemed necessary by the District Engineer to allow for shrinkage or settlement, but in no case will such increase exceed 10% of the height indicated on the drawings. The materials for embankment will be procured from the borrow pit area as designated. No brush, roots, sod, or other perishable or unsuitable materials as determined by the District Engineer, shall be placed in the embankment. The fill shall be started the full width as indicated by toe stakes and shall be brought up in approximately horizontal layers over the entire width of the cross section and throughout the entire length of the immediate section under construction. A blanket of impervious material shall be placed on the riverside face of the new dike as indicated on the drawings provided the impervious material is found in the regular borrow areas. Impervious blanket shall extend from the toe of the new slope to the top of the new crown with a minimun thickness of 3'-0" measured normal to the slope as indicated on the drawings.

b. Material. - (1) The material in the embankment other than the impervious blanket shall conform to classification 2, 3, 4 or 5, or satisfactory mixtures of these as classified in Table No. 1 and Plate No. 1 of these specifications.

(2) The material in the impervious blanket shall conform to classification 8, 9, 10 or 11, or suitable combinations thereof as classified in Table No. 1 and Plate No. 1 of these specifications.

c. Transportation and placement. - (1) Unless otherwise authorized by the District Engineer all materials for the embankments shall be hauled and placed in the fills by means of tractor and wagons, trucks or similar equipment, the travel of which, over material in place will be regulated and directed, so as to compact the fill for the entire width during the placement. After dumping, the materials shall be spread by bulldozers, fresnos, or other approved methods, in approximately horizontal layers over the compacted embankment or prepared foundation areas, not to exceed twelve inches in thickness. When authorized by the District Engineer the embankment may be placed by dragline operations.

(2) If trucks are used for the hauling and dumping, the layers shall not be greater than twelve inches in thickness before compaction. The surface of the fill shall be so maintained during construction that water will drain freely to the slopes. If the compacted surfaces of any layer of material is too smooth to bond properly with the succeeding layer, it shall be roughened or loosened by harrowing or otherwise to the satisfaction of the District Engineer before the succeeding layer is placed thereon.

(3) When the embankment is constructed by dragline operations, the material shall be deposited over the full width of the base and carried upward to full sectional area. The material shall be spread in layers not exceeding 8 inches in depth by bulldozers or other approved methods and each layer thoroughly compacted by the use of an approved tamper roller. The roller shall be drawn by a crawler type tractor of suitable power at a speed of approximately 2-1/2 miles per hour. Each layer of the fill shall be compacted by a minimum of three complete trips of the roller. Each trip of the roller shall slightly overlap the preceding or adjacent trip. The weight of the roller under working conditions shall be not less than 1100 pounds per linear foot of tread.

(4) The material in the impervious blanket shall be thoroughly compacted as outlined in subparagraph c (1) above. In event thorough compaction cannot be obtained using this procedure an approved tamper roller shall be used. Specifications and method of procedure for use of the roller are contained in subparagraph c (3) above.

d. Moisture control and compaction. - Immediately before placing and spreading of the materials for a layer, the surface of the preceding compacted layer shall be dampened. The amount of water required shall be that necessary to increase the moisture content of succeeding layers to the amount necessary to give the greatest possible compaction after rolling. The moisture content shall be sufficient to dampen the filled materials as required, but the amount of sprinkling shall be controlled so that no free water will appear on the surface during or subsequent to the rolling. When the moisture content and condition of the spread layer is satisfactory, the fill shall be compacted as described in paragraph c, above. Should the material as dumped, spread or moistened be too wet to permit the rolling necessary to obtain compaction, in the opinion of the District Engineer

the work shall be delayed until the material has dried to the required consistency. Portions of the earth fill which the roller, trucks or other compacting equipment cannot reach for any reason shall be thoroughly compacted by tamping in 2-inch layers. The dumping, spreading, sprinkling and compaction of the embankment may be carried on at the same time at different points of the embankment fill when, in the opinion of the District Engineer, there is sufficient area to permit these operations to be carried on simultaneously in accordance with the specifications. The District Engineer may require at any time that any or all of the operations cease or may require that the s everal operations be carried on consecutively if in his opinion s uch requirement is necessary to secure the desired compaction.

e. Permeability. - Every effort shall be made to construct the blanket portion of the embankment as impervious as possible. The materials shall be especially selected and the placing and compacting such as to secure the maximum compaction consistent with the materials used. In general the coefficient of permeability (Darcy's) for the blanket shall be near 1×10^{-4} cm/sec. but in no case shall it be permitted to exceed 5×10^{-4} cm/sec.

For the pervious or main portion of the embankment the coefficient of permeability of the materials as finally placed shall not be less than 50×10^{-4} cm/sec. nor greater than 300×10^{-4} cm/sec.

f. Special test requirements. - Materials as finally placed and rolled will be tested for the degree of compaction and permeability as required by these specifications. Test samples will be taken as are necessary or as directed by the District Engineer and will be tested by and at the Providence District soils laboratory in Providence, R. I.

g. Objectionable material. - No materials objectionable to the Distric Engineer shall be placed in any portion of the embankment, but disposed of as directed by the District Engineer, and satisfactory materials substituted therefor.

Should defects in the work appear, such defects shall be promptly remedied.

h. Slides. - In case of slides in any part of the embankment during the construction, the Area Engineer shall remove the material from the part affected and rebuild that portion of the dike in accordance with these specifications.

i. Frozen material. - No earth shall be placed upon a frozen surface, nor shall frozen earth, snow, or ice be placed in the embankment.

j. Placing top soil. - Where the dike material is a soil unsuitable for growing grass, the embankment shall be constructed to a sub-grade 6 inches below the finished grade and slopes. A suitable top soil shall then be placed on the crown and slopes in a quantity sufficient to complete the dike to the required section.

Section 1.08. Seeding. - The main dike and other fills, except where the area is to be used as a travelled way shall be seeded in accordance with the following subparagraphs:

a. Raking, preparing and seeding. - All grass or cover crop seeding will be sown at the earliest practicable date in the spring or at the time directed by the District Engineer so as to secure the greatest possible protection against erosion. The finished surface grade of the slopes shall be maintained in a true and even condition during the seed sowing operation and the soil shall be raked to a depth of 3/4 inch by using iron rakes immediately previous to sowing seed. All raking shall be done in a direction parallel to the contour lines on the slope and not uphill or downhill. All sticks, stone, weeds, or trash appearing on the surface shall be removed.

b. Seed mixture. - The grass seed mixture approved for the particular condition of growth in this area shall be made up in the following proportions by weight.

Domestic Rye	1 part
Red Top	1 part
Chewing's Fescue.....	1 part
Spring Rye	4 parts
White Sweet Clover.....	1 part

On northward facing or shaded portions of slopes, if required by the District Engineer, there shall be added to three parts of the above mixture one part of Rough Stalked Meadow Grass (pea trivialis). No other grass seeds or nurse crop seeds shall be sown.

All grass seeds sown shall have a minimum purity of 85%, a minimum germination rate of 80%, and a maximum weed content of 1/2 of 1%. All seed shall conform to the laws of the State of Connecticut pertaining to the same.

c. Method of seeding. - Lawn grass seed shall be sown at the rate of 100 pounds per acre. Wherever possible the seed shall be sown in two applications; one-half the seed shall be sown while the sower travels in one direction, and the other half while the sower travels in a direction at right angles to the first. After all the seed is sown, the surface shall be lightly raked with iron rakes, and then lightly rolled. All raking shall be done in the direction parallel to the contour lines on the slope.

Section 1.09. Temporary drains and ditches. - The Area Engineer shall provide such ditching as may be required to maintain the site of the work and the ground immediately adjacent to the site free from collection of surface water if such collection of water affects the safety or condition of the work.

Section 1.10. Measurement. - The measurement of all embankments shall be based on a survey made over the foundation areas immediately after stripping and grubbing have been completed. The reported quantity shall be the volume in cubic yards computed between the finished embankment lines and the foundation surface as indicated by the above-mentioned survey. No credit shall be allowed for embankment outside the ordered embankment lines. The length of the haul shall be the distance from the pit to the weighted mean of the embankment.

REMOVAL OF STOP-LOG STRUCTURE (Item 2)

Section 2.01. Stop-Log Structure. - Under Item 2 shall be included the removal and disposal of the existing stop-log structure.

Section 2.02. Removal of stop-log structure. The existing concrete stop-log structure shall be removed as indicated on the plans or as ordered by the District Engineer. Care shall be exercised not to disturb the foundation for the new structure, in removing the existing works.

Section 2.03. Disposal. - All material from the structure shall be disposed of in a spoil bank provided by the local interests.

Section 2.04. Measurement. - Credit for the work shall be on the basis of the whole item satisfactorily removed and disposed of.

EXCAVATION AND BACKFILL FOR STOP-LOG STRUCTURE (Item 3).

Section 3.01. Work included. - Under Item 3 the work shall include the excavation through whatever materials may be encountered, both above and below the water level in the river, to the ordered lines and grades or to such other lines and grades as the nature of foundation materials may require, for the concrete footings and seeprings of the stop-log structure. Necessary backfilling shall also be included under Item 3.

Section 3.02. Structure excavation. - The character, location and limits of the foundations for the work are as shown on the d rawings. If suitable materials are not found at the elevations and within the limits specified, the depth, width or character of the foundations shall be modified as directed by the District Engineer. Where only small quantities of unsuitable material are encountered, such materials shall be removed and replaced with approved materials deposited in 6-inch layers. Each layer shall be thoroughly compacted by hand tamping. The same method of filling shall be observed where the natural surface of the ground

is below the foundation line. In all cases where concrete is to be placed on earth, the bed shall be thoroughly compacted so as to leave a smooth solid surface to receive the concrete. If seepage water is present in the foundation, it shall be led to a sump in one corner of the excavation and removed by pumping or bailing.

Section 3.03. Backfill. - a. Definition. - Structure back filling as used in these specifications shall include all filling of the excavated area around concrete or other structures as prescribed by the District Engineer.

b. Materials. - Materials for back-fill shall be material approved by the District Engineer. Back-fill material shall be free from roots, brush, or objectionable material, and no frozen material shall be placed nor shall back-fill be placed on frozen surfaces.

c. Placing. - After the structures for the dikes are completed and all shoring forms and d ebris have been removed, the excavated area shall be back-filled to natural ground, or in cases where the finished structure projects above the natural ground, to graded or slope lines as directed by the District Engineer. Back-fill shall be placed in 6-inch layers and thoroughly compacted by hand tamping, or as otherwise directed by the District Engineer.

d. Filters. - Filters as indicated on Drawing CT-4-1023 shall be placed along the landside base with loads to low ground. The filters shall be of selected material of the dimensions shown and shall be hand tamped in place.

Section 3.04. Disposal of w asto excavation. - Materials designated by the District Engineer as unsuitable for backfill or embankment shall be spoiled at locations adjacent to the work. Spoil areas shall be left in neat condition and evenly dressed to blend with other topography.

Section 3.05. Measurement. - The quantity of excavation and backfill to be credited to the work shall be the volume in cubic yards computed between the

original surface of the ground and the final surfaces of the required excavation and backfill as determined by the ordered lines and grades.

CONCRETE (Item 4)

Section 4.01. Work included. - Under Item 4 the work shall include the construction of a concrete stop-log structure and any other structures of plain or reinforced concrete shown on the drawings or ordered.

Section 4.02. Quality and proportions of concrete. - a. Composition. - Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate and water so proportioned and mixed as to produce a plastic, workable mix in accordance with all requirements under this section and suitable to the specific conditions of placement.

b. Classification. - All concrete shall be of Class "B", except where otherwise specified or indicated on the drawings, or directed by the District Engineer.

c. Strength. - (1) The mixes shall be designed to secure concrete having the following compressive strengths at the age of 28 days (7 days for high-early-strength), as determined by breaking standard 6-inch diameter by 12-inch height or 8-inch diameter by 16-inch height test specimens.

Class	Minimum Average for any 25 Consecutive Cylinders	Minimum for any One Cylinder
"A"	3400 lbs. per sq. in.	2600 lbs. per sq. in.
"B"	3000 lbs. per sq. in.	2200 lbs. per sq. in.

(2) High-early-strength concrete made with high-early-strength Portland cement or other special cements shall be used only when authorized by the District Engineer. The 7-day compressive strength of concrete of any class, when made with high-early-strength cement, shall be at least equal to the above specified minimum 28-day compressive strengths for that class. All provisions of these

specifications, except for cement, shall be applicable to such concrete. Any high-early-strength cement used shall be approved by the District Engineer before use.

d. Proportioning. - (1) Basis. - All concrete materials shall be proportioned so as to produce a workable mixture in which the water content shall not exceed the maximum specified.

(2) Control. - The exact proportions of all materials entering into the concrete shall be as directed by the District Engineer. All equipment necessary positively to determine and control the actual amounts of all materials entering into the concrete shall be provided. The proportions shall be changed whenever in the opinion of the District Engineer such change becomes necessary to obtain the specified strength and the desired density, uniformity and workability.

(3) Measurement. - All materials shall be measured by weight except that water may be measured by volume when so authorized by the District Engineer. One bag of cement shall be considered as 94 pounds in weight and 1 gallon of water as 8.33 pounds.

(4) Cement content. - Each cubic yard of concrete shall contain not less than the quantity of cement stated below:

Class "A" - 5.5 bags or 517 pounds
Class "B" - 4.5 bags or 423 pounds

For concrete deposited in water, the minimum cement content shall be 6.5 bags or 611 pounds to each cubic yard of concrete in place.

(5) Water content. - In calculating the total water content in any mix, the amount of moisture carried on the surfaces of the aggregate particles shall be included. The total water content per bag of cement for each batch of concrete shall not exceed the following:

Class "A" - 5.5 gallons or 45.8 pounds
Class "B" - 6.5 gallons or 54.1 pounds

In all cases, however, the amount of water to be used shall be the minimum amount

necessary to produce a plastic mixture of the strength specified and of the desired density, uniformity and workability. In general, the consistency of any mix shall be that required for the specific placing conditions and methods of placement, and ordinarily the slump shall be between 1/2 inch and 3 inch when tested in accordance with the method stated in Section 3, paragraph 8 of North Atlantic Division Circular No. 13 dated February 24, 1937.

An increase in the maximum water content, based only on the requirements of materials added in accordance with paragraph 4.06 to improve workability will not be permitted unless comparative tests under job conditions show conclusively that such increase in water content will not result in a decrease in concrete strength and provided further that such increase does not exceed 1 gal. per cu. yd.

(6) Aggregate content. - The total volume of aggregate to be used in each cubic yard of concrete shall be that necessary to produce a dense mixture of the required workability as determined by the District Engineer.

MATERIALS.

Section 4.03. Cement. - a. Standard specifications. - Cement shall conform to Federal Specifications SS-C-206 for "Cement; Portland, Moderate-Heat-of Hardening," September 30, 1936.

b. High-early-strength Portland cement. - Cement for high-early-strength concrete shall be in accordance with Federal Specifications SS-C-201, dated September 30, 1936, for Cement; Portland, high-early-strength.

c. Special test requirements. - Cement shall be tested by the District Engineer at the Laboratory referred to in Section 4.11b hereof. Samples to be tested shall be taken either at the mills or at the work. No cement shall be used until notice has been given by the District Engineer that the test results

are satisfactory. Cement which has been stored, other than in the bins at the mills, for more than four months after being tested shall be retested before use. Ordinarily, no cement shall be used until after it has satisfactorily passed both the 7 and 28-day tests, but in cases of emergency the District Engineer may waive the 28-day tests and permit the use of cement which has satisfactorily passed the soundness and 7-day tests; provided it is the product of a quarry and mill having established a reputation of not less than 3 years' standing, for the production of high-grade cement.

Section 4.04. Fine aggregate. - a. Composition. - Fine aggregate shall be natural sand.

b. Quality. - The sand shall consist of grains or particles of quartz or other hard and durable rocks, the surfaces of which are not coated with any foreign material, nor worn smooth. The grains shall be moderately sharp, free from soft, decomposed, or partly decomposed, sand grains, lumps of clay, or ferruginous cemented sand, mica, loam, sea salts, organic matter, or other foreign materials.

c. (1) Grading. - The sand shall be well graded from coarse to fine, and when tested by means of square-mesh laboratory sieves, shall meet the following requirements.

Passing	No. 4	Sieve.....	90% - 100%
"	No.16	"	45% - 75%
"	No.50	"	10% - 25%
"	No.100	"	1.5% - 7%

(2) Deficiencies in the percentages of fine aggregates passing the #50 and #100 sieves, as required in the above graduation, may be remedied by the addition of pozzuloanic or cementitious materials, excepting Portlant cement, provided, at least 5 per cent passed the #50 sieve and the aggregate is of proper consistent gradation within the specified limits. Such added material, which

will be considered and included as fine aggregate, shall conform to the requirements in Section 4.06 and shall be in sufficient quantity to meet the minimum requirements above for percentage passing the #100 sieve and otherwise to produce the workability required by the District Engineer. The quantity and characteristics of any material used for the purpose of correcting workability shall be such that when the concrete is gaged to the proper consistency the total water content shall not exceed by more than 1 gal. per cu. yd. the minimum quantity required for proper consistency when not using the admixture. The blending of any material with the original naturally graded sand to remedy deficiency in gradation shall be accomplished in charging the mixer, unless otherwise specifically authorized by the District Engineer.

d. Deleterious substances. - The substances designated shall not be present in excess of the following amounts:

	Per cent by weight
Clay lumps	1
Material removed by decantation from aggregates not more than	3

e. Mortar strength. - Mortar specimens made with the fine aggregate shall have a compressive strength at 28 days of at least 90 per cent of the strength of similar specimens made with Ottawa sand having a fineness modulus of 2.40 + 0.10.

f. Tests. - Fine aggregate shall be subjected to careful, thorough analyses to determine conformity with all requirements of these specifications.

Section 4.05. Coarse aggregate. - a. Composition. - Coarse aggregate shall be washed gravel or crushed stone.

b. Quality. - Coarse aggregate shall consist of hard, tough and durable particles free from adherent coating. It shall contain no vegetable matter nor soft, friable, thin or elongated particles in quantities considered deleterious by

the contracting officer. The substances designated shall not be present in excess of the following amounts:

Soft fragments	5%
Clay lumps	1/4%
Removed by decantation	1%

When the material removed by decantation consists essentially of crusher dirt the maximum amount permitted may be raised to 1-1/2 per cent. Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered by the work under consideration, shall not be used. When crushed stone is used the crusher shall be equipped with a screening system which will entirely separate the dust from the stone and convey it to a separate bin.

c. Size. - (1) Coarse aggregate shall be well graded from fine to coarse so that concrete of the required workability, density, and strength can be made without the use of an excess amount of sand, water, or cement.

For Class "A" concrete, the maximum size mesh screen for the aggregate shall be not less than 3/4 inch nor more than 1 inch.

For Class "B" concrete, the maximum size mesh screen for the aggregate shall not be less than 3/4 inch nor more than 1-1/2 inches.

(2) When the maximum size mesh screen is greater than one inch the aggregate shall be separated, and the specified sizes delivered separately to individual proportioning hoppers, in accordance with the following:

For Maximum Size Mesh Screen, 1 in. to 2 in. inclusive:

(1) No. 4 to 1/2 maximum size mesh screen, inclusive.

(2) Over 1/2 maximum size to and including full maximum size mesh screen.

Within any of the above-indicated size limits, not less than 85 per cent of the material shall be retained on a standard square mesh screen of the minimum size

indicated and not more than 5 per cent shall be retained on a standard square mesh screen of the maximum size indicated.

(3). The grading of the coarse aggregate, in the mixed concrete shall fall within the following limits:

Sieve (square openings)	(Per cent by weight) Passing
1-1/2 inch	95 - 100
1 "	70 - 80
3/4 "	47 - 57
1/2 "	25 - 35
3/8 "	15 - 25
4 mesh	0 - 5

d. Tests. - Coarse aggregate shall be subjected to freezing and thawing tests and to careful, thorough analysis to determine conformity with all requirements of these specifications. Where the concrete in the finished work will be exposed to contact with aggressive soils or waters, or other destructive agents, the coarse aggregate shall be subjected to the sodium-sulphate accelerated soundness test. However, aggregate failing to pass this test may be used with the approval of the District Engineer, provided it has given satisfactory service for a period of not less than 5 years under exposure conditions similar to those to which it will be subjected in the proposed work.

Section 4.06. Material added for workability. - a. The use of any material added to the mix to improve workability, which, in the opinion of the District Engineer, may have an injurious effect on the strength, density, and durability of the concrete, will not be permitted. Before approval of any material, samples for analysis will be submitted to the Concrete Testing Laboratory (Section 4.11b). Subsequent tests will be made of samples taken from the supply of the material being used on the work to determine whether it is uniform in quality with that approved.

b. The material added shall be pozzuolanic, cementitious or silicious.

It shall not contain effective early-heat-producing elements nor compounds, such as those contained in Portland cement, nor shall its use result in a material increase in the free-lime content of the concrete. It shall also be in conformity with the following requirements:

Free moisture - a total of not more than 3 per cent by weight.
Passing #30 sieve - not less than 100 per cent by weight.
Passing #200 sieve - not less than 85 per cent by weight.

Section 4.07. Water. - The water used in mixing concrete shall be fresh, clean and free from injurious amounts of oil, acid, alkali or organic matter.

Section 4.08. Storage of Materials. - a. Cement. - Cement shall be stored in a thoroughly dry, weathertight, and properly ventilated building or barge with adequate provisions for the prevention of the absorption of moisture. Storage shall be such as to permit easy access for inspection and definite identification of each shipment.

b. Aggregates. - The fine and coarse aggregates shall be stored separately and in such manner as to avoid the inclusion of any foreign material in the concrete. Stock piles of coarse aggregates shall be built in horizontal layers to avoid segregation.

Section 4.09. Sampling and testing aggregates. - Except where provided otherwise by these specifications, all sampling and testing of aggregates will be made in accordance with the Federal specifications. Unless specified otherwise, all test samples will be supplied by the dealer at his expense, and all tests will be made by and under the supervision of the United States at its expense. Suitable samples, as they are to be used in the concrete, shall be furnished by the dealer to the District Engineer at least 30 days in advance of the time when the placing of the concrete is expected to begin.

Section 4.10. Mixing and placing. - a. Equipment at the site. (1) The District Engineer may provide at the site of the work an approved power driven mixer

in good condition of adequate size for the work, or may approve the use of truck mixed concrete from a commercial source. Adequate equipment and facilities will be provided for accurate measurement and control of all materials and for readily changing the proportions of materials to conform to the varying conditions of the work in order to produce concrete of the required uniform strength and workability.

(2) Time. - The minimum time for mixing each batch, after all materials are in the mixer shall be as follows:

1/2 cu. yd. mixer, or smaller	1-1/4 minutes
3/4 to 1-1/2 cu. yd. mixer	1-1/2 minutes

The mixer shall revolve a minimum of 12 revolutions after all materials have been placed in it, and at a uniform speed. Neither speed nor volume capacity of the mixer shall exceed those recommended by the manufacturer. Excessive overmixing, requiring additions of water to preserve the required consistency, will not be permitted.

b. Truck mixing. (1) When truck mixed concrete is approved by the District Engineer the proportioning plant shall conform to the following requirements:

The complete plant assembly, including provisions to facilitate the inspection of all operations at all times, including suitable quarters within which to prepare reports, and the adequacy and dependability of each of its parts shall be subject to the approval of the District Engineer.

The equipment shall provide adequate facilities for the accurate measurement and control of each of the materials entering the concrete.

It shall be capable of ready adjustment for compensating for the varying moisture content of the aggregates and for changing the proportionate batch weights.

It shall be capable of controlling the delivery of all materials to within one per cent by weight of the specified amounts.

It shall be arranged to permit the convenient removal of materials in excess of the specified tolerances.

It shall include a visible dial or equally suitable device which will accurately register the scale load.

The accuracy of the weighing equipment shall conform to the requirements of the U. S. Bureau of Standards and shall be tested monthly, without expense to the United States.

(2) The size of the batch shall not exceed the maximum rated capacity of the mixer as stated by the manufacturer and as stamped in metal in a prominent place on the mixer. The mixer shall be water-tight when closed. Each batch of concrete shall be mixed not less than 50 nor more than 150 revolutions of the mixer at the rate of rotation specified by the manufacturer as mixing speed. Additional mixing, if any, shall be done at a slower speed specified by the manufacturer for agitation. Except as subsequently provided, the truck mixer shall be equipped with a tank for carrying the mixer water. The water shall be measured and placed in the tank at the proportioning plant unless the tank is equipped with an automatic measuring device of the required accuracy and capable of being locked. The truck shall be equipped with a discharge chute and extension.

(3) Delivery. - Concrete shall be hauled in a water-tight container in which segregation will not take place, and from which concrete can be discharged freely, and shall be delivered to the work at the consistency specified.

(4) Time of hauling. - Concrete shall be delivered to the site of the work, and discharge from the hauling container shall be completed within a period of 45 minutes after the introduction of the mixing water to the cement and aggregates, or the cement to the aggregate when the fine aggregate contains moisture in excess of 6 per cent by weight and the coarse aggregate contains moisture in excess of 3 per cent by weight.

(5) Temperature. - Concrete delivered in outdoor temperatures lower than 40°F. (5°C.) shall arrive at the work having a temperature not less than 60°F. (15°C.), nor greater than 100°F. (38°C).

c. Conveying. - Concrete shall be conveyed from mixer to forms as rapidly as practicable, by methods which will prevent segregation or loss of ingredients. It shall be deposited as nearly as practicable in its final position. Chutes used shall be such that the concrete slides in them and does not flow. Chutes with a flatter slope than 1 on 2 will not be permitted. There shall be no free vertical drop greater than 5 feet except where specifically authorized by the District Engineer.

d. Placing. (1) Concrete shall be placed before initial set has occurred, and in no event after it has contained its water content for more than 45 minutes.

(2) Unless otherwise specified, all concrete shall be placed in the dry upon clean, damp surfaces, free from running water, and never upon soft mud, dry porous earth, frozen ground, or upon fills that have not been subjected to approved puddling or tamping so that ultimate settlement has occurred.

(3) Rock surfaces upon which concrete is placed shall be approximately horizontal or stepped, rough, and free from loose material or other matter interfering with a satisfactory bond. The rock shall be washed, scrubbed with steel brushes or brooms, and spread with a layer of mortar about 1/2 inch thick, immediately before the concrete is placed. The mortar shall be of the same cement-sand ratio as used in the concrete.

(4) The concrete shall be compacted and worked in an approved manner into all corners and angles of the forms and around reinforcement and embedded fixtures by forking or spading by hand in order to secure smooth, dense even surfaces.

(5) In dropping concrete through reinforcement, care shall be taken

that no segregation of the coarse aggregate occurs. On flat surfaces, where the congestion of steel near the forms make placing difficult, a mortar of the same cement-sand ratio as is used in the concrete shall be first deposited to cover the forms.

(6) All top surfaces not covered by forms and which are not to be covered by additional concrete or back-fill shall be carried slightly above grade and struck off by board finish (see Section 4.14), except that top surfaces of walls and piers not covered by forms and which are not to be covered by additional concrete or back-fill when poured in excess of 10 feet in height in one pour shall be carried not less than 2 inches above the specified finished elevation and struck off by board finish.

e. Construction joints. - Vertical joints shall be formed with tongue and groove bonds or keys at such locations and of such shapes and dimensions as indicated on the drawings or as approved or directed by the District Engineer. Horizontal joints shall be formed with keys, or, where horizontal pressure is always in one direction, with steps, as indicated on the drawings or as directed by the District Engineer. Where required, dowel rods shall be used. All concrete in vertical members shall have been in place not less than 12 hours before concrete in horizontal members resting thereon is placed. After the concrete in a lift has taken its initial set but prior to final set, the surface of the concrete shall be scoured clean with water or air. The time and method of using the water or air shall be such that all laitance, scum, etc., is cleaned off, and the concrete shall be cut away, where necessary, to insure a strong dense concrete at the joint. Immediately prior to placing the next pour, the surface of the concrete shall be thoroughly cleaned and roughened to secure adequate bond. The surface of the concrete shall then be spread with a 1/2-inch layer of mortar of the same cement-sand ratio as is used in the concrete, immediately before the new concrete is deposited

Where specified or otherwise required by the District Engineer for water-tight construction, copper strips not less than 18 inches in width and weighing not less than 20 ounces per square foot, properly crimped or bent, shall be placed in the concrete to span the joint.

f. Cold weather. - Concrete shall not be placed when the ambient atmospheric temperature is below 35 deg. F., nor when the concrete is likely to be subjected to freezing temperatures before final set has occurred, unless specifically authorized by the District Engineer in writing. When so authorized, the materials shall be heated in order that the temperature of the concrete, when deposited, shall be not less than 50 degrees F. nor more than 100 degrees F. Salt or other chemicals shall not be admitted into the mixture to prevent freezing.

g. Hot weather. - For concrete placed during the extremely warm summer months and otherwise, when directed by the District Engineer, the aggregates shall be cooled by frequent spraying in such manner as to utilize the cooling effect of evaporation. During such periods the placement schedule shall be arranged as approved by the District Engineer in such manner as to provide time for the temperature of the previously placed course to begin to recede. The mixing water shall be the coolest available at the site insofar as is practicable.

Section 4.11. Test specimens. - a. Number. - Test specimens to determine whether the compressive strength of the concrete is in accordance with that specified in Section 4.02 shall be taken by the inspector. At least 1 set of 3 specimens will be made for every 100 cu. yds. of concrete placed, but in any event, a sufficient number of specimens shall be taken during each pour to give a comprehensive knowledge of the concrete in each section of the work.

b. Method. - All specimens shall be taken from the concrete as it is placed in the forms and in accordance with the current specifications of the American Society for Testing Materials. The specimens shall be tested by and at

the expense of the United States, either in its laboratory known as the Central Concrete Laboratory, U.S.M.A., West Point, New York, or in that of a recognized commercial testing agency.

Section 4.12. Forms. - a. Materials. - Forms shall be of wood, steel or other approved material, except that where form lining is not specified, and unless otherwise specifically authorized, the sheeting for all exposed surfaces shall be tongue-and-groove lumber of uniform width. The type, size, shape, quality and strength of all materials of which the forms are made shall be subject to the approval of the District Engineer.

b. Construction. - Forms shall be built true to line and grade, and shall be mortar-tight and sufficiently rigid to prevent displacement or sagging between supports. Their surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed faces. Bolts and rods used for internal ties will be so arranged that, when the forms are removed, all metal shall be not less than 2 inches from any concrete surface. Wire ties shall not be permitted where the concrete surface will be exposed to weathering and where discoloration will be objectionable. All forms shall be so constructed that they can be removed without hammering or prying against the concrete. Unless otherwise indicated, suitable moldings shall be placed to bevel or round exposed edges, at expansion joints and any other joints as may be required by the District Engineer.

c. Coating. - Forms for exposed surfaces shall be coated with a non-staining mineral oil applied shortly before the concrete is placed. Forms for unexposed surfaces may be thoroughly wetted in lieu of oiling, immediately before the placing of concrete, except that in freezing weather oil shall be used.

d. Removal. - Forms shall not be removed without the approval of the District Engineer, and all removal shall be accomplished in such manner as will prevent injury to the concrete. Forms shall not be removed before the expiration

of the minimum number of days indicated below, except when specifically authorized by the District Engineer. When, in the opinion of the District Engineer, conditions on the work are such as to justify it, forms may be required to remain in place for longer periods.

Beams and slabs.....	14 days
Columns.....	7 days
Walls and vertical faces.....	2 days

Section 4.13. Finishing. - Immediately after placement, the concrete shall be properly forked back along the faces of all forms by the use of standard concrete forks or spades. The finished surfaces shall be free from voids and the plastering over of such surfaces will not be permitted. Defective concrete shall be repaired by cutting out the unsatisfactory material and placing new concrete which shall be formed with keys, dove-tails or anchors to attach it securely to the other work. This concrete shall be drier than the usual mixture and will be thoroughly tamped into place. Unless otherwise specified, all top surfaces of concrete shall have a board float finish without mortar, and shall be true to elevations as indicated on drawings. Joints shall be carefully made with a jointing tool. Every precaution shall be taken to protect finished surfaces from stains or abrasions. No fire will be kindled on concrete. Concrete surfaces, or edges likely to be injured during the construction period, shall be properly protected by leaving the forms in place, or by erecting covers satisfactory to the District Engineer.

Section 4.14. Curing. - a. Warm weather. - All concrete shall be adequately protected from injurious action by the sun. Fresh concrete shall be protected from heavy rains, flowing water, and mechanical injury. All concrete shall be kept wet for a period of not less than 14 days by covering with water, or with an approved water-saturated covering, or by a system of perforated pipes or mechanical sprinklers, or any other approved method which will keep all surfaces continuously (not

periodically) wet. Where wood forms are left in place for curing, they shall be kept wet at all times to prevent opening at the joints and drying out of the concrete. Water for curing shall be generally clean and entirely free from any elements which in the opinion of the District Engineer might cause staining or discoloration of the concrete.

b. Cold weather. - Concrete when placed during cold weather, as specified herein (see Section 4.10f) shall be subject to the provisions in subparagraph a above for warm weather curing, and in addition when placed in freezing weather shall be provided with adequate protection, subject to the approval of the District Engineer, so that the air in contact with the concrete will be maintained at temperatures between 50 degrees F. and 70 degrees F. for at least 5 days of the curing period.

Section 4.15. Embedded items. - Before placing concrete, care shall be taken to determine that all embedded metal or wood parts are firmly and securely fastened in place as indicated. They shall be thoroughly clean and free from coating, rust, scale, oil, or any foreign matter. The embedding of wood in concrete shall be avoided whenever possible. If wood is allowed, it shall be thoroughly wetted before the concrete is placed.

Section 4.16. Measurement. - Measurement of concrete shall be made on the basis of the actual volume of concrete in cubic yards within the lines of the structures as indicated on the plans or otherwise required. No deduction shall be made for rounded or beveled edges.

REINFORCING STEEL (Item 5)

Section 5.01. Work included. - Under Item 5, the work shall include the furnishing, cutting, bending, and placing, in accordance with drawings and directions, all reinforcing steel of satisfactory deformed bars, and dowels or anchors.

Steel reinforcement may be cut and bent at the mill or in the field. All bending shall be done in accordance with standard approved practice and by approved machine methods.

Section 5.02. Quality. - The bars shall be new billet intermediate grade open-hearth steel, deformed, and shall conform to the Federal Specifications No. QQ-B-71 (amended February, 1935), for "Bars, Reinforcement, Concrete, Type B, Grade 2 and Class 'A' Bars."

Section 5.03. Reinforcement steel. - All reinforcement shall be, when surrounding concrete is placed, entirely free from rust, scale, grease or other coating which may destroy or reduce its bond with concrete. All placing shall be in accordance with drawings furnished or approved by the District Engineer.

Section 5.04. Cutting and bending. - Reinforcement steel may be mill or field bent. All bending shall be in accordance with standard approved practice and by approved methods. Bar lists and bending schedules shall be included in the drawings for the work.

Section 5.05. Spacing, splicing and supports. - Spacing. - The clear distance between parallel rods shall be not less than 1-1/2 times the diameter of round rods, or twice the side dimensions of square rods, and, unless specifically authorized, shall in no case be less than 1 inch.

Splicing. - Where splices in reinforcement, in addition to those indicated, are necessary, there shall be sufficient lap to transfer the stress by bond, as may be directed. Rods shall be lapped not less than 40 diameters and splices will be staggered. The lapped ends of rods shall be separated sufficiently or connected properly to develop the full strength of the rod.

Supports.- All reinforcement shall be secured in place true to the lines and grades indicated, by the use of metal or concrete supports, spacers or ties as approved by the District Engineer. Such supports shall be of sufficient strength to

maintain the reinforcement in place throughout the concreting operation, and shall be used in such a manner that they will not be exposed on the face of nor in any way discolor nor be noticeable in the surface of the finished concrete.

Section 5.06. Protective covering. - Except where otherwise indicated, reinforcement shall be placed as follows:

(1) All main reinforcement shall be placed not less than 2 inches from any surface for walls and similar structures of comparatively thin sections exposed to the weather, and 3 inches from any surface for walls and similar structures embedded in earth.

(2) The covering of stirrups, spacer rods, and similar secondary reinforcement may be reduced by the diameter of such rods. The above dimensions shall be measured from the face of the reinforcement to the face of the forms.

(3) Protection for future use. - Exposed reinforcement intended for bonding with future work shall be protected from corrosion by painting with a heavy coat of neat cement grout.

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U. S. ENGINEER OFFICE,
Providence, R. I.
February 24, 1938.
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