CONNECTICUT RIVER FLOOD CONTROL PROJECT

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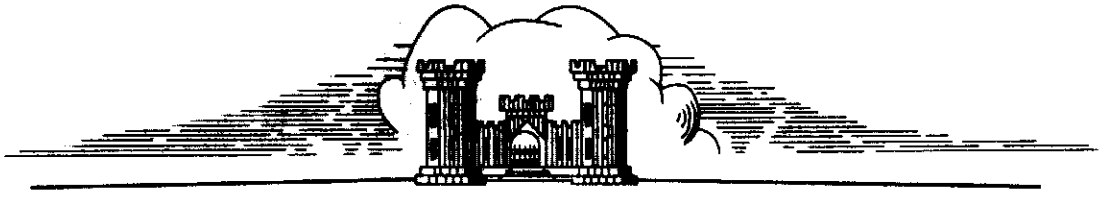
HARTFORD, CONN.

CONNECTICUT RIVER, CONNECTICUT

ANALYSIS OF DESIGN FOR LOCAL PROTECTION WORKS

FISCAL YEAR 1939 SECTION, ITEM Ht.4
CONTRACT - NORTH MEADOWS DIKE
AND STOP-LOG STRUCTURE



APRIL 1939

CORPS OF ENGINEERS, U.S. ARMY

U.S. ENGINEER OFFICE PROVIDENCE, R.I.

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CONNECTICUT RIVER FLOOD CONTROL

ANALYSIS OF DESIGN

HARTFORD DIKE

FISCAL YEAR 1939 SECTION

NORTH MEADOWS DIKE AND
STOP-LOG STRUCTURE CONTRACT

ITEM Ht. 4

CORPS OF ENGINEERS, UNITED STATES ARMY

UNITED STATES ENGINEER OFFICE PROVIDENCE, RHODE ISLAND

ANALYSIS OF DESIGN

FLOOD PROTECTION WORKS, NORTH MEADOWS DIKE, HARTFORD, CONNECTICUT

MEMORIAL BRIDGE TO STATION 122+00

PROJECT NO. Ht. 4

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NORTH MEADOWS DIKE CONTRACT Ht. 4

PERTINENT DATA

Location Connecticut River, Hartford, Connecticut

Area protected by the total North Meadows dike from Station 0+00 to Station 168+00	1,100 acres
Limits of total dike	Station 0+00 to Station 168+00
Limits of this contract	Between Station 0+00 to Station 122+00 and between Station 158+53 to Station 162+53

Elevation (Mean Sea Level)

Top of dike, Morgan Street, Station 0+00	46.0
Top of retaining wall at Morgan Street	46.0
Top of dike and stop-log structure No. 1, Station 50+70	47.0
Top of dike, Station 122+00	47.4
Top of dike, Station 135+00 to Windsor Avenue, Station 168+00	47.5
Top of stop-log structure No. 2, Station 160+53	47.5
Top of riprap in North Meadows	39.5
Top of riprap in Riverside Park	39.0 and 38.0

Embankment

Maximum height of dike	33 feet
Total length (0+00 to 122+00, 158+58 to 162+53)	12,600 feet
Total impervious embankment fill	259,000 cu. yd.
Total pervious embankment fill	987,000 cu. yd.
Total random embankment fill	201,000 cu. yd.
Grand total embankment	1,447,000 cu. yd.
Total steel sheet piling in this contract	190,450 sq. ft.

Total steel sheet piling in place from Station 58+00 to Station 122+60	206,650 sq. ft.
Total riprap (this contract)	27,100 cu. yd.
Total riprap requested by City of Hartford (this contract) - included in above items	3,050 cu. yd.
Total gravel bedding	19,300 cu. yd.
Total topsoil	51,200 cu. yd.

Concrete Retaining Wall

Type	cantilever
Maximum height of stem	15 feet
Total length	360 feet

Concrete quantities

Total	2,360 cu. yd.
Retaining wall	590 cu. yd.
Stop-log structure No. 1 (at Station 50+70)	850 cu. yd.
Stop-log structure No. 2 (at Station 160+53)	850 cu. yd.
Miscellaneous structures	70 cu. yd.

I. INTRODUCTION

I. INTRODUCTION

A. AUTHORIZATION AND PAST REPORTS. - The flood protection work from Memorial Bridge north to Station 122+00 is a part of the local protection works for the City of Hartford, Connecticut. The original project is included in the report on flood control for the Connecticut River and published as House Document No. 455, 75th Congress, 2d Session. The project is authorized under the Flood Control Act approved June 28, 1938.

B. NECESSITY FOR THE PROTECTION. - An area of approximately 1,200 acres between Memorial Bridge and Station 168+00 was inundated during the great flood of 1936. The major portion of this area is low and subject to frequent flooding. The lands comprising the westerly and southerly portions of this area are thickly settled and have numerous industrial establishments thereon. There are also included within this area several miles of the New York, New Haven and Hartford Railroad Company's main line tracks. The flood protection works covered in this analysis in combination with a section of dike at the northerly end, now under construction by hired labor force, are essential parts of the local protection works for the City of Hartford.

C. PROVISION FOR PUMPING FACILITIES. - The construction of the protection works around the area just described will prevent the natural surface drainage within the area from reaching the Connecticut River at high stages. For the purpose of discharging the accumulated surface drainage, including that from local storm run-off from within the protected area during high flows and seepage through the dikes or their foundations, a pumping station is necessary and its construction will be provided under

a separate contract and therefore will not be included in this analysis.

D. CONSULTATION WITH REPRESENTATIVES OF THE CITY AND THE RAILROAD. - Before and during the actual design of the protective works, consultations involving basic features were held with officials of the City of Hartford and the Flood Control Commission of Hartford. The New York, New Haven and Hartford Railroad Company was also consulted on details such as clearances as related to stop-log and track structures. The Hartford Flood Control Commission was represented by Mr. Charles Bennett, Consulting Engineer and Executive Secretary for the Commission, and the New York, New Haven and Hartford Railroad Company by Mr. E. E. Oviatt, Chief Engineer. The City of Hartford, through its Flood Control Commission, requested additional construction items not planned by this office to be included, all of which will be paid for by the City. Paramount above these items were additional fill to construct the dike to elevations 6 feet higher than the grade recommended by the Board of Engineers for Rivers and Harbors and additional riprap to provide a continuous riprapped slope from Willimantic Bridge north to the Springfield Division stop-log structure. Construction of a boulevard through Riverside Park, with a concrete retaining wall and a clover leaf road construction at Morgan Street, was proposed by the City as an integral part of the flood control works. The City was to contribute the difference in cost. However, the City Council failed to vote the amount necessary and the plan was abandoned. None of this extra boulevard work is, therefore, included in these protective works. The design as finally developed, meets with the approval of the City of Hartford and the New York, New Haven and Hartford Railroad Company.

E. SHORT DESCRIPTION OF THE PROTECTION WORKS. - Beginning at the northerly end of an existing wall, the same being an integral part of the Memorial Bridge abutment, a concrete wall with steel sheet pile cut-off will provide full protection for a distance of 200 feet and in combination with an earth dike for an additional 150 feet. At the end of the concrete wall, a full section of earth dike including a steel sheet pile cut-off will continue northerly to the Willimantic Division of the New York, New Haven and Hartford Railroad at which point it will bear east following the railroad embankment to a point about 450 feet from the Connecticut River. At this point the railroad tracks will be crossed by means of a stop-log structure. The dike will then continue in a general northerly direction and parallel with the Connecticut River to the section of dike now under construction which continues north and then west crossing the Springfield Division of the New York, New Haven and Hartford Railroad and ultimately terminates on high ground. At the crossing of the Springfield Division a stop-log structure is provided and will be made a part of this contract. (See Plate No. 15.) Ramps will be provided near the southerly end of the dike to afford access to Riverside Park and the existing Meadow Road from Morgan Street. Ramps will be provided for access to the pumping station and the Willimantic stop-log structure. Further ramp construction will be provided to give easy access to the stop-log structure at the Springfield Division and one other set of ramps at the request of the City of Hartford to transit the dike at a location approximating that of the existing meadow road. The total length of the earth dike protection as planned for this contract will be approximately

11,750 feet with an average height of 30 feet. The total length of protection by concrete wall is approximately 350 feet with a maximum height of 15 feet. For location and general plans see Plates Nos. 1, 13, 14, and 15. Provisions are being made in the specifications to extend the project by the same contract to Station 130+00. This extension will be made if it is found impossible to complete the project now being executed by hired labor force within the time limit scheduled for that job.

II. SELECTION OF ALIGNMENT AND TYPE OF PROTECTION

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A. OTHER ALIGNMENTS CONSIDERED. - In all, three alignments were considered. The first alignment studied followed along the west boundary of Riverside Park from Morgan Street, continued northerly through the westerly half of the meadows terminating at high ground about 1,500 feet south of the end of the selected dike. Although this alignment was the shortest of those considered, the cost, due to low swampy ground traversed, when compared with the alignment finally proposed is substantially the same, but it leaves the major portion of the meadows unprotected. The meadow area, if protected, appears to hold great promise for future development. The second alignment considered was substantially the same as the first, except that Riverside Park was included in the protected area along with the Willimantic Division of the New York, New Haven and Hartford Railroad adjacent to the park on the north. The scheme of protecting the park area was abandoned because of the size and proximity of two large ponds to the river which would have imposed extraordinary protective treatment at these points. Further, the City of Hartford was opposed to excluding the view of the river from the park, contending that by so doing the beauty of the park would be sacrificed.

B. SELECTED ALIGNMENT. - The alignment as selected embodies all of the desirable features of the other plans considered and affords the maximum of desired protection at a minimum of cost. The dike is sufficiently far back from the river to prevent any danger from erosion.

C. SELECTION OF TYPE OF PROTECTION. - Economy and available alignment width dictated the selection of an earth section, concrete walls being

too expensive. Materials for construction of an earth dike are readily available in abundance at the site. Furthermore, foundation conditions, required height of protection and available space for permanent construction make an earth structure well suited to the site. The use of a short section of concrete wall near Morgan Street is necessary because of restrictions to construction space imposed by existing structures. The stop-log structures will be constructed of concrete with timber stop logs to be installed in time of flood. Steel sheet piling will be used to effect a cut-off for the entire length of the protection.

III. GEOLOGICAL INVESTIGATIONS

III. GEOLOGICAL INVESTIGATIONS

A. SITE AND FOUNDATION CONDITIONS.

1. Nature of valley. - The dike is located on the westerly side of a broad, deeply buried pre-glacial rock valley. The lowermost extent of the rock floor is not certain, but seismic determinations have been made on the left bank of the river to a depth of 180 feet below sea level without locating rock. Except for a comparatively thin mantle of flood plain sands and silts adjacent to the river, the overburden is entirely of glacial origin. The river, in eroding these deposits, has reached a condition where it is now entrenched in broad meanders, the banks of which are not sufficiently high to restrain the river during high water. As a result the stream periodically overflows its banks and deposits additional sediment on the flood plain.

2. Method and extent of explorations. - A large number of borings along the dike alignment were made by the City of Hartford. In addition, the Providence District has completed other bore holes mainly for the purpose of checking the accuracy of data obtained by the City of Hartford. A comparison of the results of both investigations showed close agreement as to the character of foundation materials. Providence District investigations by core borings, utilizing drive sampling methods, were made (1) to check on the City of Hartford's determinations as to the character and thickness of overburden forming the dike foundations and (2) to investigate sediments in the Connecticut River as a possible source of pervious embankment material. Augor borings were used in the investigation of land borrow areas. The locations of points of exploration are

shown on Plate No. 4 entitled "Subsurface Explorations" and on Plate No. 8 entitled "Borrow Areas." The records of some of these explorations are shown on Plate No. 5 entitled "Record of Subsurface Explorations No. 5."

3. Site. - Underground conditions are similar throughout much of the North Meadows area. Periodic floods have deposited a mantle of fine sand and silt, varying in thickness from about 5 feet to 20 feet. Near the river these flood plain deposits are composed chiefly of a Class 6 soil, grading between a Class 4 and Class 8. Nearer the dike, and extending beyond, they contain considerably more silt, being made up predominantly of Class 8 and 10 material. (For classification of materials see Paragraph V B.)

The geologic sections shown on Plates Nos. 6 and 7 indicate a comparatively uniform distribution of the three principal types of overburden. Medium and coarse sands (chiefly Classes 2 and 4) occur as an intermediate moderately thick layer, below the flood plain deposits and above glacial silt and clay strata. These pervious materials extend to and outcrop in the river. Bedrock, red shale, was encountered at both ends of the proposed dike. For a considerable stretch, in the northerly section where the dike terminates in higher ground (this stretch is now under construction, the work being done by the Providence District), rock was encountered at a depth ranging from about 5 feet to 30 feet. In the southerly end, adjacent to Memorial Bridge, rock is located at a greater depth varying between 30 feet and 55 feet. Between these two stretches the rock surface is more deeply buried.

4. Nature of excavations. - Preparation of the dike foundations

will require excavations for the two toe trenches and for stripping of top-soil throughout the foundation area. Excavations for the impervious toe trench will be carried to an average depth of 6 feet. That for the rock toe drain is, in general, more shallow, the depth varying from 2 feet to 7 feet. In addition, a shallow drainage ditch will be excavated on the landside of the dike as well as lateral drains connecting the rock toe with the drainage ditch.

5. Subsurface leakage. - Seepage through the pervious Class 2 and 4 strata will be effectively stopped by construction of a sheet pile cut-off extending throughout the entire length of the dike. (See Criteria 5 and 9, Paragraph V A.)

B. BORROW AREAS. - Three borrow areas are proposed as shown on Plate No. 8 entitled "Borrow Areas." Areas A_1 and A_2, located in the bed of the Connecticut River adjacent to the dike, are the available sources of materials for pervious embankment construction. These river sediments are composed of coarse to fine sand, Classes 2 and 4, interstratified with beds of mixed materials graded from gravel to fine sand and coarse silt, chiefly Classes 3 and 5. They occur to a depth of from 5 feet to 20 feet below river bottom where they overlie unsuitable fine silt and clay deposits. The quantity available is far in excess of that required for construction. Cross sections of these areas are shown on Plate No. 9 entitled "River Cross Sections."

The pervious materials will be dredged from the river bed and disposed of on shore in stock-piles from which they will be placed in the embankment by rolled fill methods.

Borrow Areas D and E are sources of impervious and random impervious materials. Borrow Area D, in back of and adjacent to the proposed dike, is located on property already acquired by the City of Hartford. The overburden is composed of two soil types: (1) coarse and medium silt containing some fine silt (chiefly Classes 8 and 11 with minor amounts of Classes 9 and 10); and (2) fine sand and coarse silt containing some medium sand (Class 6). Type (1) is suitable for selected impervious blanket construction; type (2) is suitable only for random impervious embankment construction. The natural water content is above that necessary for maximum compaction.

Borrow Area E is the proposed storage pond excavation. The materials are very similar to those found in Borrow Area D and, as in Area D, the natural water content is above that necessary for satisfactory compaction. Approximately one-half of the excavation from Area E is suitable for impervious blanket construction, the other half being suitable only for random embankment construction. The total quantity from Areas D and E is in excess of that required for construction.

Amounts of materials available and their suitability are summarized in Table No. 1. Grain-size curves of typical materials in Areas A, D, and E are shown on Plate No. 10.

TABLE NO. 1

BORROW MATERIALS AVAILABLE

Borrow Area	Occurrence	Volume Available, Cu.Yds.	Volume Required, Cu.Yds.	Intended Use	Test Data Indicating Suitability: Classification	Natural Water Content	Optimum Water Content	Typical Grain-size Distribution
A_1 A_2	Varies between 0 - 5 feet and 0 - 20 feet	1,000,000+	987,000	Pervious section of dike	Classes 2 & 4, some 3 & 5	Under water	None	See Plate No. 10
D	Varies - generally 0 - 5 feet	250,000±	142,000	Impervious section of dike	Classes 8 & 11, some 9 & 10	20%± - 40%±	19%	See Plate No. 10
		76,000±		Random section of dike	Class 6	15%± - 45%±	15%	See Plate No. 10
E (Storage Pond Excavation)	Varies	117,000±	117,000	Impervious section of dike	Classes 8 & 11, some 9	20%± - 45%±	19%	See Plate No. 10
		118,000±	118,000	Random section of dike	Class 6	20%± - 25%±	15%	

IV. FLOOD HYDRAULICS

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A. DESIGN FLOOD. - The design flood on which the dike grade is based is the maximum predicted flood reduced by the 20 reservoirs of the Comprehensive Plan. The determination of the maximum predicted flood is discussed in Appendix 1 of "The Report of Survey and Comprehensive Plan for the Connecticut River," dated March 20, 1937. It has a peak discharge at Hartford of 318,000 c.f.s., approximately 10 per cent greater than the maximum flood of record. (See Criterion 1, Paragraph V A.)

B. FREEBOARD. - The survey report proposed a uniform freeboard of 3 feet for both concrete walls and earth embankment. This was based on consideration of wave fetch and velocity. (See Criteria 1 and 2, Paragraph V A.) The Board of Engineers for Rivers and Harbors recommended that, since the entire reservoir plan might not be effective for some time, the earth section be raised 2 feet. The design has been modified to meet this recommendation.

The City of Hartford has made flood studies and desires greater protection than that which will be offered by the dikes proposed by this office. The grades proposed by Hartford are based on a flood 25 per cent greater than the maximum flood of record and are about 6 feet higher than those proposed by this office.

The dikes will be constructed to the grades proposed by the City of Hartford which to mean sea level datum are: 47.43 at Station 122+00; 47.0 at Station 50+71; and 46.0 at Station 0+00 or Morgan Street. The City will pay the extra costs involved.

C. LOCAL CONDITIONS. - Flood stages in the Connecticut River between

Hartford and East Hartford will be increased slightly by the confinement caused by dikes at the two locations. The dike grades have been adjusted to meet this situation.

D. PUMPING REQUIREMENTS. - The natural surface drainage and storm run-off from the area inclosed by the dike, and the seepage through the dike, will have to be pumped from the protected area to the river. The pumping station which will take care of this is handled in a separate contract, and the selection of pumping capacity has been treated in the design analysis for that pumping station. (See Criterion 9, Paragraph V A.)

V. EARTH EMBANKMENT, DESIGN CRITERIA, AND LABORATORY INVESTIGATIONS

V. EARTH EMBANKMENT, DESIGN CRITERIA, AND LABORATORY INVESTIGATIONS

A. GENERAL DESIGN AND CRITERIA. - The design of the embankment is based on the standard section as adopted by the Providence District. (See Plates Nos. 16, 17, and 18.) This section consists of an impervious riverside blanket extending to and around a steel sheet piling cut-off. The steel sheet piling cut-off in turn penetrates the pervious layers of the foundation and is finally founded in impervious strata. The impervious blanket is backed up by a random section which provides a transition to the pervious section on the landside. A landside toe drain is provided which tends to hold the saturation line within the pervious section and facilitates disposal of seepage to the drainage system and pumping station. Riprap is provided on riverside slopes which will be subject to erosion, scour or wave action. This section is considered stable at sudden drawdown of the river and other adverse conditions and affords adequate resistance against seepage. The dike is designed and will be constructed to satisfy the following criteria:

1. The crest of the dike is at such a grade that there is no danger of overtopping when the design flood occurs. (Paragraph IV A and B.)

2. The freeboard is sufficient to greatly reduce the danger of overtopping by waves. (Paragraph IV B.)

3. The slopes of the dike are such that with the materials used in construction, they will be stable under all conditions. (Paragraph V B.)

4. The line of saturation is well within the landside toe (large pervious section and toe drain).

5. Water which passes through and under the dike will, when it comes to the surface, have a velocity so small that it is incapable of moving any of the material of which the dike and foundation are composed. (Paragraph III A 5.)

6. There is no possibility for the free passage of water from the riverside to the landside face of the dike (sufficient impervious blanket).

7. No material soluble in water is used in any part of the dike. (Paragraph V B.)

8. The foundation is sufficiently stable to resist undue stresses caused by the embankment load. (Paragraph V B.)

9. Seepage through the dike and foundation will be reduced to a total quantity well within economic pumping limitations. (Paragraphs III A 5, B, and IV D.)

B. LABORATORY INVESTIGATIONS. - The various soil classes recognized in the Providence Soil Classification, some of which are used in Section III, are described in Table No. 3 on Page 18 and shown graphically in Plate No. 11 entitled "Diagram Showing Limits of Soil Classes." Table No. 2 indicates the range limits of permeability for each class of overburden material. These values have been determined from laboratory tests of both undisturbed and disturbed samples. The principle use of this table is as a guide for evaluating relative permeabilities of foundation and borrow materials.

TABLE NO. 2

General Type	Class	Coefficient of Permeability	
		$k \times 10^4$ cm./sec.	$k \times 10^4$ ft./min.
Uniform	2	120 to 400	240 to 800
	4	20 to 120	40 to 240
	6	5 to 20	10 to 40
	8	1 to 5	2 to 10
	10 or 10C	0.1 to 1	0.2 to 2
	12 or 12C	less than 0.1	less than 0.2
Variable	1	greater than 1000	greater than 2000
	3	200 to 1000	400 to 2000
	5	50 to 200	100 to 400
	7	15 to 50	30 to 100
	9	3 to 15	6 to 30
	11	0.2 to 3	0.4 to 6
	13 or 13C	less than 0.2	less than 0.4

Borings and tests show that steel sheet piling cut-off should be used to prevent excessive seepage. (See Criteria 5 and 9.)

The nature of the earth materials in the foundation indicates that there will be little settlement and no lateral displacement. The superimposed load at the center line of a maximum section of dike is about 4,000 pounds per square foot, which is within the safe bearing capacity of the soil. (See Criterion 8.)

Mechanical analysis curves of typical samples of materials encountered in the contemplated borrow areas are shown on Plate No. 10.

Compaction characteristics of the proposed selected impervious and random impervious borrow materials are expressed on Plate No. 12 in terms of dry compacted weight in pounds per cubic foot and water content per cent. These characteristic curves are typical of results obtained from numerous Proctor analyses performed upon samples of each type of

material. The optimum conditions indicated by the curves are as follows:

Type of Material	Optimum Water Content, %	Maximum Dry Compacted Weight, lbs./cu. ft.
Selected Impervious	19.0	107.1
Random Impervious	15.2	106.9

Tests for maximum and minimum density were performed upon samples of the proposed free-draining material. Averages of the values obtained are as follows:

Maximum density = 114.2 lbs./cu. ft.

Minimum density = 94.4 lbs./cu. ft.

Assuming the "degree of compaction" for maximum stability to be 80 per cent, it is indicated that the most desirable density to be obtained in the embankment is 109.3 lbs./cu. ft. This was determined from the equation

$$P_v = \frac{e_0 - e}{e_0 - e_{100}} \times 100$$

in which P_v = degree of compaction, %

e = void ratio of material in embankment

e_0 = void ratio of material at minimum density

e_{100} = void ratio of material at maximum density

Values of the angle of internal friction, ϕ, as obtained by direct shear tests, are within the range 33° - 37° for all types of borrow materials encountered in the contemplated areas. (See Criterion 3.)

No material intended for the embankment is soluble in water. (See Criterion 7.)

TABLE NO. 3

PROVIDENCE SOIL CLASSIFICATION
UNITED STATES ENGINEER OFFICE
PROVIDENCE, RHODE ISLAND

CLASS	DESCRIPTION OF MATERIAL
1	Clean Gravel - Contains little coarse to medium sand.
2	Uniform Coarse to Medium Sand - Contains little gravel and fine sand.
3	Variable - Graded from Gravel to Medium Sand - Contains little fine sand.
4	Uniform Medium to Fine Sand - Contains little coarse sand and coarse silt.
5	Variable - Graded from Gravel to Fine Sand - Contains little coarse silt.
6	Uniform Fine Sand to Coarse Silt - Contains little medium sand and medium silt.
7	Variable - Graded from Gravel to Coarse Silt - Contains little medium silt.
8	Uniform Coarse to Medium Silt - Contains little fine sand and fine silt
9	Variable - Graded from Gravel to Medium Silt - Contains little fine silt.
10	Uniform Medium to Fine Silt - Contains little coarse silt and coarse clay. Possesses behavior characteristics of silt.
10C	Uniform Medium Silt to Coarse Clay - Contains little coarse silt and medium clay. Possesses behavior characteristics of clay.
11	Variable - Graded from Gravel or Coarse Sand to Fine Silt - Contains little coarse clay.
12	Uniform Fine Silt to Medium Clay - Contains little medium silt and fine clay (colloids). Possesses behavior characteristics of silt.
12C	Uniform Clay - Contains little silt. Possesses behavior characteristics of clay.
13	Variable - Graded from Coarse Sand to Clay - Contains little fine clay (colloids). Possesses behavior characteristics of silt.
13C	Variable Clay - Graded from sand to fine clay (colloids). Possesses behavior characteristics of clay.

VI. STRUCTURAL DESIGN

VI. STRUCTURAL DESIGN

A. GENERAL. - Included in the North Meadows dike are a reinforced concrete retaining wall extending from dike Station 1+08± to 4+66± and two reinforced concrete stop-log structures; one to permit the Willimantic Division of the New York, New Haven and Hartford Railroad to pass through the dike at Station 50+70.1 and the other to permit the Springfield Division of the same railroad to pass through the dike at Station 160+53.

1. Retaining wall. - The retaining wall is of the cantilever type and will retain a section of the roadway on top of the proposed North Meadows dike just north of the Memorial Bridge between dike Stations 1+08± and 4+66±.

The principal load upon the retaining wall is the horizontal earth pressure when the river is down and the cantilever type used to resist this load is the most economical under the existing conditions.

For typical cross-sections of this retaining wall, see Plate No. 16.

2. Stop-log structures. - The two stop-log structures are, in general, similar and each consists of two counterfort walls, approximately perpendicular to the railroad and in line with the North Meadows dike. Due to the unusual height of the structures, some saving in cost has been realized by placing the counterfort walls perpendicular to the railroad rather than parallel, as is the usual practice for smaller stop-log structures. A barrier of timber logs supported in vertical grooves will provide a closure between the walls.

In the case of the Springfield Division structure, the clear distance between faces of the retaining walls is too great to permit the use of logs of a practicable size. A center support in the form of a detachable bracket of the "A" frame type is provided which reduces the barrier to simple beams of one-half of the total span, reducing the depth and length of the logs to a size which can be handled easily. The center support is built of structural steel members and has a suitable concrete foundation which forms an integral part of the stop-log sill.

For the two structures, a width of concrete equal to the logs is brought to within two inches of the base of the wall, and the remaining width of sill is twenty inches beneath the base of rail to allow room for the ties and sufficient ballast to reduce impact stresses.

The principal load upon the counterfort walls is the horizontal earth and hydrostatic pressures when the river is up; that upon the stop-log barrier is the horizontal water pressure in time of flood. The timber stop-logs are to be backed with sandbags or battens at time of floods to reduce leakage.

For details of these stop-log structures, see Plates Nos. 19 to 22, inclusive.

B. SPECIFICATIONS FOR STRUCTURAL DESIGN.

1. General. - The structural design of the retaining wall and the two stop-log structures has been executed, in general, in accordance with standard practice. The specifications which follow cover the conditions affecting the design for stability, reinforced concrete, structural steel and timber.

2. Unit weights. - The following unit weights for materials were assumed in the design of the structures.

Water	62.5	pounds	per	cubic	foot
Dry earth	100	"	"	"	"
Saturated earth	125	"	"	"	"
Concrete	150	"	"	"	"
Steel	490	"	"	"	"
Timber	50	"	"	"	"

3. Earth pressures. - In computing active earth pressures, equivalent fluid pressures were computed by the use of Rankine's formula. They are as follows:

Earth, dry, equivalent liquid loading = 35 pounds per cubic foot.

Earth, saturated, equivalent liquid loading = 80 pounds per cubic foot.

In computing passive resistances, Rankine's formula was used with the coefficient of internal friction = 35 degrees.

4. Hydrostatic uplift.

a. Retaining wall. - With the river stage down below the elevation of the base of the wall, the hydrostatic uplift on the base has been assumed as full tailwater head on the landside of the sheet piling and one-half the tailwater head on the riverside of the sheet piling. The uplift has been assumed to act uniformly under the entire base.

b. Willimantic Division stop-log structure. - With a river stage assumed as high as the top of the structure, the uplift pressure on the base on the riverside of the sheet piling was assumed as full head due

to headwater. The uplift pressure on the base on the landside of the sheet piling was assumed to diminish uniformly along the base from 50 per cent of the differential head plus full tailwater head of the sheet piling to full tailwater head at the edge of the base slab.

c. Springfield Division stop-log structure. - Due to the fact that the structure rests on a rock foundation, the hydrostatic uplift, with the river stage as high as the top of the structure, was assumed to vary uniformly along the base from 50 per cent of the headwater at the riverside toe to 50 per cent of the tailwater head at the landside toe.

5. Stability. - The criterion was used that the resultant of all external loads, including hydrostatic uplift and excluding base pressure, shall fall within the middle third for all loading conditions.

6. Sliding.

a. Retaining wall. - For resistance to sliding, the criterion was used that the total horizontal forces due to external loads shall not exceed the resistance available from friction and passive resistance. The coefficient of friction to be used in such computations is 0.45.

b. Stop-log structures. - The coefficient of sliding shall not exceed 0.45 for Class 4 or 6 material.

7. Bearing. - The total bearing pressure, equal to the sum of hydrostatic pressure plus the remaining effective base pressure, shall not exceed the maximum allowable base pressure of 4,000 pounds per square foot which was determined by the District Soils Laboratory.

8. Frost cover. - All footing bases shall lie at least 4 feet

beneath the surface of the ground to avoid heaving by frost action.

9. Path of creep.

a. Retaining wall. - The steel sheet piling cut-off will be driven to a depth of about 38'-6" below the base of the wall. This is more than sufficient to take care of the path of creep. For drainage an adequate tile drain, vitrified clay, laid with open joints, will be laid in screened gravel, approximately two feet above the landside base slab for the entire length of the wall.

b. Willimantic Division stop-log structure. - A sheet pile cut-off of sufficient length to connect with impervious material will be provided.

c. Springfield Division stop-log structure. - Since the structure rests on a rock foundation, the path of creep criteria do not govern. Sheet piling, driven to rock, will be provided under the stop-log sill to prevent seepage between the two walls of the structure.

10. Reinforced concrete.

a. General design practice. - The design of the reinforced concrete was in accordance with the recommendations of the Joint Committee and the American Concrete Institute.

b. Allowable stresses. - Specifically, the working stresses used are as follows:

(1) Ultimate strength. - The allowable working stresses in concrete are based on an average ultimate compressive strength of 3,400 pounds per square inch in 28 days.

(2) Flexure. - Extreme fiber stress in compression = 800 pounds per square inch.

(3) Shear. - Without special anchorage = 60 pounds per square inch. With special anchorage = 90 pounds per square inch.

(4) Bond. - Without special anchorage = 100 pounds per square inch. With special anchorage = 200 pounds per square inch.

(5) Embedment. - Minimum embedment to develop bond = 40 diameters.

(6) Ratio of moduli of elasticity. - $E_s/E_c = n = 12$.

(7) Protective concrete covering.

In lower face of footings = 4 inches.

Other than in lower face of footings = 3 inches.

(8) Temperature steel. - Minimum steel in any exposed face is 5/8" Ø bars spaced one foot on centers.

11. Reinforcing steel. - The steel assumed to be used is new billet steel, intermediate grade, deformed bars. The effective cross-sectional areas are taken as net and the working stress used is as follows:

Tension, main steel = 18,000 pounds per square inch.

12. Structural steel. - The design of the steel structures has been governed by the standard specifications for steel construction of the American Institute of Steel Construction. Maximum allowable unit working stresses are as follows:

a. Flexure (tension or compression) = 24,000 pounds per square inch.

b. Shear = 13,500 pounds per square inch.

13. Timber. - The structural timber to be used is select white oak, surfaced four sides, and creosoted. The maximum allowable working

stresses used are high, due to intermittent use and to the probability of support by sandbags. They are as follows:

a. Flexure (tension or compression) = 1,750 pounds per square inch.

b. Shear (parallel to grain) = 156 pounds per square inch.

c. Bearing (perpendicular to grain) = 265 pounds per square inch.

C. LOADINGS. - In general, each member of the retaining walls and the stop-log structures was designed to resist the most unfavorable combination of loadings in every direction.

1. Retaining wall. - The principal load on the wall is due to the horizontal pressure from the earth dike and the equivalent earth surcharge due to the roadway on top of the dike. The stem and base of the wall were designed as simple cantilever beams fixed at the edge of support. The principal load on the stem is the horizontal pressure from the earth dike and the equivalent earth surcharge due to the roadway. The stem was also designed to resist the load resulting when the river is up to the top of the wall. The principal load on the base slab is the difference between the weights acting down and the hydrostatic and bearing pressures acting up.

2. Stop-log structures.

a. Structural action. - The structure is assumed to act as a counterfort wall resisting lateral forces in both directions and the horizontal thrust from the stop-logs when all are in place during flood. The restraint of the sheet piling to both horizontal and vertical loads

is neglected, as is the thrust which can be developed in the sill to resist overturning of the walls by earth pressures.

b. Vertical stem. - The stem is designed as a continuous beam fixed between supports to carry the differential load to earth and hydrostatic pressure to the counterforts by beam action.

c. Base slab. - The load on the base is the difference between the weights down and the bearing and uplift pressures up. The design of the riverside base slab is the same as that of the vertical stem. The landside base slab is designed as a simple cantilever supported at the stem.

d. Counterforts. - The counterforts shall be designed to take the load in tension transferred from the stem and base. The counterforts adjacent to the railroad shall be designed to take the additional load resulting when the stop-logs are in place and the river is in flood stage.

3. Stop logs. - The load on the stop logs is due to the head of the river water. They are designed as simple beams supported at the walls by special grooves. The case of the Springfield Division structure the span is reduced in half, the logs being supported at the center of the opening by a steel bracket consisting of a vertical wide flange beam with supporting members and foundation.

4. Center bracket for the Springfield Division structure. - The bracket is designed as an "A" frame to resist the load transferred to it by the stop-log barrier. The bracket is so connected that its parts can be easily handled and quickly set in place. Detachable hoists are

provided to facilitate the handling of the stop logs.

D. ARCHITECTURAL TREATMENT OF RETAINING WALL. - The retaining wall is located immediately north of the Memorial Bridge, and since a concrete railing obscures the view of the wall from the bridge, no detailed architectural treatment will be used. A coping at the top and 2'-0" wide pilasters at the expansion joints, spaced approximately 40 feet, are the only treatments used. There will be no architectural treatment of the stop-log structures.

VII. CONSTRUCTION PROCEDURE

VII. CONSTRUCTION PROCEDURE

A. SEQUENCE OF OPERATIONS. - It is assumed that construction will be started about June 1, 1939. It is estimated that it will require 485 calendar days to complete all of the work. Since it will be necessary to stock-pile the major portion of the borrow excavation to effect a reduction in water content before inclusion in the embankment structure, dredging of river sand and pond excavation will be prosecuted from the start. Concurrently with stock-piling of the various earth materials, foundation preparation, trench excavation and driving of steel sheet piling cut-off should proceed throughout the length of the proposed work. It will be required that the full length of embankment be constructed to Elevation 30, mean sea level, by December 1, 1939, or that flood protection be afforded to Elevation 30 by a temporary raise to the dike. It will also be required that all concrete be in place by December 1, 1939. Embankment closures at the concrete stop-log structures will be made as soon as possible after completion of these structures in order to insure full protection to Elevation 30 before December 1, 1939. Winter operations will be restricted to placement of riprap and such other work that may be carried on unaffected by weather. Completion of the embankment, riprapping, placement of top-soil, sodding and seeding, road surfacing, minor fills and general clean-up will be performed as soon as weather permits in the spring of 1940. All work will be completed by November 1, 1940.

B. CONSTRUCTION PERIOD. - A study of hydrographs plotted from data recorded by the United States Weather Bureau from 1917 to 1938, a total of 22 consecutive years, shows that the majority of the floods at Hartford

occur in the spring months of March, April and May. From the records it is determined that these portions of the permanent works lying below Elevation 14.0, mean sea level, will be subject to flooding at least once each year. However, the probability of high water reaching any considerable part of the protection works during the period June 1st to December 1st is small. The records show that of the 22 years studied, in only 5, flooding occurred in the above period. It was determined from the above study that it will be of prime importance to bring the permanent works to a stage of completion by December 1, 1939, as Elevation 30 or higher so that a minimum of temporary protection works would be necessary in event of high water during March, April and May of 1940.

The following schedule shows the major items of work involved, the approximate quantities and planned construction periods for each:

First Season - 1939

Item	From	To	No. of Working Days	Quantity	Average Daily Rate
Preparation of site and foundation excavation	June 1	Sept. 1	60	161,600 c.y.	2,700 c.y.
Borrow dredging	June 1	Dec. 1	150	*654,000 c.y.	4,300 c.y.
Borrow excavation	June 1	Dec. 1	150	250,000 c.y.	1,700 c.y.
Steel sheet piling	June 5	Sept. 5	60	190,500 s.f.	3,200 s.f.
Embankment	June 15	Dec. 1	140	870,000 c.y.	6,200 c.y.
Concrete structure	July 1	Dec. 1	125	2,400 c.y.	20 c.y.
Riprap	Aug. 1	Jan. 1	125	7,000 c.y.	56 c.y.
Drainage system	Aug. 1	Jan. 1	125	-	-

*This quantity includes approximately 200,000 cubic yards of material previously contracted for.

Second Season - 1940

Item	From	To	No. of Working Days	Quantity	Average Daily Rate
Borrow dredging	April 15	Aug. 15	100	333,000 c.y.	3,330 c.y.
Borrow excavation	May 1	Oct. 1	125	127,000 c.y.	1,000 c.y.
Embankment	May 1	Oct. 1	125	635,000 c.y.	5,100 c.y.
Riprap	June 1	Nov. 1	125	20,000 c.y.	160 c.y.
Drainage system	June 1	Nov. 1	-	-	-
Miscellaneous items	Sept. 1	Nov. 1	-	-	-

C. CONSTRUCTION DETAILS.

1. Preparation of site and foundation excavation. - The preparation of site consists of clearing and grubbing for the embankment and concrete structures. Removal of public utilities from the site of the work will be made by their respective owners. Foundation excavation will be closely followed by earth and concrete construction.

2. Borrow dredging. - The major portion of the pervious embankment will be obtained from the river by dredging. A contract is now in force to dredge approximately 600,000 cubic yards of river sand, a part of which, approximately 200,000 cubic yards, after being stock-piled, will be used in this contract. In addition to this quantity, the existing contract will be extended to furnish all dredged material to be used in dike construction to December 1, 1939. Dredged material required in the second season's work in excess of the quantity required in the first season will be furnished by the dike contractor.

3. Borrow excavation. - Embankment material not supplied by dredging or from foundation excavations will be supplied from a designated

impervious borrow area and pond excavation. It is assumed that this latter work will be done with shovel or dragline, but that the material must be stock-piled before use in the embankment.

4. Steel sheet piling. - The steel sheet piling will be driven to place in advance of earth or concrete construction. Steel sheet piling to be driven under the main line tracks of the New York, New Haven and Hartford Railroad will be placed under the supervision of the railroad company.

5. Embankment. - Following the operation of driving the steel sheet piling and foundation preparation, embankment will be placed and rolled by modern methods. Pneumatic tampers will be employed in all places not accessible to rolling equipment. Selection of earth materials for inclusion in the various divisions of the embankment will be in accordance with best practice and supplied from borrows and structure excavations. It is contemplated that all embankment will be in place to Elevation 30 by December 1, 1939. It is believed that this elevation involves a reasonable construction schedule and affords protection against all but the very great floods.

6. Concrete structures. - The short section of flood wall near Morgan Street will be cantilever type concrete construction having expansion joints at intervals of 40 feet. Copper water stops and expansion joint materials will be used to effect continuous watertight protection. The stop-log structures to be provided at the railroads are of counterfort type concrete construction having a sill slab immediately below the track to cap off the steel sheet piling. Temporary steel sheet piling

will be provided adjacent to the tracks to retain railroad embankment from structure excavations.

7. Riprap. - It will be desirable to have the riprap protections follow embankment construction closely so that at the close of the first season's work full protection will be effective to Elevation 30.0. The rock will be well bedded in gravel and be secured by tightly driven spalls.

8. Drainage systems. - The drainage systems consist of pipe, concrete and rock structures. Construction of the drainage systems will progress as rapidly as practicable to avoid excessive construction of temporary drainage structures.

9. Miscellaneous items. - The miscellaneous items consist of sodding and seeding, road surfacing and general clean-up of the site. Sodding and seeding will be done in accordance with recommended practice and careful attention will be given the areas treated through the early stages of growing. Road surfacing will not be placed until all of the work in close proximity has been completed. The new surface will not be traveled upon by heavy construction equipment.

D. LABORATORY AND FIELD TESTS DURING CONSTRUCTION.

1. Embankment construction. - The Soils Laboratory at Providence, Rhode Island, and the field soils laboratory at Hartford, Connecticut, will perform the necessary tests to investigate and record the characteristics of the types of soil used in construction. Tests will be performed to determine the mechanical classifications of soils, water contents and density of material in place and compaction characteristics of borrow

material. Supplementary shear and permeability tests will also be made.

The embankment will consist of three types of materials, impervious, random and pervious fill. All ramps will be built of pervious material on the landside and impervious material on the riverside. Screened gravel as used for the toe drain and bedding for riprap will be obtained from commercial sources and will not be subject to rigid laboratory tests.

The types of materials intended for embankment fill and their placement will be subject to close control before and during construction. It will also be required that the equipment used in the construction of the embankment will be maintained in good operating condition at all times.

2. Concrete construction. - Materials used in the making of concrete will be tested at the Central Concrete Testing Laboratory, West Point, New York. The field tests will principally be used for control of the quality of concrete during construction. Facilities will be available for grading the aggregates, designing mixes, making of slump tests and for casting and curing concrete cylinders for compression tests.

Cement will be tested by a recognized testing laboratory and results of these tests will be known before the cement is used; only one brand will be used throughout at each location. Fine and coarse aggregates will be obtained from approved commercial sources. The amount of water used for each batch of concrete will be predetermined; it will, in general, be the minimum amount necessary to produce a plastic mixture of the strength specified. Storage of cement and aggregates, mixing and placing of concrete as well as placing of reinforcement steel will be supervised and directed by Government inspectors.

VIII. SUMMARY OF COST

VIII. SUMMARY OF COST

The total construction cost of the Hartford North Meadows dike, from Station 0+00 at Morgan Street to Station 122+00 and between Station 158+53 and Station 162+53, including structures in place between Station 58+00 and Station 122+00, has been estimated to be $1,814,000 which includes 10 per cent for contingencies and 15 per cent for engineering and overhead. This summary does not include the cost of a pumping station or the relocation of existing public utilities. The total estimated cost of the work involved under this contract is $1,470,000 including 10 and 15 per cent.

There follows a list of the major divisions of work involved and their relative costs:

1.	Excavation	$ 151,000	
2.	Embankment	777,000	
3.	Concrete features	70,000	
4.	Drainage systems	20,000	
5.	Steel sheet piling	243,000	
6.	Riprap, hand placed	195,000	
7.	Miscellaneous	14,000	
	Subtotal		$1,470,000
8.	Structures in place from Station 58+00 to Station 122+00		344,000
	Total		$1,814,000

1. The item of excavation covers all excavation necessary for concrete and pipe structures, drainage ditches, storage pond and miscellaneous.

2. The embankment item includes all borrow excavation and fill for

the dike structure with cut-off trench and toe drains, including such other items as topsoil, sodding and seeding, all road surfacing, ramp and road construction and all structure backfilling.

3. The item of concrete features includes all cement, concrete and imbedded items such as reinforcing steel and copper water stops.

4. The drainage systems include the estimates on tile pipe, reinforced concrete pipe, corrugated iron pipe, grouted stone gutters, brick manholes and all costs incidental to furnishing and placement.

5. Steel sheet piling includes the estimates of furnishing and driving the piling.

6. The item of hand placed riprap includes gravel bedding, furnishing and placing the rock for riprap.

7. The miscellaneous item covers estimates for preparation of site, timber logs and all estimates of work not included under Items 1 to 6, inclusive, as shown above.

8. This item indicates the estimated costs of structures now in place between Station 58+00 to Station 122+00 which consist of all stripping in this area, cut-off trench excavation, steel sheet piling and stock-piling of approximately 200,000 cubic yards of river sand.

IX. PLATES

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7	Geologic Sections No. 2
8	Borrow Areas
9	River Cross Sections
10	Mechanical Analysis
11	Diagram Showing Limits of Soil Classes
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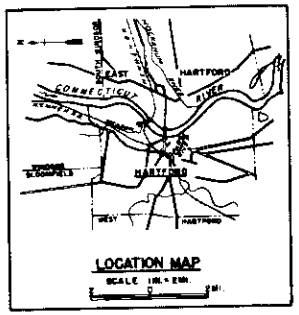
23	District Organization Chart

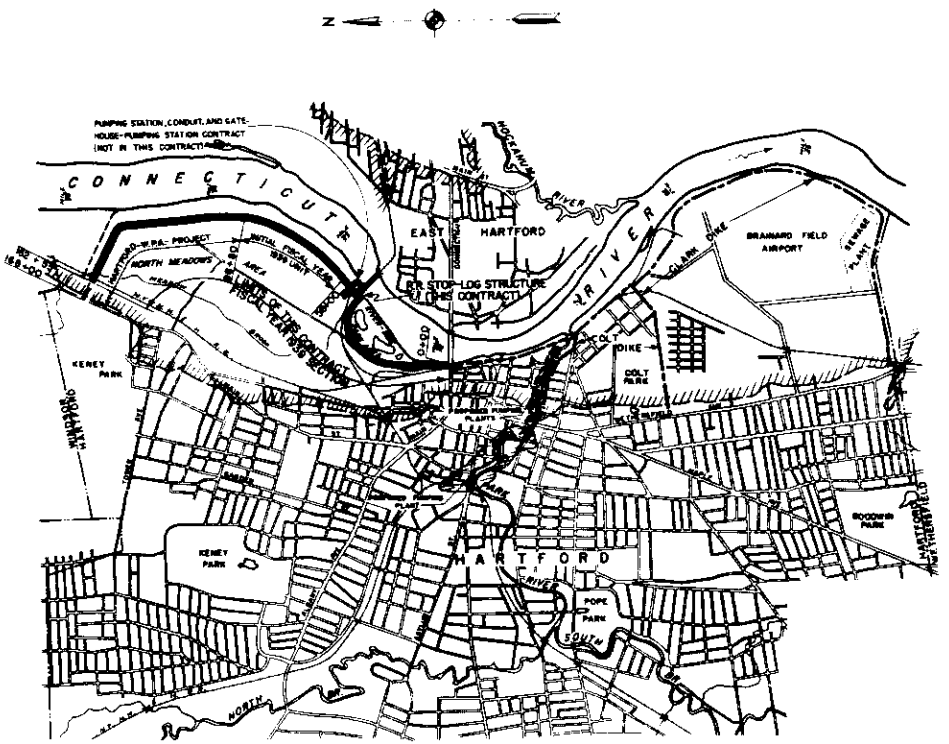
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY.



LOCATION MAP

SCALE 1 IN. = 2 MI.



VICINITY MAP

SCALE 1" = 2000'

LEGEND

Proposed Project

Present Dike

Future Construction

Overflow Limits of the March 1936 Flood

Hartford-W.P.A.-Project

DATE	REVISION	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

PROJECT LOCATION AND INDEX

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 66 SHEETS — SCALE 1 IN = 2000 FT. — SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R.I., APRIL 1939

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.

APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER

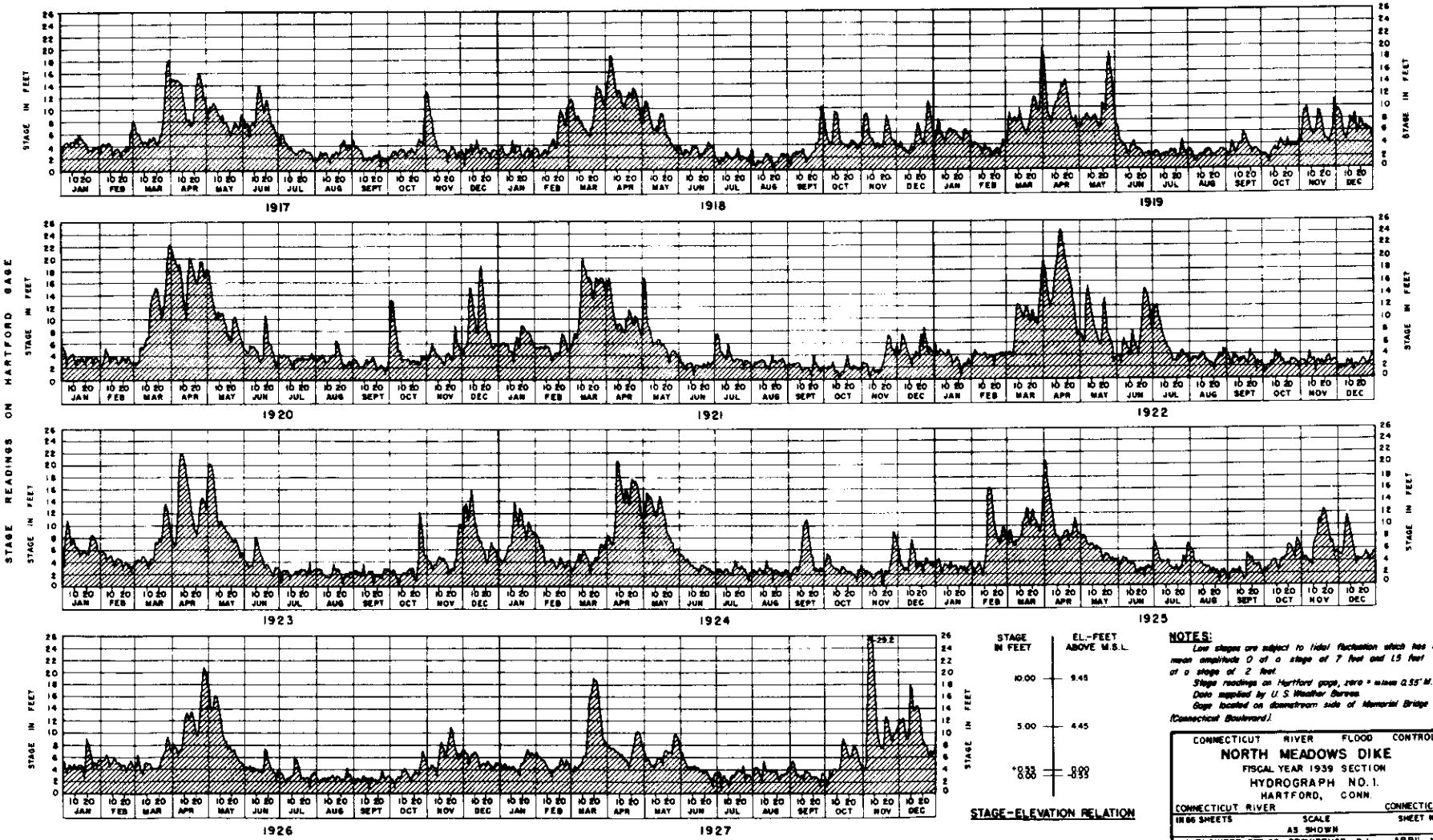
DRAWN BY: A.T. TRACED BY: R.S.S. CHECKED BY: NOE

FILE NO. CT-4-1440

PLATE NO. 1

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY.



STAGE-ELEVATION RELATION

NOTES:

Low stages are subject to tidal fluctuation which has a mean amplitude 0 at a stage of 7 feet and 1.5 feet at a stage of 2 feet.

Stage readings on Hartford gage, zero = minus 0.55' M.S.L.

Data supplied by U. S. Weather Bureau.

Gage located on downstream side of Memorial Bridge (Connecticut Boulevard).

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

HYDROGRAPH NO. 1.

HARTFORD, CONN.

CONNECTICUT RIVER CONNECTICUT

IN 66 SHEETS SCALE AS SHOWN SHEET NO. 2

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., APRIL 1939

SUBMITTED: ENGINEER, HEAD, HYDRAULICS SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.

APPROVED: DIST. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASSOC. ENGINEER

DRAWN BY: W.V.V. & F.C.T.

TRACED BY: F.J.G.

CHECKED BY: W.C.H.

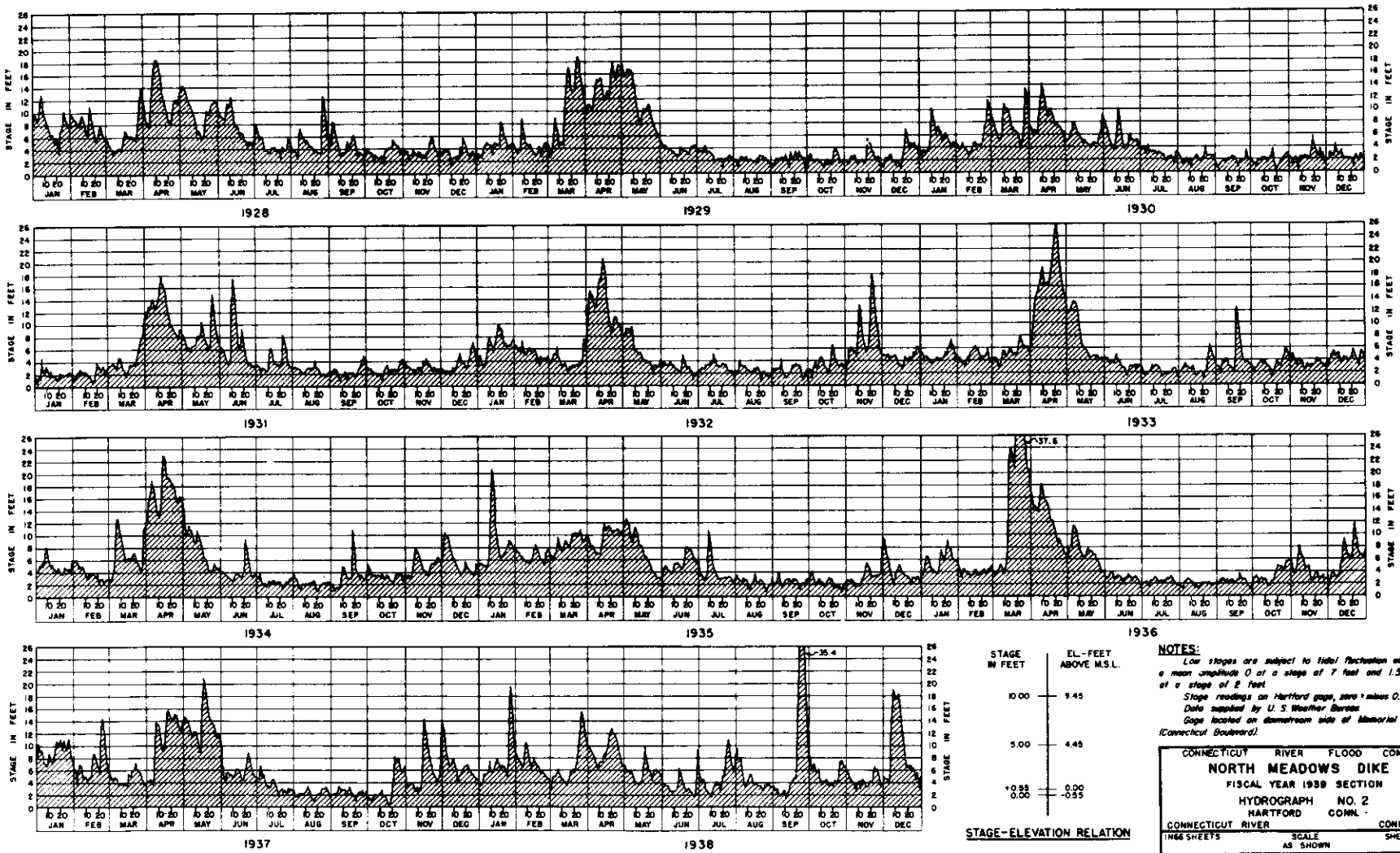
FILE NO. CT-3-1093

DATE	REVISION	REV. BY	CK. BY	AP. BY

PLATE NO. 2

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



STAGE IN FEET	EL.-FEET ABOVE M.S.L.
10.00	9.45
5.00	4.45
+0.55	0.00
0.00	-0.55

STAGE-ELEVATION RELATION

NOTES:

Low stages are subject to tidal fluctuation which has a mean amplitude 0 at a stage of 7 feet and 1.5 feet at a stage of 2 feet.

Stage readings on Hartford gage, zero = minus 0.55' M.S.L.

Data supplied by U. S. Weather Bureau.

Gage located on downstream side of Memorial Bridge (Connecticut Boulevard).

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

HYDROGRAPH NO. 2

HARTFORD CONN.

CONNECTICUT RIVER CONNECTICUT

1N66 SHEETS SCALE AS SHOWN SHEET NO. 3

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., APRIL 1939

SUBMITTED: John B. Drisko, ENGINEER, HEAD, HYDRAULICS SECTION

APPROVAL RECOMMENDED: PROJECT ENGINEER, CHIEF, F.C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: Kenneth H. Kittelsen, ENGINEER

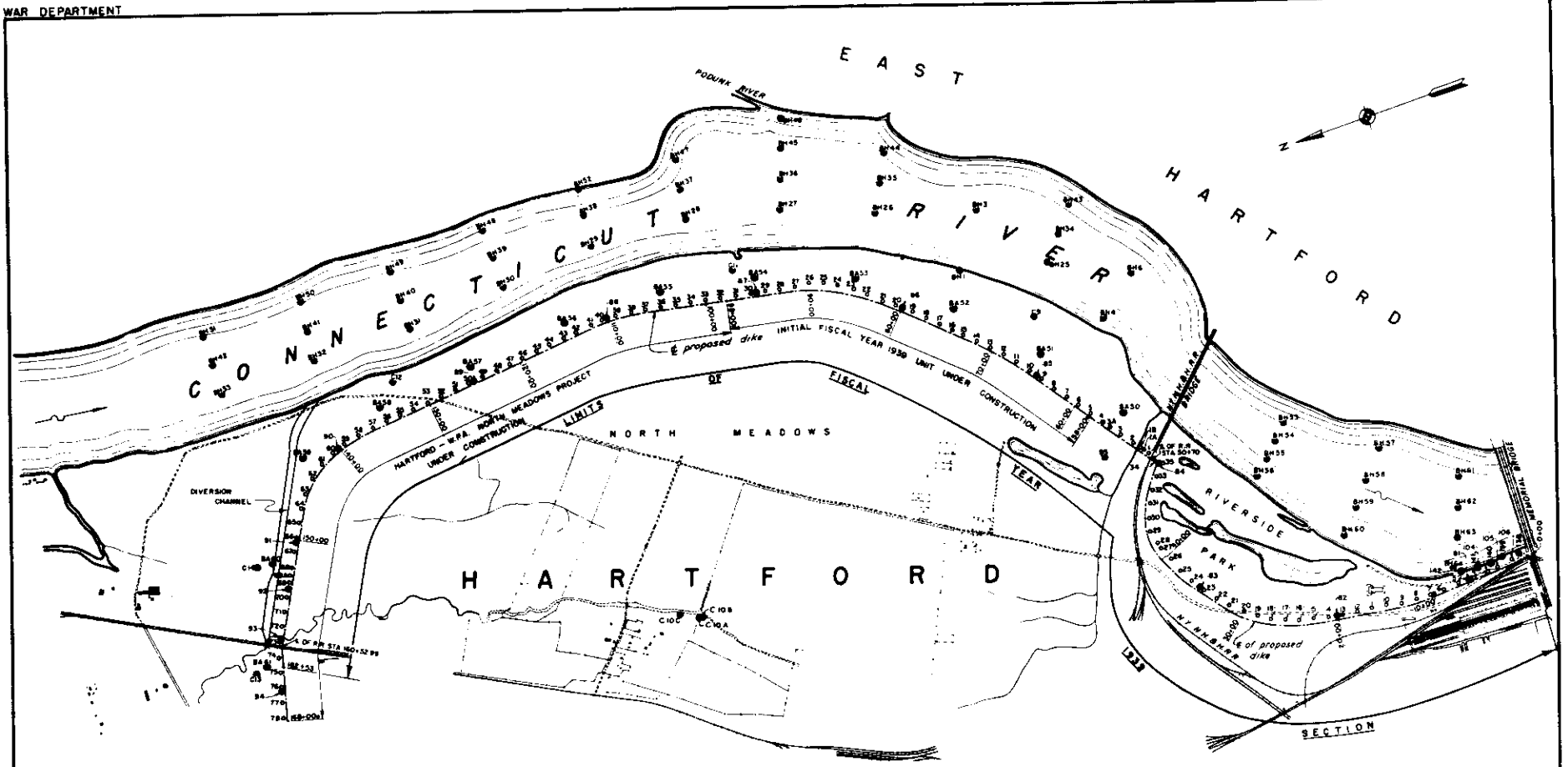
DRAWN BY: W.W.V. & F.C.T.
TRACED BY: W.H.M.
CHECKED BY: MCN

FILE NO. CT-3-1094

PLATE NO. 3

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTE:

For records of U.S.E.D. core borings (except BH 138 thru BH 142) and auger borings see Sheet No.5.
For records of Hartford borings in Riverside Park (Sta. 0+0 to Sta. 50+70) see Sheet No.6.
For records of Hartford borings between Sta. 50+70 and Sta. 108+00 see Sheet No.7.
For records of Hartford borings between Sta. 108+00 and Sta. 168+00 see Sheet No.8
For records of U.S.E.D. core borings BH 138 thru BH 142 see Sheet No.9

LEGEND

○ Core Borings by City of Hartford. (Records on Sheets No. 6, 7 & 8.)
● Core Borings by U.S.E.D. (Records on Sheets No. 5 and 9.)
● Auger Borings by U.S.E.D. (Records on Sheet No. 5.)

DATE	REVISION	REV BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

SUBSURFACE EXPLORATIONS

HARTFORD, CONN.

CONNECTICUT RIVER, CONNECTICUT

IN 66 SHEETS — SCALE: 1 IN. = 500 FT. — SHEET NO. 4

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., APRIL 1939

SUBMITTED: Chief, Soils Section — APPROVED & RECOMMENDED: Chief, Engineering Div. — APPROVED: District Engineer

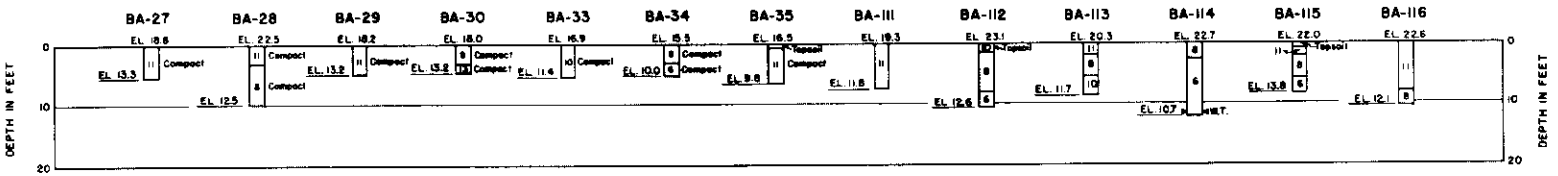
COMPILED: Asst. Engineer — DRAWN BY: F.S. — TRACED BY: S.G.P. - I.S.W. — CHECKED BY:

FILE NO. CT-2-1140

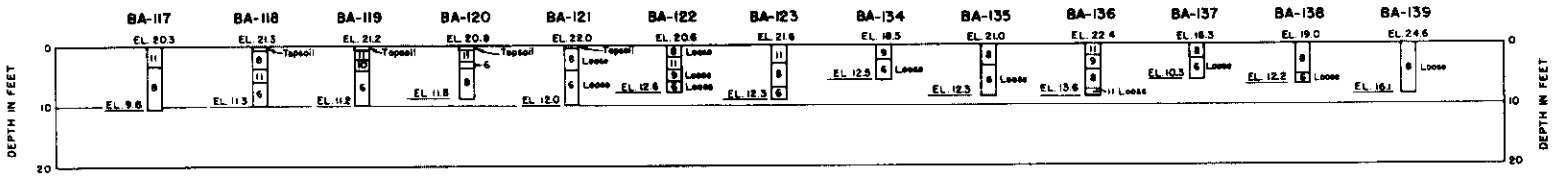
PLATE NO. 4

WAR DEPARTMENT

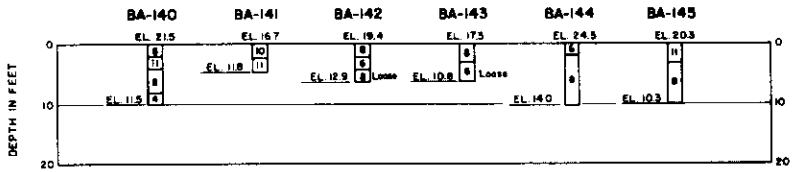
CORPS OF ENGINEERS, U.S. ARMY



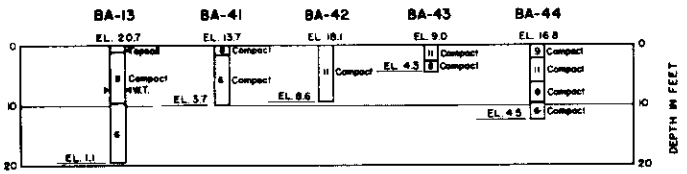
BORROW AREA D



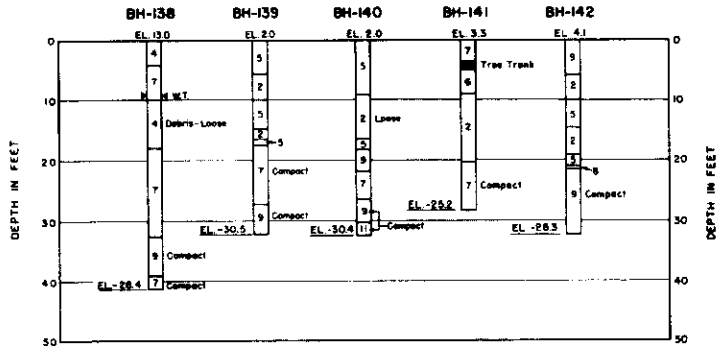
BORROW AREA D



BORROW AREA D



BORROW AREA E



BORINGS ADJACENT TO MEMORIAL BRIDGE

NOTES:

Elevations refer to M.S.L. datum.
For locations of core borings see Sheet No. 4 (Symbol-◉)
For description of numerical classes see Sheet No. 6
For locations of auger borings see Sheet No. 11 (Symbol-◉)
Water table elevation coincides with bottom of auger boring unless otherwise indicated.
Borings shown on this sheet made by Providence District, U.S.E.D.

LEGEND:

BH *Core boring*
BA *Auger boring*
H/H W.T. *Water Table at time of exploration*

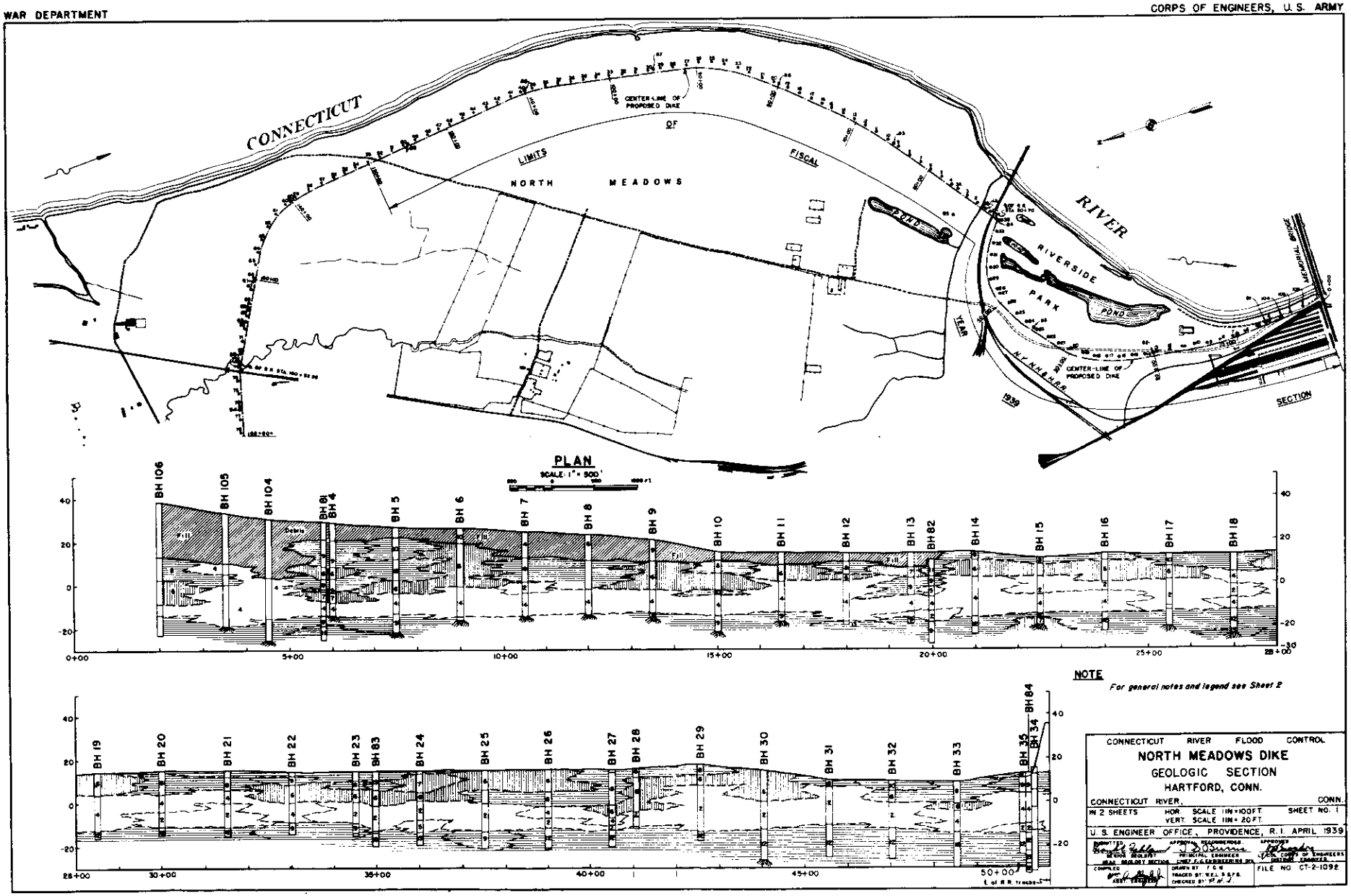
DATE	REVISION	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL
NORTH MEADOWS DIKE
FISCAL YEAR 1939 SECTION
RECORD OF SUBSURFACE EXPLORATIONS NO. 5
HARTFORD, CONN.
CONNECTICUT RIVER — CONNECTICUT
IN 66 SHEETS — VERT. SCALE: 1 IN = 10 FT. — SHEET NO. 9
U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — APRIL 1939
SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION
APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV.
APPROVED: LEGAL CORPS OF ENGINEERS, DISTRICT ENGINEER
COMPILED: ASST. ENGINEER
DRAWN BY W.F.B.
TRACED BY R.B.
CHECKED BY P.H.J.
FILE NO. CT-2-1135

PLATE NO. 5

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NOTE

For general notes and legend see Sheet 2

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

GEOLOGIC SECTION

HARTFORD, CONN.

CONNECTICUT RIVER, CONN.

IN 2 SHEETS HOR. SCALE 1IN = 100 FT. VERT. SCALE 1IN = 20 FT. SHEET NO. 1

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. APRIL 1939

SUBMITTED: SENIOR GEOLOGIST, HEAD GEOLOGY SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF F.C. ENGINEERING DIV.

APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

DRAWN BY: F. C. H.
TRACED BY: W.E.L. & S.F.B.
CHECKED BY: P.H.J.

FILE NO. CT-2-1092

PLATE NO. 6

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY

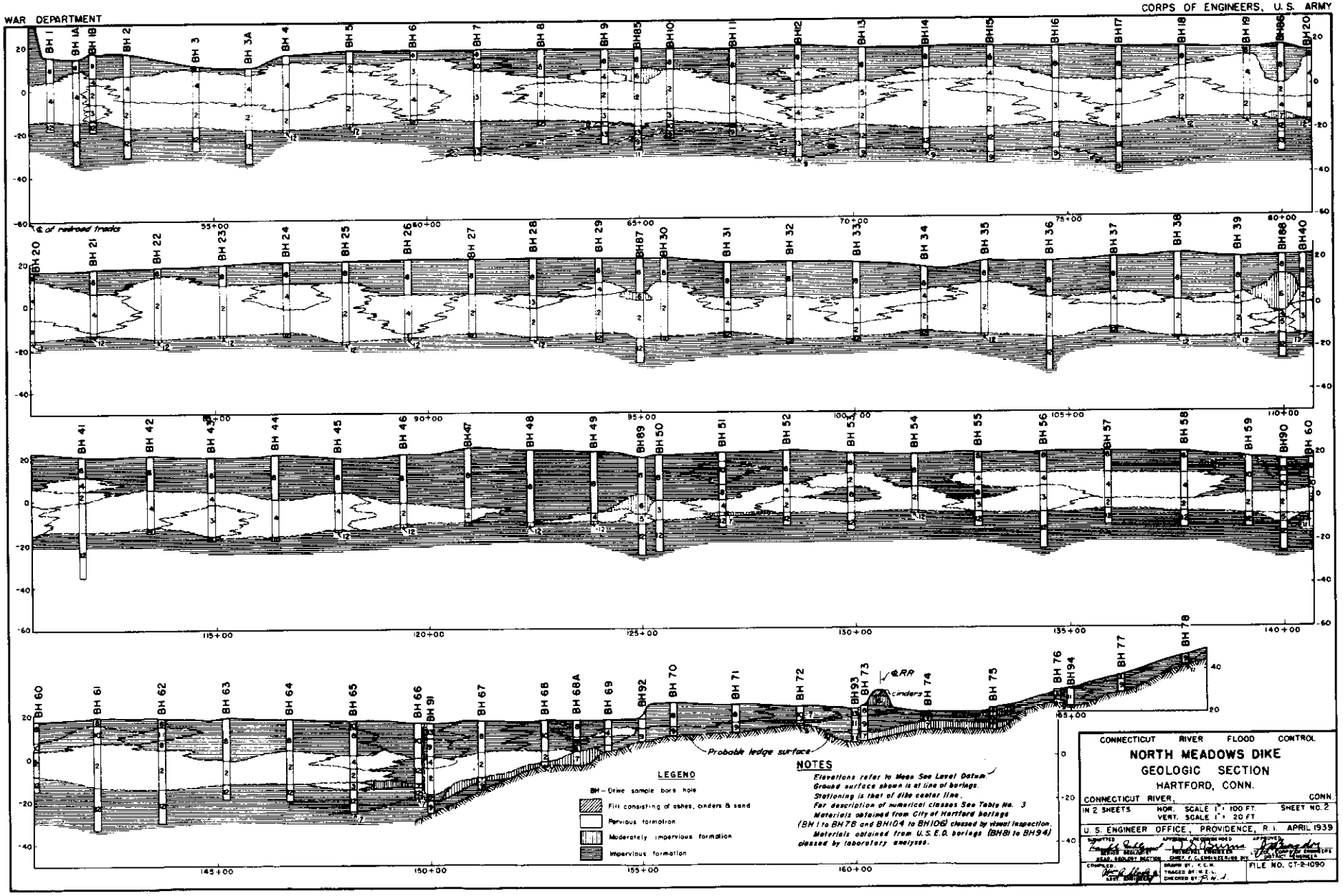
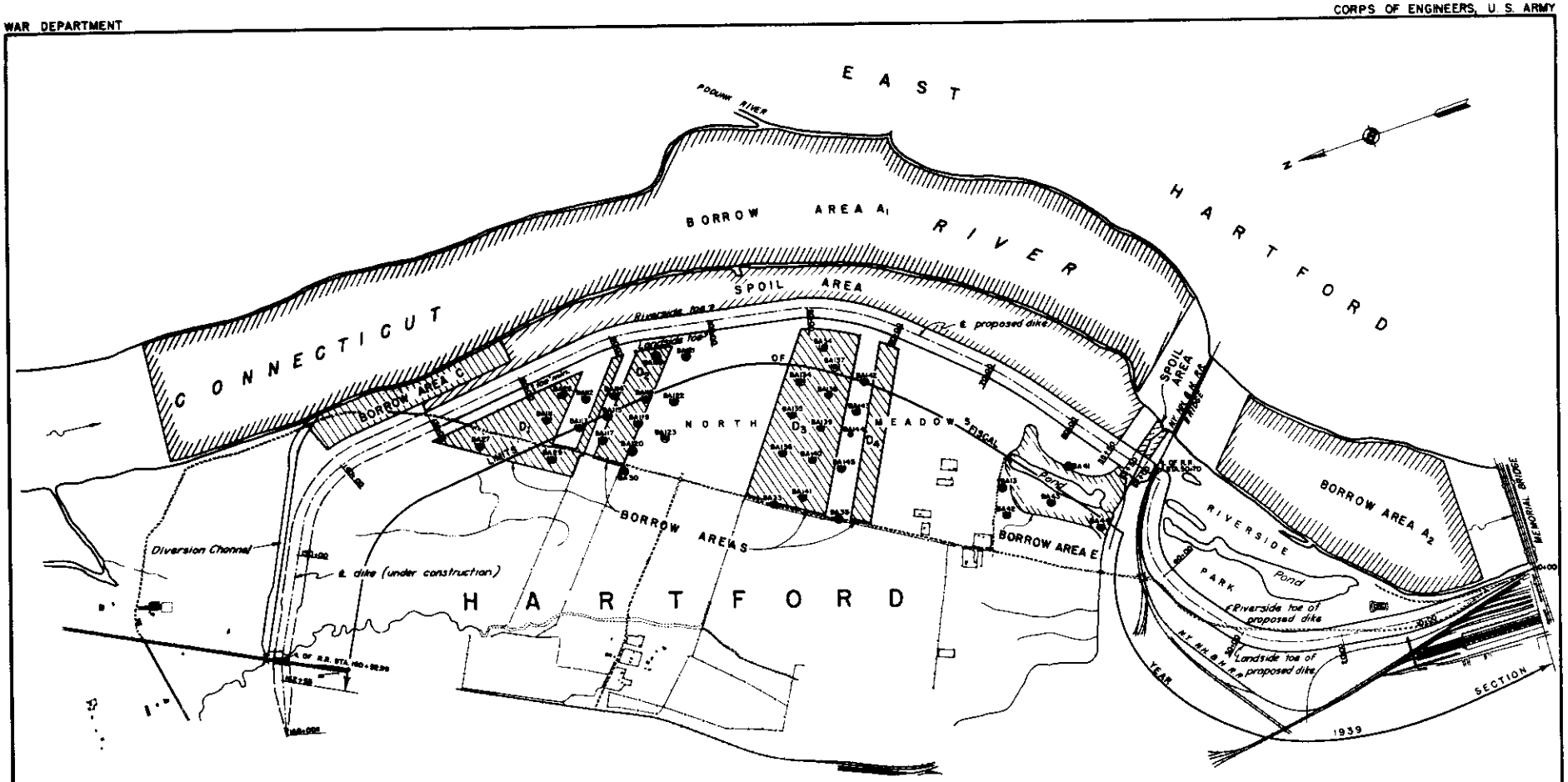


PLATE NO. 7

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



BORROW AREAS A_1 & A_2	BORROW AREAS $C-D_1-D_2-D_3-D_4$	BORROW AREA E
Permissible source of pervious embankment materials. River sediments composed of beds of coarse to fine sand interstratified with beds of mixed materials graded from gravel to fine sand and coarse silt. Suitable materials occur to a depth ranging from 5 to 20 feet below river bottom level where they overlie unsuitable fine silt and clay deposits.	Permissible borrow areas for impervious and random impervious embankment materials. Located on property acquired by City of Hartford. Overburden composed of two soil types (1) coarse and medium silt containing some fine sand and fine silt, and (2) fine sand and coarse silt containing some medium sand. Type (1) is suitable for selected impervious blanket construction. Type (2) is suitable only for random impervious embankment construction. Water table ranges in depth from 5 to 10 feet. Natural water content of type (1) above that necessary for satisfactory compaction.	(STORAGE POND EXCAVATION) Permissible source of impervious and random impervious embankment materials. Overburden composed of two soil types (1) coarse and medium silt containing some fine sand and fine silt, and (2) fine sand and coarse silt containing some medium sand. Type (1) is suitable for selected impervious blanket construction. Type (2) is suitable only for random impervious embankment construction. Water table ranges in depth from 5 to 10 feet. Natural water content of types (1) and (2) above that necessary for satisfactory compaction.

NOTE

For record of auger borings see Sheet No. 9.

LEGEND

● *Auger Boring by U.S.E.D.*

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

BORROW AREAS

HARTFORD, CONN.

CONNECTICUT RIVER, CONNECTICUT

IN 66 SHEETS SCALE 1 IN = 500 FT. SHEET NO. 11

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., APRIL 1939

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION

APPROVAL RECOMMENDED: MUNICIPAL ENGINEER, CHIEF, F. C. ENGINEERING DIV.

APPROVED: COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER

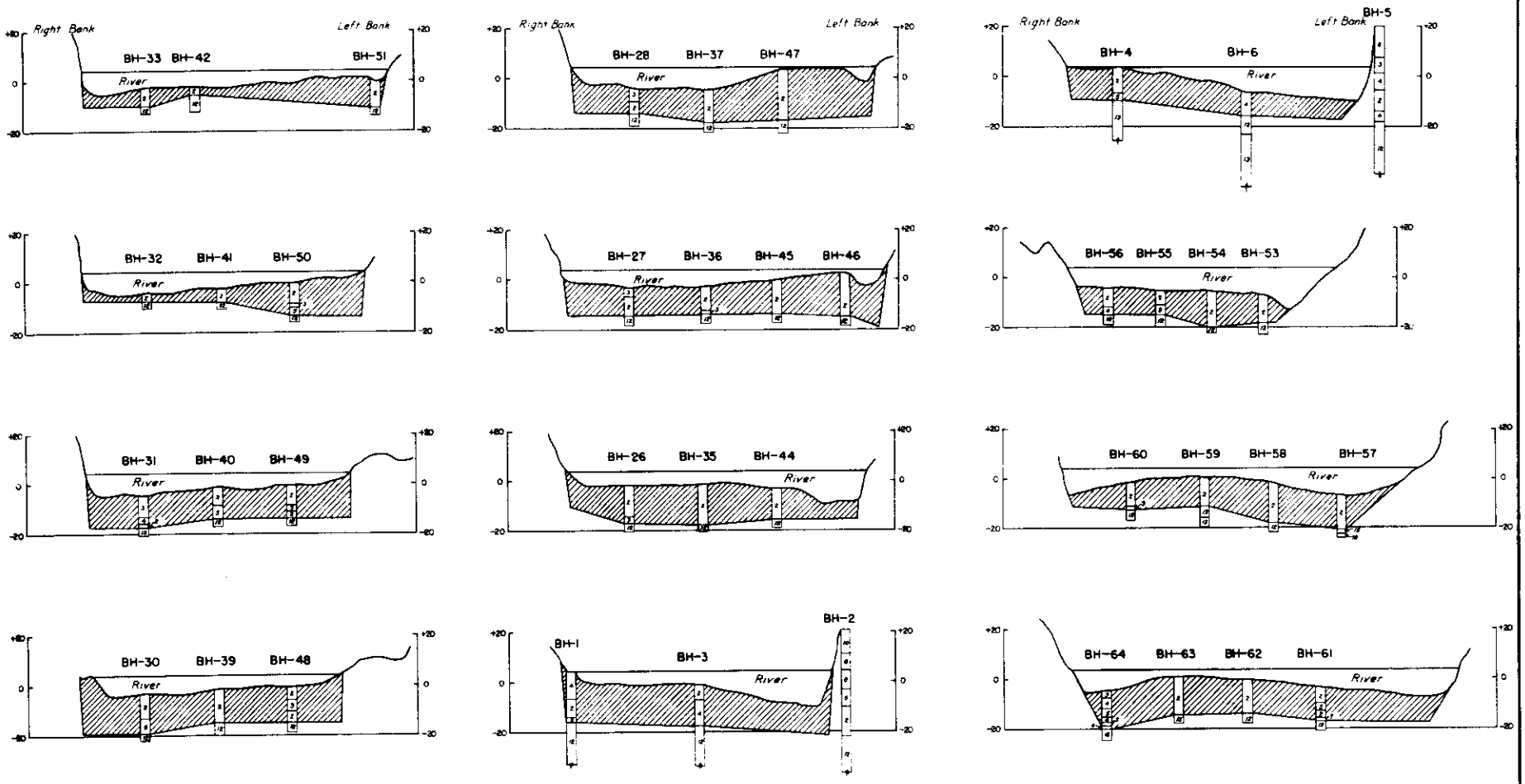
DRAWN BY: W. F. S.
TRACED BY: L.A.D.-I.C.W.
CHECKED BY: T. H. S.

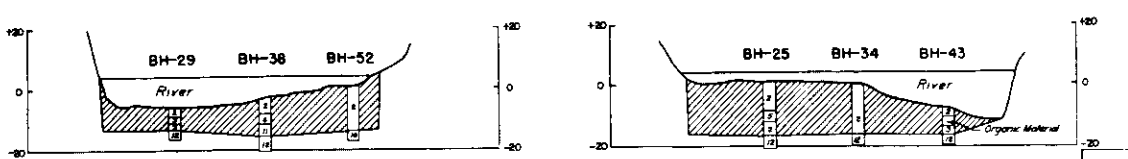
FILE NO. CT-2-1105

PLATE NO. 8

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY.





NOTES:

Elevations refer to Mean Sea Level Datum.
For location of borings see sheet No. 4
For description of numerical classifications see Sheet No. 6
Cross hatched areas show limit of borrow

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

RIVER CROSS SECTIONS

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 66 SHEETS — HORIZONTAL SCALE: 1 IN = 200 FT — SHEET NO. 10

VERTICAL SCALE 1 IN = 20 FT.

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. APRIL 1939

SUBMITTED: SENIOR GEOLOGIST, HEAD, GEOLOGY SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. ENGINEERING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER — DRAWN BY: W.A.S. TRACED BY: L.A.D. CH. ANCL. CHECKED BY: P.H.J.

FILE NO. CT-2-1145

PLATE NO. 9

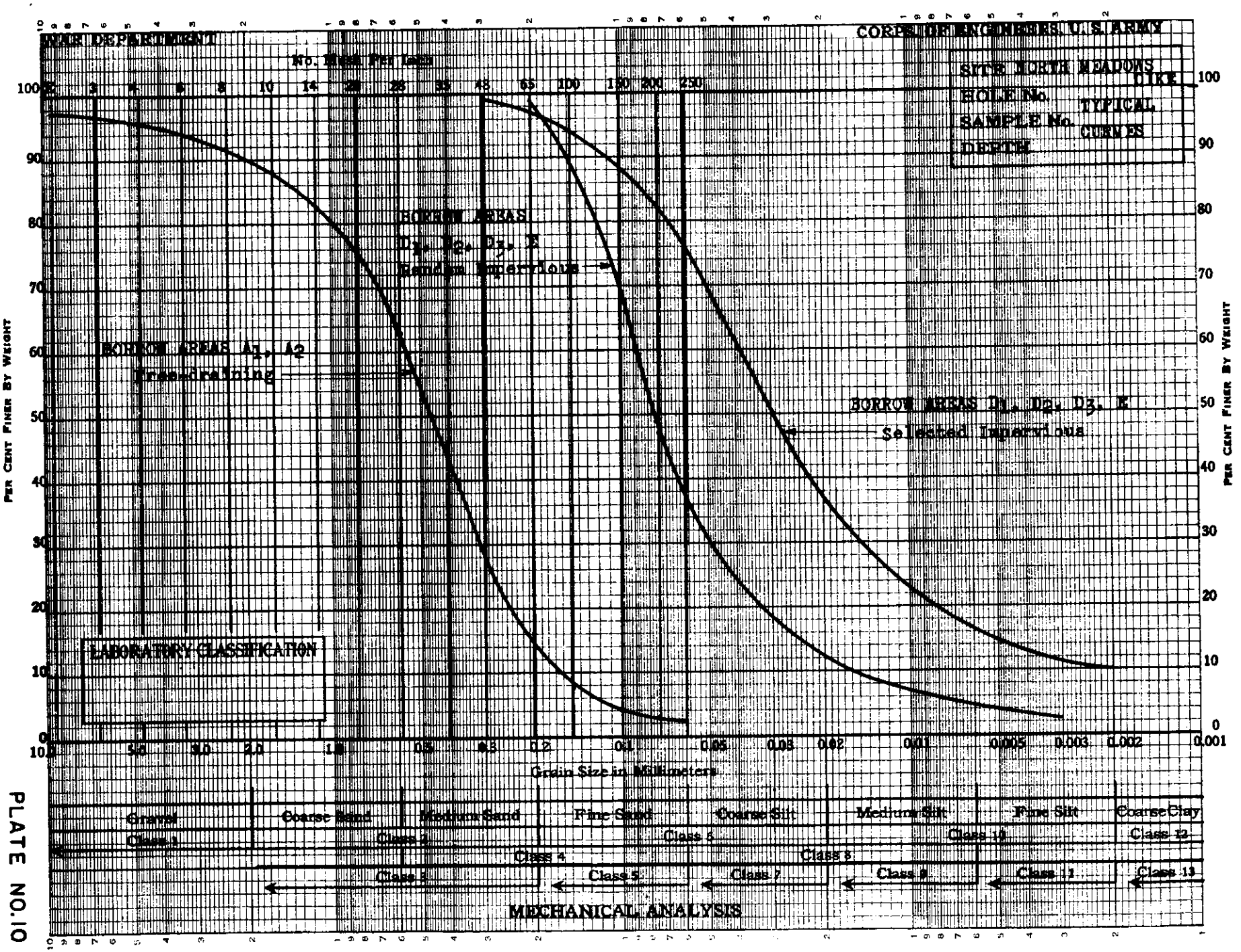

WAR DEPARTMENT
CORPS OF ENGINEERS, U. S. ARMY
SITE NORTH MEADOWS DIKE
HOLE No.
SAMPLE No.
DEPTH
TYPICAL CURVES
No. Mesh Per Inch
BORROW AREAS D1, D2, D3, E
Random Impervious
BORROW AREAS A1, A2
Free-draining
BORROW AREAS D1, D2, D3, E
Selected Impervious
LABORATORY CLASSIFICATION
PER CENT FINER BY WEIGHT
Grain Size in Millimeters
Gravel
Coarse Sand
Medium Sand
Fine Sand
Coarse Silt
Medium Silt
Fine Silt
Coarse Clay
Class 1
Class 2
Class 3
Class 4
Class 5
Class 6
Class 7
Class 8
Class 9
Class 10
Class 11
Class 12
Class 13
MECHANICAL ANALYSIS

PLATE NO.10

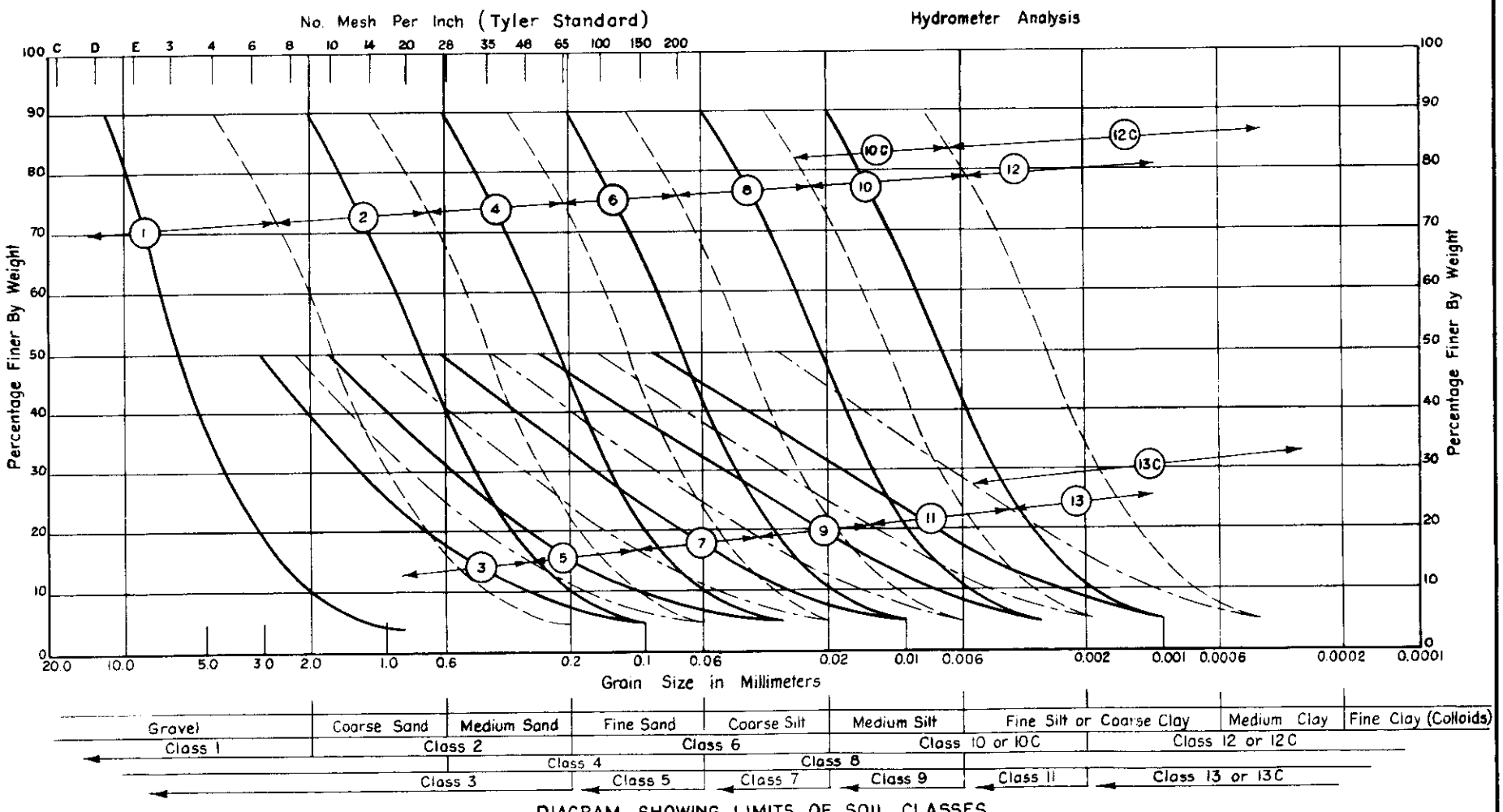


DIAGRAM SHOWING LIMITS OF SOIL CLASSES

PLATE NO. 11

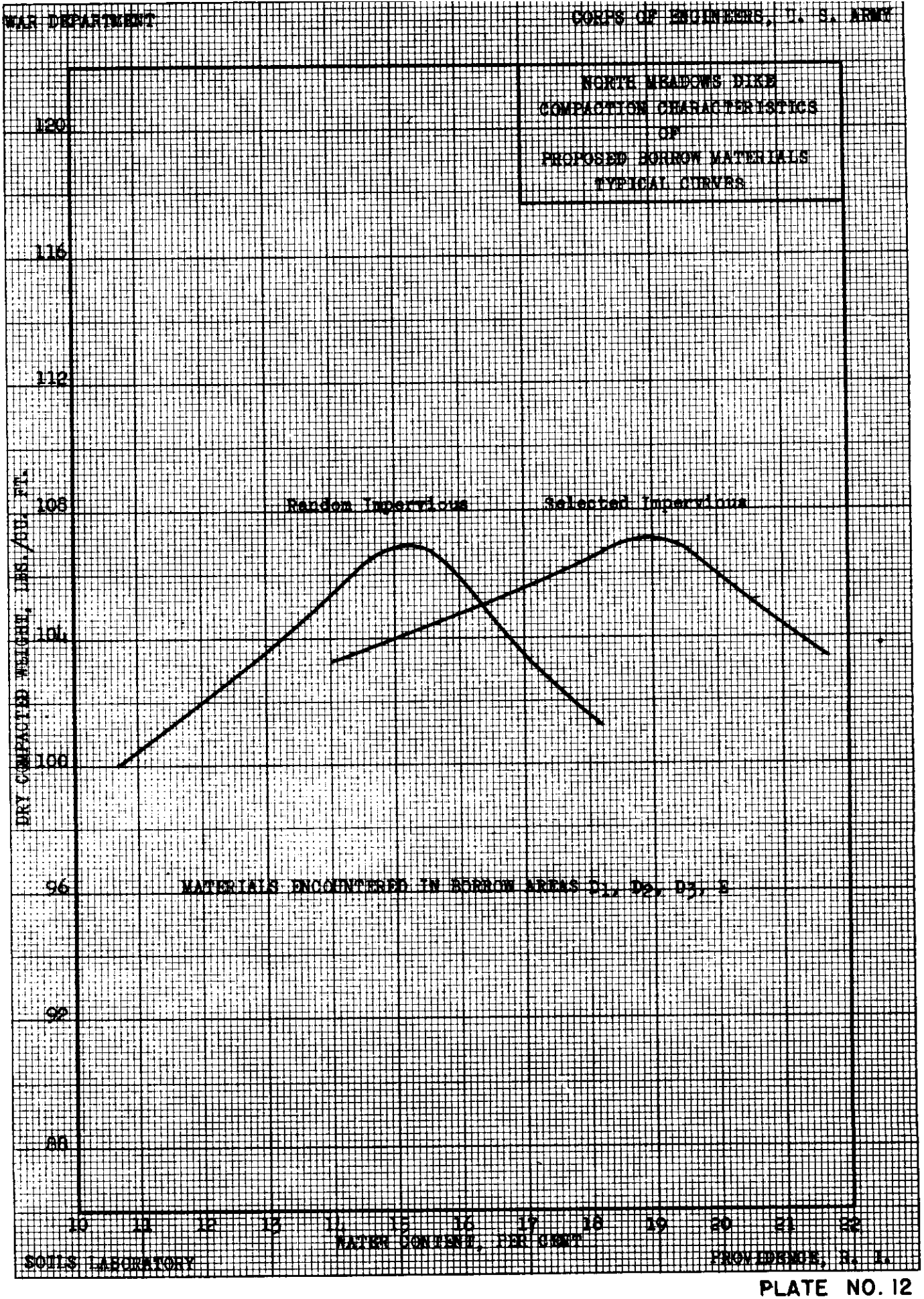
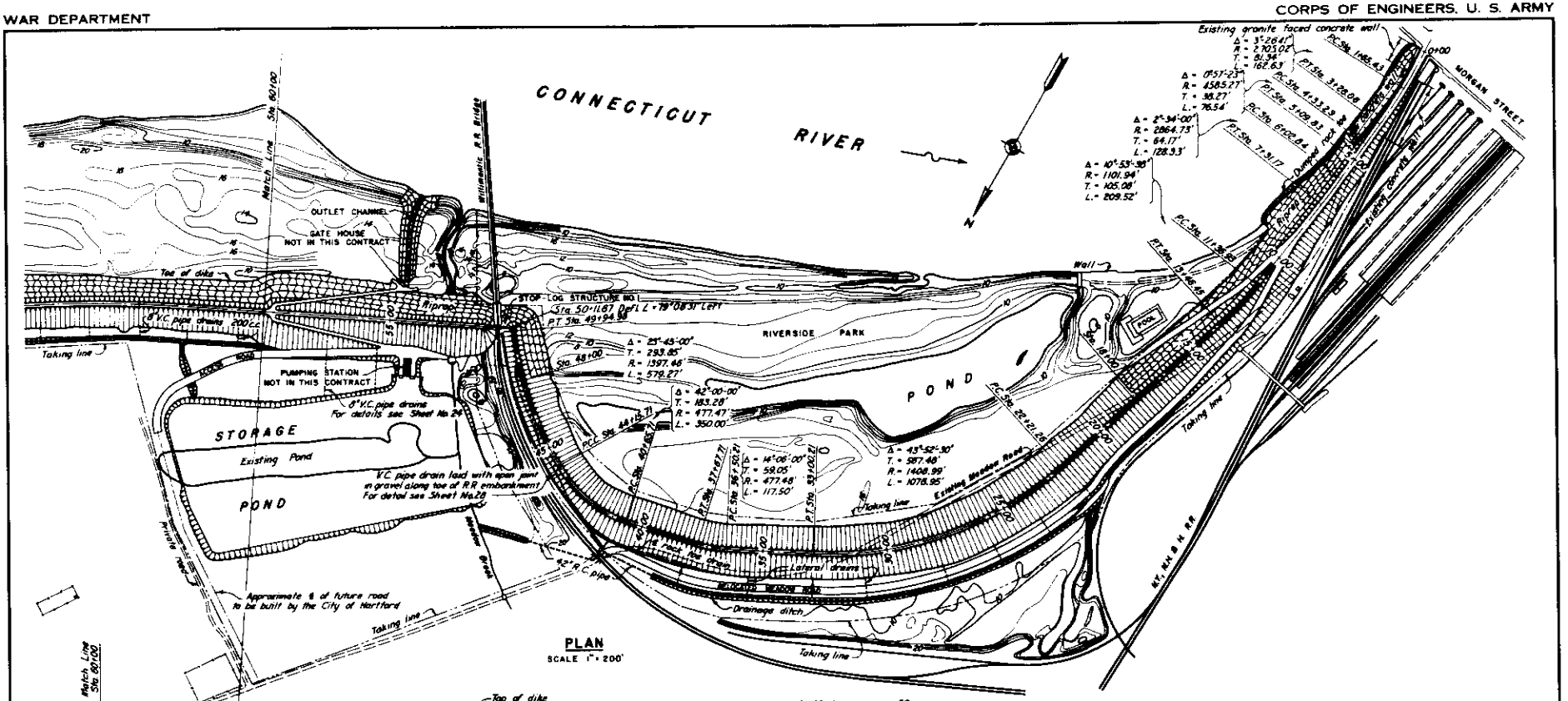

NORTH MEADOWS DIKE
COMPACTION CHARACTERISTICS
OF
PROPOSED BORROW MATERIALS
TYPICAL CURVES
Random Impervious
Selected Impervious
MATERIALS ENCOUNTERED IN BORROW AREAS D1, D2, D3, E
DRY COMPACTED WEIGHT, LBS./CU. FT.
120
116
112
108
104
100
96
92
88
10
11
12
13
14
15
16
17
18
19
20
21
22
WATER CONTENT, PER CENT

PLATE NO. 12

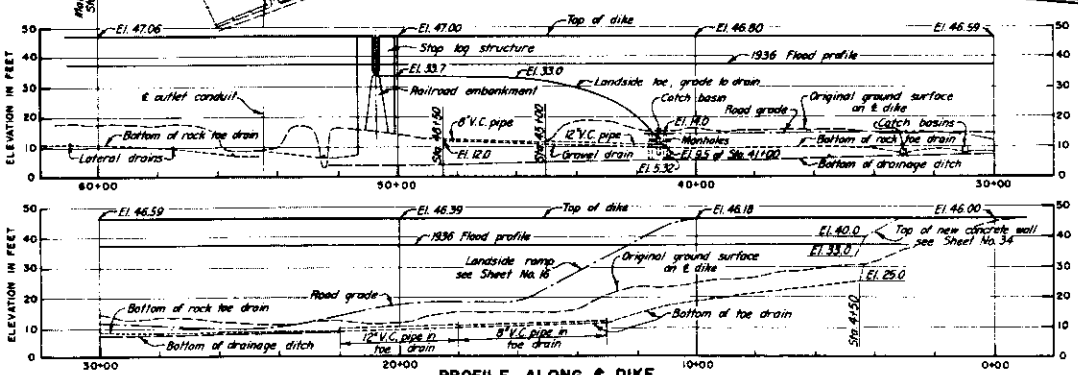
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



PLAN

SCALE 1" = 200'



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1" = 200' VERT. 1" = 20'

NOTES

Elevations refer to Mean Sea Level Datum.
For details of embankment see typical sections on Sheets No. 22, 24, 25, 26, 27, 28, 29, 44 and 45
For schedule of V.C. lateral drains see Sheet No. 13

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

GENERAL PLAN NO. 1

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 66 SHEETS — SCALE 1 IN. = 200 FT. — SHEET NO. 12

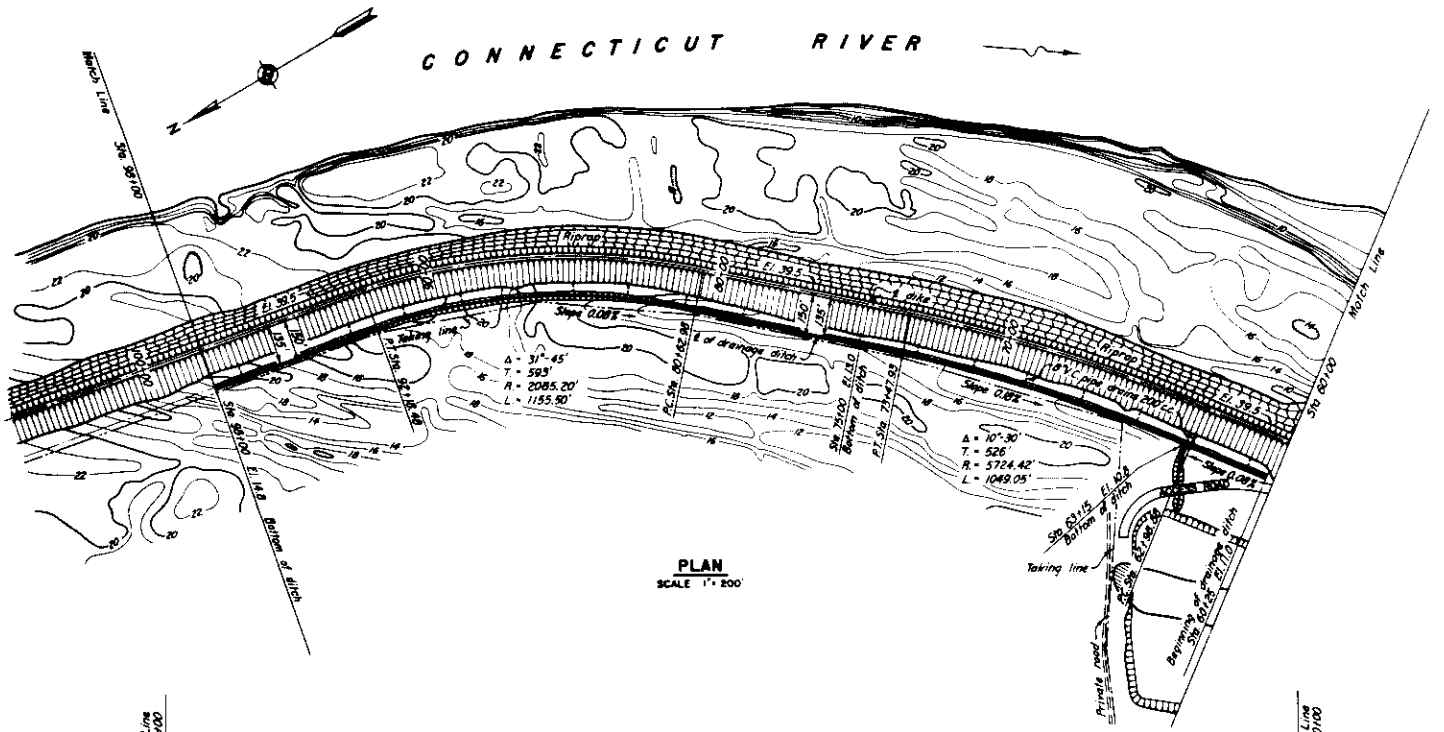
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — APRIL 1939

SUBMITTED: DENVER ENGINEER, HEAD, DESIGN SECTION — APPROVAL RECOMMENDED: ASSOCIATE ENGINEER, CHIEF F. C. ENGINEERING DIV. — APPROVED: DISTRICT ENGINEER

DESIGNED: ASSOC. ENGINEER — DRAWN: R.A.H. & P.B.M. — TRACED: L.F.S. — CHECKED: L.O.B.

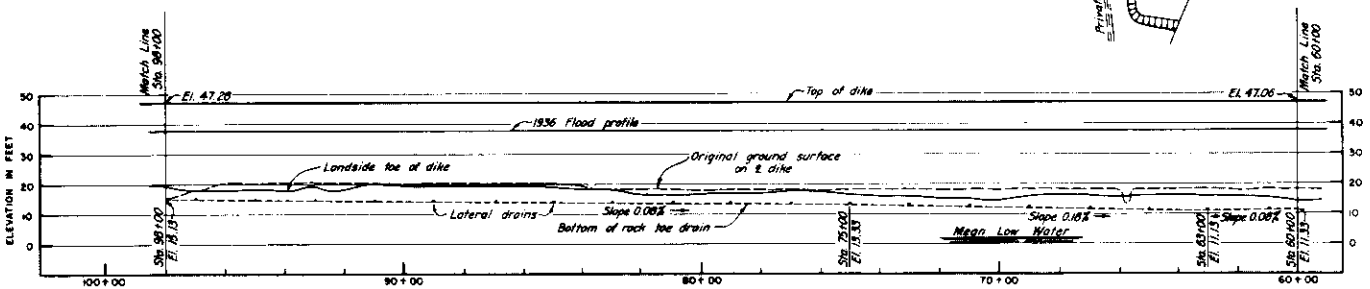
FILE NO. CT-4-1441

PLATE NO. 13



PLAN

SCALE 1" = 200'



PROFILE ALONG ℄ DIKE

SCALE: HOR. 1" = 200'
VERT. 1" = 20'

SCHEDULE OF 8" V.C. LATERAL TILE DRAINS	
STATION	LIN. FT.
3 + 83	76
24 + 00	74
26 + 00	78
28 + 00	78
31 + 00	86
33 + 00	22
35 + 50	88
38 + 00	26
52 + 40	58
55 + 50	196
57 + 50	242
61 + 00	38
63 + 00	38
65 + 00	42
67 + 00	40
69 + 00	40
71 + 00	40
73 + 00	36
75 + 00	36
77 + 00	40
79 + 00	38
81 + 00	38
83 + 00	46
85 + 00	46
87 + 00	46
89 + 00	48
91 + 00	54
93 + 00	50
95 + 00	42
97 + 00	44
102 + 00	38
104 + 00	50
106 + 00	50
108 + 00	50
110 + 00	46
112 + 00	48
114 + 00	46
119 + 00	56
121 + 00	54
123 + 00	50
125 + 00	50
127 + 00	50
129 + 00	24
TOTAL	2440

NOTE:

For general notes applying to details shown on this sheet see Sheet No. 12

DATE	REVISION	REV. BY	CH. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

GENERAL PLAN NO. 2

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 66 SHEETS — SCALE 1 IN. = 200 FT. — SHEET NO. 13

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — APRIL, 1939

SUBMITTED: Henry B. Hale, Senior Engineer, Head Design Section

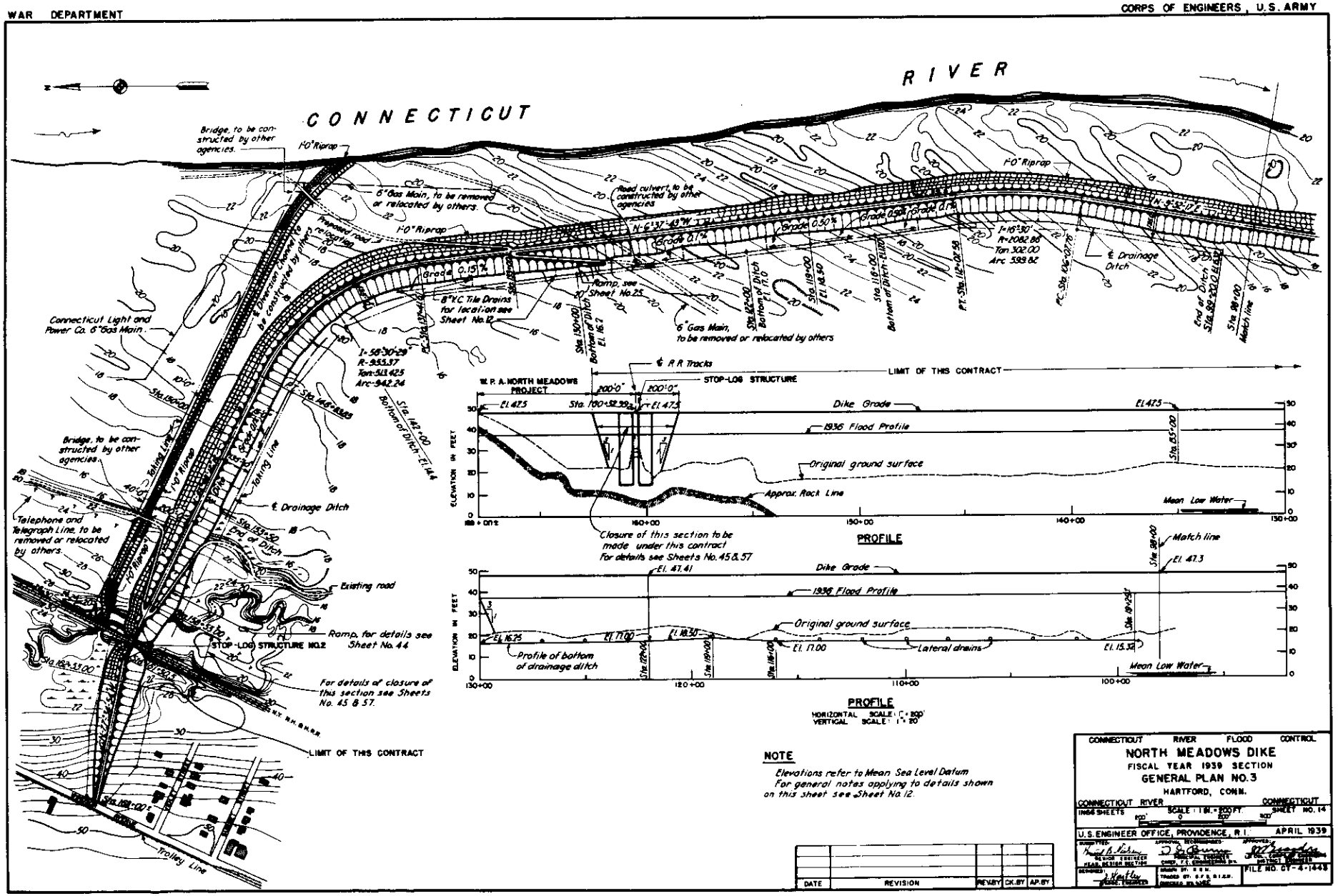
APPROVAL RECOMMENDED: D. S. Johnson, Principal Engineer, Chief F. C. Engineering Div.

APPROVED: W. E. Hopkins, Colonel, Corps of Engineers, District Engineer

DESIGNED: J. Martin, Asst. Engineer

DRAWN: W. R. M. & W. P. D. H.
TRACED: J. F. D.
CHECKED: J. M. B.

FILE NO. CT-9-1492



NOTE

Elevations refer to Mean Sea Level Datum
For general notes applying to details shown on this sheet see Sheet No. 12.

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

GENERAL PLAN NO. 3

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

INDEX SHEETS — SCALE: 1 IN. = 100 FT. — SHEET NO. 14

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — APRIL 1939

SUBMITTED: SENIOR ENGINEER, HEAD, DESIGN SECTION

APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. CONSTRUCTION DIV.

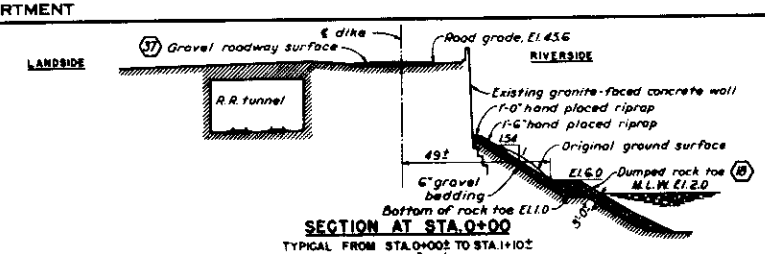
APPROVED: JOHN C. BURNS, COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: DRAWN BY: R.E.N. TRACED BY: G.F.S. & J.C.D. CHECKED BY: J.H.C.

FILE NO. CT-4-1648

WAR DEPARTMENT

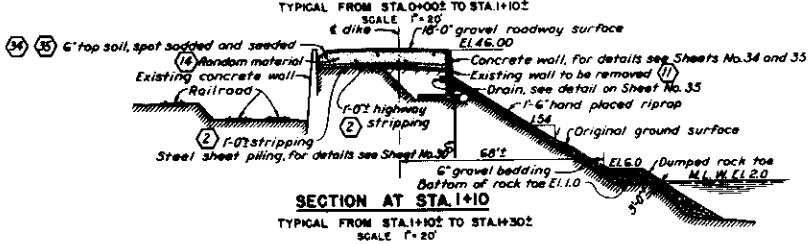
CORPS OF ENGINEERS, U. S. ARMY



SECTION AT STA. 0+00

TYPICAL FROM STA. 0+00± TO STA. 1+10±

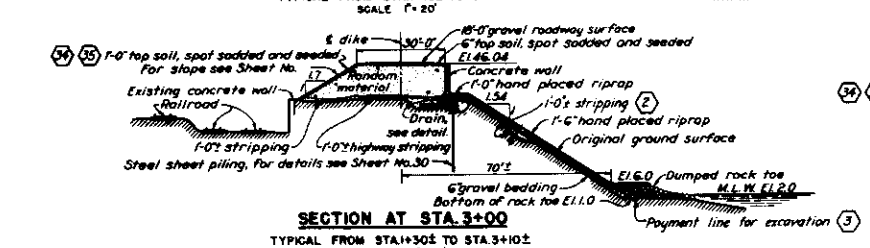
SCALE 1" = 20'



SECTION AT STA. 1+10

TYPICAL FROM STA. 1+10± TO STA. 1+30±

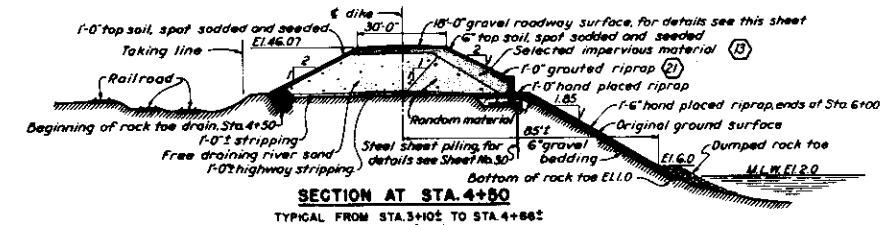
SCALE 1" = 20'



SECTION AT STA. 3+00

TYPICAL FROM STA. 1+30± TO STA. 3+10±

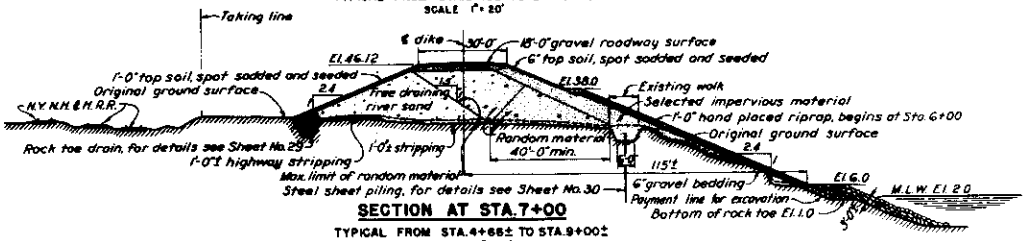
SCALE 1" = 20'



SECTION AT STA. 4+50

TYPICAL FROM STA. 3+10± TO STA. 4+66±

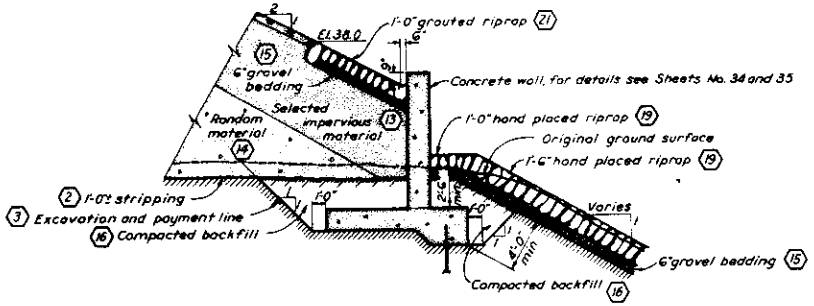
SCALE 1" = 20'



SECTION AT STA. 7+00

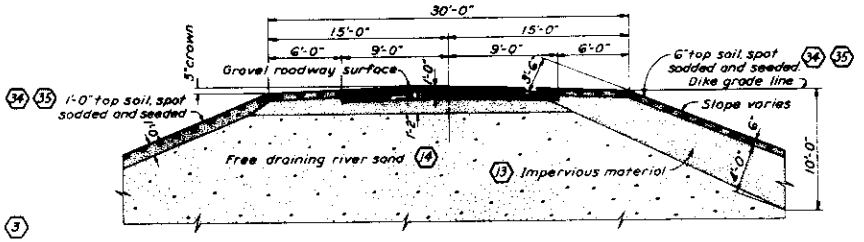
TYPICAL FROM STA. 4+66± TO STA. 9+00±

SCALE 1" = 20'



SECTION THRU CONCRETE WALL

SCALE 1/4" = 1'-0"



DETAIL OF TOP OF DIKE

TYPICAL FROM STA. 3+10± TO STA. 9+00±

SCALE 1" = 5'

NOTES

Elevations refer to Mean Sea Level Datum.

Working line for the proposed surface of riprap is the existing ground line at El. 6.00. For variations of slope see Sheet No. 15.

Figures in hexagons indicate item numbers under which payment will be made.

DATE	REVISION	REV BY	CK. BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

TYPICAL CROSS SECTIONS NO. 1

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

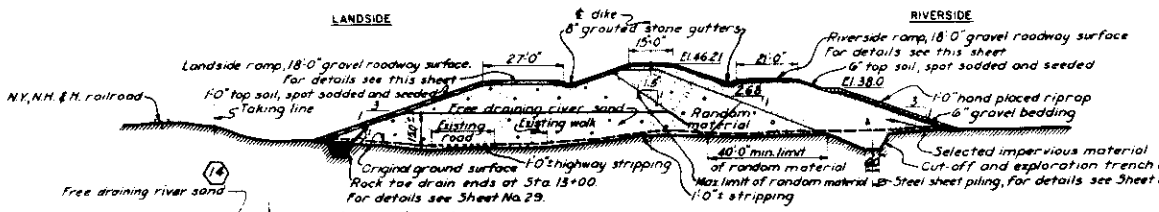
IN 46 SHEETS — SCALE 1" = 20 FT. — SHEET NO. 24

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — APRIL 1939

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

DESIGNED — DRAWN P.D.M. TRACED J.T. CHECKED — FILE NO. CT-4-1456

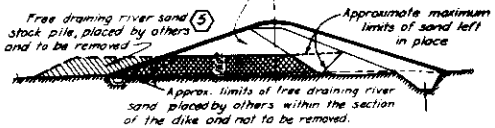
PLATE NO. 16



SECTION AT STA. 11+50

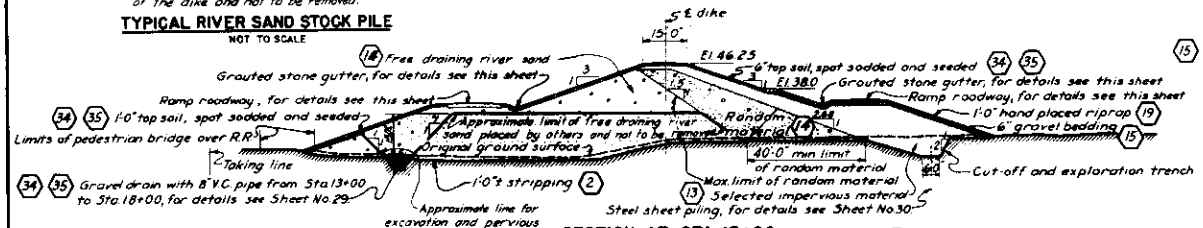
TYPICAL FROM STA. 9+00± TO STA. 12+05±

SCALE: 1" = 20'



TYPICAL RIVER SAND STOCK PILE

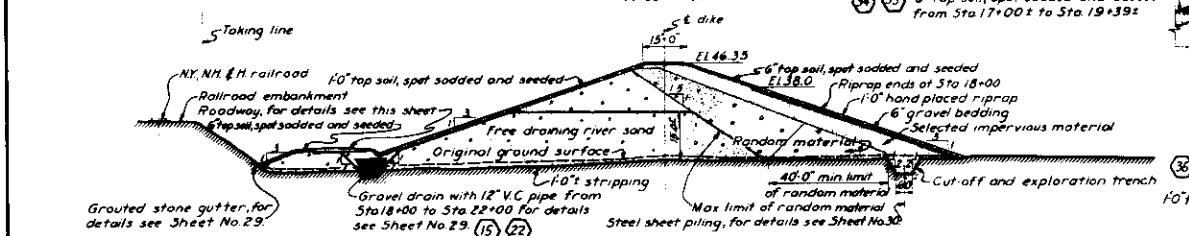
NOT TO SCALE



SECTION AT STA. 13+00

TYPICAL FROM STA. 12+05± TO STA. 17+00±

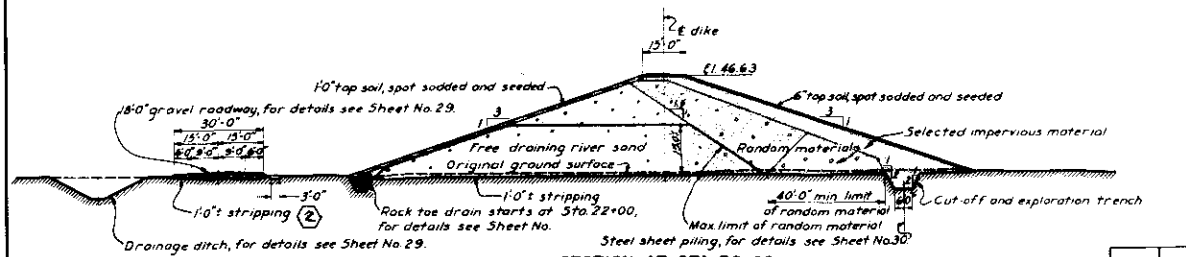
SCALE: 1" = 20'



SECTION AT STA. 18+00

TYPICAL FROM STA. 17+00± TO STA. 21+50±

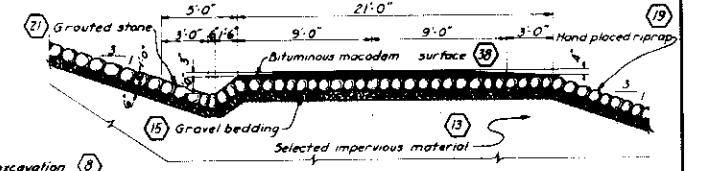
SCALE: 1" = 20'



SECTION AT STA. 32+00

TYPICAL FROM STA. 21+50± TO STA. 41+00±

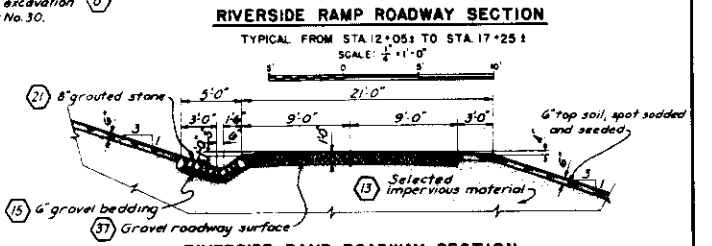
SCALE: 1" = 20'



RIVERSIDE RAMP ROADWAY SECTION

TYPICAL FROM STA. 12+05± TO STA. 17+25±

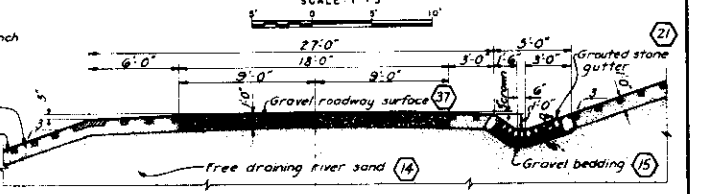
SCALE: 1/4" = 1'-0"



RIVERSIDE RAMP ROADWAY SECTION

TYPICAL FROM STA. 10+00± TO STA. 12+05±

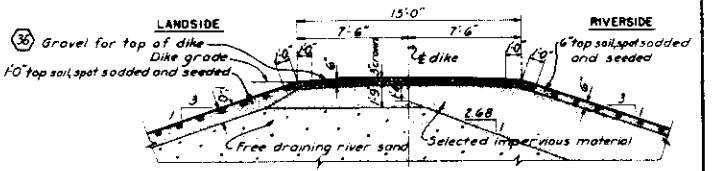
SCALE: 1" = 5'



LANDSIDE RAMP ROADWAY SECTION

TYPICAL FROM STA. 10+00± TO STA. 19+39±

SCALE: 1/4" = 1'-0"



DETAIL OF TOP OF DIKE

TYPICAL FROM STA. 10+50± TO STA. 98+00±

SCALE: 1/4" = 1'-0"

NOTE

For general notes applying to details shown on this sheet, see Sheet No. 26.

DATE	REVISION	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

TYPICAL CROSS SECTIONS NO. 2

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

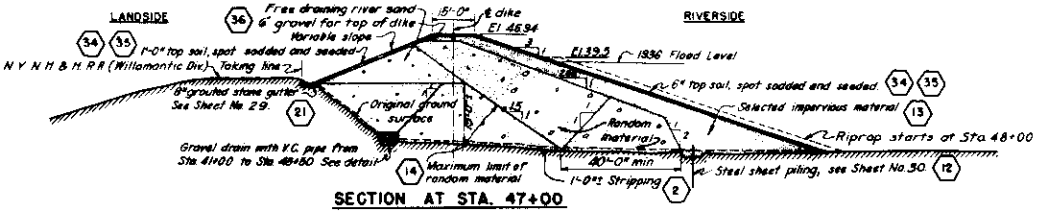
IN 66 SHEETS — SCALE: 1 IN. = 20 FT. — SHEET NO. 27

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — APRIL 1939

SUBMITTED: SENIOR ENGINEER, CHIEF, DESIGN SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, C. ENGINEERING DIV. — APPROVED: COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: J. Martin, CIVIL ENGINEER — DRAWN: P. B. W. — TRACED: P. J. T. — CHECKED: A. D. R.

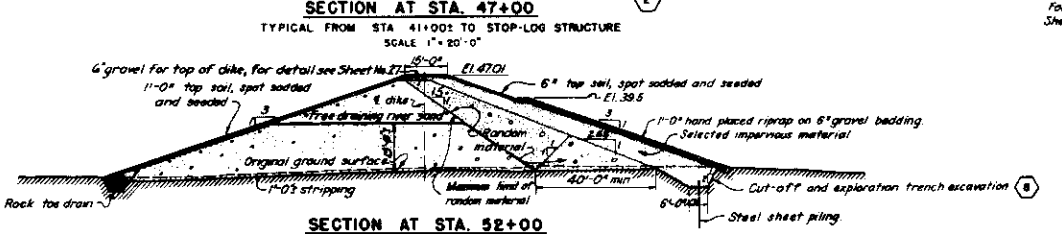
FILE NO. CT-4-1458



SECTION AT STA. 47+00

TYPICAL FROM STA 41+00± TO STOP-LOG STRUCTURE

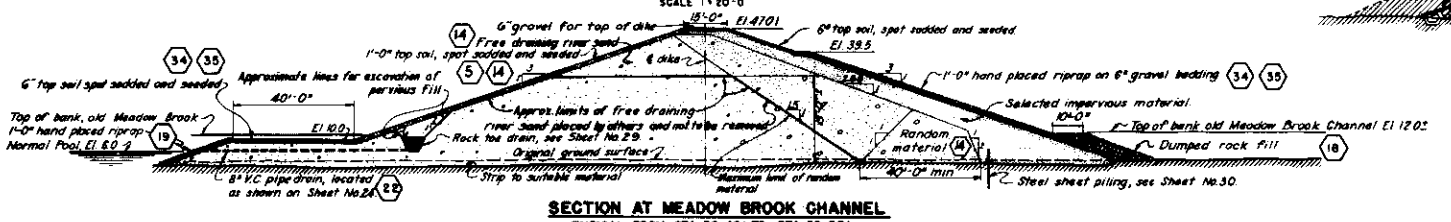
SCALE 1" = 20'-0"



SECTION AT STA. 52+00

TYPICAL FROM STOP-LOG STRUCTURE TO STA. 52+40± AND FROM STA. 52+80± TO STA. 54+00±

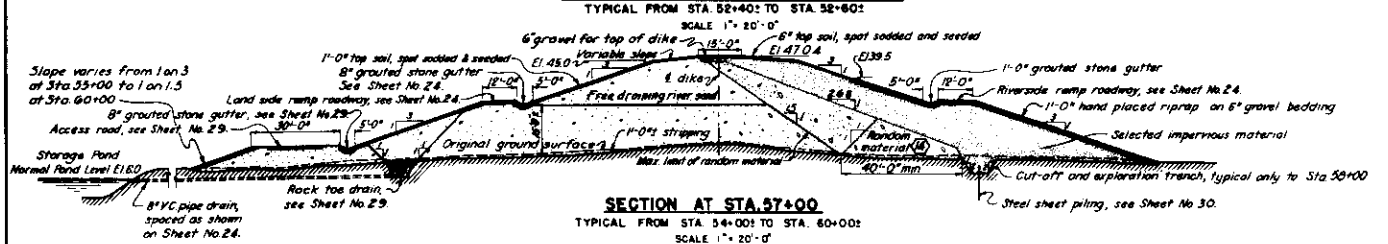
SCALE 1" = 20'-0"



SECTION AT MEADOW BROOK CHANNEL

TYPICAL FROM STA. 52+40± TO STA. 52+60±

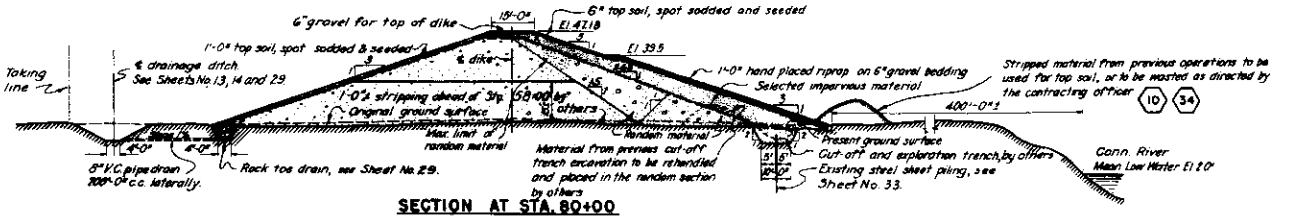
SCALE 1" = 20'-0"



SECTION AT STA. 57+00

TYPICAL FROM STA. 54+00± TO STA. 60+00±

SCALE 1" = 20'-0"



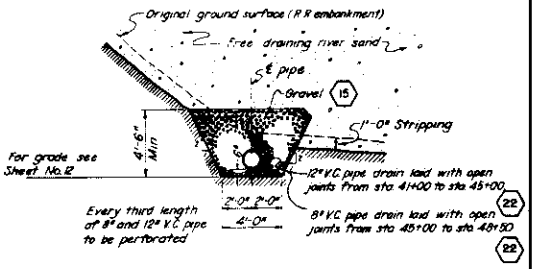
SECTION AT STA. 80+00

TYPICAL FROM STA. 60+00± TO STA. 130+00

SCALE 1" = 20'-0"

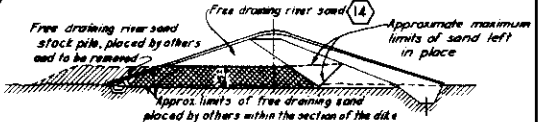
LIMITS OF WORK BY OTHERS STA. 60-00 TO STA. 98-00 ———

LIMITS OF WORK BY OTHERS STA. 98-00 TO STA. 130-00 — — —



DETAIL OF GRAVEL DRAIN

SCALE $\frac{1}{4}$" = 1'-0"



TYPICAL RIVER SAND STOCK PILE

NOT TO SCALE

NOTES

For general notes applying to details shown on this sheet see Sheet No. 26

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

TYPICAL CROSS SECTIONS NO. 3

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

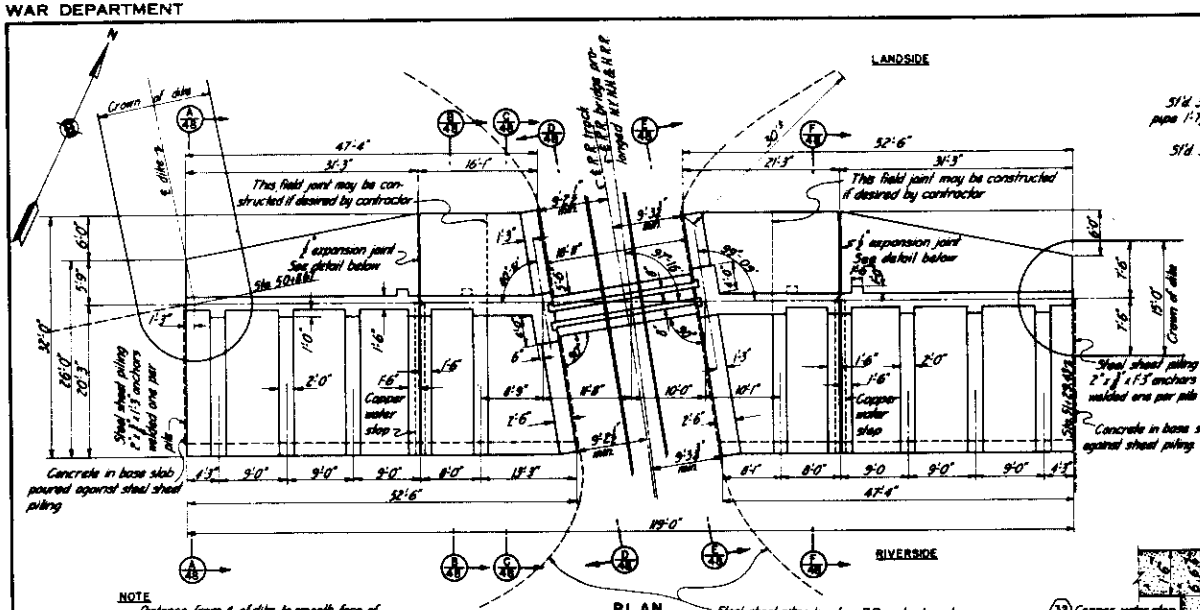
IN 66 SHEETS — SCALE 1 IN = 20 FT — SHEET NO. 28

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — APRIL 1939

SUBMITTED: Henry A. Barbour, Branch Engineer, Hydr. Design Section — APPROVAL RECOMMENDED: S. Sollins, Principal Engineer, Chief, L. L. Engineering Div. — APPROVED: R. W. Crosby, Col., Corps of Engineers, District Engineer

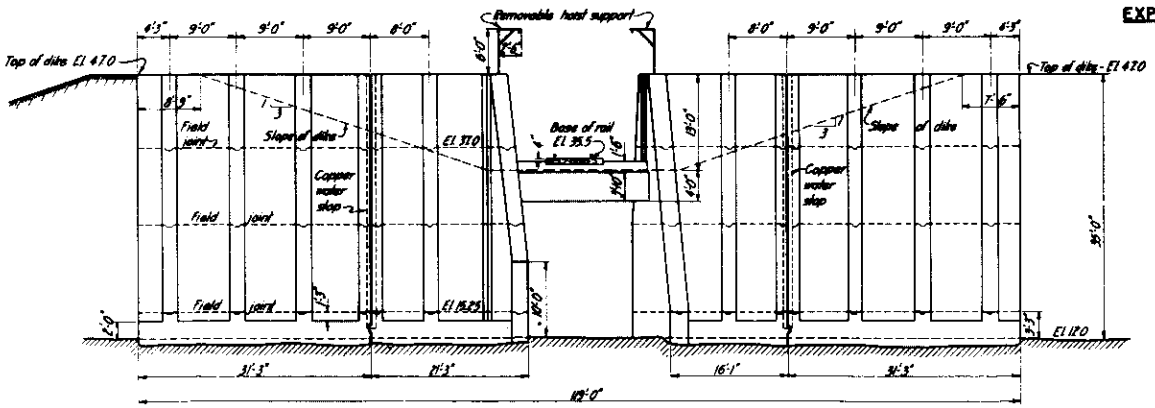
DESIGNED: J. Hartley, Asst. Engineer — DRAWN: H.G.M. — TRACED: W.F. — CHECKED: W.B.B.R. — FILE NO. CT-4-1457

PLATE NO. 18

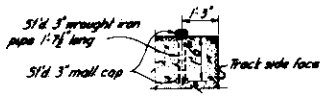


NOTE
Distance from ℄ of dike to smooth face of near abutment of R.R. bridge, measured along ℄ of bridge prolonged equals 96.87.

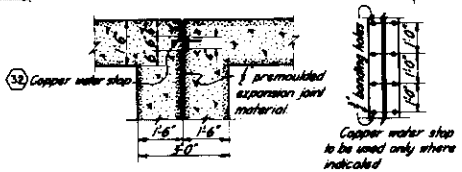
PLAN
SCALE 1/8" = 1'-0"



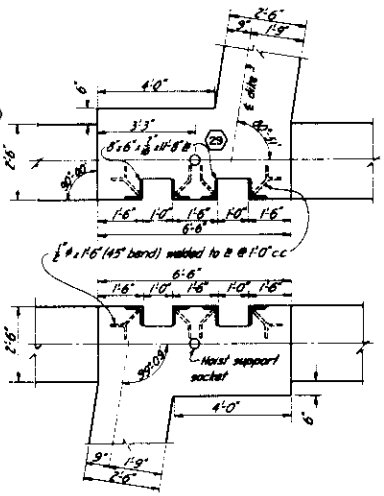
RIVERSIDE ELEVATION
SCALE 1/8" = 1'-0"



HOIST SUPPORT SOCKET (31)
SCALE 1/4" = 1'-0"



EXPANSION JOINT DETAILS
SCALE 1/4" = 1'-0"



DETAILS AT LOG GROOVES
SCALE 1/4" = 1'-0"

NOTES

All stop logs shall be White Oak (structural grade and creosoted) and will be paid for under Item No. 33

For details of removable stop-log hoist support, see Sheet No. 59

For location plan see Sheet No. 12

For layout of steel sheet piling, see Sheets No. 30 to 33 incl.

For steel reinforcement details, see Sheets No. 49 to 53 incl.

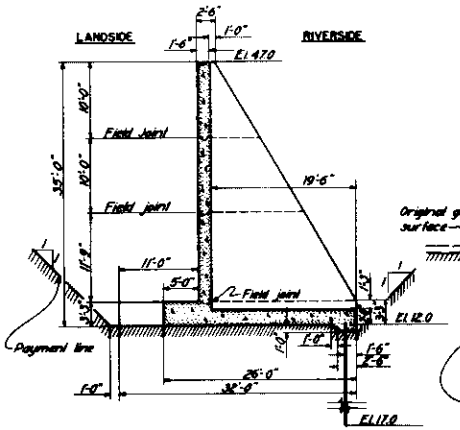
For additional concrete details, see Sheet No. 48

THIS SHEET SUPERSEDES SHEET NO. 47, FILE NO. CT-4-1478.

CONNECTICUT RIVER FLOOD CONTROL
NORTH MEADOWS DIKE
FISCAL YEAR 1939 SECTION
R. R. STOP LOG STRUCTURE NO. 1
CONCRETE DETAILS NO. 1
HARTFORD, CONN.

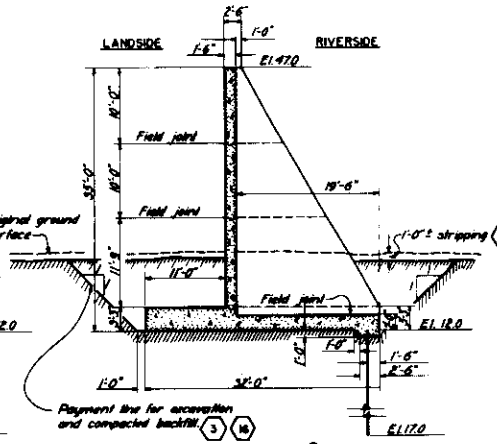
CONNECTICUT RIVER — CONNECTICUT
IN 66 SHEETS — SCALE: 1/8 IN. = 1 FT. — SHEET NO. 47
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — MAY 1939
FILE NO. CT-4-1700

DATE	REVISION	REV BY	CK BY	AP BY



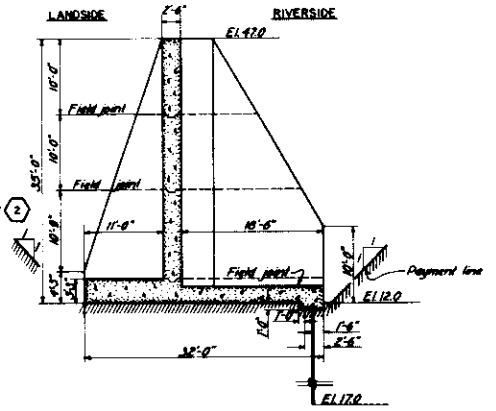
SECTION A 47

SCALE: 1/8"=1'-0"



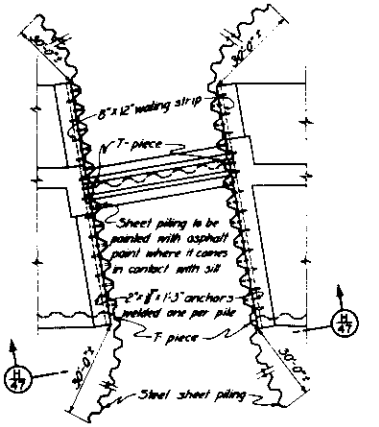
SECTION B 47

SCALE: 1/8"=1'-0"



SECTION C 47

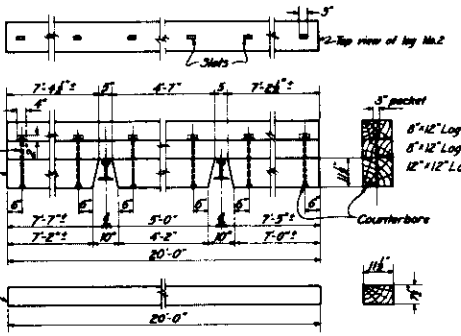
SCALE: 1/8"=1'-0"



Sheet piling to be carried a distance determined in the field to provide adequate support for railroad fill during construction.

PLAN OF STEEL SHEET PILING

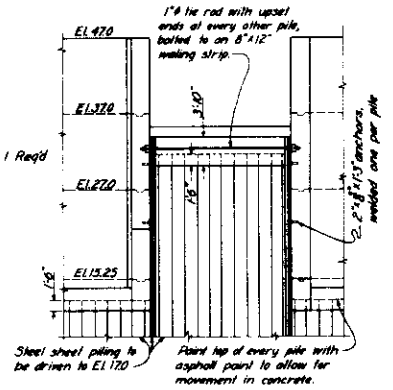
SCALE: 1/8"=1'-0"



DETAIL OF STOP LOG

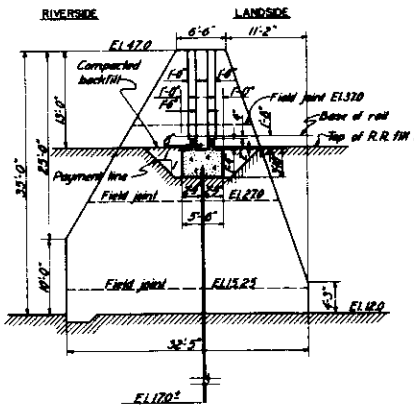
16 REQUIRED

SCALE: 1/8"=1'-0"



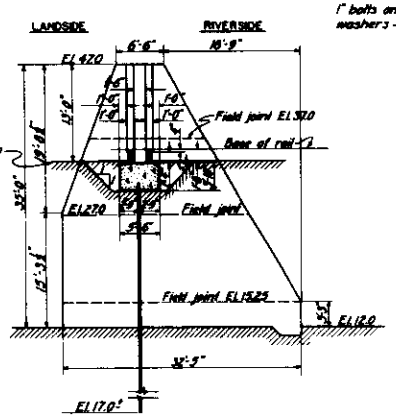
SECTION H 47

SCALE: 1/8"=1'-0"



SECTION D 47

SCALE: 1/8"=1'-0"



SECTION E 47

SCALE: 1/8"=1'-0"

NOTES:

Steel sheet piling to be driven to impervious material.

Tie rods and waling strip to be removed before concrete is poured above field joint at EL 27.0.

All concrete shown on this sheet shall be Class "A" and will be paid for under Item No. 27.

For steel reinforcement see Sheets No. 49 to 56.

For additional concrete details see Sheet No. 47.

DATE	REVISION	REV BY	CK. BY	AP. BY

THIS SHEET SUPERSEDES SHEET NO 48 FILE NO. CT-4-1477

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

R.R. STOP-LOG STRUCTURE NO. 1

CONCRETE DETAILS NO. 2

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 66 SHEETS — SCALE 1/8" = 1 FT — SHEET NO. 49

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — MAY 1938

SUBMITTED: Henry B. Kelsey, Design Engineer, Hydr. Design Section

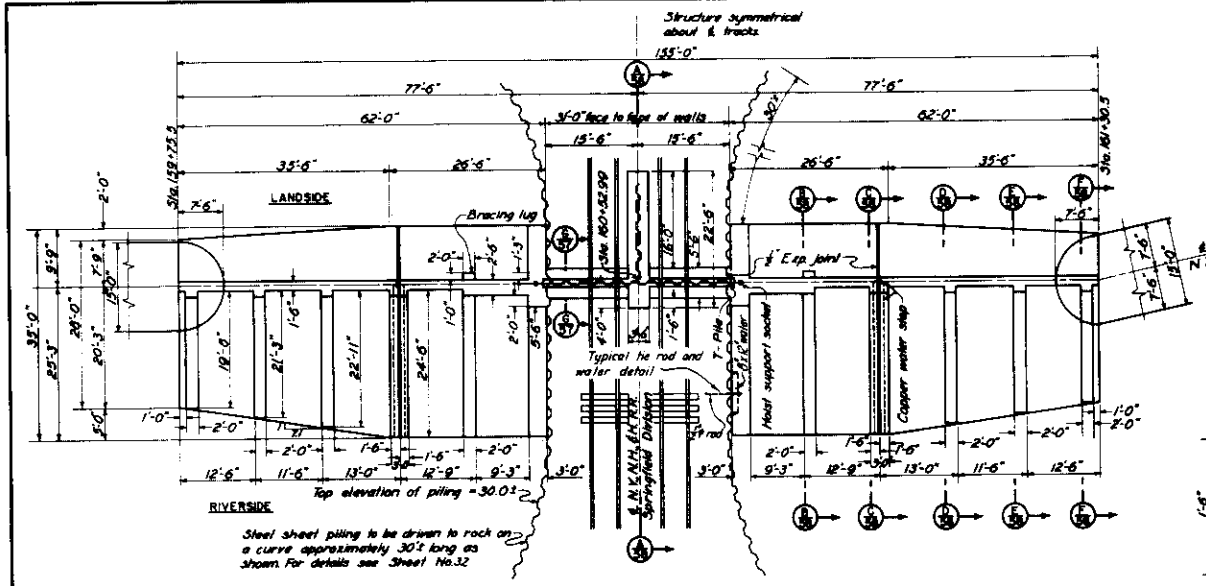
APPROVAL RECOMMENDED: T. B. Sherman, Principal Engineer, Chief F. & Engineering Div.

APPROVED: Wheeler, Lt. Col. Corps of Engineers, District Engineer

DESIGNED: F. A. Ziegler, Asst. Engineer

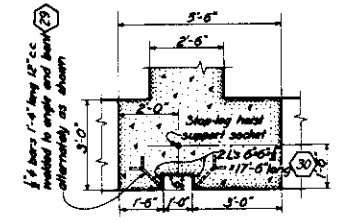
DRAWN: H. E. W. & J. T. — TRACED: J. H. T. — CHECKED: C. W. F. M.

FILE NO. CT-4-1703



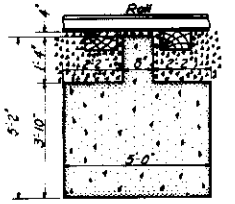
PLAN OF STOP-LOG STRUCTURE

SCALE 1" = 10'-0"



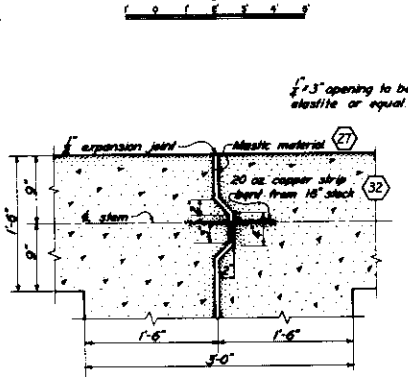
DETAIL OF LOG GROOVES

SCALE: ½" = 1'-0"



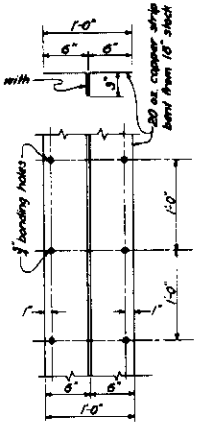
SECTION 6/37

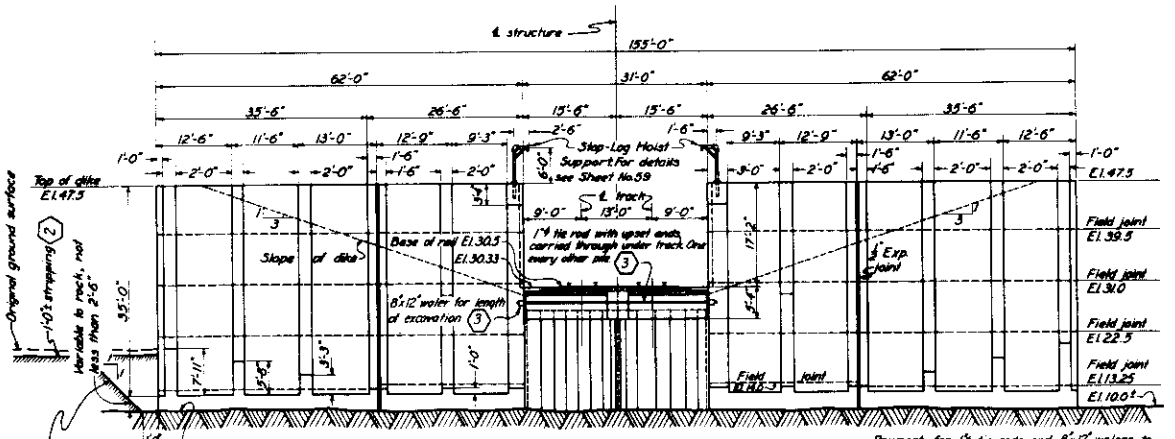
SCALE: ½" = 1'-0"



COPPER WATER STOP

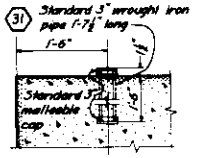
SCALE 1½" = 1'-0"





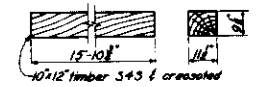
RIVERSIDE ELEVATION OF STRUCTURE

SCALE: 1" = 10'-0"



DETAIL HOIST SUPPORT SOCKET

SCALE: 1" = 1'-0"



DETAIL OF STOP-LOG

44 REQUIRED

SCALE ½" = 1'-0"

NOTES:

All concrete for this structure shall be Class A and will be paid for under Item No. 27.

For center support detail see Sheet No. 58

All timber for this structure shall be White Oak (structural grade and creosoted) and will be paid for under Item No. 33.

Furnishing, fabricating, welding, erecting, and painting all miscellaneous structural steel for this structure will be paid for at contract price under Item No. 28.

Figures in hexagons indicate item numbers under which payment will be made.

Furnishing, fabricating, welding, erecting, and painting all W.I. pipe for Hoist Support will be paid for at contract price under Item No. 31.

DATE	REVISION	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

R.R. STOP-LOG STRUCTURE NO. 2

CONCRETE DETAILS NO. 1

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 86 SHEETS — SHEET NO. 57

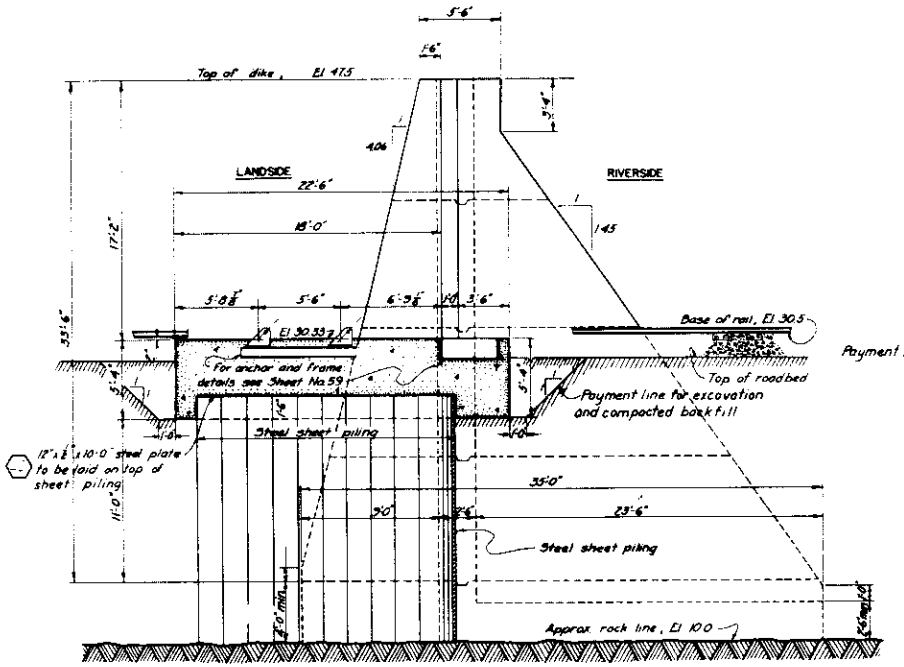
SCALE 1 IN = 10 FT

U.S. ENGINEER OFFICE, PROVIDENCE, R. I., APRIL 1939

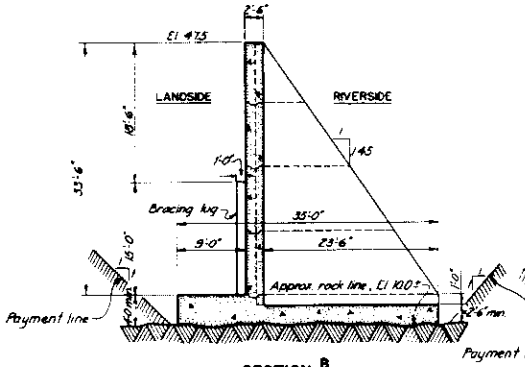
SUBMITTED: Senior Engineer, Head, Design Section — APPROVAL RECOMMENDED: Principal Engineer, Chiefly Engineering Div. — APPROVED: Colonel, Corps of Engineers, District Engineer

DESIGNED: Junior Engineer — DRAWN J.S.M. TRACED J.K.L. CHECKED W.E.J.

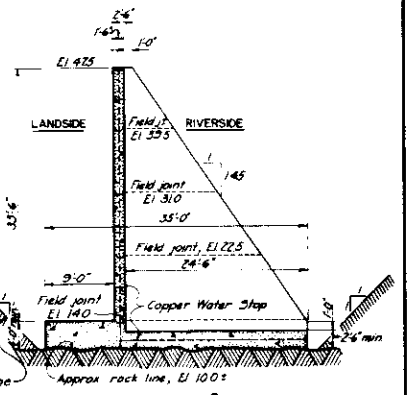
FILE NO. CT-6-1486



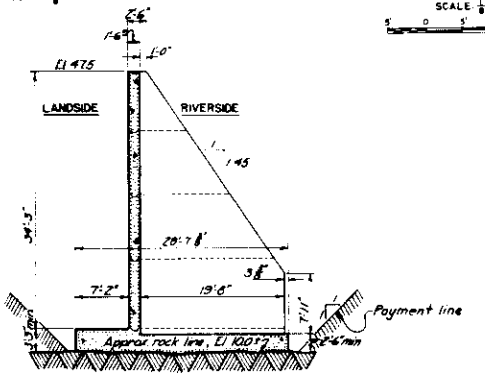
SECTION A/57
SCALE 1/8" = 1'-0"



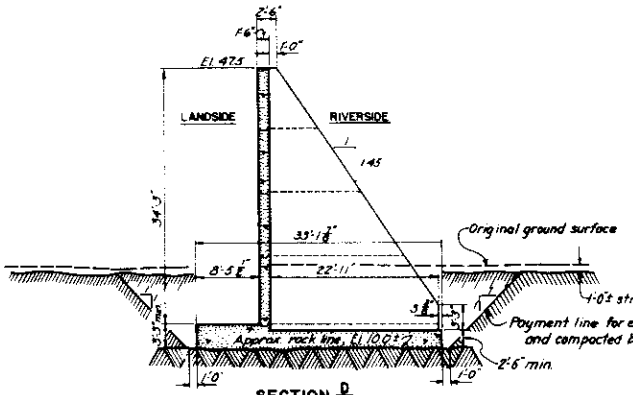
SECTION B/57
SCALE 1/8" = 1'-0"



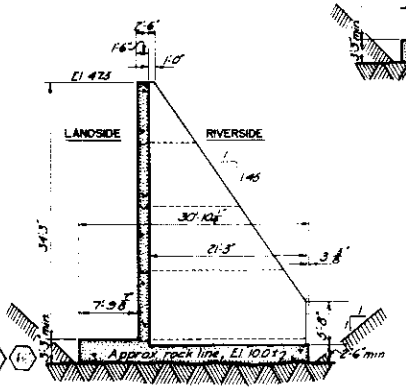
SECTION C/57
SCALE 1/8" = 1'-0"



SECTION F/57
SCALE 1/8" = 1'-0"



SECTION D/57
SCALE 1/8" = 1'-0"



SECTION E/57
SCALE 1/8" = 1'-0"

NOTES

For location of Sections see Sheet No. 57

For general notes see Sheet No. 57

All exterior corners shall be chamferred 1"

DATE	REVISION	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

NORTH MEADOWS DIKE

FISCAL YEAR 1939 SECTION

R.R. STOP LOG STRUCTURE NO. 2

CONCRETE DETAILS NO. 2

HARTFORD, CONN.

CONNECTICUT RIVER — CONNECTICUT

IN 66 SHEETS — SCALE 1/4 IN = 1 FT — SHEET NO. 58

U. S. ENGINEER OFFICE, PROVIDENCE, R. I., APRIL 1939

SUBMITTED: Rud N. Weiss, SENIOR ENGINEER, HEAD, DESIGN SECTION

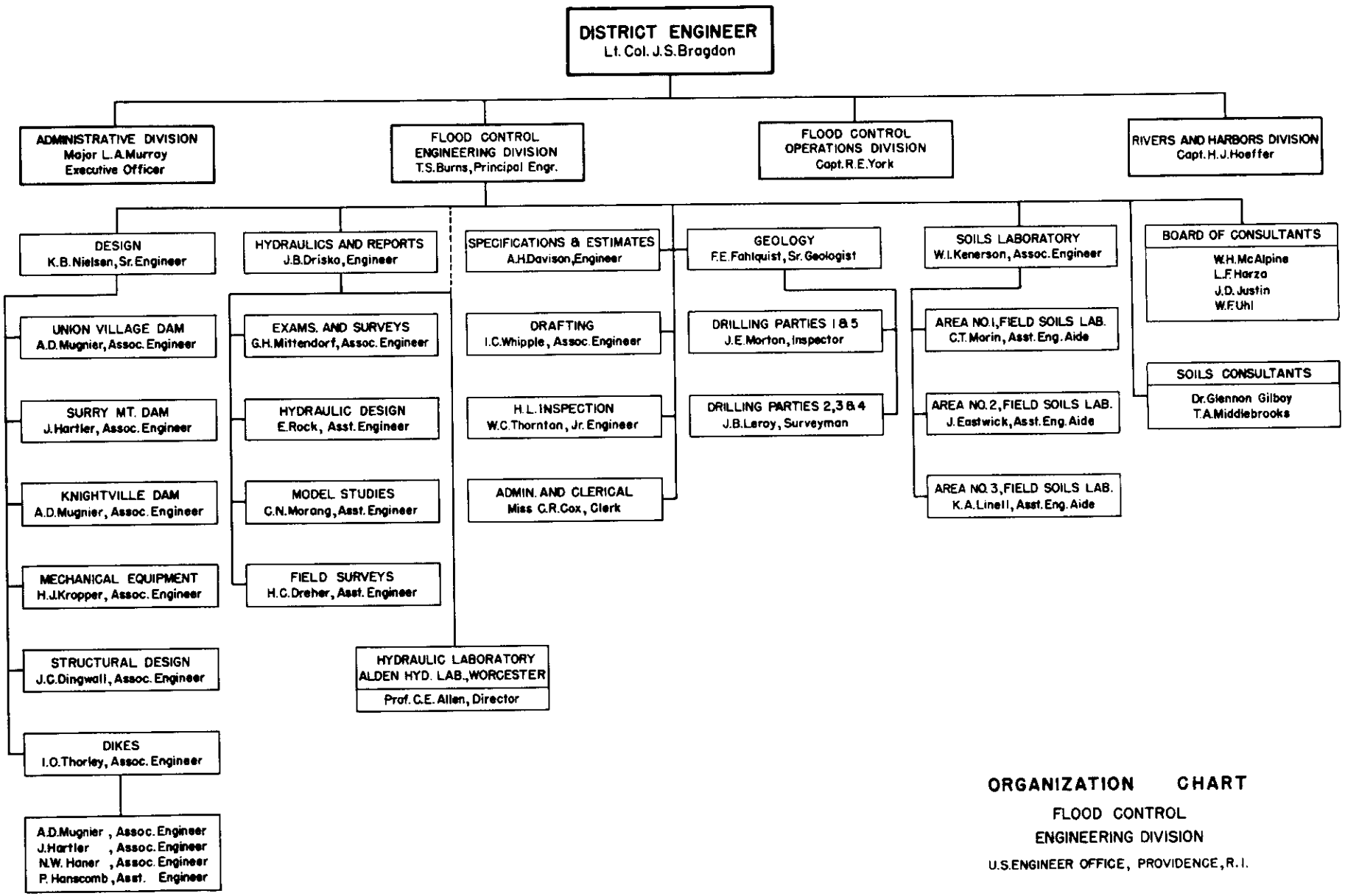
APPROVAL RECOMMENDED: D. B. Gilcreas, PRINCIPAL ENGINEER, CHIEF, R. C. ENGINEERING DIV.

APPROVED: Wm. Sanders, COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER

DESIGNED: [illegible], ASSOC. ENGINEER

DRAWN: J. R. M.; TRACED: H. J. P.; CHECKED: W. F. J.

FILE NO. CT-4-1487



ORGANIZATION CHART

FLOOD CONTROL
ENGINEERING DIVISION

U.S. ENGINEER OFFICE, PROVIDENCE, R.I.

PLATE NO. 23

CONNECTICUT RIVER FLOOD CONTROL PROJECT

HARTFORD, CONN.

CONNECTICUT RIVER, CONNECTICUT

ANALYSIS OF DESIGN FOR LOCAL PROTECTION WORKS

FISCAL YEAR 1939 SECTION, ITEM Ht. 4
CONTRACT — NORTH MEADOWS DIKE
AND STOP-LOG STRUCTURE

APPENDIX A

APRIL 1939

CORPS OF ENGINEERS, U.S. ARMY

U.S. ENGINEER OFFICE PROVIDENCE, R.I.

ANALYSIS OF DESIGN

NORTH MEADOWS RETAINING WALL

HARTFORD, CONN.

DIKE STA. 1+08± to 4+66±

DESIGN COMPUTATIONS FOR FOUR SECTIONS

OF CANTILEVER RETAINING WALL WITH STEM AVERAGING

FROM 6'0" TO 15'0" ABOVE THE BASE SLAB

DIKE STA. 1+08± to 4+66±

NORTH MEADOWS RETAINING WALL

HARTFORD, CONN.

This is the complete Analysis of Design for the Concrete Retaining Wall proposed at North Meadows, Hartford, Connecticut between dike Stations 1+08± and 4+66±. The wall is of the cantilever type and will retain a section of the roadway on top of the proposed North Meadows Dike just north of the Memorial Bridge at Hartford, Connecticut.

There is included the full design computations for four sections of the wall averaging from 6'0" to 15'0" above the base slab.

Complete details concerning this wall may be found on drawings File Nos. CT-4-1463 to 1467, inclusive.

CONTENTS

		Page
I.	General Design Data	A-2 to A-4 inc.
II.	15'0" Wall (Sta. 1+08± to 1+48± and Sta. 2+68± to 3+09±)	A-5 to A-13 inc.
III.	12'0" Wall (Sta. 1+48± to Sta. 2+68±)	A-14 to A-20 inc.
IV.	14'0" Wall (Average Section, Sta. 3+09± to 3+69± and Sta. 3+89± to 4+08±)	A-21 to A-26 inc.
V.	12'6" Wall (Average Section, Sta. 3+69± to 3+89± and Sta. 4+08± to 4+66±)	A-27 to A-33 inc.

I. GENERAL DESIGN DATA

GENERAL DESIGN DATA

1. Loading. - The walls shall be loaded to give the worst possible condition. In general, the walls shall be investigated for the following condition of loading.

Water down below base of wall with 100% uplift on landside of sheet piling due to tailwater head and 50% uplift on riverside of sheet piling due to tailwater head.

2. Seepage. - The sheet pile cut-off shall be carried 38'6" below the base of the wall. This is more than ample to take care of the path of creep around the cut-off and under the base.

An adequate tile drain, V.C. and open joint, shall be laid in screened gravel approximately two feet above the landside base slab for the entire length of the wall.

3. Overturning. - The resultant shall intersect the base within the middle third under all conditions.

4. Sliding. - The frictional force between the base of the wall and the earth shall be taken as 0.45 of the sum of all vertical loads down to the shear plane, reduced by hydrostatic uplift. This force acts along the shear plane between the base and earth.

The passive resistance shall then be the algebraic sum of all the horizontal forces, including the friction force, acting on the wall. The passive resistance shall be assumed as acting one-third the distance from the shear plane to the ground surface on the leading side and shall not exceed the maximum available passive resistance as computed by

$$\frac{wh2}{2} \left(\tan^2 \left(45° + \frac{\phi}{2}\right) - \tan^2 \left(45° - \frac{\phi}{2}\right)\right)$$

where $\phi = 35°$ (Angle of internal friction obtained from the Soils Laboratory)

h = distance from the shear plane to the ground surface on the leading side.

w = weight of dry or saturated earth.

5. Reinforced Concrete.

(a) In general, the concrete design is based on the "Joint Code of the American Concrete Institute and the Reinforcing Steel Institute for the Design of Concrete and Reinforced Concrete" issued in 1928 and the "Progress Report" of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete issued in January, 1937.

(b) The allowable working stresses to be used are as noted below:

(1)	Maximum allowable steel stress	fs =	18,000#/□"
(2)	Maximum allowable concrete compression stress	fc =	800#/□"
(3)	Maximum allowable concrete shear stress		
	(without special anchorage)	v =	60#/□"
	(with " ")	v =	90#/□"
(4)	Maximum allowable concrete bond stress		
	(without special anchorage)	u =	150#/□"
	(with " ")	u =	200#/□"
(5)	Length of embedment for bond diameters of reinforcing bar	L =	40
(6)		n =	12

All reinforcement to be deformed bars of new billet steel, intermediate grade.

6. Stem. - The vertical stem shall be designed as a cantilever beam fixed at the top of the base support.

7. Footings. - Both riverside and landside footings shall be designed as cantilever beams fixed at edge of support.

8. Covering of Reinforcement. - Cover on all surfaces for main reinforcement shall be at least 3 inches in the stem and at least 4 inches in the footings.

9. Symbols and Notations.

Pel_1 Pel_2 = Horizontal force due to dry and saturated earth on landside.

Per. - Horizontal force due to earth on riverside

Pr. - Horizontal passive resistance force on leading side.

FR - Horizontal friction force on shear plane between base and earth.

Eh_1 Eh_2 - Weight of earth on landside

ER - Weight of earth on riverside

C_1 C_2 etc. - Weight of concrete

U_1 - Uplift pressure on riverside of sheet piling

U_2 - Uplift pressure on landside of sheet piling

10. Unit Weights

Weight of water - 62.5 #/cu.ft.

Weight of dry earth - 100 #/cu.ft.

Weight of saturated earth - 125 #/cu.ft.

Weight of concrete - 150 #/cu.ft.

Equivalent liquid pressure of dry earth - 35 #/cu.ft.

Equivalent liquid pressure of saturated earth - 80 #/cu.ft.

Angle of internal friction, ϕ - obtain from Soils Laboratory = 35°

HARTFORD - NORTH MEADOWS

ANALYSIS OF DESIGN

APPENDIX A

SECTION I

WALL COMPUTATIONS

WALL NORTH OF MEMORIAL BRIDGE

II. 15'0" WALL (STA. 1+08± to 1+48±
AND STA. 2+68± to 3+09±)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

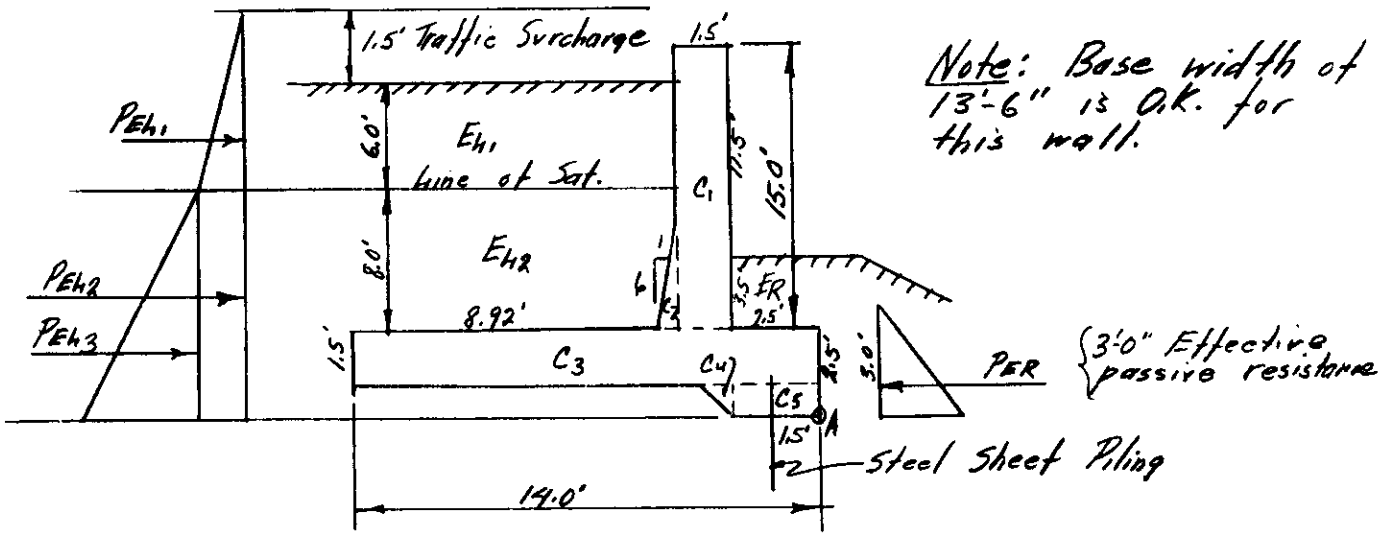
Page

Subject: North Meadows Retaining Wall - Hartford, Conn.

Computation: Sta. 1+08± to 1+48± And Sta. 2+68± to 3+09±

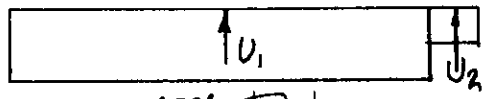
Computed by: J. McL. Checked by: J. H. B. Date: March - 1939

Case I - Water Down

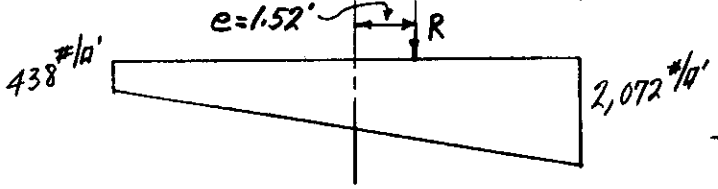


Note: Base width of 13'-6" is O.K. for this wall.

3'-0" Effective passive resistance

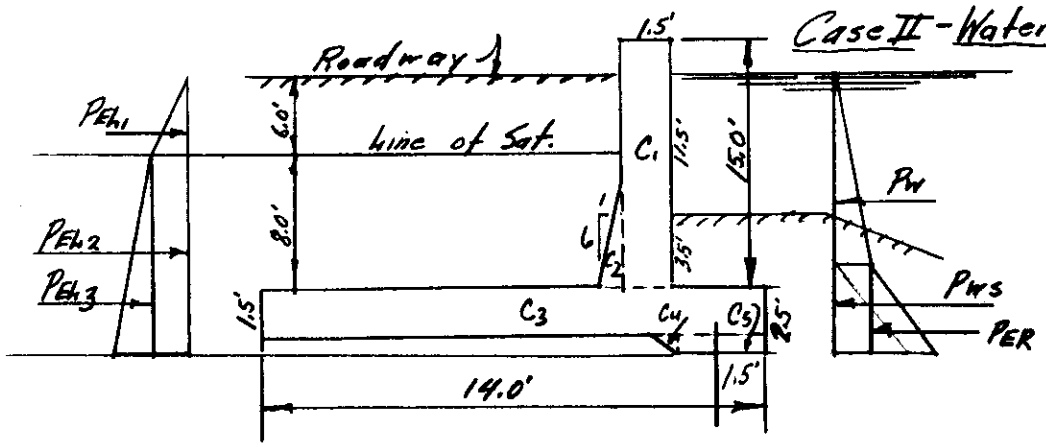


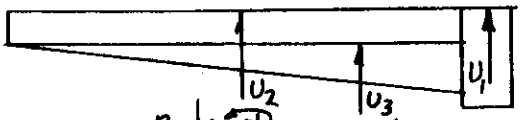
Uplift Diagram



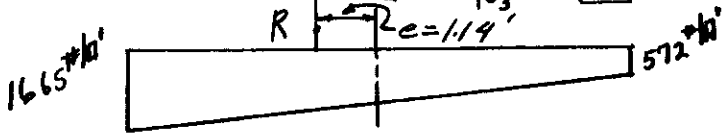
Bearing Diagram

Case II - Water upto El. 46.0





Uplift Diagram



Bearing Diagram

A-5.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation: Sta. 1+08± to 1+48± & Sta. 2+68± to 3+09±

Computed by: J. McL. Checked by: J. H. B. Date: March-1939

Water Down - Traffic surcharge - 1.5' earth

	Forces Acting	↓	↑	→	←	Arm	⟶	↶
C_1	1.5 × 15.0 × 150	3375				3.25	–	10969
C_2	½ × 6.5 × 1.08 × 150	528				4.36	–	2302
C_3	1.5 × 14.0 × 150	3150				7.0	–	22050
C_4	½ × 1.0 × 1.0 × 150	75				2.83	–	212
C_5	1.0 × 2.5 × 150	375				1.25	–	469
E_{L1}	7.5 × 10.0 × 100	7500				9.0	–	67500
E_{L2}	8.0 × 8.92 × 125	8920				9.54	–	85097
E_{L2a}	½ × 6.5 × 1.08 × 125	439				4.72	–	2072
E_{L2b}	1.5 × 1.08 × 125	203				4.54	–	922
E_R	3.5 × 2.5 × 100	875				1.25	–	1094
U_1	9.5 × 12.5 × 62.5		7422			7.75	57520	
U_2	½ × 9.5 × 1.5 × 62.5		445			0.75	334	
P_{EL1}	½ × 7.5 × 7.5 × 35			984		13.0	12792	
P_{EL2}	7.5 × 10.5 × 35			2756		5.25	14469	
P_{EL3}	½ × 10.5 × 10.5 × 80			4410		3.5	15435	
P_{ER}	½ × 3.0 × 3.0 × 35				157	0.73		115
F	Max = 17573 × .45 = 7907				7907	0.5		3954
P_R					86	0.73		63
		25440	7867	8150	8150		10,0,550	196,819
								96,269

$\Sigma V = 17573$

$\frac{\Sigma M}{\Sigma V} = 5.48$ Middle Third = 4.67 / 9.33 } OK.

Passive Resistance Max passive resistance based on h = 2.2'

$\frac{wh^2}{2} \tan^2(45° + \frac{\phi}{2}) = \frac{100 \times 2.2^2}{2} \times 1.555^2 = 583$ #

Net max. allowable = 583 − 157 = 426# } OK.
Used 86#

Note: Could have used base width = 13.5'

$$\text{Eccentricity} = \frac{14}{2} - 5.48 = 1.52$$

$$\text{Bearing} = \frac{17,573}{14}\left(1 \pm \frac{6 \times 1.52}{14}\right) = \begin{matrix} 438\ \#/\square' \text{ Landside} \\ 2072\ \#/\square' \text{ Riverside} \end{matrix}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page ...

Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation:

Computed by: J. McL. Checked by: J. H. B. Date: March - 1939

Water upto El. 46.0 - No traffic

	Forces Acting	↓	↑	→	←	Arm	↷	↶
C_1	1.5 x 15.0 x 150	3375.				3.25		10,969.
C_2	½ x 6.5 x 1.08 x 150	528.				4.36		2302
C_3	1.5 x 14.0 x 150	3150.				7.0		22050.
C_4	½ x 1.0 x 1.0 x 150	75.				2.83		212
C_5	1 x 2.5 x 150	375.				1.25		469.
E_{L1}	6.0 x 10.0 x 100	6000.				9.0		54000.
E_{L2}	8.0 x 8.92 x 125	8920.				9.54		85097.
E_{L2a}	½ x 6.5 x 1.08 x 125	439.				4.72		2072
E_{L2b}	1.5 x 1.08 x 125	203.				4.54		922
E_R	2.5 x 3.5 x 125	1094.				1.25		1368.
W_1	2.5 x 10.5 x 62.5	1641.				1.25		2051.
U_1	1.5 x 16.5 x 62.5		1547.			0.75	1160.	
U_2	12.5 x 9.5 x 62.5		7422.			7.75	57520.	
U_3	½ x 12.5 x 6.0 x 62.5 x ½		1172.			5.67	6645.	
P_{EL1}	½ x 6.0 x 6.0 x 35			630		12.5	7875.	
P_{EL2}	6.0 x 10.5 x 35			2205.		5.25	11576.	
P_{EL3}	½ x 10.5 x 10.5 x 80			4410.		3.5	15435.	
P_W	½ x 13.5 x 13.5 x 62.5				5695.	7.5		42712.
P_{WS}	13.5 x 3.0 x 62.5				2531.	1.5		3796.
P_{Er}	½ x 3.0 x 3.0 x 80				360.	1.0		360.
F	Max = 15659 x .45 = 7047			1341.		0.5	670.	
		25800.	10141.	8586.	8586.		100881.	228,350.

$\Sigma V = 15659.$ $\Sigma M = 127,499.$

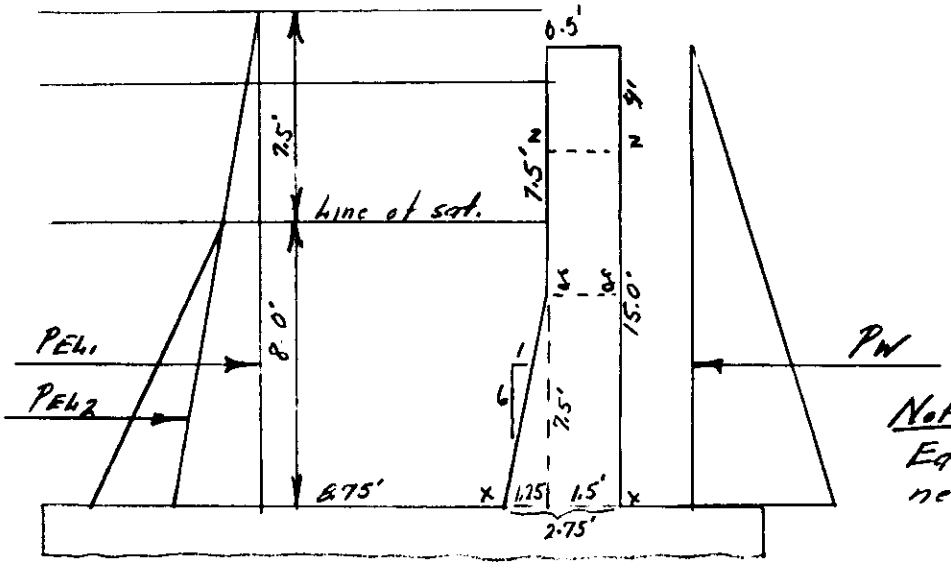
$\frac{\Sigma M}{\Sigma V} = 8.14$ Middle Third: $\begin{cases} 4.67 \\ 9.33 \end{cases}$ OK.

Eccentricity $= \frac{14}{2} - 8.14 = 1.14$

Bearing $= \frac{15,659}{14}\left(1 \pm \frac{6 \times 1.14}{14}\right) = \begin{matrix} 1665\ \#/\square' \text{ Landside} \\ 572\ \#/\square' \text{ Riverside} \end{matrix}$

Subject North Meadows Retaining Wall
Computation
Computed by JSWC Checked by J. McL. Date March - 1939

Design of Stem



Note
Earth on landside neglected

Case I — Water Down

$P_{EH_1} = \frac{1}{2} \times 35 \times 15.5^2 = 4,200 \times 5.17 = 21,700$

$P_{EH_2} = \frac{1}{2}(80-35) \times 8.0^2 = 1,440 \times 2.67 = 3,840$

$\Sigma Y = 5,640 \qquad \Sigma M = 25,540$

$d_{x-x} = \sqrt{\frac{25,540}{123}} = \sqrt{208} = 14.5 + 3.5 = 18''$ O.K.

Unit Shear $= \frac{5,640}{12 \times 0.88 \times 29.5} = 18.1$ #/□" O.K.

$A_{s_{x-x}} = \frac{25,540 \times 12}{18,000 \times 0.88 \times 29.5} = 0.66$ □" Use { 3/4"φ @ 6" c.c. giving $A_s = 0.88$ □" }

$M_{y-y} = \frac{1}{2} \times 35 \times 8^2 \times 2.67 = 3,000$ ft.lb.

$A_{s_{y-y}} = \frac{3,000 \times 12}{18,000 \times 0.88 \times 14.5} = 0.16$ □"

Bond stress @ x-x $= \frac{V}{\Sigma o j d} = \frac{5,640}{2 \times 2.356 \times 0.88 \times 29.5} = 46.2$ #/□" O.K.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

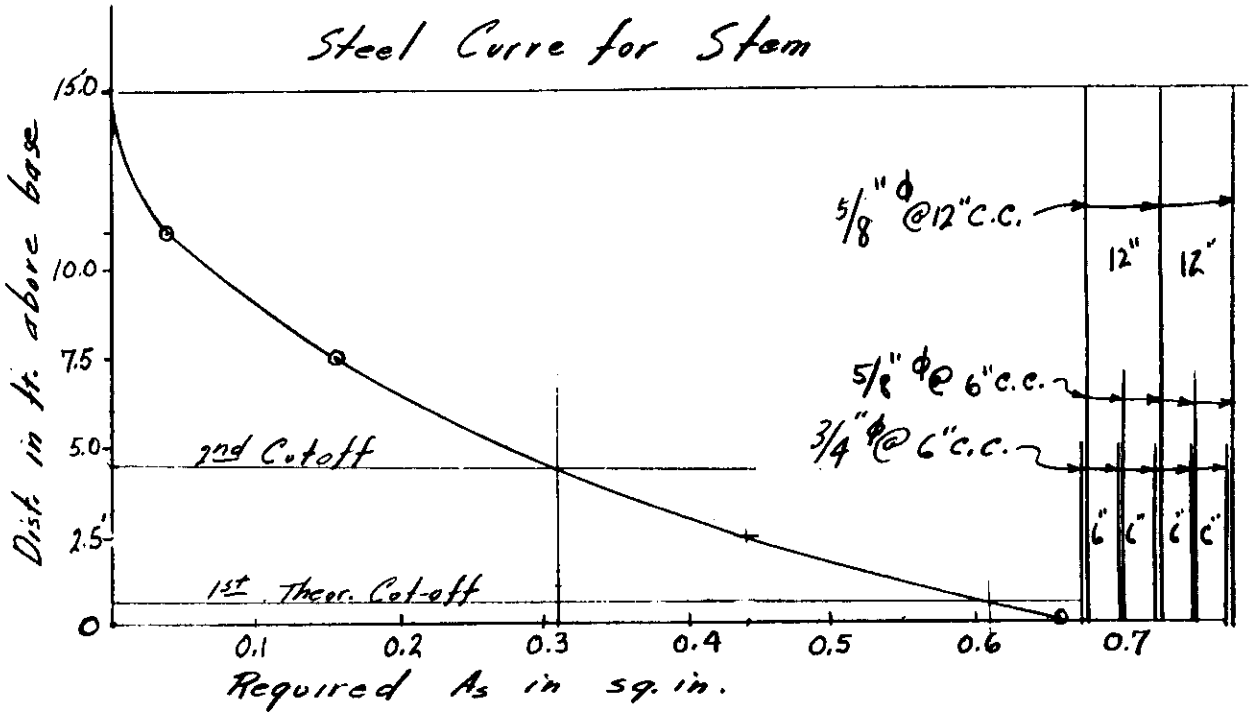
Subject North Meadows Retaining Wall, Hartford, Conn.

Computation

Computed by JSM Checked by J. McL Date March-1939

$$M_{2\text{-}2} = \frac{1}{2} \times 35 \times 4.5^2 + \frac{4.5}{3} = 532'^{\#}$$

$$A_{s\,2\text{-}2} = \frac{532 \times 12}{18{,}000 \times 0.88 \times 14.5} = \underline{\underline{0.03^{\square''}}}$$



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows Retaining Wall

Computation:

Computed by: J.J.L. Checked by: J. McL. Date: March, 1939

Design of Stem – Case II – Water to top of wall

$P_W = \frac{1}{2} \times 62.5 \times 15^2 \times 5 = 35{,}200$ ft.lb.

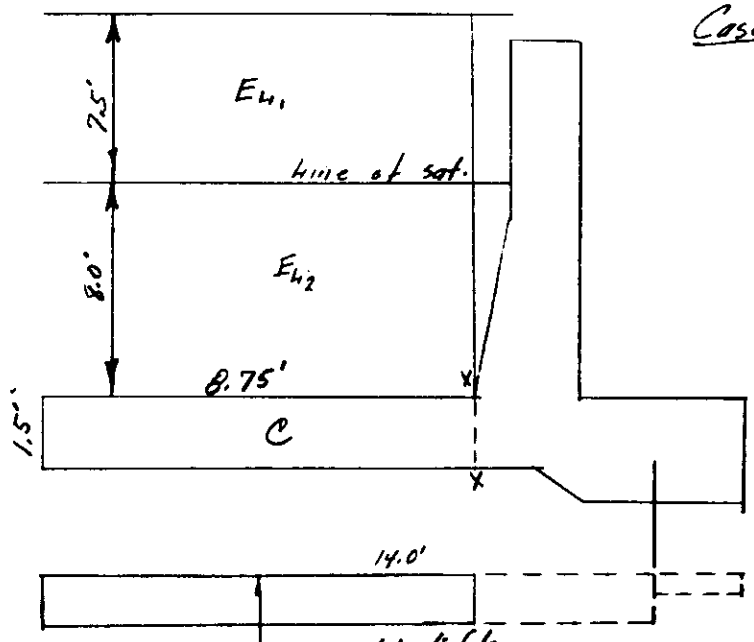
$\frac{1}{2} \times 35 \times 14^2 \times 4.67 = 16{,}020$
$\frac{1}{2}(80-35) \times 8 \times 2.67 = 3{,}840$
$M = 19{,}860$

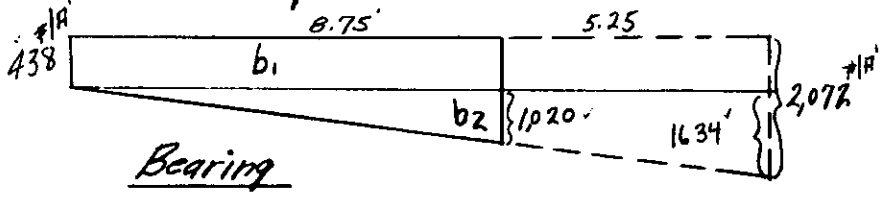
$\Sigma M = 35{,}200 - 19{,}860 = 15{,}340$ ft.lb.

$A_{s_{x-x}} = \frac{15{,}340 \; 12}{18{,}000 \times 0.88 \times 29.4} = 0.40 \square''$ Use $\frac{3}{4}''\phi$ @ 12" c.c giving $A_s = 0.44 \square''$

Design of Landside Base Slab

Case I – Water Down





$\frac{x}{1634} = \frac{8.75}{14.0}$

$x = 1{,}020$

Bearing

Forces Acting		↓	↑	Arm	↙	↗
E_{H_1}	7.5 × 8.75 × 100	6,560		4.38	28,733	
E_{H_2}	8.0 × 8.75 × 125	8,750		4.38	38,325	
C	1.5 × 8.75 × 150	1,970		4.38	8,629	
U_1	9.5 × 62.5 × 8.75		5,200	4.38		22,776
b_1	438 × 8.75		3,835	4.38		16,797
b_2	½ × 1,020 × 8.75		4,470	2.92		13,052
		17,280	13,505		75,687	52,625
		ΣV = 3,775 ↓			ΣM = 23,062 ↙	

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows Retaining Wall

Computation

Computed by: [illegible] Checked by: J. McL. Date: March - 1939

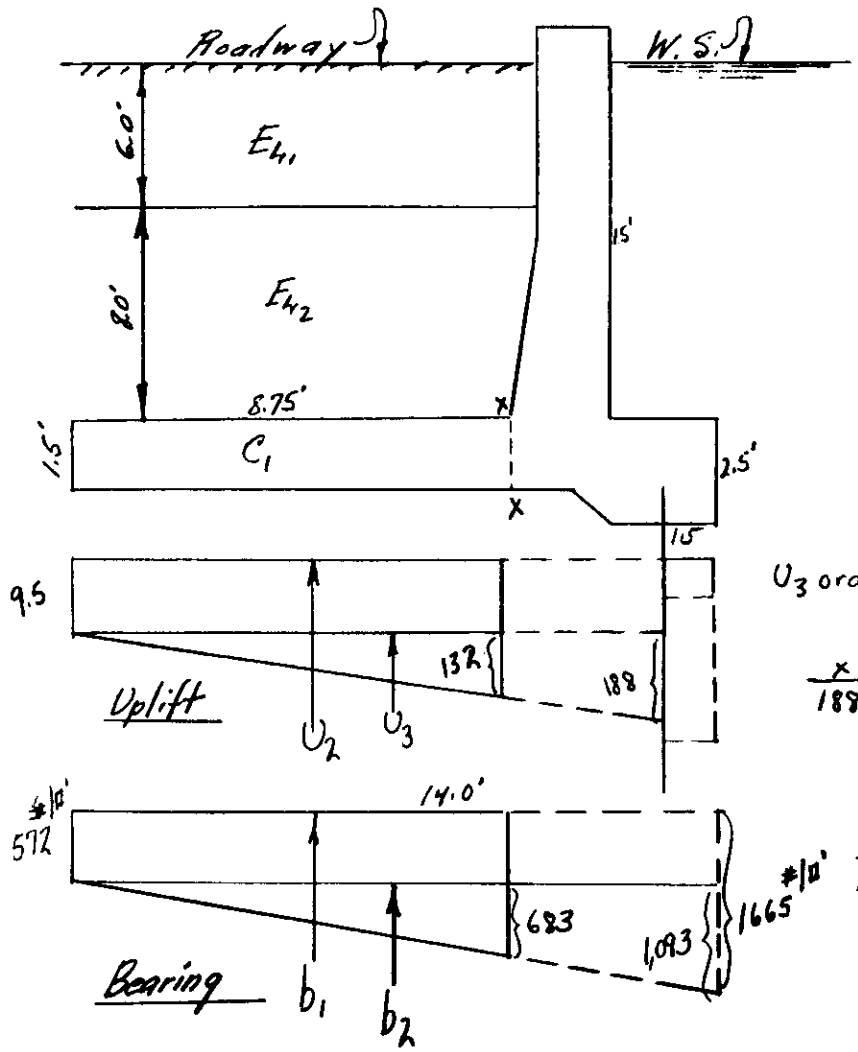
$$d_{x-x} = \sqrt{\frac{23062}{123}} = \sqrt{187} = 13.7'' + 4.5 = \underline{18.2''} \text{ O.K.}$$

$$\text{Unit Shear} = \frac{3,775}{12 \times 0.88 \times 13.5} = \underline{26.4}^{\#/\square''} < 60^{\#/\square''} \therefore \text{O.K.}$$

$$A_{s\,x-x} = \frac{23,062 \times 12}{18,000 \times 0.88 \times 13.5} = \underline{1.30}^{\square''} \text{ Use } \left\{ \begin{array}{l} 1''\phi @ 6''\text{c.c.} \\ \text{giving } A_s = 1.57^{\square''} \end{array} \right\}$$

$$\text{Unit Bond Stress} = \frac{3,775}{3.142 \times 2 \times 0.88 \times 13.5} = 50.5^{\#/\square''}$$

Case II – Water Up – No Traffic



U_3 ordinate $= \frac{1}{2} \times 6.0 \times 62.5$
$= 188$

$$\frac{x}{188} = \frac{8.75}{12.5}$$
$$x = 132$$

$$\frac{x}{1,093} = \frac{8.75}{14}$$
$$x = 683$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows Retaining Wall

Computation

Computed by: JBM Checked by: J. McL. Date: March-1939

Case II

Forces Acting		↓	↑	Arm	Moments ↙	Moments ↗
E_{h_1}	6.0×8.75×100	5,250		4.38	22,995	
E_{h_2}	8.0×8.75×125	8,750		4.38	38,325	
C	1.5×8.75×150	1,970		4.38	8,629	
U_2	9.5×8.75×62.5		5,200	4.38		22,776
U_3	½×132×8.75		578	2.92		1,688
b_1	572×8.75		5,000	4.38		21,900
b_2	½×683×8.75		2,990	2.92		8,731
		15,970	13,768		69,949	55,095
		ΣV = 2,235			ΣM = 14,854	

Case I – Governs

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

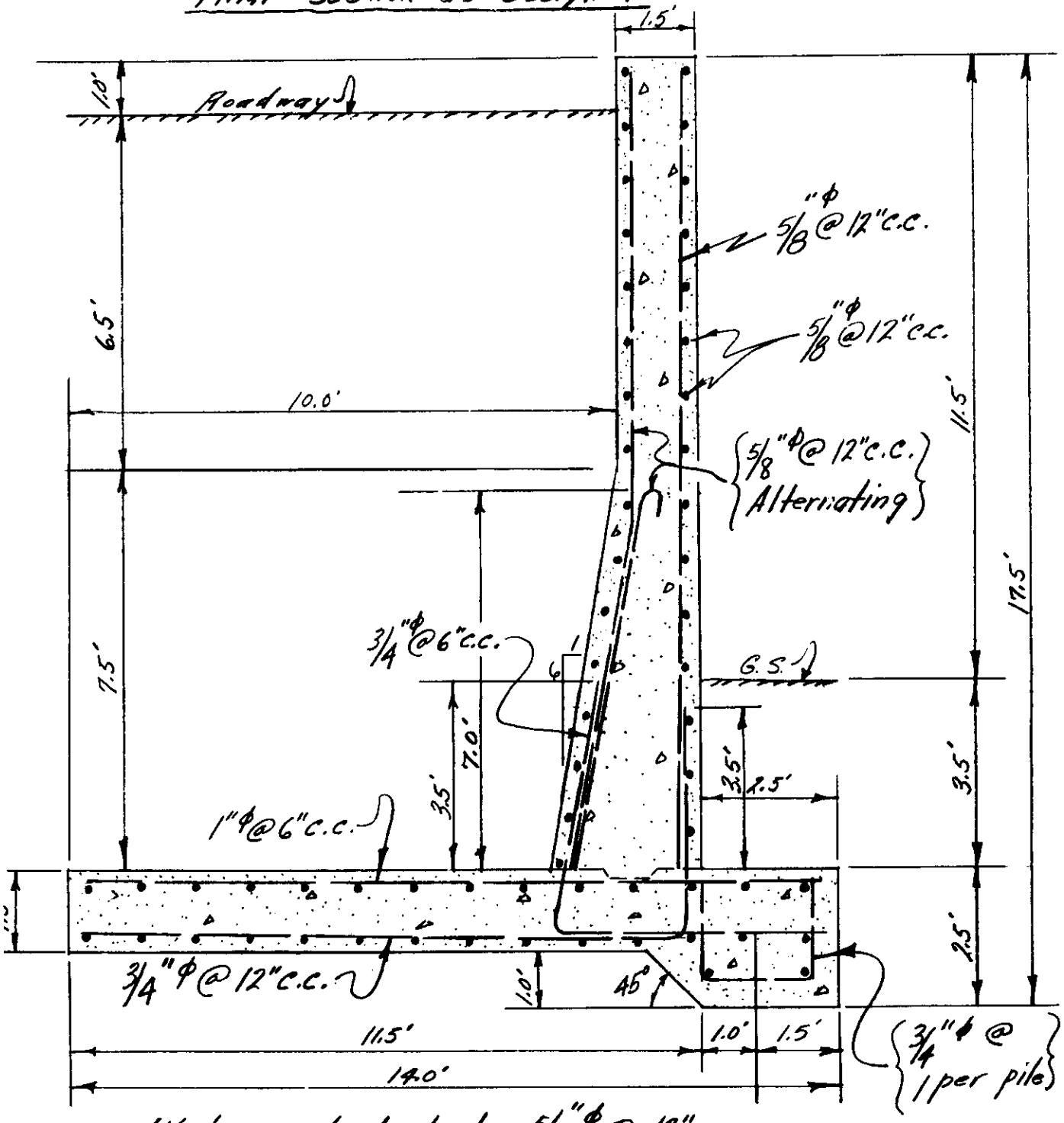
Page

Subject North Meadows Retaining Wall

Computation Sta. 1+08± to 1+48± & Sta. 2+68± to 3+09±

Computed by JM Checked by J. McL. Date March - 1939

Final Section as Designed



All temp. steel to be 5/8"φ @ 12"c.c.

A-13.

III. 12'0" WALL (STA. 1+48±
to STA. 2+68±)

WAR DEPARTMENT

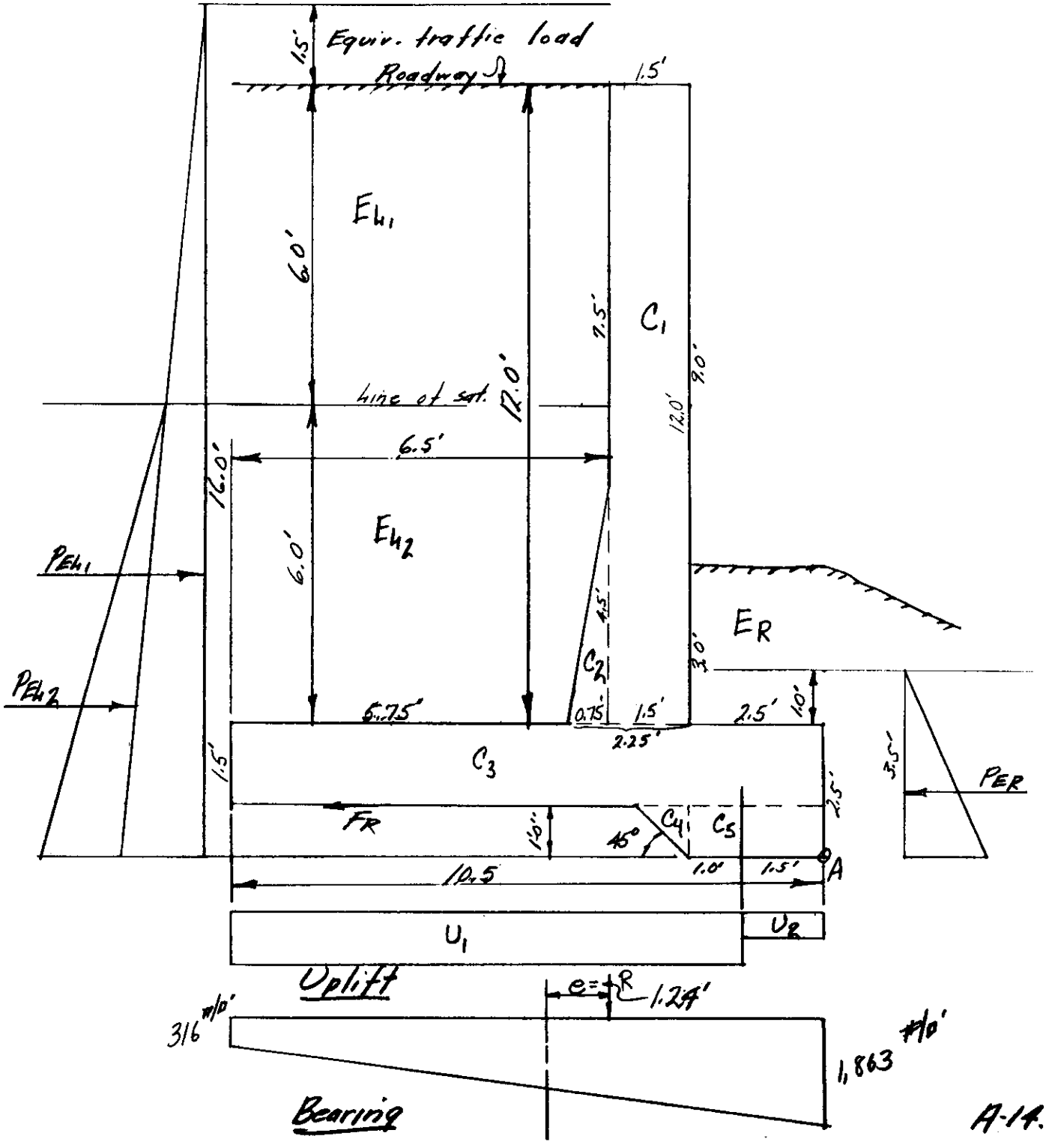
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows Flood Wall - Hartford, Conn.

Computation: Sta. 1+48± to Sta. 2+68±

Computed by: JSM Checked by: S.H.B. Date: March-1939



A-14.

Page

Subject North Meadows Flood Wall, Hartford, Conn.

Computation

Computed by JSM Checked by S.H.B. Date March-1939

10.5' Base

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	1.5×12×150	2,700				3.25		8,775
C_2	1/2×0.75×4.5×25	42				4.25		179
C_3	1.5×10.5×150	2,360				5.25		12,390
C_4	1/2×1×1×150	75				2.83		212
C_5	2.5×1×150	375				1.25		469
E_{4L1}	7.5×6.5×100	4,880				7.25		35,380
E_{4L2}	6×6.5×125	4,880				7.25		35,380
E_{4R}	3×2.5×100	750				1.25		938
P_{EL1}	1/2×35×76^2			4,480		5.33	23,878	
P_{EL2}	1/2(80-35)×8.5^2			1,625		2.83	4,599	
P_{ER}	1/2×35×3.5^2				215	1.17		252
U_1	7.5×62.5×9.0		4,220			6.00	25,320	
U_2	(8.5×62.5×1.5)1/2		398			0.75	299	
F_R	0.45×11,444				5,150	1.00		5,150
P_R	6,105−5365				740	1.17		866
		16,062	4,618	6,105	6,105		54,096	99,991
		ΣV = 11,444		ΣH = 0			ΣM = 45,895	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{45,895}{11,444} = 4.01'$ O.K. Middle 3rd $= \frac{10.5}{3} = 3.5'$

Passive Res. $= \frac{100 \times 3.5^2}{2} \times 3.43 = 2,100^{\#} > 740^{\#}$ ∴ O.K.

Eccentricity $= \frac{10.5}{2} - 4.01 = 1.24$

A-15.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

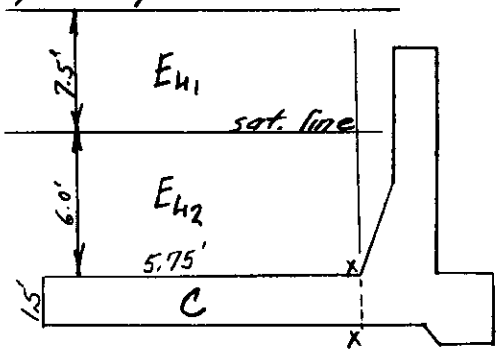
Subject: North Meadows Flood Wall, Hartford, Conn.

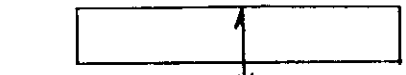
Computation

Computed by: JM Checked by: S.H.B. Date: March, 1939

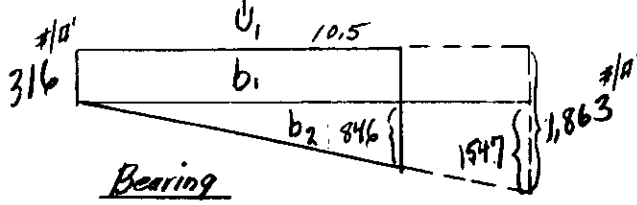
$$\text{Bearing} = \frac{11,444}{10.5}\left(1 \pm \frac{(6)(1.24)}{10.5}\right) = \frac{11,444}{10.5} \times 1.71 = 2,863\ \#/\square' \qquad \times 0.29 = 316\ \#/\square'$$

Design of Landside Base Slab





Uplift



$$\frac{x}{1547} = \frac{5.75}{10.5} \qquad x = 846$$

Bearing

Forces Acting		↓	↑	Arm	Moments ↺	Moments ↻
E_{H_1}	7.5 × 5.75 × 100	4320		2.88	12,442	
E_{H_2}	6 × 5.75 × 125	4,320		2.88	12,442	
C	1.5 × 5.75 × 150	1,293		2.88	3,724	
U_1	7.5 × 62.5 × 5.75		2700	2.88		7,776
b_1	116 × 5.75		667	2.88		1,921
b_2	1/2 × 846 × 5.75		2432	1.92		4,669
		9,933	5,799		28,608	14,366
		ΣV = 4,134 ↓			ΣM = 14,242 ↺	

$$d_{x-x} = \sqrt{\frac{14,242}{123}} = \sqrt{109} = 10.4 + 3.5'' = \underline{13.9''} \quad \text{O.K.}$$

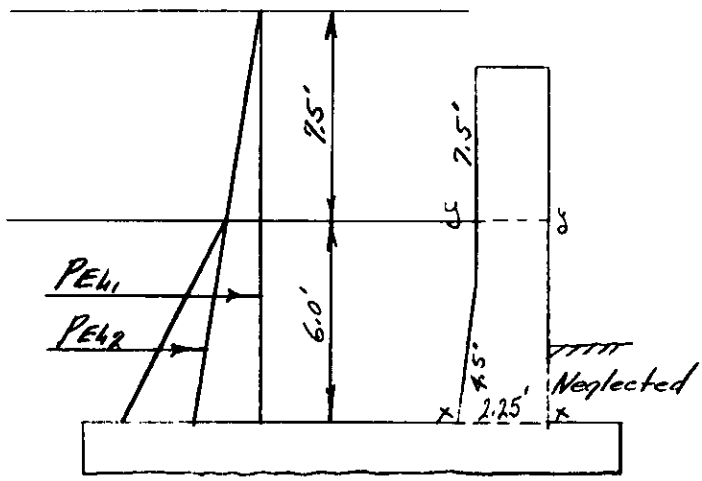
$$\left.\begin{matrix}\text{Unit}\\ \text{Shear}\end{matrix}\right\} = \frac{4,134}{12 \times 0.88 \times 14.5} = \underline{27.0\ \#/\square''} < 60\ \#/\square'' \quad \therefore \text{O.K.}$$

Subject North Meadows Flood Wall, Hartford, Conn.
Computation
Computed by JBM Checked by S.H.B. Date March-1939

$$A_{s\,x-x} = \frac{14{,}242 \times 12}{18{,}000 \times 0.88 \times 14.5} = 0.75^{\square''} \text{ Use } \left\{ \begin{array}{l} 3/4''\phi @ 6''\text{c.c.} \\ \text{giving } A_s = 0.88^{\square''} \end{array} \right\}$$

Top of base

Design of Stem - Case I - Water Down



$P_{EH_1} = \frac{1}{2} \times 35 \times 13.5^2 = 3{,}190^{\#}$

$P_{EH_2} = \frac{1}{2}(80-35) \times 6^2 = 810$

$\Sigma H = 4{,}000^{\#}$

$\Sigma M =$
$3{,}190 \times 4.5 = 14{,}355$
$810 \times 2.0 = 1620$
$\Sigma M = 15{,}975$

$$d_{x-x} = \sqrt{\frac{15{,}975}{123}} = \sqrt{130} = 11.4'' + 3.5'' = 14.9'' \text{ O.K.}$$

$$\left.\begin{array}{l}\text{Unit}\\ \text{Shear}\end{array}\right\} = \frac{4{,}000}{12 \times 0.88 \times 23.5} = 16.2^{\#/\square''} < 60^{\#/\square''} \therefore \text{O.K.}$$

$$A_{s\,x-x} = \frac{15{,}975 \times 12}{18{,}000 \times 0.88 \times 23.5} = 0.52^{\square''} \text{ Use } \left\{ \begin{array}{l} 5/8''\phi @ 6''\text{c.c.} \\ \text{giving } A_s = 0.61^{\square''} \end{array} \right\}$$

$$\Sigma M_{y-y} = \frac{1}{2} \times 35 \times 7.5^2 \times 2.5 = \underline{2{,}460} \text{ ft. lb.}$$

$$A_{s\,y-y} = \frac{2{,}460 \times 12}{18{,}000 \times 0.88 \times 14.5} = 0.13^{\square''}$$

$$\left.\begin{array}{l}\text{Unit Bond}\\ \text{Stress}\end{array}\right\}_{x-x} = \frac{4{,}000}{4.7 \times 0.88 \times 23.5} = 41.2^{\#/\square''} < 150^{\#/\square''} \therefore \text{O.K.}$$

WAR DEPARTMENT

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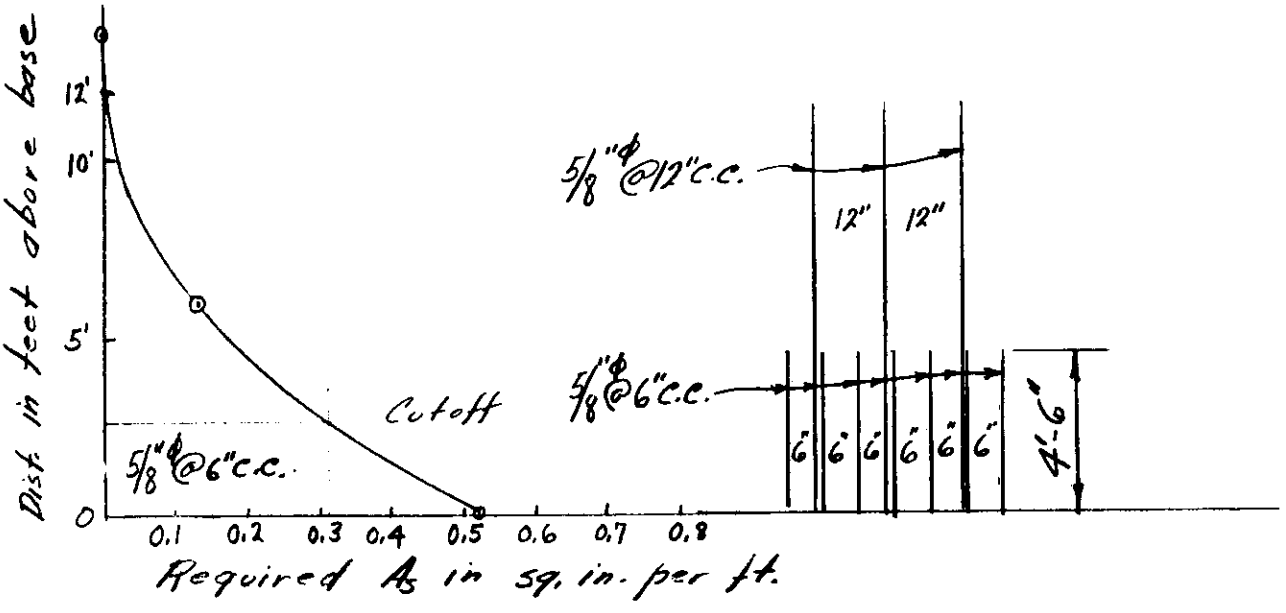
Subject North Meadows Flood Wall, Hartford, Conn.

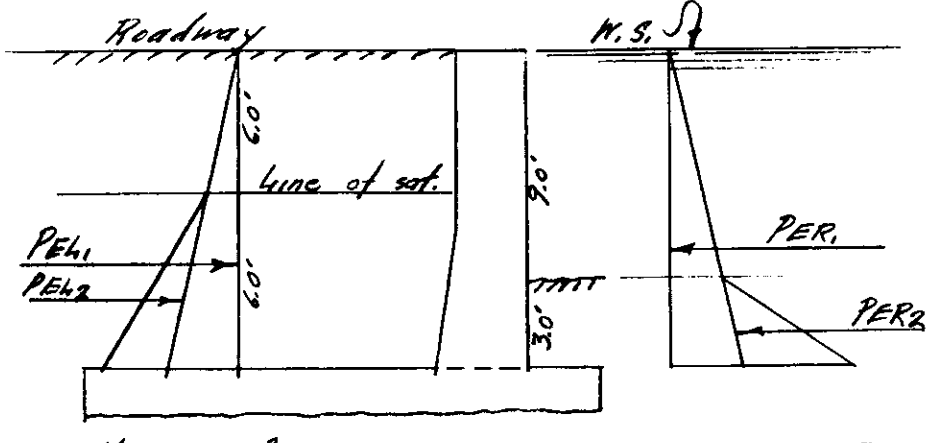
Computation

Computed by JSM Checked by S.H.B. Date March-1939

Design of Stem Con't.



Design of Stem Con't. - Case II - Water to top of wall.



$P_{EH_1} = \frac{1}{2} \times 35 \times 12^2 = 2{,}520 \quad \times 4.00 = 10{,}080$

$P_{EH_2} = \frac{1}{2}(80-35) \times 6^2 = 810 \quad \times 2.00 = 1{,}620$

$\Sigma H = 3{,}330 \rightarrow \quad \Sigma M = 11{,}700 \curvearrowright$

$P_{ER_1} = \frac{1}{2} \times 62.5 \times 12^2 = 4{,}500 \quad \times 4.00 = 18{,}000$

$P_{ER_2} = \frac{1}{2}(\overset{17.5}{80-62.5}) \times 3^2 = 78.7 \quad \times 1.00 = 78.7$

$\Sigma H = 4{,}579 \leftarrow \quad \Sigma M = 18{,}709 \curvearrowleft$

$\Sigma H = 1{,}249 \leftarrow \quad \Sigma M = 6{,}379$ ft.lbs. $\curvearrowleft$

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Subject North Meadows Flood Wall, Hartford, Conn.

Computation

Computed by JM Checked by S.H.B. Date March-1939

$$A_{s_{xx}} = \frac{6{,}379 \times 12}{18{,}000 \times 0.88 \times 23.5} = \frac{0.21\,\square''}{5} \text{ Use } \left\{ \begin{array}{l} 5/8''\phi \text{ @ } 12'' \text{ c.c.} \\ \text{giving } A_s = 0.31\,\square'' \end{array} \right\}$$

Temp. steel - Use min. steel - 5/8"ϕ @ 12" c.c.

WAR DEPARTMENT

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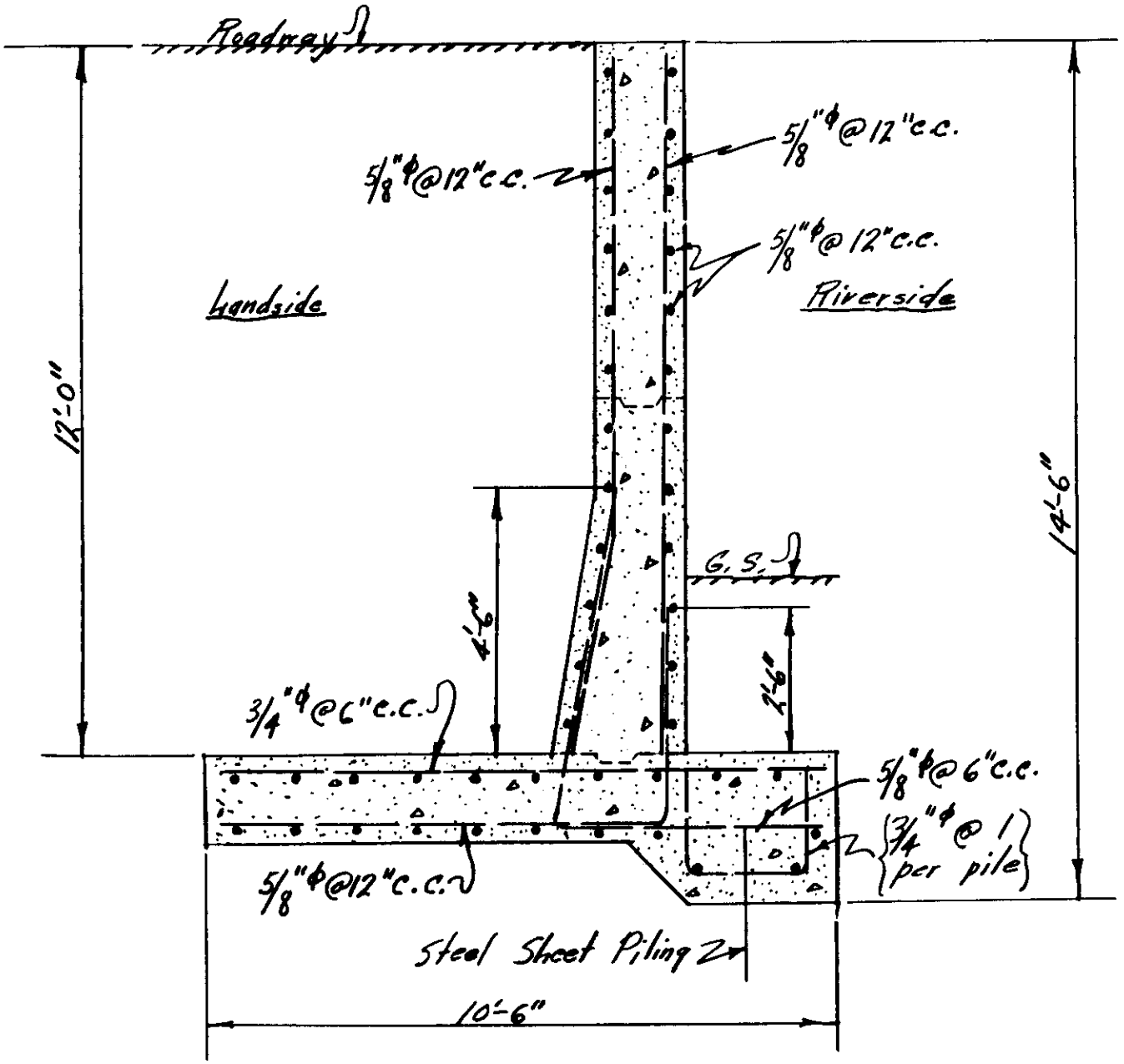
Page

Subject: North Meadows Flood Wall, Hartford, Conn.

Computation: Sta. 1+48 ± to Sta. 2+68 ±

Computed by: JJM Checked by: S. H. B. Date: March-1939

Final Section as Designed



Min. cover for steel in stem = 3"

" " " " " base = 4"

All temp. steel to be 5/8"φ@12"c.c.

A-20.

IV. 14'0" WALL (AVERAGE SECTION) (STA. 3+09± to 3+69± and STA. 3+89± to 4+08±)

WAR DEPARTMENT

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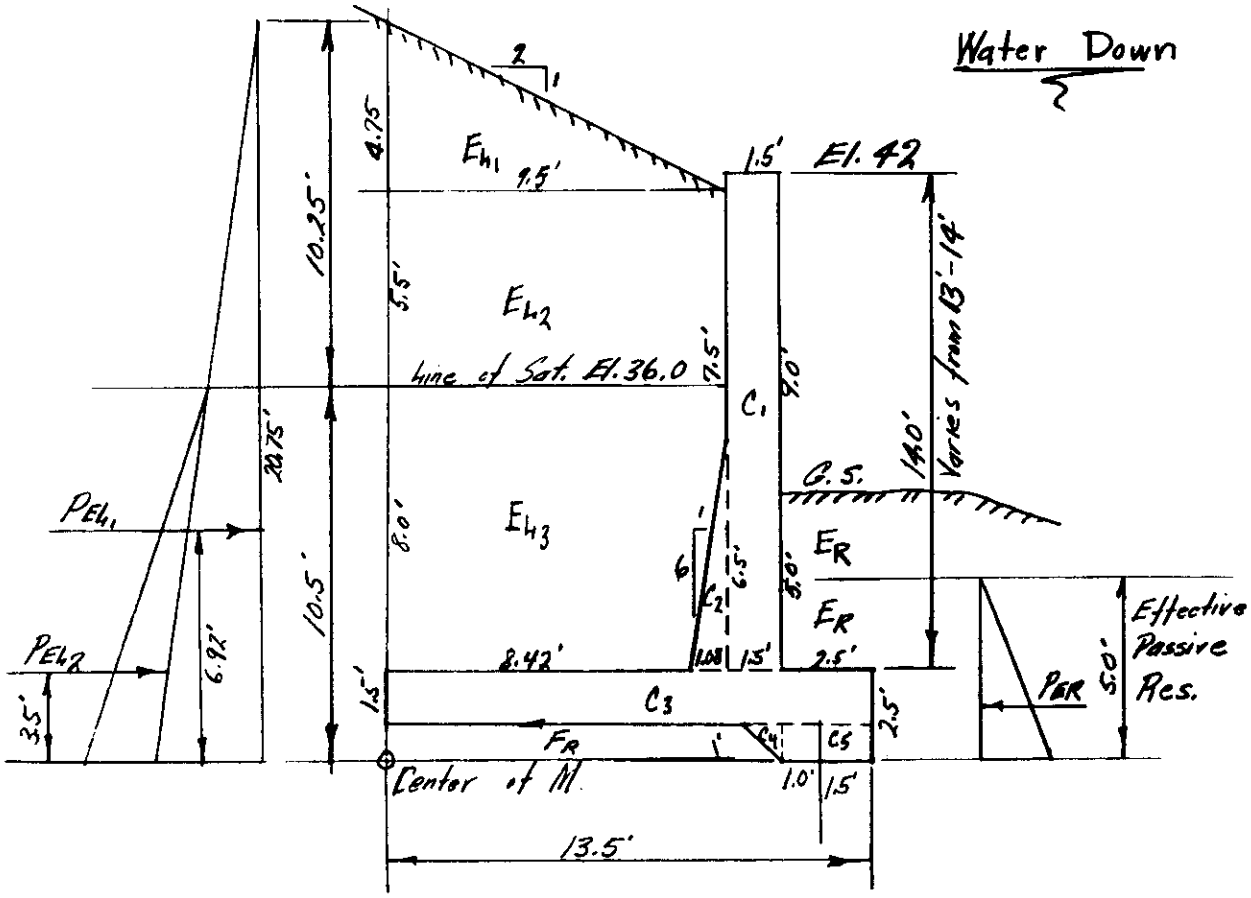
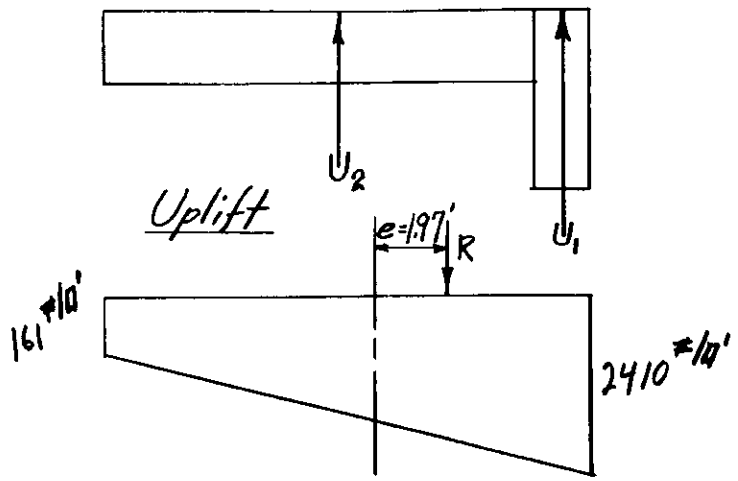
Page

Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation: Average Section - Sta. 3+09± to 3+69± & Sta. 3+69± to 4+08±

Computed by: JSM Checked by: Date: March - 1939





Uplift

Bearing

A-21.

Page

Subject North Meadows Retaining Wall, Hartford, Conn.

Computation

Computed by JSM Checked by Date March-1939

FORCES ACTING		↓	↑	→	←	ARM	MOMENTS ABOUT A ↻	MOMENTS ABOUT A ↺
C_1	1.5×14×150	3,150				10.25	32,288	
C_2	½×1.08×6.5×25	88				9.14	804	
C_3	1.5×13.5×150	3,040				6.75	20,520	
C_4	½×1×1×150	75				10.67	800	
C_5	2.5×1×150	375				12.25	4,594	
E_{h1}	½×4.75×9.5×100	2,260				3.17	6,530	
E_{h2}	5.5×9.5×100	5,230				4.75	24,843	
E_{h3}	8×9.5×125	9,500				4.75	45,125	
F_R	5×2.5×100	1,250				12.25	15,313	
P_{Eh1}	½×35×20.75²			7,540		6.92	52,177	
P_{Eh2}	½(80-35)10.5²			2,480		3.50	8,680	
P_{ER}	½×35×5²				442	1.67		738
U_1	½×10.5×1.5×62.5		493			12.75		6,286
U_2	9.5×12.0×62.5		7,120			6.00		42,720
F_R	0.45×17,355				7,810	1.00		7,810
P_R					1,768	1.67		2,953
		24,968	7,613	10,020	10,020		211,674	60,507
		ΣV = 17,355 ↓		ΣH = 0			ΣM = 151,167 ↻	

Position of Resultant $= \frac{\Sigma M}{\Sigma V} = \frac{151,167}{17,355} = 8.71$ O.K. Middle 3rd = 4.5' to 9.0'

Max. Passive Res. $= \frac{100 \times 5.0^2}{2} \times 3.44 = 4,300^{\#} > 1,768^{\#}$ O.K.

Eccentricity $= \frac{13.5}{2} - 4.79 = 1.97$

WAR DEPARTMENT

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Subject: North Meadows Retaining Wall, Hartford, Conn. Page

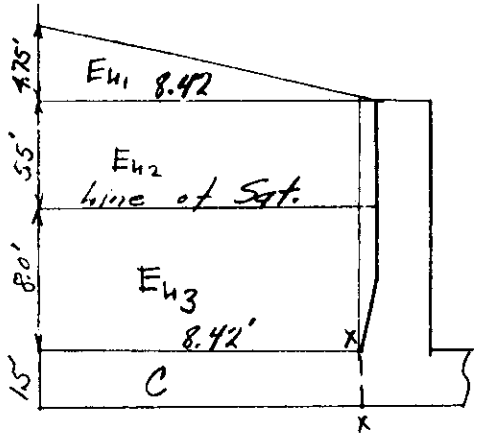
Computation

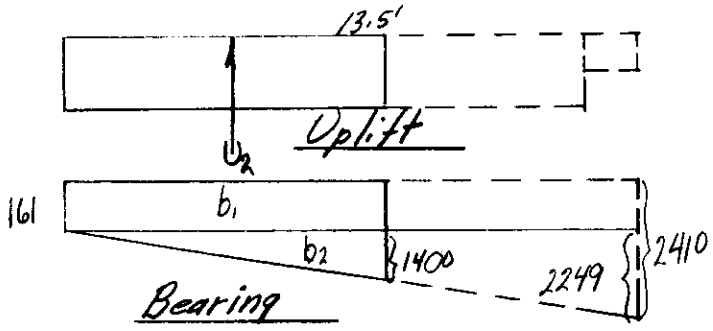
Computed by: JSM Checked by Date: March-1939

$$\text{Bearing} = \frac{17{,}355}{13.5}\left(1 \pm \frac{(6)(1.97)}{13.5}\right) = \frac{17{,}355}{13.5} \times 1.875 = 2{,}410 \ \#/\square' \qquad \left(\frac{(6)(1.97)}{13.5} = 0.875\right)$$

$$\times 0.125 = 161 \ \#/\square'$$

Design of Landside Base Slab





$$\frac{x}{2249} = \frac{8.42}{13.5}$$

$$x = 1{,}400$$

Forces Acting		↓	↑	Arm	Moments x-x ↶	↷
E_{h1}	½×4.75×8.42×100	2,000		5.61	11,220	
E_{h2}	5.5×8.42×100	4,630		4.21	19,492	
E_{h3}	8.0×8.42×125	8,420		4.21	35,448	
C	1.5×8.42×150	1,893		4.21	7,970	
U_2	9.5×8.42×62.5		5,000	4.21		21,050
b_1	161×8.42		1,358	4.21		5,717
b_2	½×1400×8.42		5,900	2.81		16,579
		16,943	12,258		74,130	43,346
		$\Sigma V = 4{,}685$			$\Sigma M = 30{,}784$ ↶	

Subject North Meadows Retaining Wall, Hartford, Conn.
Computation
Computed by JSM Checked by Date March-1939

$$d_{x-x} = \sqrt{\frac{M}{K}} = \sqrt{\frac{30,784}{123}} = \sqrt{250} = 15.8 + 3.5 = \underline{19.3''}$$

18" base O.K. Note: Heavier steel put in for this short section rather than increasing the base 2"

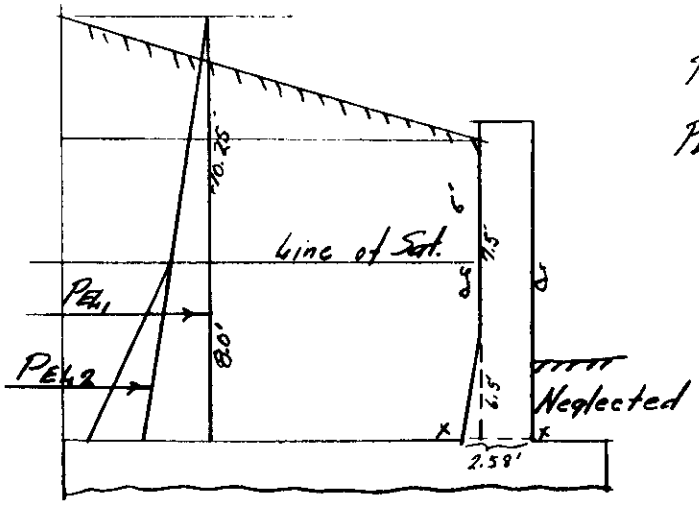
$$\left.\begin{matrix}\text{Unit}\\ \text{Shear}\end{matrix}\right\}_{x-x} = \frac{V}{bjd} = \frac{4,685}{12 \times 0.884 \times 14.5} = 32.9^{\#/\square'} < 60^{\#/\square'} \therefore \underline{O.K.}$$

$$A_{s\,x-x} = \frac{M}{f_s j d} = \frac{30,784 \times 12}{18000 \times 0.884 \times 14.5} = 1.60^{\square''/'} \text{ of wall in Top of base.}$$

Use $\left\{\begin{matrix}1''\phi @ 6''\text{C.C.}\\ \text{giving } A_s = 1.57^{\square''}\end{matrix}\right\}$ O.K. since this section varies from 13'-0" to 14'-0" above base.

$$\left.\begin{matrix}\text{Unit}\\ \text{Bond}\end{matrix}\right\}_{x-x} = \frac{V}{\Sigma o j d} = \frac{4,685}{6.3 \times 0.884 \times 14.5} = 58^{\#/\square''} < 150^{\#/\square''} \underline{O.K.}$$

Design of Stem



$$P_{EH_1} = \tfrac{1}{2} \times 35 \times 18.25^2 = 5,840$$

$$P_{EH_2} = \tfrac{1}{2}(80-35) \times 8.0^2 = 1,440$$

$$\Sigma H_{x-x} = 7,280^{\#}$$

ΣM

$$5,840 \times 6.08 = 35,507$$

$$1,440 \times 2.67 = 3,845$$

$$\Sigma M = 39,352 \text{ ft. lb.}$$

$$d_{x-x} = \sqrt{\frac{39,352}{123}} = \sqrt{320} = 17.9 + 3.5 = 21.4'' \ \underline{O.K.}$$

$$\left.\begin{matrix}\text{Unit}\\ \text{Shear}\end{matrix}\right\}_{x-x} = \frac{7,280}{12 \times 0.884 \times 27.5} = 25^{\#/\square''} < 60^{\#/\square''} \therefore \underline{O.K.}$$

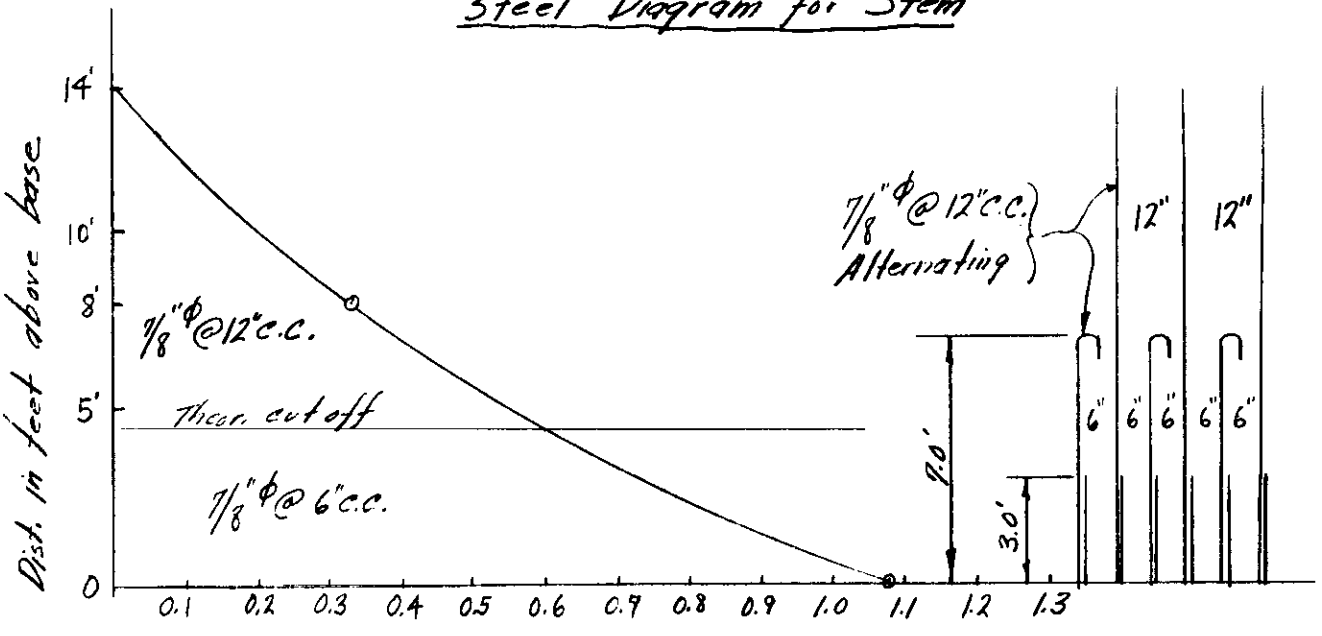
Subject North Meadows Retaining Wall, Hartford, Conn.
Computation
Computed by JSM **Checked by** **Date** March – 1939

$$A_{s_{x-x}} = \frac{39{,}352 \times 12}{18{,}000 \times 0.884 \times 27.5} = 1.08^{\square''} \quad \text{Use} \left\{ \begin{array}{l} 7/8''\phi \text{ @ } 6'' \text{ c.c.} \\ \text{giving } A_s = 1.20^{\square''} \end{array} \right\}$$

$$\Sigma M_{y-y} = \left(\tfrac{1}{2} \times 35 \times 10.25^2\right) \times \frac{10.25}{3} = 6{,}280 \text{ ft.lb.}$$

$$A_{s_{y-y}} = \frac{6{,}280 \times 12}{18{,}000 \times 0.884 \times 14.5} = \frac{0.33^{\square''}}{5}$$

Steel Diagram for Stem



Temp. Steel – Use min. of 5/8"φ @ 12" c.c.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

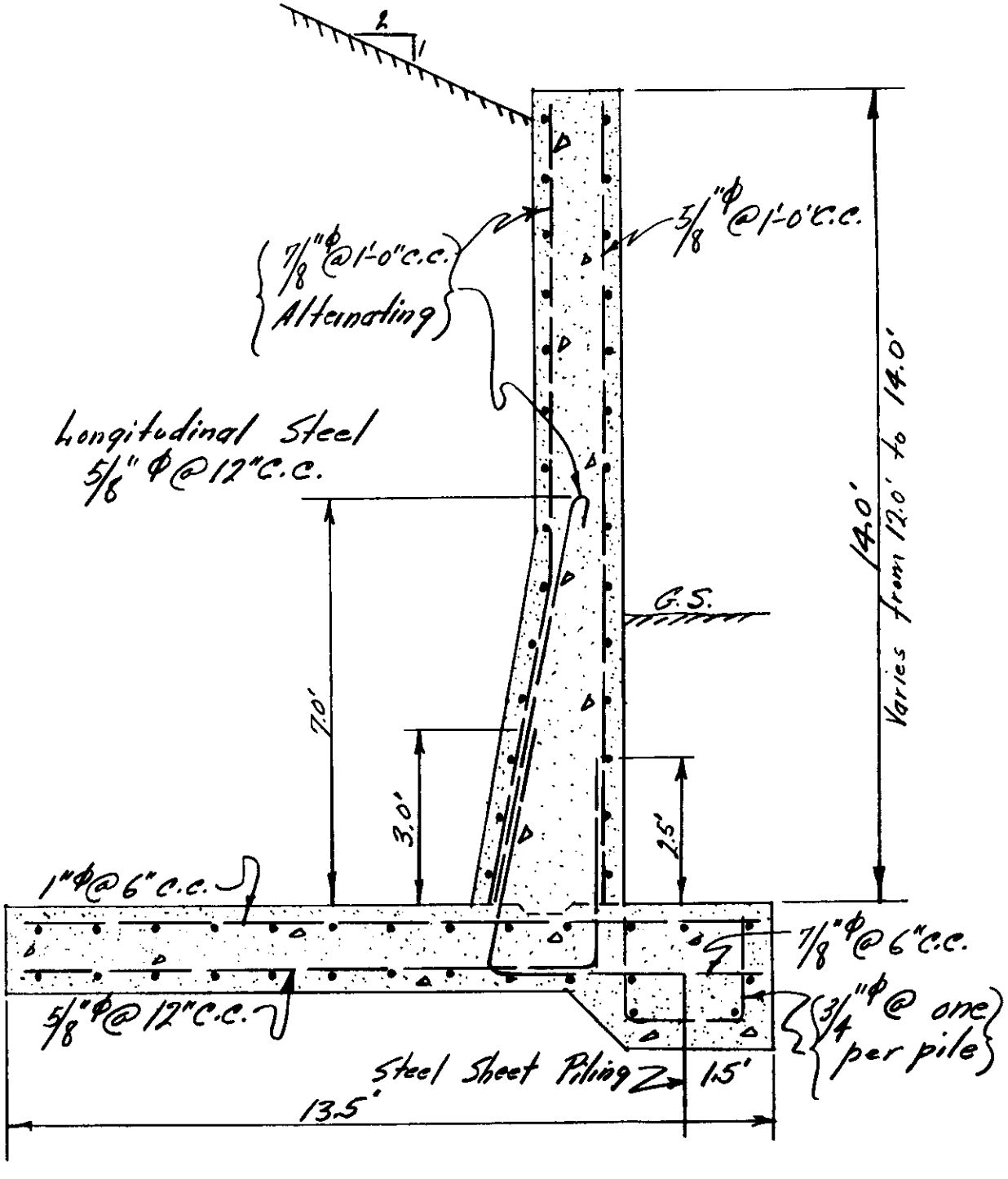
Page

Subject North Meadows Retaining Wall, Hartford, Conn.

Computation Average Section - Sta. 3+09± to 3+69± & Sta. 3+89± to 4+08±

Computed by JBM Checked by Date March - 1939

Final Section as Designed



A-26.

V. 12'6" WALL (AVERAGE SECTION) (STA. 3+69± to 3+89± and STA. 4+08± to 4+66±)

WAR DEPARTMENT

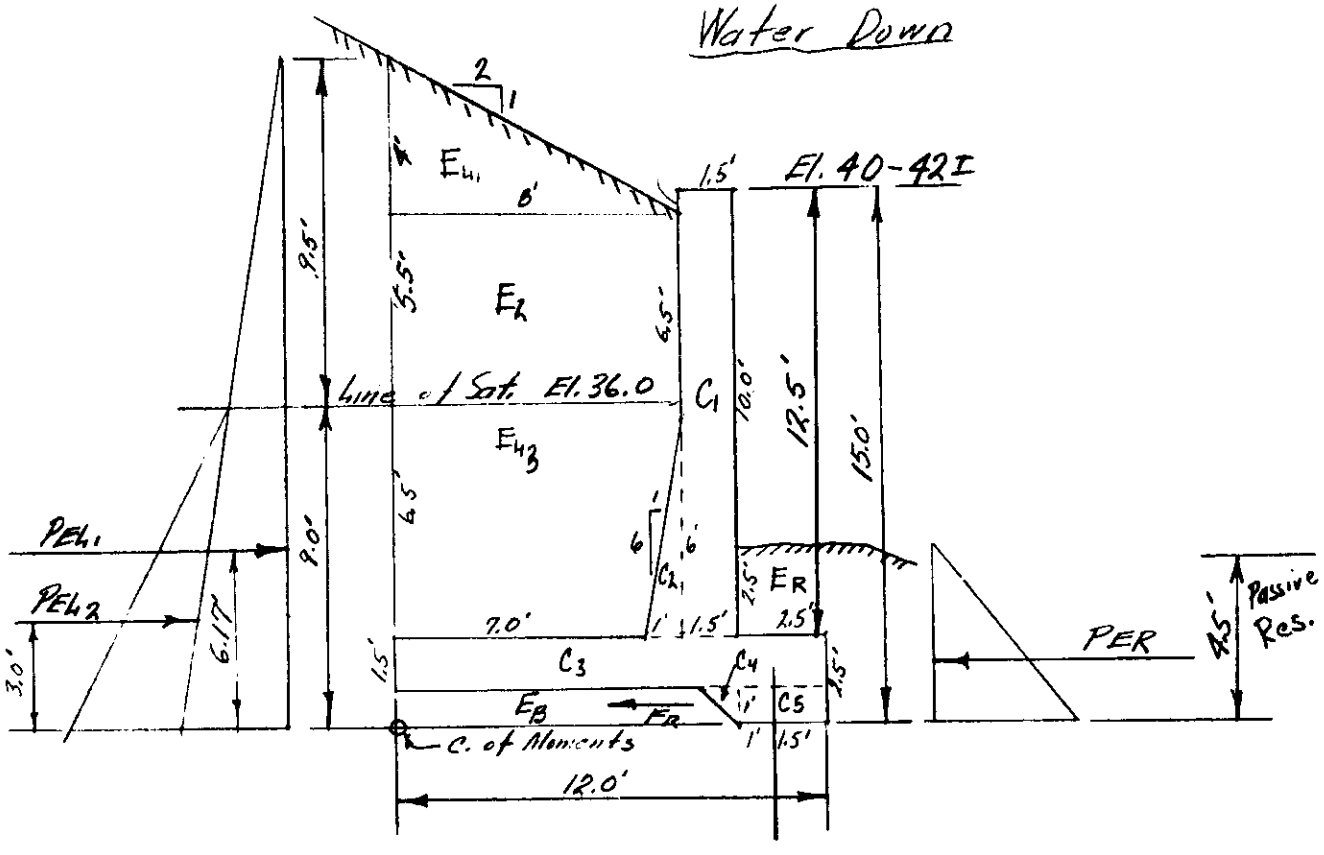
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

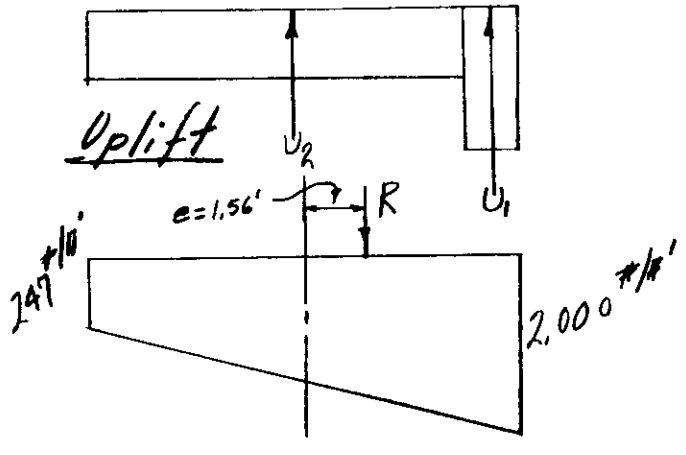
Page

Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation: Average Section - Sta. 3+69± to 3+89± & Sta. 4+08± to 4+66±

Computed by: JSWL Checked by: RHM Date: March - 1939





Bearing

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Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation

Computed by: HM Checked by: J. McL. Date: March-1939

Forces Acting		↓	↑	→	←	Arm	Moments ↷	Moments ↶
C_1	1.5×12.5×150	2,810				8.75	24,588	
C_2	½×1×6×25	75				7.67	575	
C_3	12×1.5×150	2,700				6.00	16,200	
C_4	½×1×1×150	75				9.17	688	
C_5	2.5×1×150	375				10.75	4,031	
E_{H_1}	½×4×8×100	1,600				2.67	4,272	
E_{H_2}	5.5×8×100	4,400				4.00	17,600	
E_B	8×6.5×125	6,500				4.00	26,000	
E_R	2.5×2.5×100	625				10.75	6,719	
P_{EH_1}	½×35×18.5²			6,000		6.17	37,020	
P_{EH_2}	½(80-35)×9²			1,821		3.00	5,463	
P_{ER}	½×35×5²				437	1.67		730
U_1	½×9×1.5×62.5		422			11.25		4,740
U_2	8×10.5×62.5		5,250			5.25		27,550
		19160	5,672	7821	437			
	ΣV=	13490		7384				
F_R	0.45×13490				6070	1.00		6070
P_R					1314	1.50		1970
		19160	5672	7821	7821		143156	41060
		ΣV= 13490 #↓		ΣH = 0			ΣM= 102100 '# ↶	

$$\frac{\Sigma M}{\Sigma V} = \frac{102100}{13490} = 7.56 \qquad \text{Middle 3rd} = 4.0' - 8.0'$$

$$\text{Max Passive Res.} = \frac{100 \times 4.5^2}{2} \times 3.44 = 3480^{\#} > \underline{1314} \text{ O.K.}$$

$$\text{Eccentricity} = \frac{12.0}{2} - 4.44 = 1.56'$$

$$\text{Bearing} = \frac{13,490}{12}\left(1 \pm \frac{(6)(1.56)}{12}\right) = \frac{13,490}{12} \times 1.78 = 2,000^{\#/\square'}$$

$$\times 0.22 = 247^{\#/\square'}$$

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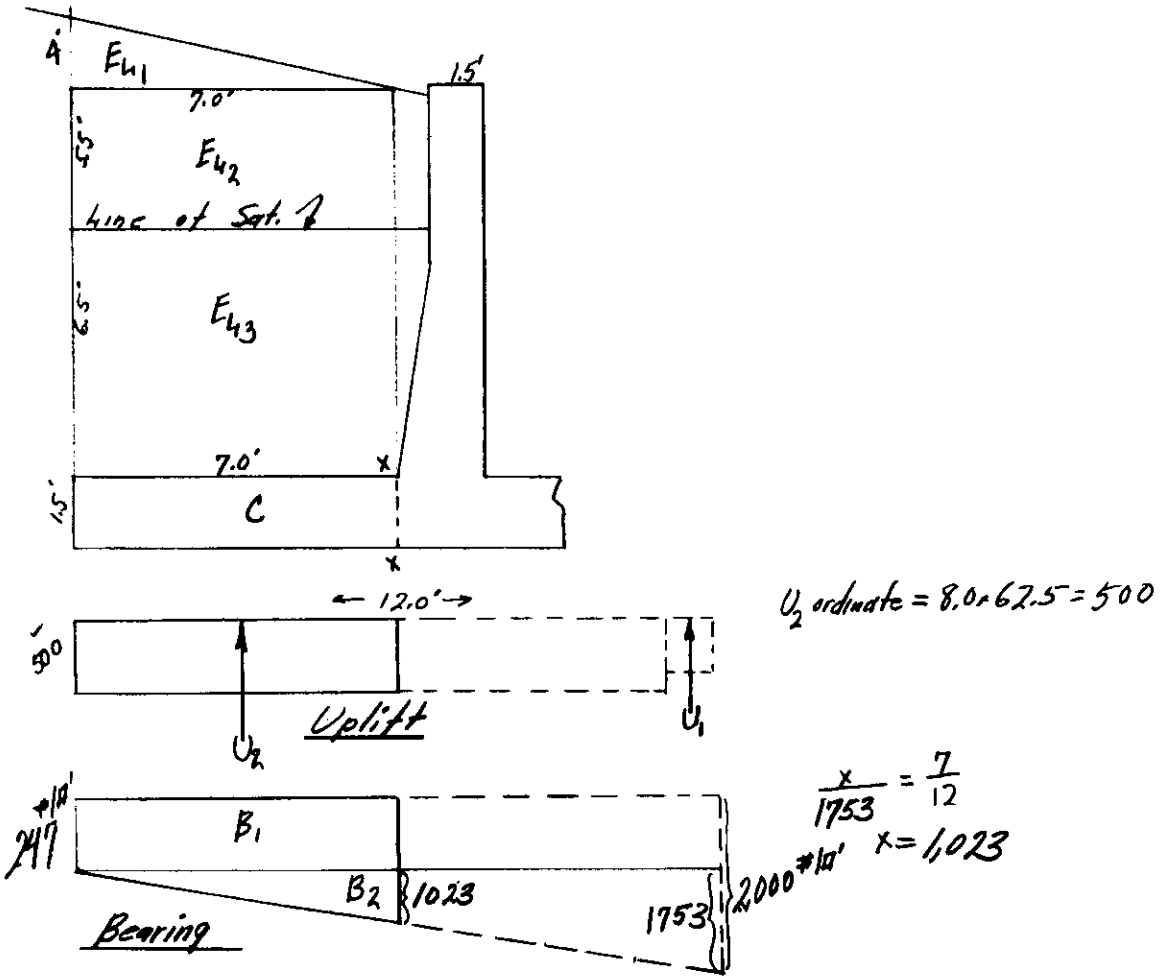
Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation

Computed by: JMM Checked by: J. McL Date: March-1939

Design of Landside Base Slab



Forces Acting		↓	↑	Arm	Moments x-x ↶	↷
E_{L1}	½ × 4 × 7 × 100	1,400		4.67	6,538	
E_{L2}	5.5 × 7 × 100	3,850		3.50	13,475	
E_{L3}	6.5 × 7 × 125	5,690		3.50	19,915	
C	1.5 × 7 × 150	1,575		3.50	5,513	
U_2	500 × 7		3,500	3.50		12,250
B_1	247 × 7		1,729	3.50		6,050
B_2	½ × 1023 × 7		3,580	2.33		8,340
		12,515	8,809		45,441	26,640
		Σv = 3,706			ΣM = 18,800	

A-29.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: North Meadows Retaining Wall, Hartford, Conn. Page

Computation

Computed by: JWK Checked by: J. McL. Date: March - 1939

$$d_{x-x} = \sqrt{\frac{M}{K}} = \sqrt{\frac{18,800}{123}} = \sqrt{153} = 12.4''$$

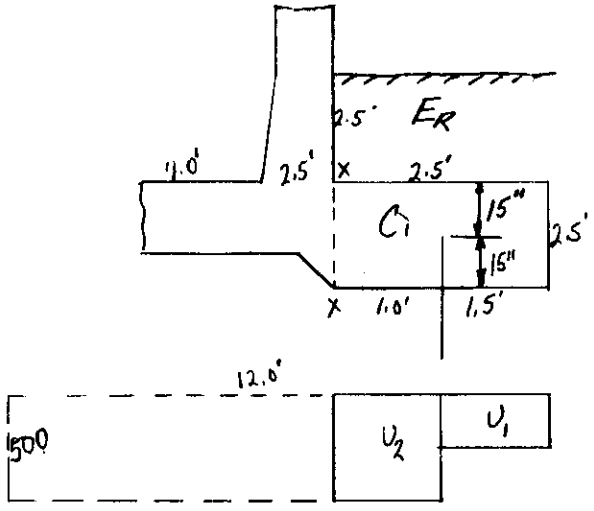
Req'd Depth = 12.4 + 4.5 = 16.9" ∴ 18" base is O.K.

$$\left.\begin{matrix}\text{Unit}\\ \text{Shear}\end{matrix}\right\}_{x-x} = \frac{V}{bjd} = \frac{3,706}{(12)(0.884)(13.5)} = 25.9^{\#/\square'} < 60^{\#/\square'} \therefore \underline{O.K.}$$

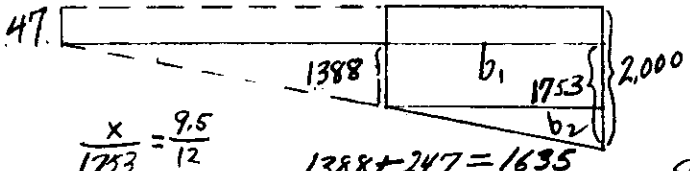
$$A_{s\,x-x} = \frac{M}{f_s jd} = \frac{18,800 \times 12}{18,000 \times 0.88 \times 13.5} = \underline{1.05}^{\square''/'} \text{ in top of base}$$

Use: 7/8" ϕ @ 6" c.c. giving $A_s = 1.20^{\square''/'}$

Design of Riverside Base Slab



Forces Acting		↓	↑	Arm	Moments ↺	Moments ↻
E_R	2.5×2.5×100	625		1.25	781	
C	2.5×2.5×150	937		1.25	1,171	
U_1	½×9×1.5×62.5		422	1.75		739
U_2	500×1.0		500	0.50		250
b_1	1635×2.5		4,090	1.25		5,112
b_2	½×365×2.5		456	1.67		762
		1,562	5,468		1952	6,863
		ΣV = 3,906			ΣM = 4911	



$$\frac{x}{1753} = \frac{9.5}{12}$$

x = 1388

1388 + 247 = 1635

$$d_{x-x} = \sqrt{\frac{4,911}{123}} = \sqrt{39.9} = \underline{6.3''} \text{ O.K.}$$

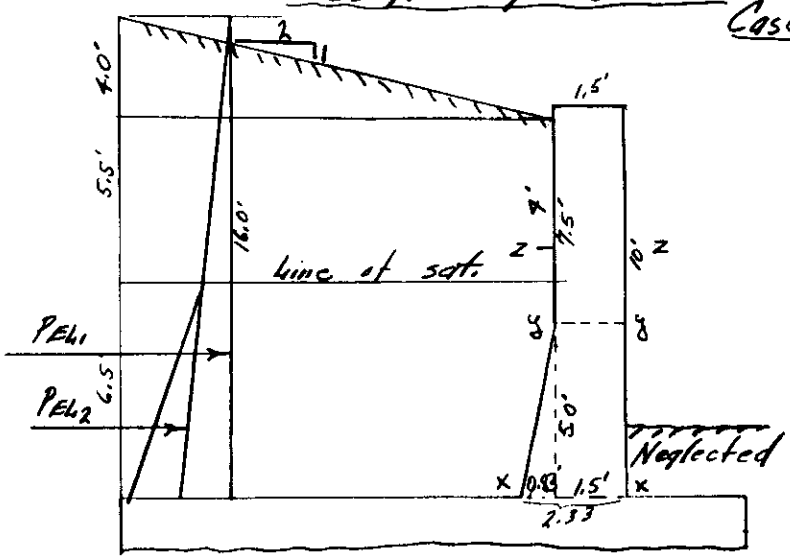
$$\left.\begin{matrix}\text{Unit}\\ \text{Shear}\end{matrix}\right\}_{x-x} = \frac{3,906}{(12)(0.884)(15)} = \underline{24.6}^{\#/\square''} \underline{\text{O.K.}}$$

$$A_{s\,x-x} = \frac{4,911 \times 12}{18,000 \times 0.88 \times 15.0} = \underline{0.25}^{\square''} ✓$$

Subject North Meadows Retaining Wall, Hartford, Conn.
Computation
Computed by JMC Checked by J. McK. Date March-1939

Design of Stem

Case: I - Water down



$P_{EL_1} = \frac{1}{2} \times 35 \times 16^2 = 4{,}480$

$P_{EL_2} = \frac{1}{2}(80-35) \times 6.5^2 = 950$

$\Sigma H_{x-x} = 5{,}430^{\#}$

$\Sigma M =$

$4480 \times 5.33 = 23{,}900$

$950 \times 2.17 = 2{,}060$

$\Sigma M_{x-x} = 25{,}960'^{\#}$

$$d_{x-x} = \sqrt{\frac{25{,}960}{123}} = \sqrt{211} = 14.5'' + 3.5'' = 18'' \quad \text{O.K.}$$

$$\left.\begin{matrix}\text{Unit}\\ \text{Shear}\end{matrix}\right\}_{x-x} = \frac{5{,}430}{(12)(0.88)(24.5)} = 21.0^{\#/\square''} < 60^{\#/\square''} : \text{O.K.}$$

$$A_{s\,x-x} = \frac{25{,}960 \times 12}{18{,}000 \times 0.88 \times 24.5} = 0.80^{\square''/'}$$

Use: $3/4''\phi$ @ 6" c.c. giving $A_s = 0.88^{\square''}$

$$\Sigma M_{y-y} = \left(\tfrac{1}{2} \times 35 \times 12^2\right) \times 4 = 10{,}080 \text{ ft.lb.}$$

$$A_{s\,y-y} = \frac{10{,}080 \times 12}{18{,}000 \times 0.88 \times 14.5} = 0.53^{\square''}$$

$$\Sigma M_{z-z} = \tfrac{1}{2} \times 35 \times 7.5^2 \times \frac{7.5}{3} = 2{,}460 \text{ ft.lb.}$$

$$A_s = \frac{2{,}460 \times 12}{18{,}000 \times 0.88 \times 14.5} = 0.13^{\square''}$$

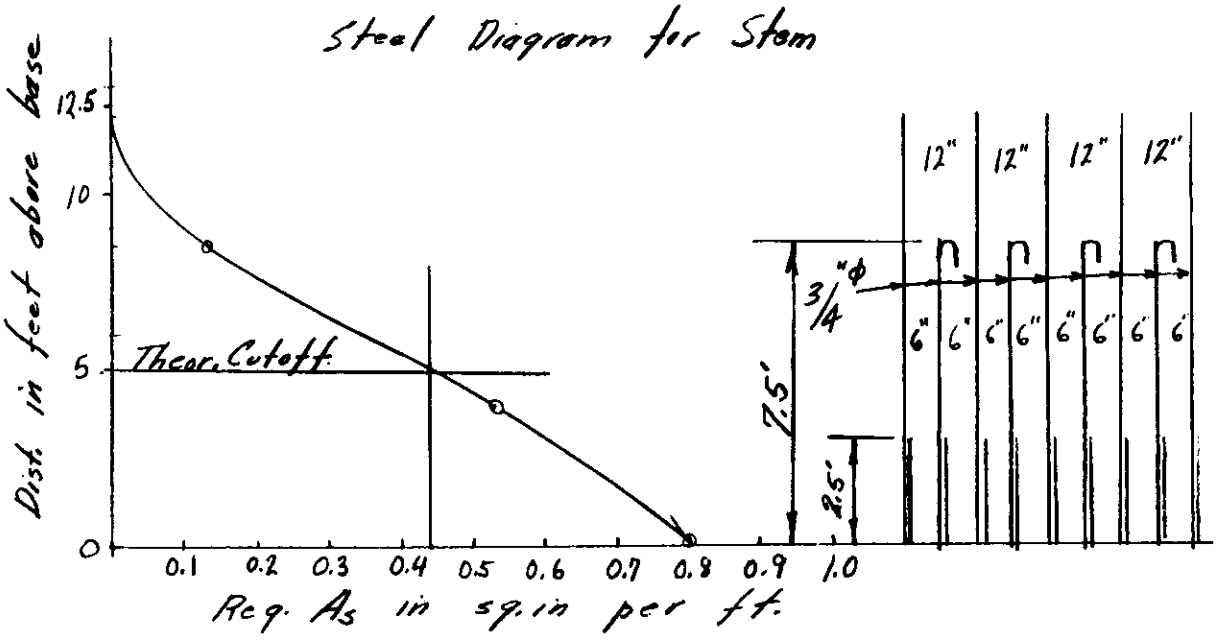
WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: North Meadows Retaining Wall, Hartford, Conn. Page

Computation

Computed by: JSM Checked by: J. McL. Date: March - 1939



Temp. Steel - Use min. of 5/8"φ @ 1'-0" c.c.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

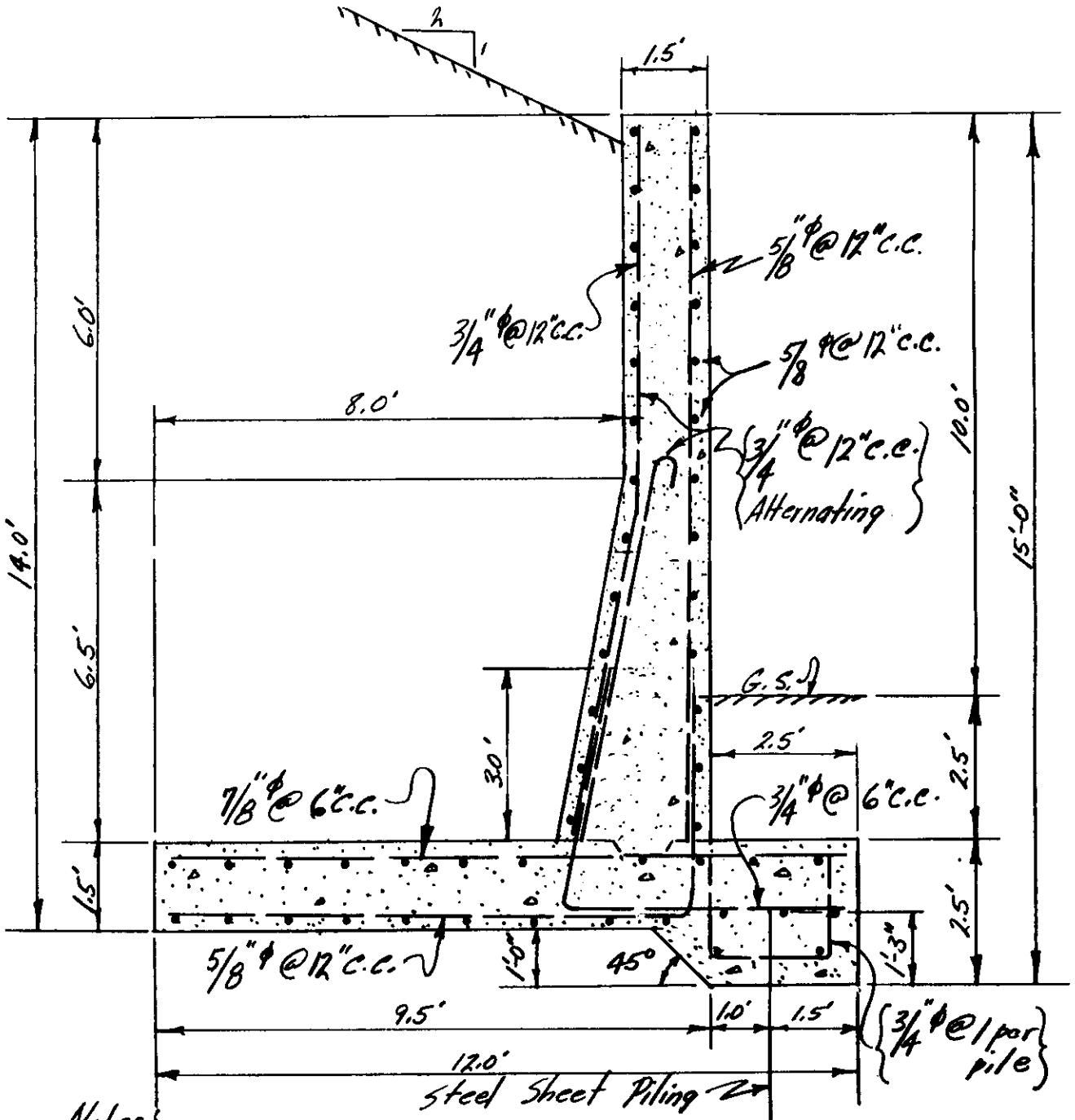
Page

Subject: North Meadows Retaining Wall, Hartford, Conn.

Computation: Average Section - Sta. 3+69 to 3+89± & Sta. 4+08± to 4+66±

Computed by: J.W.C. Checked by: J. McL. Date: March - 1939

Final Section as Designed



Notes:

Min cover for steel in stem = 3"

" " " " base = 4"

All temp steel 5/8"φ @ 12" c.c.

A-33.

HARTFORD - NORTH MEADOWS

ANALYSIS OF DESIGN

APPENDIX A

SECTION II

STOP-LOG STRUCTURE NO. 1

WILLIMANTIC DIVISION

ANALYSIS OF DESIGN

CONCRETE STOP-LOG STRUCTURE #1. NEW YORK,

NEW HAVEN AND HARTFORD RAILROAD - WILLIMANTIC DIVISION

AT DIKE STA. 50+70.1

NORTH MEADOWS - HARTFORD, CONN.

INTRODUCTION

This is the complete Analysis of Design for the concrete stop-log structure #2 proposed at the New York, New Haven and Hartford Railroad - Springfield Division - Dike Sta. 160+52.99 - North Meadows, Hartford, Connecticut.

The structure consists of two counterfort walls, founded in rock, and placed perpendicular to the railroad in line with the North Meadows earth dike. Due to the unusual height of the structure, some saving in cost has been realized by placing the counterfort walls perpendicular to the railroad rather than parallel as is the usual practice for smaller stop-log structures.

One set of grooves are provided for a single row of timber stop-logs. A wide flange beam with supporting struts and foundation is provided to reduce by one-half the length of the stop-log timbers. The timber stop-logs are to be backed with sandbags at time of floods to reduce leakage.

Loading conditions and uplift assumptions comply with those recommended for Flood Walls and similar structures.

For concrete and reinforcement details of structure - see drawings File Nos. CT-4-1486 to 1495, inclusive.

GENERAL DESIGN DATA

1. Loading. - The structure shall be loaded to give the worst possible condition. The two counterfort walls shall be investigated for the following condition of loading.

Water to top of wall on riverside.

a. Uplift pressure on base on riverside of sheet piling assumed to be full hydrostatic pressure at that point.

b. Uplift pressure on base on landside of sheet piling assumed to diminish uniformly along path of creep from 50% of the differential head at the sheet piling to zero at the edge of the base slab.

c. Uplift from tailwater assumed to be 100% effective.

2. Path of Creep. - The minimum path of creep with sheet pile cut-off and without a filter shall be taken as 6 times the head.

3. Overturning. - The resultant shall intersect the base within the middle third.

4. Sliding. - The coefficient of sliding shall not exceed 0.45 for class four or six material. Passive pressure against the shear key and the top foot of the sheet pile, due to bearing on the earth at the land-side edge at the key, may be considered to resist sliding.

5. Reinforced Concrete.

a. In general, the concrete design is based on the "Joint Code of the American Concrete Institute and the Reinforcing Steel Institute for the Design of Concrete and Reinforced Concrete" issued in 1928 and the "Progress Report" of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete issued in January 1937.

fs = 18,000#/□ "; fc = 800#/□ "

V = 60#/□ " (without special anchorage)

V = 90#/□ " (with special anchorage)

u = 150#/□ " (without special anchorage)

u = 200#/□ " (with special anchorage)

n = 12

Length of embedment for bond - 40 diameters of reinforcing bar

All reinforcement to be deformed bars of new billet steel, intermediate grade.

6. Stem. - The vertical stem shall be designed as a continuous beam fixed between the counterforts.

7. Riverside Base Slab. - The riverside base slab shall be designed as a continuous beam fixed between the counterforts.

8. Landside Base Slab. - The landside base slab shall be designed as a cantilever beam fixed at the edge of support.

9. Counterforts. - The counterforts shall be designed to take the load in tension transferred from the stem and base.

10. Covering of Reinforcement. - Cover on all surfaces for reinforcement shall be at least 3 inches, except where concrete is deposited against earth in which case a cover of 4 inches shall be used.

11. Unit Weights.

Weight of water = 62.5#/cu.ft.

Weight of dry earth = 100#/cu.ft.

Weight of saturated earth = 125#/cu.ft.

Weight of reinforced concrete = 150#/cu.ft.

Maximum coefficient of sliding = 0.45 (obtained from Soils Laboratory)

Equivalent liquid pressure of dry earth = 35#/cu.ft.

Equivalent liquid pressure of saturated earth = 80#/cu.ft.

12. Timber. - Timber for the stop-logs to be select White Oak S4S and creosoted.

The working stresses used in the design of the stop-logs are as follows:

Timber stress fs	=	1750#/□ "
Vertical shear	=	156#/□ "
Horizontal shear	=	125#/□ "
Bearing - b	=	265#/□ "
Weight	=	50#/ cu.ft.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

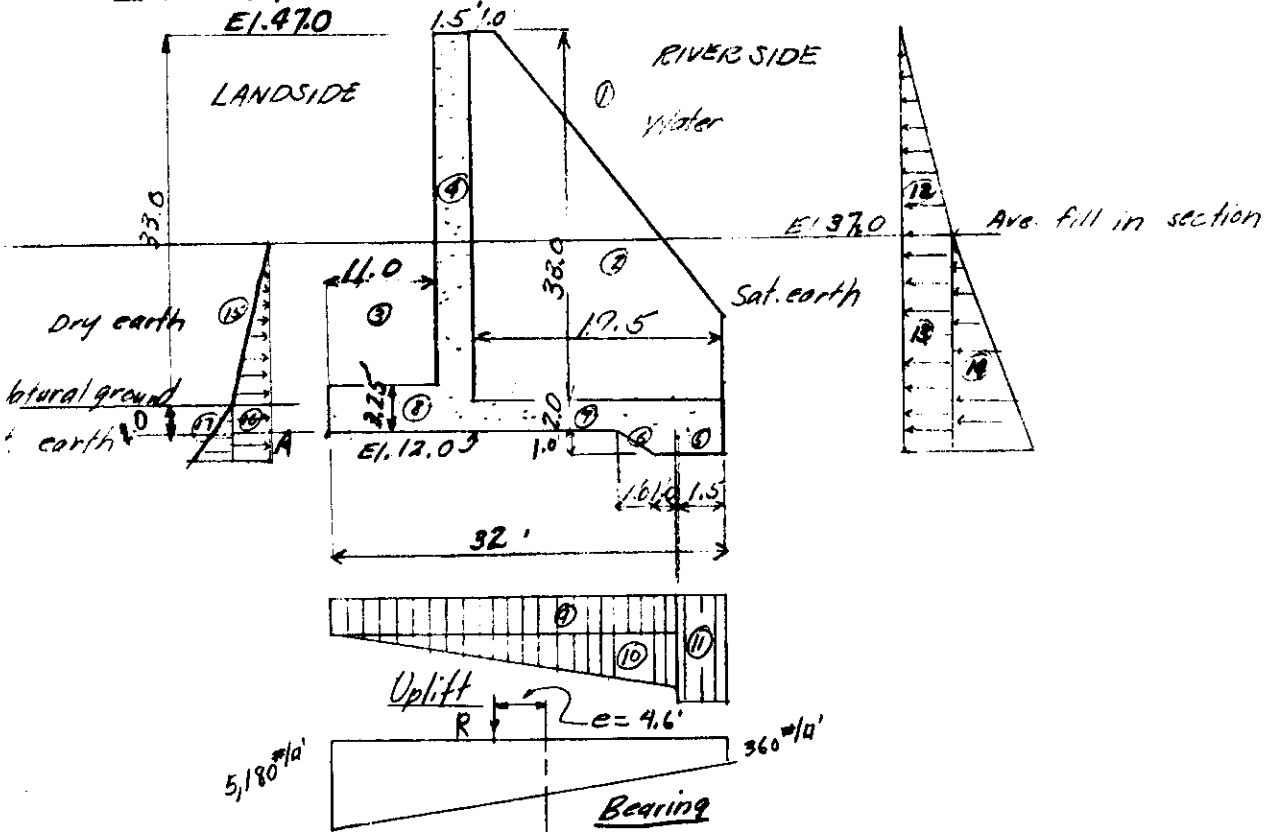
Subject: HARTFORD - NORTH MEADOWS

Computation: STOP-LOG STRUCT. - WILLIMANTIC DIVISION

Computed by: RSM Checked by: ..... Date: Jan. - 1939

I. SECTION NEXT TO R.R.

a. Direct load on wall



Moments about "A" - Horizontal forces, per foot					
	Force		Dimensions	Magnitude	Arm	Moment
12	Water	←	$62.5 \times \overline{10}^2/2$	3130 #	28.33	88,900
13	" -surcharge	←	$62.5 \times 26 \times 10$	16250	13.0	211,000
14	Sat. earth	←	$80 \times \overline{26}^2/2$	27000	7.67	206,500
	Total	←		46380		506,400
15	Dry earth	→	$35 \times \overline{23}^2/2$	9250	9.67	89,300
16	" " -sur	→	$35 \times 23 \times 3$	2420	.5	1,200
17	Sat. "	→	$80 \times \overline{3}^2/2$	360	0	0
	Total	→		12030		90,500
Σ	Horizontal			34,350		415,900 #

B-4.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject: HARTFORD - NORTH MEADOWS

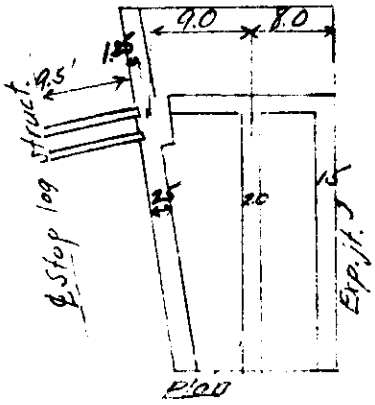
Computation: Stop-Log-Struct. - Willi. Div.

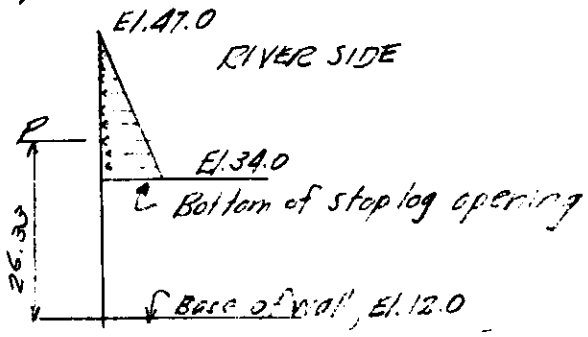
Computed by: CSIT Checked by: ..... Date: Jan. - 1939

I (Con)

b Load transmitted from stop-logs.

(Neglect weight of stop logs and of counterforts, consider pressure against stop-logs applied normal to stem.)





Due to stop logs

$P = \frac{wh^2}{2}$ $62.5 \times 13^2/2 =$ 5280 #/ft.

$M = 9.5 \times 5280 \times 26.33 =$ 1,320,000 '#, total from stop logs.

c. Moments about "A", vertical forces, per foot

	Force		Dimensions	Magnitude	Arm	Moment
1	Water	↓	62.5 × 19.5 × 10	12,190	22.25	271,500
2	Sat earth		125 × 19.5 × 23	56,100	22.25	1,247,000
3	Dry "		100 × 11 × 22	24,200	5.5	133,000
4	Concrete		150 × 1.5 × 32	7,200	11.75	84,700
5	"		150 × 2.5 × 1	375	30.75	11,500
6	"		150 × 1.0 × 1/2	75	29.2	2,200
7	"		150 × 19.5 × 2	5850	22.25	130,000
8	"		150 × 12.5 × 3	5630	6.25	35,200
	Total	↓		111,620		1,915,100
9	Uplift	↑	62.5 × 30.5 × 2	3810	15.25	58,100
10	"		62.5 × 30.5 × 16.5/2	15,700	20.33	319,800
11	"		62.5 × 1.5 × 36	3370	31.25	105,300
	Total	↑		22,880		483,200
Σ				88,740		1,431,900

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject HARTFORD - NORTH MEADOWS

Computation Stop Log Strut - Willimantic Div.

Computed by RSM **Checked by** ..... **Date** Jan. - 1939

[Con)

Stability

$$\frac{\Sigma M}{\Sigma V} = \frac{(143,900 \times 18.25) - (415,900 \times 18.25) - 1,320000}{88,740 \cdot 18.25} = 11.4'$$

middle third at 10.7

$$e = (32.0/2) - 11.4 = 4.6'$$

Base pressure

$$f = \frac{V}{b}\left(1 \pm \frac{6e}{b}\right) = \frac{88740}{32}\left(1 \pm \frac{6 \times 4.6}{32}\right) = 2770(1 \pm .87)$$

= 5180# at landside heel.
360# " riverside "

Sliding $\frac{\Sigma H}{\Sigma V}$ $\frac{34350}{88740} = .39$

B-6)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

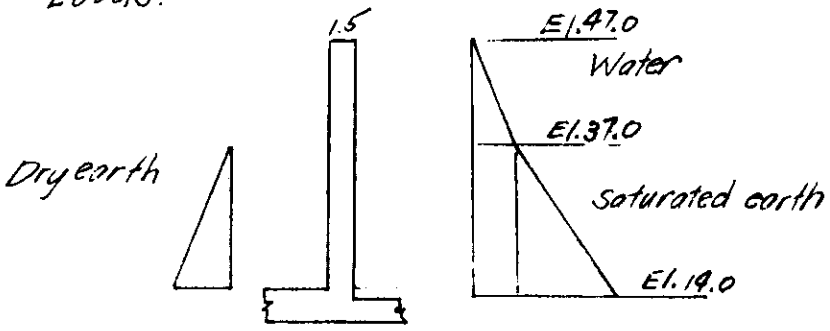
Subject: HARTFORD-NORTH MEADOWS.

Computation: STOP-LOG STRUCT. - Willimantic Div.

Computed by: RSM Checked by: Date: Jan.-1939

DESIGN OF STEM Counterforts spaced 9'-0" c.-c.

Loads.



Elevation / Height	14 / 33	17 / 30	22 / 25	27 / 20	32 / 15	37 / 10	42 / 5	
Load: u	1660	1525	1300	1075	850	625	313	#
Moment: $wl^2/8$; $l = 7.0'$	10150	9350	7970	6590	5200	3825	1915	'#
$d = \sqrt{\frac{M}{Kb}}$	9.1"							
Shear: .625 wl ; $l = 7.0'$	7260	6660	5690	4710	3720	2740	1370	
$d = \frac{V}{bjv}$	11.4"							
Supplied thickness	18"	Throughout						
Effective depth (3" cover)	14.5"	Throughout						
Reinforcement $A_s = M/f_s jd$	.53 ⅜"@8"	.48 ⅜"@1'-0"	.42 ⅜"@1'-0"	.35 ¾"@1'-0"	.29 →	.20 →	.10 →	□"
Bond $u = \frac{V}{j(\Sigma o)d}$	187 #/□"	196	168		(Anchor negative steel at end)			
$f_c = \frac{2M}{kjbd^2}$	325 #/□"							

B-7)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject: HARTFORD - NORTH MEADOWS

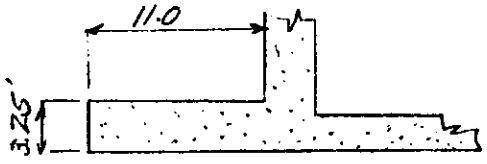
Computation: STOP-LOG STRUCT. - WILLIMANTIC DIV.

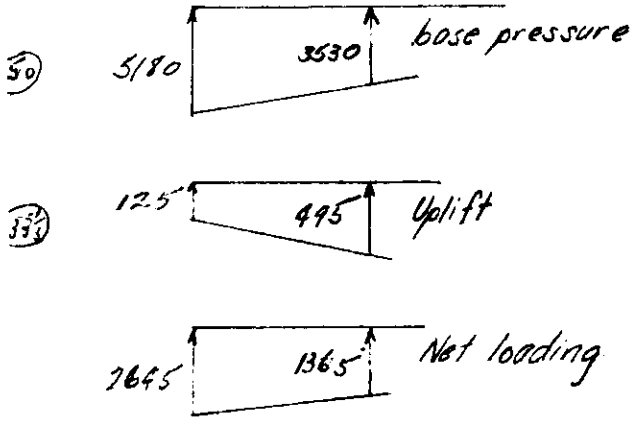
Computed by: RSM Checked by: ..... Date: Jan. - 1939

LANDSIDE TOE - Note: Thickness increased to 3'-3"

Loading

Dry earth	21.75 × 100 =	2175	#
Conc.	3.25 × 150 =	485	
		2660	#





Design as cantilever

		Shear	Arm	Moment
1365 × 11	=	15025	5.5	82800
1280 × 11/2	=	7040	7.33	51500
		22065 #		134300 '#

Req'd d

$$d = \frac{V}{bjv} \quad \frac{22065}{12 \times .884 \times 60} = 34.8 \; ; \; d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{134300}{123}} = 33.0''$$

Supplied d = 39 - 4.5 = 34.5"

$$A_s = \frac{M}{f_s j d} = \frac{134300 \times 12}{18000 \times .884 \times 34.5} = 2.94 \text{ □''} \quad \text{Use } 1\tfrac{1}{4}\text{"□ @ 6" c.-c.}$$

$$\text{Bond} = \frac{V}{j \Sigma_o d} = \frac{22065}{.884 \times 10 \times 34.5} = 73 \text{ \#/□''}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

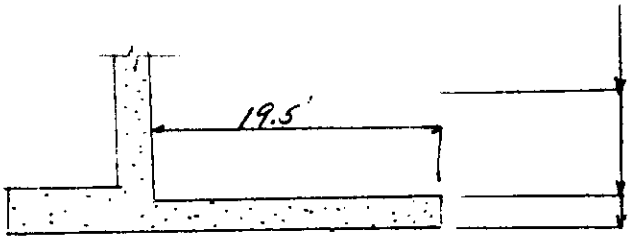
Page .....

Subject: HARTFORD - NORTH MEADOWS

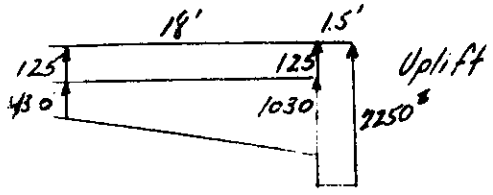
Computation: Stop-Log Struct. - Willimantic Div.

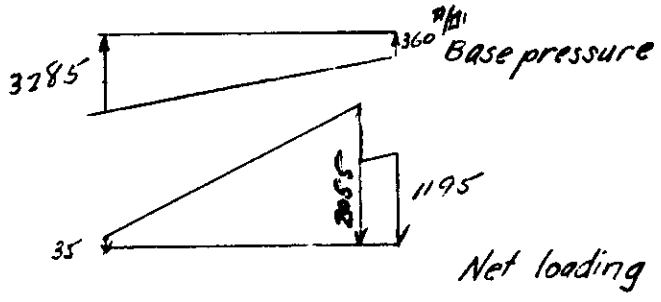
Computed by: RSM Checked by: ..... Date: Jan. - 1939

RIVERSIDE BASE SLAB



Water	10'@62.5	625
Sat. earth	23'@125	2880
Concrete	2'@150	300
		5805 #/□'





Design as continuous beam between counterforts 7'-7.0'

1. Consider 1-ft. strip, 18' from stem.

$M = wl^2/10 = 2055 \times 7^2/10 = 10050'\#$

$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{10050}{123}} = 9.1''$

$V = \frac{wl}{2} = 2055 \times 7/2 = 7200\ \#$

$d = \frac{V}{bjv} = 7200/12 \times .884 \times 60 = 11.3''$

$d(\text{Supplied}) = 24 - 4.5 = 19.5''$

$A_s = M/f_s jd = 10050 \times 12/18000 \times .884 \times 19.5 = .39''^2$

Use 1"φ @ 1'-0" c-c., $A_s = .7854$

$u = V/\Sigma o\, jd = 7200/.884 \times 3.142 \times 19.5 = 133\ \#/□''$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject: NORTH MEADOWS - HARTFORD

Computation: Stop-log struct - Willimantic Div.

Computed by: RSM Checked by: ..... Date: Jan. - 1939

RIVERSIDE BASE SLAB (Con.)

2. Consider point 15' from stem

$w = 1735$ #/□'

$M = wL^2/10 = 1735 \times 7^2/10 = 8510'$#

$A_s = M/f_s jd = 12 \times 8510 / 18000 \times .884 \times 19.5 = .33$ □"

Use $\frac{3}{4}$" ϕ @ 1'-0"

$u = \frac{1735 \times 3.5}{.884 \times 2.356 \times 19.5} = 150$ #/□"

COUNTERFORTS

1. Steel reqd. to transfer loads to counterforts.

Stem.

At $h = 33'$, $A_s = 7 \times 1660 / 18000 = .65$ □" (Includes steel on both sides)

Use $\frac{3}{4}$" ϕ @ 1'-0" c-c.

Base slab

18' from stem - $A_s = 9 \times 2055 / 18000 = 1.03$ □" (Includes steel on both sides)

Use $\frac{7}{8}$" ϕ @ 1'-0" c-c.

15' " " - $A_s = 9 \times 1735 / 18000 = .66$ □" (" " " ")

Use $\frac{3}{4}$" @ 1'-0" c-c.

2. Tension steel along inclined face.

a. Base of counterfort

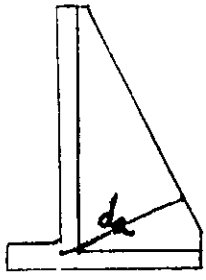
$M = \frac{62.5 \times 33}{6} \times 9$ 3,479,500'#

Less $(17.5 \times 23^3/6) \times 9$ - 319,700

3,159,800'#

$d_a = (18'-6") - 6" = 210"$

$A_s = \frac{M}{f_s(d - \frac{t}{2})} = \frac{3159800 \times 12}{18000 \times 201} = 10.48$ □"



b. $h = 28'$

$M = (62.5 \times 28^3/6) \times 9 = 2052000$

Less $(17.5 \times 18^3/6) \times 9$ - 188,700

1,863,300'#

$d_b = (16'-2") - 6" = 186"$

$A_s = \frac{M}{f_s(d - \frac{t}{2})} = \frac{1863300 \times 12}{18000 \times 177} = 7.03$ □"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: NORTH MEADOWS - HARTFORD

Computation: Stop-log Struct - Willimantic Div.

Computed by: CSIT Checked by: Date: Jan. - 1939

COUNTERFORTS (Con.)

c. $h = 23'$

$M = 9 \times 62.5 \times \overline{23}^3/6 = 1{,}140000$ '#

Less $9 \times 17.5 \times \overline{13}^3/6 = -57600$

1082400

$d_c = (13'-8") - 6" = 158"$

$A_s = \frac{1082400 \times 12}{18000 \times 149} = 4.8$ □"

d. $h = 18'$

$M = 9 \times 62.5 \times \overline{18}^3/6 = 548000$ '#

Less $9 \times 17.5 \times \overline{8}^3/6 = -13400$

534600

$d_d = (11'-2") - 3" = 131"$

$A_s = \frac{534600 \times 12}{18000 \times 122} = 2.92$ □"

e. $h = 13$

$M = 9 \times 62.5 \times \overline{13}^3/6 = 206700$ '# Less $9 \times 17.5 \times \overline{3}^2/6 = 700$ '#

$d_e = (8'-8") - 3" = 101"$

$A_s = \frac{206000 \times 12}{18000 \times 101} = 1.37$ □"

f. $h = 8$

$M = 9 \times 62.5 \times \overline{8}^3/6 = 48{,}000$ '#

For $h = 33'$

$l_1 = \frac{f_s d}{4u} = \frac{18000 \times 1.25}{4 \times 150} = 38"$ reqd. for embedment

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

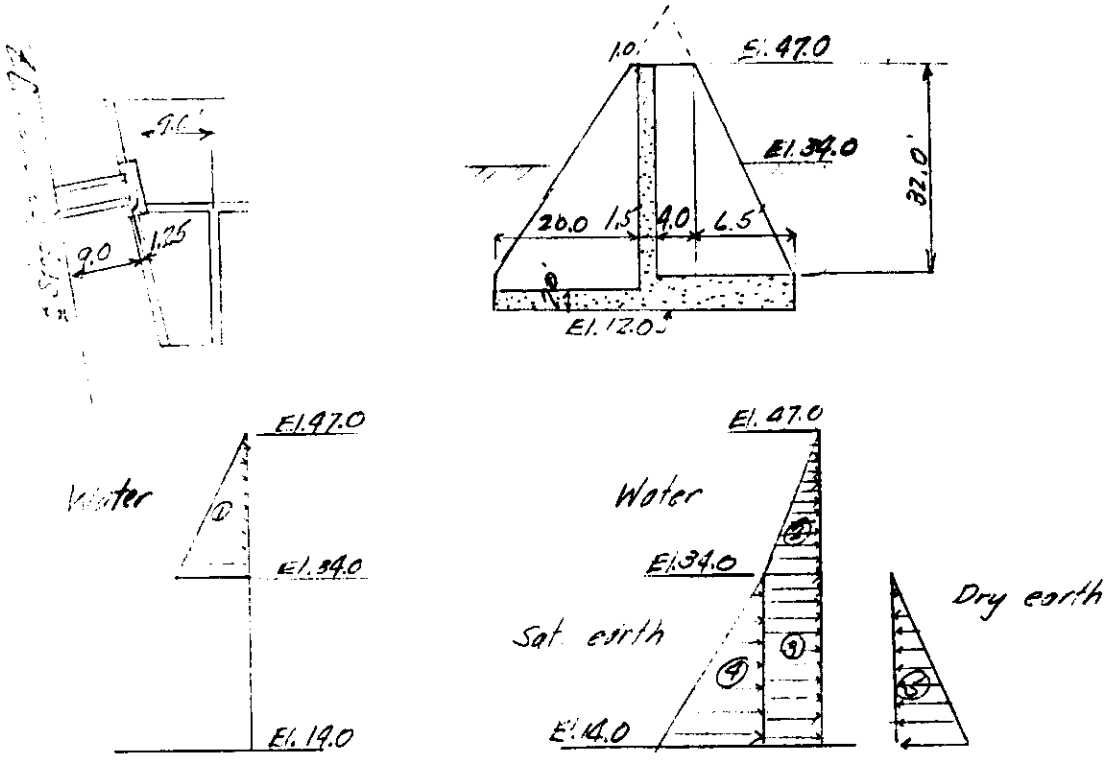
Page .....

Subject: HARTFORD - NORTH MEADOWS

Computation: Stop log structure - Willimantic Div.

Computed by: [illegible] Checked by: ..... Date: Jan. - 1939

II DESIGN OF COUNTERFORT NEXT TO R.R.



Load, stop log opening

Load on flood wall

Assume all thrust from load on stop logs is delivered to the base of the wall through this counterfort.

1. Tension steel along riverside face. Figure moments about points along landside face.

To determine arm "a" at height "h"

$(6.5 - c)\tan(90° - 30°42.5') = c\tan(90° - 11°28')$

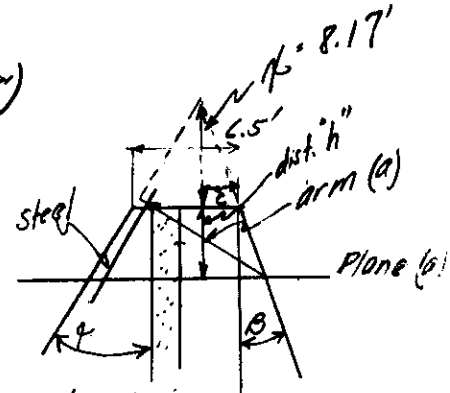
$c = 1.66 \quad 6.5 - c = 4.84'$

$x = 1.66/\tan 11°28' = 8.17'$

$= 4.84/\tan 30°42.5' = 8.17'$ Check.

$a = (8.17 + h) \times \left(\frac{6.5\cos 30°42.5}{8.7}\right)$

$= .683(8.17 + h)$



$\beta = \tan^{-1} 6.5/32 = 11°28'$

$\alpha = \tan^{-1} 19.0/32.0 = 30°42.5$

B-12.1

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject: N.M. - HARTFORD

Computation: Stop log structure - Willimantic Dir.

Computed by: [illegible] Checked by: ..... Date: Jan. - 1939

II (Cor.)

a $h = 5'$

$M_{①} = 62.5 \times \overline{5}^2/2 \times 9.5 \times 1.67 \quad 12400$ '#

$M_{②} = 62.5 \times \overline{5}^2/2 \quad 5.75 \times 1.67 \quad 7500$ '#

$19{,}900$ '#

$a: .683(8.17+5) = 9.01'; 108" - 4"(cover) = 104"$

$A_s = \frac{M}{f_s jd} = \frac{19900 \times 12}{18000 \times .884 \times 104} = .192$ □"

b $h = 13'$

$M_1 = 62.5 \times \overline{13}^2/2 \times 9.5 \times 4.33 = 217000$ '#

$M_2 = 62.5 \times \overline{13}^2/2 \times 5.75 \times 4.33 = 131500$

348500

$a: .683(8.17+13.0) = 14.45'; 173" - 4" = 169"$

$A_s = \frac{348500 \times 12}{169 \times 18000 \times .884} = 1.56$ □"

c $h = 18'$

$M_1 = 50200 \times 9.33 = 468{,}000$ '#

$M_2 = 30400 \times 9.33 = 283500$

$M_3 = (62.5 \times 13) \times 5 \times 2.5 \times 5.75 = 58500$

$M_{(E35)} = (80-35) \times 5.75 \times \overline{5}^2/2 \times 5/3 = 5400$

815400 '#

$a: .683(8.17+18.0) = 17.87'; 214 - 6'(\text{to c.g. of bars}) = 208"$

$A_s = \frac{815400 \times 12}{208 \times 18000 \times .884} = 2.96$ □"

d $h = 23'$

$M_1 = 50200 \times 14.33 = 720000$ '#

$M_2 = 30400 \times 14.33 = 436000$

$M_3 = 4670 \times 10 \times 5 = 233500$

$M_{(E35)} = 45 \times 5.75 \times \overline{10}^2/2 \times 10/3 = 43000$

1432500 '#

$a: .683(8.17+23.0) = 21.25'; 255" - 6" = 249"$

$A_s = \frac{1432500 \times 12}{249 \times 18000 \times .884} = 4.35$ □"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: NORTH MEADOWS HARTFORD

Computation: Stop log struct. - Willimantic Div.

Computed by: RSM Checked by: Date: Jan. - 1939

II (Con.)

e h = 28'

M_1 = 50200 × 19.33 = 970000 '#

M_2 = 30400 × 19.33 = 588000

M_3 = 4670 × 15 × 7.5 = 528000

$M_{(4SS)}$ = 45 × 5.75 × $\overline{15}^2$/2 × 15/3 = 158500

2244500 '#

a: .683(8.17 + 28.0) = 24.7'; a = 296 - 6 = 290"

A_s = 2,244,500 × 12/290 × 18000 × .884 = 5.85 □"

f h = 33'

M_1 = 50200 × 24.33 = 1,218,000 '#

M_2 = 30400 × 24.33 = 740,000

M_3 = 4670 × 20 × 10 = 934,000

$M_{(4SS)}$ = 45 × 5.75 × $\overline{20}^2$/2 × 20/3 = 346000

3238000 '#

a: .683(8.17 + 33.0) = 28.1'; a = 337 - 6 = 331"

A_s = 3238000 × 12/331 × 18000 × .884 = 7.38 □"

Shear at [illegible]

50200 50,200

30400 30400

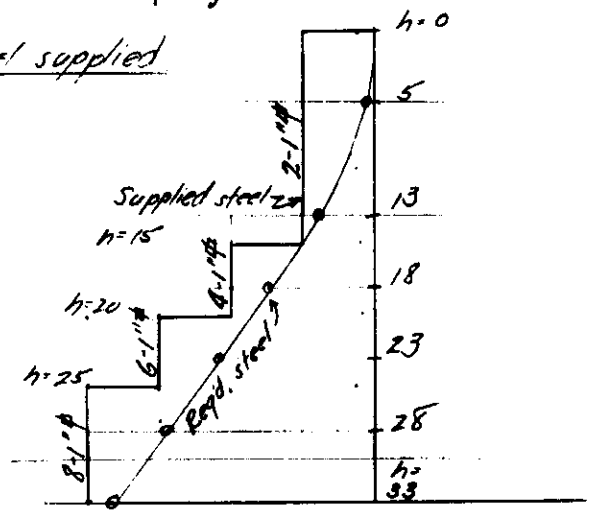
$\frac{[2 \times 4670 + (20 \times 45 \times 5.75)]}{2} \times 20$ = 145,200

225,800 #

V = 225,800 #

$v = \frac{225800}{.884 \times 24(net) \times 32.5 \times 12}$ = 27 #/□" OK

Steel supplied



B-14.)

Subject NORTH MEADOWS - HARTFORD
Computation Step log structure - Willimantic Div.
Computed by BSM **Checked by** ..... **Date** Jan. - 1939

II (Cor.)

DESIGN OF BASE ADJACENT TO COUNTERFORT
(Consider 5.75' width (area) of base)

Moments considered

$M_1 = 50\,200 \times 26.33 = 1\,318\,000$ '#
$M_2 = 30\,490 \times 26.33 = 800\,000$ '#
$M_3 = 4670 \times 22 \times 11 = 1\,130\,000$ '#
$M_{4\&5} = 45 \times 5.75 \times 22^2/2 \times 22/3 = 599\,000$
$\Sigma M_H = 5\,147\,000$ '#

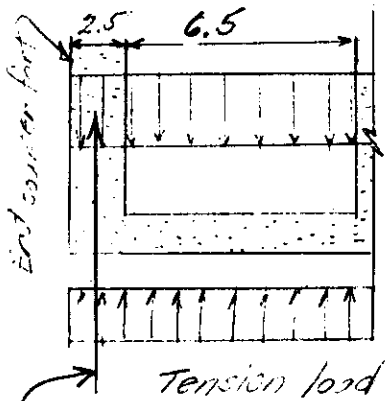
Moments vertical use diagram on pg. B-5

$\Sigma M_V = 1\,421\,900 \times 5.75 = 8\,230\,000$ '#
$\Sigma V = 88\,740 \times 5.75 = 510\,500$ #

$\frac{\Sigma M}{\Sigma V} = \frac{8230\,000 - 3147\,000}{510\,000} = 8.6$; $e = 16 - 8.6 = 7.4$

$f = \frac{510\,000}{32}\left(1 \pm \frac{6 \times 7.4}{32}\right) = 15\,900\,(1 \pm 1.388)$
$= 38\,000$ # Compression, landside toe, outer 1-ft. strip.
$= 6\,210$ " Tension, riverside toe " " "

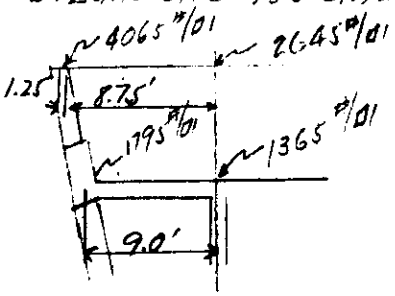
1. Riverside toe analysis (See also pg. 13a)



Loading = 3805 #/ft., see pg. B-9
Net loading = 1555 #/ft.
R due to net loading = 1555 × 5.75 = 8950 #
Uplift = 2250 #/ft., see pg. B-9
Tension load 6210 #, transmitted through counterfort.

Net "R" at counterfort, considering tension loading, tending to balance earth load, is 8950 − 6210 # = 2740 #

2. Landside toe analysis.



Load at toe = 6600 + 125 − 2660 = 4065 (See pg. B-8.)
" " stem = 3960 + 495 − 2660 = 1795

Assume loads as average for section, as given on pg. 5, for intermediate counterfort.
Design outer 1-ft. strip as cantilever from base of end counterfort.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

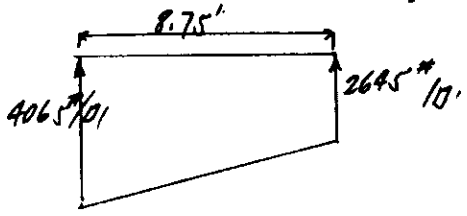
Subject: NORTH MEADOWS, HARTFORD

Computation: Stop log structure, Willimantic Div.

Computed by: RSM Checked by: ..... Date: Jan.-1939

II (Con.)

2. Landside toe analysis (con.) Beam 39" - 4.5 = 34.5" effective depth.



M:

$2645 \times \overline{8.75}^2/2 = 101{,}000$ '#

$1420 \times 8.75/2 \times 8.75/3 = 18{,}100$

$118{,}100$ '#

$V = \frac{2645+4065}{2} \times 8.75 = 29{,}400$ #

$v = \frac{V}{bjd} = 29400/12 \times .884 \times 34.5 = 81$ #/□"

This exceeds allowable shear. Use special bent-up bars from point where shear exceed 60#/□". This point is two ft. from face of counterfort: $\frac{2645+3745}{2} \times 6.75 = 21500$#

Allowable shear $= 60 \times .884 \times 12 \times 34.5 = 21{,}900$#

Allowing $\frac{3}{4}$"ϕ bent up bars @1'-0" c-c., spacing is

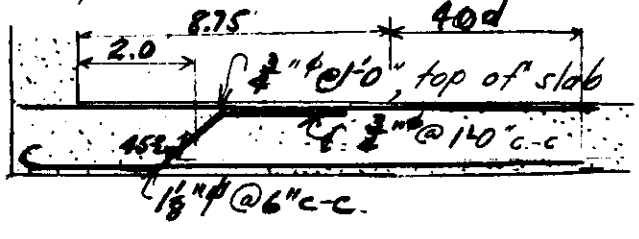
$s = \frac{A_v f_v jd}{.7 V_1} = \frac{.442 \times 18100 \times .884 \times 34.5}{.7 \times (29400 - 21900)} = 46$" max.

In this portion of the slab continue thru the temperature steel used in the next panel and bend up 2'-0" from face of end counterfort. Bend up a total of 7 bars.

$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{118100}{123}} = 31$"

$A_s = \frac{M}{f_s jd} = \frac{118{,}100}{18{,}000 \times .884 \times 34.5} = 2.15$ □" Use 14-$1\frac{1}{8}$"ϕ @6" c-c.

Bond: $\frac{V}{\Sigma_o jd} = \frac{29400}{9 \times .884 \times 34.5} = 107$ #/□"



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: NORTH MEADOWS, HARTFORD

Computation: Stop log structure, Willimantic Div.

Computed by: R.S.M. Checked by: Date: Jan.-1939

2. Landside toe analysis (con.)

Strip adjacent to stem

M: $1365 \times 7.75 \times 7.75/2 = 41{,}000$ '#

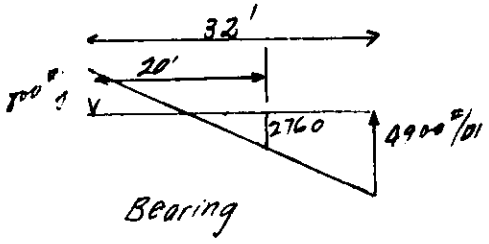
$430 \times 7.75^2/6 = 4300$ '#

$45{,}300$ '#

$A_s = 45{,}300 \times 12 / 18000 \times .884 \times 34.5 = .99$ □"

Use 1"□ @ 1'-0" c-c.

1. Riverside toe (con.)



Strip adjacent to stem

−Net loading 1555 #/□'

+Bearing 2760

1205 #/□'

$M = \frac{1205 \times 7^2}{8} = 7390$ '#

$A_s = \frac{7390 \times 12}{18000 \times .884 \times 19.5} = .29$ □"

Use $\frac{3}{4}$"□ @ 1'-0" c-c.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

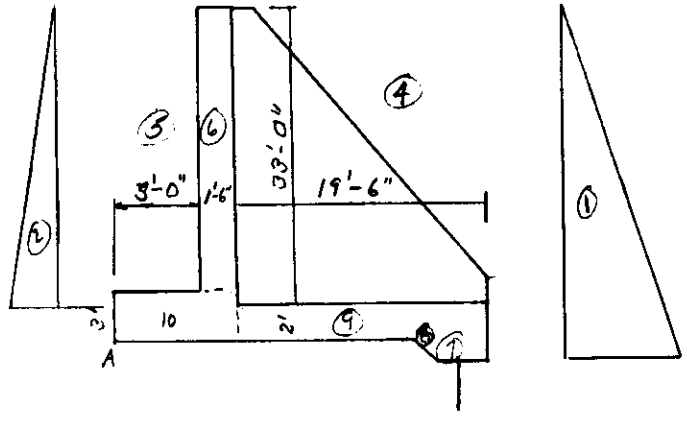
Page .....

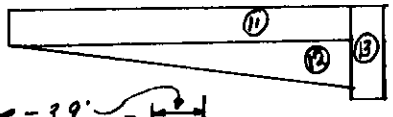
Subject: North Meadows, Hartford

Computation: Step-leg Structure, Willimantic Div.

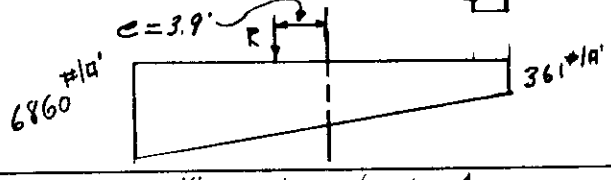
Computed by: R.S.M. Checked by: ..... Date: Jan.-1939

Min Sect. (End Counterfort)





Uplift Diagram



Bearing Diagram

Moments about A

	Force	Dimensions	Magnitude	Arm	Moment
1	Sat. earth ←	80 × 36 1/2	52 000	11	572,000
2	Dry " →	35 × 33 1/2	19,020	13	247,500
3	" sur ←	35 × 33 × 3	3460	.5	1,700
4	Sat " →	80 × 3 1/2	360	0	0
			29,160		322,800
4	Sat. earth	125 × 33 × 19.5	80,600	16.25	1,309,750
5	Dry "	100 × 32 × 5	16 000	2.5	40,000
6	Concrete	150 × 32 × 1.5	7,200	5.75	41,400
7	"	150 × 2.5 × 1.0	375	24.75	9,281
8	"	150 × 1 × 1/2	75	23.3	1,748
9	"	150 × 2 × 19.5	5,850	16.25	95,063
10	"	150 × 6.5 × 3	2,925	3.25	9,506
			113,025		1,506,748
11	Uplift ↑	62.5 × 2 × 24.5	3,063	12.25	37,522
12	" ↑	62.5 × 245 × 16.5/2	12,631	16.3	205 885
		62.5 × 1.5 × 33	3,370	25.25	85,093
			19,064		328,500
			93,961		1,178,248

$$\frac{\Sigma M}{\Sigma V} = \frac{1,178,248 - 322,800}{93,961} = 9.12 \text{ middle third} = 8.67$$ B-18.)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows, Hartford

Computation: Stop-log Structure – Willimantic Dir.

Computed by: R.S.H. Checked by: Date: Jan.-1939

Min. Section

$e = 26.0/2 - 9.1 = 3.9$

Base Pressure

$f = \frac{V}{b}\left(1 + \frac{6e}{b}\right) = \frac{93,961}{26}\left(1 \pm \frac{6 \times 3.9}{26}\right) = 3,610(1 \pm .90$

$= 6860$ landside heel

361 riverside heel

Sliding $\frac{\Sigma H}{\Sigma V} = \frac{29,160}{93.961} = .31$

Earth to top of Wall

Elevation Height	14 33	17 30	22 25	
Load w	1485	1350	1,125	
Moment $\frac{wl^2}{10}$ $l = 7.0'$	7,270	6,620	5520	
$d = \sqrt{\frac{M}{Kb}}$	d: 7.7			
Shear .6 wl $l = 7.0$	6,230	5,670	4,720	
$d = \frac{V}{bJv}$	9.8			
Supplied thickness	18"	Throughout		
Effective depth (3" cover)	14.5		"	
Reinforcement				
$A_s = M/f_s jd$ 7/8" ϕ	.31 7/8" ϕ	.29 3/4" ϕ		
Bond $u = \frac{V}{\Sigma(E_0)(d)}$	176#/□"	187	Anchor negative steel at end	

B-19.)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

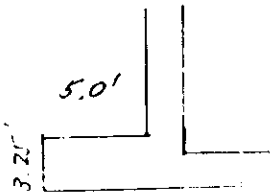
Page

Subject: North Meadows, Hartford

Computation: Stop-log Structure, Willimantic Div.

Computed by: R.S.M. Checked by: Date: Jan.-1939

LANDSIDE TOE

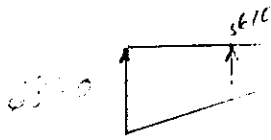


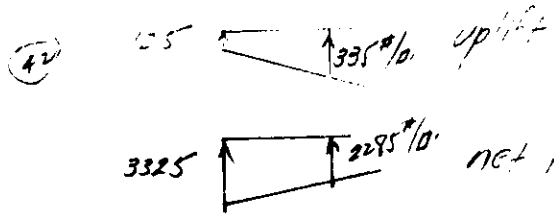
Loading

Dry earth	31.75×100 =	3175
Concrete	3.25×150	485
		3660 #

Design as cantilever

	Shear	Arm	Moment
2285×5 =	11420 #	2.5	28,600 '#
1040×5/2 =	2600	3.33	8,600
	14,000 #		37,200 '#



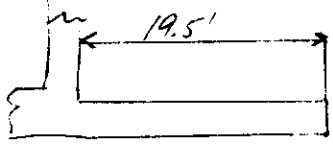


$A_s = \frac{37200 \times 12}{18000 \times .884 \times 34.5} = .81 \square''$

Use $\frac{3}{4}''\phi$ bars @ 6" c-c.

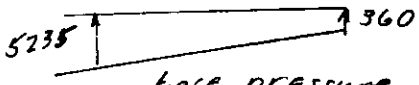
Bond $\frac{14000}{4.71 \times .884 \times 34.5} = 98\#/\square''$

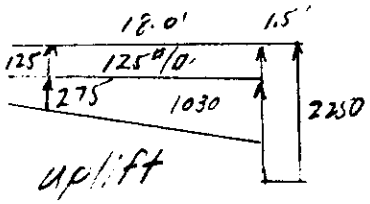
RIVERSIDE TOE

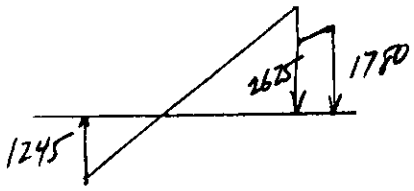


Loading

Saturated earth	32.75×125 =	4090
Concrete	2×150	300
		4390







1. Strip 18' from stem

$M = wl^2/10 = 2625 \times 7^2/10 = 12850\#$

$d = \sqrt{M/kb} = \sqrt{12850/123} = 10.25''$

$V = wl/2 = 2625 \times 7/2 = 9100\#$

$d = 9,100/12 \times .884 \times 60 = 14.2''$

d (supplied) = 19.5" net.

$A_s = 12850 \times 12/18000 \times .884 \times 19.5 = .50 \square''$

Use 1"# @ 1'-0" c-c. $A_s = 1.0 \square''$

$u = 9100/.884 \times 19.5 \times 4 = 132\#/\square''$

Net. loading

2. At strip 13' from stem, $\frac{3}{4}''\phi$ @ 1'-0" c-c. is allowable $u = \frac{16.5 \times 3.5}{.814 \times 19.5 \times 2.356} = 146\#/\square''$

B-201

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

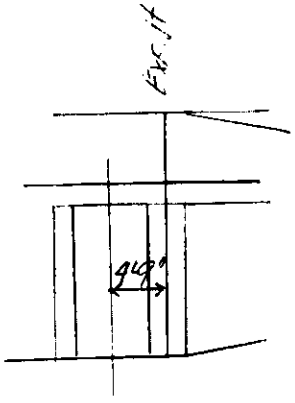
Page

Subject: HARTFORD - No. MEADOWS

Computation: Stop log - Willimantic Div.

Computed by: RJM Checked by: Date: Jan. - 1939

COUNTERFORT AT EXPANSION JOINT



1. Leave steel to transfer loads from stem and base to counterfort same as for middle counterfort (See pg. B-10)

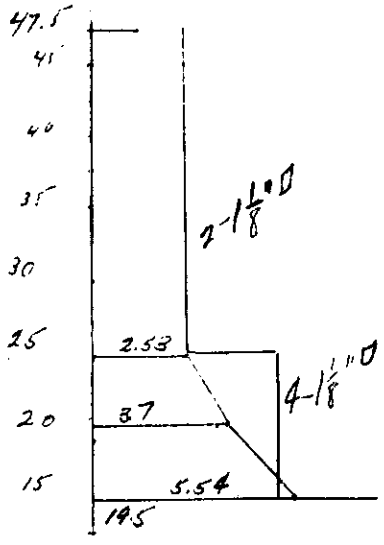
2. Tension steel along inclined face. Steel will be in direct proportion as length of wall supported, with middle counterfort, as analyzed on pg. B-15 & B-16.

a. Base

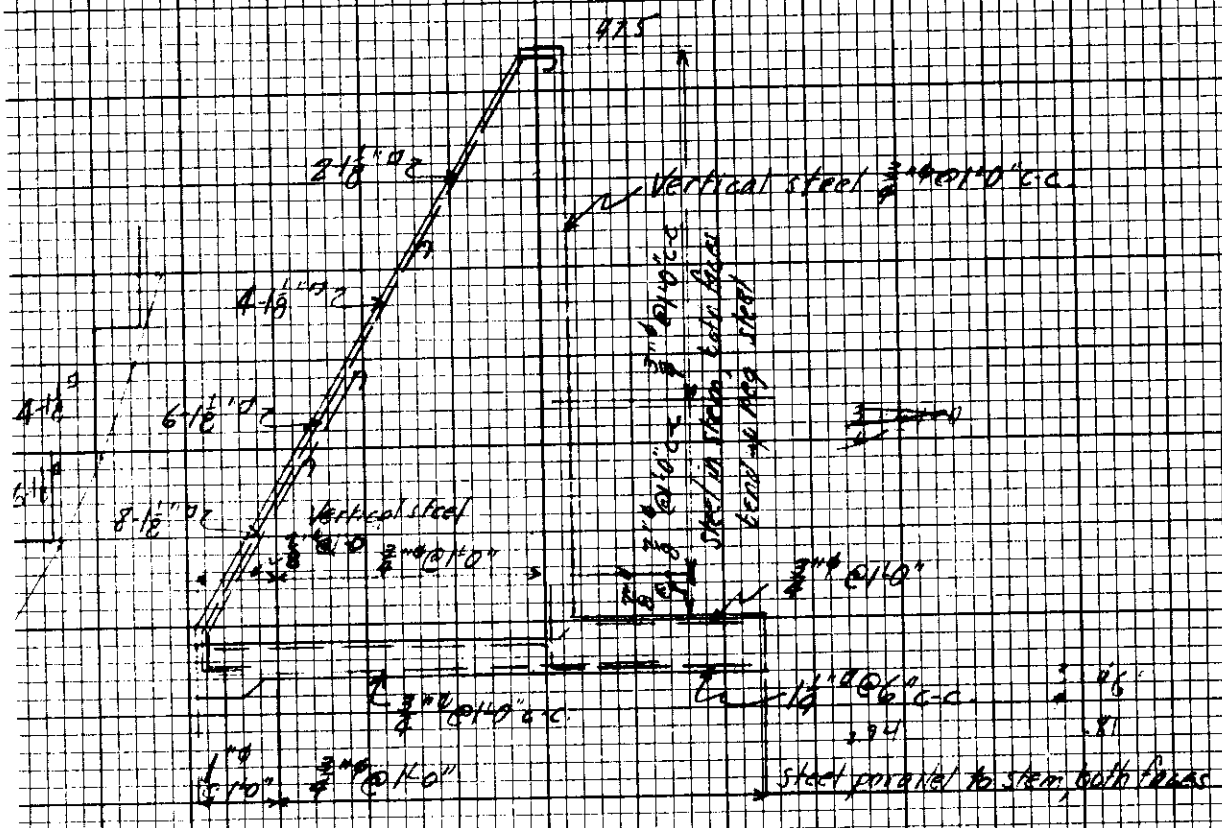
$A_s = 10.48 \times 4.75/9.0 = 5.54^{\square''}$

b. h - 27' $A_s = 7.03 \times 4.75/9.0 = 3.7^{\square''}$

c. h - 23' $A_s = 4.8 \times 4.75/9.0 = 2.53^{\square''}$



Jan. -1939

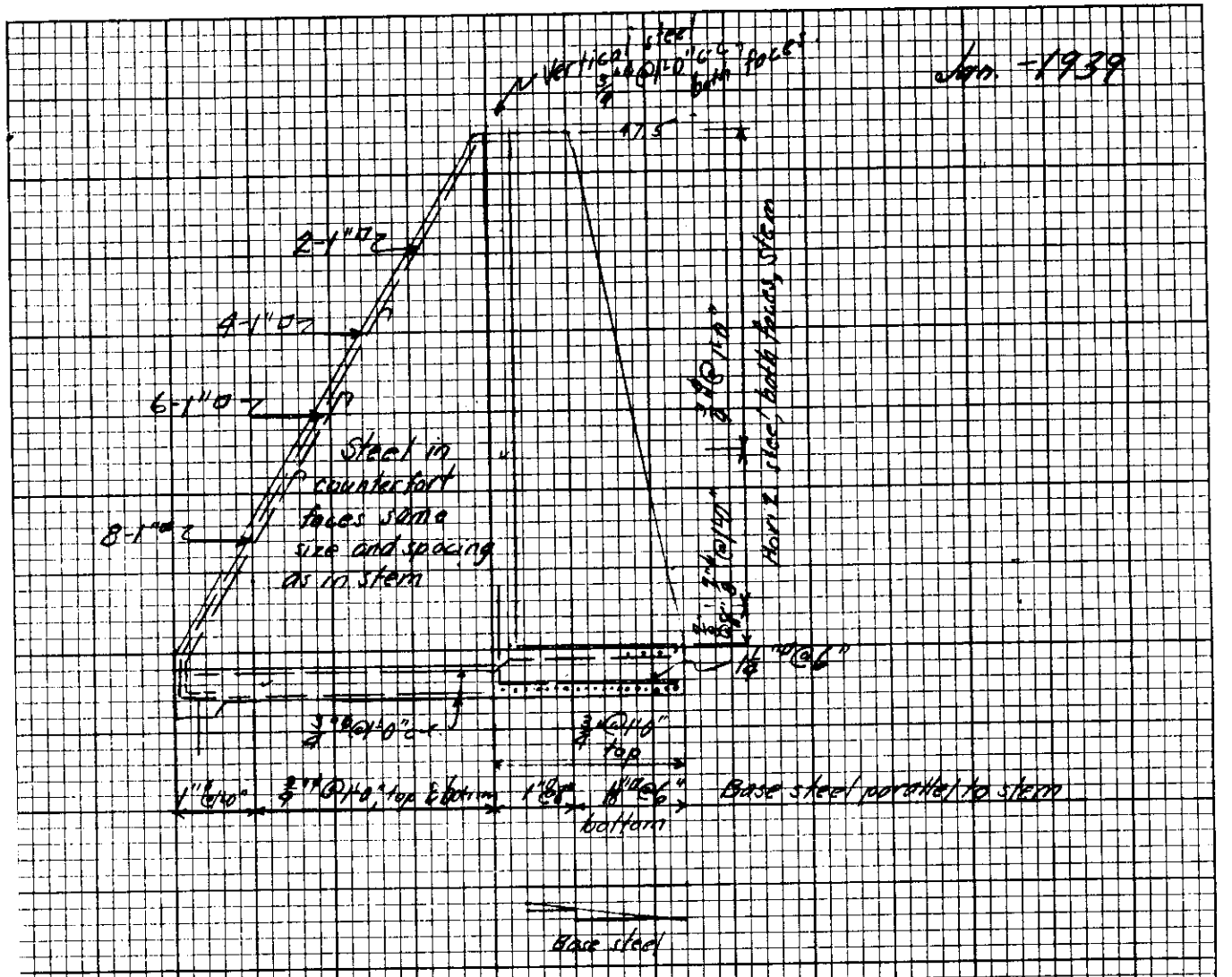


MIDDLE COUNTERFORT

Scale 1"=10'

B-22.)

Jan. -1939



R.R. Counterfort

For final sections as designed see drawings as noted on page B-4.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page

Subject: North Meadows Dike, Hartford, Conn.

Computation: N.Y., N.H., & H.R.R. Stop-Log Structure, Willimantic, Div.

Computed by: JM Checked by: Date:

Design of Stop-Logs

Head of water = 13'-0"

Req. length of logs = 20'-0"

Logs to be select white oak

$f = 1750$ #/□" Bearing = 265 #/□"

(vert.) $r = 156$ #/□"

(hor.) $r = 125$ #/□" Wt. = 50 #/cu. ft.

Load per ft. on bottom log $\} = 62.5 \times 13.0 = 813$ #

$$M = \frac{wl^2}{8} = \frac{813 \times 20.0^2}{8} = 40{,}700 \text{ ft. lb.}$$

$$(\text{Req'd})\ \frac{I}{c} = \frac{M}{f} = \frac{40{,}700 \times 12}{1750} = 279$$

Use 12" x 12" logs

$$\text{Actual } \frac{I}{c} = \frac{bd^3}{12} \times \frac{2}{d} = \frac{bd^2}{6} = \frac{12 \times 12^2}{6} = 288 > 279 \therefore \text{O.K.}$$

$$\text{End bearing} = \frac{Wl}{2} = \frac{813 \times 20.0}{2} = 8{,}130 \text{ #}$$

Unit Vertical Shear $\} r = \frac{8{,}130}{12 \times 12} = 56.5$ #/□" < 156 #/□" ∴ O.K.

Unit horizontal shear $\} = 3/2 \times 56.5 = 84.7$ #/□" < 125 #/□" ∴ O.K.

End Bearing on 5" of log in slot $\} = \frac{8{,}130}{5 \times 12} = 136$ #/□" < 265 #/□" ∴ O.K.

Use 12"x12" Timber S4S and Creosoted

26 logs Req'd.

B-24.)

HARTFORD - NORTH MEADOWS

ANALYSIS OF DESIGN

APPENDIX A

SECTION III

STOP-LOG STRUCTURE NO. 2

SPRINGFIELD DIVISION

ANALYSIS OF DESIGN

CONCRETE STOP-LOG STRUCTURE #2

NEW YORK, NEW HAVEN AND HARTFORD RAIL-

ROAD - SPRINGFIELD DIVISION

AT DIKE STA. 160+52.99

NORTH MEADOWS - HARTFORD, CONNECTICUT

INTRODUCTION

This is the complete Analysis of Design for the concrete stop-log structure #1 proposed at the New York, New Haven and Hartford Railroad - Willimantic Division - Dike Sta. 50+70.1 - North Meadows, Hartford, Connecticut.

The structure consists of two counterfort walls, approximately perpendicular to the railroad and in line with the North Meadows earth dike. Due to the unusual height of the structure, some saving in cost has been realized by placing the counterfort walls perpendicular to the railroad rather than parallel as is the usual practice for smaller stop-log structures.

One set of grooves are provided for a single row of timber stop-logs. The timber stop-logs are to be backed with sandbags or battened at time of floods to reduce leakage.

Loading conditions and uplift assumptions comply with those recommended for Flood Walls and similar structures.

For concrete and reinforcement details of structure - see drawings File Nos. CT-4-1476 to 1485, inclusive.

GENERAL DESIGN DATA

1. Loading. - The structure shall be loaded to give the worst possible condition. The two counterfort walls shall be investigated for the following condition of loading.

Water to top of wall on riverside with uplift pressure over one-half the base decreasing uniformly from full hydrostatic pressure at the riverside toe to full tailwater at the landside heel.

2. Overturning. - The resultant shall intersect the base within the middle third.

3. Sliding. - The bond between the base and the rock foundation is considered adequate to resist sliding.

4. Reinforced Concrete

a. In general, the concrete design is based on the "Joint Code of the American Concrete Institute and the Reinforcing Steel Institute for the Design of Concrete and Reinforced Concrete" issued in 1928 and the "Progress Report" of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete issued in January 1937.

fs = 18,000#/□ "; fc - 800#/□ "

V = 60#/□ " (without special anchorage)

V = 90#/□ " (with special anchorage)

u = 150"/□ " (without special anchorage)

u = 200"/□ " (with special anchorage)

n = 12

Length of embedment for bond - 40 diameters of reinforcing bar.

All reinforcement to be deformed bars of new billet steel intermediate grade.

5. Stem. - The vertical stem shall be designed as a continuous beam fixed between the counterforts.

6. Riverside Base Slab. - The riverside base slab shall be designed as a continuous beam fixed between the counterforts.

7. Landside Base Slab. - The landside base slab shall be designed as a cantilever beam fixed at the edge of support.

8. Counterforts. - The counterforts shall be designed to take the load in tension transferred from the stem and base.

9. Covering of Reinforcement. - Cover on all surfaces for reinforcement shall be at least 3 inches, except where concrete is deposited against earth in which case a cover of 4 inches shall be used.

10. Unit Weights.

Weight of water = 62.5#/cu.ft.

Weight of dry earth = 100#/cu.ft.

Weight of saturated earth = 125#/cu.ft.

Weight of reinforced concrete = 150#/cu.ft.

Equivalent liquid pressure of dry earth = 35#/cu.ft.

Equivalent liquid pressure of saturated earth = 80#/cu.ft.

11. Timber. - Timber for the stop-logs to be selected White Oak S4S and creosoted.

The working stresses used in the design of the stop-logs are as follows:

Timber stress fc	=	1750 #/□"
Vertical shear	=	156 #/□"
Horizontal shear	=	125 #/□"
Bearing - b	=	265 #/□"
Weight	=	50 #/□"

12. Structural Design. - Standard practices have been followed in the design of the structural members of the intermediate supporting frame of the stop-log timbers. High stresses were used to keep the weight of the members as low as possible. In no case, however, are tension or bearing stresses above 24,000 lbs. per square inch, and shearing stresses above 13,500 lbs. per square inch.

WAR DEPARTMENT

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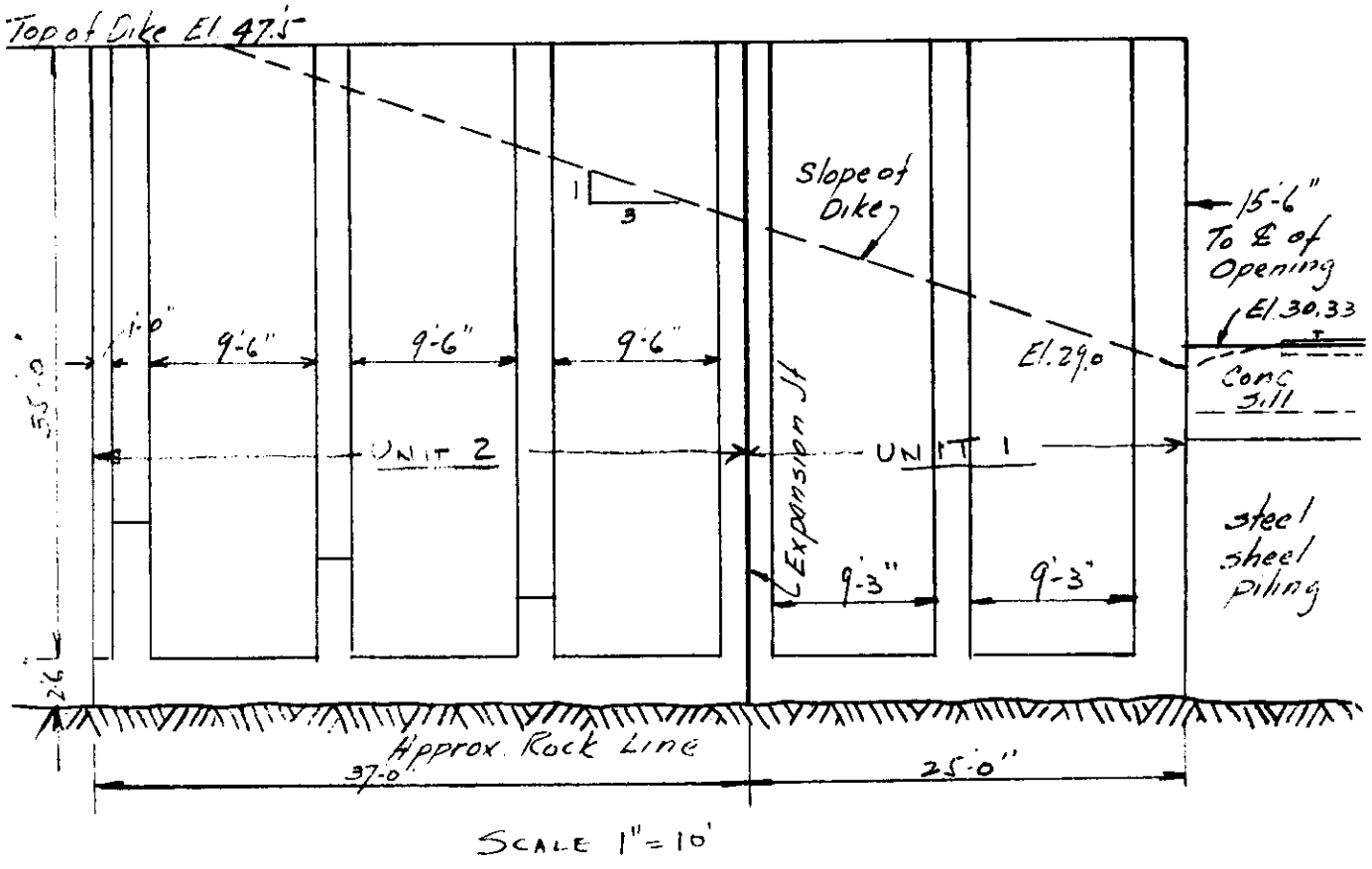
Page .....

Subject HARTFORD, CONN. NORTH MEADOWS DIKE

Computation R.R. STOP LOG STRUCTURE - SPRINGFIELD DIV.

Computed by ..... Checked by ..... Date .....



SCALE 1" = 10'

Thickness of Counterforts

Middle counterforts	2'-0"
Counterfort at levee	2'-0"
Counterforts at exp jt	1'-6"
Counterforts at stop log	3'-0"

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

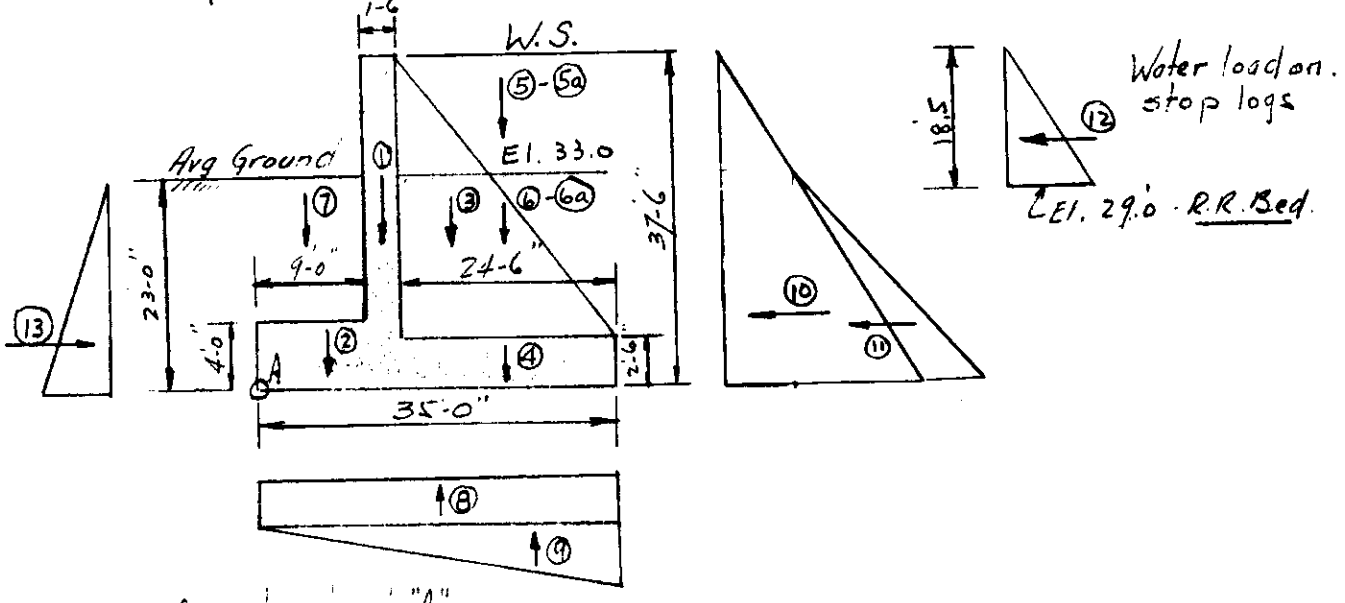
Subject HARTFORD CONN., NORTH MEADOWS DIKE

Computation R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV.

Computed by P.C.H. **Checked by** W.F.R., R.S.M. **Date** 10-6-38

UNIT ONE

Stability analysis.



Moments about "A"

Force	Dimensions	Magnitude Load / ft.	Length Feet	Total Magnitude	Arm Ft	Moment Ft. Lbs.
1.	150×1.5×33.5	7550 ↓	25	188,200 ↓	9.75	1,833,000
2.	150×4×10.5	6300 ↓	25	157,500 ↓	5.25	827,000
3	150×½×24.5×33.5	61500 ↓	6.5	400,000 ↓	18.7	7,490,000
4	150×2.5×24.5	9200 ↓	25	229,500 ↓	22.75	5,220,000
5	62.5×14.5×24.5	22,200 ↓	18.5	411,000 ↓	22.75	9,350,000
5a	62.5×½(24.5+12)14.5	16,550 ↓	6.5	107,500 ↓	25.68	2,760,000
6	125×24.5×20.5	62,800 ↓	18.5	1,160,000 ↓	22.75	26,400,000
6a	125×½×12×20.5	15,370 ↓	6.5	100,000 ↓	31.83	3,183,000
7	125×9×19	21,400 ↓	25	535,000 ↓	4.5	2,408,000
8	62.5×9.5×35	21,700 ↑	25	520,000 ↑	17.5	9,100,000
9	62.5×½ 9.25×35	10,100 ↑	25	252,500 ↑	23.33	5,900,000
ΣV				2,516,200 ↓		44,471,000
10	62.5×½×37.5²	44000 ←	25	1,100,000 ←	12.5	13,780,000
11	17.5×½×23²	4,620 ←	25	115,500	7.67	887,000
12	62.5×½×18.5²	10,700 ←	7.5	80,300	25.2	2,025,000
13	30×½×23²	7,940 →	25	198,000	7.67	1,520,000
ΣH				← 1,097,800		15,172,000

Position of Resultant $X = \frac{\Sigma M}{\Sigma V} = \frac{44,471,000 - 15,172,000}{2,516,200} = 11.90'$,

Resultant falls within middle third. C.S.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject HARTFORD CONN. NORTH MEADOWS DIKE

Computation R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV.

Computed by P.C.H. **Checked by** WFR - RSM **Date** 10-6-38

UNIT ONE

Eccentricity $\frac{35}{2} - 11.90 = 5.6'$

Base Pressures $\frac{\Sigma V}{b \times 25}\left(1 \pm \frac{6e}{b}\right) = \frac{2,516,200}{35 \times 25}\left(1 \pm \frac{6 \times 5.6}{35}\right)$

Pressure, Landside 5500 #/□'
" River side 120 #/□'

Sliding $\frac{\Sigma H}{\Sigma V} = \frac{1,097,800}{2,516,200} = 0.44$

With no uplift

Position of Resultant $X = \frac{\Sigma M}{\Sigma V} = \frac{59,471,000 - 15,172,000}{3,288,700} = 13.45$

Resultant falls within middle third.

Eccentricity $\frac{35}{2} - 13.45 = 4.05'$

Base Pressures $\frac{\Sigma V}{b \times 25}\left(1 \pm \frac{6e}{b}\right) = \frac{3,288,700}{35 \times 25}\left(1 \pm \frac{6 \times 4.05}{35}\right)$

Pressure, Landside = 6390 #/□'
" , Riverside = 1145 #/□'

Design of Stem Spans between counter forts Span length 9'.0

Forces (10) (11) & (12) Acting

Head	Loading	Moment	d.	As
33.5'	1835 #/□'	14820 #'	15"	0.75 □"
28.0	1600	12250	15	0.618
22.0	1320	10400	15	0.526
16.0	1000	8100	15	0.391

$M = \frac{1}{10} w l^2$, $f_s = 18000$ #/□", $j = .88$, $d = 18 - 3 = 15"$

Steel for temperature requirements $A = 18 \times 12 \times .0025 = .54$ □" (half in each face)

Use 3/4"Φ 12" c.c. = .88 in each face

C-6.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject HARTFORD, CONN. NORTH MEADOWS DIKE

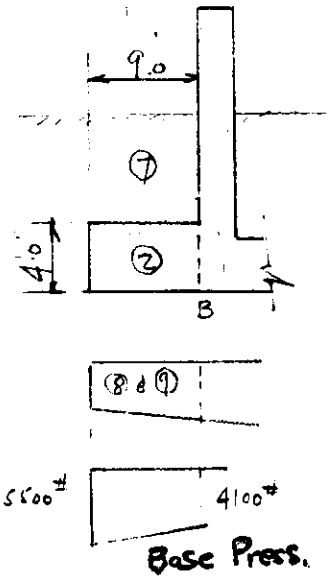
Computation R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV.

Computed by PGH **Checked by** WFR RSM **Date** 10-6-38

UNIT ONE.

Design of Base

1. Landside



Moment about "B"		Vertical Forces		
Force	Dimensions	Magnitude	Arm	Moment
8	9.5×62.5×9	5340# ↑	4.5	24,100 #'
9	½×2.44×62.5×9	690 ↑	3.0	2070
S.P.	4100×9	36,900 ↑	4.5	166,000
B.P.	½×1400×9	6,300 ↑	6.0	37,800
7	19×125×9	21,400 ↓	4.5	96,500
2	4×9×150	5,400 ↓	4.5	24,300
ΣV		26,800 ↑		109,200

$$A_s = \frac{M}{f_s j d} = \frac{109,200 \times 12}{18000 \times .884 \times 44.0} = 1.87 \square''$$ 1" ⊞ @ 6" centers

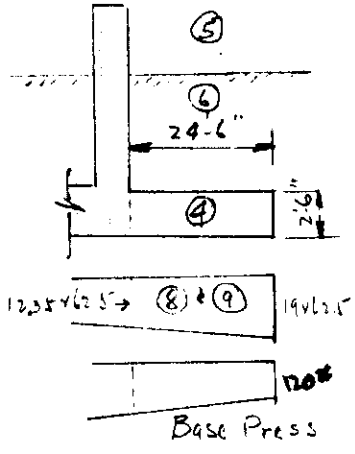
$$u = \frac{26,800}{2 \times 4 \times .884 \times 44} = 86.2 \ \#/\square''$$

$$\text{Shear} = \frac{V}{b j d} = \frac{26800}{12 \times .884 \times 44} = 57.5 \ \#/\square''$$

Depth for concrete compression.

$$d = \sqrt{\frac{M \times 12}{123\, b}} = \sqrt{\frac{109,200}{123}} = \sqrt{891} = 29.8''$$

2. Riverside. With uplift (force 8 & 9) CASE I



Spans between counterforts - Span length 9'-6"

Forces acting			Outer foot	Inner foot.
5	18.5×62.5	↓	1158	1158
6	16.5×125	↓	2060	2060
4	2.5×150	↓	375	375
8 & 9		↑	1190	770
BP		↑	120	3920
			2485 ↓	1095 ↑

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject HARTFORD CONN NORTH MEADOWS DIKE

Computation R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV

Computed by PGH Checked by WFR RSM Date 10-6-38

UNIT ONE.

Outer foot

$M = \frac{wl^2}{10} = \frac{2485 \times 9.5^2}{10} = 22,400^{\#'}$

$A_s = \frac{M}{f_s j d} = \frac{22400 \times 12}{18000 \times .884 \times 25.5} = 0.663^{\square''}$ 1"ϕ @ 12" c.to c.

Depth for concrete compression $d = \sqrt{\frac{M \times 12}{b \times 123}} = \sqrt{\frac{22400}{123}} = 13.5''$

Shear $V = \frac{1}{2} w P = \frac{1}{2} \times 2485 \times 9.5 = 11800^{\#}$

$v = \frac{V}{bjd} = \frac{11800}{12 \times .884 \times 25.5} = 44^{\#}/\square''$

Bond $\frac{V}{\Sigma o j d} = \frac{11800}{3.14 \times .884 \times 25.5} = 167^{\#}/\square''$ Anchor req. steel at ends

Inner foot.

$M = \frac{wl^2}{10} = \frac{1095 \times 9.5^2}{10} = 9900^{\#'}$

$A_s = \frac{M}{f_s j d} = \frac{9900 \times 12}{18000 \times .884 \times 25.5} = .29^{\square''}$ 3/4"ϕ @ 1'-0" c.c

2 Riverside Without uplift (forces ⑧ & ⑨) Case II

Forces acting		Outer foot	Inner foot
⑤ 18.5×62.5	↓	1158	1158
⑥ 16.5×125	↓	2060	2060
④ 2.5×150	↓	375	375
B.P.	↑	1145	4805
		2450 ↓	1210 ↑

Outer foot - about same as for above Case I

Inner foot

$M = \frac{wl^2}{10} = \frac{1210 \times 9.5^2}{10} = 10900^{\#'}$

$A_s = \frac{10900 \times 12}{18000 \times .884 \times 25.5} = 0.322^{\square''}$ 3/4"ϕ @ 1'-0" c.c.

Temperature steel. Landside - $48 \times 12 \times .0025 = 1.44^{\square''}$ } half in each face
Riverside - $30 \times 12 \times .0025 = 0.90$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject HARTFORD CONN., NORTH MEADOWS DIKE

Computation R.R. STOP LOG STRUCTURE SPRINGFIELD DIV.

Computed by PCH. Checked by WFR RSM Date 10-6-38

UNIT ONE

Design of Center Counter fort.

Thickness 2'-0"
Length of wall supported = 11.25'

steel required to transfer base loads.

Outer foot: $A_s = \frac{W}{f_s} = \frac{2485 \times 11.25}{18000} = 1.56 \square''$

Inner foot: $A_s = \frac{1210 \times 11.25}{18000} = 0.76 \square''$

steel required to transfer stem loads

$h = 5.0$, $w = 5 \times 62.5 = 313^{\#}$, $A_s = \frac{313 \times 11.25}{18000} = 0.20 \square''$
$h = 10.0$, $w = 10 \times 62.5 = 625$, $A_s = 0.39 \square''$
$h = 15.0$, $w = 15 \times 62.5 = 938$, $A_s = 0.59 \square''$
$h = 20.0$, $w = 20 \times 62.5 - 5.5 \times 15.5 = 1152^{\#}$, $A_s = 0.74 \square''$
$h = 25.0$, $w = 25 \times 62.5 - 10.5 \times 15.5 = 1387^{\#}$, $A_s = 0.88 \square''$
$h = 30.0$, $w = 30 \times 62.5 - 15.5 \times 15.5 = 1622^{\#}$, $A_s = 1.11 \square''$

Investigation for shear (base of counter fort)

Load, bottom of stem $14.5 \times 62.5 = 910$
$20.5 \times 80. = 1640$
$- 20.5 \times 35 = 715$
$1835^{\#} \times 11.25 = 20,600^{\#}$

" at ground $14.5 \times 62.5 = 910 \times 11.25 = 10,210^{\#}$

Total shear $\frac{1}{2} \times 10,210 \times 14.5 = 74,100$
$\frac{1}{2}(20,600 + 10210) \times 25 = 324,000$
Total = $398,100^{\#}$

req'd. $d = \frac{398,100}{884 \times 60 \times 24} = 313 \div 12 = 26'-1''$

available d $24.5 + 1.5 = 26.0$

Tension steel along inclined face of counter fort - Consider as Tee-Beam

At base of stem, $h = 35'-0''$ $d = 20.31 \times 12 = 256''$

Moment $= \frac{wh^3}{6} = \frac{62.5 \times 11.25 \times 35^3}{6} = 4,820,000$

(80 - 62.5 - 35 = 17.5) Less $\frac{17.5 \times 11.25 \times 20.5^3}{6} = \frac{281,000}{4,539,000}$ #'

C-9.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page .....

Subject HARTFORD CONN. NORTH MEADOWS DIKE

Computation R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV.

Computed by P.C.H. Checked by WFR. ESM Date 10-6-38

UNIT ONE

$$A_s = \frac{M}{f_s(d-\frac{t}{2})} = \frac{4,539000}{18000(256-9)} = 12.30\square'' \quad (8-1\tfrac{1}{4}\square \text{ bars in 2 rows})$$

$$\text{Bond, } u = \frac{398,100}{8\times 5\times 884\times 237} = 47.5\ \#/\square''$$

$$d \text{ for compression of concrete} = \sqrt{\frac{M}{bK}} = \sqrt{\frac{4,539,000\times 12}{24\times 123}} = 136''$$

At $h = 28'$ $\qquad d = .59h + .71 = .59\times 28 + .71 = 206''$

Moment $\frac{wh^3}{6} = \frac{62.5\times 11.25\times 28^3}{6} = 2,580,000$

Less $\frac{wh^3}{6} = \frac{17.5\times 11.25\times 13.5^3}{6} = 82,000$

$2,498,000\ \#'$

$$A_s = \frac{2,498,000\times 12}{18000(206-9)} = 8.45\square''$$

At $h = 22'$ $\qquad d = .59h + .71 = 165''$

Moment $\frac{wh^3}{6} = \frac{62.5\times 11.25\times 22^3}{6} = 1,250,000$

Less $\frac{wh^3}{6} = \frac{17.5\times 11.25\times 7.5^3}{6} = 14,000$

$1,236,000\ \#$

$$A_s = \frac{1,236,000\times 12}{18000(165-9)} = 5.39\square''$$

At $h = 16'$ $\qquad d = .59h + .71 = 122''$

Moment $\frac{wh^3}{6} = \frac{62.5\times 11.25\times 16^3}{6} = 481,000\ \#'$

Less $\frac{wh^3}{6} = \frac{17.5\times 11.25\times 1.5^3}{6}$ $\quad 110$

$481,000\ \#'$

$$A_s = \frac{481000\times 12}{18000(122-9)} = 2.83\square''$$

Temperature steel $24\times 12\times .0025 = .72\square''$ (half in each face

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page _____

Subject: HARTFORD, CONN. NORTH MEADOWS DIKE

Computation: R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by: W.R.K. Checked by: F.W.L. Date: 3-31-39

UNIT ONE

Design of Counterfort at Expansion joint.

Thickness 1'-6"
Length of wall supported 6.125'

Ratio of loading of counterfort to center counterfort $= \frac{6.125}{11.25} = .544$ ✓

Steel required to transfer base load (Page C-9)

Outer foot $A_s = 1.56 \times .544 = 0.85\ \square''$ ✓
Inner " $A_s = 0.76 \times .544 = 0.413\ \square''$ ✓

Steel required to transfer stem loads (Page C-8)

h = 5.0	$A_s = 0.20 \times .544$	= 0.109
10.0	$A_s =$	0.212
15.0	$A_s =$	0.321
20.0	$A_s =$	0.403
25.0	$A_s =$	0.479
30.0	$A_s =$	0.604

Investigation for Shear (base of counterfort)
Shear $398{,}100 \times .544 = 216{,}000^{\#}$ ✓

Req'd d $= \frac{216{,}000}{.884 \times 60 \times 18} = 226'' \div 12 = 18'-10''$

Available d $= 24.5 + 1.5 = 26'-0''$

Tension steel along inclined face of counterfort - Consider as Tee-Beam

ft h = 35,	$A_s = 12.30\ \square'' \times .544 =$	$6.70\ \square''$ ✓
h = 28,	$= 8.45 \times .544 =$	$4.60\ \square''$ ✓
h = 22,	$= 5.39 \times .544 =$	$2.94\ \square''$ ✓
h = 16,	$= 2.83 \times .544 =$	$1.54\ \square''$ ✓

Temperature steel $18 \times 12 \times .0025 = 0.54\ \square''$ ✓

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page _____

Subject: HARTFORD, CONN. NORTH MEADOWS DIKE

Computation: R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV

Computed by: W.R.K. Checked by: F.W.L. Date: 3-31-39

UNIT ONE

Design of counterfort nearest railroad.

Thickness 3'-0"

Length of wall supported 7.625'

" " stoplog " 7.75'

15.375 ✓ (Upper 17'-2" only)

Steel required to transfer base load (Page C-9)

Outer foot $A_s = 1.56^{\square''} \times \frac{7.625}{11.25} = 1.06^{\square''}$ ✓

Inner foot $A_s = 0.76^{\square''} \times \frac{7.625}{11.25} = .52^{\square''}$ ✓

Steel required to transfer stem loads (Page C-9)

$h = 5.0$ $A_s = 0.20^{\square''} \times \frac{15.375}{11.25} = 0.27^{\square''}$

$h = 10$ $A_s = .39 \times d_0 = 0.53^{\square''}$

$= 15$ $A_s = .59 \times d_0 = 0.81^{\square''}$

$h = 20$ $A_s = .74 \times \frac{7.625}{11.25} = 0.50^{\square''}$

$h = 25$ $A_s = .88 \times d_0 = 0.60^{\square''}$

$h = 30$ $A_s = 1.11 \times d_0 = 0.75^{\square''}$

Tension steel along inclined face of counterfort, riverside $A_s = \frac{M}{f_s j d}$

At $h = 35'.0$ $d = 25'-6" - 6" = 25'-0" = 300"$ (scaled)

$M = 4,539,000^{\#'} \times \frac{7.625}{11.25} =$ (Page 7.) $3,070,000^{\#'}$

+ stoplog $\frac{62.5 \times 7.75 \times 17.17}{2} \times 23.55$ $1,680,000^{\#'}$

$4,750,000^{\#'}$

$A_s = \frac{4,750,000 \times 12}{18000 \times .884 \times 300} = 9.95^{\square''}$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Page _____

Subject: HARTFORD CONN. NORTH MEADOWS DIKE

Computation: R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV

Computed by: W.R.K. Checked by: F.W.L. Date: 4-7-38

UNIT ONE

At $h = 28'$, $d = 29'-6" - 6" = 29'-0" = 348"$ (scaled)

$M = 2{,}498{,}000 \times \frac{7.625}{11.25} =$ 1,695,000 #'

+ stop log $\frac{62.5 \times 7.75 \times 17.17^2}{2} \times 1.55 =$ 1,184,000

2,879,000 #'

$A_s = \frac{2{,}879{,}000 \times 12}{18000 \times .884 \times 348"} = 6.25 \square"$

At $h = 22'$, $d = 25'-0" - 6" = 24'-6" = 294"$ (scaled)

$M = 1{,}236{,}000 \times \frac{7.625}{11.25} =$ 837,000 #'

+ stop log $\frac{62.5 \times 7.75 \times 17.17^2}{2} \times 1.55$ 755,000

1,592,000 #'

$A_s = \frac{1{,}592{,}000 \times 12}{18000 \times .884 \times 294} = 4.09 \square"$ ✓

At $h = 16'$, $d = 19'-9" - 6" = 19'-3" = 231"$ (scaled)

$M = 481{,}000 \times \frac{7.625}{11.25} =$ 328,000 #'

+ stop log $\frac{62.5 \times 7.75 \times 16^3}{6} =$ 327,000 #'

655000 #'

$A_s = \frac{655000 \times 12}{18000 \times .884 \times 231} = 2.14 \square"$

Temperature steel . $36 \times 12 \times .0025 = 1.08 \square"$ (half in each face.)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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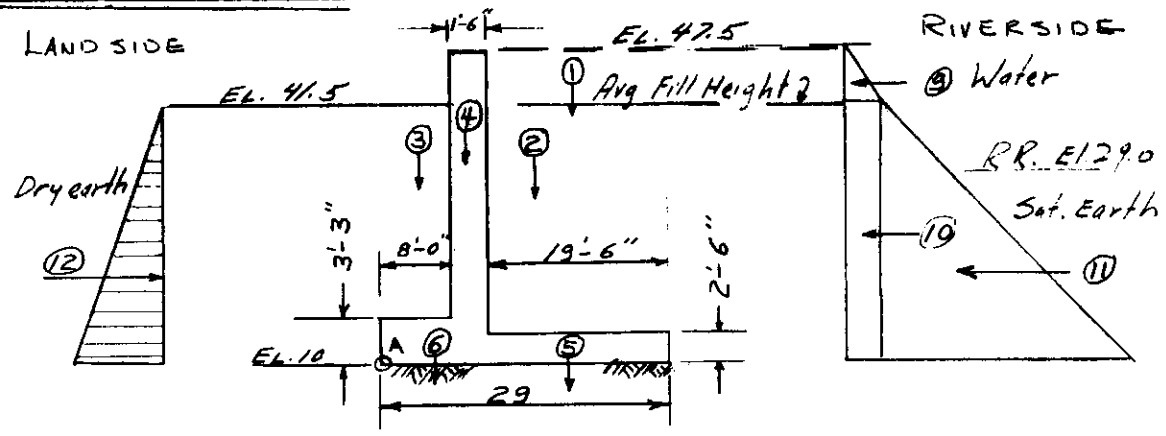
Subject: HARTFORD CONN. NORTH MEADOWS DIKE

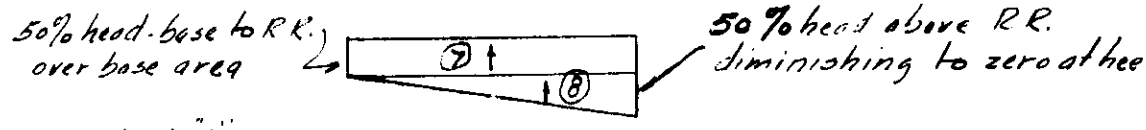
Computation: R.R. STOP LOG STRUCTURE, SPRINGFIELD DIV.

Computed by: R.S.M. Checked by: H.P.S. Date: 12-1-38

UNIT TWO

Stability Analysis.





Moments about "A"

Force	Dimensions	Magnitude	Arm Ft.	Moments Ft. Lbs.
1.	62.5 x 19.5 x 6	7310 ↓	19.25	140700
2.	125 x 19.5 x 29	70690 ↓	19.25	1358000
3.	100 x 8.0 x 28.25	22600 ↓	4.0	90400
4.	150 x 1.5 x 28.25	6360 ↓	8.75	55700
5.	150 x 19.5 x 2.5	7310 ↓	19.25	140500
6.	150 x 8.0 x 3.25	3900 ↓	4.75	18500
7.	62.5 x 9.5 x 29.0	17220 ↑	14.50	249200
8	62.5 x 9.25 x 29/2	8380 ↑	19.33	162000
ΣV.		92,570 ↓		1,392,600
9	62.5 x 6² x 1/2	1125 ←	33.5	37690
10	62.5 x 6 x 31.5	11815 ←	15.75	186090
11	80 x 31.5² x 1/2	39690 ←	10.5	416750
12	35 x 31.5² x 1/2	17360 →	10.5	182280
ΣH		35270 ←		458250

Position of Resultant. $X = \frac{\Sigma M}{\Sigma V} = \frac{1,392,600 - 458,250}{92,570} = 10.05'$

Resultant falls within middle third.

C-A.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject: HARTFORD CONN. NORTH MEADOWS DIKE

Computation: R. R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by: R.S.M. Checked by: H.R.S. Date: 12-1-38

UNIT TWO

Eccentricity

$$\frac{29.0}{2} - 10.05 = 4.45'$$

Base Pressures

$$\frac{\Sigma V}{b}\left(1 \pm \frac{6e}{b}\right) = \frac{92570}{29}\left(1 \pm \frac{6 \times 4.45}{29}\right) = 3190(1 \pm .92)$$

Pressure Landside = 6130 #/□'

" Riverside = 255 #/□'

Sliding

$$\frac{\Sigma H}{\Sigma V} = \frac{35270}{92570} = 0.38$$

With no uplift

Position of Resultant $X = \frac{\Sigma M}{\Sigma V} = \frac{1803800 - 458250}{118170} = 11.4'$

Resultant falls within middle third.

$$\text{Eccentricity} = \frac{29.0}{2} - 11.4 = 3.1'$$

Base Pressures

$$\frac{\Sigma V}{b}\left(1 \pm \frac{6e}{b}\right) = \frac{118170}{29}\left(1 \pm \frac{6 \times 3.1}{29}\right) = 4080(1 \pm .64)$$

Pressure Landside = 6700 #/□'

" Riverside = 1470 #/□'

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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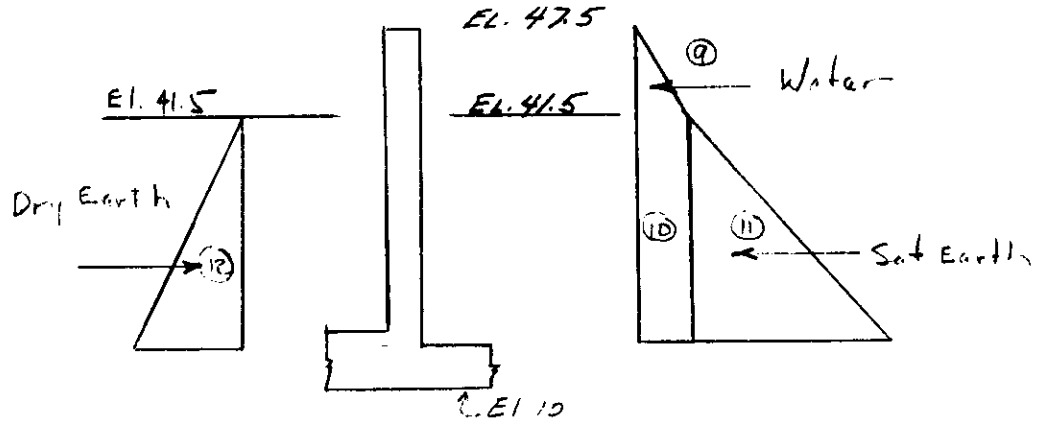
Subject HARTFORD, CONN. NORTH MEADOWS DIKE

Computation R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by W.R.K **Checked by** R.S.M. **Date** 12-1-38

UNIT TWO
DESIGN OF STEM



Allowable Stresses

$f_s = 18000$ $f_c = 800$ $n = 12$ $v = 60$ $u = 100$

$K = .348$ $j = .884$ $K = 123$

ELEVATION	12.5	17.5	22.5	27.5	32.5	37.5	42.5
HEAD	35.0	30.0	25.0	20.0	15.0	10.0	5.0
Load w	1680#	1455	1230	995	780	555	313
Moment $\frac{wl^2}{12}$ $l = 9.5$	12600#'	10900	9220	7470	5850	4160	2350
$d = \sqrt{\frac{M}{Kb}}$	10.15"	9.4					
Shear $\frac{6}{10}wl$ $l = 9.5$	9600#	8300	Supplied Thickness 7100	5950	4680	18" Throughout	
$d = \frac{V}{bjv}$	15.1"	13.1	Effective Depth			14.5"	"
$A_s = \frac{M}{f_s j d}$	.56□"	.48□"	.40□"	.33□"	.25□"	.18□"	.10□"
Bar & Spacing	3/4"φ @ 6"	3/4"φ @ 6"	3/4"φ @ 7"	3/4"φ @ 9"	3/4"φ @ 12"	3/4"φ @ 12"	3/4"φ @ 12"
As Supplied	0.88□"	0.88□"	0.76□"	0.59□"	0.44□"		
Bond $u = \frac{V}{j\Sigma_o d}$	159#/□"	137#/□"	(Anchor negative steel at ends)				
$f_c = \frac{2M}{Kjbd^2}$		280#/□"					

Temperature steel 18 × 12 × .0025 = 54□" ½ in each face { Use 3/4" 12" c.c. A = .88 in each face } C-16.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject: HARTFORD, CONN. NORTH MEADOWS DIKE

Computation: R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by: R.S.M. Checked by: H.R.S. Date: 12-1-38

UNIT TWO

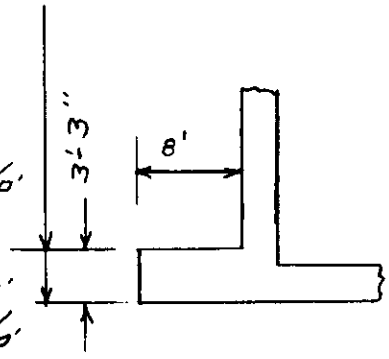
DESIGN OF BASE

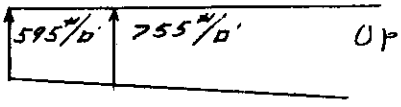
1. LANDSIDE

Loads

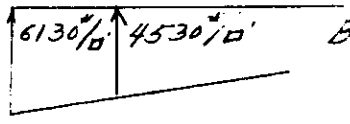
Dry Earth
28.25 x 100 = 2825 #/□'

Concrete
3.25 x 150 = 485 #/□'
TOTAL 3310 #/□'

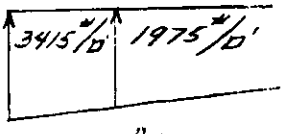




Uplift



Base Pressure



Net Loading

Design as cantilever

	Shear #	Arm	Moment '#
1975 x 8	15800	4	63200
1440 x 8/2	5760	5.33	30700
	21560 #		93900 '#

Req'd "d"

$$d = \frac{V}{bjv} = \frac{21560}{12 \times .884 \times 60} = 33.9''$$

$$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{93900}{123}} = 27.6''$$

Supplied "d" 39" − (4" Cover + 1/2") = 34.5"

$$A_s = \frac{M}{f_s j d} = \frac{93900 \times 12}{18000 \times .884 \times 34.5} = 2.05 \square''$$

Use 1" □ @ 6" c-c
A_s = 2.00 □"

$$\text{Bond } u = \frac{V}{j \Sigma o d} = \frac{21560}{.884 \times 8 \times 34.5} = 89 \#/\square''$$

$$f_c = \frac{2M}{Kjbd^2} = \frac{2 \times 93900 \times 12}{.348 \times .884 \times 12 \times 34.5^2} = 5.15 \#/\square''$$

Temperature steel A_s = .39 x 12 x 40 ÷ 60 = 1.18 □" (half in each face) (Use 3/8" □ c-c A_s = .88 in each face) C-17

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject: HARTFORD CONN. NORTH MEADOWS DIKE

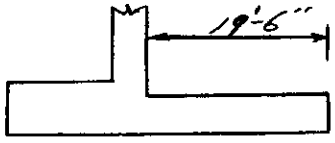
Computation: R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by: R.S.M. Checked by: H.R.S. Date .....

UNIT TWO

DESIGN OF BASE

2. Riverside With Uplift

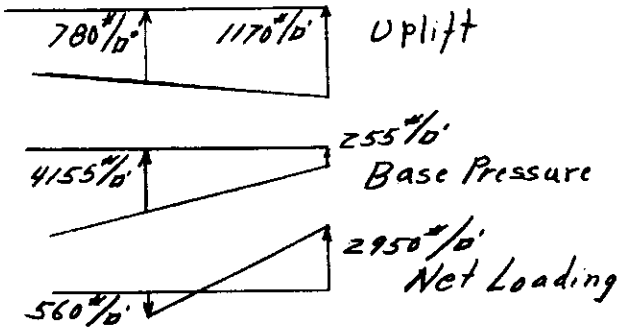


6' Water @ 62.5 = 375#

29' Sat. Earth @ 125 = 3625#

2.5' Conc. @ 150 = 375#

4375#



Design as continuous beam between counterforts

1. Consider outer 1 ft. strip

$$M = \frac{wl^2}{10} = \frac{2950 \times 19.5^2}{10} = 39010'\#$$

$$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{39010}{123}} = 17.8''$$

Shear $V = .6wl = .6 \times 2950 \times 9.5 = 16800\#$

$$d = \frac{V}{bvj} = \frac{16800}{12 \times .884 \times 60} = 26.4''$$

$$d\,(\text{supplied}) = 30 - (4 + \tfrac{1}{2}) = 25.5''$$

Reinforcing $A_s = \dfrac{M}{f_s\, jd} = \dfrac{39010 \times 12}{18000 \times .884 \times 25.5} = .98\,\square''$

Use 1"□ @ 9" c-c

$$f_c = \frac{2M}{kjbd^2} = \frac{2 \times 39010 \times 12}{.348 \times .884 \times 12 \times 25.5^2} = 392\,\#/\square''$$

$$u = 16800 / .884 \times 5.3 \times 25.5 = 141\,\#/\square''$$

Temperature steel: ($A_s = 30 \times 12 \times .0025 = 0.90\,\square''$ half in each face
Use 3/4" 12" c.c. $A_s = .88\,\square''$ in each face)

Subject: HARTFORD, CONN NORTH MEADOWS DIKE
Computation: R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.
Computed by: R.S.M. Checked by: H.R.S. Date:

UNIT TWO

DESIGN OF BASE

2. Riverside With Uplift.

2. Strip 10' from stem.

$L = 1800^{\#}/FT.$

$M = 1800 \times \frac{11.5^2}{10} = 23700'^{\#}$

$As = \frac{23700}{39010} \times .94 = .57^{\square''}$

$U = 11400/.884 \times 25.5 \times 3.14 = 161^{\#}/\square''$

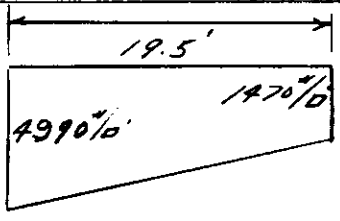
Use $1''\phi$ @ $1'-0''$ C-C

3. Inner 1' strip

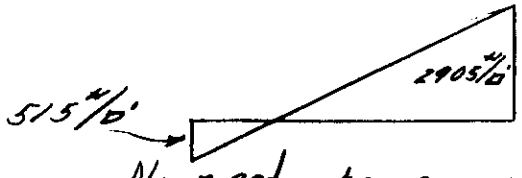
$M = 560 \times \frac{11.5^2}{10} = 7400'^{\#}$

$As = \frac{7400}{39100} \times .94 = .18^{\square''}$ Upper side of slab

3. Riverside Without uplift.



Base Pressure



Net loading

No need to carry computations further as these loads are less than with uplift.

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject: HARTFORD CONN. NORTH MEADOWS DIKE

Computation: R.R. STOPLOG STRUCTURE SPRINGFIELD DIV.

Computed by: W.M.A. Checked by: P.S.M. Date: 17-1-39

UNIT TWO

DESIGN OF MIDDLE COUNTERFORT

Thickness 2'-0" Spaced 11'-6" C-C

Wall supported, 11.50'

Steel Required to transfer loads into counterforts.

Stem

at 30' $\frac{1455 \times 11.5}{18000} = .93 \square''$

at 25' $\frac{1230 \times 11.5}{18000} = .79 \square''$

at 20' $\frac{995 \times 11.5}{18000} = .63 \square''$

at 15' $\frac{780 \times 11.5}{18000} = .50 \square''$

at 10' $\frac{555 \times 11.5}{18000} = .35 \square''$

at 5' $\frac{313 \times 11.5}{18000} = .20 \square''$

Heel

Outer Ft. $\frac{2950 \times 11.5}{18000} = 1.88 \square''$

Inner Ft. $\frac{560 \times 11.5}{18000} = 0.36 \square''$

Tension Steel along inclined face, Considered as Tee-beam

Moment at Base of Stem

$$\frac{62.5 \times \overline{33.5}^3}{6} = 392.000 \#'$$

Less $$\frac{12.5 \times \overline{27.5}^3}{6} = \frac{60,400}{331,600} \#'$$

$$d = 21'-9" - 6" = 21'-3" = 255"$$

$$A_s = 11.5 \frac{M}{f_s\left(d - \frac{t}{2}\right)}$$

$$A_s = 11.5 \frac{331,600 \times 12}{18000(255-9)} = 10.3 \square''$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject HARTFORD, CONN NORTH MEADOWS DIKE

Computation R.R. STOPLOG STRUCTURE SPRINGFIELD DIV.

Computed by Checked by Date

UNIT TWO

Moment 10' above base of stem

$$\frac{62.5 \times \overline{23.5}^3}{6} = 135000^{\#'}$$

$$\text{Less} \quad \frac{17.5 \times 17.5^3}{6} = 15600$$

$$119400^{\#'}$$

$$d = 16'-0'' - 6'' = 15'-6'' = 174''$$

$$A_s = 11.5 \times \frac{119400 \times 12}{18000(174-9)} = 5.55^{\square''}$$

Moment 20' above base of stem.

$$\frac{62.5 \times \overline{13.5}^3}{6} = 25600^{\#'}$$

$$\text{Less} \quad \frac{17.5 \times \overline{7.5}^3}{6} = 1200$$

$$24400^{\#'}$$

$$d = 10'-3'' - 6'' = 9'-9'' = 117''$$

$$A_s = 11.5 \times \frac{24400 \times 12}{18000 \times (117-9)} = 1.8^{\square''}$$

Moment 5' above base of stem

$$\frac{62.5 \times \overline{28.5}^3}{6} = 241{,}000^{\#'}$$

$$\text{Less} \quad \frac{17.5 \times \overline{22.5}^3}{6} = 33200$$

$$207{,}800^{\#'}$$

$$A_s = \frac{207800 \times 12 \times 11.5}{18000 \times 206} = 7.75^{\square''}$$

(Temperature steel $A = 24 \times 12 \times .0025 = .72^{\square''}$ half in each face
Use 3/4"ϕ .12"cc, $A = .88$ in each face)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject HARTFORD CONN. NORTH MEADOWS DIKE

Computation R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by HRS. Checked by WRK Date 3-31-39

UNIT TWO

DESIGN OF COUNTERFORT AT EARTH DIKE

Thickness 2'-0"
Length of Wall supported 7.75'

Ratio of loading of counterfort and middle counterfort $= \frac{7.75}{11.50} = .674$

Steel Required to transfer loads int counterfort.
See Page C-20.

STEM

at 30'	$\frac{7.75}{11.50} = .674 \times$	.93	=	.63 □"
at 25'	.674 ×	.79	=	.53 □"
at 20'	.674 ×	.63	=	.42 □"
at 15'	.674 ×	.50	=	.34 □"
at 10'	.674 ×	.35	=	.24 □"
at 5'	.674 ×	.20		.13 □"

HEEL

Outer Ft.	.674 ×	1.88	=	1.27 □"
Inner Ft.	.674 ×	1.36	=	0.24 □"

Tension steel along inclined face, considered as Tee Beam

At Base	.674 ×	10.3	=	6.95 □"
5' Above Base of Stem	.674 ×	7.75	=	5.22
10' " " "	.674 ×	5.55	=	3.74
20' " " " "	.674 ×	1.80	=	1.22

Subject HARTFORD, CONN. NORTH MEADOWS DIKE
Computation R. R. STOPLOG STRUCTURE, SPRINGFIELD, MASS.
Computed by HRS Checked by WRK Date 3-31-39

UNIT TWO

DESIGN OF COUNTERFORT AT EXPANSION JOINT

Thickness 1'-6"
Length of Wall supported 6.25'

Ratio of loading of counterfort and middle counterfort $= \frac{6.25}{11.5} = .544$

Steel required to transfer loads into counterforts.
See Page C-20.

Stem

at 30' $\frac{6.25}{11.5} = .544 \times .93 = .51 \square''$
at 25' $.544 \times .79 = .43 \square''$
at 20' $.544 \times .63 = .34 \square''$
at 15' $.544 \times .50 = .27 \square''$
at 10' $.544 \times .35 = .19 \square''$
at 5' $.544 \times .20 = .11 \square''$

Heel

outer Ft. $.544 \times 1.88 = 1.03 \square''$
Inner Ft. $.544 \times 0.36 = 0.20 \square''$

Tension Steel along inclined face, considered as Tee Beam

At Base $.544 \times 10.3 = 5.61 \square''$
5' Above Base of Stem $.544 \times 7.75 = 4.23 \square''$
10' " " " " $.544 \times 5.55 = 3.01 \square''$
20' " " " " $.544 \times 1.80 = 0.98 \square''$

(Temperature steel A .18 × 12 × .0025 = .54 □" half in each face
Use 3/4" ϕ 12" cc A = .88 □" in each face)

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject HARTFORD CONN. NORTH MEADOWS DIKE

Computation R.R. STOPLOG STRUCTURE SPRINGFIELD DIV.

Computed by W.R.K. Checked by C.W.B.M. Date 3-24-39

STOPLOG AND CENTER SUPPORT

DESIGN OF STOPLOGS

White oak log Dressed size 11½" Deep Span 15.5'

Max. Load $62.5 \times 17.17 = 1075$ #/□'

Moment $\frac{Wl^2}{8} = \frac{1075 \times 15.5^2}{8} = 32,200$ #

Shear $\frac{Wl}{2} = \frac{1075 \times 15.5}{2} = 8340$ #

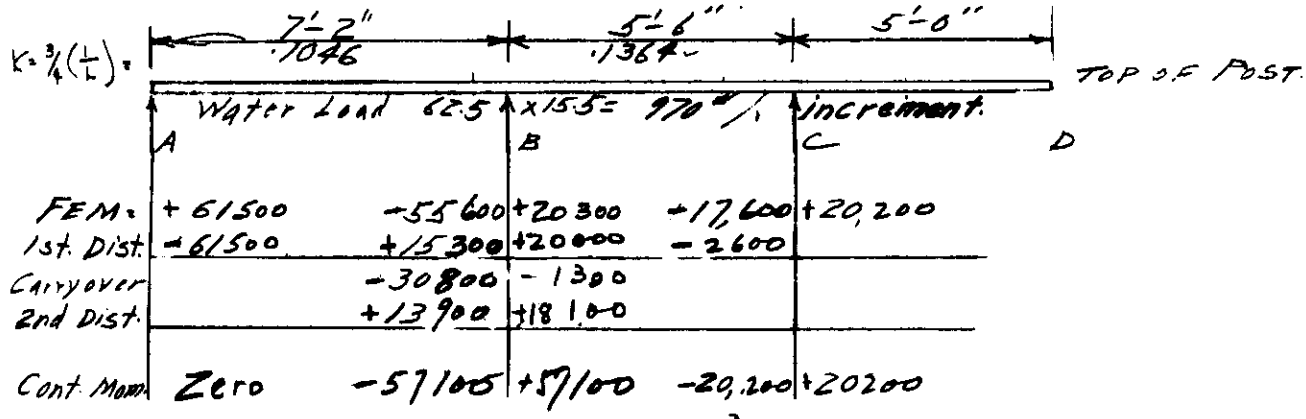
FIBER STRESS $\frac{M \times 12}{\frac{bd^2}{6}} = \frac{32200 \times 12}{\frac{12 \times 11.5^2}{6}} = 1460$ #/□' O.K.

BEARING AREA REQ'D.

Allowable bearing 265 #/□" or 3180 #/Ft. of width.

Depth of recess $\frac{8340}{3180} = 2.62 + 0.5 = 3.12$"

DESIGN OF CENTER SUPPORT



$$R_C = -\frac{57100}{5.5} + \frac{62.5 \times 15.5 \times 10.5^3}{6 \times 5.5} = 23,800 \text{ \#}$$

$$R_B = -\frac{23800 \times 12.67}{7.17} + \frac{62.5 \times 15.5 \times 17.17^3}{6 \times 7.17} = 71700 \text{ \#} \checkmark$$

$$R_A = \frac{62.5 \times 17.17^3 \times 15.5}{2} - 71700 - 23800 = 47500 \text{ \#}$$

WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

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Subject HARTFORD CONN. NORTH MEADOWS DIKE

Computation R.R. STOPLOG STRUCTURE SPRINGFIELD DIV.

Computed by W.P.K. **Checked by** C.W.B.M. **Date** 3-24-39

Maximum Moment.

$$\frac{970x^2}{2} = 23800 + 71700 = 95500$$

$$x = 14'$$

$$M = 3.5(71700) + 9(23800) - \frac{970 \times 14^3}{6} = 20800^{\#'}$$

$$\therefore 57100^{\#'} = M_{Max.}$$

Axial Tension $23800 + 71700 = 95500^{\#}$

VERTICAL BEAM

Try a 14" x 34" C.B.

$A = 10.0^{\square''}$ $S = 48.5$

$$f = \frac{95500}{10} + \frac{57100 \times 12}{48.5} = 23600^{\#}/\square'' \quad \text{O.K.}$$

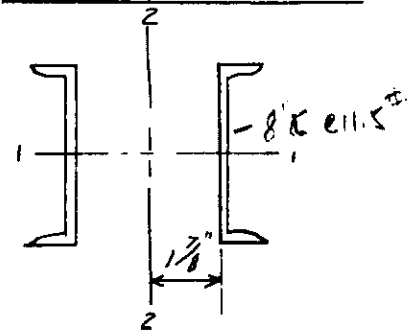
INNER STRUT Pin supported Length = 8.25' ±

Reaction = $71,700\sqrt{2} = 101,300^{\#}$

Pin Size $= \frac{101300}{2 \times 13500} = 3.75^{\square''}$ USE 2½"

Thickness for bearing $t = \frac{101300}{2\frac{1}{2} \times 29000} = 1.68''$ Use 2"

STRUT MEMBER



8" Channel $A = 3.36^{\square''}$ $I_1 = 1.3$ $y = .58'$

$I_2 = I_1 + Ad^2 = 1.3 + 3.36 \times 2.455^2 = 21.5$

I_{1-1} $2 \times 21.5 = 43.0 \text{ in.}^4$

$$r_{2-2} = \sqrt{\frac{I}{A}} = \sqrt{\frac{43.0}{6.72}} = 2.53$$

$$r_{1-1} = 3.10 \times 2 = 6.20$$

$$\frac{l}{r} = \frac{8.25 \times 12}{2.53} = 39.2$$

$$18000 - \frac{70l}{r} = 18000 - 70 \times 39.2 = 15260^{\#}/\square'' \quad f_s = \frac{P}{A} = \frac{101300}{6.72} = 15150^{\#}/\square''$$

O.K.

C-25.

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Subject HARTFORD, CONN. NORTH MEADOWS DIKE

Computation RR STOPLOG STRUCTURE SPRINGFIELD DIV.

Computed by W.R.K. Checked by C.W. B.M. Date 3-24-39

OUTER STRUT

Length = 16'-0" ±

Reaction = 23800 x 1.2 = 33600 #

Pin Size = $\frac{33600}{2 \times 13500}$ = 1.25" Use 2½"

Thickness for bearing =

$t = \frac{33600}{2\frac{1}{2} \times 24000}$ = 0.56" Use 2"

Use same member as for inner strut.

$\frac{l}{r} = \frac{16.0 \times 12}{2.53} = 76$

$18000 - \frac{70 l}{r} = 18000 - 70 \times 76 = 12690$ #/□"

$f_s = \frac{P}{A} = \frac{33600}{6.72} = 5000$ #/□" O.K.

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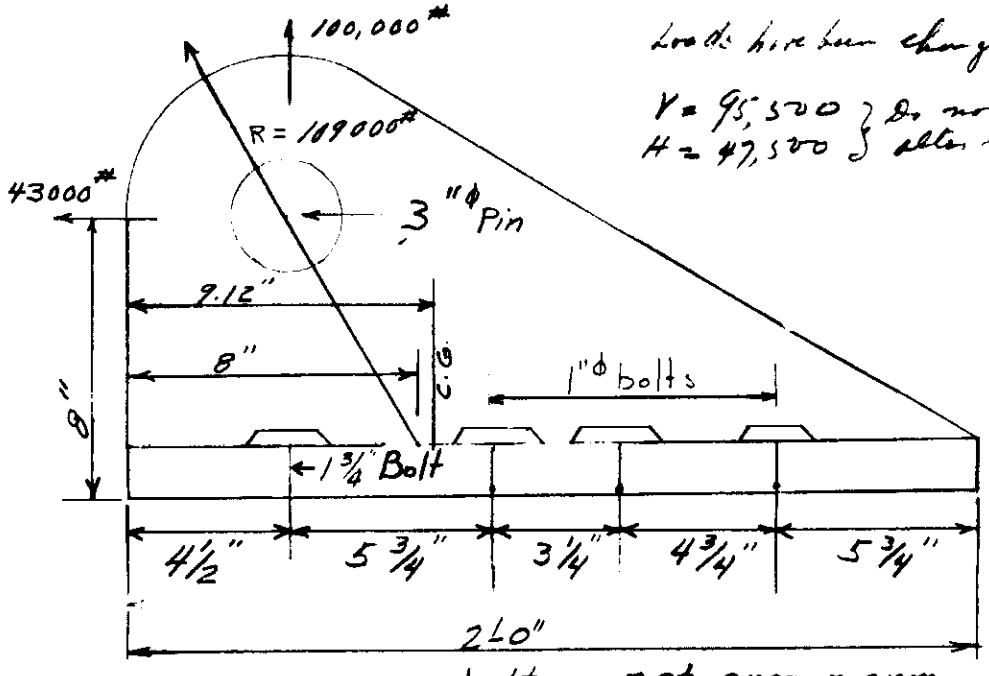
Computation: R.R. STOPLOG STRUCTURE, SPRINGFIELD DIV.

Computed by: W.R.K. Checked by: S.H.B. Date: 3-31-39

CENTER POST - ANCHOR CASTING

Stresses in bolts



Loads have been changed

V = 95,500 } Do not appreciably
H = 47,500 } alter stresses

bolt net area x arm

c.g. of bolts

1¾	1.744 x 4.5	=	7.85
1	.551 (10.25+13.5+18.25)		23.15
	3.397		31.00

$$\times \frac{31.00}{3.397} = 9.12''$$

I of bolts	$+ I_o + 1.744 \times (\overline{4.62})^2$	=	37.55
	$+ I_o + .551 \times \overline{1.13}^2$	=	.75
	$+ I_o + .551 \times \overline{4.38}^2$	=	10.63
	$+ I_o + .551 \times \overline{9.13}^2$	=	45.90
I - TOTAL OF BOLT CLUSTER			94.8 in.⁴

Moment about c.g.

	100000 x 4.62	=	462,000 #"
−	43000 x 8.00	=	344,000
			118,000 #"

$$f_{1\frac{3}{4}''\phi \text{ bolt}} = \frac{P}{A} + \frac{M}{I}y \quad \frac{100000}{3.397} + \frac{118000}{94.8} \times 4.62 = 35150\ \#/\square'' \div 2 = 17600\ \#/\square''$$

$$f_{1''\phi \text{ bolt}} = \frac{P}{A} - \frac{M}{I}y \quad \frac{100000}{3.397} - \frac{118000}{94.8} \times 1.13 = 28000\ \#/\square''$$

$$\frac{28000}{2} = 14000\ \#/\square''$$

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Computation R.R. STOPLOG STRUCTURE SPRINGFIELD DIV

Computed by W.R.K. Checked by S.H.B. Date 3-31-39

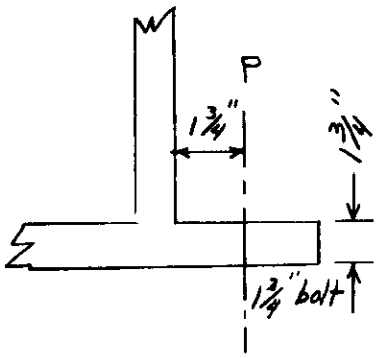
Shearing stress $\frac{43000}{3.397 \times 2} = 6400\ \#/\square''$

Combined stress $s = \frac{s}{2} + \sqrt{\frac{s^2}{4} + v^2}$

$1\frac{3}{4}''\phi$ bolt $= \frac{17600}{2} + \sqrt{\frac{17600^2}{4} + 6400^2} = 19{,}700\ \#/\square''$

$1''\phi$ bolt $\frac{14000}{2} + \sqrt{\frac{14000^2}{4} + 6400^2} = 16500\ \#/\square''$

Thickness of base



$P = 19700 \times 1.744 = 34400\ \#$

$M = 34{,}400 \times 1.75 = 60200\ ''\#$

$\frac{M}{S} = \frac{60200}{18000} = 3.34$

$\frac{bd^2}{6} = 3.34$ $b = 6''$ (Assumed)

$d^2 = \frac{3.34 \times 6}{6} = 3.34$

$d = 1.83''$ Use $1\frac{3}{4}''$ base.

Size of Pin

Investigation for shear

$V = 109000$ $A = \frac{109000}{2 \times 10000} = 5.45\ \square''$

Use 3" Pin

Thickness of Pin Support

For bearing. $t = \frac{109000}{3.0 \times 24000} = 1.52$ Use $1\frac{1}{2}''$ thickness.

For shear

$w \times 1.5 \times 2 \times 13500 = 109000$

$w = \frac{109000}{3 \times 13500} = 2.7$ Make collar $2\frac{3}{4}''$ C-28.

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Computation R.R. STOP LOG STRUCTURE SPRINGFIELD DIV

Computed by W.R.K. Checked by H.R.S. Date 4-4-39

CENTER POST - ANCHOR CASTING

Anchor bolts

Size of bearing plate

$1\frac{3}{4}''$ bolt ; $A - 1.744 \square''$ Total stress $1.744 \times 18000 = 31500^{\#}$
For 2 bolts $31500 \times 2 = 63000^{\#}$

Area for bearing $\frac{63000}{500} = 126 \square''$

Use 7" [9.8#, 18" long, $A = 126 \square''$

1" bolt, $A = .551 \square$ Total stress $.551 \times 16500 = 9100^{\#}$
For 3 bolts $3 \times 9100 = 27300^{\#}$

Area for bearing $\frac{27300}{500} = 55 \square''$

Use 5" [6.7#, 12" long, $A = 60 \square''$

Depth of imbedment

$1\frac{3}{4}''$ bolt - perimeter of bearing [= 50"

$$d = \frac{63000}{50 \times 60} = 21.0''$$

1" bolt - perimeter of bearing [= 34"

$$d = \frac{27300}{34 \times 60} = 13.4''$$

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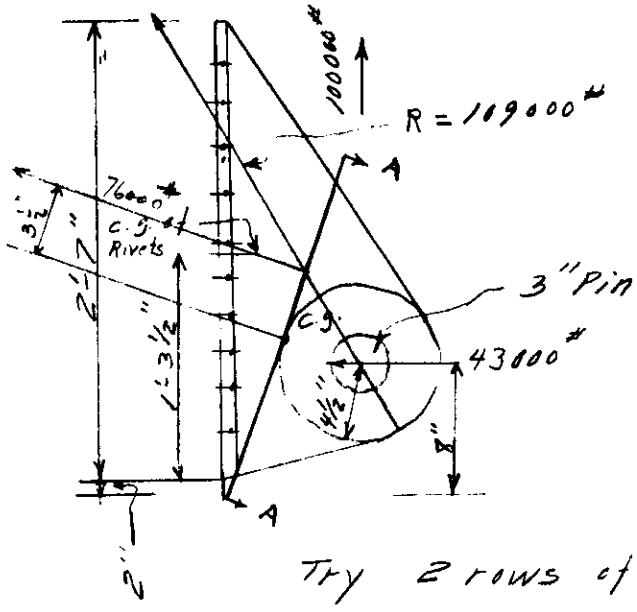
CENTER POST POST-CASTING

Stresses in rivets



Try 2 rows of 10 - 3/4" rivets - Sq. 9 x 3 = 27 + 4 = 31

I of Rivets (1 row) Area = .4418 □"

$I = .4418(1.5^2 + 4.5^2 + 7.5^2 + 10.5^2 + 13.5^2) = 328 \text{ in.}^4$ (1 row)

Moment about c.g.

$100000 \times 8 = 800,000$ #"

$- 43000 \times 9.5 = -408,000$

$392,000$ #"

$f = \frac{P}{A} + \frac{M}{I} y = \frac{43000}{4.418} + \frac{392000}{328} 13.5 = 25900$ #/□"

$\frac{25900}{2} = 13000$ #/□"

Shearing Stress $v = \frac{100000}{4.418 \times 2} = 11300$ #/□"

Combined Stresses

$S = \frac{f}{2} + \sqrt{\frac{f^2}{4} + v^2} = \frac{13000}{2} + \sqrt{\frac{13000^2}{4} + 11300^2}$

$S = 6500 + 13000 = 19,500$ #/□"

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Thickness of Base

$$t = \frac{100000}{18000 \times \frac{3}{4} \times 20} = .37''$$

use $\frac{1}{2}''$ Thickness

Width of Flange of 14" C.B. $= \frac{7}{16}'' = .437''$ ∴ O.K.

Investigation of web

Reduce from collar of $1\frac{1}{2}''$ to $\frac{3}{4}''$

See Page 4 Section A-A

$b = 18.5''$ $e = 3\frac{1}{2}''$ (scaled)

$P = 76000^{\#}$

$$f = \frac{P}{A}\left(1 \pm \frac{6e}{b}\right) = \frac{76000}{\frac{3}{4} \times 18.5}\left(1 \pm \frac{6 \times 3.5}{18.5}\right)$$

$$= 5480(1 \pm 1.13)$$

$$= 5480 \times 2.13 = 11700^{\#}/\square'' \quad \text{O.K.}$$

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Computation: R.R. STOPLOG STRUCTURE SPRINGFIELD DIV.

Computed by: W.R.K. Checked by: H.R.S. Date: 4-8-39

STOP LOG SILL AND FOUNDATION FOR CENTER SUPPORT

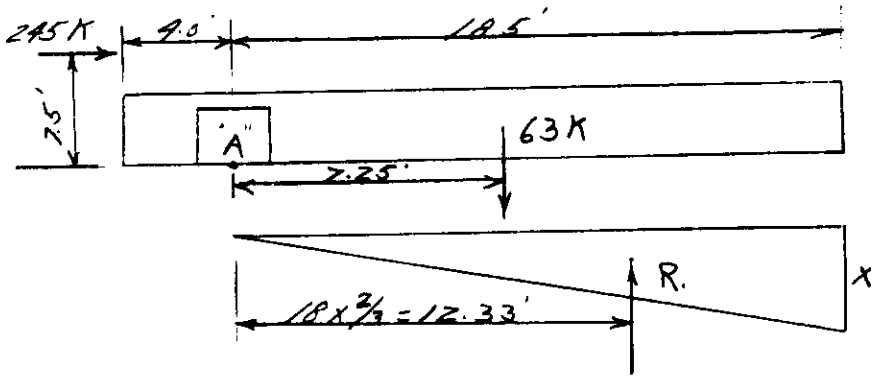
Analysis of stresses

Loading Horizontal water load $\frac{22.5^2}{2} \times 62.5 \times 15.5 = 245$ K.

Dead Load center $3.5 \times 5.33 \times 22.5 \times 150 = 63$ K

Sill $\left.\begin{array}{l} 5.3 \times 3.83 \times 31.0 \times 150 \\ 1 \times 1.5 \times 31.0 \times 150 \end{array}\right\}$ 96 K

Assume center support rotates about sill



To Find R Take moments about "A."

$12.33 R = 7.5 \times 245 + 7.25 \times 63 = 1840 + 457$

$R = 187$ K.

Base Pressure $X = \frac{187{,}000 \times 2}{18.5 \times 3.5} = 5770$ #/□'

Total reaction upward at $A = 187 - 63 = 124$ K.

Stoplog sill Span 31' with fixed ends.

1. River Stage at 47.5'
Moment caused by vertical loading.

	Support	Center
Upward Load	480 K'	480 K'
Dead Load	-248 K'	-124 K'
	232 K'	356 K'

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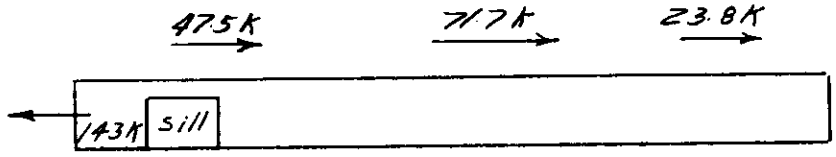
INVESTIGATION FOR TENSION

• See Page C-24.



Max Tension in beam on landside of stoplog sill

$T = 71.7 - 23.8 = 95.5\ K$

$A_s = \frac{95500}{18000} = 5.3\ \square''$

Supplied Steel $= 4-1''\square'' = 4.00$

$= 8-\frac{3}{4}''\phi = 3.62$

$7.62\ \square''$

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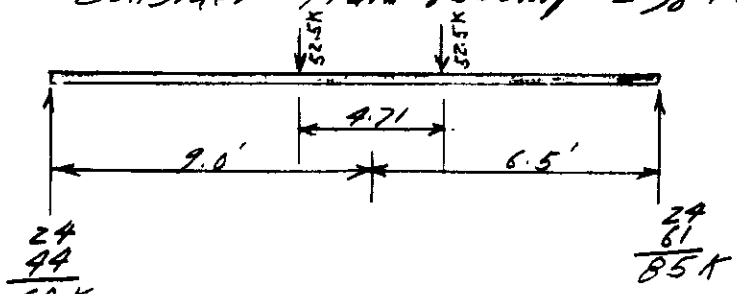
$$d = \sqrt{\frac{356000 \times 12}{183 \times 60}} = 24'' \qquad f_s = \frac{356000 \times 12}{.884 \times 40 \times 6.25} = 19300\ \#/\square''$$

Moment caused by horizontal load

$$\text{Load} = 245K - 8K = 237K$$
$$M = 237 \times \frac{15.5}{4} = 916K'$$
$$d = \sqrt{\frac{916{,}000 \times 12}{123 \times 44}} = \sqrt{2030} = 45''$$
$$\text{Available } d = 60'' - 4'' = 56''$$
$$\text{Supplied } A_s = 7\text{-}1\tfrac{1}{4}''^{\square} = 1.56 \times 7 = 10.9\ \square''$$
$$f_s = \frac{916000 \times 12}{.884 \times 56 \times 10.9} = 20400\ \#/\square''$$

2. River Stage Normal

Consider train loading E70 +50% impact



Assume ½ load carried by counterfort and ½ by center support.

$$\text{Left Reaction} = 24 + \frac{52.5 \times 8.85 + 52.5 \times 4.15}{15.5} = 68K.$$

Max. Moment occurs under left wheel.

Load	Arm	Moment, K'
67 K	6.65	+ 446
$\frac{96}{31} \times 6.65$	3.33	− 68.5
		+ 377.5 K' = 377,500 #'

$$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{377{,}500 \times 12}{123 \times 60}} = 24.8''$$

$$A_s = \frac{377500 \times 12}{18000 \times .884 \times 40} = 7.1\ \square'' \qquad \text{Supplied } A_s = 4\text{-}1\tfrac{1}{4}''^{\square} = 6.24\ \square''$$

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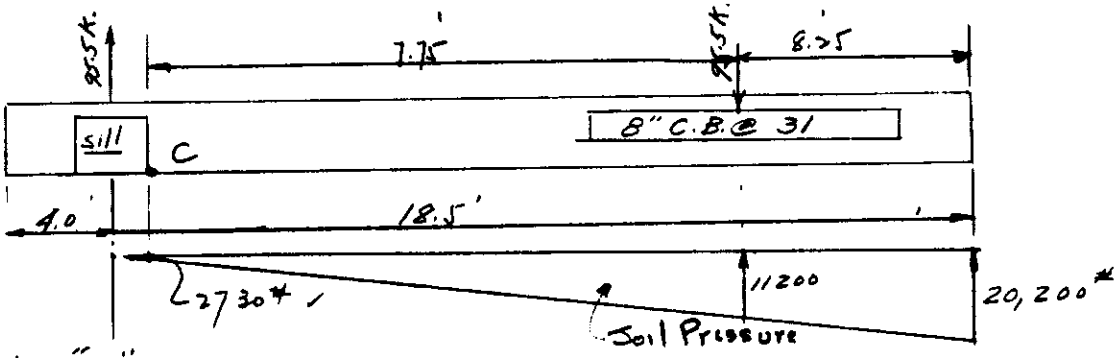
Center Support

Investigation of stresses caused by moment



AT "C"

LOAD	Arm	Moment
95500	7.75	+ 740000 #'
2800 x 16	8.00	+ 358,000
2730 x 16	8.00	- 350,000 #'
17470 x 8	16 x 2/3	- 1490 .0
		- 742000 #'

$$d = \sqrt{\frac{742000 \times 12}{123 \times 42}} = \sqrt{1725} \quad 41.5''$$

$$A_s = \sqrt{\frac{742,000 \times 12}{18000 \times .884 \times 60}} = 9.3^{\square''}$$

Use $6 \cdot 1\frac{1}{4}''\square$, $A = 6 \times 1.56 = 9.4^{\square''}$

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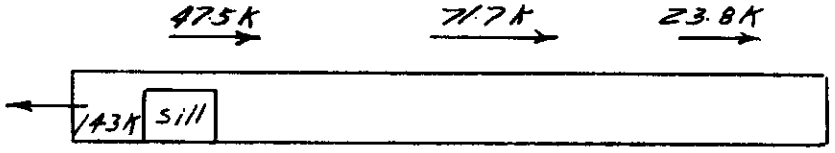
INVESTIGATION FOR TENSION

• See Page C-24.



Max Tension in beam on landside of stoplog sill

$T = 71.7 - 23.8 = 95.5\ K.$

$A_s = \frac{95500}{18000} = 5.3\ \square''$

Supplied Steel $= 4-1''\ \square'' = 4.00$

$= 8-\frac{3}{4}''\ \square'' = 3.62$

$7.62\ \square''$