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HOUSATONIC RIVER FLOOD CONTROL

NORTHFIELD BROOK
DAM & RESERVOIR

NORTHFIELD BROOK

(LOWER NAUGATUCK RIVER, BELOW THOMASTON)

CONNECTICUT

DESIGN MEMORANDUM NO. 8

DETAILED DESIGN OF STRUCTURES

U.S. Army Engineer Division, New England
Corps of Engineers Waltham, Mass.

AUGUST 1962

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

15 August 1962

NEDGW

SUBJECT: Northfield Brook Dam and Reservoir - Northfield Brook - Housatonic River Basin, Connecticut - Design Memorandum No. 8 - Detailed Design of Structures

TO: Chief of Engineers
ATTN: ENGCW-E
Department of the Army
Washington, D. C.

There is submitted for review and approval Design Memorandum No. 8 - Detailed Design of Structures for the Northfield Dam and Reservoir - Northfield Brook - Housatonic River Basin, Connecticut, in accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

John Wm Leslie

1 Incl (10 cys)
Design Memo No. 8

JOHN WM. LESLIE
Chief, Engineering Division

FLOOD CONTROL PROJECT

NORTHFIELD BROOK DAM AND RESERVOIR

NORTHFIELD BROOK

HOUSATONIC RIVER BASIN

CONNECTICUT

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2	Site Geology	12 Apr 1962	8 May 1962
3	General Design	29 Jun 1962	
4	Relocations	30 Apr 1962	29 Jun 1962
5	Concrete Materials	21 Nov 1961	7 Dec 1961
6	Real Estate		
7	Embankments and Foundation	13 Jul 1962	
8	Detailed Design of Structures	15 Aug 1962	
9	Reservoir Management		

NORTHFIELD BROOK DAM AND RESERVOIR

NORTHFIELD BROOK

HOUSATONIC RIVER BASIN

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
OFFICE OF THE DIVISION ENGINEER
WALTHAM 54, MASS.

FLOOD CONTROL PROJECT

NORTHFIELD BROOK DAM AND RESERVOIR

NORTHFIELD BROOK
HOUSATONIC RIVER BASIN
CONNECTICUT

DESIGN MEMORANDUM NO. 8

DETAILED DESIGN OF STRUCTURES

August 1962

A. INTRODUCTION

1. Purpose.- The purpose of this memorandum is to facilitate the review by higher authority of the structural design of the various features of the project. The basic criteria, typical design computations, and other data pertinent to the design are presented herein.

2. Scope. - This memorandum covers the following structures: outlet works, spillway, lining and retaining walls.

3. Previous Reports. - No previous report on the structural design of these structures has been submitted. The latest previous description of the proposed structures is set forth as part of the recommended project plan in Design Memorandum No. 3 - General Design, submitted on 29 June 1962.

4. Location of Project. The Northfield Brook Reservoir Project is located within the Towns of Thomaston and Litchfield. The reservoir is formed by a dam located on Northfield Brook about 1.3 miles above the confluence with the Naugatuck River and a spillway in the east abutment. The reservoir extends up the Northfield Brook about 1.5 miles. The total drainage area of Northfield Brook is 6.6 square miles and the drainage area at the dam site is 5.7 square miles.

5. Description of Proposed Structures. -

a. General. - A description at each of the principal elements of the proposed plan of improvement for the Northfield Brook Reservoir Project is presented in the following paragraphs. See General Plan, Plate No. 1.

b. Dam. - The dam to be constructed across Northfield Brook is composed of a rock and rolled earth fill embankment 810 feet in length and having a maximum height of 118 feet above stream bed. The top elevation is at 591 feet above mean sea level which provides for a 10.1-foot spillway surcharge and 4.9-foot freeboard. The top width of the dam is 20 feet with a 14-foot gravel surface roadway. Highway guard rails will not be provided since access will be limited to official use only. Access to the top of the dam will be from the relocated road on the west abutment.

On the basis of the foundation conditions, the availability and characteristics of borrow materials, and the utilization of materials from the required excavation, an embankment section has been selected which consists of a large impervious fill zone of compacted glacial till, a random fill zone, a small upstream and a small downstream rock fill toe, rock slope protection, gravel bedding, a pervious internal wick drain, and a pervious drainage blanket in the downstream portion of the embankment. The rock will be obtained from required rock excavations and the impervious embankment materials will be obtained from a borrow area located adjacent to and upstream of the east abutment of the dam. Materials from required earth excavations in the dam foundation area will be utilized in the random fill zone. The embankment slopes, on the basis of experience with other designs using similar materials, have been tentatively established upstream at 1 on 3 from top of dam to elevation 550, thence 1 on 3.5 to elevation 505 where a 12-foot berm has been provided as access to the intake structure, and 1 on 3 below elevation 505; downstream 1 on 2.5 slope. Seepage through the embankment will be controlled by the arrangement of zones of materials with different permeabilities. Seepage through the embankment foundation will be controlled by an impervious foundation cut-off to bedrock, a contiguous grout curtain in the bedrock, a pervious drainage blanket, and a downstream rockfill toe. Both the drainage blanket and the rockfill toe will be in contact with the bedrock surface over most of the downstream portion of the embankment. The above-described embankment section is considered to be tentative pending completion of all subsurface investigations and embankment design studies. The details of the final embankment section have been presented in the Design Memorandum on Embankment and Foundations, submitted on 13 July 1962.

c. Outlet Works. - The outlet works are located on the west abutment under the dam and founded on rock, and consist of an inlet channel, an inlet structure, a conduit, and an outlet channel. See Plate Nos. 2, 3, 4, 5, 6, and 7.

(1) The inlet channel is excavated in earth and rock and is about 110 feet long with a bottom width of 10 feet and invert elevation of 480 feet, m.s.l. On the east side a short section of gravity wall separates the channel from the dam embankment.

(2) The inlet structure, founded on rock, contains a reinforced concrete control weir with crest elevation 498 feet, m.s.l. and a conduit transition having an overall length of 12 feet with invert elevation at 476 feet, m.s.l. Stop-logs are provided to control and operate the permanent pool. A 2' x 3' manually operated gate is provided upstream of the structure for the flow of the stream during construction, and before a permanent pool is established, and to operate and dewater the permanent pool. A 3' x 3' manually operated sluice gate is provided at the entrance of the conduit. The gate will be locked in a predetermined position with a 1.1-foot opening to control the desired discharge capacity of the conduit. A 12-inch steel pipe air vent will be provided. A structural steel trash rack is also provided.

(3) The 36-inch circular conduit is 544 feet long sloping from an upstream invert elevation of 476 to an invert elevation of 474 at the outlet portal. The conduit is precast 36-inch diameter reinforced concrete pipe on a concrete cradle founded on rock. A grout ring in line of the foundation cut-off trench and two seepage collars will be provided.

(4) The outlet channel, excavated in rock and earth, is 14 feet wide and approximately 315 feet long, having a 2.5 percent slope from elevation 472 feet, m.s.l. to the brook. Downstream of the conduit portal for a length of 25 feet, a reinforced concrete structure is provided for the transition. A stilling basin is not considered necessary.

d. Spillway. - The spillway is located adjacent to the east abutment of the dam and separated from the embankment by a concrete retaining wall. The spillway is an uncontrolled, fixed-crest, trapezoidal weir with a crest length of 72 feet at elevation 576.0 feet, m.s.l. The weir will be designed as a gravity ogee section founded on rock and, if required, an upstream grout curtain will be provided under the weir to minimise uplift. The structure has a maximum discharge capacity of 8,800 c.f.s. (the outflow for the spillway design flood) under the design head of 10.1 feet. Flood discharges over the structure will occur infrequently and no improvement is planned in the valley immediately below the spillway discharge channel.

The spillway approach channel excavated in rock and earth is about 210 feet long. It has a maximum invert elevation of 571 at the weir and it slopes down from the weir at one percent grade. The spillway chute or discharge channel excavated in rock and earth is about 850 feet long. It slopes down from invert elevation 571 at the

weir to invert elevation 520, in 228 feet, and thence to invert elevation 465, in 340 feet, and one percent grade to the end. Final grades and sections were determined to provide the minimum required rock for the dam embankment. Earth excavation will be utilized as a random fill.

Operations will proceed at a rate that will allow the excavated materials to be placed in the embankment with minimum stockpiling. See Plate Nos. 8,9, and 10.

e. Reservoir Clearing. -The portion of the reservoir below the permanent pool will be cleared.

f. Staff and Recording Gages. - A series of staff gages and a recording gage of the bubbler type will be provided for reading and recording reservoir stages. The bubbler gages will be housed in a concrete structure located on top of the dam.

g. Access Roads. - The site is located on State Road No. 854 which will be relocated. The reconstructed road will be adjacent to the west abutment of the dam and will serve as the main access road. Access to the top of the dam will be limited for official use only.

Access to the reservoir and permanent pool area will be via existing State Road No. 854 which will be connected to the relocated road. A 12-foot wide service road will be provided from existing State Road No. 854 as access to the inlet structure.

B. HYDROLOGY

6. General. - The Design Memorandum No. 1, Hydrology and Hydraulics Analysis, submitted on 31 May 1962 and approved on 29 June 1962, includes the basic data and hydrological requirements for the spillway and outlet works. A summary of the hydrology criteria is given below.

7. Spillway Design Flood. - The spillway design flood represents the most severe condition of run-off that would result from the probable maximum precipitation over the watershed falling on the ground saturated from previous rains. Concurrently it is assumed that the reservoir is filled to spillway crest and that the outlet is inoperative. The probable maximum precipitation over the watershed amounts to 24.4 inches in 24 hours with 19.2 inches occurring in a 6-hour period.

Infiltration, surface detention and other losses are assumed at the rate of 0.05 inches per hour, resulting in a total rainfall excess of 23.2 inches. The adopted spillway design flood with a peak inflow of 9,000 c.f.s. was developed by applying the rainfall excess to the adopted unit hydrograph for the net drainage area above the dam. Routing the flood through the reservoir results in a maximum surcharge elevation of 586.1 feet, m.s.l. and a maximum discharge of 8,800 c.f.s.

8. Flood Control Outlet. - The estimated channel capacity of 160 c.f.s. downstream of the dam was the deciding factor in determining the size of the outlet. For the overall required length of 566 feet an ungated 30-inch circular conduit would discharge 160 c.f.s. with the pool at spillway crest elevation. However, as inspection and maintenance of a 30-inch conduit of this length would be quite difficult, a 36-inch diameter was considered to be a practical minimum size. A 36-inch circular conduit with a 3-foot x 3-foot sluice gate at the entrance locked in a predetermined position with a 1.1-foot opening also met the desired discharge capacity and was adopted.

9. Freeboard. - A freeboard of 4.9 feet above the maximum surcharge pool elevation of 586.1 is provided resulting in a top of dam elevation of 591.0 feet, m.s.l.

C. HYDRAULIC DESIGN

10. General. - The hydraulic design of the spillway and outlet works is discussed in Design Memorandum No. 1, Hydrology and Hydraulic Analysis. Data pertinent to the design of the spillway and outlet works are given below.

11. Spillway. - The spillway selected is a chute channel type and is an uncontrolled, fixed crest weir having a crest length of 72 feet and a crest elevation of 576.0 feet, m.s.l. To satisfy stability requirements, the upstream face will have a 3 vertical on 2 horizontal slope with a circular curve (Radius = 3.77'). Based on a hydraulic design head of 10.1 feet, the shape of the lower nappe will conform to the equation:

$$y = .0729\ x^{1.8295}$$

To facilitate the construction of the weir, a tangent with a slope of 0.60 is used to separate the parabolic curve from the bucket curvature which has a radius of 10 feet. The toe of the weir is set at elevation 572.0, 1-foot above the proposed channel grade to avoid the possibility of any uneven rock excavation interfering with the flow. Assuming the reservoir full at the beginning of inflow and neglecting the relatively small discharge through the outlet the maximum pool would be elevation 586.1 with a corresponding discharge of 8,800 c.f.s.

12. Outlet Conduit. - A three (3) foot circular conduit, controlled at the entrance by a 3-foot x 3 foot manually operated sluice gate set in position with an opening of 1.1 foot, was adopted. The 3-foot circular conduit is 544 feet long with an entrance invert at 476.0, and the portal invert elevation at 474.0 feet, m.s.l.

13. Intake. - The Trapezoidal intake channel will have a bottom width of 10 feet and an elevation of 480 feet. A concrete structure at the entrance to the conduit will maintain a permanent pool at about elevation 500 feet, m.s.l. The weir will include 2 stop-log sections each 5 feet in length with sills at elevation 498.0. Drawdown of the pool behind the weir will be accomplished with a hand operated sluice gate, 2 feet by 3 feet, located in the upstream face of the weir with a gate invert at 480.5 feet, m.s.l. The vertical curve at the conduit entrance was determined from the following formula:

$$\frac{X^2}{D^2} + \frac{Y^2}{\left(\frac{2D}{3}\right)^2} = 1 \quad \text{where } D=3 \text{ feet}$$

The horizontal entrance to the conduit is designed as a circular curve with a radius of 10 feet. A transition section of 8 feet in length will provide fillets from the 3-foot square entrance to the 3-foot diameter circular section of the conduit. A structural steel trash rack and a 12-inch circular steel pipe air vent will also be provided.

14. Outlet Channel. - A stilling basin is not considered necessary; however, the transition from the portal end of the circular conduit to the trapezoidal discharge channel will be a 25-foot reinforced concrete apron to spread the discharge. The 14-foot wide outlet channel, excavated in rock and earth has a 2.5 percent slope from elevation 472 feet, m.s.l. to the stream bed.

D. GEOLOGY

15. General. - A detailed discussion of geologic conditions, and a record of subsurface investigations is presented in Design Memorandum No. 2, Site Geology, submitted on 12 April 1962 and approved on 8 May 1962.

16. Site Geology. - Bedrock protrudes through the thin overburden at the site in numerous and extensive outcrops. The overburden is variable but consists generally of outwash silty sands and gravels in the valley bottoms and outwash with highly modified till composed of siltier sands and gravels on the abutments. The bedrock is mainly quartz mica schist which is locally granitized and is cut by granitic stringers and dikes. The schist is very well foliated with the foliations trending generally north-south and dipping westward. Below the nominal weathered zone which ranges from 1 to 5 feet in depth, the rock is fresh except for weathering along open foliation planes and areas of close jointing which extends to depths of more than 20 feet below the rock surface. Structure excavations cross the trend of the rock structure at generally small angles and because of the strongly developed foliation, the cuts will tend to be assymetric with rough, hackly faces on the westward sides of the excavation and smoother, slabby slopes on the eastward sides. The prientation of the cuts in relation to the rock structure will make control of overbreak difficult particularly in areas of close jointing in the partly granitized schist. Grouting in the rock will be required to assist in control of seepage through the open joints and foliations. Wherever possible, anchor bars should be inclined normal to the foliation to secure engagement of a maximum volume of rock.

E. CONCRETE MATERIALS

17. General. - Concrete materials are covered in detail in Design Memorandum No. 5, Concrete Materials, submitted on 20 November 1961 and approved on 7 December 1961.

F. STRUCTURAL DESIGN

18. Purpose. - This section of the Design Memorandum presents the design criteria, basic data and assumptions used in the structural design of the appurtenant structures. A brief description of the structures with loading conditions and assumptions used is included to show the design procedures. Typical computations are included in the Appendix showing the maximum conditions for the critical structures. Additional computations following the same procedure will be made wherever warranted by a change in loading or a reduction in section.

19. Scope. - The structural design of the spillway retaining wall and lining; spillway; inlet structure; and conduit transition are included herein.

20. Design Criteria. -

a. General. - All working stresses conform to those specified in the Engineering Manual EM 1110-1-2101, "Working Stresses for Structural Design," dated 6 January 1958. Loading conditions, design assumptions and other design criteria are based on the following applicable parts in the Engineering Manual for Civil Works; Standard Practice for Concrete (Part CXX, October 1953) and Retaining Walls (EM 1110-2-2502, dated 29 May 1961). Accepted engineering practice has been employed in cases where the Engineering Manual for Civil Works does not apply.

b. Concrete. - The following table lists the concrete and reinforced concrete stresses used in the design of structures.

(1) Structures Other Than Concrete Pipe. -

Flexure	Lbs. per Sq. In.
Extreme fiber stresses in compression	1,050
Extreme fiber stresses in tension (plain concrete)	60
Shear (v)-	
Beams - no web reinforcement	90
Beams with properly designed web reinforcement	240
Footings at critical section	75
Bond-(u) Deformed Bars -	
Top bars	210
All Others	300
Bearing-(fc)-	
Load on entire area	750
Load on one-third area or less maximum permissable	1,125
Modular Ratio-(n) -	10

(2) Precast Concrete Pipe. - The concrete for precast concrete pipe will have an ultimate working stress of 5,000 p.s.i.

c. Reinforcement. -

(1) Grade and Working Stresses. - All reinforcement in the structures except the concrete pipe including temperature and shrinkage reinforcement was designed for the working stresses of new billet steel, intermediate grade, deformed bars which is 20,000 p.s.i. in flexural tension. The reinforcement will conform to the requirements of Federal Specification QQ-S-632, Type II, Grade C and to ASTM A-305-56T. The reinforcement for concrete pipe shall conform to ASTM A-432-59T deformed bars or ASTM 185-58T welded wire fabric.

(2) Spacing. - The clear distance between parallel bars will not be less than $1\frac{1}{2}$ times the diameter of round bars except that in no case will the clear distance between parallel bars be less than 1 inch, or $1\frac{1}{2}$ times the maximum size of the coarse aggregate.

(3) Minimum Cover for the Main Reinforcement. - The minimum cover from main steel reinforcement to surface was maintained at 4" except for concrete pipe where the clear distance inside will be 4" and outside 1 inch.

(4) Splices. - All splices will be lapped 24 diameters to develop by bond, the total working strength of the bars. Splices in the main reinforcement at points of maximum moment have been avoided in the design.

(5) Temperature and Shrinkage Reinforcement. - Temperature and shrinkage reinforcement will be provided where the main reinforcement extends in only one direction. Such reinforcement will provide for a ratio of steel area to concrete area (bd) of 0.002 with a minimum of .0012 in each face up to a maximum of #6 bars at 12" cc.

d. Structural Steel. - Structural steel was designed for the working stresses of ordinary bridge and building steel (yield point 33,000 p.s.i. minimum) which conforms to the specifications for the Design,Fabrication and Erection of Structural Steel for Buildings, issued by the American Institute of Steel Construction. Basic stress under this specification is 20,000 p.s.i.

21. Basic Data and Assumptions. -

a. Controlling Elevations of Dam and Appurtenant Structures(msl)

Top of Dam	591.0
Spillway Crest	576.0
Maximum Water Surface just upstream at Spillway Weir	586.0
Conduit Intake Invert	476.0
Conduit Outlet Invert	474.0

b. Loads. -

(1) Dead Loads. - The following unit weights for materials were used:

Material	Unit Weight (lbs/cu.ft.)			
	Dry	Saturated	Moist	Submerged
Rockfill	120	140		78
Earth fill	130	145	140	83
Pervious fill	135	147	142	85
Concrete (plain & reinforced)	150			
Steel	490			

(2) Live Loads. - The following live loads were used:

Water	62.5 lbs. per cu. ft.
Wind	30 lbs per sq. ft.
Snow	40 lbs per sq. ft.

c. External Water Pressures. - Triangular Distribution of the water pressure in the reservoir pool on the structures was used. Tailwater pressure was taken at 60% of full value for the spillway section.

d. Internal Water Pressures. - Uplift pressure under structures was assumed effective on 100% of the area of the base, varying uniformly from tailwater head at the toe to full headwater at the heel.

e. Earth Pressure. - Earth pressures were determined in general accordance with EM 1110-2-2502, Retaining Walls, dated 29 May 1961. "At rest" pressures were used in all cases.

f. Earthquake Forces. - Because of the small size of the structures involved, earthquake forces are not a factor and were disregarded.

g. Ice Pressure. - Horizontal forces due to ice pressure were included in the design of the conservation weir. A value of 6,000 lbs. per linear ft. was used.

h. Frost Protection. - On the basis of temperature records and frost penetration depth curves derived by the Arctic Construction and Frost Effects Laboratory of the Corps of Engineers, a minimum frost protective cover of 4 feet above foundation level will be used for any structure founded on earth.

22. Main Spillway Weir and Lining. -

a. Description. - The ogee shaped weir is 72 feet in length with crest elevation at 576.0 and channel bed elevation at 569.0. At the west end of the weir, the abutment is a gravity type wall and at the east end there is a short section of concrete lining anchored to the rock. Contraction joints in the weir will be provided at an 18'-0" spacing and in the gravity wall at 20'-0" maximum spacing.

b. Spillway Stability. - The following loading conditions were investigated in the design.

Case I - Reservoir empty and dead load of weir.
Case II- Reservoir to spillway crest, no tailwater, uplift varying from full headwater at the heel to 0 at the toe.
Case III - Omitted.

Case IV - Reservoir at maximum surcharge elevation of 586.0 and maximum tailwater elevation at 576.5, uplift varying from maximum headwater at heel to maximum tailwater at toe.

c. Spillway Design. - Maximum bearing is only 1000 psf under Case I loading and the resultant falls within the middle third of the base for all conditions of loading. Under Case IV loading the shear friction coefficient was found to be 51.5 and rock anchors will not be required.

d. Spillway Lining. - Rock anchors holding the 1'-0" thick lining to the rock face were figured for a head of approximately 10 feet. Rock anchors will be #10 bars sunk 10'-0" into the rock and are spaced to hold a 35 sq. ft. area. Reinforcing steel will be #6 bars at 1'-0" in both directions.

e. Gravity Wall. - The gravity wall at the west side was investigated for a construction condition; a rapid drawdown condition assuming saturated soil and no uplift and a flood condition with water to maximum surcharge elevation 586.0 and tailwater at the base of the wall. An at rest co-efficient of 0.5 was used. The resultant load falls within the mid third under both conditions and the maximum bearing pressure was found to be 4600 lbs. per sq. ft.

23. Inlet Structure. -

a. Description. - The inlet structure consists of a gravity type training wall on the east bank upstream of a box type inlet structure. Beyond the inlet structure, there is a 12'-0" transition section leading into the precast pipe conduit. The inlet structure provides a conservation weir at elevation 498.0.

b. Gravity Wall. - Section was investigated similar to the gravity section at the spillway. The wall is founded on rock and maximum bearing pressure under Case II is only 3450 lbs. per sq. ft.

c. Inlet Structure. - The inlet structure was investigated as a monolithic box assuming distribution both vertically and horizontally. A 6000 lbs per ft. ice pressure was applied to the front face, but not to the side walls as ice pressure cannot build up on the sides. Platforms and trash rack members will be investigated for equipment loads or a differential head of 5 feet.

d. Transition Section. - The transition section was investigated for a drawdown condition and a submerged condition with water at spillway crest using normal stresses. Internal pressure within the section has been neglected because it would have only a negligible effect. The walls and roof have been held at 1'-6" minimum in order to obtain a satisfactory placement of concrete and because this thickness provides a satisfactory tie in with the intake structure and the conduit pipe. Reinforcing steel was found to be nominal.

24. Conduit Pipe. - The conduit pipe will be 3'-0" in diameter and will be set in a concrete saddle. The pipe manufacturer will be required to furnish pipe to take a load of 105 kips per linear foot at the center section of the dam and a load of 50 kips per linear foot at the ends of the dam. These loads were determined by using the weight of water and submerged or saturated earth above the pipe applying a factor of 1.0 where top of pipe is wholly below the rock surface and 1.5 where it is above the rock surface. Applying a load factor of 3 at least three sections of pipe shall be tested by the three edge bearing method to determine the load to produce a .01 inch crack at the ultimate strength. The test load required to produce a .01 inch crack shall be based on a factor of safety of not less than 1.33. The test load to produce failure shall be based on a factor of safety of at least 2.0.

25. Outlet Portal. - The outlet portal consists of 1'-0" thick channel lining anchored to the rock walls and bottom. The lining will be designed similar to the spillway channel lining. The headwall at the end of the conduit will be horizontally supported by the channel lining.

26. Sluice Gates. -

a. A cast iron sluice gate 2'-0" wide by 3'-0" high will be installed on the upstream wall of the weir structure with the invert at Elevation 480.50. A floorstand with hand crank for manual operation of the gate will be mounted on the weir deck at Elevation 503.0.

This gate will be used for the flow of the stream during construction and before a permanent pool is established and to operate and dewater the permanent pool.

b. A cast iron sluice gate 3'-0" wide by 3'-0" high will be installed at the inlet of the conduit with invert Elevation 476.0. A floorstand with hand crank for manual operation of the gate will be mounted on the deck at Elevatiom 509.0. This gate will be designed for a hydrostatic head of 110 feet. The gate will be locked in a predetermined position with a 1.1-foot opening to control the desired discharge capacity of the conduit. A 12-inch steel pipe air vent will be provided.

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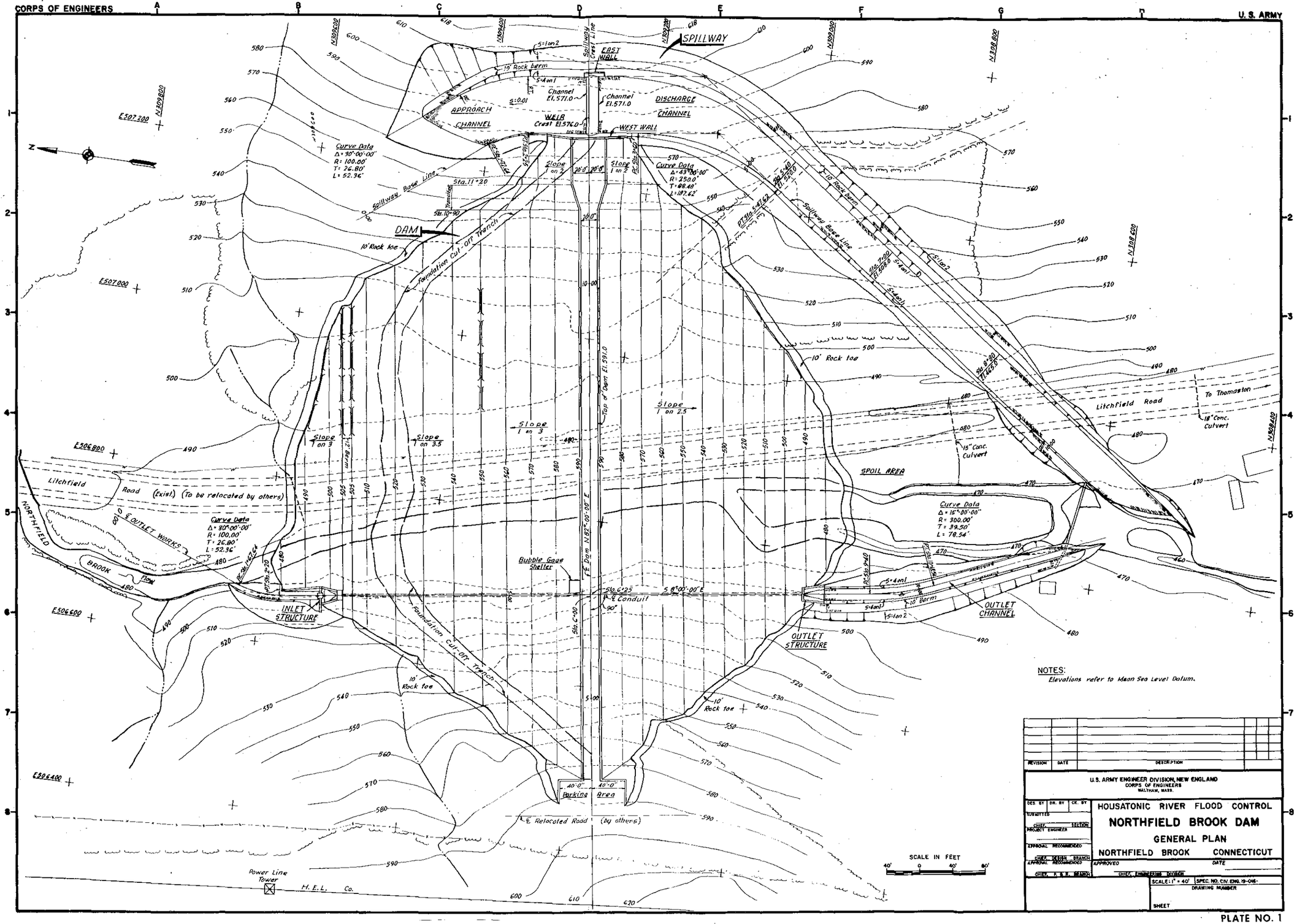


NOTES:
Elevations refer to Mean Sea Level Datum.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL

NORTHFIELD BROOK DAM

GENERAL PLAN

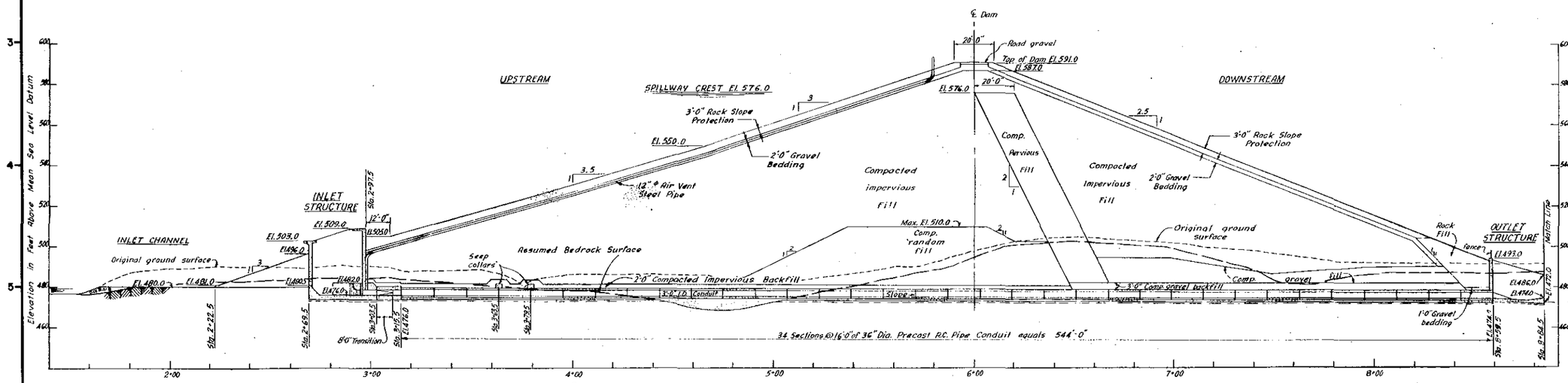
NORTHFIELD BROOK CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE: 1" = 40' | SPEC. NO. CIV. ENG. 19-046-
DRAWING NUMBER
SHEET

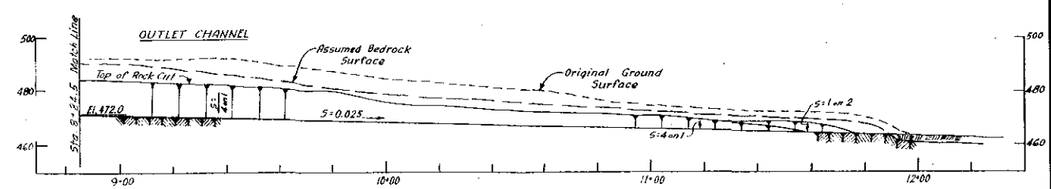
PLATE NO. 1

CORPS OF ENGINEERS U. S. ARMY

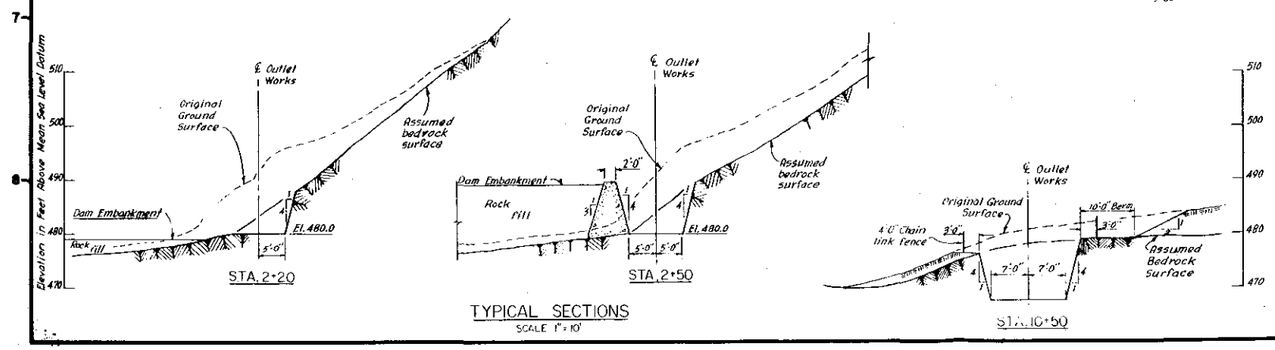


PROFILE ALONG ℄ OF OUTLET WORKS

SCALE 1" = 20'



PROFILE CON'T.



TYPICAL SECTIONS

SCALE 1" = 10'

NOTES:

FOR GENERAL NOTES, SEE SHEET NO.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, R. & R. BRANCH

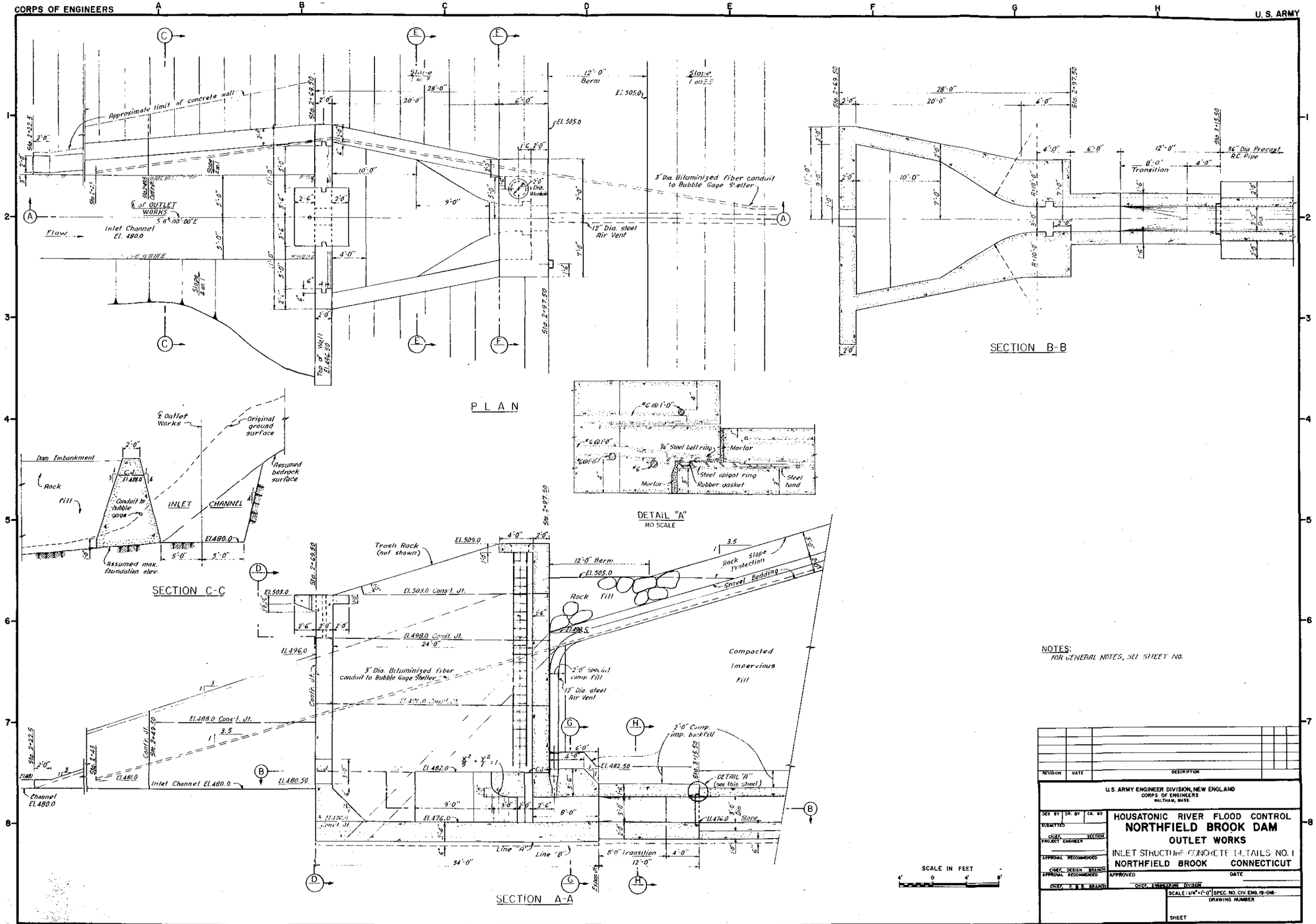
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
PROFILE AND SECTIONS
NORTHFIELD BROOK CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE
SPEC. NO. CIV. ENG. 19-OM-
DRAWING NUMBER
SHEET

PLATE NO. 2

CORPS OF ENGINEERS — U. S. ARMY



NOTES:
FOR GENERAL NOTES, SEE SHEET NO.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

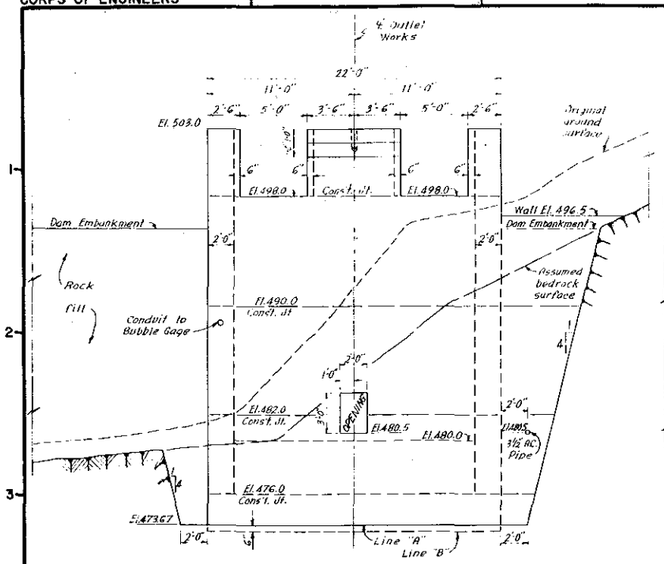
HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
INLET STRUCTURE CONCRETE DETAILS NO. 1
NORTHFIELD BROOK CONNECTICUT

APPROVED — DATE
CHIEF, ENGINEERING DIVISION

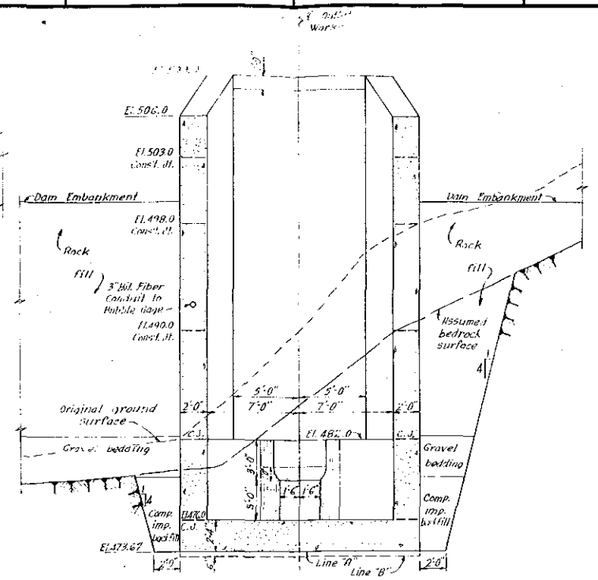
SCALE: 1/4" = 1'-0" | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 3

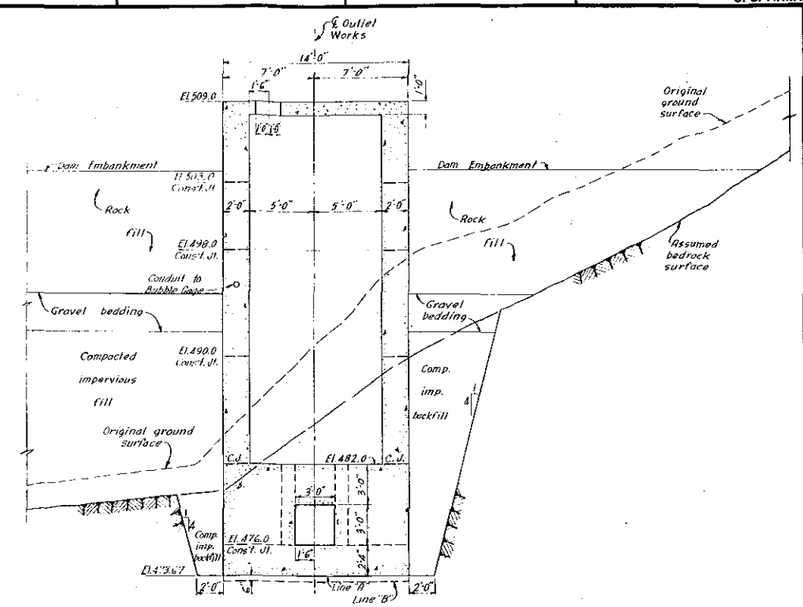
CORPS OF ENGINEERS U. S. ARMY



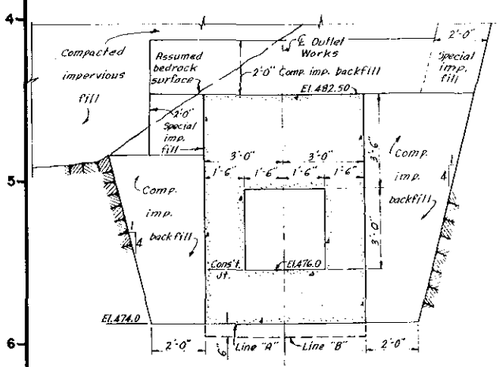
SECTION D
SCALE 1/4" = 1'-0"



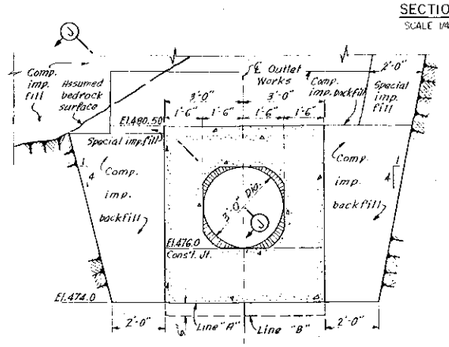
SECTION E
SCALE 1/4" = 1'-0"



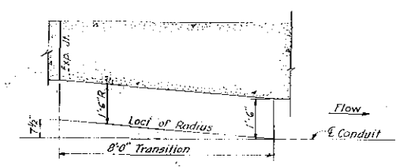
SECTION F
SCALE 1/4" = 1'-0"



SECTION G
SCALE 1/2" = 1'-0"



SECTION H
SCALE 1/2" = 1'-0"



SECTION J-J
SCALE 1/2" = 1'-0"

NOTES:
FOR GENERAL NOTES, SEE SHEET NO.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

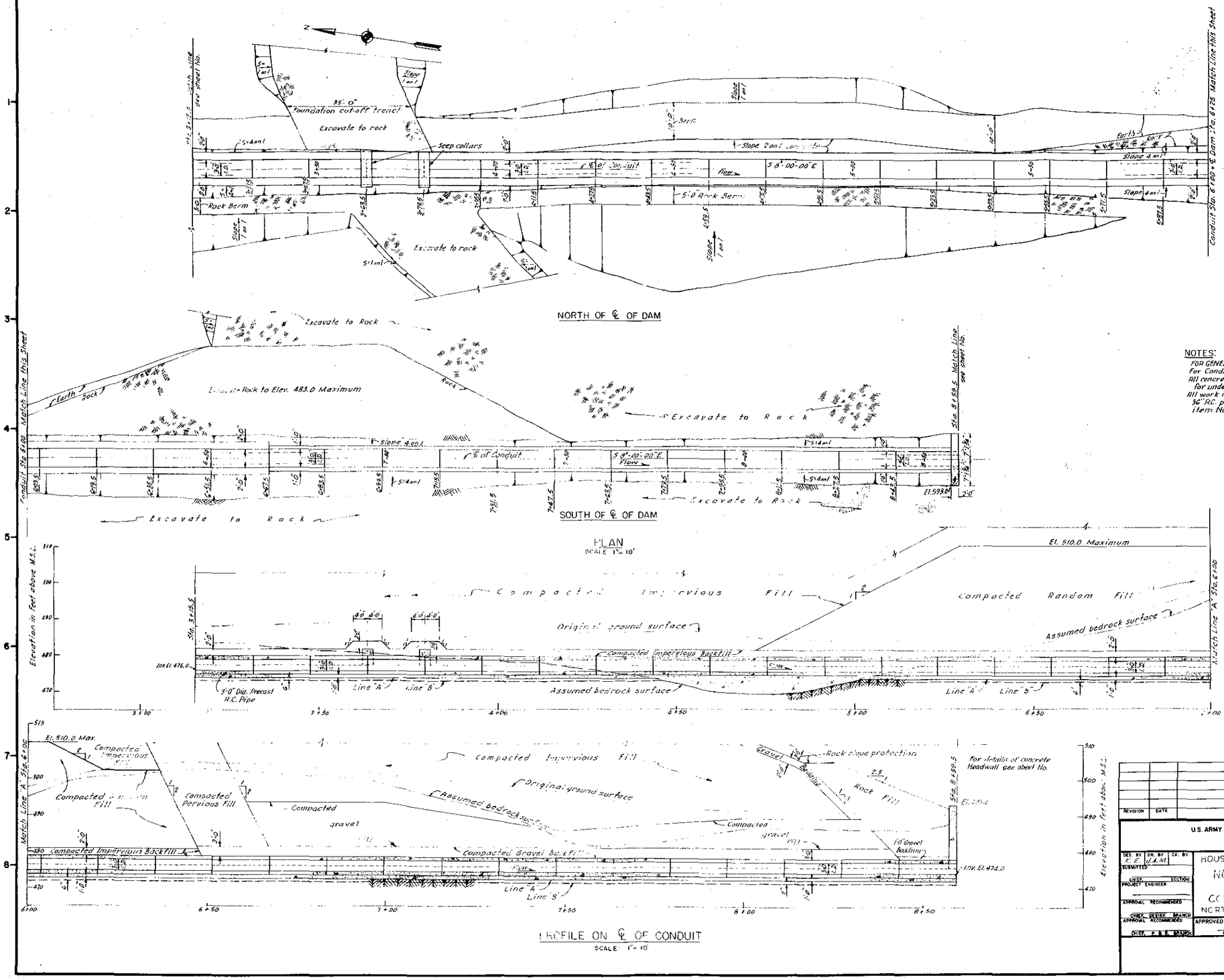
DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
INLET STRUCTURE-CONCRETE DETAILS NO. 2
NORTHFIELD BROOK CONNECTICUT

APPROVED
CHIEF, ENGINEERING DIVISION
DATE
SCALE
SPEC NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 4

CORPS OF ENGINEERS U. S. ARMY



NOTES:

FOR GENERAL NOTES, SEE SHEET NO.
For Conduit Sections, see sheet No.
All concrete from Sta. 3+15.5 to Sta. 8+59.5 will be paid for under item No.
All work in connection with furnishing and placing 36" R.C. pipe conduit will be paid for under item No.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

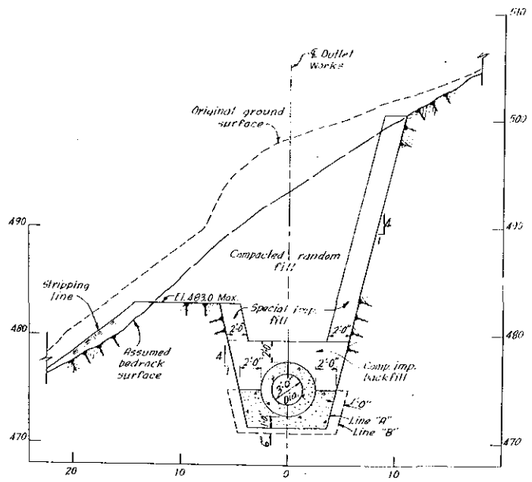
DES. BY K.E. DR. BY J.A.M. CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. B. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
CONDUIT - PLAN AND PROFILE
NORTHFIELD BROOK CONNECTICUT

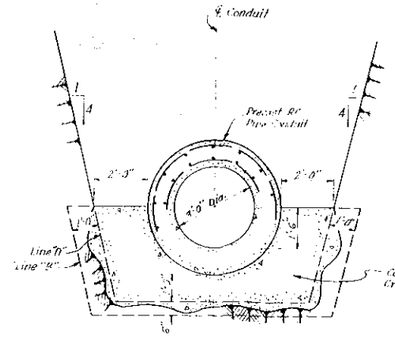
APPROVED DATE
CHIEF, ENGINEERING DIVISION
SCALE 1" = 10'
SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 5

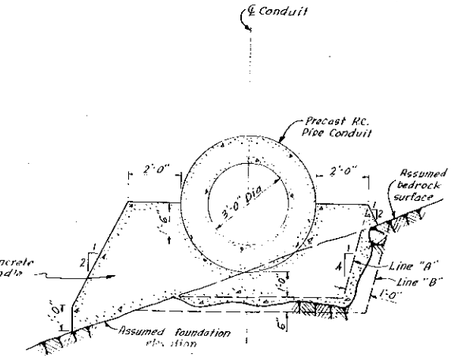
CORPS OF ENGINEERS — U. S. ARMY



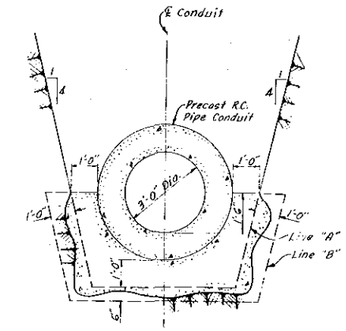
STA. 6+00



FROM STA. 3+15.5 TO STA. 4+10± AND
FROM STA. 5+40± TO STA. 6+67.5

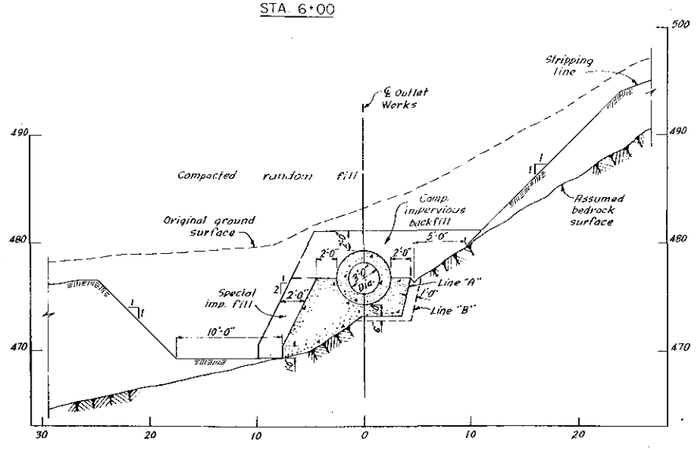


FROM STA. 4+10± TO STA. 5+40±

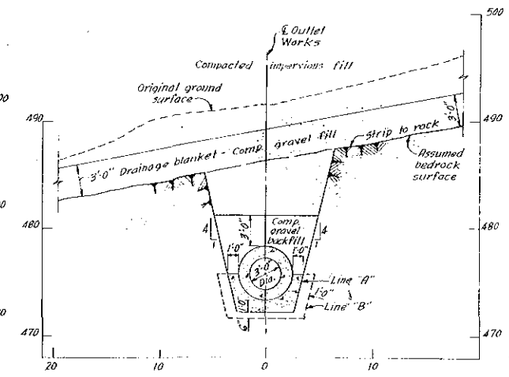


FROM STA. 6+67.5 TO STA. 8+59.5

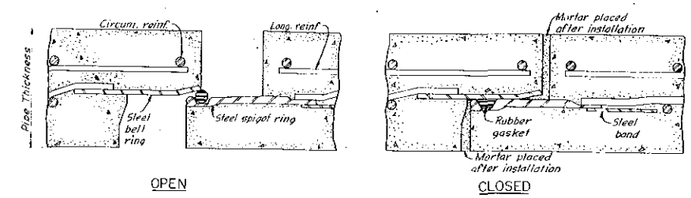
TYPICAL CONDUIT SECTIONS
SCALE 1/2" = 1'-0"



STA. 5+00

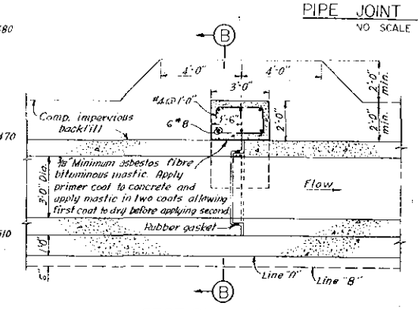


STA. 8+00

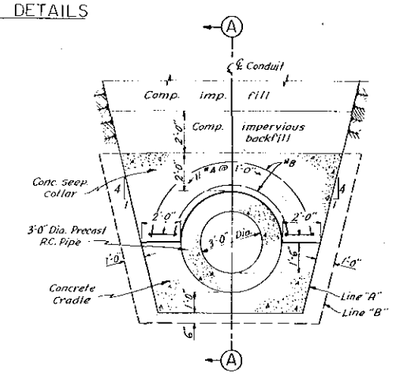


OPEN — CLOSED

PIPE JOINT DETAILS
NO SCALE



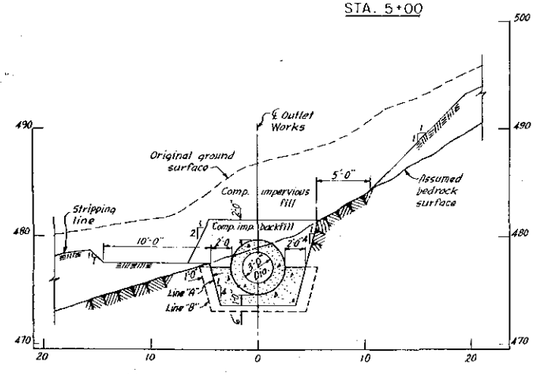
SECTION A-A
COLLAR DETAILS - STA. 3+63.5 & 3+79.5
SCALE 3/8" = 1'-0"



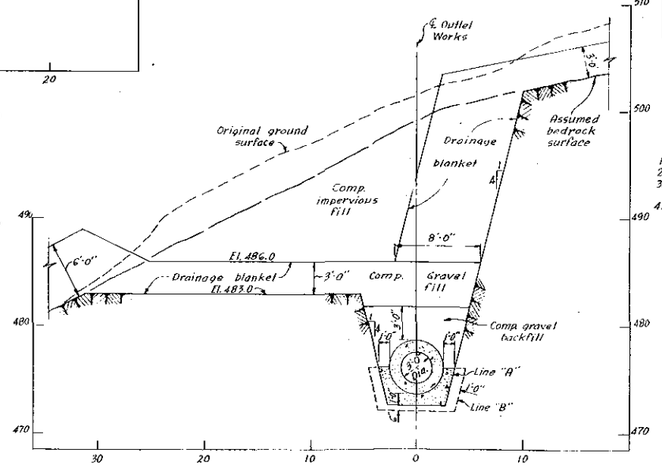
SECTION B-B
SCALE 3/8" = 1'-0"

NOTES FOR PRECAST CONCRETE PIPE

1. Concrete must have a minimum f'c of
2. Steel reinforcement must have a minimum yield strength of
3. Pipe to be designed for a vertical load of from Sta. to Sta. and from Sta. to Sta.
4. For details of pipe testing see specifications.



STA. 4+00



STA. 7+00

CONDUIT SECTIONS
SCALE 1" = 5'

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
OUTLET WORKS
CONDUIT - SECTIONS
NORTHFIELD BROOK CONNECTICUT

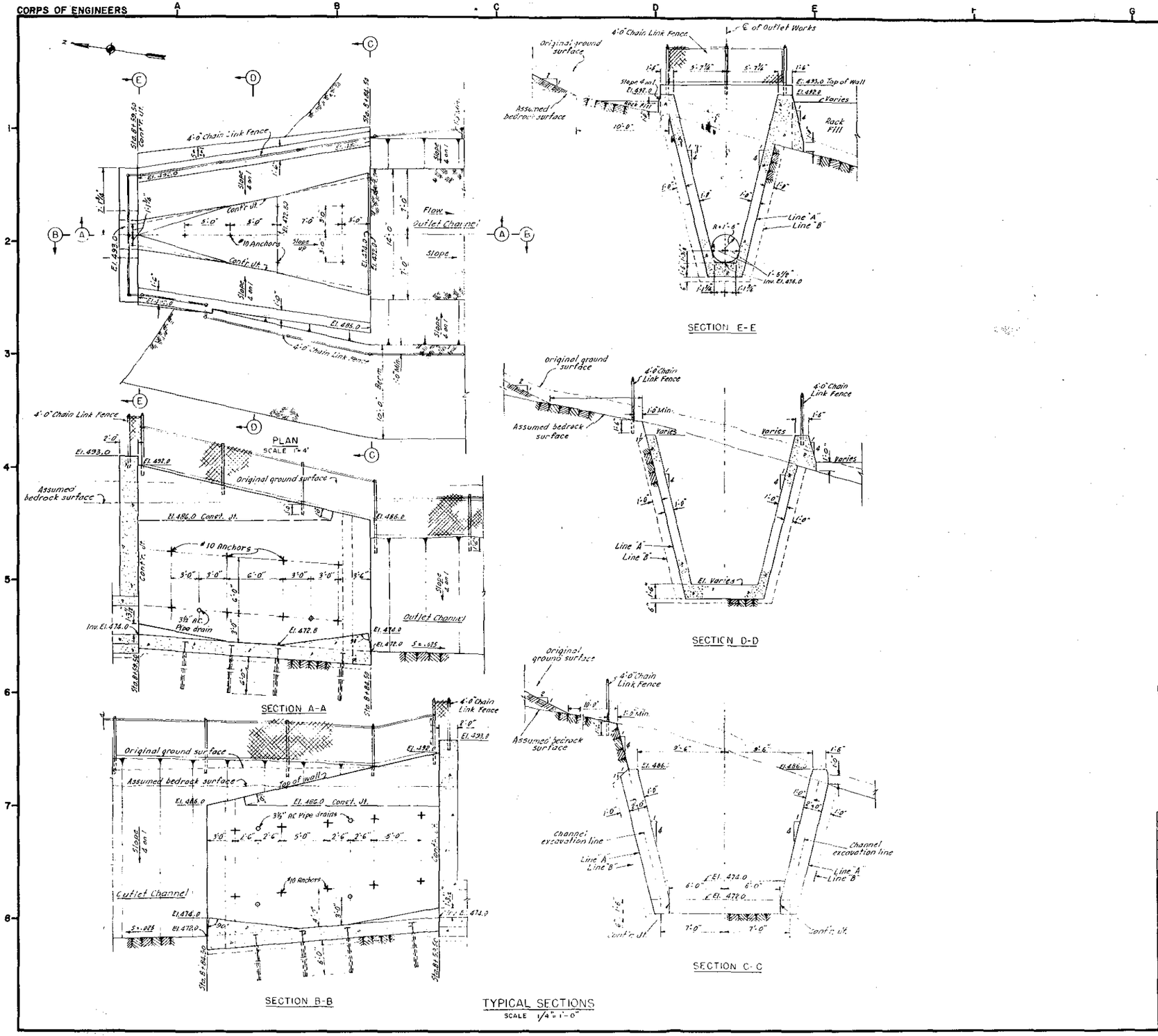
APPROVED
CHIEF, ENGINEERING DIVISION
DATE

SCALE
SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 6

CORPS OF ENGINEERS

U. S. ARMY



TYPICAL SECTIONS
SCALE 1/4" = 1'-0"

NOTES

For General notes applying to this Sheet see Sheet No.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY K.F. | DR. BY J.A.M. | CK. BY

SUBMITTED

CHIEF, SECTION

PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, DESIGN BRANCH

APPROVAL RECOMMENDED

CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL

NORTHFIELD BROOK DAM

OUTLET WORKS

OUTLET STRUCTURE - CONCRETE DETAILS

NORTHFIELD BROOK CONNECTICUT

APPROVED | DATE

CHIEF, ENGINEERING DIVISION

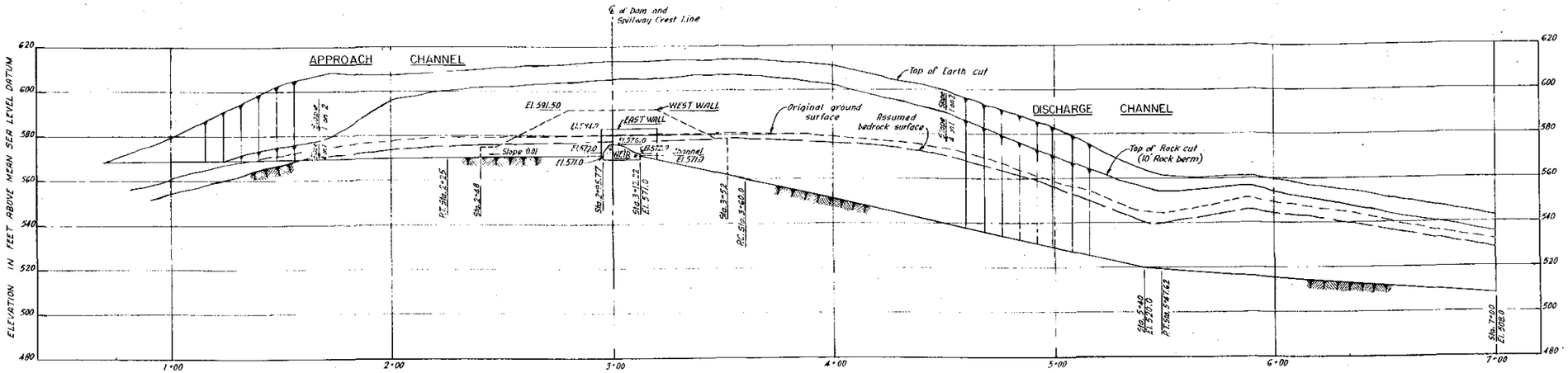
SCALE 1" = 1'-0" | SPEC. NO. CIV. ENG. 19-016-

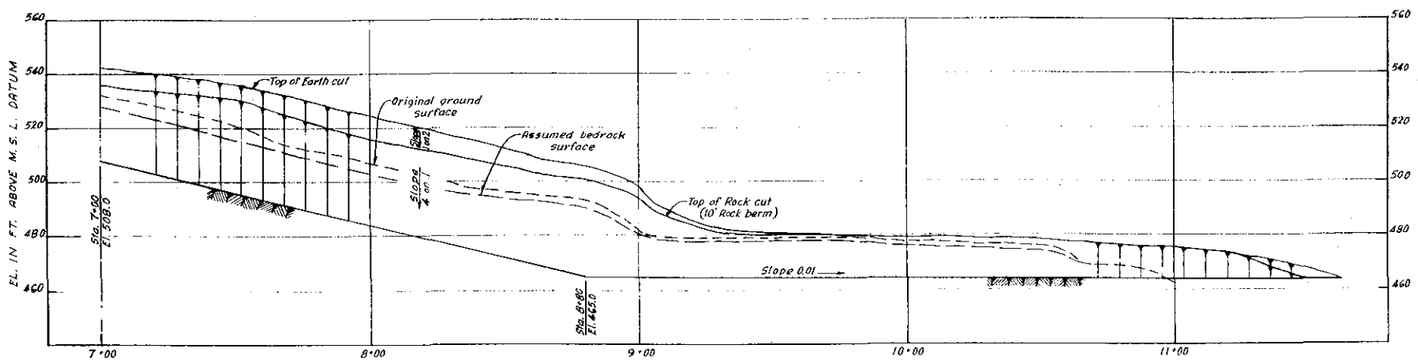
DRAWING NUMBER

SHEET

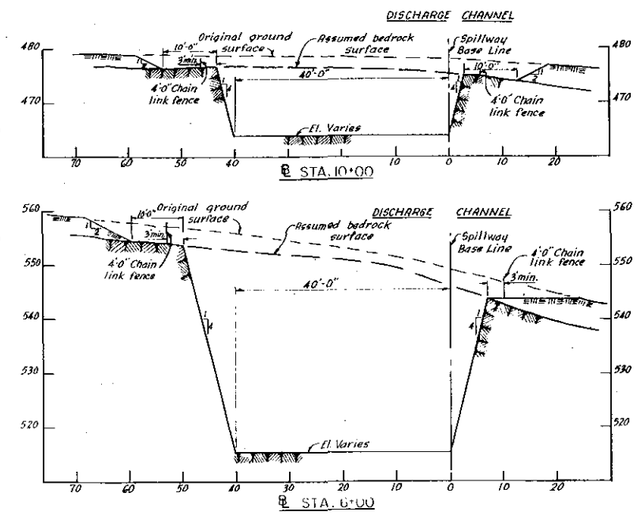
PLATE NO. 7

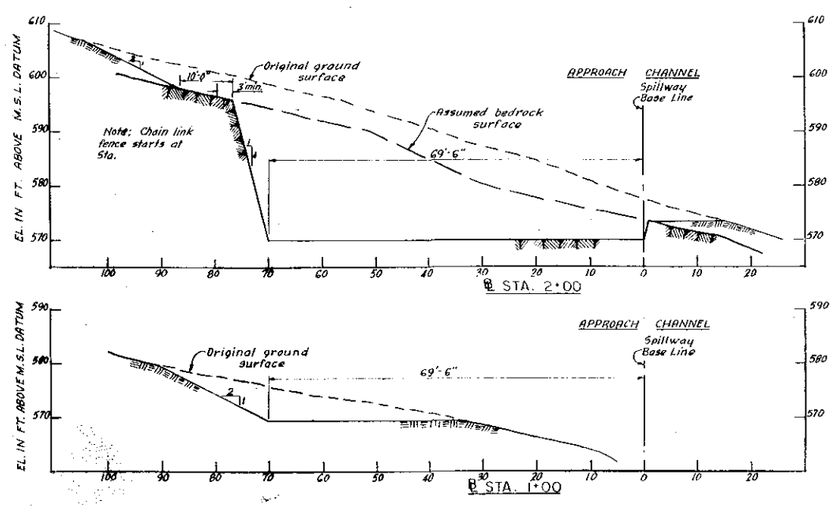
CORPS OF ENGINEERS — U. S. ARMY

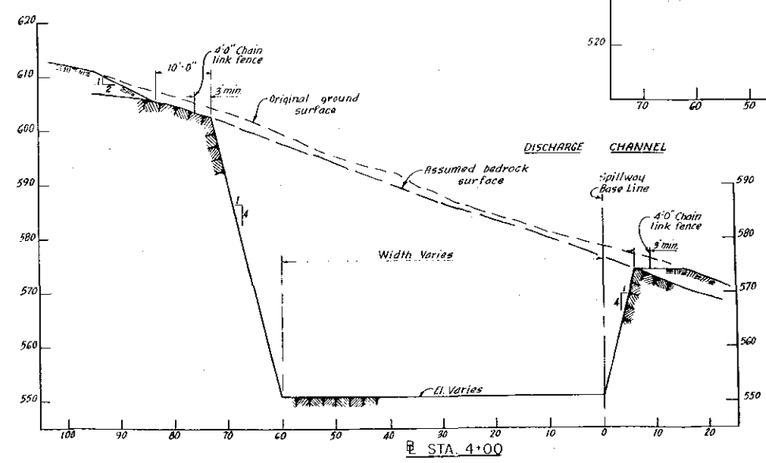




PROFILE ALONG ℄ OF SPILLWAY CHANNEL
SCALE 1" = 20'







TYPICAL SECTIONS
SCALE 1" = 10'

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
SPILLWAY
PROFILE AND SECTIONS
NORTHFIELD BROOK CONNECTICUT

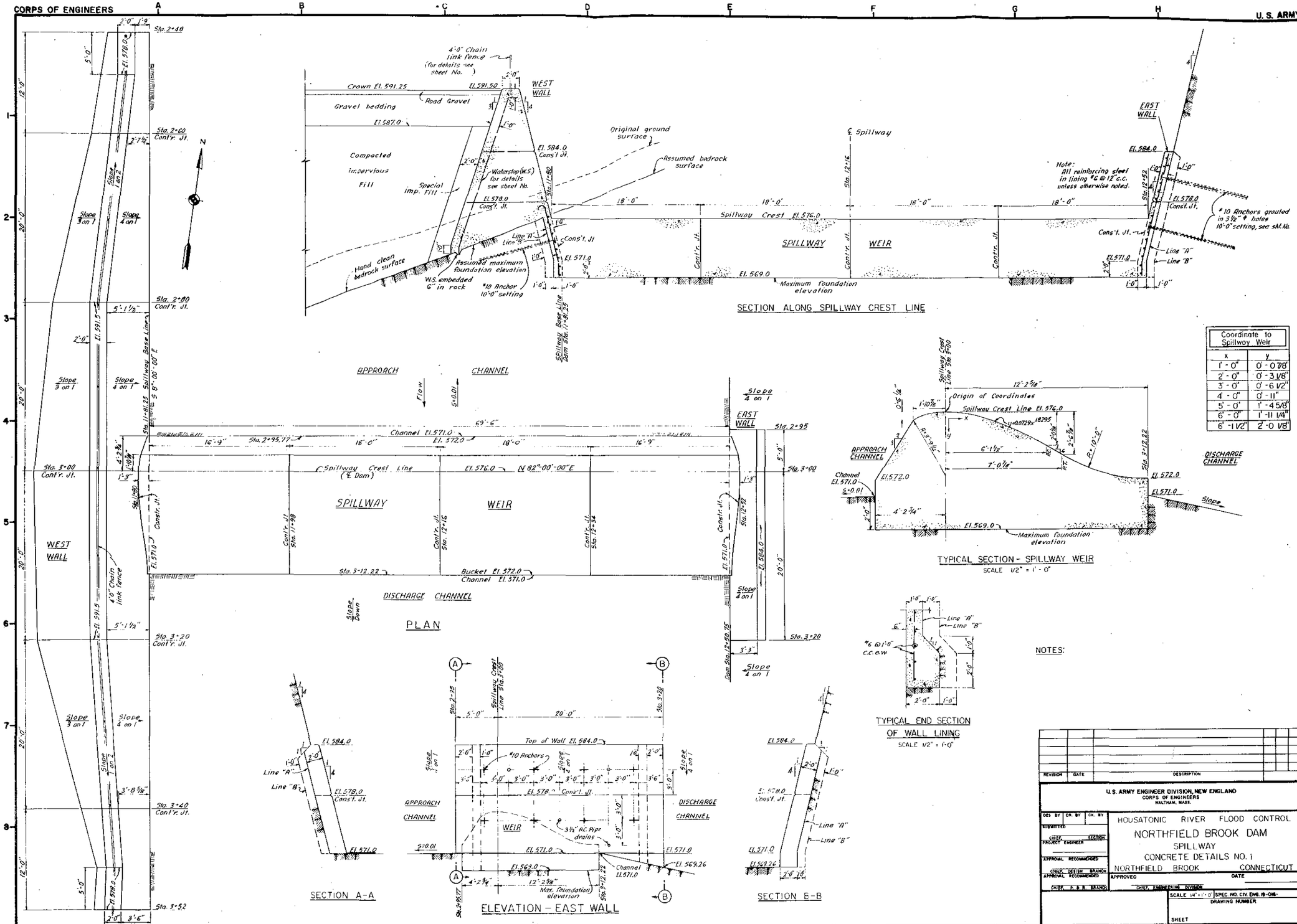
APPROVED DATE
CHIEF, ENGINEERING DIVISION

SCALE | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 8

CORPS OF ENGINEERS

U. S. ARMY



Coordinate to Spillway Weir	
x	y
1'-0"	0'-0 7/8"
2'-0"	0'-3 1/8"
3'-0"	0'-6 1/2"
4'-0"	0'-11"
5'-0"	1'-4 5/8"
6'-0"	1'-11 1/4"
6'-1 1/2"	2'-0 1/8"

NOTES:

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

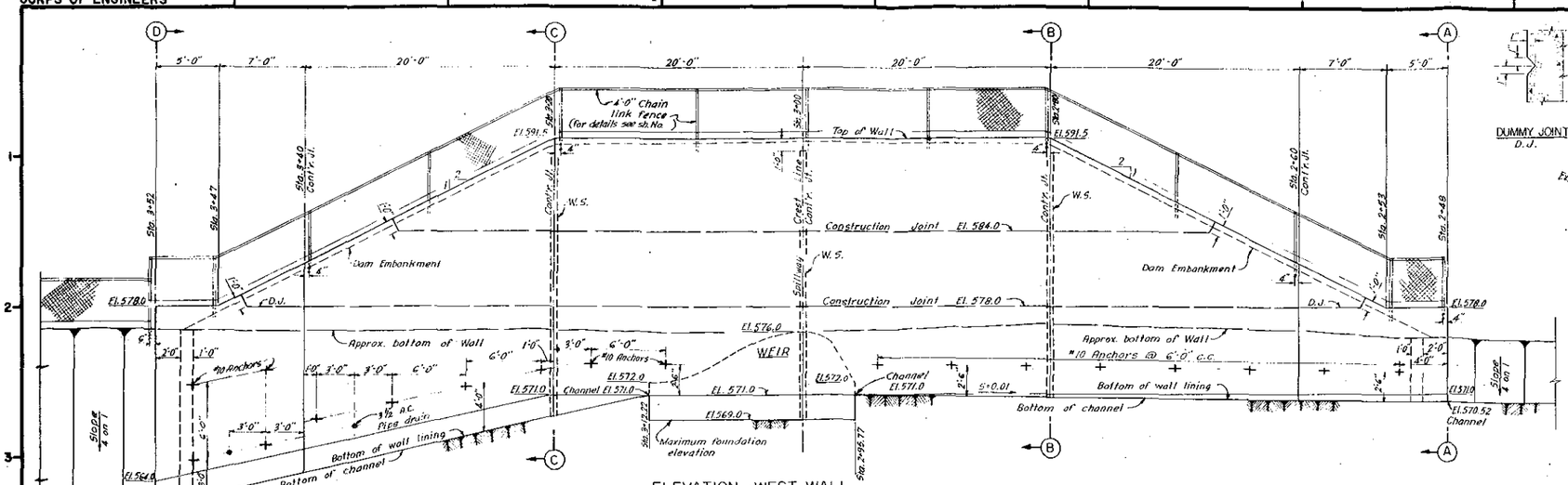
DES BY | CK. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
SPILLWAY
CONCRETE DETAILS NO. 1
NORTHFIELD BROOK CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

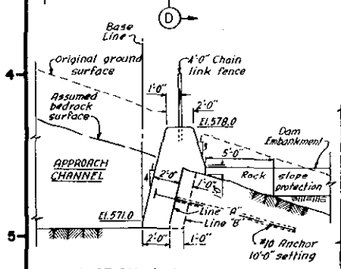
SCALE (48" x 1'-0") SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER
SHEET

PLATE NO. 9

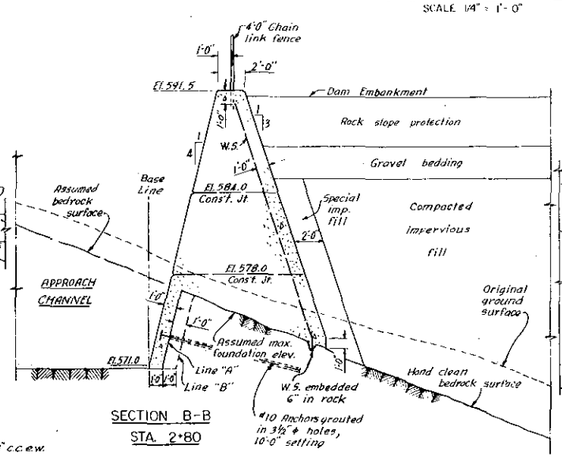


ELEVATION – WEST WALL

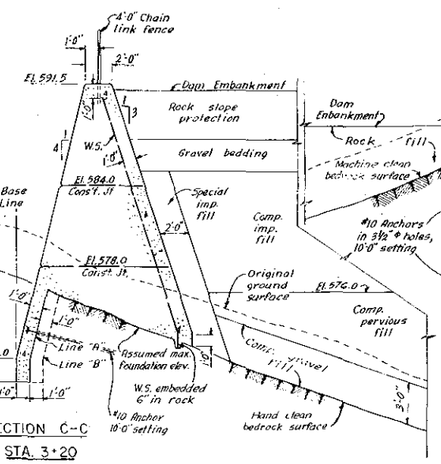
SCALE 1/4" = 1'-0"



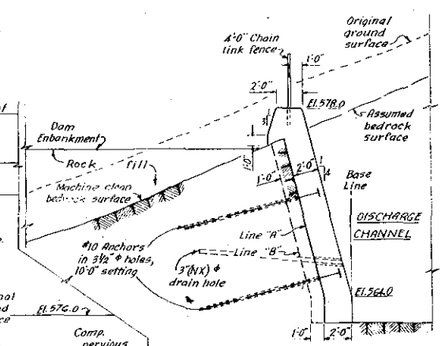
SECTION A-A
STA. 2+48



SECTION B-B
STA. 2+80

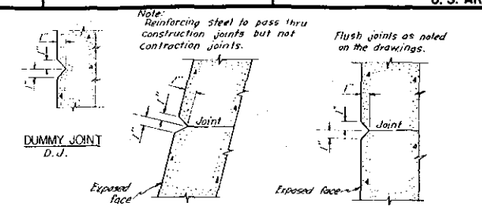


SECTION C-C
STA. 3+20



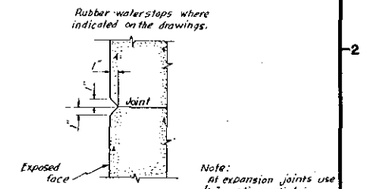
SECTION D-D
STA. 3+52

WEST WALL - SECTIONS
SCALE 1/4" = 1'-0"



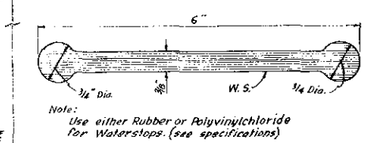
CONSTRUCTION JOINT SLOPING FACE
Cons't. Jt.

CONSTRUCTION JOINT VERTICAL or HORIZONTAL
Cons't. Jt.



CONTRACTION JOINT
Cont'r. Jt.

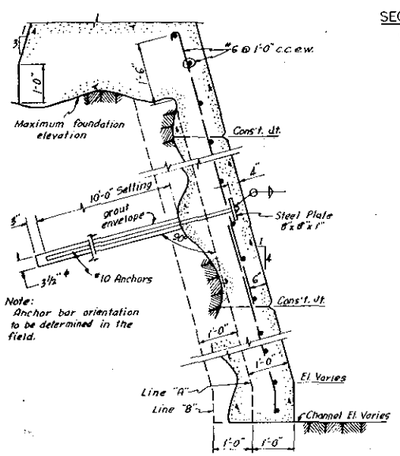
STRUCTURAL JOINT DETAILS
NO SCALE



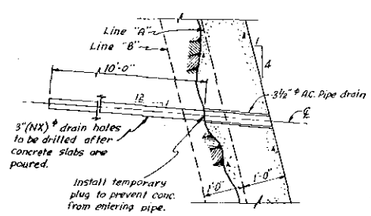
WATERSTOP
FULL SCALE

Waterstops to be continuous

NOTES:
FOR GENERAL NOTES SEE SHEET No.
For notes applying to this sheet, see sheet No.



TYPICAL ANCHOR BAR AND REINFORCEMENT DETAIL
SCALE 3/4" = 1'-0"



TYPICAL DRAINAGE DETAIL
SCALE 3/4" = 1'-0"

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY | CK. BY
SUBMITTED
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, DESIGN BRANCH
APPROVAL RECOMMENDED
CHIEF, P. & R. BRANCH

HOUSATONIC RIVER FLOOD CONTROL
NORTHFIELD BROOK DAM
SPILLWAY
CONCRETE DETAILS NO 2
NORTHFIELD BROOK CONNECTICUT

APPROVED DATE
CHIEF, ENGINEERING DIVISION

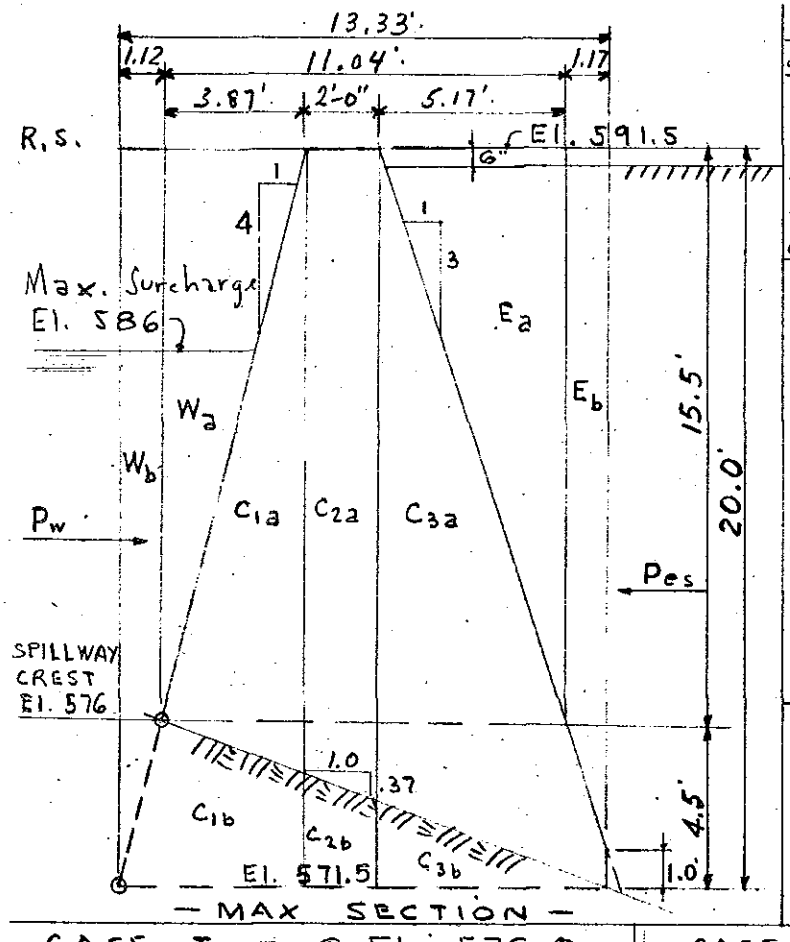
SCALE
SPEC. NO. CIV. ENG. 18-016-
DRAWING NUMBER
SHEET

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

PAGE 1

SUBJECT: NORTHFIELD BROOK DAM & RES
COMPUTATION: WEST WALL – SPILLWAY – GRAVITY TYPE
COMPUTED BY: AJD CHECKED BY: JWF DATE: 6/5/62



— MAX SECTION —

ASSUMPTIONS:

UNIT WT. #/CF	DRY	MOIST	SAT.	SUB.	φ	K
WATER			62.5			
CONCRETE	150					
ROCKFILL	120		140	78		
PERV. FILL	135	142	147	85		.5
Earth Fill	130	140	145	83		.5

L'd'g conditions: —

CASE I – CONSTRUCTION COND.

CASE II – SAT. BACKFILL @ WALL
No HYDRO. PRES.
No TAILWATER

CASE III – R.S. WATER TO TOP OF WALL
Just downstream of ℄ Dam: SAT. BACKFILL @ WALL
TAILWATER @ EL. 571.5
RESULTANT TO FALL WITHIN BASE

ANALYZE HORIZONTAL PLANES @ EL. 576 & EL. 571.5

CASE I – @ EL. 576.0

	Factors	LD'S	ARM	MOM.
C_{1a}	$.15 \times 15.5 \times 3.87/2$	4.50↓	2.58	+11.60
C_{2a}	$.15 \times 15.5 \times 2$	4.65↓	4.87	+22.60
C_{3a}	$.15 \times 15.5 \times 5.17/2$	6.02↓	7.59	+45.70
	ΣV	15.17↓	ΣM	+79.90

$\Sigma M/\Sigma V = 79.90/15.17 = 5.27' > 3.68' < 7.36'$

CASE I – @ EL. 571.5

	Factors	LD'S	ARM	MOM.
C_{1b}	$.15 \times 20.0 \times 5.0/2$	7.50↓	3.33	+25.00
C_{2b}	$.15 \times 20.0 \times 2.0$	6.00↓	6.00	+36.00
C_{3b}	$.15 \times 20.0 \times 6.67/2$	10.00↓	9.22	+92.20
	ΣV	23.50↓	ΣM	+153.20

$\Sigma M/\Sigma V = 153.20/23.5 = 6.52' > 4.45' < 8.9'$

CASE II @ EL. 576.0

C_a		15.17↓		+79.90
E_a	$0.147 \times 5.01 \times 15/2$	5.53↓	9.32	+51.50
	ΣV	20.70↓		
P_{esa}	$0.147 \times .5 \times 15^2/2$	8.3←	$.38 \times 15/2$ 5.7	-47.40
	ΣH	8.3←	ΣM	+84.00

$\Sigma H/\Sigma V = 8.3/20.70 = .40 < .65$

$\Sigma M/\Sigma V = 84.0/20.70 = 4.05' > 3.68' < 7.36'$

$f = \frac{20.70}{11.04}\left(1 \pm \frac{6 \times 1.47}{11.04}\right)$ (.80)

$f_{max} = 1.88(1.80) = 3.39$ K/SF.

$f_{min} = 1.88(.20) = 0.38$ K/SF.

CASE II @ EL. 571.5

C_b		23.50↓		+153.20
E_b	$0.147 \times 6.34 \times 19.5/2$	9.10↓	11.23	+102.20
	ΣV	32.60↓		
P_{esb}	$0.147 \times .5 \times 19.5^2/2$	14.0←	$.38 \times 19.5$ 7.41	-103.50
	ΣH	14.0←	ΣM	+151.90

$\Sigma H/\Sigma V = 14.0/32.6 = 0.43 < .65$

$\Sigma M/\Sigma V = 151.9/32.6 = 4.67' > 4.45' < 8.95'$

$f = \frac{32.60}{13.33}\left(1 \pm \frac{6 \times 2.00}{13.33}\right)$ (.90)

$f_{max} = 2.45(1.90) = 4.61$ K/SF

$f_{min} = 2.45(.10) = 0.245$ K/SF

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NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT: NORTHFIELD BROOK DAM & RES
COMPUTATION: WEST WALL - SPILLWAY - GRAVITY TYPE
COMPUTED BY: AJD CHECKED BY: [illegible] DATE: 6/5/62

STABILITY (CONT.)

CASE III - @ El. 576.0

	FACTORS	LD	ARM	MOM.
C_a		15.17↓		+79.90
E_a		5.53↓		+51.50
W_a	.062×5×15.5×3.87/2	1.88↓	1.29	+ 2.45
U_a	.062×5×15.5×11.04/2×.5	2.68↓	3.68	- 9.86
	ΣV	19.90↓		
P_{esa}		8.3←		-47.40
P_{wa}	.062×5×15.5²/2	7.5→	5.17	+38.80
	ΣH	0.8←	ΣM	+115.39

$\Sigma H/\Sigma V = 0.8/19.90 = .04$

$\Sigma M/\Sigma V = 115.39/19.90 = 5.80'$ WITHIN MID 1/3 O.K.

CASE III - @ El. 571.5

	FACTORS	LD.	ARM	MOM.
C_b		23.50↓		+153.20
E_b		9.10↓		+102.20
W_b	.062×5×20×5/2	3.12↓	1.67	+ 5.20
U_b	.062×5×20×13.33/2	8.34↓	4.44	- 37.10
	ΣV	27.38		
P_{esb}		14.0→		-103.50
P_{wb}	.062×5×20²/2	12.5→	6.67	+ 83.30
	ΣH	1.5←	ΣM	+203.30

$\Sigma H/\Sigma V = 1.5/27.38 = .055$

$\Sigma M/\Sigma V = 203.30/27.38 = 7.44'$ within mid 1/3 O.K.

$$f = \frac{27.38}{13.33}\left(1 \pm \frac{6 \times 7.77}{13.33}\right)$$

(2.05; .346)

$f_{MAX} = 2.05(1.346) = 2.76$ K/□

$f_{MIN} = 2.05(.654) = 1.34$ K/□

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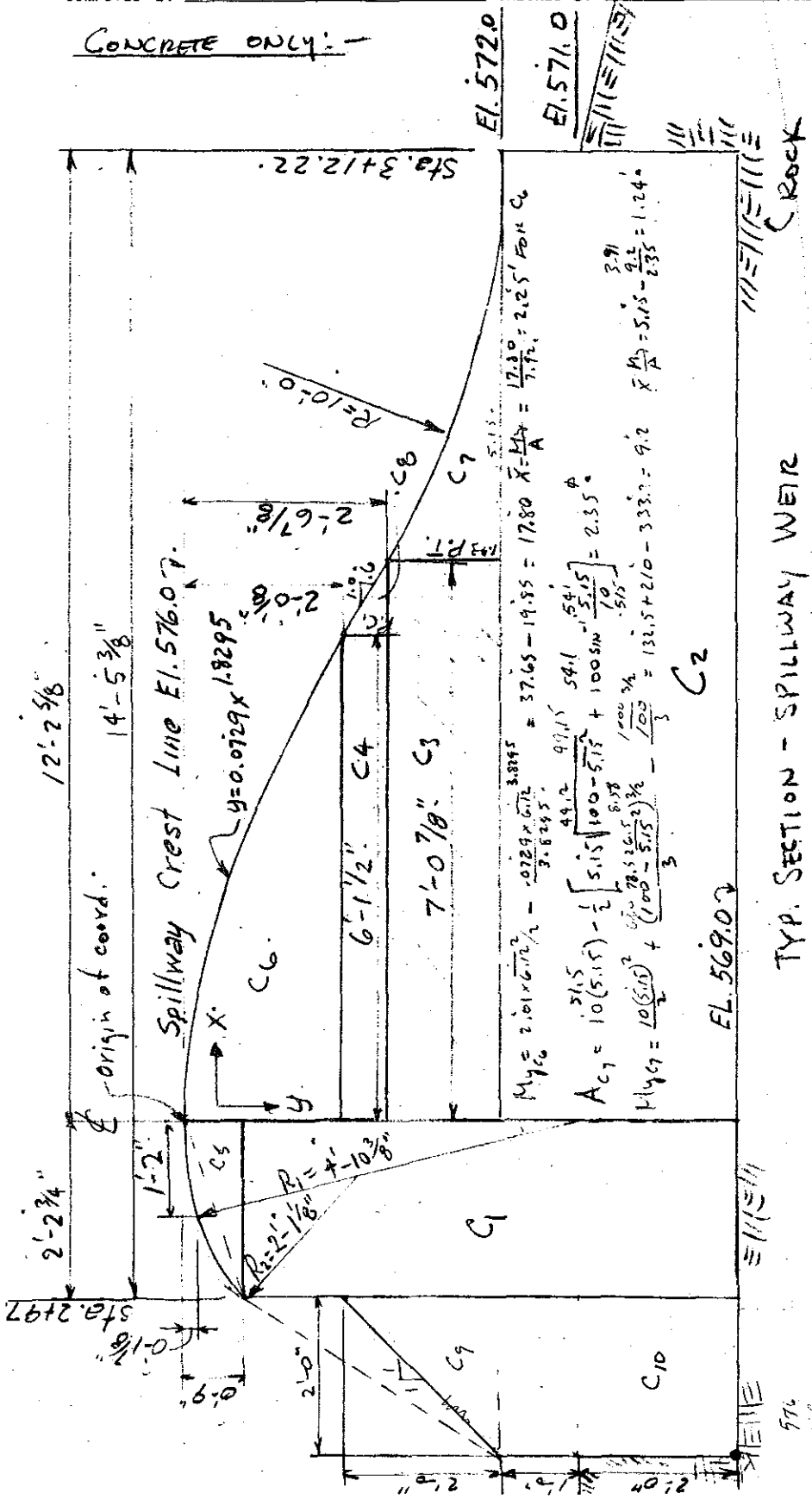
NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT: NORTHFIELD BROOK DAM & RES.
COMPUTATION: SPILLWAY WEIR
COMPUTED BY: CMB CHECKED BY: AJD DATE: 5/29/62

CONCRETE ONLY:—



$M_{y_{C_6}} = 2.01 \times \frac{6.12^2}{2} - \frac{.0729 \times 6.12^{3.8295}}{3.8295} = 37.65 - 19.85 = 17.80$ $\bar{X} = \frac{M_y}{A} = \frac{17.80}{7.92} = 2.25'$ for C_6

$A_{C_7} = 10(5.15) - \frac{1}{2}\left[5.15\sqrt{100-5.15^2} + 100\sin^{-1}\frac{5.15}{10}\right] = 2.35^{\#}$

$M_{y_{C_7}} = \frac{10(5.15)^2}{2} + \frac{(100-5.15^2)^{3/2}}{3} - \frac{1000^{3/2}}{3} = 132.5 + 210 - 333.3 = 9.2$ $\bar{X} = \frac{M_y}{A} = 5.15 - \frac{9.2}{2.35} = 1.24'$

X	Y
1.0	0.07
2.0	0.26
3.0	0.54
4.0	0.92
5.0	1.38
6.0	1.94
6.12	2.01

ITEM	FACTORS	LOADS	ARM	MOM.
C1	.15 × 2.23 × 6.25	2.09	3.11	+ 6.50
C2	.15 × 12.22 × 3.00	5.50	10.34	+ 56.86
C3	.15 × 7.07 × 1.43	1.53	7.77	+ 11.78
C4	.15 × 6.12 × 0.576	0.51	7.29	+ 3.74
C5	.15 × 2.23 × 1.0/2	0.17	3.34	+ 0.56
C6	.15(2.01×6.12 − .0729×6.12^3.8295/2.8295)	1.19	6.48	+ 7.70
C7	.15 × 2.35	0.35	12.54	+ 4.42
C8	.15 × 0.56 × 0.95/2	0.04	10.67	+ 0.42
C9	.15 × 2 × 2/2	0.30	1.55	+ 0.40
C10	.15 × 2 × 3	0.90	1.0	+ 0.90
ΣC		12.58	ΣMc	+ 93.28

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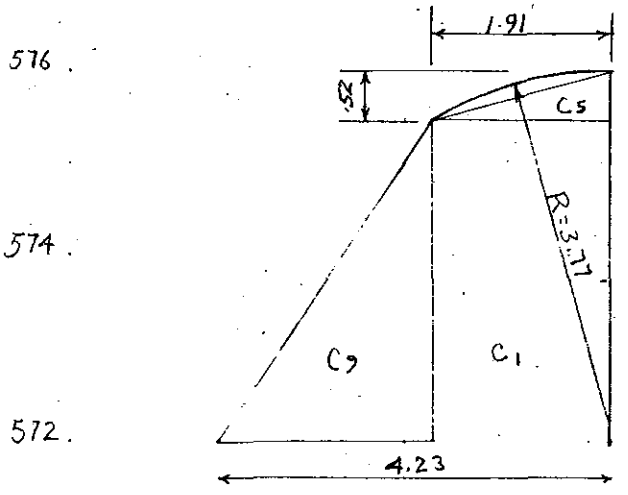
SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION SPILLWAY WEIR - REVISION
COMPUTED BY JWF CHECKED BY DATE



Note
Subsequent to the stability analysis the weir crest was modified slightly to the adjacent shape. The tabulation below shows that the change has only minor effect and can be neglected

ITEM	Factors	LOADS	ARM	MOM.
C_1	.15 x 1.91 x 6.48	1.86 ↓	3.27	+ 6.07
C_2		5.50 ↓	10.34	+ 56.86
C_3		1.53 ↓	7.77	+ 11.78
C_4		0.51 ↓	7.29	+ 3.74
C_5	1.91 x 0.52/2 x .15	.07 ↓	3.59	+ 0.25
	1.91 x 0.1 x .15 ESTIM.	.03 ↓	3.27	+ 0.10
C_6		1.19 ↓	6.48	+ 7.70
C_7		.35 ↓	12.54	+ 4.42
C_8		.04 ↓	10.67	+ 0.42
C_9	.15 x 2.32 x 3.48/2	.61 ↓	1.55	+ 0.94
C_{10}	.15 x 2.32 x 3	1.05 ↓	1.16	+ 1.21
		ΣV = 12.74 ↓	ΣM =	93.49

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NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT: NORTHFIELD BROOK DAM & RES.
COMPUTATION: SPILLWAY WEIR - STABILITY
COMPUTED BY: [illegible] CHECKED BY: [illegible] DATE: 6/1/62

LOADING CONDITIONS; — REF. EM-1110-2-2200

CASE I — CONSTRUCTION CONDITION — NO WATER, NO T.W., NO WIND (NEGLIGIBLE)

CASE II — NORMAL OPERATING CONDITION, R TO FALL WITHIN MID 1/3, $\frac{\Sigma H}{\Sigma V} \geq .65$
WATER TO SPILLWAY CREST EL. 576
T.W. EL. 569.0, NO ICE PRESSURE (PERM. POOL EL 500)
UPLIFT VARIES UNIFORMLY FROM HEADWATER TO TAILWATER

CASE III — INDUCED SURCHARGE CONDITION — NOT APPLICABLE

CASE IV — FLOOD DISCHARGE CONDITION — WATER EL. 586.0 (25' UPST. OF WEIR)
60% T.W. FOR LATERAL PRES., 100% T.W. FOR UPLIFT
T.W. @ EL. 576.5, HEAD @ P.T = EL. 580
HD. @ UPST. FACE = EL. 583.5, NO ICE PRES. R WITHIN MID 1/3, $\frac{\Sigma H}{\Sigma V} \geq .65$

CASE V — CONST. COND. W/ EARTHQUAKE — NEGLIGIBLE

CASE VI — NORM. COND. W/ EARTHQUAKE — NEGLIGIBLE

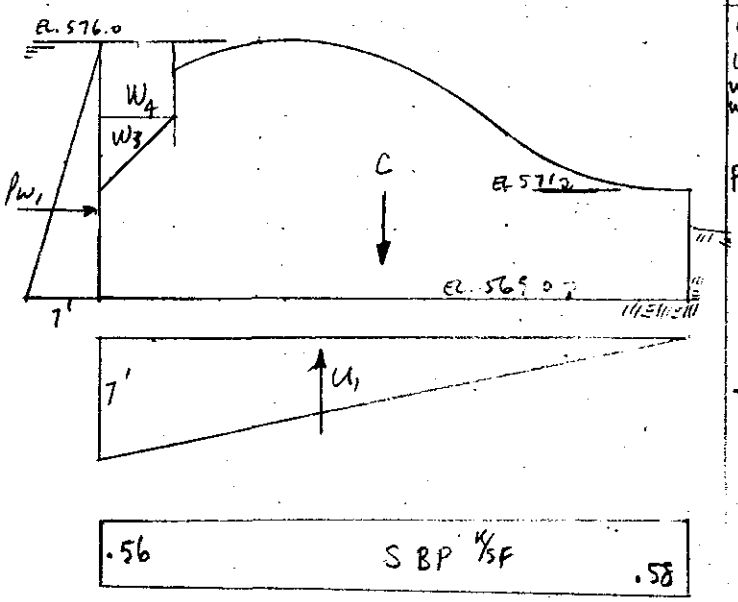
CASE I: — CONST. CONDITION (CONCRETE ONLY)

$f = \frac{12.58}{16.45}\left(1 \pm \frac{6(.80)}{16.45}\right)$
$f = .764(1 \pm .292)$
$f_{MAX} = 0.99\ ^K/\phi$
$f_{MIN} = 0.54\ ^K/\phi$

$\Sigma V = 12.58\ ^K/_1$ $\Sigma M = +93.28\ ^{1K}/_1$

$\Sigma H/\Sigma V = 0/12.28 = 0$ $\Sigma M/\Sigma V = \frac{93.28}{12.58} = 7.42' > 5.48 < 10.96'$ ok

CASE II: — NORM. OPER. COND.



FACTORS		LD	A	MOM.
C		12.58↓		+ 93.28
U_1	.0625 x 7 x 16.45/2	3.60↑	5.48	- 19.75
W_3		0.13↓	0.67	+ 0.08
W_4	.0625 x 2 x 2	0.25↓	1.0	+ 0.25
	ΣV	9.36		
P_{W_1}	.0625 x $\bar{7}^2/2$	1.53→	2.33	+ 3.56
	ΣH	1.53→	ΣM	+ 77.42

$\Sigma H/\Sigma V = \frac{1.53}{9.36} = 0.17 < .65$ ok

$\Sigma M/\Sigma V = \frac{77.42}{9.36} = 8.26 > 5.5' < 11.0'$ ok

$f = \frac{9.36}{16.45}\left(1 \pm \frac{6 \times .04}{16.45}\right) = 0.569(1 \pm .0146)$

$f_{MAX} = 0.569(1.0146) = 0.58\ ^K/_{SF}$
$f_{MIN} = 0.569(.9854) = 0.56$ } ok

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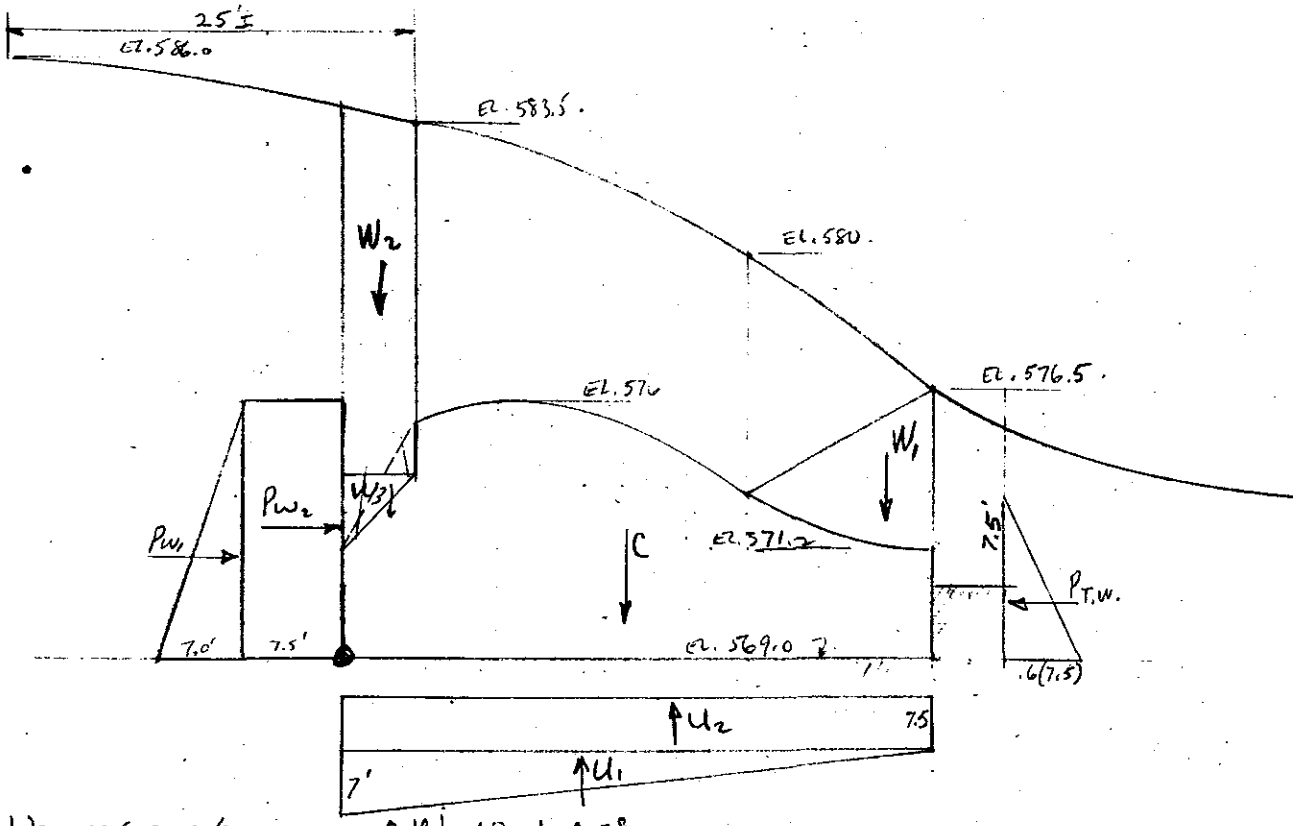
SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION SPILLWAY WEIR – STABILITY
COMPUTED BY CMC CHECKED BY DATE 6/1/62

CASE IV :– FLOOD DISCHARGE COND.



W_3 .0625 x 2 x 2/2 0.13↓ .67 + 0.08

	FACTORS	LD	A	MOM.
C		12.58↓		+93.28
W_1	.0625 x 5.5 x 5.15/2	0.89↓	14.73	+13.04
U_1	.0625 x 7 x 16.45/2	3.60↑	5.48	−19.75
U_2	.0625 x 7.5 x 16.45	7.71↑	8.22	−63.42
W_2	.0625 x 2 x 9.5	1.18↓	1.0	+ 1.18
	ΣV	3.47↓		
P_{w_1}		1.53→		+ 3.56
P_{w_2}	.0625 x 7.5 x 7.0	3.28→	3.5	+ 11.47
P_w	.0625 (7.5 x .6)²/2	0.63←	1.5	− 0.95
	ΣH	4.18→	ΣM	+38.49

$f_{MAX} = \frac{2(3.47)}{16.45} = 0.422$ K/□

$f_{MIN} = 0$

$\Sigma H/\Sigma V = 4.18/3.47 = 1.21 > .65$ N.G.

$\Sigma M/\Sigma V = 38.49/3.47 = 11.08 > 5.5 > 11.0$ ok @ MID 1/3

$S_{s.f} = \frac{.65(3.47) + 1.0(90)\ 16.45(.144)}{4.18} = \frac{2.3 + 213.5}{4.18} = \frac{215.8}{4.18} = 51.5 > 4.0$ ok

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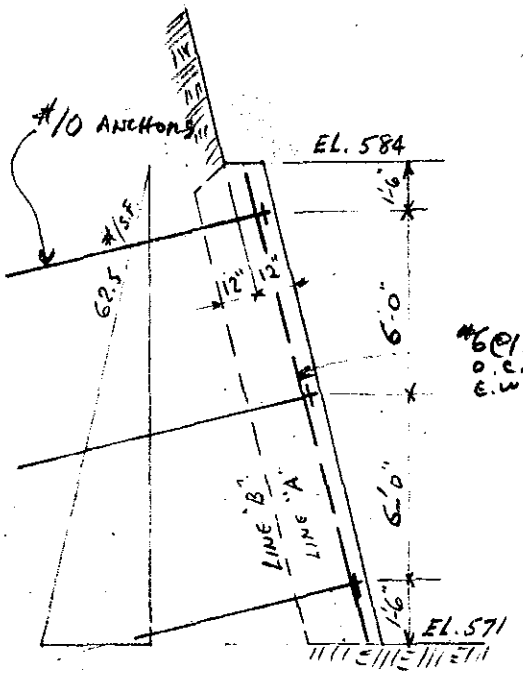
SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION SPILLWAY LINING
COMPUTED BY Cnt CHECKED BY DATE 7/30/62



ASSUME 10' HEAD ON 12" LINING
" ANCHOR SPACING 5'x7' = 35 ⌀

TOTAL LD./ANCHOR = .0625 (10) 36 = 22.5 K

ALLOWABLE LD. ON #10 ⌀ = 1.27 (20) = 25.4 K > 22.5 K ok

#6@12 O.C. E.W. ∴ USE #10 ⌀ BARS – 10'-0" LONG INTO ROCK
@ 6'-0" VERTICAL SPACING
& 6'-0" HORIZONTAL SPACING

REINF FOR LINING.

$w = 350$ #/⌀

$V = .35(6/2) = 1.05$ K/'

$M = .35(6)^2/8 = 1.58$ 'K/'

$d_n = \sqrt{\frac{1.58}{.16}} = \sqrt{9.9} = 3.15" > 6"$ ok

$A_s = \frac{1.58}{1.44(6)} = 0.18$ ⌀/'

MIN $A_s = .0025(12)12 = 0.36$ ⌀/'

∴ USE #6@12 OC @ CENTER OF SLAB E.W.

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SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION OUTLET WORKS - INTAKE STRUCTURE
COMPUTED BY CMF CHECKED BY JWF DATE 6/7/62

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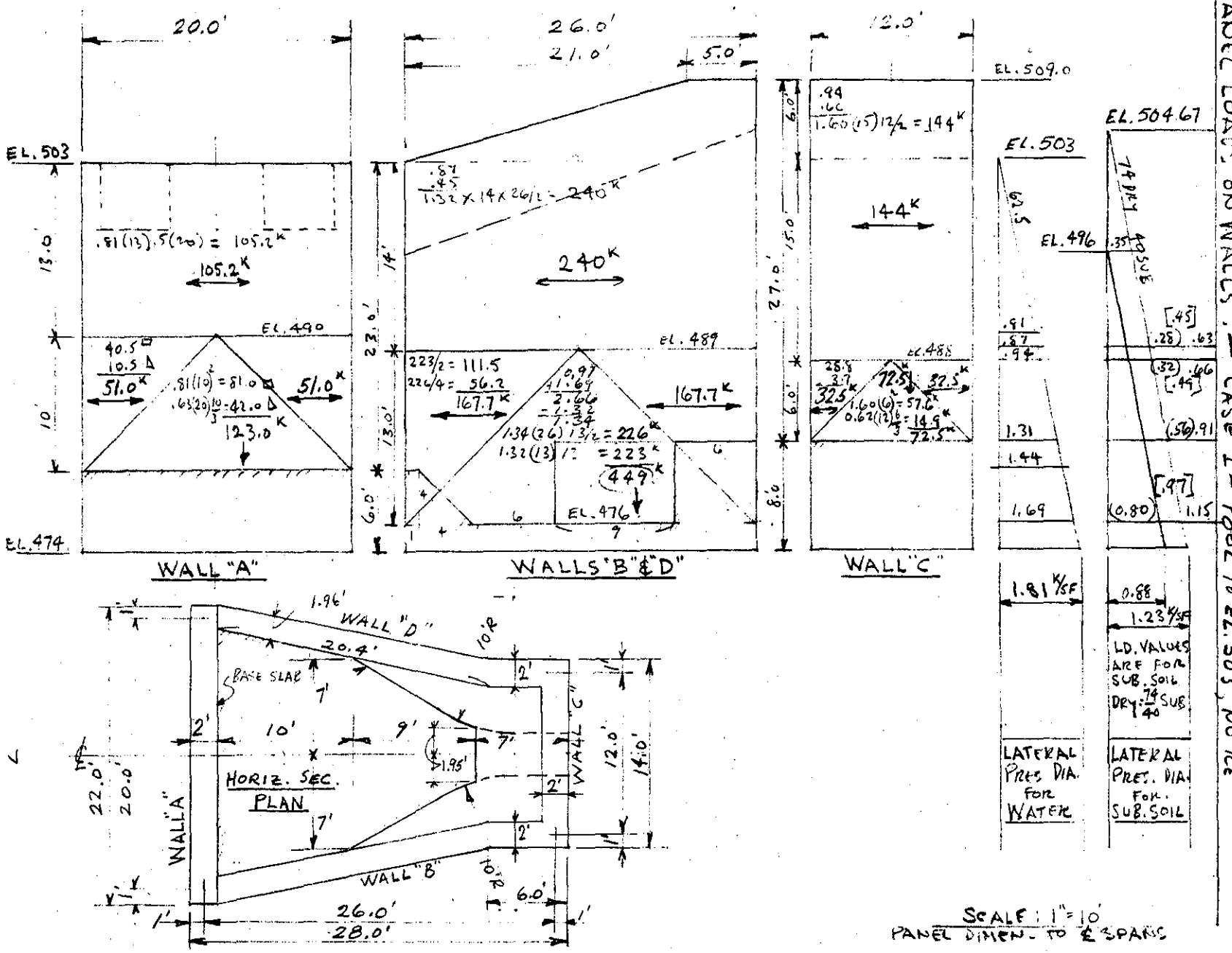
PANEL LOADS ON WALLS :- CASE I - POOL TO EL. 503, NO ICE



SCALE: 1" = 10'
PANEL DIMEN. TO ℄ SPANS

SUBJECT: NORTHFIELD BROOK DAM & RES.
COMPUTATION: OUTLET WORKS – INTAKE STRUCTURE
COMPUTED BY: GMB CHECKED BY: JWM DATE: 6/11/62

COMPUTE BASE PRESSURE:—

WALL A	× 29 × 2 × 22	= +	1277
	× 5 × 5 × 2 × 2	= −	100
	× 2 × 3 × 2	= −	12
" B & D	× 2 × 2 × 29 × 20.4	= +	2365
	× 2 × 2 × 4 × 3.5	= +	560
	× 2 × 2 × 6 × 20.4/2	= +	245
" C	× 2 × 14 × 35	= +	980
	× 2 × 3 × 3	= −	18
BASE	× 2 × 10 × 10	= +	200
	× 2 × 14 × 10	= +	280
	× 2 × 4 × 10	= +	80
	× 2 × 2/2 × 10 × 4	= +	80
VENTURI	× 5 × 6 × 10	= +	300
	× 3 × 3 × 5	= −	30
	× 6 × 9 × 3.5/2 × 2	= +	189
HAUNCH	× 4 × 4/2 × 18	= +	144
PLATFORM UPST.	× 1.5 × 7 × 2.5	= +	26
	× 1.0 × 7 × 2.0	= +	14
" DWST.	× 4.0 × 1.0 × 10	= +	40
	× 1.0 × 3.14	= −	3
TAIL	× 6 × 14 × 8.5	= +	715
	× 3 × 3 × 6	= −	54
	× 2.25 × 2.25/2 × 14	= −	35

WT. OF CONCRETE = +7243
−6 × 8.5 × 2 = 102 = −102
7141 × .15 = 1080^K ↓

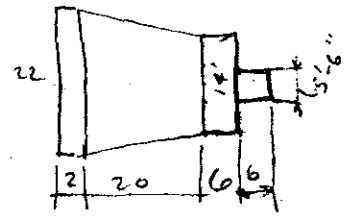
BASE PRESSURE, CONST. COND. = 1080/521 = 2.06 K/SF

BASE PRESSURE, WET COND. (POOL TO EL. 503 − 474 = 29')

CONC. = + 1080
UPLIFT = (.0625 × 29) × 521 = − 944
SAT. SOIL = .145 × 23 × 6 × 5.5 = + 110
+ 246 ↓

SBP = 246/521 = 0.472 K/SF

BASE AREA

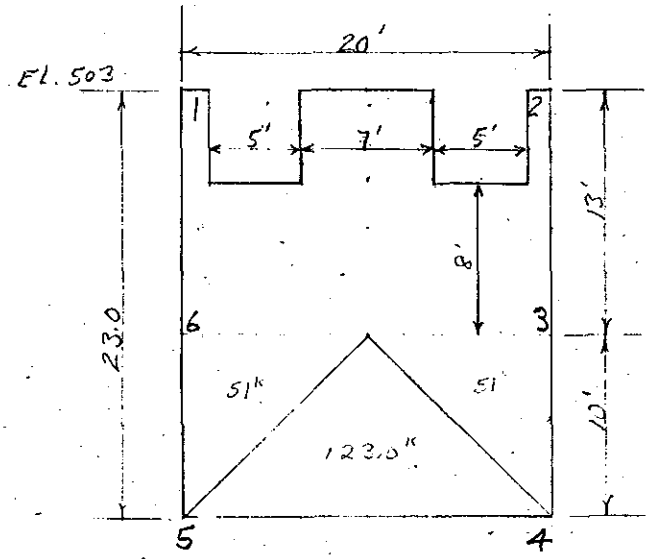


A = 22 × 2 = 44
20 × 18 = 360
14 × 12 = 168
572
− 6 × 8.5 = 51
A = 521

SUBJECT NORTHFIELD BROOK INTAKE STRUCTURE

COMPUTATION WALL A

COMPUTED BY JWF CHECKED BY AEB DATE 7 Jun. 62



Design Criteria

$f_c' = 3000$ $f_s = 20{,}000$

$f_c = 1050$ $a = 1.44$

$n = 10$ $K = 160$

$v = 90$ No web Rein.

240 with " "

$u = 210$ top Bars

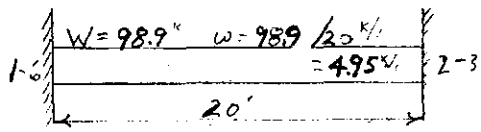
210 Ext surface Bars

300 All others

cover 3" walls I.F & OF

3" Base top

4" Base - Bot.



Load taken by 8' section

$(.31 \times 8 \times 20) + (.5 \times 8 \times \frac{1}{2} \times 20) + (.31 \times \frac{5 \times 12}{2})$

$49.6 + 40 + 9.3 = 98.9$

$M^F_{(1\text{-}6 \,\&\, 2\text{-}3)} \; \frac{wl^2}{12} = \frac{98.9 \times 20}{12} = 165^{'K}$

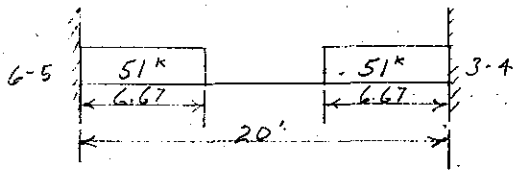
$165/8 = 20.6^{'K}/'$

$SBM = wl^2/8 = 98.9 \times 20^2/8 = 247^{'K}$

$247/8 = 30.9^{'K}/'$

$V_{(1\text{-}6 \,\&\, 2\text{-}3)} = wl/2 = 98.9/2 = 49.5^K$

$49.5/8 = 6.2^{K}/'$



$M^F_{(6\text{-}5 \,\&\, 3\text{-}4)} = \frac{wa^2}{6L}(3L - 2a) =$

$\frac{51 \times 6.67}{6 \times 20}(3 \times 20 - 2 \times 6.67) = 2.84(46.67)$

$132.5^{'K}$ $132.5/10 = 13.25^{'K}/'$

$W = 51^K$ $w = 51/6.67 = 7.65^K/'$

$SBM_{(6\text{-}5 \,\&\, 3\text{-}4)} \; wa^2/2 = 7.65(6.67)^2/2 = 170.5^{'K}$

$170.5/10 = 17.05^{'K}/'$

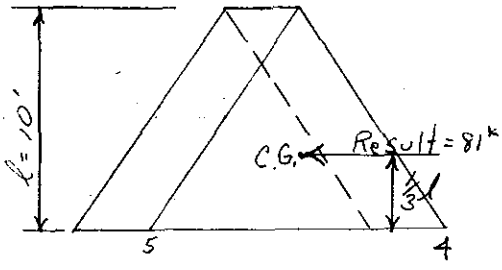
$V_{(6\text{-}5 \,\&\, 3\text{-}4)} = 51^K$

$51/10 = 5.1^{K}/'$

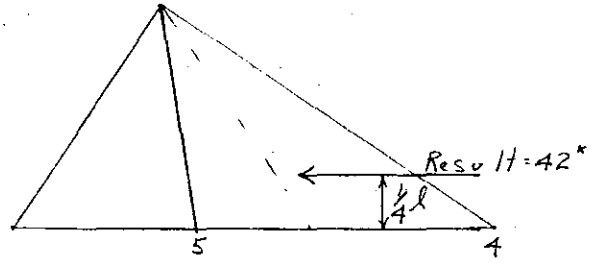
NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

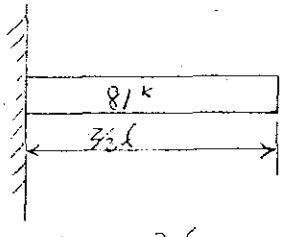
SUBJECT NORTHFIELD BASIN - INTAKE STRUCTURE
COMPUTATION WALL A
COMPUTED BY JWF CHECKED BY A&D DATE 11 Jun 62

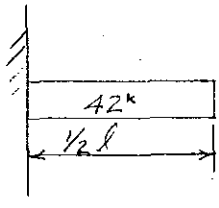


distribute loading as uniform load over 2/3 ℓ.



distribute load as uniform load over 1/2 ℓ.





$W = w \times \frac{2}{3}\ell$

$W = w \times \frac{1}{2}\ell$

$M = w(\frac{2}{3}\ell)^2/2$

$M = w(\frac{1}{2}\ell)^2/2$

$M = \frac{2}{3}W\ell/2 + \frac{1}{2}W\ell/2 =$

$M_{(5-4)} = W\ell/3 + W\ell/4 = 81 \times 10/3 + 42 \times 10/4 = 270 + 105 = 375^{'k}$

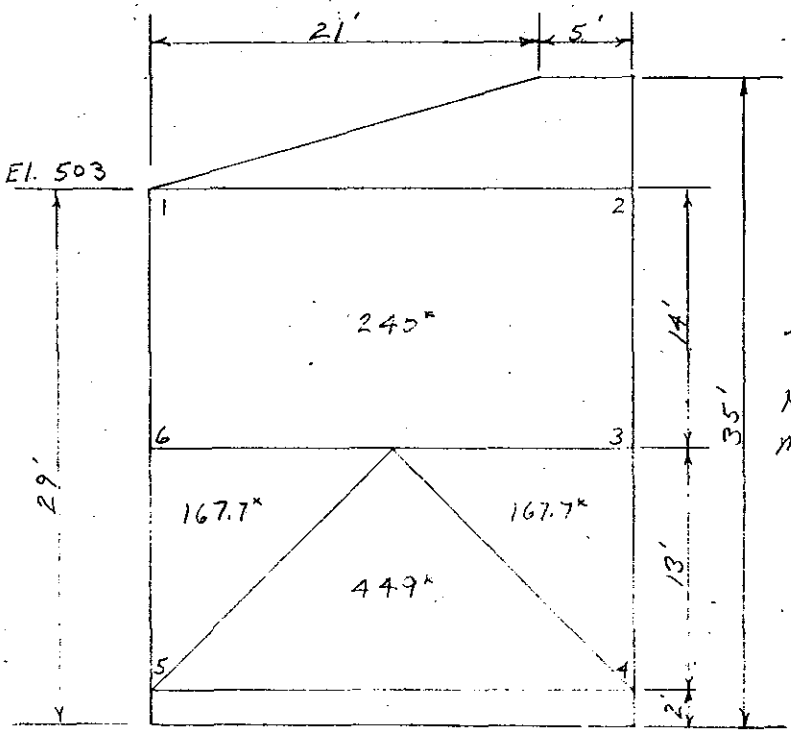
$375/20 = 18.8^{'k/'}$

$V_{(5-4)} = 81 + 42 = 123^k$ $\quad 123/20 = 6.15^{k/'}$

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT NORTHFIELD BROOK INTAKE STRUCTURE
COMPUTATION WALL B&D
COMPUTED BY JWF CHECKED BY AKD DATE 11 Jun 62



See diagrams pg. 2

$\ell = 13'$ W(uniform) = 223^k
W(increasing) = 226^k

$M_{(5-4)} = W\ell/3 + W\ell/4$

$M_{(5-4)} = 223 \times 13/3 + 226 \times 13/4 =$
$966 + 735 = 1701'^k$

$1701/26 = 65.5'^k/'$

$V_{(5-4)} = 223 + 226 = 449^k$
$\frac{449}{26} = 17.3^k/'$

1-6 | W = 240^k w = 240/26 = 9.23^k/' | 2-3

$M^F_{(1-6 \,\&\, 2-3)} = wl^2/12 = 240 \times 26/12 = 520'^k$ $520/14 = 37.2'^k/'$

$V_{(1-6 \,\&\, 2-3)}$ $W/2 = 120^k$ $120/14 = 8.57^k/'$

$SBM_{(1-6 \,\&\, 2-3)} = wl^2/8 = 240 \times 26/8 = 780'^k$ $780/14 = 55.7'^k/'$

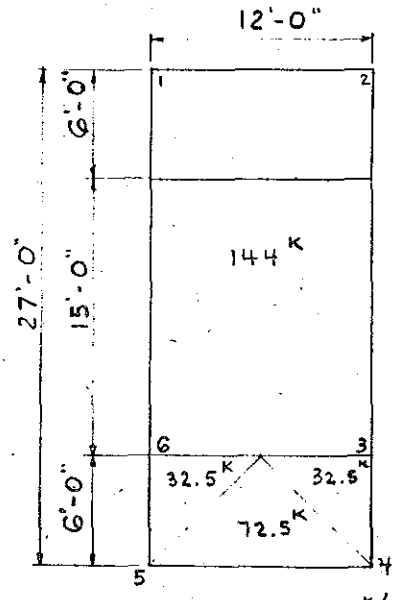
6-5 | 167.7^k, 8.67 | 167.7^k, 8.67 | 3-4

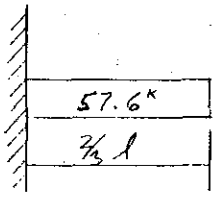
$SBM_{(6-5 \,\&\, 3-4)} = wa^2/2 = 19.34(8.67)^2/2 =$
$727'^k$
$727/13 = 56.0'^k/'$

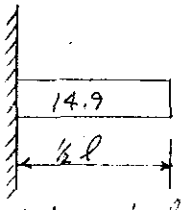
$M^F_{(6-5 \,\&\, 3-4)} = \frac{wa^2}{6L}(3L - 2a) = \frac{167.7 \times 8.67}{6 \times 26}(3 \times 26 - 2 \times 8.67) = 9.32 \times 60.66 =$
$565'^k$ $565/13 = 43.5'^k/'$

$V_{(6-5 \,\&\, 3-4)} = 167.7^k$
$167.7/13 = 12.9^k/'$

SUBJECT: Northfield Brook
COMPUTATION: Intake Structure – WALL "C"
COMPUTED BY: ASD CHECKED BY: Cmt DATE:







$W = w \times \frac{2}{3} l$

$M = \frac{w(\frac{2}{3} l)^2}{2}$

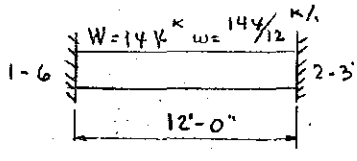
$W = w \times \frac{1}{2} l$

$M = \frac{w(\frac{1}{2} l)^2}{2}$

$M = \frac{2}{3} \frac{Wl}{2} + \frac{1}{2} \frac{Wl}{2}$ $M_{5-4} = \frac{Wl}{3} + \frac{Wl}{4}$

$M_{5-4} = \frac{57.6}{3}(6) + \frac{14.9}{4}(6) = 115.2 + 22.5 = 137.7^{'K}$

$137.7/12 = 11.5^{'K/'}$ $V_{(5-4)} = 57.6 + 14.9 = 72.5^K$ $\frac{72.5}{12} = 6.04^{K/'}$



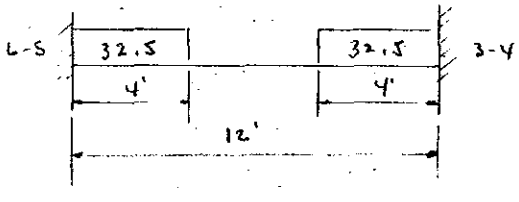
$S.B.M = \frac{1}{8} wl^2$
$= \frac{1}{8}(144)(12)$
$= 216^{'K}$

$216/15 = 14.4^{'K/'}$

$F.E.M_{(1-6,\,2-3)} = \frac{wl^2}{12}$
$= \frac{144(12)}{12}$
$= 144^{'K}$

$144/15 = 9.6^{'K/'}$

$V_{1-6\ \&\ 2-3} = wl/2 = 144/2 = 72^K$ $72/15 = 4.8^{K/'}$



$M^F_{(6-5\ \&\ 3-4)} = \frac{wa^2}{6L}(3L - 2a) =$

$\frac{32.5(4)}{6 \times 12}\left[3(12) - 2(4)\right] = 50.6^{'K}$

$50.6/6 = 8.45^{'K/'}$

$W = 32.5^K$ $w = 32.5/4 = 8.12^{K/'}$

$SBM_{(6-5\ \&\ 3-4)} = 8.12(4)^2/2 = 65^{'K}$

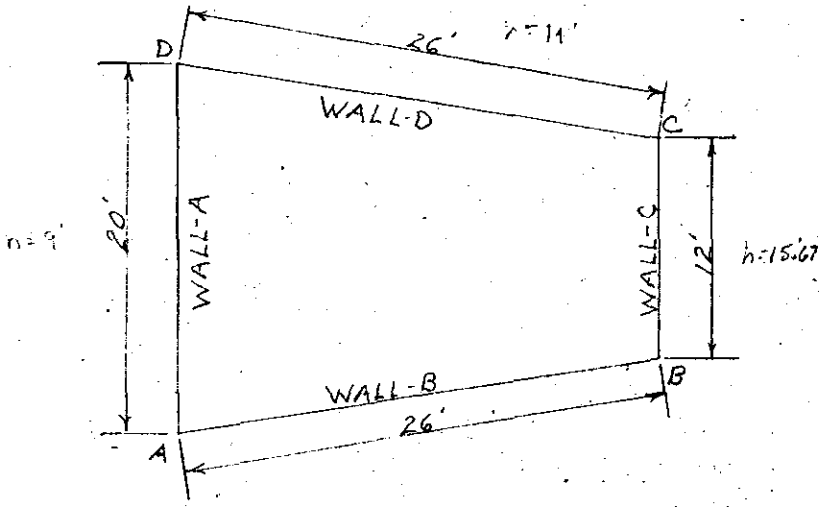
$\frac{65}{6} = 10.8^{'K/'}$ $V_{(5-6)+3-4} = \frac{32.5}{6} = 5.41^{K/'}$

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS Between El. 503 & 489
COMPUTED BY JWF CHECKED BY ASH, BW DATE 13 Jun. 62

MOMENT DISTRIBUTION ON SECTION ABOVE WALL LINE 6-3.

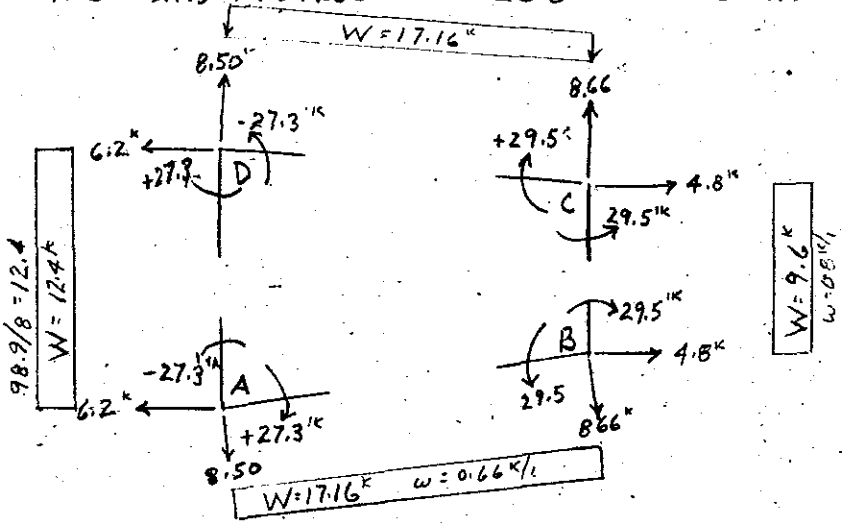


Rel stiff $= \frac{I}{L}$ $I = \frac{bh^3}{12}$

WALL	I	I/L
A	$\frac{8(2)^3}{12}$	$8/20 = .40$
B&D	$\frac{14(2)^3}{12}$	$14/26 = .54$
C	$\frac{15(2)^3}{12}$	$15/12 = 1.25$

	A	WALL-B 26'	B	WALL-C 12'	C	WALL-D 26'	D	WALL-A 20'	A
Rel Stiff		.54		1.25		.54		.40	
K/ΣK	.575	.302	.698	.698	.302	.575	.425	.425	
FEM @	+37.2	-37.2	+9.6	-9.6	+37.2	-37.2	+20.6	-20.6	
1st Dist.	-9.5	+8.3	+19.3	-19.3	-8.3	+9.5	+7.1	-7.1	
Carry over	+4.2	-4.8	-9.7	+9.7	+4.8	-4.2	-3.6	+3.6	
2nd dist.	-4.5	+4.3	+10.2	-10.2	-4.3	+4.5	+3.3	-3.3	
Carry over	+2.2	-2.3	-5.1	+5.1	+2.3	-2.2	-1.7	+1.7	
3rd dist.	-2.3	+2.2	+5.2	-5.2	-2.2	+2.3	+1.6	-1.6	
Final mom.	+27.3	-29.5	+29.5	-29.5	+29.5	-27.3	+27.3	-27.3	
V	8.58	8.58	4.8	4.8	8.58	8.58	6.2	6.2	
	-.08	+.08	0	0	+.08	-.08	0	0	
Total V	8.50	8.66	4.8	4.8	8.66	8.50	6.2	6.2	

A-B $27.3 - 29.5 + 26B = 0$ $26B = 2.2$ $B = .08$



NED FORM 223
27 Sept 49

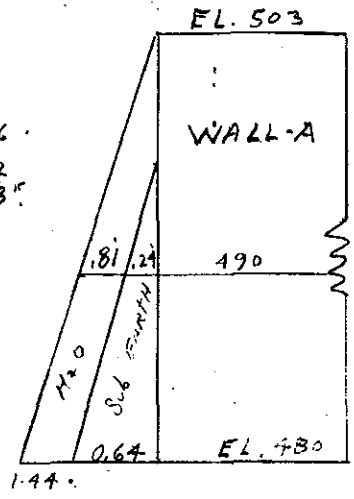
NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION AXIAL LOADING (OTHER THAN REACTIONS)
COMPUTED BY JWF CHECKED BY ATO DATE 19 Jun 62

$.81 \times 13/2 = 5.26$
$.24 \times 6/2 = .72$
5.98^k

$5.98/13 = .46^{k/1}$
8.43
$8.89^{k/1}$

Say $8.9^{k/1}$
EL. 503 to 490



$1.18 \times \frac{40}{74} = 0.64$

$1.44 \times 23/2 = 16.6$
$0.64 \times 16/2 = 5.1$
21.7^k

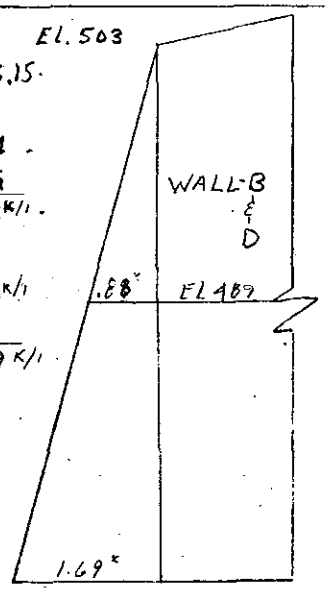
EL. 490 to 480 $\left\{ \begin{array}{l} 21.7/23 = .95 \\ 13.04 \\ 14.99 \text{ Say } 15.0 \end{array} \right.$

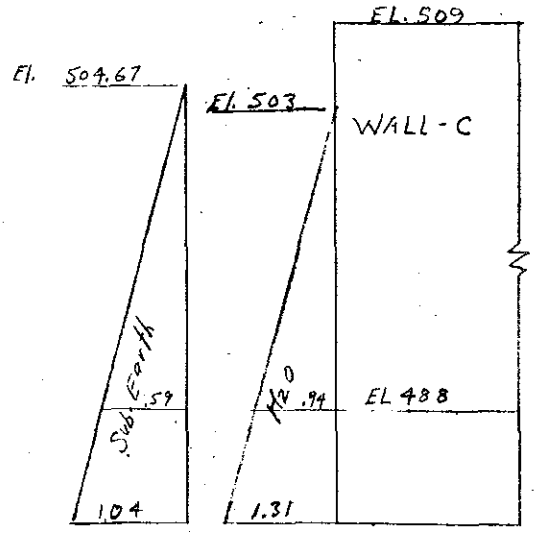
EL. 503

$.88 \times 14/2 = 6.15$

$6.15/14 = .44$
$\frac{105.2}{2 \times 13} = 4.05$
$4.49^{k/1}$

$\left(\frac{1.69 + .88}{2}\right) = 1.29^{k/1}$
$+ 5.1$
$6.39^{k/1}$





$.94 \times 15/2 = 7.05$
$.59 \times 16.67/2 = 4.90$
11.95^k

$11.95/15 = 0.80^{k/1}$
8.68
$9.48^{k/1}$

$\frac{.59 + 1.04}{2} = .82^{k/1}$

$\frac{.94 + 1.31}{2} = 1.12^{k/1}$
12.76
13.88

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS
COMPUTED BY JWF CHECKED BY BTW DATE 10 July 62

WALL-A EL 498 - 490

$V(face) = 6.2^k - .62 \times 1.0 = 5.58^k$ $d_{avail} = 24 - 3.5 = 20.5$

$M(face) = M - \frac{1}{3} V La = 27,300 - \frac{1}{3} \times 5.58 \times 2.0 = 27,300 - 3,720 = 23,580'^k$

$M_s = M + \frac{d}{12} N = 23,580 + \frac{8.5}{12}(8900) = 23,580 + 6,300 = 29,880'^k$

$-A_s = \frac{12 M_s}{f_s j d} - \frac{N}{f_s} = \frac{12 \times 29.88}{20 \times .885 \times 20.5} - 0.45 = .99 - .45 = .54 in^2$ use #7@12"

$v = \frac{5,580}{12 \times j \times 20.5} = 26 \#/in^2$ ok $\Sigma_o = \frac{5,580}{210 \times j \times 20.5} = 1.5 in$

$+ Mom = -27.3 + 6.2 \times 10 - 6.2 \times 5$
$-25.7 + 55.6 - 27.80 = 4.0'^k$

$+ M_s = M + \frac{d}{12} N = 4,000 + 6,300 = 10,300'^k$

$+ A_s = \frac{12 \times 10,300}{20000 \times j \times 20.5} - 0.45 = 0.34 - 0.45$

Temp Steel $= .0010 \times 12 \times 24 = .29 in^2$ use #5@12" $A_s = .31 in^2$

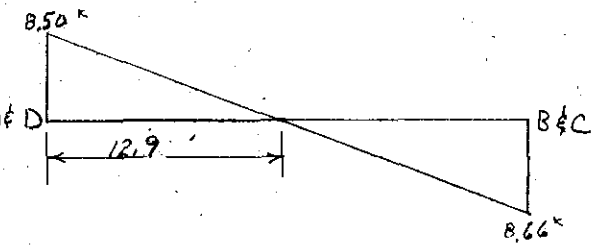
d req'd $= \sqrt{\frac{29.88}{160}} = 13.7 in$ ok

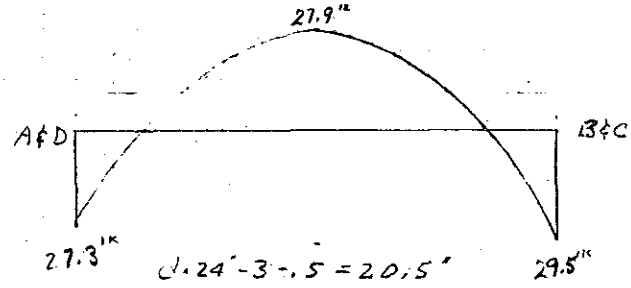
SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS Between El. 503 & 489
COMPUTED BY JWF CHECKED BY BPW DATE 13 June 62

WALL B & D

$8.50^k / .66^{k'} = 12.9$ ft. = Pt of zero shear

$+MOM = -27.3 + (8.50 \times 12.9) - (8.50 \times 6.45)$
$= -27.2 + 109.7 - 54.6$
$= 27.9^{'k}$





$V(face) = 8.50 - 0.66 \times 1.0 = 7.84^k$ - Pt A
$V(face)\ 8.66 - 0.66 \times 1.0 = 8.00^k$ - Pt B
$M = 27.3 - \frac{1}{3} \times 7.84 \times 2.0 = 22.1^{'k}$ - Pt A
$M = 29.5 - \frac{1}{3} \times 8.00 \times 2.0 = 24.2$ - Pt B

d. 24" - 3" - .5 = 20.5"

Pt A
$-M_s = M + \frac{d''}{12} N = 22,100 + \frac{8.5 in}{12} \times 4,490 = 22,100 + 3,200 = 25,300'^{\#}$

Pt B
$-M_s = M + \frac{d''}{12} N = 24,200 + \frac{8.5}{12} \times 4,490 = 24,200 + 3,200 = 27,400'^{\#}$

$+M_s = M + \frac{d''}{12} N = 27,900 + \frac{8.5}{12} \times 4,490 = 27,900 + 3,200 = 31,100'^{\#}$

Pt. A. & D $- A_s = \frac{12 M_s}{f_s j d} - \frac{N}{f_s} = \frac{12 \times 25.3}{20 \times j \times 20.5} - \frac{4.49}{20} = .83 - 0.22 = \underline{0.61 in^2}$

Pt B & C $- A_s = \frac{12 \times 27.40}{20 \times j \times 20.5} - \frac{4.49}{20} = .91 - 0.22 = \underline{0.69 in^2}$

$+A_s = \frac{12 \times 31.1}{20 \times j \times 20.5} - \frac{4.49}{20} = 1.03 - 0.22, = \underline{0.81 in^2}$

$v = \frac{V}{b j d} = \frac{8000}{12 \times j \times 20.5} = \underline{37 \#/in^2}$ ok $d_{req'd} = \sqrt{\frac{31.1}{.160}} = 14 in$ ok

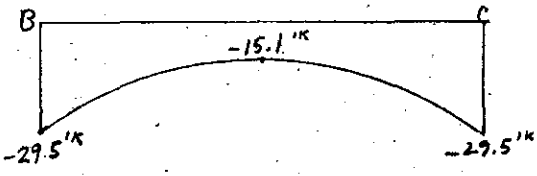
$\Sigma_o = \frac{V}{u j d} = \frac{8000}{210 \times j \times 20.5} = \underline{2.1 in.}$

$-A_s$ @ A & D #7 @ 12" $A_s = 0.60 in^2$ $\Sigma_o = 2.8 in$
$-A_s$ @ B & C #8 @ 12" $A_s = 0.79 in^2$ $\Sigma_o = 3.1 in$
$+A_s$ #8 @ 12" $A_s = 0.79 in^2$ $\Sigma_o = 3.1 in$

WALL - C

$\Sigma MOM = -29.5 + (4.8 \times 6) - (4.8 \times 3) = -15.1$

Pt B & C $V(face) = 4.8 - 0.8 \times 1 = 4.0^k$
$M(face)\ 29.5 - \frac{1}{3} \times 4.0 \times 2 = 26.8^{'k}$



$M_s = 26.8 + \frac{8.5}{12} \times 9.48 = 26.8 + 6.7 = 33.5^{'k}$

$d = \sqrt{\frac{33.5}{.160}} = 14.5"$ ok $- A_s = \frac{12 \times 33.5}{20 \times j \times 20.5} - \frac{9.48}{20} = 1.12 - .47 = \underline{.65 in^2}$

$\Sigma_o = \frac{4000}{210 \times j \times 20.5} = 1.05 in$ $v = \frac{4000}{12 \times j \times 20.5} = 18$ PSI. OK

+As use temp steel #5 @ 12 $-A_s$ #8 @ 12" $A_s = 0.79 in^2$ $\Sigma_o = 3.1 in$

-7 +2(

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS BETWEEN El. 490 & 476
COMPUTED BY J.W.F. ✓ CHECKED BY BJW DATE 14 June 62

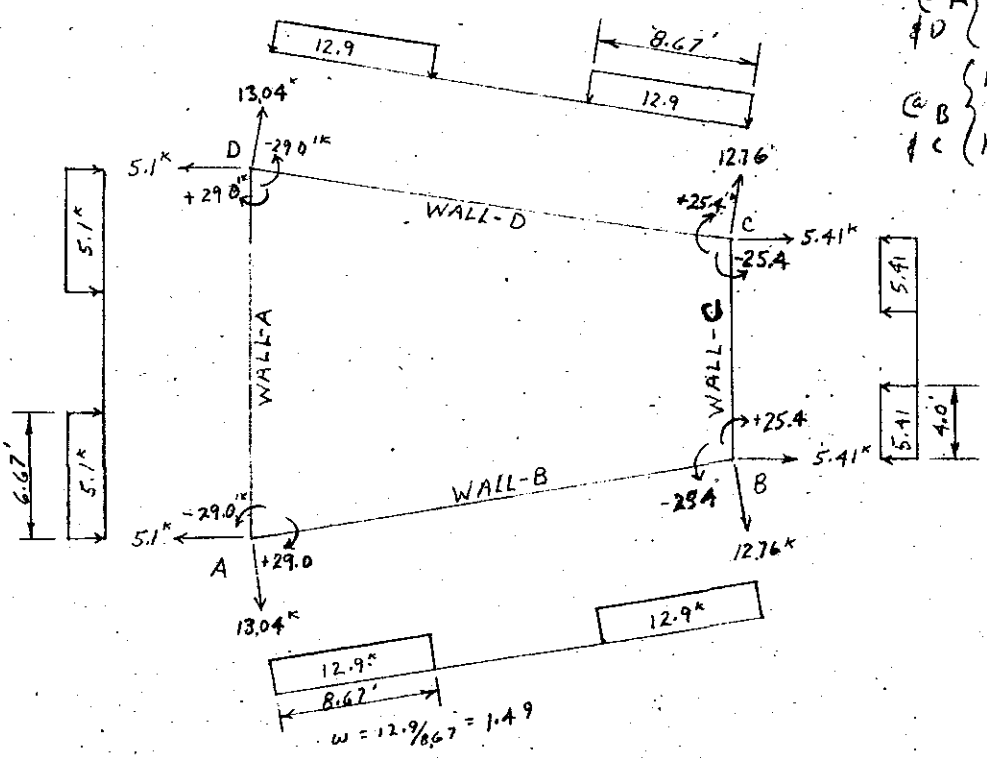
	WALL-A	A	WALL-B	B	WALL-C	C	WALL-D	D
Rel. Stiff.	0.5		0.5		0.5		0.5	
K/ΣK	.5	.5	.5	.5	.5	.5	.5	.5
FEM ↺	-13.3	+43.5	-43.5	+8.5	-8.5	+43.5	-43.5	+13.3
1st Dist.	-15.1	-15.1	+17.5	+17.5	-17.5	-17.5	+15.1	+15.1
Carry Over	+7.5	+8.7	-7.5	-8.7	+8.7	+7.5	-8.7	-7.5
2nd Dist.	-8.1	-8.1	+8.1	+8.1	-8.1	-8.1	+8.1	+8.1
Carry Over	+4.0	+4.0	-4.0	-4.0	+4.0	+4.0	-4.0	-4.0
3rd Dist	-4.0	-4.0	+4.0	+4.0	-4.0	-4.0	+4.0	+4.0
Final Moment	-29.0	+29.0	-25.4	+25.4	-25.4	+25.4	-29.0	+29.0
V	5.1	12.9	12.9	5.41	5.41	12.9	12.9	5.1
ΔV	0	+.14	-.14	0	0	-.14	+.14	0
total V	5.1	13.04	12.76	5.41	5.41	12.76	13.04	5.1

A-B $29.0 - 25.4 + 2\Delta B = 0$
$2\Delta B = -3.6$
$\Delta B = -.14$

C-D $25.4 - 29.0 - 2\Delta C = 0$
$2\Delta C = -3.6$
$\Delta C = -.14$

@ A & D: $K_{AB} = \frac{13}{26} = .5 = .5$; $K_{AD} = \frac{10}{20} = \frac{.5}{1.0} = .5$

@ B & C: $K_{BA} = \frac{13}{26} = .5 = .5$; $K_{BC} = \frac{6}{12} = \frac{.5}{1.0} = .5$



SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS BETWEEN EL. 490 & 476
COMPUTED BY JWF CHECKED BY BPW DATE 15 June 62

WALL A Between El. 490 & 480

$V(face) = 5.1 - .77 \times 1.0 = 4.33$. $M(face) = 29.0 - \frac{1}{3} \times 4.33 \times 2 = 29.0 - 2.9 = 26.1^{'k}$

$M_s = M + \frac{d''}{12} N$ $d = 24 - 3 - .5 = 20.5$ $d'' = 20.5 - 12 = 8.5$

$M_s = 26.1 + \frac{8.5}{12} \times 15.0 = 26.1 + 10.6 = 36.7^{'k}$

$-A_s = \frac{12 \times 36.7}{20 \times j \times 20.5} - \frac{15.00}{20} = 1.22 - 0.75 = 0.47 in^2$

$\Sigma M = -29.0 + 5.1 \times 10 - 5.1 \times 6.67 = -29.0 + 51 - 34 = -12^{'k}$

Use temp. steel in opp. face

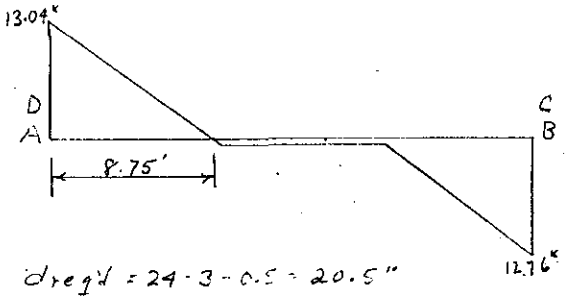
$d_{req'd} = \sqrt{\frac{M_s}{Kb}} = \sqrt{\frac{36.7}{.160}} = 15.2 in$ ok

$v = \frac{V}{bjd} = \frac{4,330}{12 \times j \times 20.5} = 20 PSI$ ok

$\Sigma_o = \frac{V}{u j d} = \frac{4,330}{210 \times j \times 20.5} = 1.14 in$

WALL B & D Between El. 490 - 476

Pt of zero shear
$13.04 - 1.49x = 0$
$x = 13.04/1.49 = 8.75'$



$+M_{om} = -29.0 + (13.04 \times 8.75) - 12.9(4.41)$

$+M = -29.0 + 114.0 - 57.0 = 28^{'k}$ $d_{req'd} = 24 - 3 - 0.5 = 20.5''$

$V(face) = 13.04 - 1.49 \times 1 = 11.55^k$
$M(face) = 29.0 - \frac{1}{3} \times 11.55 \times 2.0 = 29.0 - 7.7 = 21.3^{'k}$

Pt A & D $M_s = 21.3 + \frac{8.5}{12} \times 6.39 = 21.3 + 4.5 = 25.8^{'k}$

$-A_s = \frac{12 \times 25.8}{20 \times j \times 20.5} - \frac{6.39}{20} = .86 - .32 = .54 in^2$ $\Sigma_o = \frac{11.55}{210 \times j \times 20.5} = 3.03$

Pt B & C $V(face) = 12.76 - 1.49 \times 1 = 11.27^k$

$M(face) = 25.4 - \frac{1}{3} \times 11.27 \times 2.0 = 25.4 - 7.5 = 17.9^{'k}$

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS BETWEEN EL. 490 & 476
COMPUTED BY JWF CHECKED BY BPW DATE 15 June 62
Revised 11 July 62

WALL - B & D cont'd $M_s = 17.9 + 4.5 = 22.4^{'k}$

Pt B & C

$$-A_s = \frac{12 M_s}{f_s j d} - \frac{N}{f_s} = \frac{12 \times 22.4}{20 \times j \times 20.5} - 0.32 = .74 - .32 = \underline{0.42 in^2}$$

$$+M_s = 28.0 + 4.5 = 32.5^{'k}$$

$$+A_s = \frac{12 \times 32.5}{20 \times j \times 20.5} - 0.32 = 1.08 - 0.32 = \underline{.76 in^2}$$

$$v = \frac{V}{b j d} = \frac{11,270}{12 \times j \times 20.5} = 52 \#/in^2 \text{ OK}$$

$$\Sigma o = \frac{V}{u j d} = \frac{11,270}{210 \times j \times 20.5} = 2.95 in$$

Pt A & D
- Steel use #6 @ 9" $A_s = 0.59 in^2$, $\Sigma o = 3.1 in$

Pt B & C
- Steel use #6 @ 9" $A_s = 0.59 in^2$, $\Sigma o = 3.1 in$

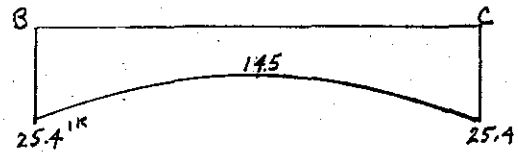
+ Steel use #8 @ 12" $A_s = 0.79 in^2$, $\Sigma o = 3.1 in$

WALL C

$d = 24 - 3 - .5 = 20.5$

$$\Sigma \text{MOMENT} = -25.4 + (5.41 \times 6) - (5.41 \times 4) = -25.4 + 32.5 - 21.6 = -14.5^{'k}$$

+As use temp steel.
#5 @ 12"



$V(face) = 5.41 - 1.35 = 4.06$

$M(face) = 25.4 - \frac{1}{3} \times 4.06 \times 2 = 25.4 - 2.7 = 22.7^{'k}$

$-M_s = 22,700 + \frac{8.5}{12} \times 13,880 = 32,500^{'k}$ $d_{req'd} = \sqrt{32.5/.160} = 14.3 in$ ok

$$-A_s = \frac{12 \times 32.5}{20 \times j \times 20.5} - \frac{13.88}{20} = 1.08 - 0.69 = \underline{0.39 in^2} \quad \underline{\#6 @ 12", A_s = .44 in^2}$$

$\Sigma o = 2.4 in$

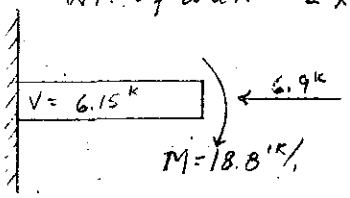
v = ok < wall B

$$\Sigma o = \frac{V}{u j d} = \frac{4,060}{210 \times j \times 20.5} = 1.1 in$$

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS - EL - 490 - 476
COMPUTED BY JWF CHECKED BY BJW DATE 18 Jun. 62

WALL - A vertical steel

Wt. of wall = 2' x 1' x 23' x .15 k/ft³ = 6.9 k/'



$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{23.7 \times 12}{.160 \times 12}} = 12$ in ok

$d_{avail.} = 24 - 3 - 1 - \frac{1}{2} = 19.5$ in

$M_s = 18.8 + \frac{7.5}{12} \times 6.9 = 18.8 + 4.3 = 23.1$ 'k

$-As = \frac{12 \times 23.1}{20 \times j \times 19.5} - \frac{6.9}{20} = .80 - .35 = 0.45 \text{ in}^2$ #6 @ 12" As = 0.44 in² Σ_o = 2.4 in

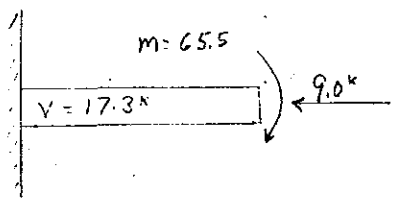
$v = \frac{V}{bjd} = \frac{6150}{12 \times j \times 19.5} = 30 \text{ \#/in}^2$ ok

$\Sigma_o = \frac{V}{u j d} = \frac{6150}{210 \times .855 \times 19.5} = 1.70$ in As temp = .001 x 12 x 24 = .29 in²

+As = use min steel #5 @ 12" - temp.

WALL - B & D

Wt of wall = 2 x 1 x 30 x .15 = 9.0 k/'
$M_s = 65.5 + \frac{8.5}{12} \times 9.0 = 65.5 + 6.4 = 71.9$ 'k



try - $d = \sqrt{\frac{71.9}{.160}} = 21.2$ use d = 21.2"

$-As = \frac{12 \times 71.9}{20 \times j \times 21.2} - \frac{9.0}{20} = 2.30 - 0.45 = 1.85 \text{ in}^2$ #9 @ 6" As = 2.00 in²

$v = \frac{V}{bjd} = \frac{17300}{12 \times j \times 21.2} = 77 \text{ \#/in}^2$ ok

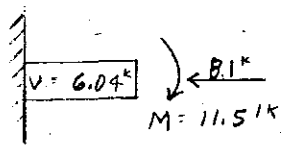
$\Sigma_o = \frac{V}{u j d} = \frac{17300}{210 \times j \times 21.2} = 4.4$ in

+As = use min steel #5 @ 12" - temp.

WALL - C

Wt. of wall 2 x 1 x 27 x .15 = 8.1 k/'

d ok see above



$M_s = 6.04 + \frac{7.5}{12} \times 8.1 = 6.04 + 5.06 = 11.1$ 'k

$-As = \frac{12 \times 11.1}{20 \times j \times 19.5} - \frac{8.1}{20} = .39 - 0.41$ use min steel

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION WALLS - EL 490-476
COMPUTED BY J.W.F. CHECKED BY Cmt DATE 18 Jun 62

WALL-C Cont'd

v = OK

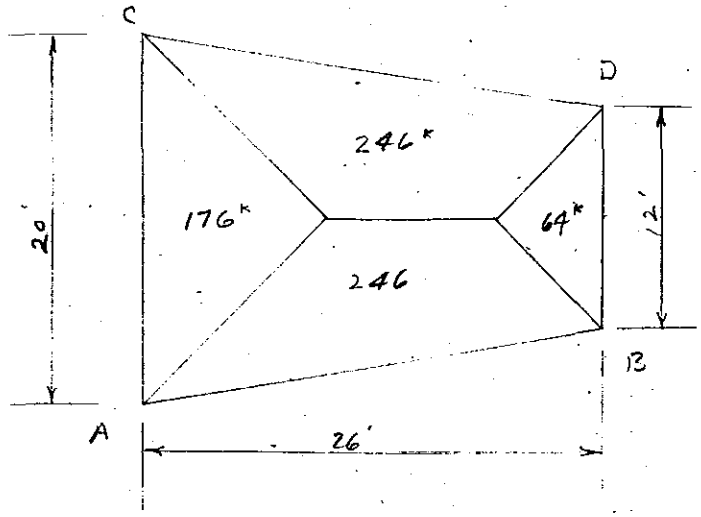
$\Sigma_0 = \frac{V}{\mu j d} = \frac{6040}{210 \times j \times 19.5} = 1.68$ in

USE #5 @ 12"
$A_s = 0.31 \text{ in}^2$
$\Sigma_0 = 2.0$ in.

Base Slab

Base pressure, Const Cond. 2.06 K/SF less slab wt = 2.06 - .30 = 1.76 K/SF
WET. COND. 0.472 K/SF

BASE SLAB REACTIONS AS SHOWN ARE ASSUMED TO BE BALANCED BY WT. OF WALLS & DISTRIBUTION FORCES (PRECISE ANALYSIS NOT REQ.)



AXIAL LOAD
$2\left[\left(\frac{0.84+1.19}{2}\right)+1.75\right] = 5.53$ WET
$2\left[\frac{1.55+2.19}{2}\right] = 3.74$ DRY.

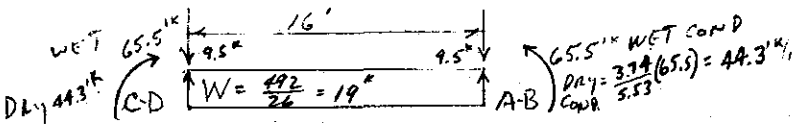
$20' \times 10/2 \times 1.76^{K/SF} = 176^K$

$12 \times 6/2 \times 1.76 = 64^K$

240

$\left(\frac{20'+12'}{2}\right) \times 26 = 416 \text{ ft}^2$

$416 \times 1.76 = 732^K$
$- \quad 240$
$492/2 = 246^K$



END MOMENTS (See pg. 4.) = 65.5
+Moment = - 65.5 + (9.5 x 8) - (9.5 x 4) = -65.5 + 76.0 - 38.0 = -27.5 'K/' BOT. WET COND
= -44.3 + 76.0 - 38.0 = - 6.3 'K/' BOT DRY COND.

V(face) = 9.5 - 1.19 x 1.0 = 8.31 K -M = 65.5 - 1/3 x 8.31 x 2.0 = 65.5 - 5.5 = 60.0 'K

WET AXIAL LOAD = 449K (see pg. 3) = 449/25 = 18 K/' + 5.53 = 23.53 K/'
DRY " " = .677 (449) = 304/25 = 12.15 + 3.74 = 15.89 K/'

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE
COMPUTATION BASE SLAB
COMPUTED BY JWF CHECKED BY BFW DATE 19 JUN 62
Revised 11 July 62

try 28" = t d = 28 - 4 - .57 = 23.4"

$-M_s = M + \frac{d''}{12}N = 60.0^{'k} + 9.4/12 \times 23.53^k = 60.0 + 18.4 = 78.4^{'k}$ $d = \sqrt{\frac{78.4}{.160}} = 22.1"$

$t = 22.1 + 4 + 1.13/2 = 26.67$ use 28"

$-A_s = \frac{12 M_s}{f_s j d} - \frac{N}{f_s} = \frac{12 \times 78.4}{20 \times j \times 23.4} - \frac{23.53}{20} = 2.27 - 1.18 = 1.09 \text{ in}^2$ #7 @ 6"

$A_s = 1.20$
$\Sigma_o = 5.5$

$\Sigma_o = \frac{V}{\mu j d} = \frac{8,310}{210 \times j \times 23.4} = 1.91$ in

$v = \frac{V}{bjd} = \frac{8,310}{12 \times j \times 23.4} = 33$ #/in² ok < 90

WET COND @ CENTER $-M = 27.5^{'k}$ $M_s = 27.5 + 18.4 = 45.9^{'k}$

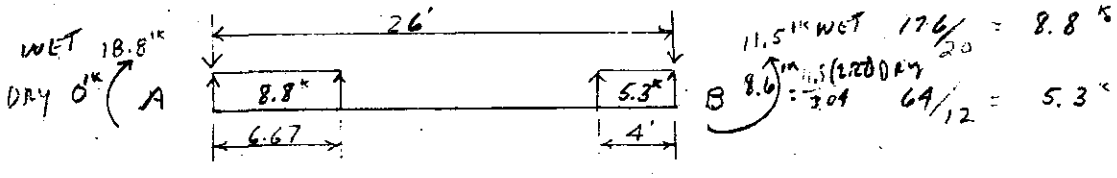
$A_s = \frac{45.9}{1.44(23.4)} - 1.18 = 1.36 - 1.18 = 0.18$ # USE MIN. A_s

DRY

This condition not governing

$+A_s$ Use min. steel

Temp. $A_s = .001 \times 12 \times 28 = 0.34 \text{ in}^2$ use #6 @ 12"



$\Sigma M_A = 0$ $18.8 - 11.5 - 5.3 \times 24 - 8.8 \times 3.33 + 26 V_B = 0$

$26 V_B = 11.5 + 127.2 + 29.3 - 18.8$

$V_B = 149.2/26 = 5.74^k$ $V_{B(face)} = 5.74 - 1.32 = 4.42^k$

$M_{B(face)} = 11.5 - \frac{1}{3} \times 4.42 \times 2.0 = 11.5 - 2.9 = 8.6^{'k}$

$V_A = 8.8 + 5.3 - 5.74 = 8.36^k$ $V_{A(face)} = 8.36 - 1.32 = 7.04^k$

$M_{A(face)} = 18.8 - \frac{1}{3} \times 7.04 \times 2.0 = 18.8 - 4.7 = 14.1^{'k}$

AXIAL LOAD - WALL C = 72.5k 72.5/12 = 6.05 d = 28-4-1-.5 =
WALL A = 123.0k 123/20 = 6.15 d = 22.5"

22.5 - 14.0 = 8.5

Pt A.

$-M_s = M + \frac{d''}{12}N = 14.1 + \frac{8.5}{12} \times 6.05 = 14.1 + 4.3 = 18.4^{'k}$ $d_{req'd} = \sqrt{\frac{18.4}{.160}} = 10.7$ ok

$-A_s = \frac{12 M_s}{f_s j d} - \frac{N}{f_s} = \frac{12 \times 18.4}{20 \times j \times 22.5} - \frac{6.05}{20} = 0.55 - 0.30 = 0.25 \text{ in}^2$ #6 @ 12" min

Pt. B.

$-M_s = 8.6 + \frac{8.5}{12} \times 6.05 = 8.6 + 4.3 = 12.9^{'k}$

$-A_s = \frac{12 \times 12.9}{20 \times j \times 22.5} - .30 = .39 - .30 = .09 \text{ in}^2$ use min steel #6 @ 12 min

$v = \frac{7040}{12 \times j \times 22.5} = 29$ #/in²

$\Sigma_o = \frac{7040}{210 \times j \times 22.5} = 1.68$ in

SUBJECT NORTHFIELD BROOK - INTAKE STRUCTURE

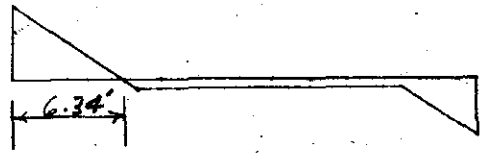
COMPUTATION BASE SLAB

COMPUTED BY JWF CHECKED BY BJW DATE 19 JUN 62

Pt. of zero Shear = $8.36 - \frac{8.8}{6.67} x = 0$ $\quad x = \frac{8.36 \times 6.67}{8.8} = 6.34'$

$+MOM = -18.8 + 8.36 \times 6.34 - \frac{8.8}{6.67} \times \frac{6.34^2}{2} =$

$-18.8 + 53.0 - 26.5 = 7.7^{'k}$



$+Ms = M + \frac{d''}{12} N = 7.7 + \frac{8.5}{12} \times 6.05 =$

$7.7 + 4.3 = 12.0^{'k}$

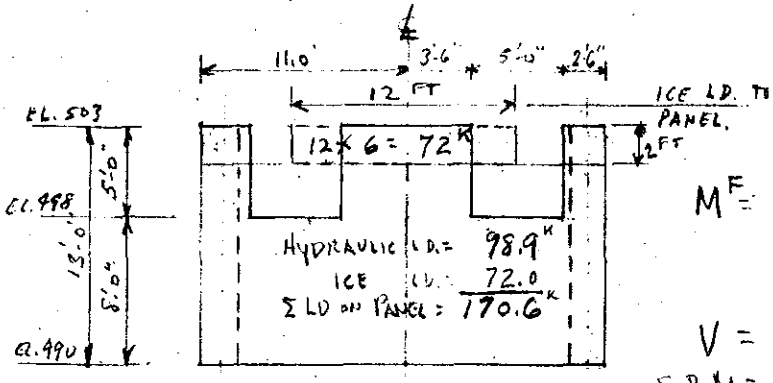
$+As = \frac{12 Ms}{fs\, jd} - \frac{N}{fs} = \frac{12 \times 12.0}{20 \times j \times 22.5} - .30 = 0.36 - 0.30 = \underline{0.06 in^2 \text{ use min. steel}}$

DRY COND. SLIGHTLY MORE SEVERE THAN WET COND.
SO USE #7 @ 12 TOP (ESTIMATE)

SUBJECT: NORTHFIELD BROOK DAM & LES.
COMPUTATION: OUTLETS WORKS - INTAKE STRUCTURES
COMPUTED BY: Cmt CHECKED BY: JWF DATE: 7/25/62

CASE II :- POOL TO EL. 503 WITH 2 FT ICE

TOP OF ICE @ EL. 503. ASSUME ICE IS EXERTING A PRESSURE OF 6 K/LF



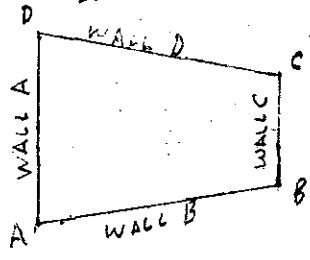
$M^F = 170.6(2.0)/12 = 284^{'K}$

$284/8 = 35.5^{'K}/'$

$V = 170.6/2 \times 8 = 10.7^{K}/'$

$SBM = 35.5 \times 1.5 = 53.3^{'K}$

Mom →



	A	WALL B	B	wall C	C	wall D	D	wall A	A
	.575	.302	.698	.698	.302	.575	.425	.425	
	-37.2	+37.2	-9.6	+9.6	-37.2	+37.2	-35.5	+35.5	
	+1.0	-5.3	-19.3	+19.3	+8.3	-1.0	-0.7	+0.7	
	-4.1	+0.5	+9.6	-9.6	-0.5	+4.1	+0.4	-0.4	
	+2.6	-3.0	-7.1	+7.1	+3.0	-2.6	-1.9	+1.9	
	-1.5	+1.3	+3.6	-3.6	-1.3	+1.5	+1.0	-1.0	
	+1.5	-1.5	-3.4	+3.4	+1.5	-1.5	-1.0	+1.0	
Final mom	-37.7	+26.2	-26.2	+26.2	-26.2	+37.7	-37.7	+37.7	
V	8.58	8.58	4.8	4.8	8.58	8.58	10.7	10.7	
ΔV	+0.44	-0.44	0	0	-0.44	+0.44	0	0	
ΣV	9.02	8.14	4.8	4.8	8.14	9.02	10.7	10.7	

M_{A-B} $-37.7 + 26.2 + 26B = 0$ $-26B = 11.5$ $B = -0.44$

WALL-A $V_{(face)} = 10.7 - 1.07 = 10.7 - 1.07 = 9.6^K$ $N = 14.7$ (...)

$-M_{(face)} = M - \frac{1}{3}VLa = 37.7 - \frac{1}{3}(9.6)(2) = 37.7 - 6.4 = 31.3^{'K}$

$-M_s = M + \frac{d''}{12}N = 31.3 + \frac{8.5}{12} \times 14.7 = 31.3 + 10.4 = 41.7^{'K}$ $d = \sqrt{\frac{41.0}{.160}} = 16.0$ OK

$-A_s = \frac{12 M_s}{f_s j d} - \frac{N}{f_s} = \frac{12 \times 41.7}{20 \times j \times 20.5} - \frac{14.7}{20} = 1.38 - 0.74 = 0.64 \text{ in}^2$

$v = \frac{9600}{12 \times j \times 20.5} = 44$ PSI OK $\Sigma_o = \frac{9600}{210 \times j \times 20.5} = 2.5''$

use #8 @ 12" $A_s = 0.79 \text{ in}^2$ $\Sigma_o = 3.1$ in

$+M = SBM - END\ MOM. = 53.3 - 37.7 = 15.6^{'K}$

$+M_s = 15.6 + \frac{8.5}{12}(14.7) = 15.6 + 10.4 = 26.0^{'K}$

$+A_s = \frac{26.0 \times 12}{20 \times j \times 20.5} - 0.74 = 0.86 - 0.74 = .12 \text{ in}^2$ use 5 @ 12" $A_s = .31 \text{ in}^2$ Temp.

SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION OUTLET WORKS - INTAKE STRUCTURE
COMPUTED BY JWF CHECKED BY Cmt DATE

CASE II Cont'd WALL B & D @ 503 TO 489
Pt A & D

$V_{(face)} = 9.02 - \frac{8.58}{13}(1) = 9.02 - 0.66 = 8.36^k$

$-M_{(face)} = 37.7 - \frac{1}{3}(8.36)(2) = 37.7 - 5.6 = 32.1'^k$

$-M_s = 32.1 + \frac{8.5}{12}(N)$

$-M_s = 32.1 + \frac{8.5}{12}(5.15)$

$-M_s = 32.1 + 3.7 = 35.8'^k$

$-A_s = \frac{12 \times 35.8}{20 \times j \times 20.5} - \frac{5.15}{2.0} =$

$-A_s = 1.19 - .26 = .93 \text{ in}^2$

$\Sigma o = \frac{8360}{210 \times j \times 20.5} = 2.2$

use * 8 @ 9" $A_s = 1.05$ $\Sigma o = 4.2$

AXIAL LOAD
water $(.87^k)(14')(\frac{14'}{2}) = 85.3^k$
Sub earth $(.63^k)(15.67')(14/2) = 69.0^k$
Load on wall C (14') to El. 489 144.3
$N = \frac{144.3}{2} \times \frac{1}{14} = 5.15^{k/1}$

$v = \frac{8360}{12 \times j \times 20.5} = 38 \text{ PSI}$ ok

for $-A_s$ @ pt B & C See sheet 17 Case I governs

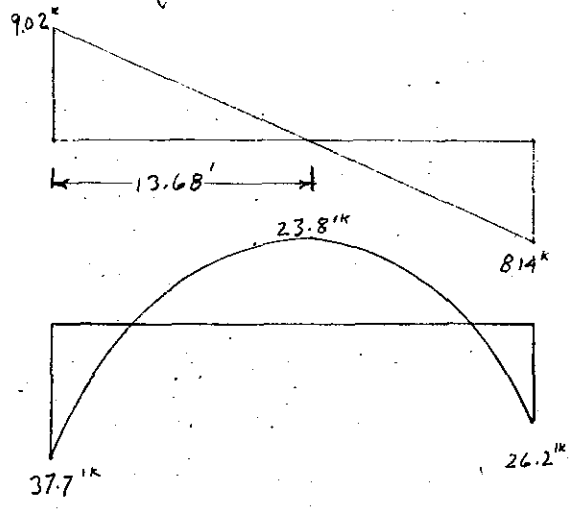
+Moment

$9.02/.66 = 13.68'$

$+M = -37.7 + 9.02 \times 13.68 - 9.02 \times \frac{13.68}{2} =$

$-37.7 + 123 = 61.5 = 23.8'^k$

+As See sheet 17 Case I governs



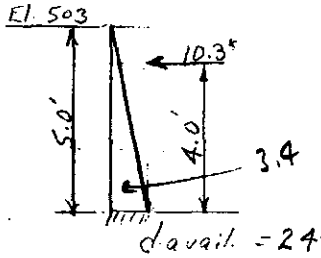
SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION OUTLET WORKS - INTAKE STRUCTURE
COMPUTED BY JWF CHECKED BY Cmt DATE 26 July 62

WALL A CANT. SECTION - (MIDDLE)

ICE LOAD = $72^k/7 = 10.3^k$

H_2O LOAD $= 0.188 \times 12 \times 3/2 = 3.4^k/7 = 0.5^k$

$V = 10.8^k$



$N = 2(5).15 + 3.93/7 + .15(2.0)1.0 = 1.54 + .56 + .3 = 2.36^{k/'}$

$M = 10.3 \times 4 + 0.5 \times 1 = 41.2 + 0.5 = 41.7^{'k/'}$

$M_s = 41.7 + \frac{8}{12}(2.36) = 41.7 + 1.6 = 43.3^{'k}$

$d_{req'd} = \sqrt{\frac{41.7}{.160}} = 16.2$ in ok

$d_{avail} = 24 - 3 - 1 - .5 = 19.5''$

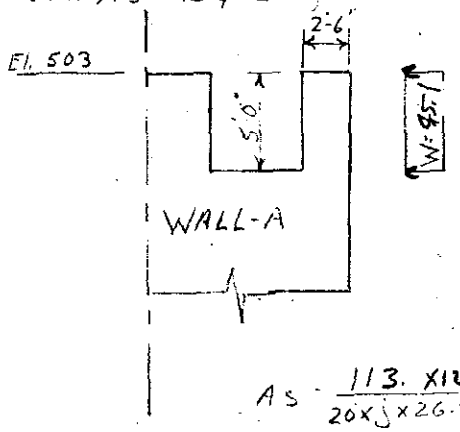
$A_s = \frac{43.3 \times 12}{20 \times j \times 19.5} - \frac{2.36}{20} = 1.42$ use #8 @ 6" $A_s = 1.58$ $\Sigma_o = 6.3$ in

$\Sigma_o = \frac{10,800}{210 \times j \times 19.5} = 3.04$ in

$v = \frac{10,800}{12 \times j \times 19.5} = 53$ PSI ok

CANT. SECTION (END)

Cantilever end sections of wall A must support walls B & D for 5' height. (NO ICE LOAD)



(see sh #25)

$W = 9.02 \times 5 = 45.1^k$

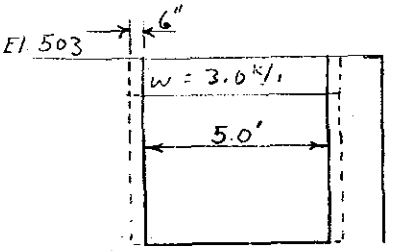
$M = 45.1 \times 2.5 = 113^{'k}$

$d\text{-}req'd = \sqrt{\frac{113(12)}{.160(24-6)}} = 21.7''$ ok

$d\text{-}avail = 30 - 3 - .5 = 26.5''$

$A_s = \frac{113 \times 12}{20 \times j \times 26.5} = 3.0^{\square}$ use 3-#9 OF & 3-#5 IF

Stop Logs (WATER ONLY, NO ICE)



$M = \frac{wl^2}{8} = .31 \times \frac{5^2}{8} = 1.0^{'k}$ $V = .31 \times 5/2 = 0.8^{'k}$

try 4"x4" Beam $w = .0625(5) = .31^{k/\square}$

$f = M/S = \frac{8}{12}\left(\frac{800 \times 12}{7.94}\right) = 400$ PSI < 1200 ok

Bearing $\frac{800}{12 \times 6} = 111$ PSI ok

Shear Hor. Shear $= 3/2 \, V/bd = 3/2 \times \frac{800}{13.1}\left(\frac{4}{12}\right) = 31$ PSI too light

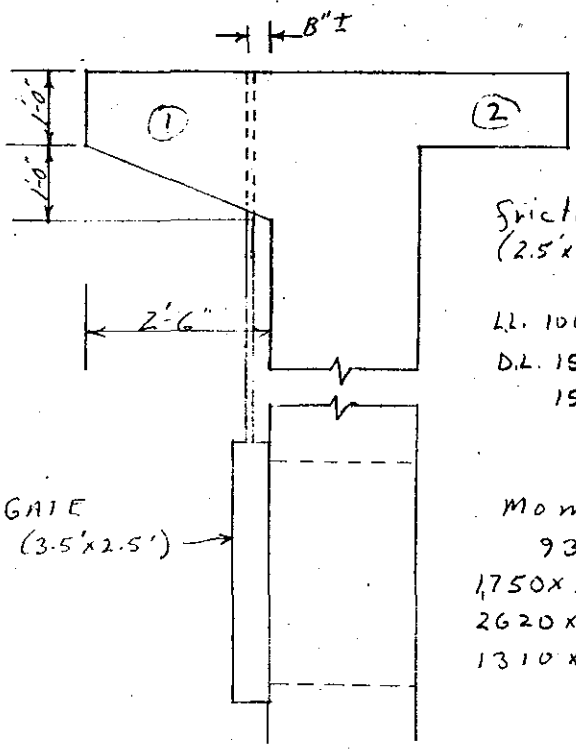
USE 6"x6" TIMBER STOP-LOGS

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT NORTHFIELD BROOK DAM & RES.
COMPUTATION OUTLET WORKS - INTAKE STRUCTURE
COMPUTED BY JWF CHECKED BY Cmt DATE 27 July 62

GATE HOIST SUPPORT



① wt of Gate 1930 lb
wt of misc Gear 500 lb
Friction force =
$(2.5' \times 3.5')(21')(62.5\ lb/ft^3)(.6) = 6900$ lb
9,330 lb
L.L. $100 \times 7 \times 2.5 =$ 1,750
D.L. $150 \times 2.5 \times 1.0 \times 7.0 =$ 2,620
$150 \times 2.5 \times 1.0/2 \times 7.0 =$ 1,310
$V = \frac{15,010}{7} = 2,150$ #/'

Mom
$9330 \times 8/12 =$ 6220
$1,750 \times 2.5/2 =$ 2180
$2620 \times 2.5/2 =$ 3280
$1310 \times 2.5/3 =$ 1090
$\frac{12770}{7} = 1,830$ '#/'

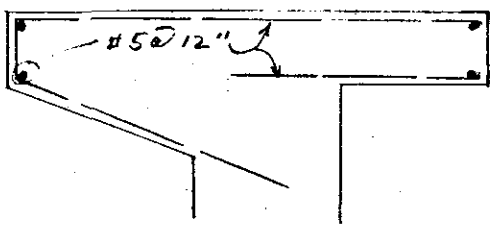
$d = \sqrt{\frac{M}{Kb}} = \sqrt{\frac{1,830}{.160}} = 3.4$ in ok have $24 - 3.5 = 20.5$

$A_s = \frac{1,830}{20 \times j \times 20.5} = .005\ in^2$ use temp. steel #5@12

$v = \frac{2,150}{12 \times j \times 20.5} = 10$ PSI. ok

② DL + LL = 250 PSF
$V = 250 \times 2 = 500$ lb/'
$M = 500 \times 1 = 500$ '#/'

$A_s = \frac{.500}{20 \times j \times 8.5} = .003$ use temp steel

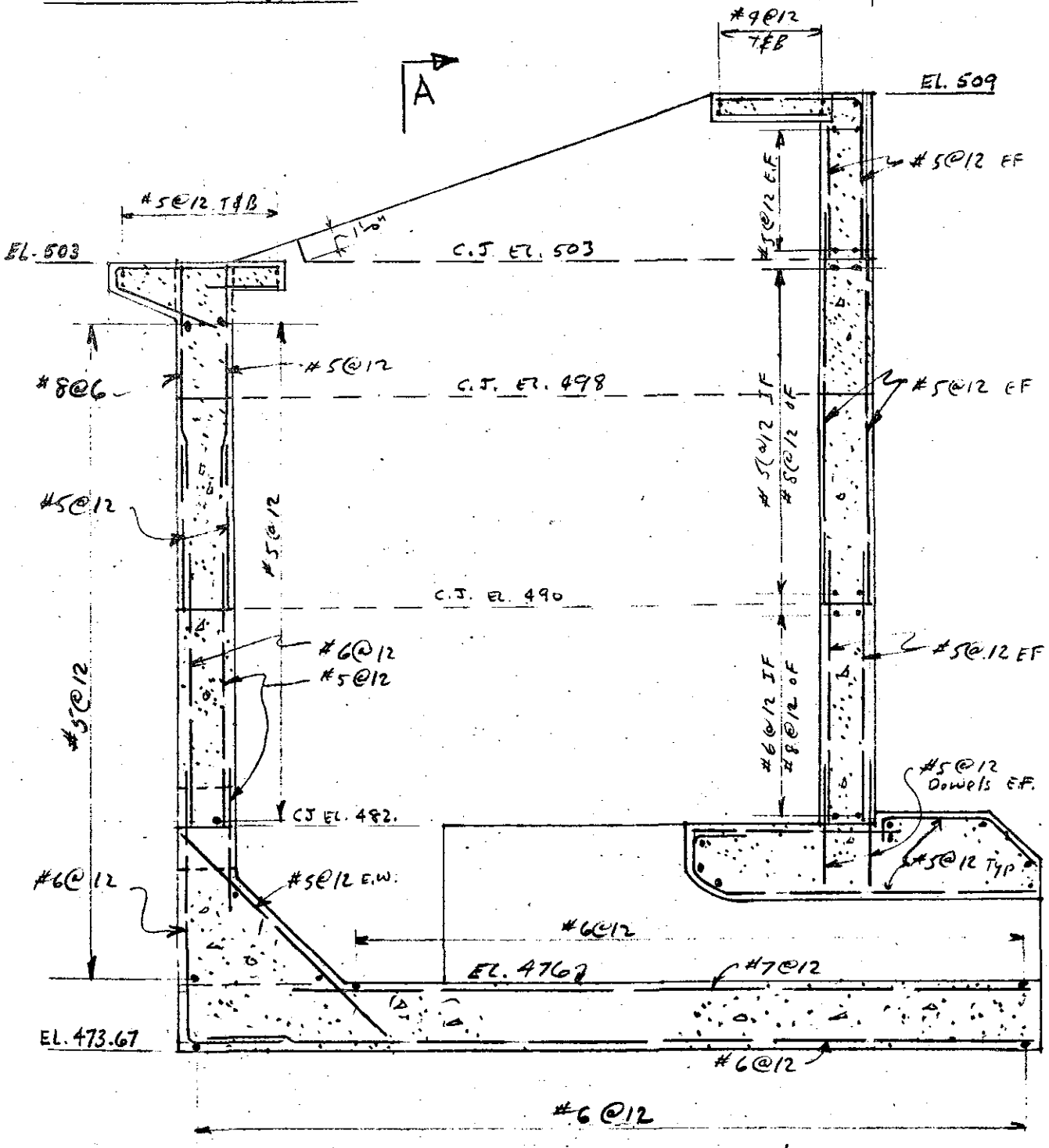


NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT: NORTHFIELD BROOK DAM & RES.
COMPUTATION: INTAKE STRUCTURE –
COMPUTED BY: Cmt CHECKED BY: JWF DATE: 7/31/62

SKETCH OF REINF: –



A

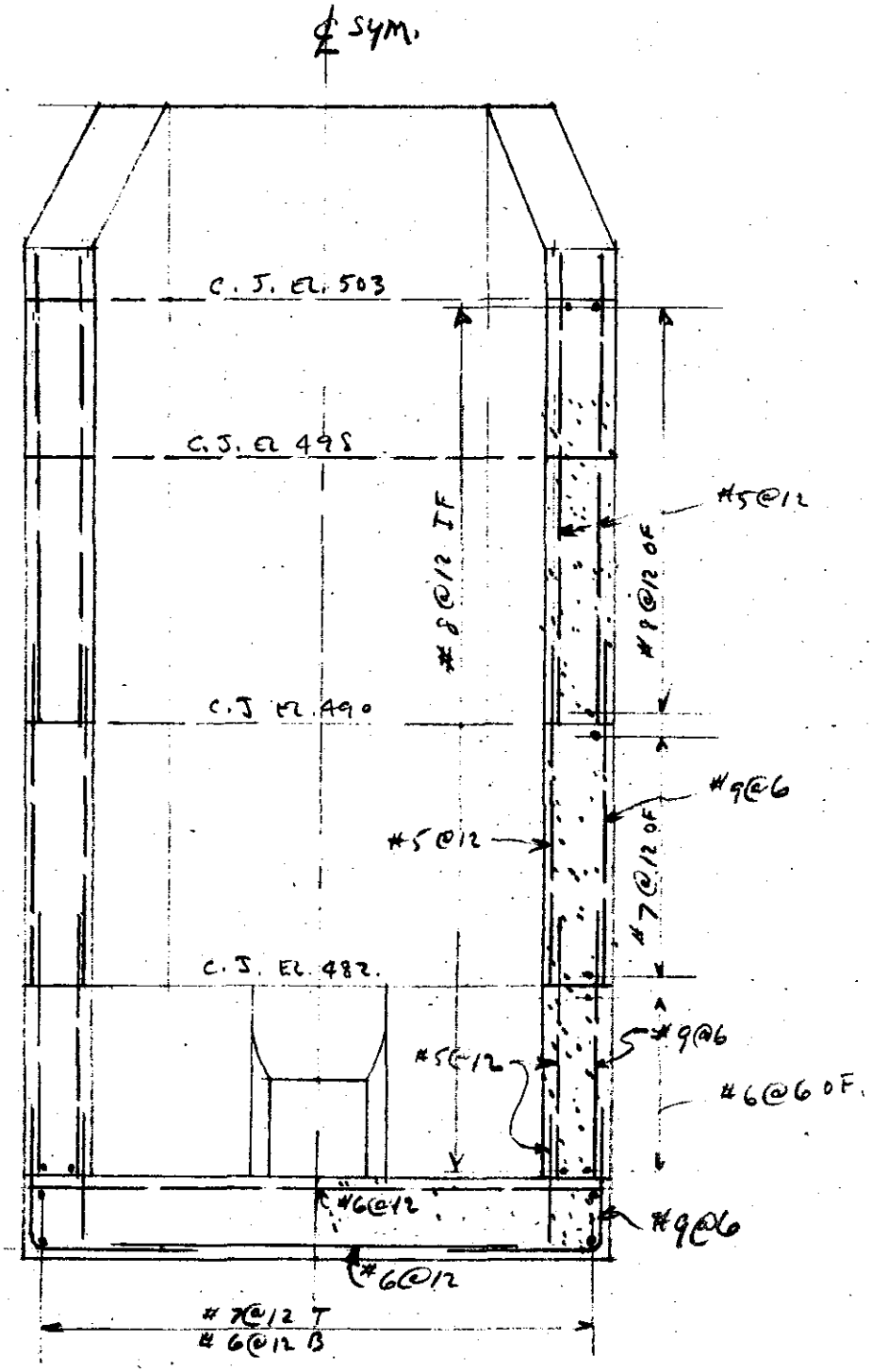
VERT. SEC. NEAR ℄ STRUCT.
SCALE: 3/16" = 1'-0"

SEE NEXT PAGE

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT: NORTHFIELD BROOK DAM & RES.
COMPUTATION: INTAKE STRUCTURE
COMPUTED BY: CMT CHECKED BY: JWF DATE: 7/31/62

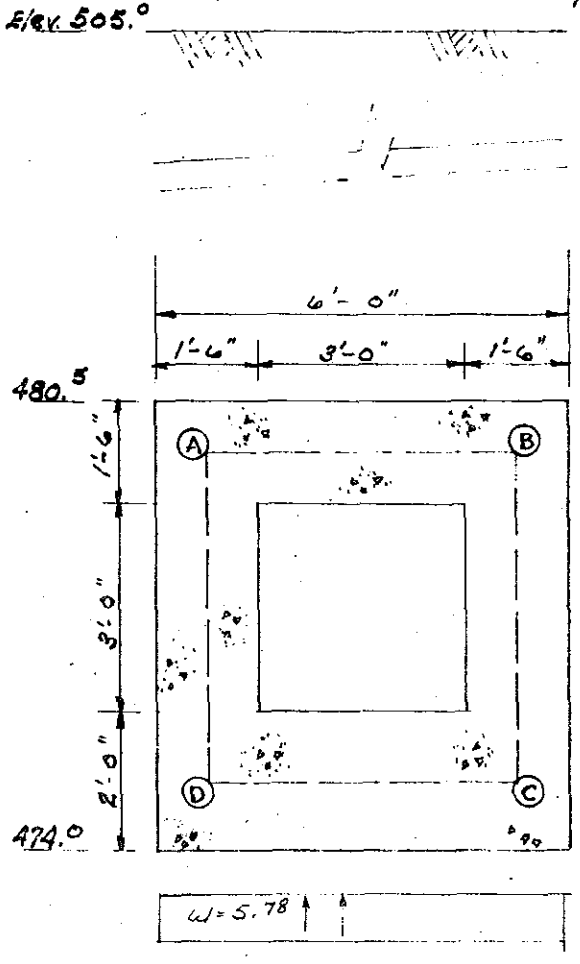


SEC. A-A
SCALE: 3/16" = 1'-0"

SUBJECT Northfield Brook ~ Intake Structure
COMPUTATION Conduit ~ Transition @ Sta. 3+03.5
COMPUTED BY R.A.K. CHECKED BY JWF DATE July 1962

Case I

Rapid Drawdown:- with earth above conduit saturated.



Loading:

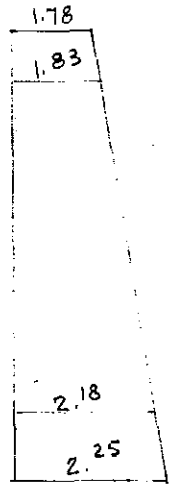
Earth $\gamma_{dry} = 130$ lbs/cf
$\gamma_{moist} = 140$ lbs/cf
$\gamma_{sat.} = 145$ lbs/cf
$\gamma_{sub.} = 82.5$ lbs/cf

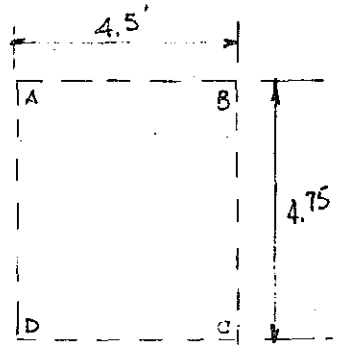
Use

1.5 x Vertical loading = Vert press
0.5 x " " = Hor. press

Water = 62.5#/cf

Conc. = 150 lbs/cf





Roof Loading $= 24.5' \times 1.5 \times .145 + 1.5 \times .150 = 5.55$.
Horizontal " $= 24.5 \times 0.5 \times .145 = 1.78$.
$= 25.25 \times 0.5 \times .145 = 1.83$.
$= 30.0$ " " $= 2.18$.
$= 31.0$ " " $= 2.25$.

Slab loading $= 5.55 + 2 \times 3.0 \times \frac{.150}{6} \times 1.5 = 5.78$.

$F.E.M_{AB} = 5.55 \times \frac{4.5^2}{12} = 9.37^{k'}$.

$F.E.M._{D-C} = 5.78 \times \frac{4.5^2}{12} = 9.75^{k'}$.

$F.E.M._{B-C} = \frac{L^2}{60}(2w_1 + 3w_2) = \frac{4.75^2}{60}(2 \times 2.18 + 3 \times 1.83) = 3.70^{k'}$. (9.85)

$F.E.M_{C-B} = \frac{L^2}{60}(3w_1 + 2w_2) = \frac{4.75^2}{60}(3 \times 2.18 + 2 \times 1.83) = 3.84^{k'}$. (10.2)

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT Northfield Brook ~ Intake Structure
COMPUTATION Conduit @ Transition, Sta. 3+03.5
COMPUTED BY R.A.K. CHECKED BY JWF DATE July 1962

Rel. "K" = $\frac{I}{L} = \frac{bh^3}{12}$ where $\frac{b}{12}$ = Constant ∴ $K = \frac{h^3}{L}$

Stiffness Factors

Roof A-B = $\frac{1.5^3}{4.5}$ = .75

Wall B-C = $\frac{1.5^3}{4.75}$ = .71

Slab C-D = $\frac{2.0^3}{4.5}$ = 1.78

AB = .75/1.75 + .71 = .514
BC = .71/1.46 = .486
CB = 1.78/.71 + 1.78 = .715
CD = .71/1.249 = .285

	(A)		(B)		(C)		(D)	(A)
K	.75		.71		1.78		.71	
K/ΣK	.514	.514	.486	.285	.715	.715	.285	.486
FEM	-9.37	+9.37	-3.70	+3.84	-9.75	+9.75	-3.84	+3.70
1st Dist	+2.91	-2.91	-2.76	+1.68	+4.23	-4.23	-1.68	+2.76
C.O.	-1.46	+1.46	+0.8	-1.38	-2.11	+2.11	+1.38	-0.84
2nd Dist	+1.16	-1.16	-1.10	+0.99	+2.49	-2.49	-0.99	+1.10
Co	-0.58	+0.58	+0.50	-0.55	-1.25	+1.25	+0.55	-0.50
3rd Dist	+0.55	-0.55	-0.53	+0.51	+1.29	-1.29	-0.51	+0.53
M	-6.79	+6.79	-6.79	+5.09	-5.10	+5.10	-5.09	+6.79
+M	+7.26		—		+9.53		—	
V.	12.49	12.49	4.24	5.24	13.00	13.00	5.24	4.24

$+M_{A-B} = 2.25 \times 12.49 - 6.79 - 5.55 \times 2.25^2/2 = 28.10 - 6.79 - 14.05 = 7.26$

$+M_{C-D} = 2.25 \times 13.00 - 5.09 - 5.78 \times 2.25^2/2 = 29.25 - 5.09 - 14.63 = 9.53$

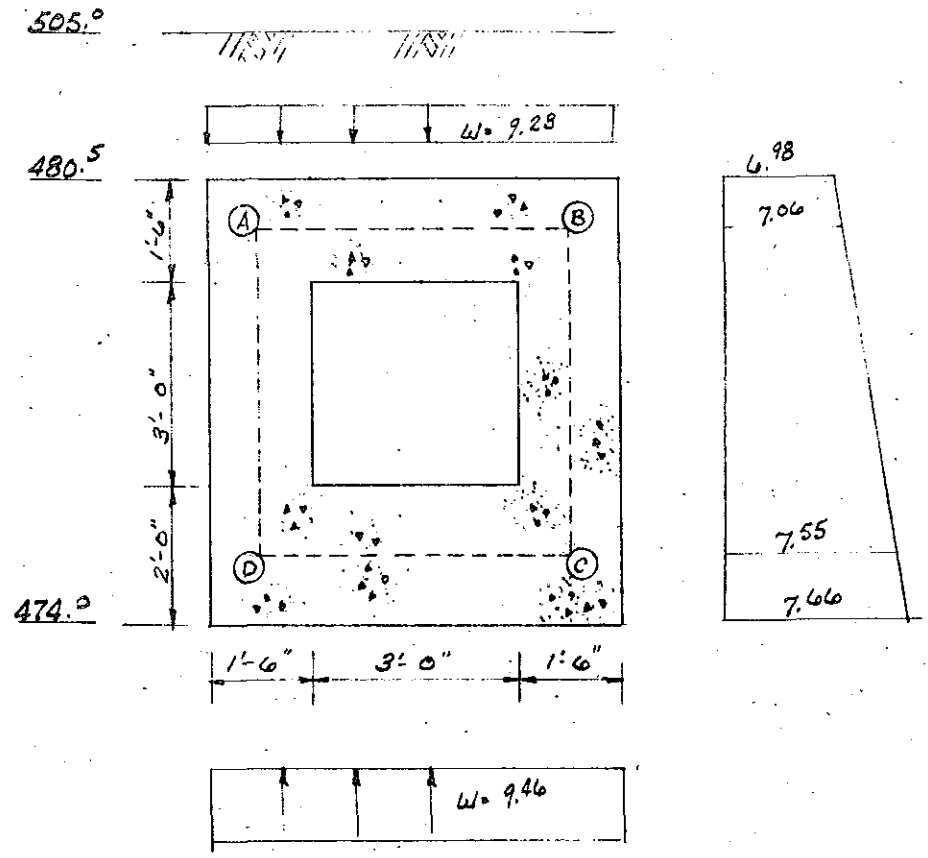
V @ Wall B-C @ B $= 1.83 \times 4.75/2 + .35 \times 4.75 \times \frac{1}{2} \times \frac{1}{3} - (6.79 - 5.09/4.75) = 4.32 + 0.28 - .36 = 4.24$
V @ C $= 4.32 + 0.56 - .36 = 5.24$

Point of zero shear: $4.24 - 1.83(x) - (.074)(x)^2/2 = \quad x = 2.3'$

$4.24 \times 2.3 - 6.79 - 1.83 \times 2.3 \times \frac{2.3}{2} - .074 \times 2.3 \times \frac{2.3}{2} \times \frac{1}{3} = 9.75 - 6.79 - 4.84 - .07 = -1.95$

SUBJECT Northfield Brook ~ Intake Structure
COMPUTATION Conduit Section @ Transition, Sta. 3+03.5
COMPUTED BY R.A.K. CHECKED BY JWF DATE July 1962

Case II. –
Water to spillway crest, elevation 576.°, design using normal stresses. This condition using normal stresses would govern over maxim surcharge with water @ elev. 586.° but using increased stresses.



Roof Loading = $95.5 \times .0625 + 24.5 \times 1.5 \times .0825 + 1.5 \times .150 = 5.97 + 3.03 + .23 = 9.23^{k/'}$
Slab Loading = $9.23^{k/'} + \frac{2 \times 3.0 \times .15 \times 1.5}{6} = 9.46$.

Horizontal = $95.5 \times .0625 + 24.5 \times 0.5 \times .0825 = 5.97 + 1.01 = 6.98$.
$96.25 \times .0625 + 25.25 \times 0.5 \times .0825 = 6.02 + 1.04 = 7.06$.
$101.0 \times$ " $+ 30.0$ " " $= 6.31 + 1.24 = 7.55$.
$102.0 \times$ " $+ 31.0$ " " $= 6.38 + 1.28 = 7.66$.

SUBJECT Northfield Brook ~ Intake Structure

COMPUTATION Conduit Section @ Transition, Sta 3+03.5

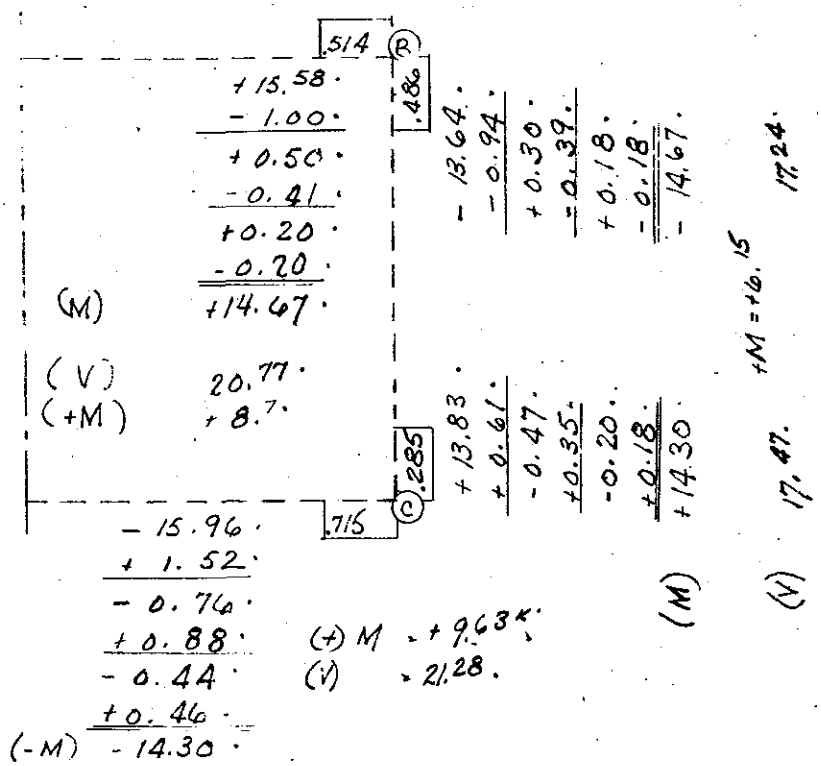
COMPUTED BY R.A.K. CHECKED BY JWF DATE July 1962

$F.E.M._{AB} = 9.23 \times \frac{4.5^2}{12} = 15.58$

$F.E.M._{D-C} = 9.46 \times \frac{4.5^2}{12} = 15.96$

$F.E.M._{B-C} = \frac{4.75^2}{60}(2 \times 7.55 + 3 \times 7.06) = .376\,(36.28) = 13.64$

$F.E.M._{C-B} = \frac{4.75^2}{60}(3 \times 7.55 + 2 \times 7.06) = .376\,(36.77) = 13.83$



$(+)M_{mom\ ab} = 20.77 \times \frac{4.5}{2} - 14.67 - 9.23 \times \frac{2.25^2}{2} = 46.73 - 14.67 - 23.36 = +8.7$

$(+)M_{CD} = 21.28 \times 2.25 - 14.30 - 9.46 \times \frac{2.25^2}{2} = 47.88 - 14.30 - 23.95 = +9.63$

Shear B-C @ B $= 7.06 \times \frac{4.75}{2} + 0.49 \times \frac{4.75}{2} \times \frac{1}{3} + \frac{14.67 - 14.30}{4.75} = 16.77 + .39 + .08 = 17.24$

@ C $= 16.77 + .78 - .08 = 17.47$

Point of zero shear $= 17.24 - 7.06(x) - (0.1)(x)\frac{(x)}{2}$ $\therefore x = 2.4'$

$+M = 17.24 \times 2.4 - 14.67 - 7.06 \times \frac{2.4^2}{2} - 0.1 \times 2.4 \times \frac{2.4}{2} \times \frac{2.4}{3} = 41.38 - 14.67 - 20.33 - 0.23 = +6.15$

SUBJECT Northfield Brook ~ Intake Structure
COMPUTATION Conduit Section @ Transition, Sta. 34 03.5
COMPUTED BY R. A. K. CHECKED BY Cmt. DATE July 1962

Member Design: -

1.) Member A-B "Roof" = 1.) Reduce -M to face of support
$14.67 - \frac{1}{3} \times 17.31 \times 1.5 = 14.67 - 8.65 = 6.02^k$

$-M_s = 6.02 + \frac{4.5}{12}(17.24 + 0.75 \times 7.02) = 6.02 + 8.44 = 14.46$ (22.50)

$-A_s = \frac{14.46}{1.44 \times 13.5} - \frac{22.5}{20.0} = 0.74 - 1.12$ ∴ No steel req'd. ✓

temperature Steel = $.0025 \times 12 \times 18 \times \frac{1}{2} = 0.27^{in^2}$.

$v = \frac{20.77 - 0.75 \times 9.23}{12 \times j \times 13.5} = 96.6$ $\quad \Sigma_o = \frac{13.85}{210 \times j \times 13.5} = 5.5^{in^2}$

$d = \sqrt{\frac{14.46}{.160}} = 9.5^{in} < 13.5$ ∴ Use #6@5, $A_s = 1.06$, $\Sigma_o = 5.7$

Check shear using Univ. of Ill. "Dev. of Design crit. for Reinf. Conc. Box Culverts" pg. 39 EQ # 42

point of Inflection = $20.77(x) - 9.23\frac{(x)^2}{2} - 14.67$ $\quad x = .88'$

$V_{pc} = 20.77 - 9.23 \times 0.88 = 12.65^k$
$N/V = 22.50 / 12.65 = 1.78$
$12\% \left[4.5 - \frac{(2)(0.88)}{13.5^{in}} \right] = 2.436 = l'/d$

$$v_{pc} = \frac{V_{pc}}{\frac{7}{8}bd} = \frac{11{,}000\,(.046 + p)\,(12 + N/V)}{(19 + l'/d)} \sqrt{\frac{f'_c}{4000\,psi}}$$

Normal unit shearing stress = $\frac{12{,}650}{\frac{7}{8} \times 12 \times 13.5} = 89.4\ \#/in^2$

Service Load = $V_{pc} = \frac{\frac{7}{8} \times 12 \times 13.5 \times 11{,}000\,(.046 + \frac{1.06}{12 \times 13.5})}{(19 + 2.436)}(12 + 1.78)\sqrt{\frac{3{,}000}{4{,}000}}$ (.052)

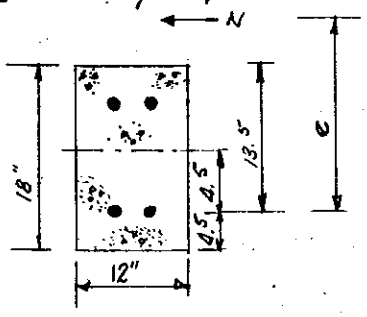
$= 45.08^k$

Safety factor = $\frac{45.08^k}{12.65^k} = 3.56 > 2.0$ ∴ ok

SUBJECT Northfield Brook ~ Intake Structure
COMPUTATION Conduit Section @ Transition, Sta. 3+03.5
COMPUTED BY R.A.K. CHECKED BY Cmt DATE Aug. 1962

Member Design:- (Check actual stresses in section using axial load; then checking bond requirements using "Dunham's "Theory + Pract. of Reinf Conc." pg. 130

1. Section @ face of support =



$M = 6.02$ $\quad f_s = 20{,}000$
$N = 22.50$ $\quad f_c = 1050$
$V = 17.31$ $\quad n = 10$
$t = 18''$ $\quad k = 160$
$d = 13.5$

1.) $e = 12 \times \frac{6.02}{22.50} + 4.5 = 7.71''$

2.) Assume #6 @ 12 for $A_s = (0.44)(10) = 4.40 \text{ in}^2$
#5 @ 12 for $A_s' = (0.31)(9) = 2.79 \text{ in}^2$

3.) $C_c = kd \times 12 \times \frac{1}{2} \times f_c = 6 f_c kd$

$T_s' = (n-1)(A_s')(f_c)\left(\frac{kd-4.5}{kd}\right) = 2.79 f_c \left(\frac{kd-4.5}{kd}\right)$

$T_s = (n)(A_s)(f_c)\left(\frac{d-kd}{kd}\right) = 4.40 f_c \left(\frac{13.5-kd}{kd}\right)$

Mome N =

$$\frac{kd}{f_c}\left[(6 f_c kd)\left(\frac{kd}{3} - 5.79\right) - 1.29 \times 2.79 f_c \left(\frac{kd-4.5}{kd}\right) - 7.71 \times 4.40 f_c \left(\frac{13.5-kd}{kd}\right)\right]$$

$\therefore kd = 17.26''$

$\Sigma H = 0$

$$\therefore 22{,}500^{\#} = 6(f_c)(17.26) + (2.79)(f_c)\left(\frac{17.26-4.5}{17.26}\right) - (4.40)(f_c)\left(\frac{13.5-17.26}{17.26}\right)$$

$\therefore f_c = 211.1 \ \#/\text{in}^2$

$f_s = 10 \times 211.1 \times \left(\frac{13.5-17.26}{17.26}\right) = -464.4 \ \#/\text{in}^2$

$f_s' = 10 \times 211.1 \times \left(\frac{17.26-4.5}{17.26}\right) = 1500 \ \#/\text{in}^2$

Note :- Because there is a compressive force over the entire face and compressive forces are so low, there will be no bond requirements.

Conclusion Use #6 @ 12 outside
#5 @ 12 Inside

SUBJECT Northfield Brook ~ Intake Structure
COMPUTATION Conduit Section @ Transition, Sta. 9+03.5
COMPUTED BY R.A.K CHECKED BY Cmt DATE July 1962

2.) Member C-D (SLAB)

1.) Reduce -M to face of support

$14.30 - 1/3 \times 17.73 \times 1.5 = 14.30 - 8.86 = 5.44^{ft\,k}$

$-M_s = 5.44 + \frac{7.5}{12}(17.47 + 1.0 \times 7.605) = 5.44 + 15.67 = 21.11$

$-A_s = \frac{21.11}{1.44 \times 17.5} - \frac{25.07}{20} = 0.84 - 1.2$ ∴ No steel req'd

$v = \frac{21.28 - .75 \times 9.46}{12 \times j \times 17.5} = 76.^{\circ}$ $\Sigma o = \frac{14.19}{210 \times j \times 17.5} = 4.4^{in^2}$

temp. steel = $.0025 \times 12 \times 24 \times 1/2 = 0.36^{in}$

3) Member B-C -

1.) Reduce -Moment to face of support

$14.67 - 1/3 \times 14.58 \times 1.5 = 7.38^{ft\,k}$ (27.69)

$M_s = 7.38 + \frac{4.5}{12}(20.77 + .75 \times 9.23) = 7.38 + 10.38 = 17.76$

$-A_s = \frac{17.76}{1.44 \times 13.5} - \frac{27.69}{20.0} = 0.91 - 1.38$ ∴ No tension steel req'd.

$v = \frac{17.24 - .75 \times 7.02}{12 \times j \times 13.5} = 84.^{\circ}\,^{psi}$ $\Sigma o = \frac{11.98}{210 \times j \times 13.5} = 5.2^{in^2}$

Member C-B

1.) Reduce - Moment to face of support

$+14.30 - 1/3 \times 14.68 \times 2.0 = 4.51$

$M_s = 4.51 + \frac{4.5}{12}(21.28 + 1.0 \times 7.60) = 4.51 + 10.83 = 15.34$

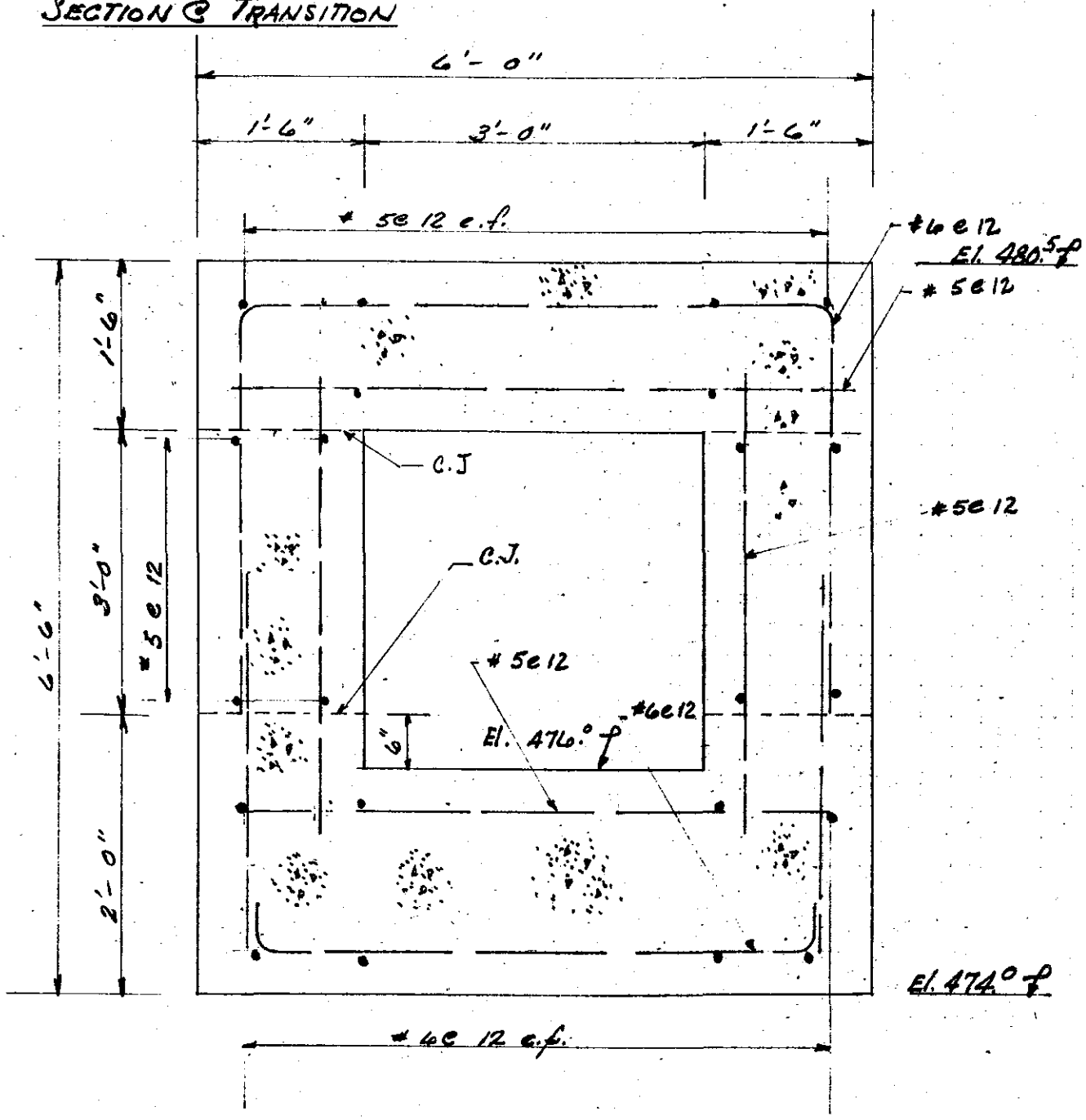
$-A_s = \frac{15.34}{1.44 \times 13.5} - \frac{28.88}{20.0} = 0.79 - 1.44$ ∴ No tension steel req'd.

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

SUBJECT NORTHFIELD BROOK ~ INTAKE STRUCTURE
COMPUTATION CONDUIT SECTION @ TRANSITION, STA. 3+03.5
COMPUTED BY R.A.K. CHECKED BY Cmt DATE AUG 1962

SECTION @ TRANSITION



SCALE 3/4" = 1'-0"

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT NORTHFIELD BROOK DAM & RES.

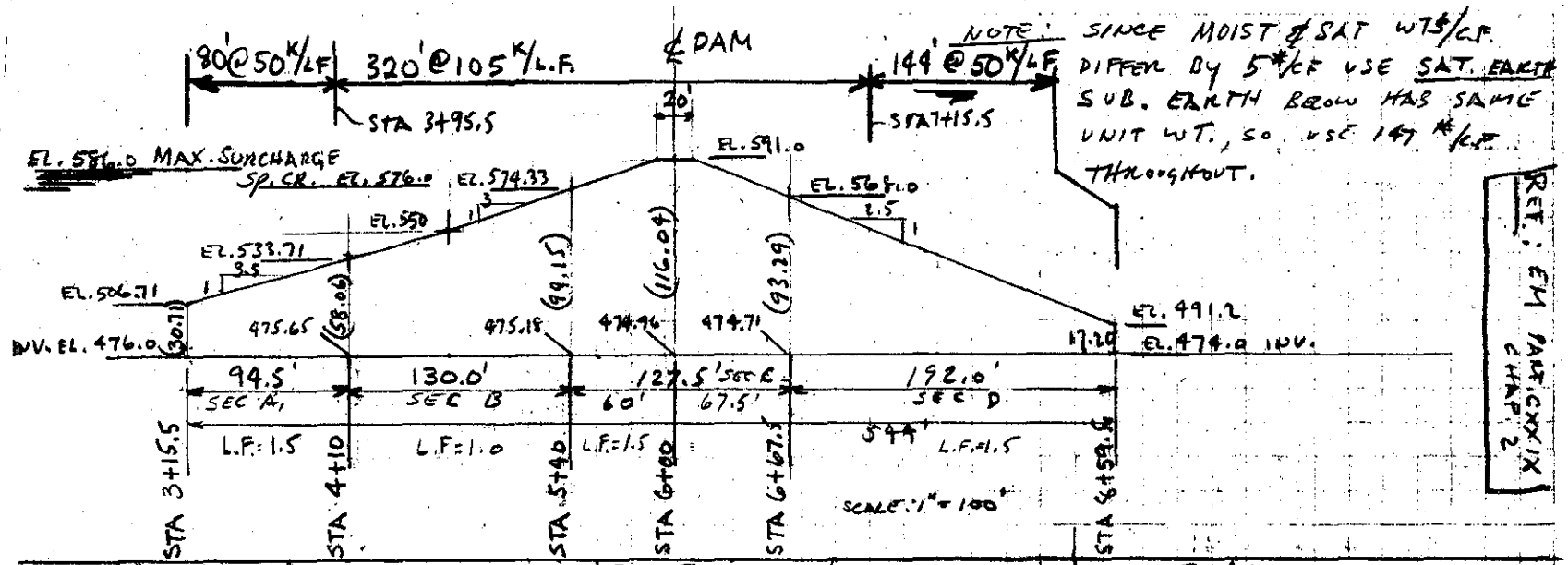
COMPUTATION LOAD ON PRE-CAST CONCRETE PIPE

COMPUTED BY [illegible] CHECKED BY _____ DATE 7/20/62

PAGE 39

RET.: EM PART. CXXIX CHAP. 2

NOTE: SINCE MOIST & SAT WTS/CF. DIFFER BY 5#/CF USE SAT. EARTH SUB. EARTH BELOW HAS SAME UNIT WT., SO USE 147 #/CF THROUGHOUT.



STA.	3+15.5		STA 4+10		STA 5+40	
INV. EL.		= 475.65		= 475.65		= 475.65
b_d		= 9.0		= 9.0		= 9.0
b_c		= 5.0		= 5.0		= 5.0
H_c	506.71 − 476. − 4.0	= 26.71	533.71 − 475.65 − 4.0	= 54.06	574.33 − 475.18 − 4.0	= 95.15
H_f	506.71 − 488	= 18.71	533.71 − 486	= 47.71		= 95.15
We_{II}	.147(5) 26.71 + 18.71/26.71 (9.8) (19.6) (6.9)	= 26.5	.147(5) 54.06 + 47.71/54.06 (20.1) (40.2) (.88)	= 57.9	.147(5) 95.15 (1.5)	= 105.0
We_{III}	1.5 (19.6)	= 29.4	1.5 (40.2)	= 60.3		
		2 $\boxed{55.9}$		= 2 $\boxed{118.2}$		
ΣWe		27.9 K/LF		= 59.1 K/LF		= 105 K/LF
	POOL @ 500 LD	= 27.9	POOL @ 500 LD.	= 59.1	POOL @ 500 LD	= 105
	POOL @ 576 .0625(576 − 506) + 27.9 (70) (4.4)	= 32.3 K/LF	POOL @ 576 .0625(576 − 534) + 59.1 (42) (2.6)	= 61.7	POOL @ 576 .0625(576 − 574) + 105 (.1)	= 105.1
	POOL @ 586 32.3 + .6	= 32.9 K/LF	POOL @ 586 61.7 + .6	= 62.3 K/LF	POOL @ 586 105.1 + .6	= 105.7 K/LF

NED FORM 223
27 Sept 49

NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U.S. ARMY

SUBJECT: NORTHFIELD BROOK DAM & RES.
COMPUTATION: LOAD ON PRECAST CONCRETE PIPE
COMPUTED BY: Gant
CHECKED BY:
DATE: 7/25/62
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STA.	6+00		6+67.5		8+59.5	
INV. EL.		= 474.96		= 474.71		= 474.0
b_d		= 9.0		= 9.0		= 7.0
b_c		= 5.0		= 5.0		= 5.0
H_c	591 − 474.96 − 4.0	= 112.04	568 − 474.71 − 4.0	= 89.29	491.2 − 474 − 4.0	= 13.2
H_f	591 − 510	= 81.0	568 − 504	= 64.00	491.2 − 991.0	= 0.
$W_{e\,II}$	$.147(5)\underset{82.4}{112.04} + \frac{81}{112}(\underset{29.8}{41.2})$	= 112.2	$.147(5)\underset{65.5}{89.29} + \frac{64}{89}(\underset{23.5}{32.7})$	= 89.0	$.147(5)13.2$	= 9.7
$W_{e\,III}$	123.5	= 123.5	1.5(65.5)	= 98.2		
		2 | 235.7		2 | 187.2		
ΣW_e		= 117.8 K/L.F.		= 93.6 K/L.F.		= 9.7 K/L.F.

POOL @ 500 LD = 117.8
SAME TO 586

859.5	93.6	
6+67.5	75.0	
192.0	9.7	

192	$\frac{65.3}{83.9}(192) = x = 150$	859.5
x		150.0
0		709.5

STA @ 75 K/L.F. = 7+15.5

FROM STA 3+15.5 TO 7+15.5 (400 FT) USE PRECAST CONCRETE PIPE W/CAP = 120 K/L.F.

" " 7+15.5 TO 8+59.5 (144 FT) USE " " " " = 80 K/L.F.

ON THE BASIS OF EITHER L.F. 1.0 FOR ROCK CUTS OR 1.5 FOR PIPE ABOVE ROCK THE CRITERIA WOULD BE REVISED AS FOLLOWS: —
STA 5+40 WOULD GOVERN MAX. LD. @ 105 K/L.F.
NOW FIND STA. WHERE 50 K/L.F. WOULD BE PERMISSIBLE.

STA 6+67.5 = 65.5
STA 8+59.5 = 9.7

65.5	192
50.0	x
9.7	0

$\frac{40.3}{55.8} \times 192 = x = 139$

859.5
720.5

STA 3+15.5 =

THEREFORE USE
FROM STA. 3+15.5 TO 3+95.5 PRECAST CONCRETE PIPE W/CAP = 50 K/L.F.
" " 3+95.5 TO 7+15.5 " " " " = 105 K/L.F.
7+15.5 TO 8+59.5 " " " " = 50 K/L.F.