J. C. Dingwall

CONNECTICUT RIVER FLOOD CONTROL PROJECT

CHICOPEE, MASS.

CONNECTICUT RIVER, MASSACHUSETTS

ANALYSIS OF DESIGN FOR CALL STREET PUMPING STATION

ITEM C.5d - CONTRACT

MAY, 1940

CORPS OF ENGINEERS, U.S. ARMY

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

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I. INTRODUCTION

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A. AUTHORIZATION. - The Call Street Pumping Station is a part of the local protection works for the City of Chicopee. The Chicopee Dike is a part of the Connecticut River flood control plan included in the Comprehensive Plan of Flood Control for the Connecticut River as described in House Document No. 455, 75th Congress, 2d Session, and authorized under the Flood Control Act approved June 28, 1938.

B. NECESSITY FOR THE STATION. - As a part of the flood protection works from the Willimansett Section of Chicopee to the Chicopee River, a pumping station in the dike is necessary to discharge the effluent of the Call Street sewer into the river during periods of high water to prevent the flooding of cellars and low areas behind the dike. Approximately 740 acres are drained by the existing 54" x 60" egg-shaped brick sewer with the outfall into the Connecticut River at the site of the station. During periods of normal river stage, the effluent will flow to the river by gravity. Pumping will be necessary when the Connecticut River stage exceeds Elevation 53.5 mean sea level datum.

C. CONSULTATION WITH THE CITY OF CHICOPEE. - Preliminary to and during the actual design of the pumping station, consultations were held with officials representing the City of Chicopee. These latter include the Mayor, the City Engineer, the head of the Sewer Department and others. The pumping station design,as finally developed, meets with the approval in its essentials, of the City of Chicopee.

D. SHORT DESCRIPTION OF THE STATION. - The building which will house the pumps and other equipment will consist of a reinforced concrete substructure and a one story superstructure, of structural steel and brick, with glass block panels to serve as windows. The concrete roof slab will be covered with a built-up type roof of four-ply asphalt and gravel. The engine room on the ground floor will contain three gasoline engines and right angle gear units for the 36-inch pumps, the electric motor for the 16-inch pump, the standby unit, the overhead crane and other equipment. The substructure will be divided into wet and dry pump rooms by a reinforced concrete partition. The wet pump room will contain three 36-inch propeller type pumps and a sump pump. The gravity flow conduit will pass through the dry pump room and serve as a suction chamber for the 16-inch volute pump. The hoist for the backwater gate and the heating equipment will be located on an intermediate floor over the dry pump room which will also provide access to the intake structure. The intake structure will contain the racks and a gate to keep the wet well dry during periods of low flow and when no pumping is required. A grouted riprap channel will be provided for the discharge of the 36-inch pumps. A new concrete discharge conduit is provided from the pumping station to the river for gravity flow and the 16-inch pump.

II. SELECTION OF THE SITE

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The Call Street Pumping Station will be located in the recently constructed Chicopee Dike near the discharge end of the Call Street sewer. This location was chosen for the following principal reasons: first, the existing sewer discharges at this point; second, it was found not economically feasible to divert the sewer to a pumping station location at any other point; and third, foundation conditions were found to be satisfactory.

III. SOIL INVESTIGATIONS

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Foundation conditions were determined mainly by a 2-1/2" boring. In addition, three foundation auger borings were explored on the river bank. Locations of these borings are shown on Plate No. 9. Generalized foundation conditions are shown on Plate No. 10 as a profile along the center line of a sewer outlet of the station. Class numbers for types of material indicated in this profile are those of the Providence Soil Classification shown graphically on Plate No. 11 and described in Table No. 1. The foundation consists of lenses of medium to fine sands overlying an interstratified deposit of moderately compressible silt, fine sand and clay.

The proposed pumping station is located across an existing low earth dike with the bottom of the foundation mat about 40 feet above the deposit of interstratified silt. In view of the 40 feet of sand between the foundation and the silt deposit and the fact that the station weighs less than the material excavated, no settlement is anticipated.

Since the dike is very low the head is insufficient to create a seepage problem.

TABLE NO. 1

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

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

IV. HYDROLOGY

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A. DRAINAGE AREA CHARACTERISTICS. - The drainage area of 740 acres, as shown on Plate 1, consists, at the present time, of approximately 20 acres of fully developed commercial and industrial area, 230 acres of fully developed residential area and 490 acres of partially developed residential and undeveloped areas. Topographically, the drainage area is divided into two parts; a lower part located in the present flood plain of the Connecticut River in which most of the area is about Elevation 70, and an upper part consisting of a bluff which parallels the river including a steep face, several draws, and a flat top. It has been determined from the sewer map of the City of Chicopee that approximately 50 percent of the drainage area is, or can be, served by the existing combined sewer system. There are three outfall sewers which serve the drainage area; namely, a 54" x 60" egg-shaped brick on Call Street, a 15" circular on Forrest Street, and an 18" circular sewer on St. Louis Street. The total normal capacity (without surcharge) of these three outfall sewers is approximately 150 c.f.s., the Call Street Sewer having a capacity of nearly 140 c.f.s. Small future extensions of the sewer system are probable but major increases in the outfall capacities are unlikely in the near future.

B. RAINFALL RECORDS. - The following table derived from data presented in Misc. Pub. #204 U.S.D.A., "Rainfall Intensity-Frequency Data" by D. L. Yarnell, presents the best available analysis of rainfall rates for different frequencies and durations to be expected at Chicopee, Massachusetts:

MAXIMUM AVERAGE HOURLY RAINFALL RATES AT CHICOPEE, MASSACHUSETTS

Frequency Years	Duration of storm in minutes			
	30	60	120	240
2	1.96	1.16	0.65	0.50
5	2.50	1.60	0.92	0.62
10	3.00	1.85	1.12	0.75
25	3.90	2.42	1.46	0.94
50	4.10	2.70	1.70	1.06

C. DIKE SEEPAGE. - The seepage flow through the dike will be small and will not contribute significant quantities of flow to the total run-off.

D. RUN-OFF RECORDS. - Records of the type that would be useful in estimating the run-off from the drainage area at Chicopee are not available.

E. DESIGN RUN-OFF. - In computing the maximum rate of run-off, the average intensity of precipitation used was that for the two hours of most intense rainfall of a storm having a frequency of 10 years for the City of Chicopee, according to the Yarnell relations. The use of a 10-year 2-hour storm has been adopted as a standard for the most intense storm for which it is economically justifiable to provide pumping capacity even in highly developed urban areas. There is evidence that this standard is more severe than similar standards adopted by numerous principal cities for use in designing storm water drains.

Run-off coefficients are determined from consideration of the size, shape and slopes of the drainage area, the types of development, the existence and type of natural or constructed drainage courses and the surface and subsurface storage. All of these factors are weighed to give the adopted figure which is, in the final analysis, based upon judgment and experience. In general, the drainage area is divided into three types for both the present state of development and an estimated future state of development. The three types are fully developed industrial and commercial, fully developed residential, and partially developed residential.

In computing run-off the product of the rainfall intensity and the run-off coefficient is modified by introducing a multiplier which is called the relative-protection-factor. When providing protection from run-off for a composite area, it is not necessary to furnish the same degree of protection for a partially developed residential area as for a fully developed industrial area. Allowance for this fact is made by introducing the relative-protection-factor (R.P.F.) which is the index of the amount of protection from run-off which one area warrants relative to another. The relative-protection-factor is defined as the ratio of the intensity of precipitation used in computing the run-off from a given area to the intensity of precipitation of the basic design storm. In other words, the adopted basic rainfall intensity multiplied by the R.P.F. gives the rainfall intensity for which protection from run-off is provided. The R.P.F. is a function of the amount of local flooding of short duration, which can be tolerated on the different types of drainage area, and of the relative topographic positions, in the drainage area, of the divisions having different types and states of development. An R.P.F. of 1.0 was used for fully developed industrial and commercial areas, 0.8 for fully developed residential areas, and 0.6 for partially developed areas. A relative-protection-factor of 0.8 corresponds approximately to a 5-year storm as compared to 1.0 for 10-year storm and 0.6 corresponds approximately to a 2-year storm.

It may occur that a partially developed portion of the drainage area, or one fully developed that is not provided with a complete system of storm drains, is so topographically situated that lines of natural drainage will prevent local ponding, and will concentrate excess run-off in other areas where additional ponding cannot be tolerated. In such cases the relative-protection-factor cannot be considered as a function of type of development only, and it may be desirable in exceptional cases to increase the factor to more than 1.0.

The divisions of the drainage area, as described in Paragraph A, together with appropriate rainfall rates, run-off coefficients, and relative-protection-factors are presented in the table below. Type "A" areas are fully developed industrial and/or commercial, type "B" areas are fully developed residential, and type "C" areas are partially developed residential. Type "C_1" areas are partially developed residential areas having steep slopes and type "C_2" areas are partially developed residential areas having moderate slopes, both situated above fully developed portions of the drainage area. Owing to the small capacity of the existing sewer system, it was deemed unnecessary to consider other than the present state of development of the drainage area.

Part	Type	Area Acres	Rainfall Rate in./hr.	Run-off Coeff.	R.P.F.	Run-off c.f.s.
Lower	A	20	1.12	0.65	1.0	14.6
Lower	B	120	1.12	0.50	0.8	53.9
Lower	C	70	1.12	0.30	0.6	14.1
Upper	B	110	1.12	0.50	0.8	49.3
Upper	C	120	1.12	0.60	0.6	48.4
Upper	C	300	1.12	0.30	0.6	60.5
					Total	240 c.f.s.

The maximum dry weather flow was computed on the basis of the present state of development as follows:

Type	Area Acres	Maximum rate of flow	Maximum discharge c.f.s.
A	20	20,000 gallons per acre daily	0.62
B - 25 persons per acre	230	200 gallons per capita daily	1.78
C - 10 persons per acre	490	200 gallons per capita daily	1.52
Infiltration of ground water	740	1,000 gallons per acre daily	1.15
		Total	5.0 c.f.s.

V. REQUIRED DISCHARGE CAPACITY

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A. PUMP CAPACITY REQUIRED. - The pumps will be required to discharge storm flow or dry weather flow whenever backwater from the Connecticut River raises the hydraulic gradient in the outfall sewer feeding the pumping station above Elevation 55. After completion of the approved plan of 20 reservoirs, a peak stage of Elevation 55 m.s.l. will be equalled or exceeded probably on an average of once in four years. For the past 68 years the Connecticut River at Call Street has equalled or exceeded Elevation 55. for a period of approximately 4 days per average year as shown on the stage duration curve (Plate 8). The discharge values given in the table below are obtained from the studies explained under IV Hydrology.

Dry weather flow	5 c.f.s.
Maximum storm flow	240 c.f.s.
Top of dike	El. 74.8 m.s.l.
Connecticut River design flood stage	El. 69.8 m.s.l.
Normal intake water surface	El. 52.0 m.s.l.
Maximum intake water surface	El. 55.0 m.s.l.
Design maximum static head (69.8 - 55.0)	14.8 ft.
10-year peak stage on Connecticut River (after 20-reservoir plan)	El. 58.0 m.s.l.

The design pumping capacity, including flow from dike toe drains, is 240 c.f.s. at a static head of 14.8 feet (69.8 - 55.0).

B. INSTALLED PUMPING CAPACITY. - The installation will consist of three pumps having a capacity of 80 c.f.s. each and an additional small pump to take care of minor flows of sewage and small amounts of storm run-off. Since existing sewer facilities are not adequate to carry the run-off which could be expected from the drainage area in its present state of development, it is considered unnecessary to install pumping capacity in excess of 240 c.f.s. to provide a factor of safety for mechanical failure.

Since the elevation of the 36-inch pump discharge pipes is 69.0 which is 0.8 foot below the Connecticut River design flood stage, the pumping head and the pumping capacity will be practically constant at all river stages.

VI. MECHANICAL DESIGN

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A. PUMP DRIVE. - The Call Street Pumping Station is one of seven pumping stations to be constructed in Chicopee. Prior to the design of any of the stations an investigation was made of the available electric power supply with the view of employing electric motor drive for the pumps. The results of the investigation indicated that suitable power was available. However, the City of Chicopee was unable to come to an agreement with the power companies on the question of rates and eventually requested this office to provide gasoline engine drive. (See Analysis of Design Jones Ferry Pumping Station, Chicopee, Mass.)

The gasoline engines for the Call Street Pumping Station will be of the heavy-duty industrial type capable of continuously driving the pumps at their rated speed under any head condition developed. The engines will not use over 85 percent of their developed horsepower. They will be mounted on concrete bases and directly connected through flexible couplings to the right angle gear units.

B. PUMPS. - From the ultimate required pumping capacity of 240 c.f.s., as determined in Section V, it was determined that provisions should be made to install three pumps. To install a larger number of pumps would materially increase the cost of the station without resulting in any great advantage and a smaller number would seriously limit the operating flexibility and reliability of the station.

A study of equipment indicated that three 36-inch propeller type pumps would be required; each pump to have a capacity of 36,000 G.P.M., or 80 c.f.s., against a total head of 17 feet. In addition, one 16-inch mixed flow type of pump having a capacity of 6,800 G.P.M. against a total of 22 feet was provided to pump the dry weather flow and dike seepage at such periods when the river is at flood stage and no storm water is to be pumped from within the protected area.

C. RIGHT ANGLE GEAR UNITS. - The gear units will be of the self-contained type designed for transmitting the power from the horizontal engine shaft through a gear train to the vertical pump shaft. The units will be inclosed in a cast iron and structural steel housing and will have a service factor of not less than 1.25 times the maximum power required to drive the pumps under any condition of head.

D. STANDBY GENERATOR UNIT. - A gasoline engine-driven generator will be provided to furnish electric power in the event of failure of commercial power. The unit will have a normal full load capacity of 93.8 kva, which will be sufficient to start and run the 16-inch pump motor as well as maintain in operation the other electrical auxiliaries and the station lighting system.

E. CRANE. - A ten ton overhead crane will be installed in the engine room to facilitate the repairing of any item of equipment. The crane will be of standard construction and hand operated throughout.

F. SLUICE GATES. - A motor-operated sluice gate will be located at the entrance to the pump sump. This gate will normally be kept closed to prevent water from collecting in the sump. It will be opened at such periods when it is necessary to operate the storm water pumps. A second motor-operated sluice gate will be located in the gravity discharge conduit to prevent backflow during periods of high water. This gate will normally be kept open to permit water to flow by gravity to the river.

G. WATER SYSTEM. - The city water supply will be connected to the pumping station and the water used for cooling the gasoline engines and station service. In addition, the sump pump will be so connected that it can be employed to furnish engine-cooling water in times of emergency.

H. GASOLINE SYSTEM. - Gasoline will be stored in a 2,900 gallon tank buried in the ground adjacent to the pumping station. Each engine will be supplied through an individual line running directly to the tank. Drip pans will be provided on each engine and connected to a common header running back to the tank. All gasoline piping will be 3/4-inch I.D. copper tubing with flared joint connections. At such points where the gasoline lines are imbedded in concrete or pass through beams, they will be protected by wrought iron sleeves.

I. SUMP PUMP. - A motor-operated sump pump of 50 G.P.M. capacity will be provided in the wet sump for the purpose of drying it up after the pumping station has been in operation.

J. VALVES. - A flap valve will be installed at the end of each pump discharge line to facilitate the starting of the pump and to prevent back flow through it. Inasmuch as the pump discharge is approximately at maximum flood stage, no gate valves will be provided in the discharge line.

K. FIRE EXTINGUISHING SYSTEM. - A carbon dioxide fire extinguishing system will be installed and so arranged that any gasoline engine can be blanketed with gas by tripping a valve located just inside the main entrance to the building. Portable extinguishers will be provided to take care of any other emergencies.

L. HEATING SYSTEM. - The heating system will be of the two pipe gravity type consisting of an oil-fired boiler supplying steam to two unit heaters located at opposite ends of the engine room. The oil burner will be of the rotary type with electric ignition. The unit heaters will be of ample capacity to heat the engine room under the coldest weather condition.

M. <u>SWITCHBOARD AND CONTROL EQUIPMENT</u>. - The switchboard will be of the steel-enclosed, low-voltage, dead-front, light duty type with all controls mounted on the front. All circuit breakers will be manually operated. Circuit breakers for the generator and incoming feeder will be the airbreak type rated at 600 volts, 60 cycles, A.C., having an interrupting capacity of 20,000 amperes, provided with three instantaneous and time-delay magnetic overcurrent trips, and magnetic lockout attachments on each so that only one can be in the closed position at any time. This lockout feature will be provided to prevent the connection of the generator in parallel with the outside source.

All controls for operating the 16-inch pump motor will be located at the switchboard in order to centralize them with those of the outside source and standby generator. The external resistance of the rotor will be varied through a drum controller to provide speed regulation at one-half, three-quarters, and full load speeds. The speed reduction will be used to provide continuous operation during periods when the flow to the pump is less than full load capacity at rated speed. The secondary resistors will be mounted on the wall to allow free circulation of air for dissipating the heat generated. The primary of the pump motor will be controlled by a magnetic contactor, fed from the main bus through a feeder circuit breaker, interlocked with the "off" position of the drum controller so that the motor cannot be started without having all of the resistance in the rotor circuit at the time of starting. Feeder protective circuit breakers for the pumping station auxiliary equipment will be mounted on the switchboard, and each circuit breaker will be rated at 600 volts, 60 cycles, A.C., having an interrupting capacity of 10,000 amperes and provided with thermal and instantaneous magnetic trips.

VII. STRUCTURAL DESIGN

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A. SPECIFICATIONS FOR STRUCTURAL DESIGN.

1. General. - The structural design of the Call Street Pumping Station has been executed in general in accordance with standard practice. The specifications which follow cover the conditions affecting the design of the reinforced concrete and structural steel.

2. Unit weights. - The following unit weights for material were assumed in the design of the structure:

Water	62.5	pounds	per	cubic	foot
Dry earth	100	"	"	"	"
Saturated earth	125	"	"	"	"
Concrete	150	"	"	"	"

3. Earth pressures. - For computing earth pressure caused by dry earth Rankine's formula was used. For saturated soils an equivalent liquid pressure of 80 pounds per square foot per foot of depth was assumed.

4. Structural steel. - The design of structural steel was carried out in accordance with the standard specifications for Steel Construction for Buildings of the American Institute of Steel Construction.

5. Reinforced concrete. - In general, all reinforced concrete was designed in accordance with the "Joint Committee on Standard Specifications for Concrete and Reinforced Concrete" issued in January 1937.

a. Allowable working stress. - The allowable working stress in concrete used in the design of the pump house structure and conduits is based on a compressive strength of 3,000 pounds per square inch in 28 days.

b. Flexure (f_c). -	Lbs. per sq.in.
Extreme fibre stress in compression	800
Extreme fibre stress in compression adjacent to supports of continuous or fixed beams or rigid frames	900
c. Shear (v). -	
Beams with no web reinforcement and without special anchorage	60
Beams with no web reinforcement but with special anchorage of longitudinal steel	90
Beams with properly designed web reinforcement but without special anchorage of longitudinal steel	180
Beams with properly designed web reinforcement and with special anchorage of longitudinal steel	270
Footings where longitudinal bars have no special anchorage	60
Footings where longitudinal bars have special anchorage	90
d. Bond (u). -	
In beams, slabs, and one way footings	100
Where special anchorage is provided	200

The above stresses are for deformed bars.

e. Bearing (f_c). -

Where a concrete member has an area

	Lbs. per sq.in.
at least twice the area in bearing	500
f. Axial compression (f_c). -	
Columns with lateral ties	450
g. Steel stresses. -	
Tension	18000
Web reinforcement	16000

h. Protective concrete covering. -

Type of members	Minimum cover in inches
Interior slabs	1-1/2
Interior beams	2
Members poured directly against the ground	4
Members exposed to earth or water but poured against forms	3

For secondary steel, such as temperature and spacer steel, the above minimum cover may be decreased by the diameter of the temperature or spacer steel rods.

B. BASIC ASSUMPTIONS FOR DESIGN. -

1. Roof slab. - The roof slab is of reinforced concrete. It is designed to carry the full dead load plus a live load of 40 pounds per square foot of roof surface.

2. Roof beams. - The roof beams are of structural steel encased in concrete fireproofing. They are designed to carry the full dead load, plus the full live load of 40 pounds per square foot of roof surface. In addition to taking up the roof load, these beams, together with the columns to which they are connected, form portal frames which take up wind load and crane thrusts on the building. The end connections are designed to take up all such horizontal loads.

3. Columns. - a. Structural steel columns in the walls of the superstructure take up the direct roof loads as well as all wind loads on the superstructure. In addition, the columns in the side walls carry crane brackets which support the crane runway. These columns are designed to carry full live and dead load from the roof; dead load, live load and impact effect from the traveling crane; bending due to eccentrically applied loads, and bending due to wind load on the building. No point of inflection was considered in the column designed, a pin-ended condition at the base being assumed.

b. Columns other than the crane columns in the building designed for full dead load and live load from roof, plus wind load on the building.

c. Allowable stress in columns figured from formula

$$P/A = \frac{18000}{1 + \frac{l^2}{18000}}$$

With a maximum allowable stress of 15,000 pounds per square inch for dead load plus live load, and a maximum allowable stress of 20,000 pounds per square inch for combined dead load, live load and wind load; l/r limited not to exceed 120.

4. Pump room.

a. The station is part of the flood protection dike. The walls are of reinforced concrete to Elevation 75.00 and of brick and steel construction from thereon up.

b. In designing the pump room the assumption was made that the whole transverse section acted as a continuous frame. It was assumed that the side members of this transverse section were hinged at the level of the engine room floor, hinged at the level of the wale beams and fully restrained at the level of the pump room floor slab.

c. The continuous frame was investigated for the condition of loading assuming a hydrostatic head on the river side up to Elevation 72.00, while on both the river side and land side saturated earth was assumed to Elevation 66.00. The loading on the base slab was taken as the distributed load of the building less the weight of the base slab.

d. The end walls of the pump room were investigated for two cases:

(1) Case I. - The end walls were assumed supported at the upper edge, supported at an intermediate point 16'-3" above the base slab and fixed at the base.

(2) Case II. - Seventy-five percent fixity at the base was assumed.

Saturated earth was assumed to Elevation 66.00.

When the end walls are fully restrained at the base slab, maximum negative moment occurred while for maximum positive moment only 75 percent fixity occurred between end walls and the base slab.

5. Horizontal walers and cross beams. - In order to decrease the thicknesses of the exterior concrete walls in the substructure, concrete walers and cross beams were placed at Elevation 60.75.

The transverse beams were assumed hinged at the wale beams. The difference in thrust between the riverside and landside wale beams was distributed to the transverse walls at the conduit and by strengthening the wales at these points.

6. Boiler room. - The boiler room floor was designed for a uniform live load of 200#/sq.ft. for the concrete slab and a uniform live

load of 160#/sq.ft. for the concrete beams, except for that portion of the floor slab occupied by the gate hoist. This portion of the floor was designed for the full load on the gate hoist plus the weight of the gate.

7. Intake conduit. - The intake conduit is connected to the existing brick sewer at its south end and to the trash rack chamber at its north end. The conduit varies in section from a rectangle 4 feet wide by 5 feet high at the sewer end to a rectangle 17 feet wide by 8'-6" high at the trash rack chamber end. The conduit was designed as a continuous frame subject to a saturated earth loading. The earth was assumed to be at Elevation 72.0.

8. Trash rack chamber. - The trash rack chamber is attached to the land-side wall of the pumping station. The chamber is 23'-9" high by 17' wide. The trash rack section is 8'-6" high and leads directly into the wet sump and the gravity flow conduit. The transverse section of the chamber was designed as a continuous frame subject to an H-20 loading on the top slab, a uniform load of 100#/sq.ft. on the raking platform, and saturated earth fill on the sidewalls. The south wall of the chamber was designed as a restrained beam acting between the top slab and the raking platform.

9. Discharge conduit. - The discharge conduit is attached to the east face of the dividing wall between the wet and dry sumps. The conduit is 6 feet high by 6 feet wide and was designed as a continuous frame subject to saturated earth loading. During normal flow the conduit operates as a gravity conduit. In flood periods the conduit is closed to flow by a gate in the trash rack chamber, the sewage flow being diverted through the wet sump.

10. Trash racks. - There is one trash rack, in two sections, at this station, located in the intake structure. The rack is made of a structural channel frame which supports 4 x 3/8 inch round edge grating bars spaced 3-1/4 inches in the clear. The rack is welded throughout.

The trash rack is designed on the assumption of stoppage of 50 percent of flow with the water rising above the top of the trash rack.

11. Stairways and ladders. - An open grating steel stairway leads from the dry pump room floor to the engine room floor. A steel ladder is provided on the outside of the building for access to the roof of the building.

C. ARCHITECTURE. - The pumping station will be a building of modern design in keeping with the architectural treatment used on similar projects elsewhere on the Connecticut River. This design will give a pleasing appearance without undue emphasis being placed on purely decorative features.

The pumping station will be a flat-roofed, brick and glass block structure 60'-4" x 24'-0" overall. The 12.5 inch thick brick walls, capped with a cast stone coping, extend above the roof slab to form a parapet wall around the entire roof. A flat-type roof was chosen as being economical and in keeping with the architectural design, as well as serving as a location for the engine exhaust mufflers. The roof system consists of steel beams encased in concrete and supported by steel columns. The roof slab will be 5 inches thick, covered with a cinder concrete fill sloped to drain. There are no outside pilasters. Inside the building there are pilasters at the chimney and at each structural steel column, the pilasters forming fire-proof column encasements. The engine room floor will be 8-inch structural concrete slab, with a monolithic finish. A hand-operated traveling crane of 10 tons lifting capacity will operate for the full length of the building and will be used for installing and moving pumps and machinery. Access for the crane hoist to the pump room will be had through openings in the machinery room floor, these openings being normally covered with removable checkered floor plates.

There is no window sash in the building. Light will be admitted through large glass block panels, glass blocks being chosen in preference to sash because of the exposed location of the pumping station near the river banks. The well-diffused and uniform light which they provide and their appearance is also in keeping with the spirit of the architectural design. To provide ventilation, adjustable louvres have been placed low in the brick walls and a motor operated exhaust ventilator has been placed on the roof.

Two doors give access into the building. The main entrance door, 7 feet wide by 10 feet high, consists of two leaves of hollow steel construction and give entrance directly to the engine room floor. It is large enough to provide adequate clearance for any replacement of mechanical equipment which may be required in the future. The small hollow steel door on the west end of the building provides a service passage.

VIII. CONSTRUCTION PROCEDURE

VIII. CONSTRUCTION PROCEDURE

A. SEQUENCE OF OPERATIONS. - The schedule of work will require the contractor to complete the pumping station and appurtenant works in 250 calendar days after receipt by the contractor of notice to proceed.

B. CONCRETE CONSTRUCTION.

1. Composition of concrete. - The concrete will be composed of cement, fine aggregate, coarse aggregate and water so proportioned and mixed as to produce a plastic, workable mixture. All concrete will be Class A except the pumping station base slab and the manhole base which will be Class B. Class A concrete will have an average compressive stress of not less than 3400 lbs. per square inch in accordance with a standard 28-day test. The average compressive stress for Class B concrete will be 3000 lbs. per square inch in accordance with a standard 28-day test. Concrete aggregates will be of suitable quality and will be tested by the Central Concrete Laboratory at West Point.

2. Laboratory Control. - A small concrete testing laboratory is available in the West Springfield Area of the district for use principally to control the quality of concrete during construction. The tests performed here will supplement those made at the Central Laboratory. Facilities will be available for testing the grading of aggregates, designing concrete mixtures, mixing of trial concrete batches for the purpose of developing actual relations between the compressive strength and the water cement ratio, and the casting of concrete cylinders for compressive strength tests.

a. Cement. - Cement will be tested by the Central Concrete

Laboratory and results of these tests shall be known before the cement is used. Portland cement of a well known and acceptable brand will be used throughout.

b. Fine aggregate. - Natural sand will be used as a fine aggregate. The aggregate will be subject to thorough analysis, including magnesium sulphate soundness tests, and tests made on mortar specimens for compressive strength.

c. Coarse aggregate. - Washed gravel or crushed stone of required sizes will be used as coarse aggregate. It will consist of hard, tough and durable particles free from adherent coating and will be free from vegetable matter. Only a small amount of soft friable, thin or elongated particles will be allowed. The aggregate will be subject to accelerated freezing and thawing tests and to thorough analysis, including magnesium sulphate tests for soundness.

d. Water. - The amount of water used per bag of cement for each batch of concrete will be predetermined; in general, it will be the minimum amount necessary to produce a plastic mixture of the strength specified. Slump tests will be required in accordance with the specifications.

3. Field Control.

a. Storage. - The concrete components will be stored in a thoroughly dry, weather-tight and properly ventilated building. The fine and coarse aggregates will be stored in such a manner that inclusion of foreign material will be avoided.

b. Mixing. - The exact proportions of all materials in the concrete will be predetermined. The mixing will be done in approved mechanical mixers of a rotating type, and there will be adequate facilities for accurate measurement and control of each of the materials used in the concrete. Mixing will be done in batches of sizes as directed and samples will be taken for slump tests and for compressive strength tests. Inspectors will at all times supervise and inspect the mixing procedure.

c. Placing. - Concrete will be placed before the initial set has occurred. Forms will be clean, oiled, rigidly braced and of ample strength. Concrete poured directly against the ground will be placed on clean damp surfaces. Mechanical vibrators will be used and forking or hand spading will be applied adjacent to forms on exposed surfaces to insure smooth, even surfaces. The location of vertical and horizontal construction joints as well as contraction and expansion joints, and the location of upper water stops are indicated on the drawings. The locations of construction joints are tentative and may be changed to suit conditions in the field. Before placing concrete, all reinforcing steel will be inspected and pouring of the concrete will be supervised and directed by Government inspectors. Adequate precautions will be taken if concrete is to be placed in cold or hot weather.

C. STRUCTURAL STEEL CONSTRUCTION. - Structural steel construction consists of the frame work for the superstructure; the walkways and stairway in the pump room; the trash rack, and the miscellaneous frames, angles, checkered plates, crane rails, railings, and ladders.

1. Superstructure framework. - The superstructure framework consists of beams and columns which will form a skeleton frame for the

exterior walls and roof, and will provide a runway for the hand-operated crane. The columns will be securely anchored to the concrete walls and will be connected to the roof beams with web connection angles and wind bracing connections. The crane rails will be fastened to the crane runway beams with bent hook bolts. Crane stops at each end of the runway will prevent the traveling crane from running into the end walls.

2. Walkways and stairways. - The grating for the walkways and stairway treads in the pump room will be supported on structural steel channels. Wrought-iron pipe railings are to be fastened to the top flanges of the stairway channels.

3. Trash racks. - The trash racks are made up of structural channel frames which support 4-inch by 3/8-inch grating bars, spaced 3-1/4 inches in the clear. The racks are welded throughout. A pair of hand-operated two-ton hoists are provided for lifting the racks out of the waterway to aid in clearing them of debris or to permit the pumping station to operate at flood times if the racks become clogged with debris.

4. Removable floor plates. - Access for the crane to the pump room will be obtained by removing checkered floor plates. The removable covers consist of 1/4-inch checkered plates welded to 3 inch x 2-1/2 inch x 5/16 inch angles. Each opening in the floor is covered. Lifting handles are provided in the plates for easy removal.

5. Miscellaneous angles and frames. - Miscellaneous structural steel such as door frames, angles, grilles, etc., will be erected and placed as indicated on the drawings and at such time as required.

IX. SUMMARY OF COST

IX. SUMMARY OF COST

The total construction cost of the Call Street Pumping Station, including the intake structure, the discharge structure and the mechanical equipment, has been estimated to be $134,000 including 10% for contingencies and 15% for engineering and overhead.

This amount has been distributed as follows:

(1)	Pumping station.		
	a. Concrete.	$20,500	
	b. Superstructure.	17,800	
	c. Miscellaneous	9,800	
	Total		$ 48,100
(2)	Conduit.		
	a. Concrete.	$ 3,800	
	b. Miscellaneous	5,500	
	Total		$ 9,300
(3)	Mechanical equipment.		76,600
	TOTAL		$134,000

(1) a. The concrete features included under the pumping station item (1) a. consist of intake structures, building foundation to and including operating floor structural slab and suction intake.

(1) b. The superstructure consists of the complete building above the operating floor.

(1) c. Miscellaneous items are common excavation and backfill, miscellaneous iron and steel, trash racks, and other items not included in (1) a and (1) b.

(2) a. The concrete under the conduit item (2) is the conduit complete.

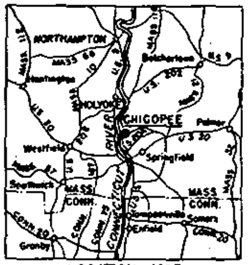
(2) b. Miscellaneous items are common excavation and backfill.

(3) The mechanical equipment consists of pumps, gas engines, gear units, crane, generating units, valves and piping, sluice gates and miscellaneous items.

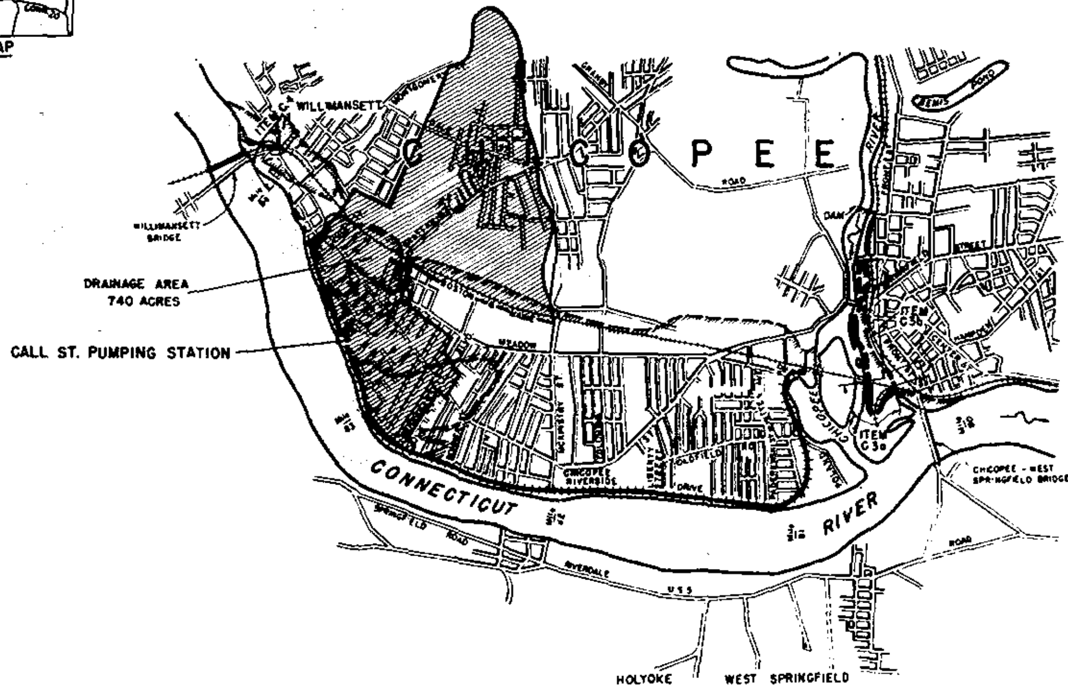
PLATES

INDEX OF PLATES

WAR DEPARTMENT | CORPS OF ENGINEERS, U. S. ARMY



LOCATION MAP
SCALE 1"=8 MILES



VICINITY MAP
SCALE 1"=1500

LEGEND

- Dikes completed Item C1 and C2
- Item C3a Fiscal Year 1940 Unit, West of B&M RR South Bank Chicopee River
- Item C3b Future Construction, Fiscal Year 1940 Unit, South Bank Chicopee River
- Item C4 Fiscal Year 1940 Section Willimansett Dike
- Overflow Limits, March 1936 Flood

KEY	DATE	REVISION	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

CALL STREET PUMPING STATION

CHICOPEE, MASS.

PROJECT LOCATION AND INDEX

CONNECTICUT RIVER — MASSACHUSETTS

IN 45 SHEETS — SCALE 1 IN = 1500 FT — SHEET NO 1

U S ENGINEER OFFICE, PROVIDENCE, R.I. — MAY 1940

FISCAL YEAR 1940

FILE NO CT-4-2426

C.5d

PLATE NO. 1

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

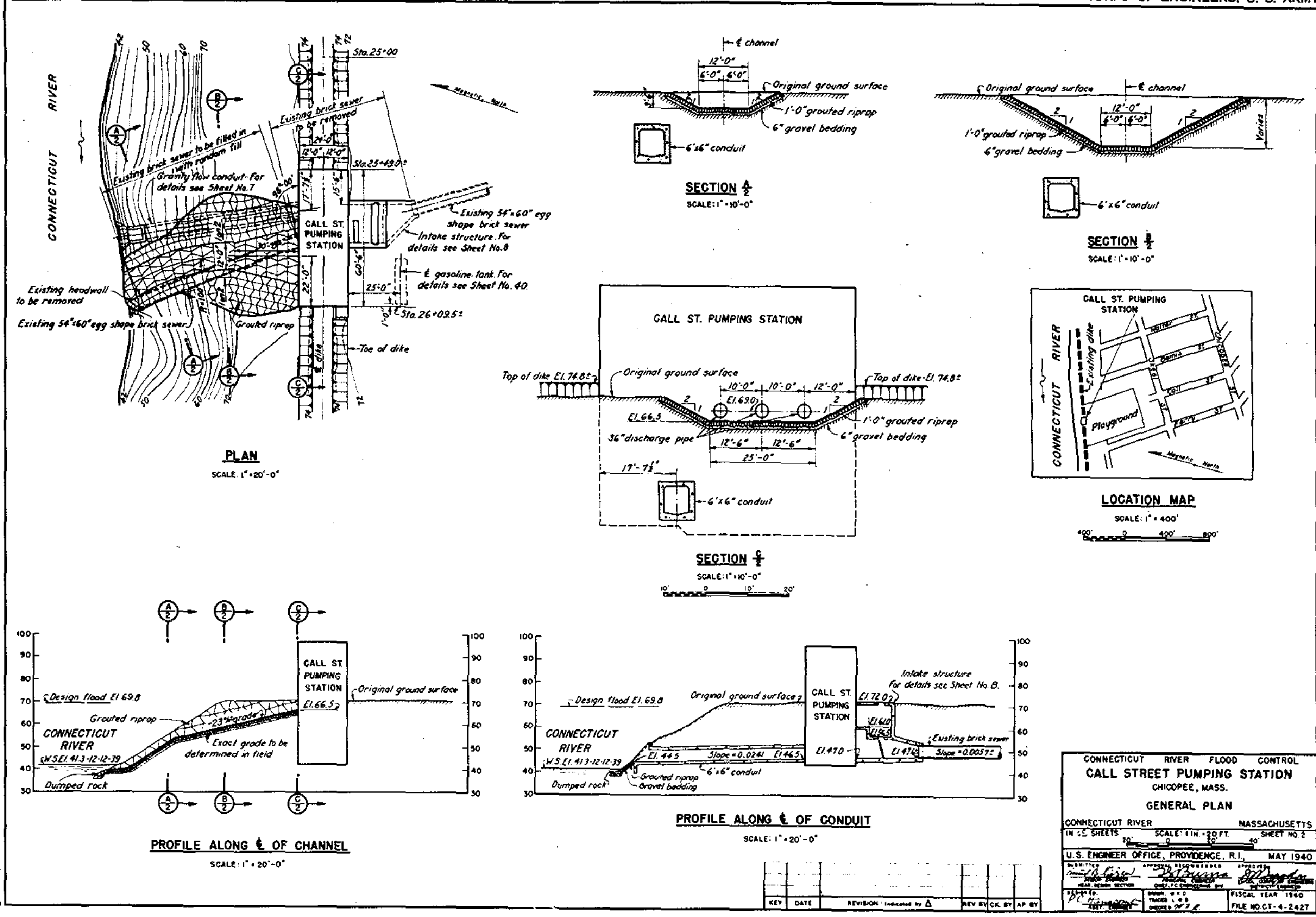


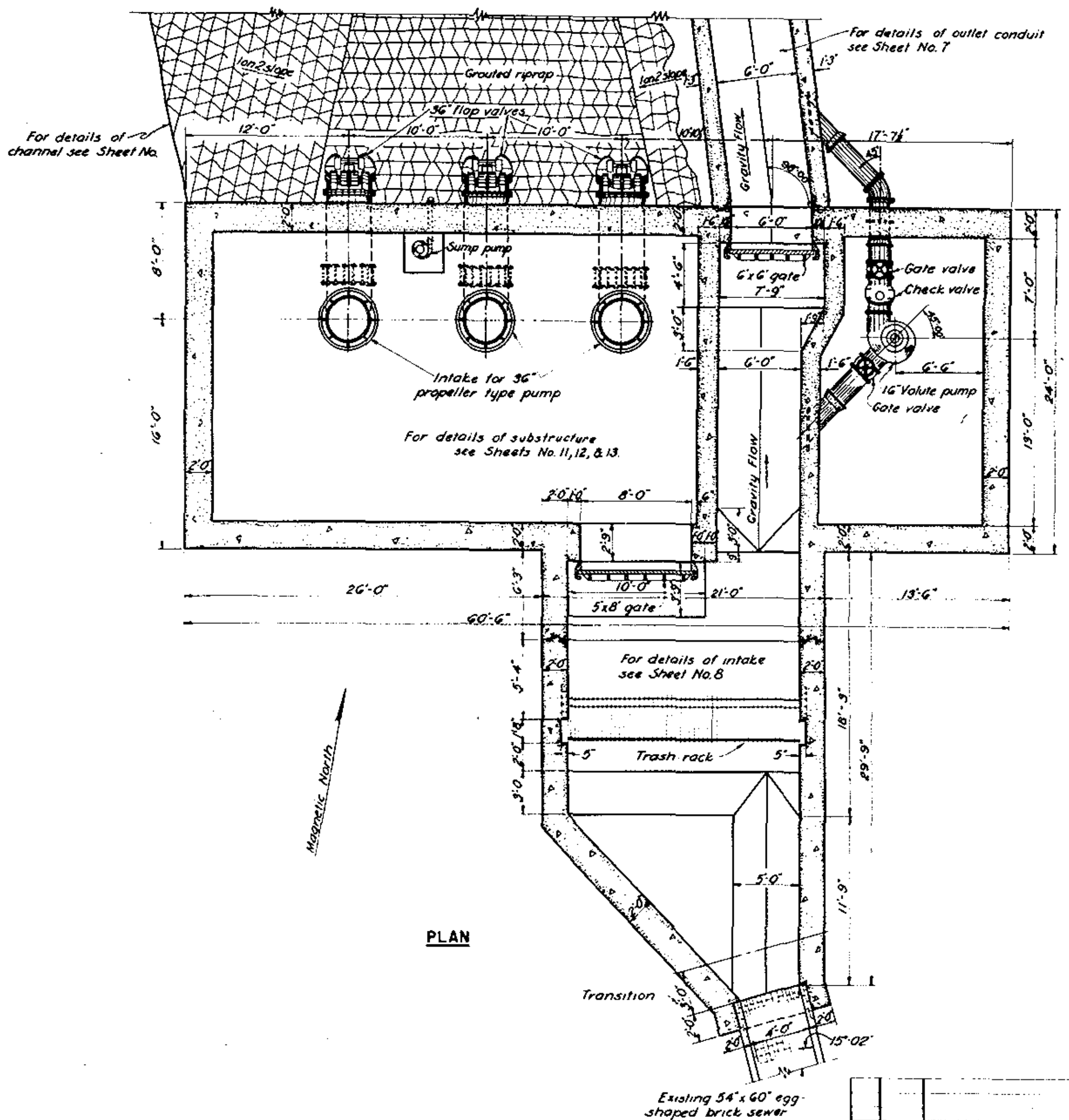
PLATE NO. 2

C.5d

2

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



KEY	DATE	REVISION (Indicated by Δ)	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL

CALL STREET PUMPING STATION

CHICOPEE, MASS

PLAN OF INTAKE
WET WELL AND OUTLET

CONNECTICUT RIVER — MASSACHUSETTS

IN 45 SHEETS — SCALE: 1/4 IN. = 1 FT — SHEET NO. 3

U. S. ENGINEER OFFICE, PROVIDENCE, R.I., MAY 1940

SUBMITTED — APPROVAL RECOMMENDED — APPROVED

FISCAL YEAR 1940

FILE NO. CT-4-2428

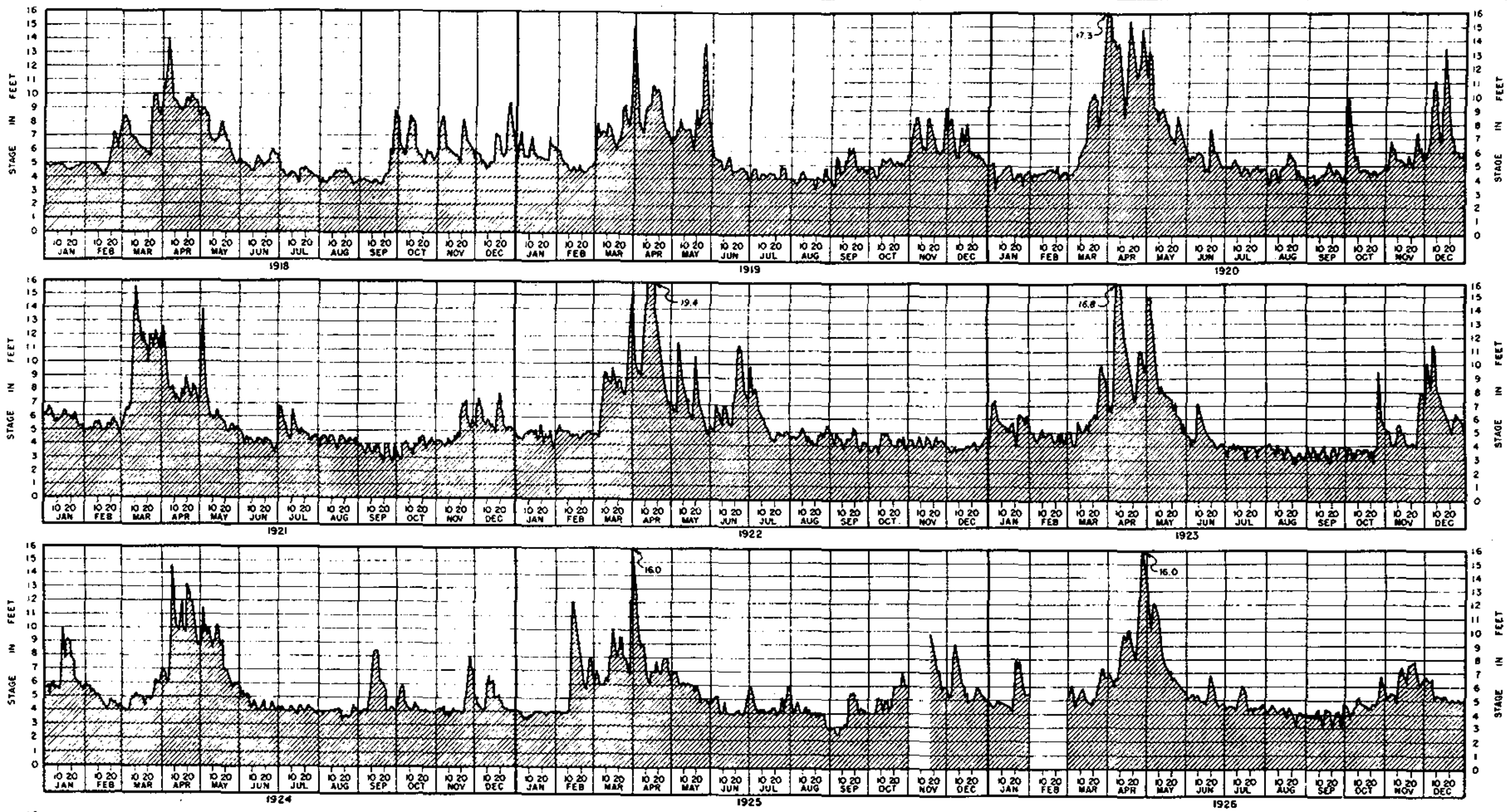
PLATE NO. 3

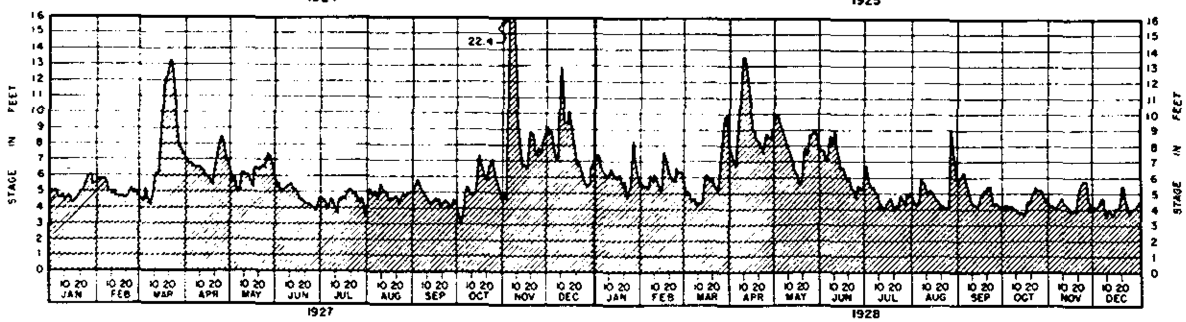
C.5d

3

WAR DEPARTMENT

CORPS OF ENGINEERS. U. S. ARMY





NOTES

Stage records at Springfield obtained from United States Weather Bureau and from the Department of Streets and Engineering, City of Springfield.

Recording gage located on upstream side of Memorial Bridge, Springfield, Mass.

Zero of gage is at elevation 37.3 m.s.l

For stage relation curve, see Sheet No. 5, File No. CT-3-1170.

KEY	DATE	REVISION (indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CALL STREET PUMPING STATION

CHICOPEE, MASS.

STAGE HYDROGRAPH NO. 1

CONNECTICUT RIVER — MASSACHUSETTS

IN 45 SHEETS — SCALE AS SHOWN — SHEET NO. 4

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — MAY 1940

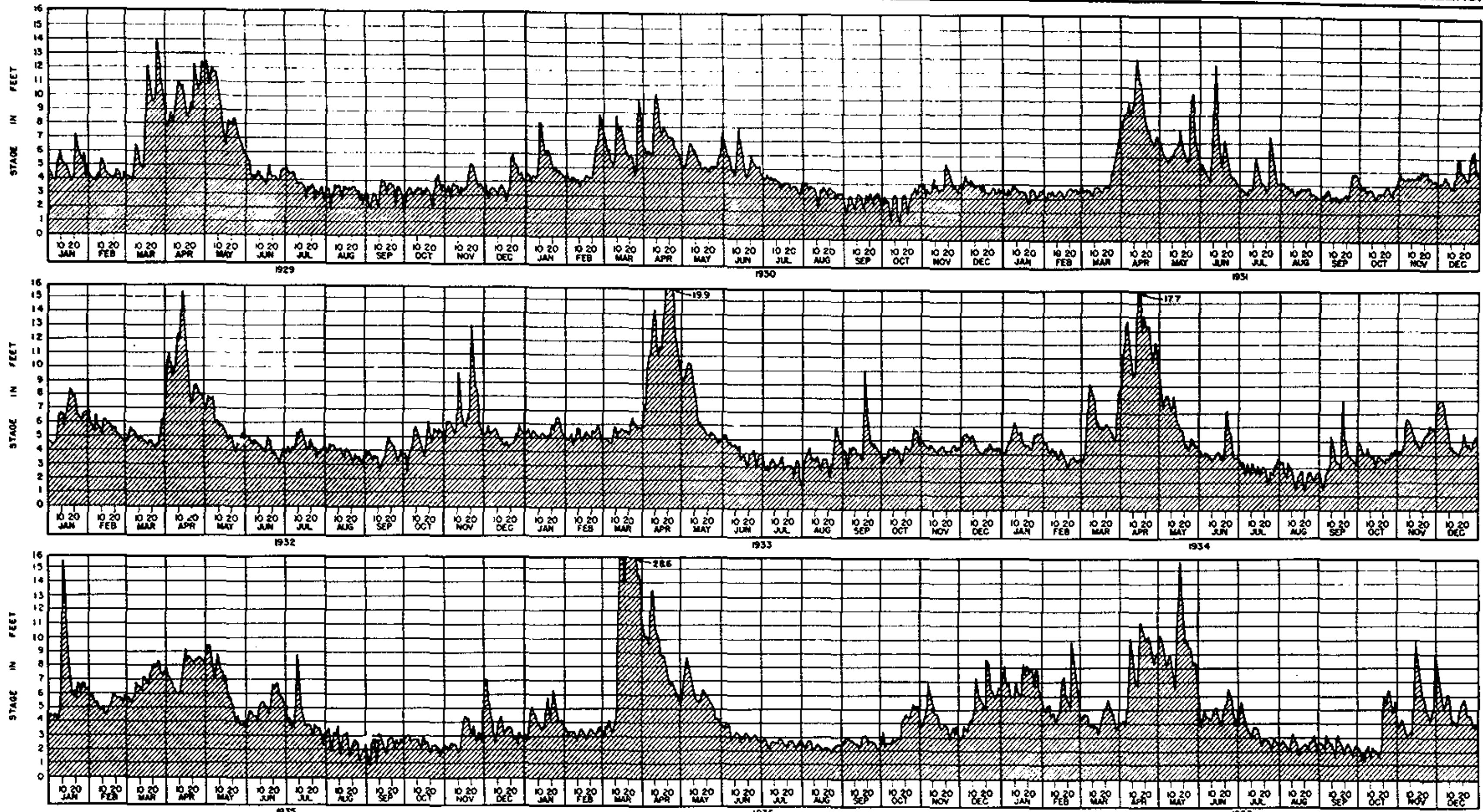
FISCAL YEAR 1940

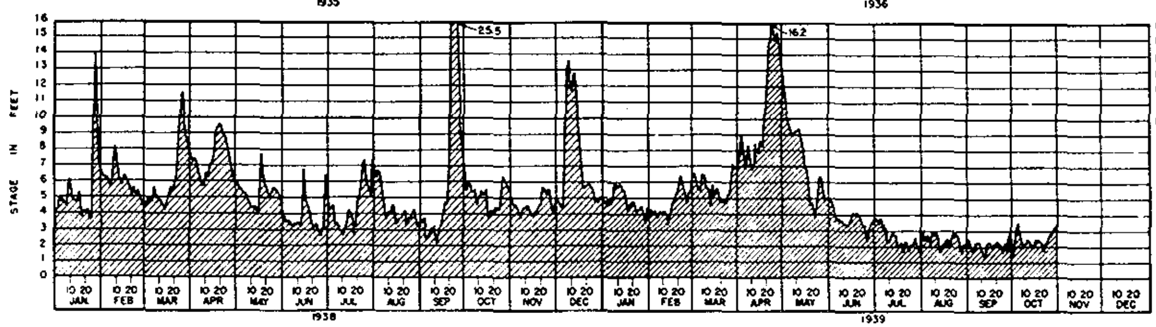
FILE NO. CT-3-1169

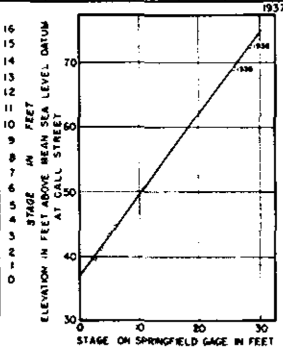
PLATE NO. 4

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY







NOTES

For notes pertaining to this sheet see Sheet No. 4, File No CT-3-1169

KEY	DATE	REVISION (indicated by △)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CALL STREET PUMPING STATION

CHICOPEE, MASS.

STAGE HYDROGRAPH NO. 2

CONNECTICUT RIVER — MASSACHUSETTS

IN 45 SHEETS — SCALE AS SHOWN — SHEET NO. 5

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. MAY 1940

SUBMITTED: John E. [signature] — APPROVAL RECOMMENDED: [signature], PRINCIPAL ENGINEER — APPROVED: [signature]

COMPILED: [signature]

FISCAL YEAR 1940

FILE NO. CT-3-1170

C. 5d

5

PLATE NO. 5

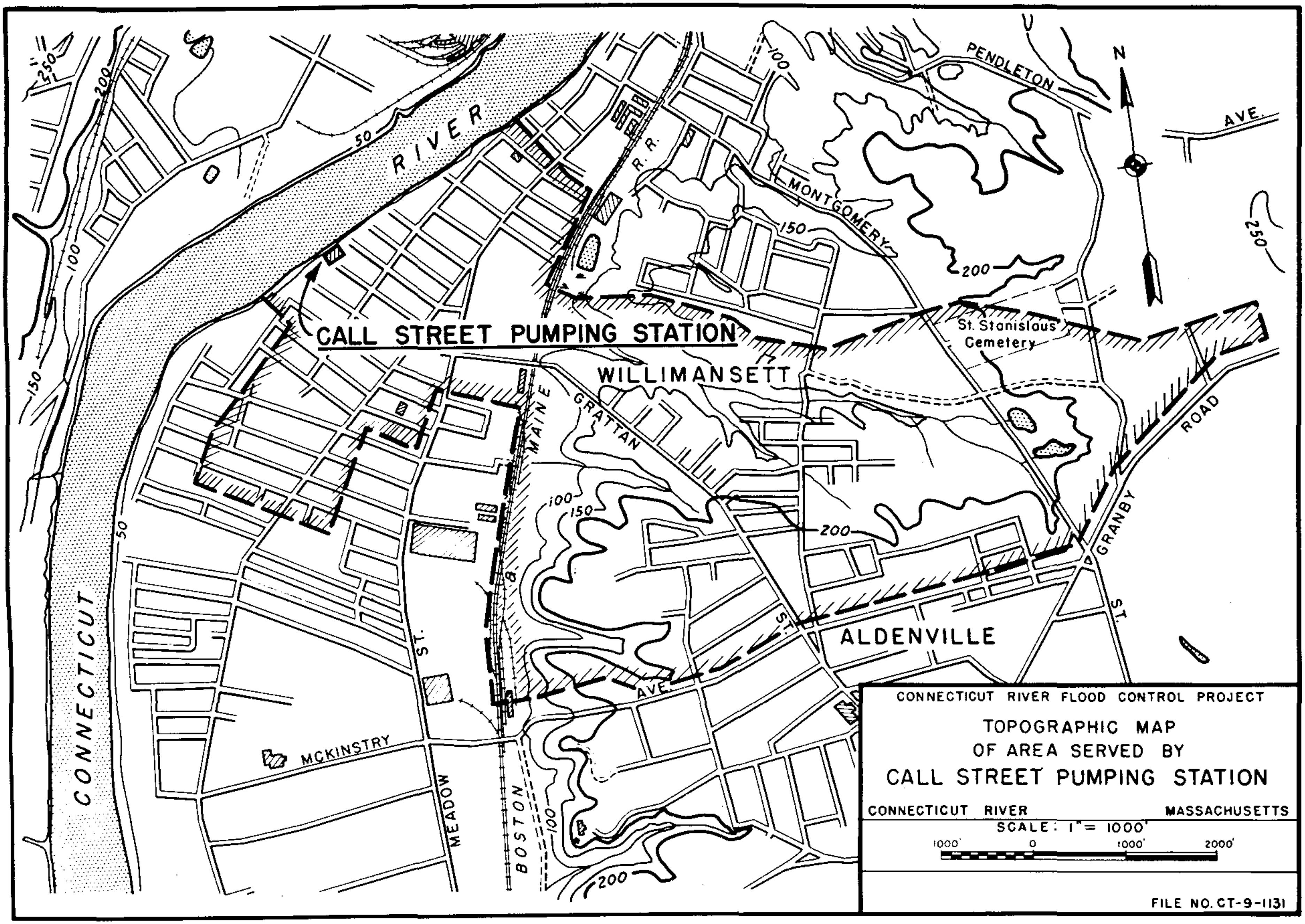

CONNECTICUT RIVER FLOOD CONTROL PROJECT
TOPOGRAPHIC MAP
OF AREA SERVED BY
CALL STREET PUMPING STATION
CONNECTICUT RIVER
MASSACHUSETTS
SCALE: 1" = 1000'
1000'
0
1000'
2000'
FILE NO. CT-9-1131
CALL STREET PUMPING STATION
WILLIMANSETT
ALDENVILLE
CONNECTICUT
RIVER
St. Stanislaus Cemetery
PENDLETON
AVE.
MONTGOMERY
GRATTAN
GRANBY
ROAD
ST.
AVE.
MEADOW
ST.
BOSTON
MAINE
R.R.
MCKINSTRY
N
50
100
150
200
250

PLATE NO. 76

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY

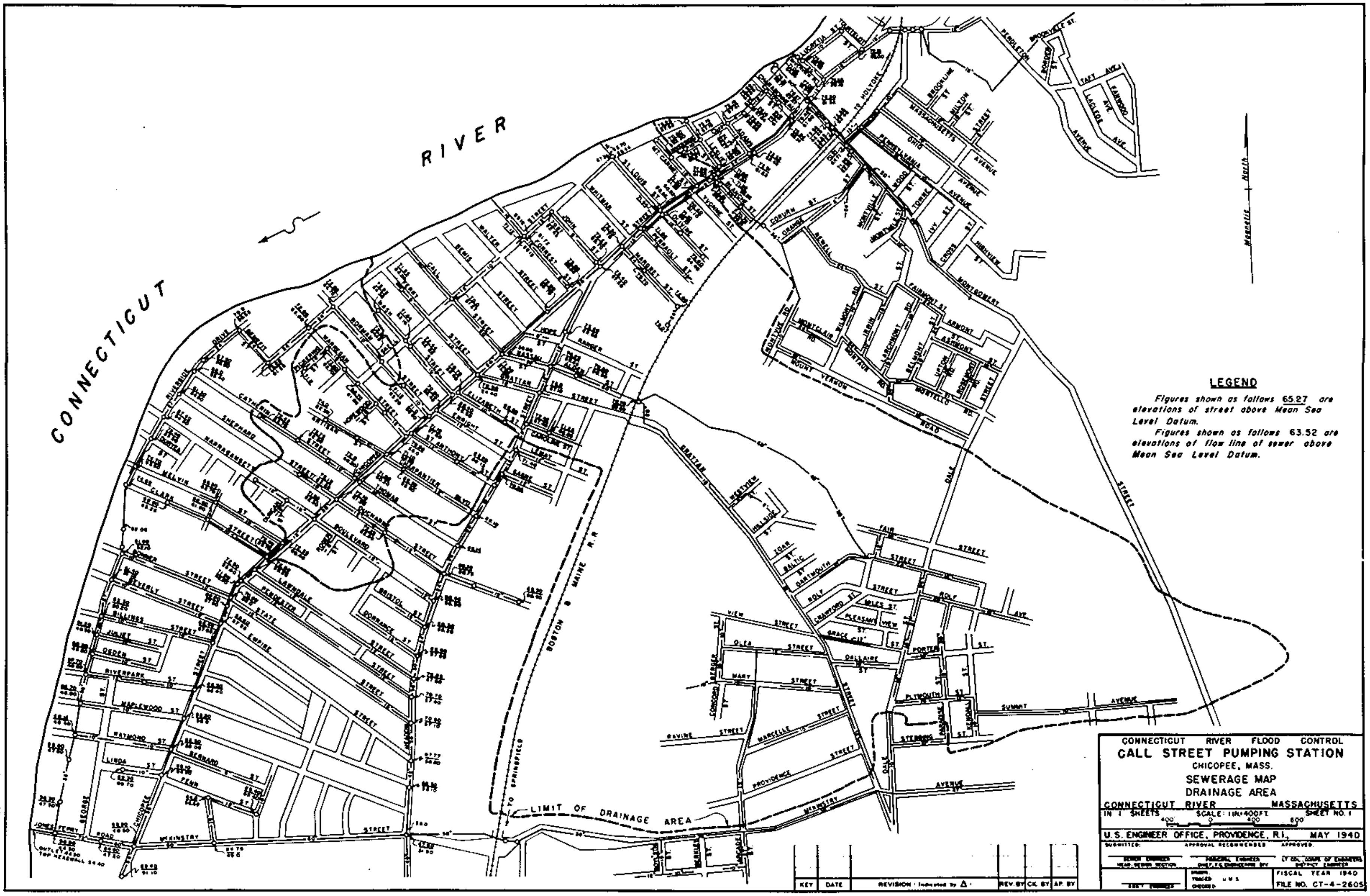
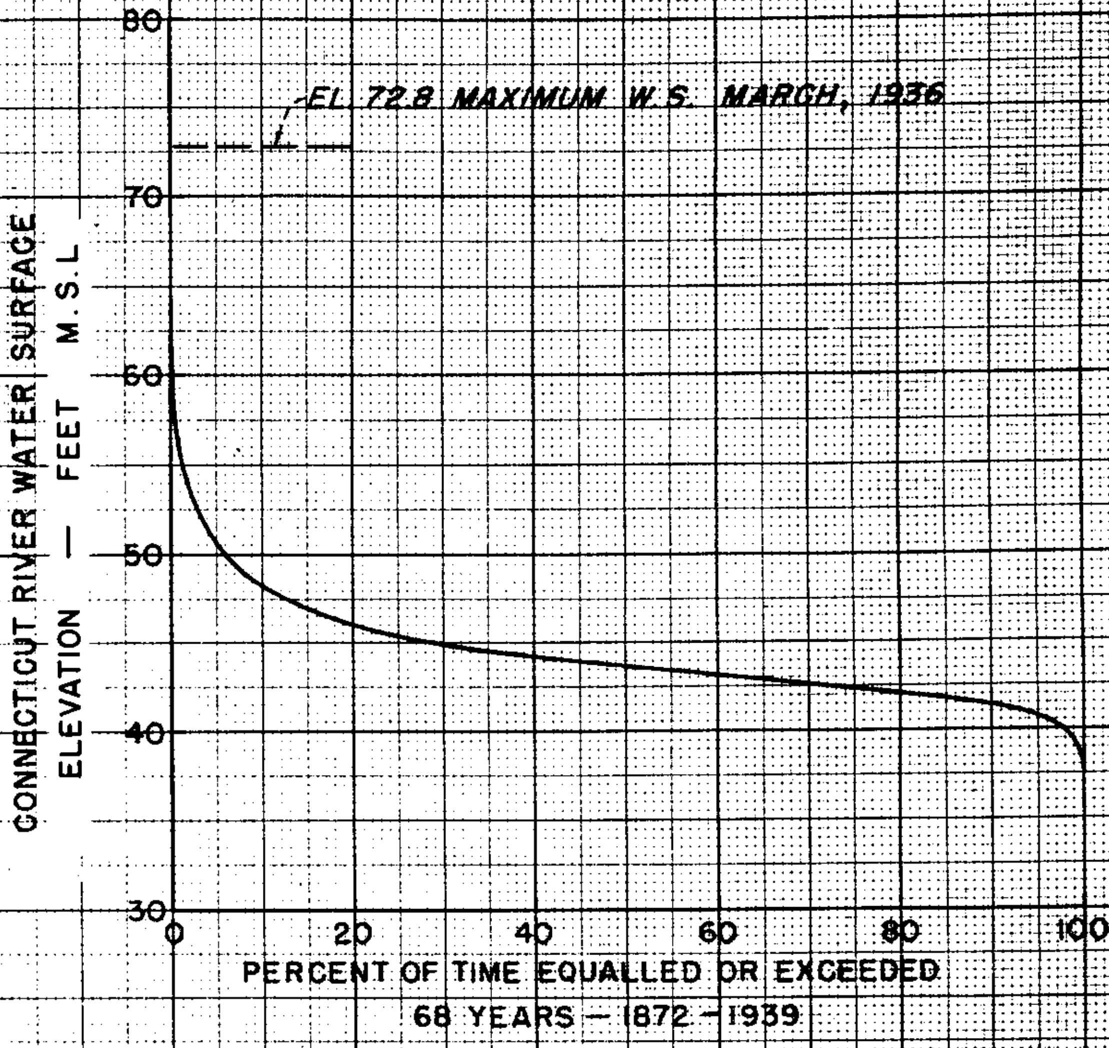


PLATE NO. 7



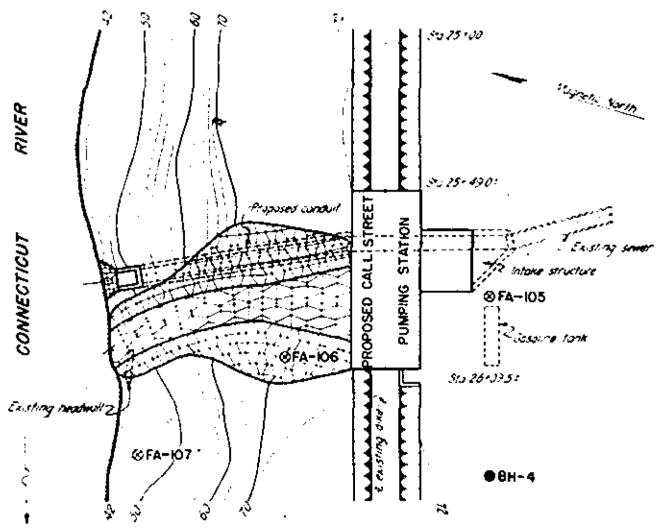
STAGE DURATION CURVE

CALL STREET PUMPING STATION

PLATE NO.8

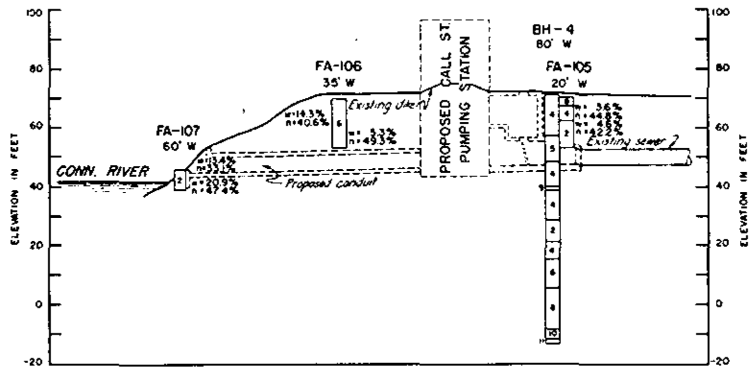
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



PLAN

SCALE 1" = 20'



PROFILE ALONG ℄ CONDUIT

SCALE 1" = 20'

DESCRIPTION OF SOIL CLASSES

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

LEGEND

- ● BH *Drive sample bore hole.*
- ⊗ FA *Foundation auger boring.*
- W *West of ℄ conduit.*
- w *Water content in natural state* = $\frac{\text{Weight of water}}{\text{Weight of solids}}$
- n *Porosity in natural state* = $\frac{\text{Volume of voids}}{\text{Total volume}}$

NOTES

Elevations refer to Mean Sea Level Datum.

Samples, test results, and logs pertaining to the materials from explorations are available for inspection by interested parties at the United States Engineer Office, Providence, R.I.

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

CALL STREET PUMPING STATION

CHICOPEE, MASS.

SUBSURFACE EXPLORATIONS

CONNECTICUT RIVER — MASSACHUSETTS

IN SHEET — SCALE 1 IN. = 20 FT. — SHEET NO.

U. S. ENGINEER OFFICE, PROVIDENCE, R.I. — MAY 1940

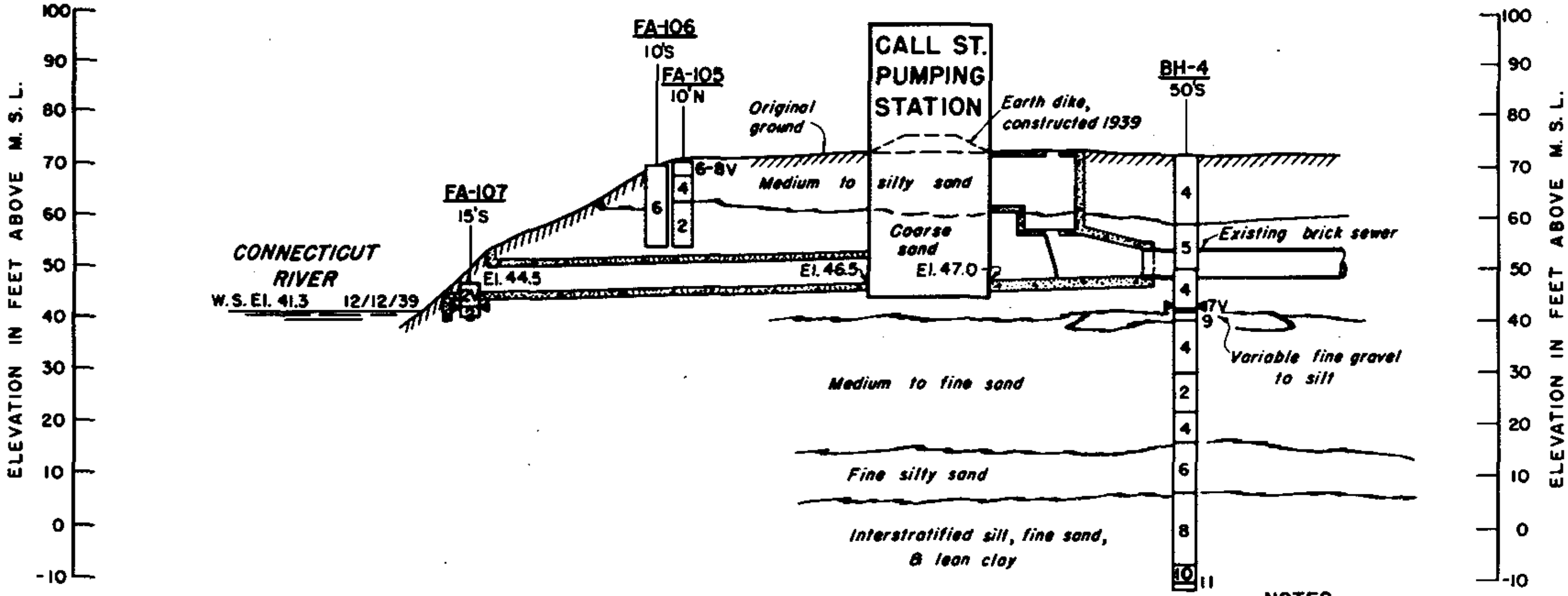
SUBMITTED — APPROVAL RECOMMENDED — APPROVED

FISCAL YEAR 1940

FILE NO. CT-2-1285

A. of D. C. 5d

PLATE NO. 9



PROFILE ALONG ℄ CONDUIT

NOTES

Ground water at time of exploration shown thus ▶◀.
Numbers indicate Providence District Soil Classification.

GEOLOGIC & SOIL PROFILE CALL ST. PUMPING STATION CHICOPEE, MASS. C.5d	
FLOOD CONTROL ENG. DIV., SOILS LABORATORY	
U.S. ENGINEER OFFICE, PROVIDENCE R.I.	
SUBMITTED BY: W. I. K.	SCALE: 1 IN. = 20FT.
ANALYSIS BY: R. A. B.	
DRAWN BY: H. M.	S. L. No. C.5d – A1d
DATE: APRIL 27, 1940	PLATE NO. 11

PLATE NO. 10

PROVIDENCE DISTRICT SOIL CLASSIFICATION

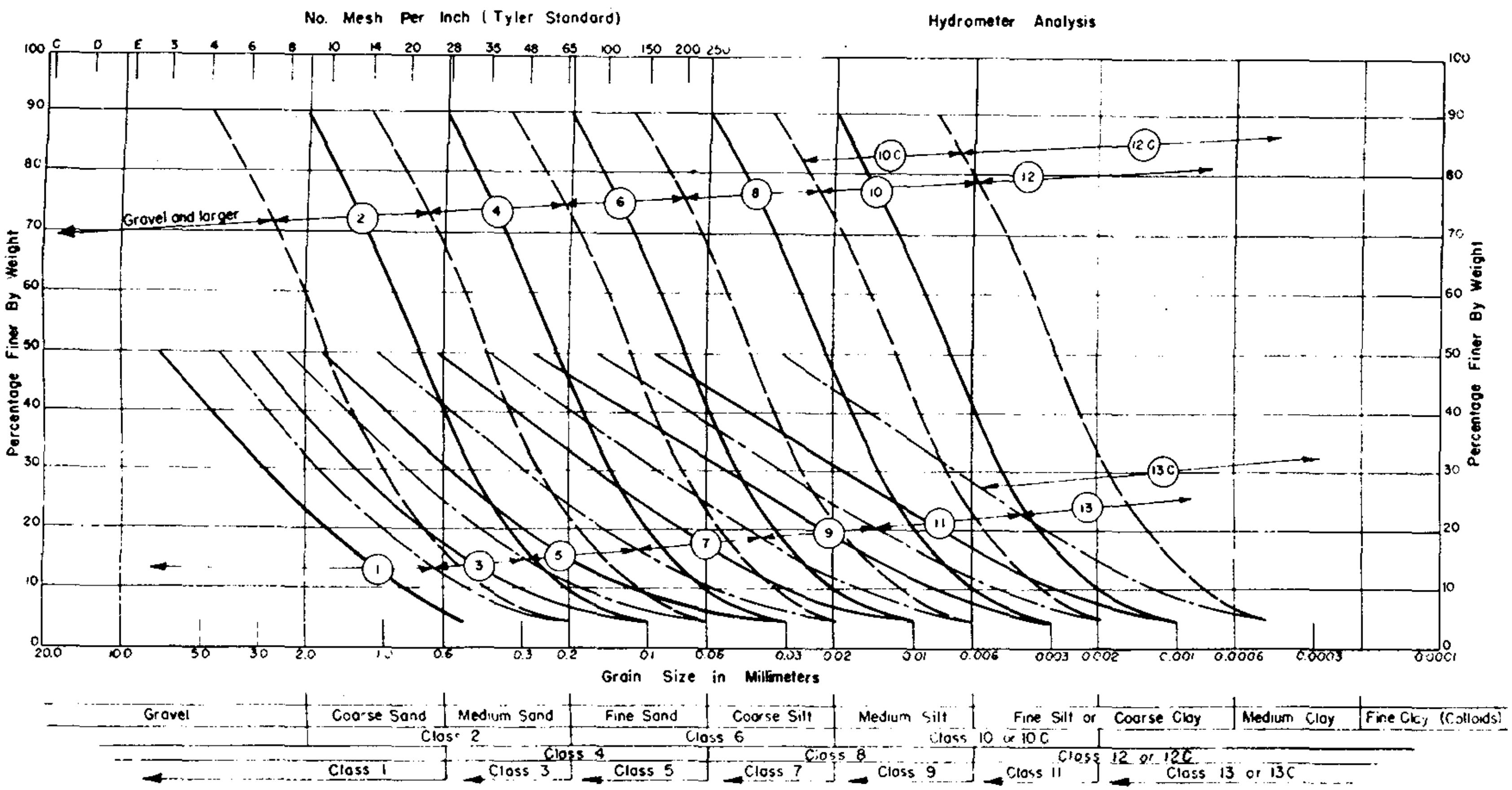
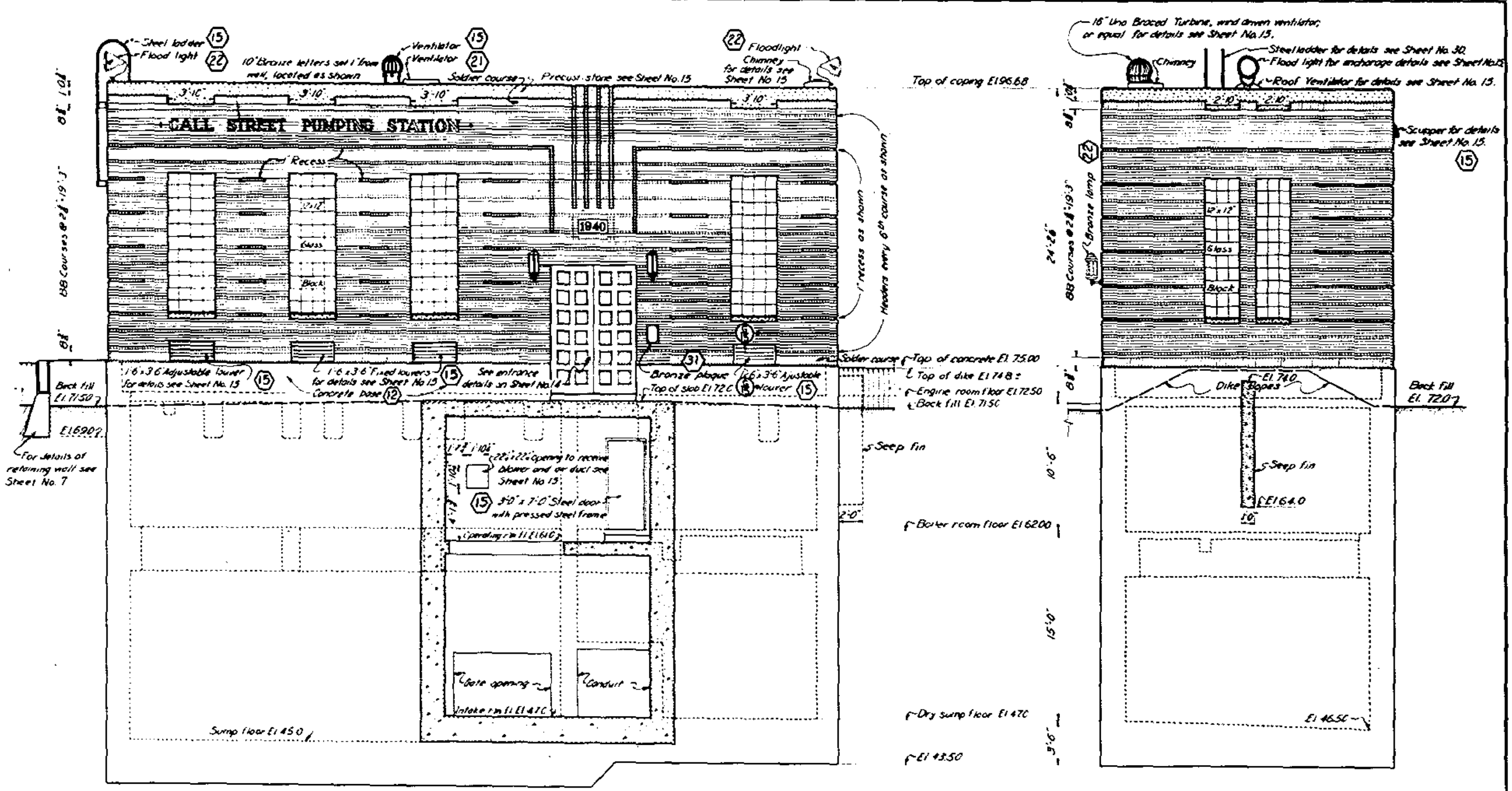


DIAGRAM SHOWING LIMITS OF SOIL CLASSES

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



SOUTH ELEVATION

SCALE $\frac{1}{8}$" = 1'-0"

EAST ELEVATION

SCALE $\frac{1}{8}$" = 1'-0"

NOTES

All items above top of concrete curb will be paid for under Item No 15 except as noted by numbers in hexagons.

All vertical brick dimensions are from bottom of brick joint to bottom of brick joint unless otherwise noted.

Brick dimensions are based on standard brick $2\frac{1}{4}$" x $3\frac{3}{4}$" x 8" with $\frac{3}{8}$" joints.

KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL
CALL STREET PUMPING STATION
CHICOPEE, MASS.
ELEVATIONS NO. 1
ARCHITECTURAL

CONNECTICUT RIVER — MASSACHUSETTS
IN 45 SHEETS — SCALE — SHEET NO. 11
U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — MAY 1940
FISCAL YEAR 1940
FILE NO. CT-4-2433

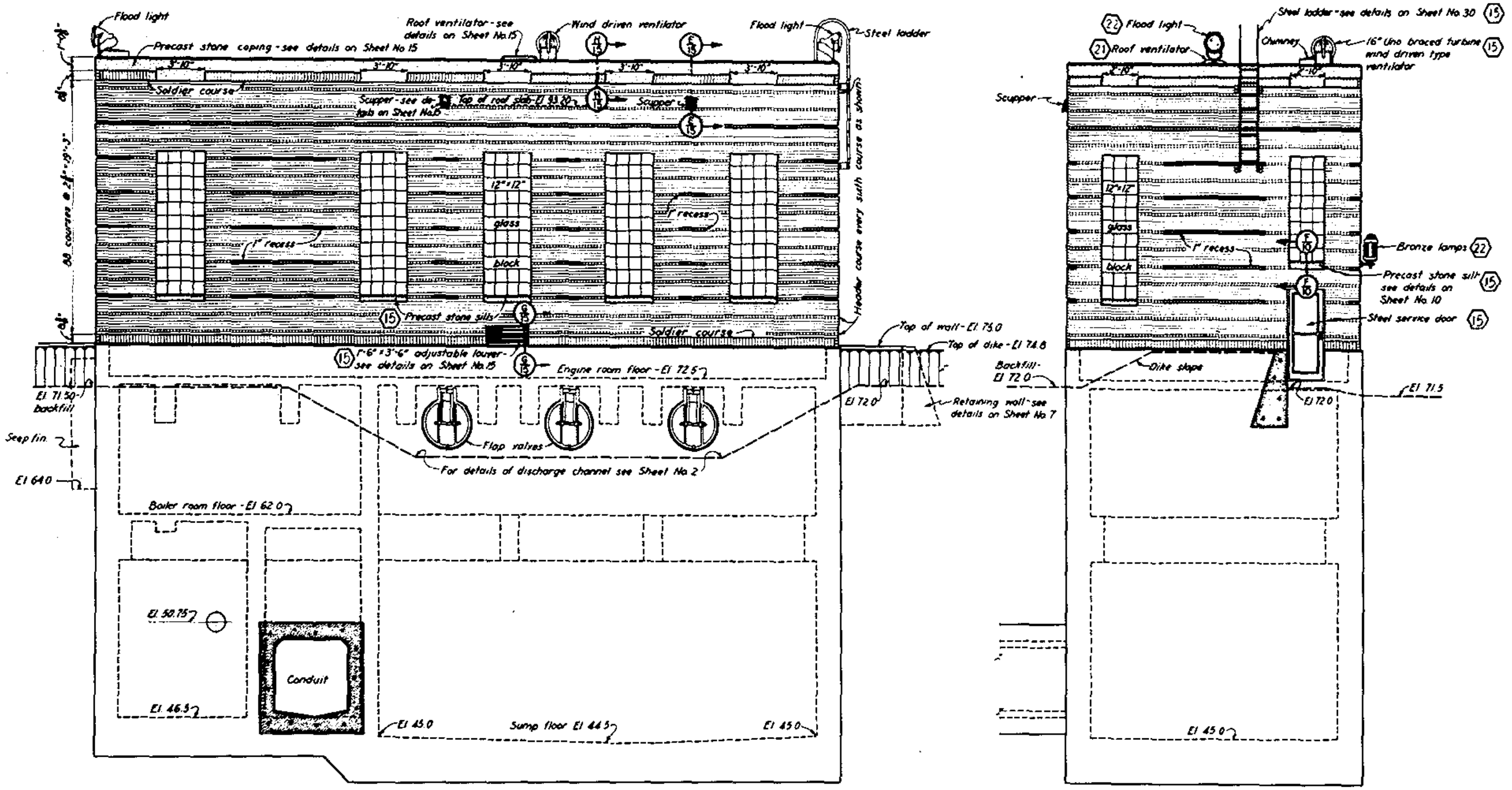
C. 56

11

PLATE NO. 12

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



NORTH ELEVATION

WEST ELEVATION

NOTES

All items above concrete curb will be paid for under item No 15 except as indicated by numbers in hexagons.
All vertical brick dimensions are from bottom of brick joint to bottom of brick joint unless otherwise noted.
Brick dimensions are based on standard brick 2 1/4" x 3 3/4" x 8" with 3/8" joints.

KEY	DATE	REVISION - Indicated by Δ	REV BY	CK. BY	AP BY

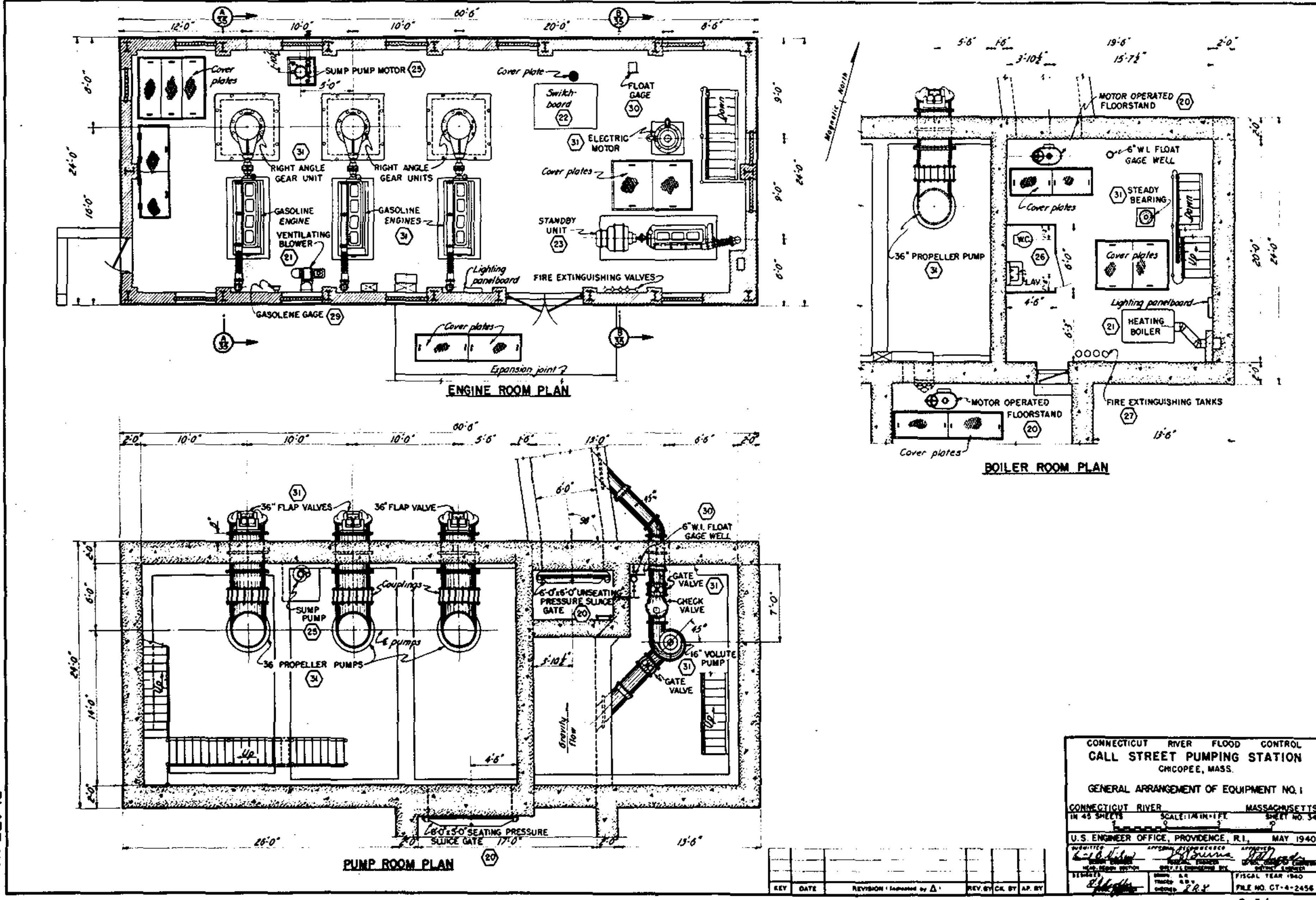
CONNECTICUT RIVER FLOOD CONTROL
CALL STREET PUMPING STATION
CHICOPEE, MASS.
ELEVATIONS NO. 2
ARCHITECTURAL

CONNECTICUT RIVER — MASSACHUSETTS
IN 45 SHEETS — SCALE: 1/4 IN = 1 FT — SHEET NO 12
U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — MAY 1940
FISCAL YEAR 1940
FILE NO. CT-4-2434

PLATE NO. 13

C. 5d

(12)



CONNECTICUT RIVER FLOOD CONTROL
CALL STREET PUMPING STATION
CHICOPEE, MASS.

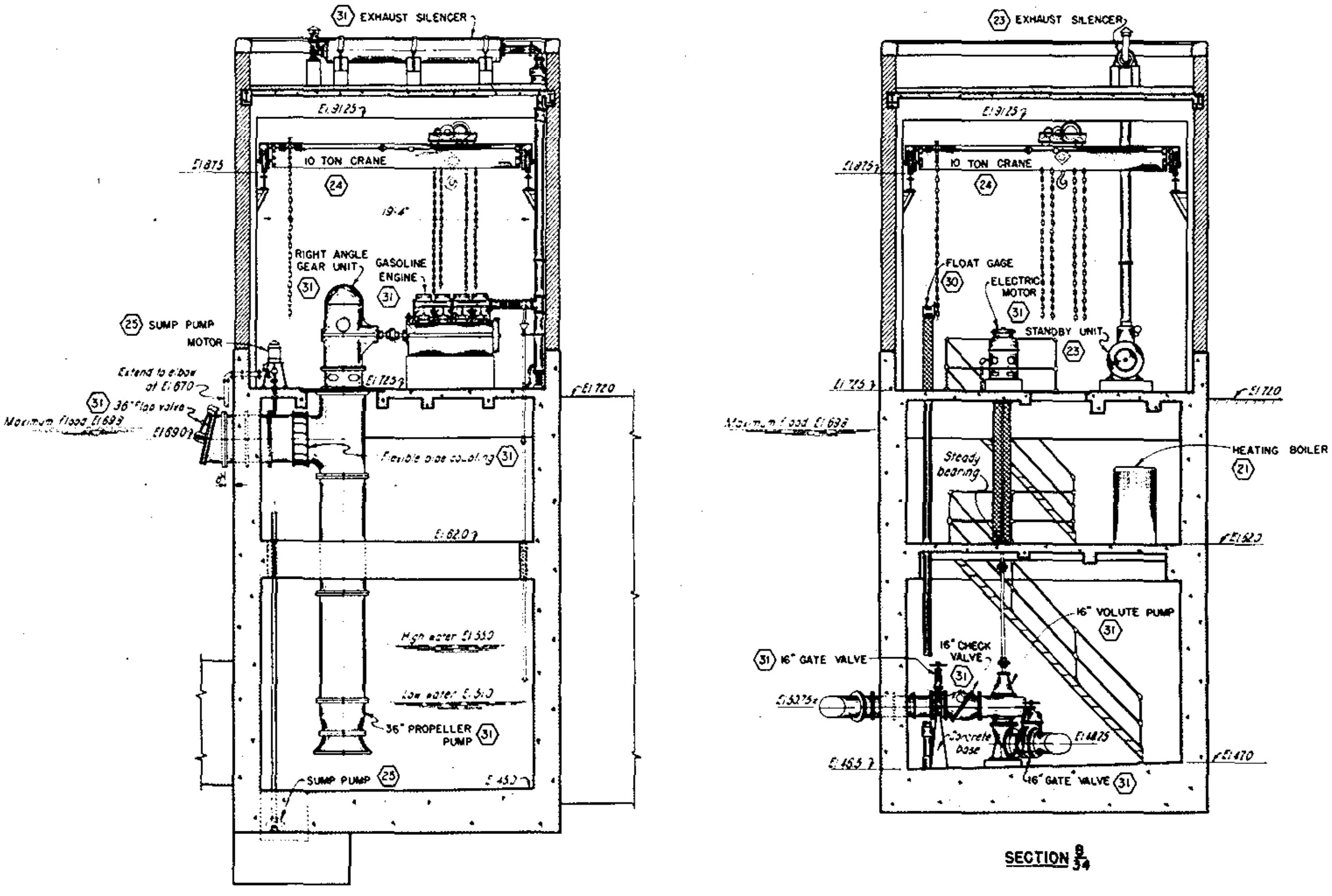
GENERAL ARRANGEMENT OF EQUIPMENT NO. 1

CONNECTICUT RIVER — MASSACHUSETTS
IN 45 SHEETS — SCALE: 1/4 IN = 1 FT. — SHEET NO. 34

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., MAY 1940

FISCAL YEAR 1940
FILE NO. CT-4-2456

KEY	DATE	REVISION	REV. BY	CK. BY	AP. BY



SECTION A/34

SECTION B/34

KEY	DATE	REVISION · Indicated by Δ	REV BY	CK BY	AP BY

CONNECTICUT RIVER FLOOD CONTROL
CALL STREET PUMPING STATION
CHICOPEE, MASS.

GENERAL ARRANGEMENT OF EQUIPMENT NO. 2

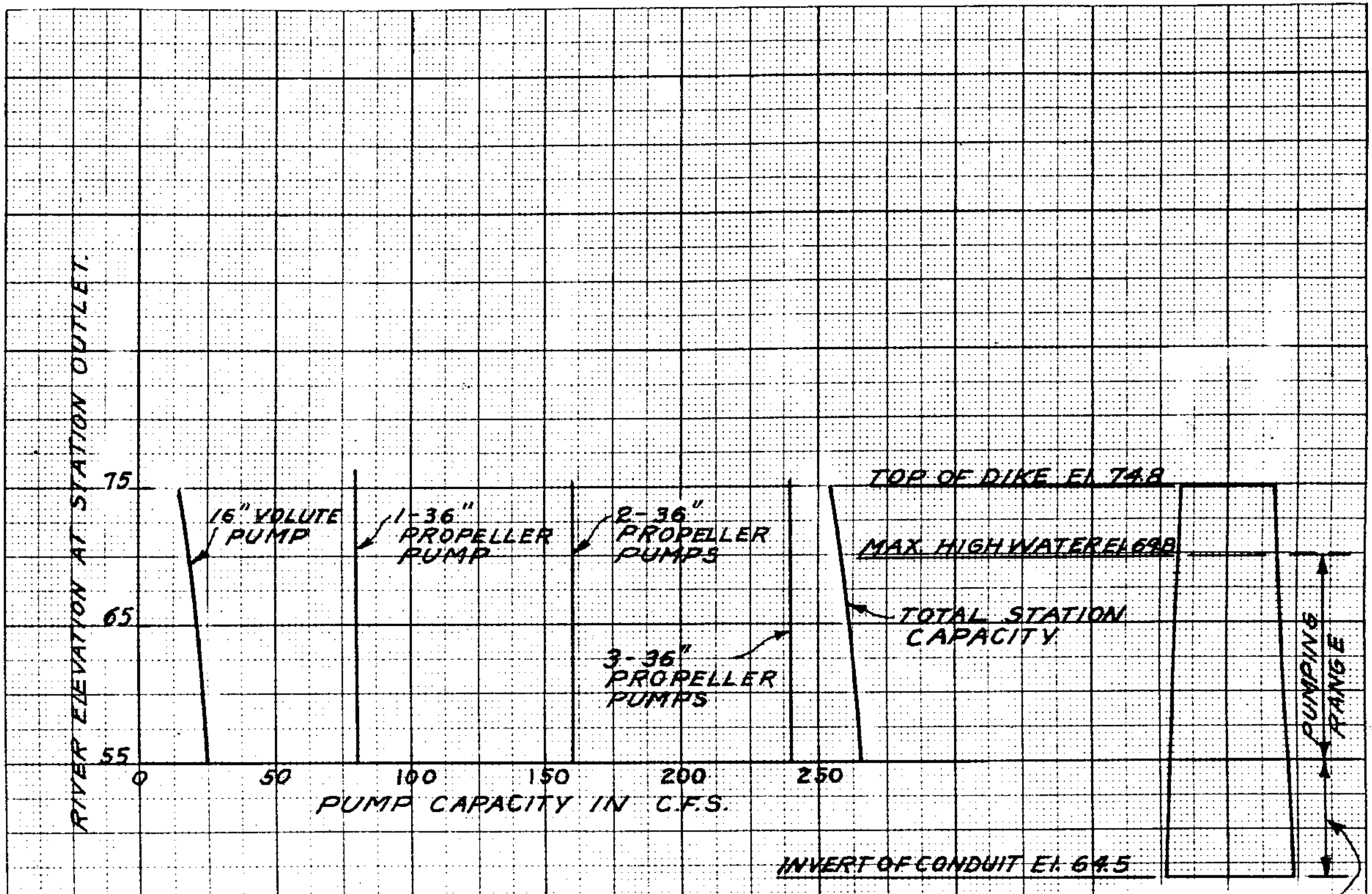
CONNECTICUT RIVER — MASSACHUSETTS
IN 45 SHEETS — SCALE — SHEET NO. 35

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — MAY 1940

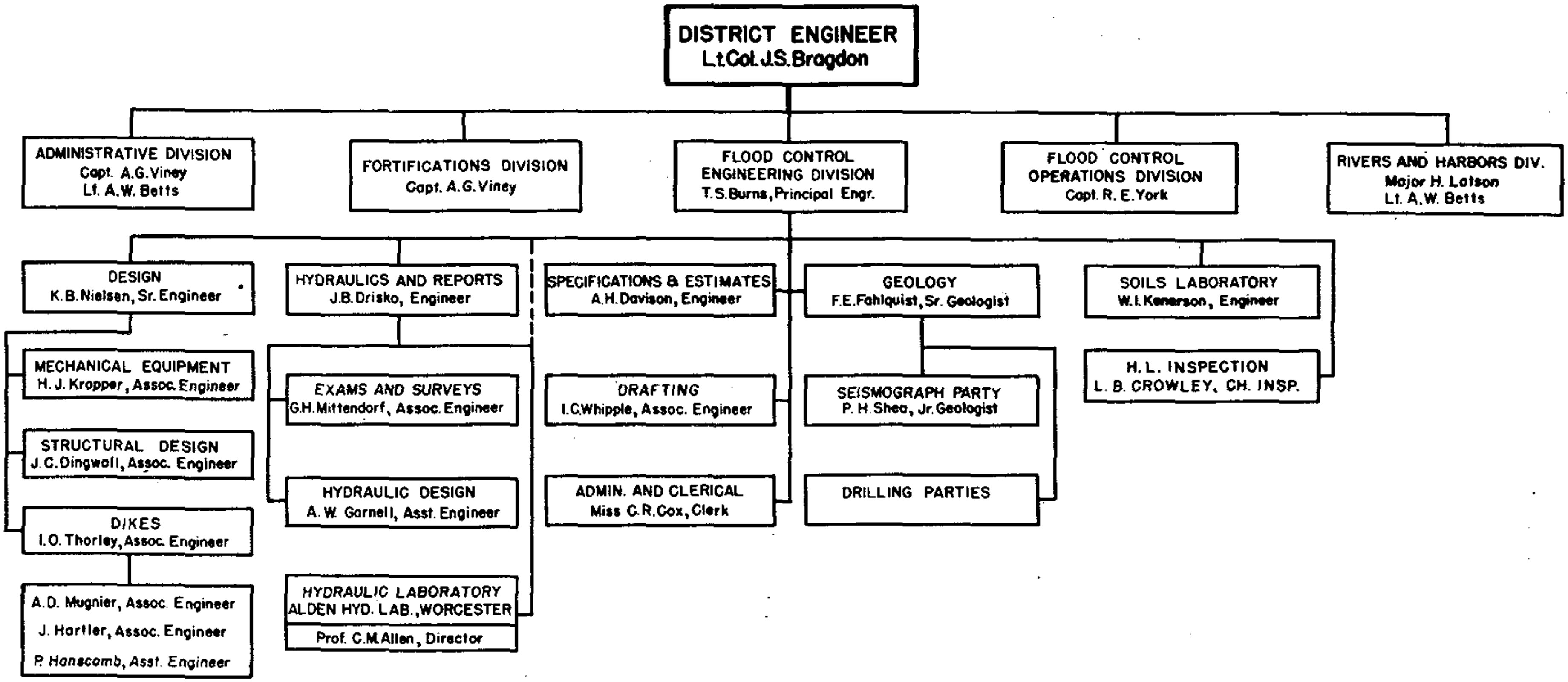
FISCAL YEAR 1940
FILE NO. CT-4-2457

C5d

PLATE NO.16



CALL STREET PUMPING STATION
PUMPING CAPACITY



ORGANIZATION CHART
FLOOD CONTROL
ENGINEERING DIVISION
U.S. ENGINEER OFFICE, PROVIDENCE, R.I.
MAY 1940

PLATE NO. 17

CONNECTICUT RIVER FLOOD CONTROL PROJECT

CHICOPEE, MASS.

CONNECTICUT RIVER, MASSACHUSETTS

ANALYSIS OF DESIGN FOR CALL STREET PUMPING STATION

ITEM C.5d - CONTRACT

APPENDIX A

MAY, 1940

CORPS OF ENGINEERS, U.S. ARMY

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

CALL STREET PUMPING STATION

1940

APPENDIX "A" STRUCTURAL DESIGN

CALL STREET PUMPING STATION

APPENDIX "A" INDEX STRUCTURAL DESIGN

APPENDIX "A" STRUCTURAL DESIGN

A. SPECIFICATIONS FOR STRUCTURAL DESIGN.

1. General. - The structural design of the Call Street Pumping station has been executed in general in accordance with standard practice. The specifications which follow cover the conditions affecting the design of the reinforced concrete and structural steel.

2. Unit weights. - The following unit weights for material were assumed in the design of the structure:

Water	62.5# per cubic foot
Dry earth	100 # per cubic foot
Saturated earth	125 # per cubic foot
Concrete	150 # per cubic foot

3. Earth pressures. - For computing earth pressure caused by dry earth Rankine's formula was used. For saturated soils an equivalent liquid pressure of 80 pounds per square foot per foot of depth was assumed.

4. Structural steel. - The design of structural steel was carried out in accordance with the standard specifications for Steel Construction for Buildings of the American Institute of Steel Construction.

5. Reinforced concrete. - In general, all reinforced concrete was designed in accordance with the "Joint Committee on Standard Specifications for Concrete and Reinforced Concrete" issued in January 1937.

a. Allowable working stress. - The allowable working stress in concrete used in the design of the pump house structure and conduits is based on a compressive strength of 3,000 pounds per square inch in 28 days.

b. Flexure (f_c). - Lbs. per sq. in.

Extreme fibre stress in compression 800

Extreme fibre stress in compression adjacent to supports of continuous or fixed beams or rigid frames 900

c. Shear (v). -

Beams with no web reinforcement and without special anchorage. 60

Beams with no web reinforcement but with special anchorage of longitudinal steel 90

Beams with properly designed web reinforcement but without special anchorage of longitudinal steel. 180

Beams with properly designed web reinforcement and with special anchorage of longitudinal steel. 270

Footings where longitudinal bars have no special anchorage. 60

Footings where longitudinal bars have special anchorage 90

d. Bond (u). -

In beams, slabs, and one way footings 100

Where special anchorage is provided 200

The above stresses are for deformed bars

e. Bearing (f_c). - Lbs. per sq. in.

Where a concrete member has an area at least twice the area in bearing 500

f. Axial compression (f_c). -

Columns with lateral ties. 450

g. Steel stresses. -

Tension.	18000
Web reinforcement.	16000

h. Protective concrete covering. -

Type of members	Minimum cover in inches
Interior slabs	1-1/2
Interior beams	2
Members poured directly against the ground	4
Members exposed to earth or water but poured against forms	3

For secondary steel, such as temperature and spacer steel, the above minimum cover may be decreased by the diameter of the temperature or spacer steel rods.

B. BASIC ASSUMPTIONS FOR DESIGN. -

1. Roof slab. - The roof slab is of reinforced concrete. It is designed to carry the full dead load plus a live load of 40# per square foot of roof surface.

2. Roof beams. - The roof beams are of structural steel encased in concrete fireproofing. They are designed to carry the full dead load, plus the full live load of 40# per square foot of roof surface. In addition to taking up the roof load, these beams, together with the columns to which

they are connected, form portal frames which take up wind load and crane thrusts on the building. The end connections are designed to take up all such horizontal loads.

3. Columns. - a. Structural steel columns in the walls of the superstructure take up the direct roof loads as well as all wind loads on the superstructure. In addition, the columns in the side walls carry crane brackets which support the crane runway. These columns are designed to carry full live and dead load from the roof; dead load, live load and impact effect from the traveling crane; bending due to eccentrically applied loads, and bending due to wind load on the building. No point of inflection was considered in the column designed, a pin-ended condition at the base being assumed.

b. Columns other than the crane columns in the building designed for full dead load and live load from roof, plus wind load on the building.

c. Allowable stress in columns figured from formula

$$P/A = \frac{18000}{1 + \frac{l^2}{18000}}$$

With a maximum allowable stress of 15,000# per square inch for dead load plus live load, and a maximum allowable stress of 20,000# per square inch for combined dead load, live load and wind load; l/r limited not to exceed 120.

4. PUMP ROOM.

a. The station is part of the flood protection dike. The walls are of reinforced concrete to Elevation 75.00 and of brick and steel construction from thereon up.

b. In designing the pump room the assumption was made that the whole transverse section acted as a continuous frame. It was assumed that the side members of this transverse section were hinged at the level of the engine room floor, hinged at the level of the wale beams and fully restrained at the level of the pump room floor slab.

c. The continuous frame was investigated for the condition of loading assuming a hydrostatic head on the riverside up to Elevation 72.00, while on both the riverside and landside saturated earth was assumed to Elevation 66.00. The loading on the base slab was taken as the distributed load of the building less the weight of the base slab.

d. The end walls of the pump room were investigated for two cases:

(1) Case I. - The end walls were assumed supported at the upper edge, supported at an intermediate point 16'-3" above the base slab and fixed at the base.

(2) Case II. - Seventy-five percent fixity at the base was assumed.

Saturated earth was assumed to Elevation 66.00.

When the end walls are fully restrained at the base slab maximum negative moment occurred while for maximum positive moment only 75% fixity occurred between end walls and the base slab.

5. <u>HORIZONTAL WALERS AND CROSS BEAMS.</u>

In order to decrease the thicknesses of the exterior concrete walls in the substructure, concrete walers and cross beams were placed at Elevation 60.75.

The transverse beams were assumed hinged at the wale beams. The difference in thrust between the riverside and landside wale beams was distributed to the transverse walls at the conduit and by strengthening the wales at these points.

6. <u>BOILER ROOM.</u>

The boiler room floor was designed for a uniform live load of 200#/sq.ft. for the concrete slab and a uniform live load of 160#/sq.ft. for the concrete beams, except for that portion of the floor slab occupied by the gate hoist. This portion of the floor was designed for the full load on the gate hoist plus the weight of the gate.

7. <u>INTAKE CONDUIT.</u>

The intake conduit is connected to the existing brick sewer at its south end and to the trash rack chamber at its north end. The conduit varies in section from a rectangle 4 feet wide by 5 feet high at the sewer end to a rectangle 17 feet wide by 8'-6" high at the trash rack chamber end. The conduit was designed as a continuous frame subject to a saturated earth loading. The earth was assumed to be at an elevation of 72.0 feet.

8. <u>TRASH RACK CHAMBER.</u>

The trash rack chamber is attached to the landside wall of the pumping station. The chamber is 23'-9" high by 17' feet wide. The trash rack section is 8'-6" high and loads directly into the wet sump and the gravity flow conduit. The transverse section of the chamber was designed as a continuous frame subject to an H-20 loading on the top slab, a uniform load of 100# per square foot on the raking platform, and saturated earth fill on the sidewalls. The south wall of the chamber was designed as a restrained beam acting between the top slab and the raking platform.

9. DISCHARGE CONDUIT.

The discharge conduit is attached to the east face of the dividing wall between the wet and dry sumps. The conduit is 6 feet high by 6 feet wide and was designed as a continuous frame subject to saturated earth loading. During normal flow the conduit operates as a gravity conduit. In flood periods the conduit is closed to flow by a gate in the trash rack chamber, the sewage flow being diverted through the wet sump.

10. TRASH RACKS.

There is one trash rack, in two sections, at this station, located in the intake structure. The rack is made of two structural channel frames which support 4 x 3/8 inch round edge grating bars spaced 3-1/4 inches in the clear. The rack is welded throughout.

The trash rack is designed on the assumption of stoppage of 50 percent of flow with the water rising above the top of the trash rack.

11. STAIRWAYS AND LADDERS.

An open grating steel stairway leads from the dry pump room floor to the engine room floor. A steel ladder is provided on the outside of the building for access to the roof of the building.

C. COMPUTATIONS. -

WAR DEPARTMENT

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

Page 8

Subject Call St. Pumping Sta.

Computation Wgt. of Mechanical Equipment

Computed by W. W. Z. Checked by ______ Date ______

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Gasoline Engines	6000#
Conc. Block under Gas. Eng. 4'-0" x 8'-6" x 1-7"	7700#
Gear Reduction Unit	5300#
Propeller Pump	18000#
Thrust on Propeller Pump	12000#
Flap Valve & Discharge Pipe Full of Water	7300#
Motor for Volute Pump	1800#
Conc. Block under Volute Pump Motor 3'-0" x 3'-0" x 0'-6"	700#
Thrust on Volute Pump	4000#
Standby Unit	14000#
Conc. Block under Standy by Unit 11'-6" x 4'-0" x 0'-9"	5000#
Switchboard	4000#
10 Ton Crane	
Max. Wheel Load	12000#
c. to c. Wheels	6'-8"
Use 30# ASCE Rail	
Volute Pump	3000#
Boiler	2000#
Floorstand (5'-0" x 5'-0" Sluice Gate) including Gate Load	12000#
Floorstand (8'-0" x 5'-0" Sluice Gate) including Gate Load	15000#

Project: Call St. Pumping Sta.
Computation: Concrete Roof Slab
Computed by: W. W. Z. Checked by: Date: 4-9-40

Assume 5" Solid Conc. Slab 5×12.5	= 65 #/□'
Roofing	= 6
3" Conc. Fill	= 30
L.L.	= 40
	140 #/□'

End Span = 9'-0" $M = \frac{1}{10} wL^2$
Intermed. Span = 9'-2" $M = \frac{1}{12} wL^2$

$M = \frac{1}{10} \times 140 \times (9)^2 = 1140$ '#

$d = \sqrt{\frac{1140}{123}} = 3.02$ say 3.5"

$A_s = \frac{1140 \times 12}{7/8 \times 18000 \times 3.5} = 0.248$ □" Use $\frac{1}{2}$"φ @ 9" o.c. Alternate bars bent

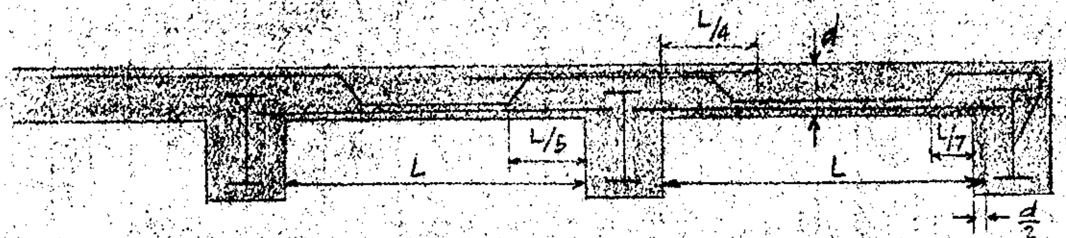
$v = \frac{140 \times \frac{1}{2} \times 9.0}{7/8 \times 12 \times 3.5} = 17$ #/□"

$u = \frac{17 \times 12}{1.57 \times \frac{12}{9}} = 98$ #/□" Special Anchorage.

$M = \frac{1}{12} \times 140 \times (9.17)^2 = 985$ '#

$A_s = \frac{985}{1140} \times 0.248$ □" $= 0.214$ □" Use $\frac{1}{2}$"φ @ 9" o.c. Alternate bars bent

5" Roof Slab
½"φ bars @ 9" o.c. Alter. bars bent (hook one end) End Spans
½"φ bars @ 9" o.c. Alter. bars bent Intermediate spans.



Subject Call St. Pumping Sta

Computation Steel Roof Beams

Computed by W. W. Z. Checked by ______ Date 4-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

RB1

Span = 22'-0"

Loading $\frac{5}{8}(9'-0") + \frac{1}{2}(10'-?) = 10.62 \times 140$ #/□ = 1500 #/'

Assume 18" WF @ 50 = 50

Fireproof'g = 220

177.0 #/'

$M = \frac{1}{8} \times 1770 \times \overline{22}^2 = 107000$ '#

$S = \frac{107000 \times 12}{18000} = 71.5$ ins³

Try 18" WF 47#

$R = \frac{1}{2} \times 22 \times 1770 = 19500$ #

Allow. $\Delta = \frac{1}{360} \times 22 \times 12 = 0.67"$

Actual $\Delta = \frac{5}{384} \times \frac{1770 \times \overline{22}^4 \times \overline{12}^4}{30 \times 10^6 \times 736.4} = 0.51"$ OK

Use 18" WF 47#

RB2

Span = 22'-0"

Loading 10' × 140 #/□' = 1400 #/'

18" WF 47 = 47

Firep'g = 220

1667 #/' say 1670

$M = \frac{1}{8} \times 1670 \times \overline{22}^2 = 101000$ '#

$R = \frac{1}{2} \times 22 \times 1670 = 18400$ #

$S = \frac{101000 \times 12}{18000} = 67.5$ ins³

Use 18" WF 47#

RB3

Span = 22'-0"

Loading 10.5 × 140 = 1470 #/'

18" WF = 47

Firep'g = 220

1737 #/'

$R_L = \frac{1}{2} \times 1740 \times 22 = 19100$ #

Use 18" WF 47#

WAR DEPARTMENT

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

Subject: Call St. Pumping Sta.

Computation: Roof Bms.

Computed by: W. W. Z. Checked by: ______ Date: 4-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

RB4

span = 22'-0"

Loading $\frac{5}{8}(9'-0") + \frac{1}{2}(11'-0")$ 140 = 1560 #/'

18" WF 47 = 47

Firep'g = 220

1827 #/' say 1830

R = $\frac{1}{2}$ × 22 × 1830 = 20100 #

deflection OK

Use 18" WF 47 #

Spandrel Steel Beam supporting Roof Steel Bm.

Span = 13'-0"

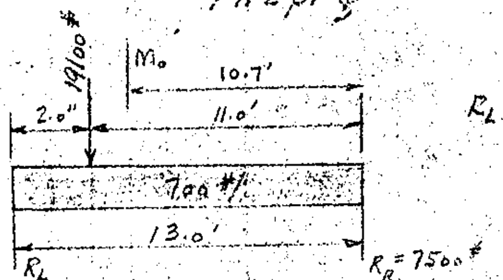
Loading Roof Bm. Reaction = 19100 #

12" brick wall 3.5 × 120 # = 420 #/'

18" Bm = 50 #

Firepr'g = 220

690 #/' say 700 #/'



R_L $\frac{1}{2}$ × 13 × 700 = 4550 #

$\frac{11}{13}$ × 19100 = 16150

20700 #

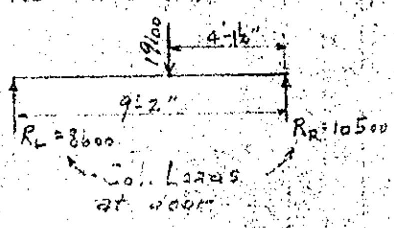
$M = 7500 \times 10.7 - 700 \times \frac{(10.7)^2}{2} = 40100$ '#

$S = \frac{40100 \times 12}{18000} = 27$ ins^3

Use 18" WF 47 #

Revised. 4/17/40 span c. to c. = 9'-2"

Use 18" WF 47 #



WAR DEPARTMENT

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

Subject: Call St. Pumping Sta.
Computation: Steel Roof Beams
Computed by: W. W. Z. Checked by: Date: 4-9-40

End Spandrel Beams span = ½ × 22 = 11.0' c to c.

Parapet Wall 3.5 × 120 = 420 #/'
Beam 8" WF 24
Firep'g 125
5" Conc. Slab 63 #/□'
3" Cind. Fill 30
L.L. 40
$\frac{3}{8}$ × 9' × 133 #/□' = 450
1020 #/'

R = 1020 × 5.5 = 5600 #

M = ⅛ × 1020 × 121 = 15500 '#

$S = \frac{15500 \times 12}{18000} = 10.3$ ins.³

Use 8" WF 17 #

Make all other spandrel beams 8" WF 17 #

For span = 10'-0" Reaction: Par. Wall = 420 #/'
Bm = 17
Firep'f = 125
565 # × 5 = 2800 # = R.

For span = 11'-0" R = 565 × 5.5 = 3100 #

For span = 9'-0" R = 565 × 4.5 = 2600 #

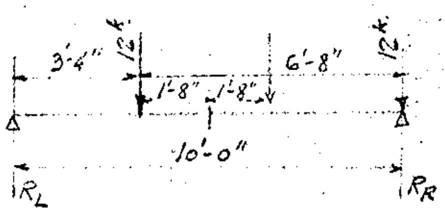
WAR DEPARTMENT

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

Project: Cali St. Pumping Sta

Computation: Crane beams

Computed by: W. W. Z. Checked by: Date: 4-9-40



10 Ton Crane – 12000#/wheel
6'-8" c. to c. wheels
30# ASCE Rail

$L = 10 \times 12 = 120''$

try 12" WF 40# Flange = 8"

$$\text{Allow. } f_s = \frac{20000}{1 + \frac{(120)^2}{2000(64)}} = 18000 \text{ \#/□''}$$

R_L (L.L.) $24000\# \times \frac{3.33}{10} = 8000\#$

Mom. (L.L.) $8000 \times 3.33 = 26670'\#$

Impact 25% = 6680

Mom. (D.L.) $\frac{1}{8} \times 65\# \times (10)^2 = 810$

$34160'\#$

Lateral Moment due to side thrust :-
Side Thrust 20% Crane capacity =
$(20000 \times 20\%) \frac{1}{4} = 1000\#/\text{wheel}$

Lat. Mom. $= \frac{1000}{12000} \times 26670 = 2220'\#$

Unit Stress due to Vert. loads $= \frac{34160 \times 12}{51.9} = 7900 \text{ \#/□''}$

do. Horiz. $\frac{2220 \times 12}{(\frac{1}{2} \times 11.0)} = 4800$

12700 #/□" (Low)

For sake of uniformity and construction

Use 12" WF 40#

Max. Vert. Shear	16000#
Bm.	200
Rail, etc.	80
	16280#

Max. Horiz. Thrust @ $R_R = 2000 \times \frac{6.67}{10} = 1330\#$

WAR DEPARTMENT

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

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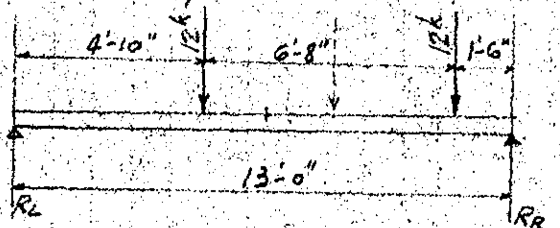
(Pro)ject: Call St. Pumping Sta.

(Co)mputation: Crane Beams

(Co)mputed by: W. W. Z. Checked by ______ Date: 4-9-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Span 13'-0" c. to c.



$L = 13 \times 12 = 156$"

Try 12" WF 53# Flange = 10"

$$\text{Allow. } f_s = \frac{20000}{1 + \frac{(156)^2}{2000 \times (10)^2}}$$

$= 17900$ #/□"

(L.L.) $R_L = 24000 \times \frac{4.83}{13.0} = 8920$#

Mom. (L.L.) $8920 \times 4.83 = 43200$ '#

Impact 25% = 10800

Mom. (D.L.) $\frac{1}{8} \times 65 \times 169$ = 1370

55370 '#

Lat. Mom. $= \frac{1000}{12000} \times 43200 = 3600$ '#

Actual Stress due to Vert. Loads $= \frac{55370 \times 12}{70.7} = 9400$ #/□"

do. Horiz. $= \frac{3600 \times 12}{9.6} = 4500$

} 13900 #/□" (Low)

For structural reasons –

Use 12" WF 53#

Max Vert. Shear $= \frac{9.67}{13.0} \times 24000 = 17850$#

Bm. = 350

Rail, etc 110

18310 #

Max. Horiz. Thrust $= \frac{9.67}{13.0} \times 2000 = 1490$ #

No 13'-0" span — Revised 4/17/40

Span 9'-2"

Use 12" WF 40# Crane Beam

WAR DEPARTMENT

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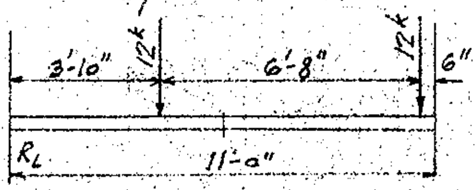
Project Call St. Pumping Sta.
Computation Crane Beams
Computed by W. W. Z. **Checked by** **Date** 4-9-40

Span = 11'-0"



R_L (L.L.) 24000 × $\frac{3.83}{11}$ = 8360 #
Mom. (L.L.) 8360 × 3.83 = 32000 '#
Impact 25% = 8000
40000
Mom. (D.L.) ⅛ × 65 × 121 = 980
40980 '#

L = 132"
Try 12" WF 40# Flange = 8"

Allow $f_s = \frac{20000}{1 + \frac{(132)^2}{2000 \times 64}}$
= 17600 #/□"

Lat. Mom. $\frac{1000}{12000}$ × 32000 = 2670 '#

Actual Stress due to Vert. Loads $\frac{40980 \times 12}{51.9}$ = 9470 #/□"
do Horiz. $\frac{2670 \times 12}{5.5}$ = 5830
15300 #/□"

Use 12" WF 40#

Max. Vert. Shear $\frac{7.67}{11.0}$ × 24000 = 16700 #
Bm = 220
Rail etc = 100
17020 #

Max. Horiz. Thrust = $\frac{7.67}{11.0}$ × 2000 = 1400 #

ject Gall St. Pumping Sta.
omputation Crane Beams
omputed by W. W. Z. Checked by ______ Date 4-10-40

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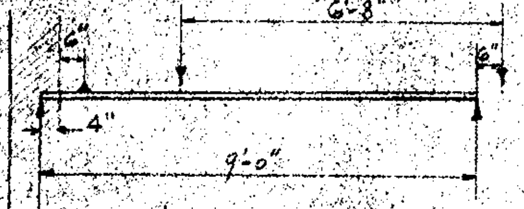
Span = 9'-0" c to c.



(L.L) Mom. = $24000 \times \frac{(2.83)^2}{9.0}$ = 21400 '#

Impact 25% = 5350

(D.L.) Mom. = $\frac{1}{8} \times 65 \times 81$ = 650

27400 '#

$L = 9 \times 12 = 108"$

Try 12" WF 28# Flange = $6\frac{1}{2}$"

Lat. Mom. = $\frac{1000}{12000} \times 21400$ = 1780 '#

Allow $f_s = \dfrac{20000}{1 + \dfrac{(108)^2}{2000 \times 42.3}}$ = 17550 #/□"

Actual Stress due to Vert. Loads $\frac{27400 \times 12}{35.6}$ = 9250 #/□"

do. Horiz. $\frac{1780 \times 12}{(\frac{1}{2} \times 5.4)}$ = 7920

} 17170 #/□" ok

Use 12" WF 28#

Max. Vert. Shear = $\frac{5.67}{9.0} \times 24000$ = 15150 #
Bm. 125
Rail, etc. 75
15350 # @ R_R

$\frac{4.83}{9.00} \times 24000$ = 12900 #
125
75
13100 # @ R_L

Max. Horiz. Thrust = $\frac{5.67}{9.0} \times 2000$ = 1260 #

$\frac{4.83}{9.0} \times 2000$ = 1100 # @ R_L

WAR DEPARTMENT

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

Project: Call St. Pumping Sta.
Computation: Steel Columns
Computed by: W.W.Z. Checked by: Date: 4-10-40

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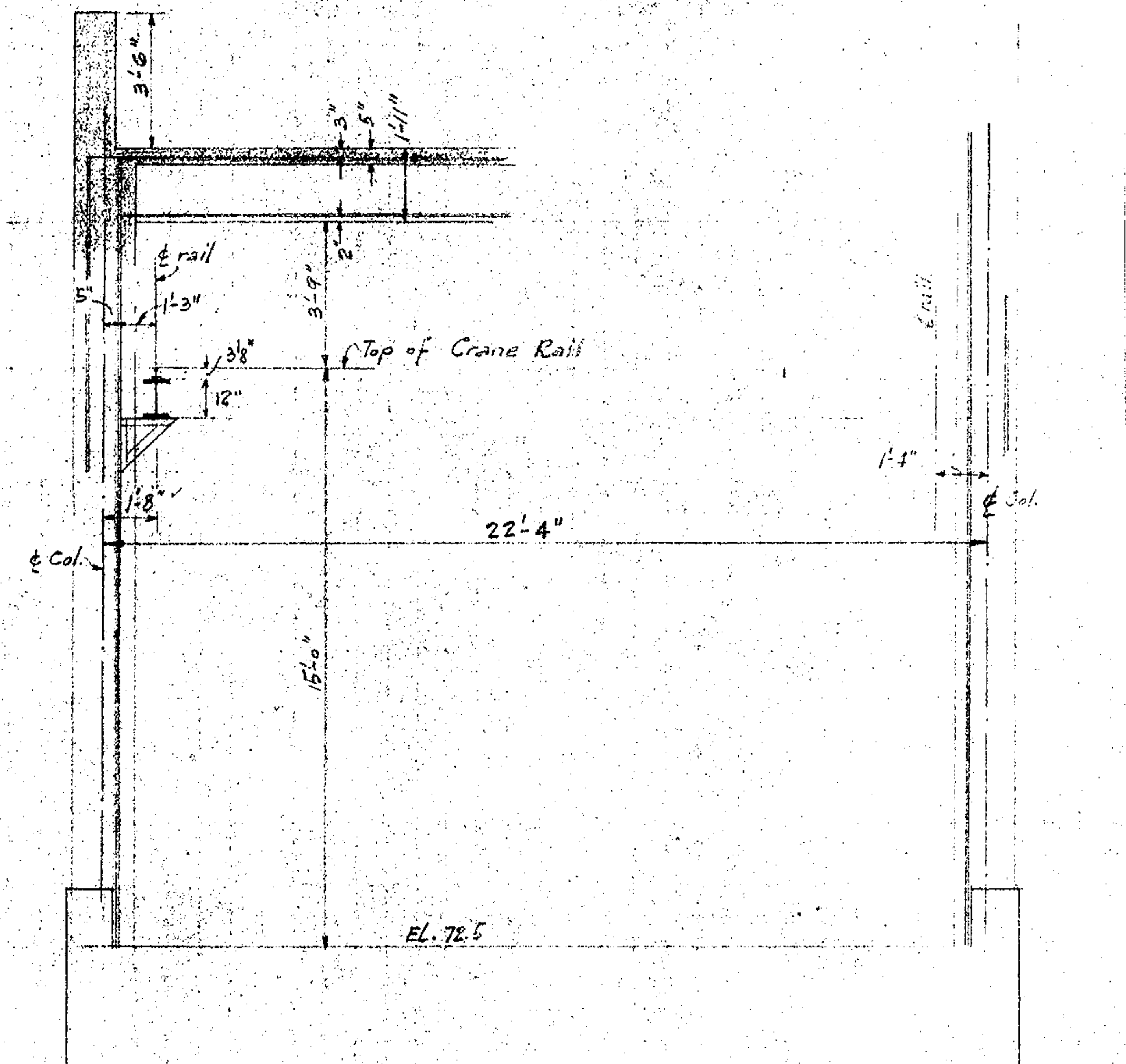
TYPICAL BENT



WAR DEPARTMENT

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

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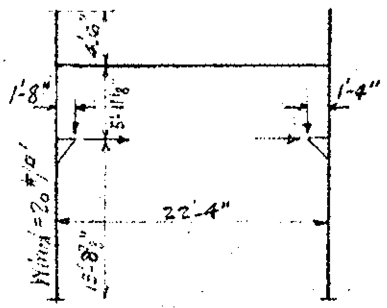
Project: Call St. Pumping Sta.
Computation: Steel Crane Columns
Computed by: W. W. Z. Checked by: Date: 4-10-40

U. S. GOVERNMENT PRINTING OFFICE 8—10528

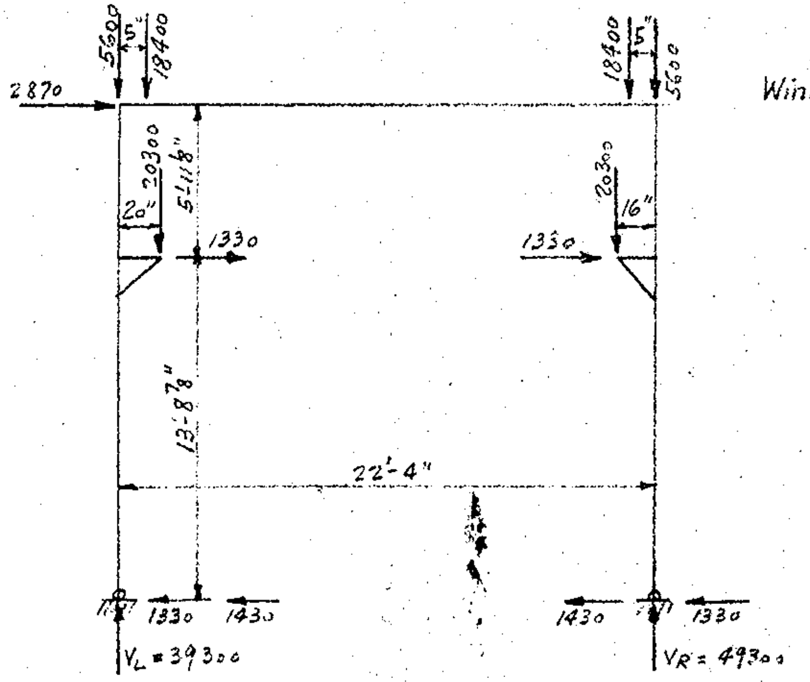
Wind = 20 #/□' or 20×10 = 200 #/'

Bracket Load - L.L. =	16000 #	
25% Impact	4000	
D.L. =	300	
	20300 #	e = {1'-4", 1'-8"}
Crane Thrust =	1330 #	
Reactions: Roof Beam =	18400 #	e = 5"
2 Spandrel Bms =	5600 #	e = 0



Wind Load: 200 × 4.5' = 900 #
½ × 19.67 × 200 = 1970
2870 #

Wind Thrust each column = 1430 #



P
5600 #
18400
20300
total = 44300 #

Leeward Column -

Max. moment at bracket due to Lateral thrust = 1300 × 13.74 =		17900 '#
do.	Roof beam = 18400 × 0.42 =	7550
do.	Bracket Load = $\frac{20300 \times 1.33}{19.67} \times 13.74$ =	18800
do.	Wind Load = 1430 × 13.74 =	19650
	total =	63900 '#

WAR DEPARTMENT

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

Project Call St. Pumping Sta.

Computation Crane Columns

Computed by W.W.Z. Checked by ________ Date 4-11-40

(cont'd)

Try 10" WF 49# $L = 13.74 \times 12 = 165"$ $r = 2.54$ $\frac{L}{r} = \frac{165}{2.54} = 65$

$$\text{Allow. } f_s = 1.33 \left[\frac{18000}{1 + \frac{(65)^2}{18000}} \right] = 19350 \text{ \#/□"}$$

$$\left.\begin{array}{l} \frac{P}{A} = \frac{44300}{14.40} = 3080 \text{ \#/□"} \\ \frac{M}{S} = \frac{63900(12)}{54.6} = 14000 \text{ \#/□"} \end{array}\right\} 17080 \text{ \#/□"} < 19350 \text{ \#/□"} \quad \text{OK.}$$

Use 10" WF 49# Col. #1.

WAR DEPARTMENT

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

Project: Call St. Pumping Sta.
Computation: Crane Columns (Corner)
Computed by: W.W.Z. Checked by: Date: 4-11-40

Reaction Spandrel Bm. — 2600# e = 5"
do. — 5600# e = 0

Crane Load — L.L. 12900; Imp. 3250; D.L. 250 — 16400# e = 1'-8"

Lateral Thrust 1100#

Total: 24600#

Wind Thrust taken by End Walls

Max. mom. due to Lateral Force	1100 × 13.74	=	15100'#
do. Beam	2600 × 0.42	=	1100
do. Bracket Load	$\frac{16400 \times 1.67}{19.67} \times 13.74$	=	19150
			35350'#

Try 10"WF 33# $L = 165"$ $r = 1.94"$ $\frac{L}{r} = \frac{165}{1.94} = 85$

$$\text{Allow. } f_s = 1.33\left[\frac{18000}{1 + \frac{(85)^2}{18000}}\right] = 17050 \text{ \#/□"}$$

$$\frac{P}{A} = \frac{24600}{9.71} = 2530 \text{ \#/□"}$$

$$\frac{M}{S} = \frac{35350(12)}{35.0} = 12100$$

} 14630#/□" < 17050#/□" ok.

Use 10"WF 33# (Corner Columns)

Project: Call St. Pumping Sta.
Computation: End Steel Columns
Computed by: W.W.Z. Checked by .... Date: 4-11-40

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Spandrel Bm. Reactions = 2 × 5600# = 11200#

Wind Load = 20 × 11 = 220 #/'

$M = \frac{1}{8} \times 220 \times (19.67)^2 = 10650$ '#

$L = 19.67 \times 12 = 236''$

Try 8" WF 24# $r = 1.61$ $\frac{L}{r} = \frac{236}{1.61} = 147$

$$\text{Allow. } f_s = 1.33 \left[\frac{18000}{1 + \frac{(147)^2}{18000}} \right] = 10900 \text{ \#/□''}$$

$$\left.\begin{array}{l} \frac{P}{A} = \frac{11200}{7.06} = 1600 \text{ \#/□''} \\ \frac{M}{S} = \frac{10650(12)}{20.8} = 6150 \end{array}\right\} 7750 \text{ \#/□''} < 10900 \text{ \#/□''} \quad \text{OK.}$$

Use 8" WF 24#

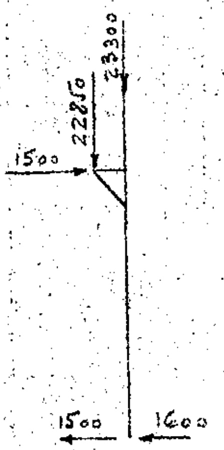
Project: Call St. Pumping Sta.
Computation: Steel Column at Door
Computed by: W. W. Z. Checked by: ______ Date: 4-11-40

U.S. GOVERNMENT PRINTING OFFICE 3—10538

Roof Beam Reaction — 20700# e=0"
do. — 2600 e=0"

Crane Loads: 17900#
25% Impact 4475
D.L. 475
total — 22850# e=1'-8"

Lateral Thrust = 1500#
Wind Force at bottom of Column = 1600#



Max. moment at bracket –
Max moment due to Roof beams = 0
do. Crane Load $\frac{22850 \times 1.67}{19.67} \times 13.74$ = 26700'#
do. Wind 1600×13.74 = 22000
do. Crane thrust 1500×13.74 = 20600
69300'#

Try 10" WF 49# r = 2.54 L = 165 $\frac{L}{r} = \frac{165}{2.54} = 65$

Allow. $f_s = 1.33 \left[\frac{18000}{1 + \frac{(65)^2}{18000}} \right] = 17350$ #/□"

$\frac{P}{A} = \frac{22850}{14.40} = 1600$ #/□"
$\frac{M}{S} = \frac{69300(12)}{54.6}$ 15200
} 16800#/□" O.K.

Use 10" WF 49#

Steel Column opposite above column
Roof Bm. Reaction — 19100# e=5"
Spandrel Bms 3100# 2800# } — 5900 e=0
Crane Loads –
L.L. 16700#
Impact 4200
D.L. 320
21220 e=1'-4"
46220#

Lateral Thrust = 1400#
Wind Force at bottom of Col. = 1600#

WAR DEPARTMENT

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

Subject Call St. Pumping Sta.

Computation Steel Column

Computed by W. W. Z. Checked by ______ Date 4-11-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

(continued)

Max. moment due to Rf. Bm. Loads $19100 \times 0.42 = 8040$ '#

do. Crane Load $\frac{21220 \times 1.33}{19.67} \times 13.74 = 19700$

do. Crane thrust $1400 \times 13.74 = 19200$

do. Wind Force $1600 \times 13.74 = 22000$

69000 '#

Allow. $f_s = 19350$ #/□" for 10" WF 49#

$\frac{P}{A} = \frac{46220}{14.40} = 3210$ #/□"

$\frac{M}{S} = \frac{69000 \times 12}{54.6} = 15150$

} 18360 #/□" < 19350 #/□" OK.

Use 10" WF 49#

WAR DEPARTMENT

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

...ect Call St. Pumping Sta

...mputation Crane Columns At Door Opening (Revised)

...mputed by W. W. Z. Checked by ______ Date 4-17-40

(REVISED)

Roof Bm. Reaction $2 \times 2600^{\#}$ = 5200# e = 0

Max. Reaction from 18" WF 47# $19100^{\#} \times \frac{5.04}{9.17}$ = 10500 e = 0

Crane Load :-

Max. Reaction 16300#

Bm. 125

Rail etc. 75

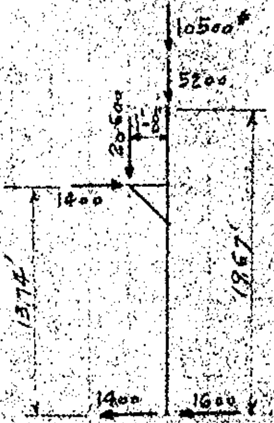
16500#

25% Impact 4100 — 20600# e = 1'-8"

36300#

Lateral Thrust = 1400#

Wind Force at bottom of Column = 1600#



Max. Moment @ Bracket -

Mom. Roof Bm. = 0

Crane Load $\frac{20600 \times 1.67 \times 13.74}{19.67}$ = 24100'#

Wind 1600×13.74 = 22000

Crane thrust 1400×13.74 = 19300

65400'#

"Try 10" WF 49" $\frac{L}{r} = \frac{165}{2.54} = 65$

Allow. $f_a = 1.33 \left\{ \frac{18000}{1 + \frac{(65)^2}{18000}} \right\} = 19350 \#/\square''$

$\frac{M}{S} = \frac{65400 \times 12}{54.6} = 14400 \#/\square''$

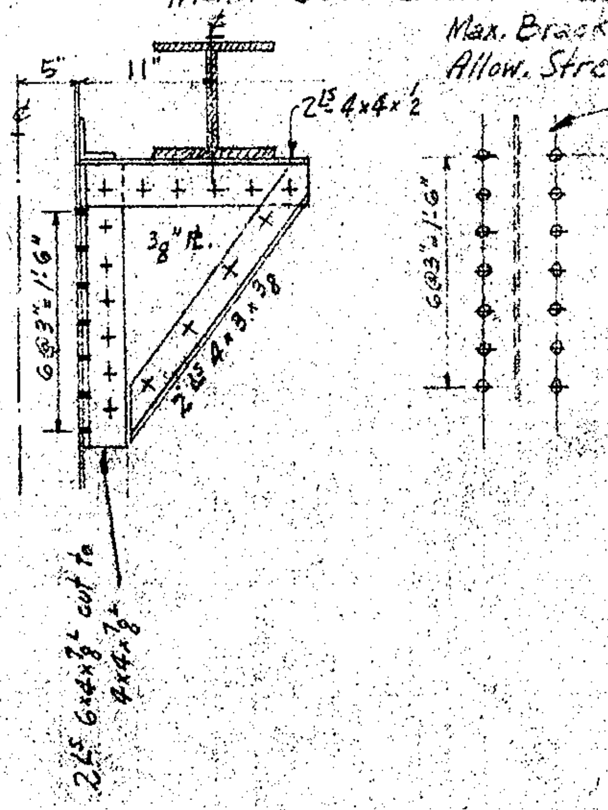
$\frac{P}{A} = \frac{36300}{14.40} = \frac{2500}{16700} \#/\square''$

Use 10" WF 49#

…ct Call St. Pumping Sta.
…mputation Crane Brackets
…mputed by W. W. Z. Checked by ______ Date 5-16-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

10" WF 49# Column
Max. Col. Load = 21200# e = 16"
Max. Bracket Mom. = 21200 × 11 = 233000"#
Allow. Stress on 3/4" rivet = 0.4418 × 13500 = 5960#



2×2×9 S = 36 S
2×2×6²/9 S = 16 S
2×2×3²/9 S = 4 S
56 S = 233000
S = 4160#

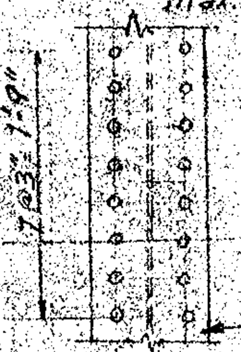
Vert. Shear = 21200/12 = 1770#/rivet

Combined Stress = $\sqrt{(4160)^2 + (1770)^2}$
= 4520# < 5960# OK.

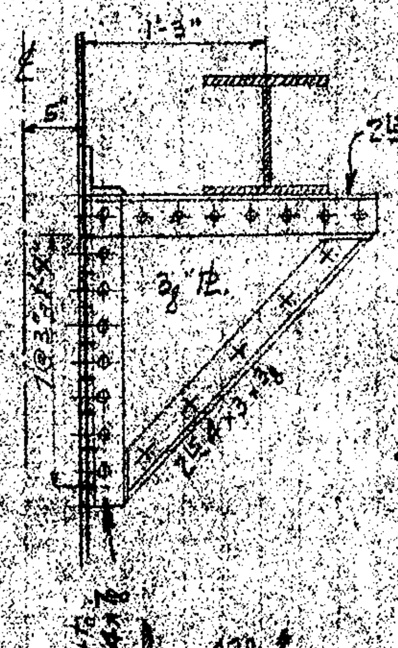
Object: Cell St. Pumping Sta.
Computation: Crane Brackets
Computed by: W. W. Z. Checked by: Date: 5-15-40

U. S. GOVERNMENT PRINTING OFFICE 3—10526

10" WF 49# Column
Max. Column Load = 20300#
Max. Bracket Moment = 20300 × 15" = 304000"#
Allow. Stress on ¾" rivet = 0.4418 × 13500 = 5960#
Vert. Shear = 20300



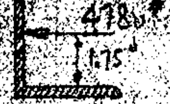
Assume Moment resisted by Flange rivet
s = stress on rivet
2×2 × 10.5 s = 42.0 s
2×2 × (7.5)²/10.5 s = 21.4 s
2×2 × (4.5)²/10.5 s = 7.7 s
2×2 × (1.5)²/10.5 s = 0.9 s
72.0 s = 304000 s = 4230#



22900/15 = 1530# shear / rivet

Combined Stress = $\sqrt{(4230)^2 + (1530)^2}$ = 4500#/rivet < 5960# OK

7.5/10.5 × 4230 = 3020#
4.5/10.5 × 4230 = 1820
1.5/10.5 × 4230 = 605



Try 4×4×¾ L
gage = 2½" 2.5 - 0.75 = 1.75"
M = 1.75 × 4780 = 8400"#
S = ⅙ bh² b = rivet spacing = 3"
h = thickness of L = ¾"
S = ⅙ × 3 × 9/16 = 9/32
f = 8400 / (9/32) = 30000 #/□" too high

Use 6×4×⅞ L cut to 4×4×⅞" L
then f = 21400 #/□" OK.

WAR DEPARTMENT

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

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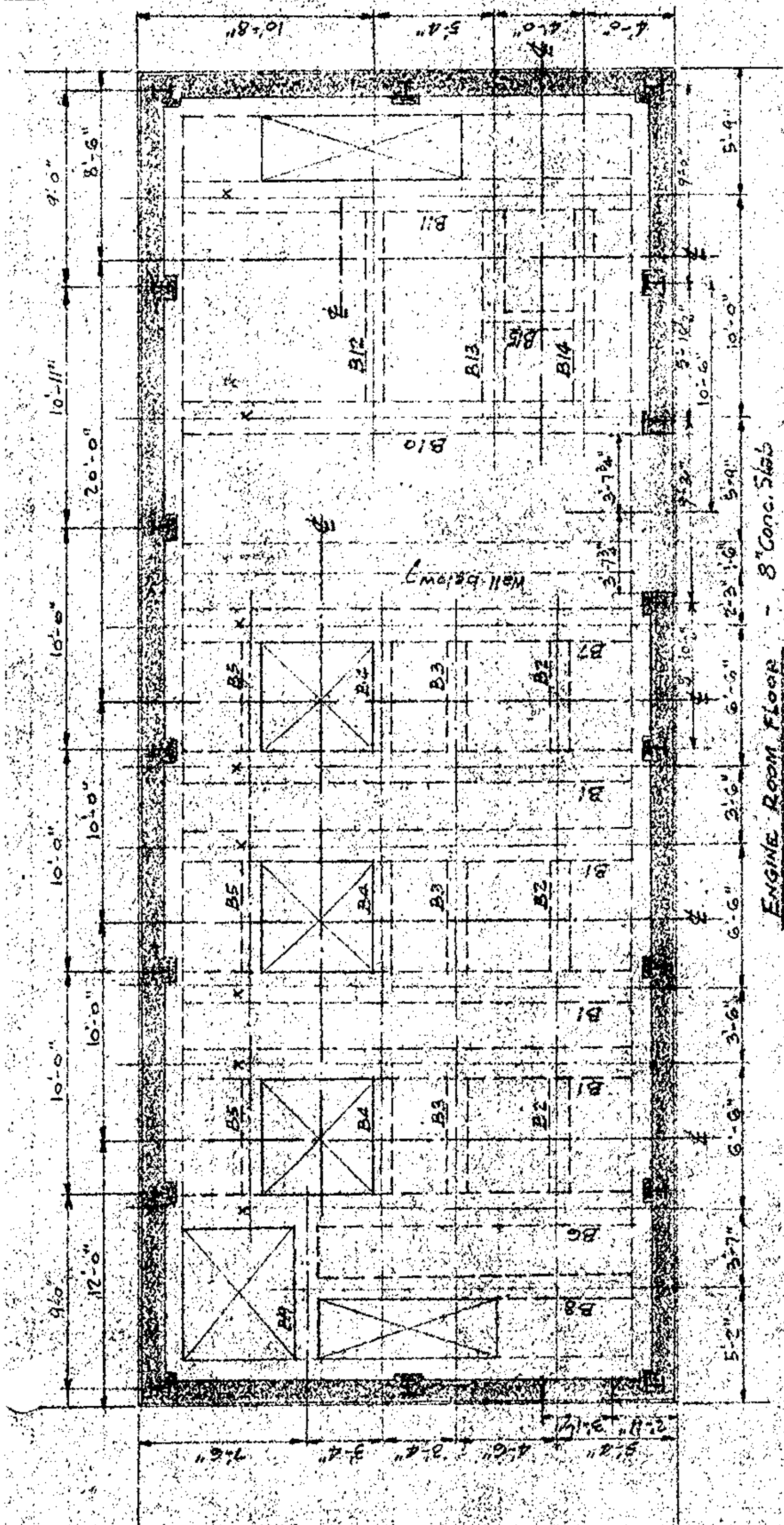
...ct Call St. Pumping Sta.

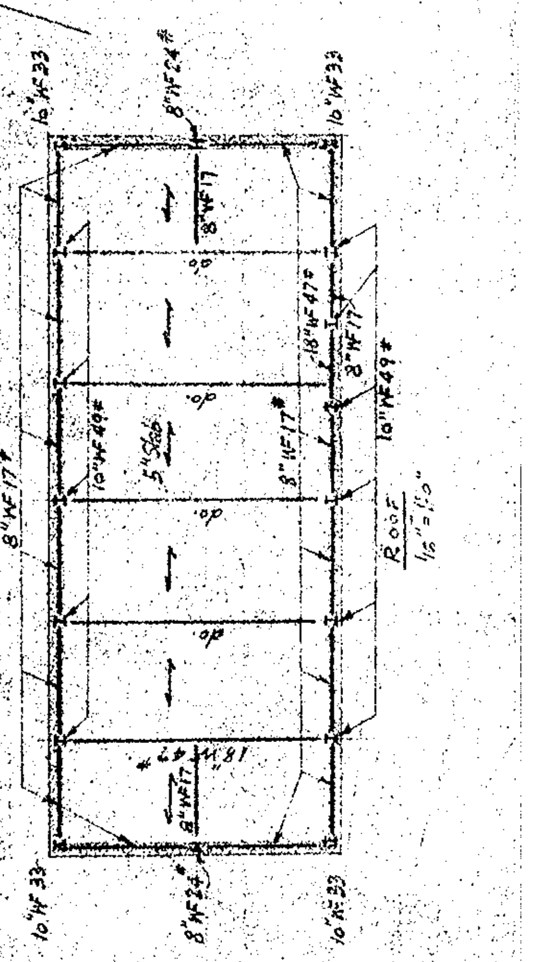
...mputation Engine Room Floor Beam Layout

...mputed by W W Z Checked by ________ Date 4-11-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



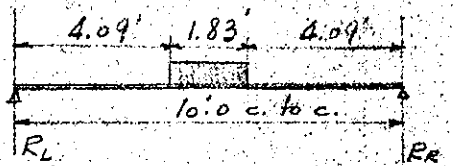
Mk.	Width	Depth
B1	18"	42"
B2	10"	17"
B3	10"	17"
B4	10"	17"
B5	10"	17"
B6	18"	42"
B7	18"	42"
B8	12"	21"
B9	12"	21"
B10	18"	42"
B11	18"	42"
B12	10"	12"
B13	12"	19"
B14	12"	17"
B15	12"	17"



ect Call St. Pumping Sta.
mputation Engine Room Floor
mputed by W. W. Z. Checked by .... Date 4-1-40

Equivalent L.L. on slabs & beams

Engine Wgt. = 6000 # Size: 6.0' × 1.83'



Width of Slab = 8.25' clear

Wgt. distribution = $\frac{6000}{6.0'}$ = 1,000 #/'

Slab span = 10.0' c.to c.

R_L = 1000 × 1.83 × ½ = 915

M = 915 × 5 − 1000 × $\frac{1.83}{2}$ × $\frac{1.83}{4}$
= 4157 '#

⅛ w L² = 4157

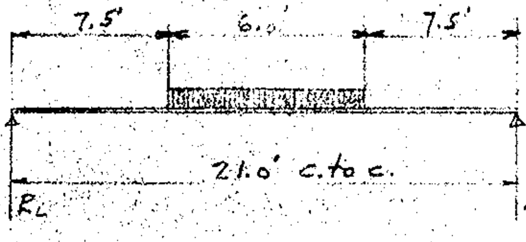
w = $\frac{4157 \times 8}{(10)^2}$ = 330 #/'

transverse wgt. distribution = $\frac{6000}{8.25}$ = 728 #/'

$\frac{728}{1000}$ × 330 #/' = 240 #/'

Average = ½ (330 + 240)
= 285 #/□'

Use 300 #/□' for Slabs



Wgt. distribution = $\frac{6000\#}{1.83}$ = 3280 # per width of beam

w = $\frac{3280}{6 \times 1.5}$ = 365 #/' $R_L = \frac{3280}{1.5} \times \frac{1}{2}$ = 1090

M = 1090 × 10.5 − 365 × 3 × $\frac{3}{2}$ = 9860 '#

M = ⅛ w L² = 9860 '#

w = $\frac{9860 \times 8}{(21)^2}$ = 180 #/'

Use 200 #/□' for beams

WAR DEPARTMENT

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

Subject Call Street Pumping Sta.
Computation Engine Room Floor
Computed by W. W. Z. Checked by ________ Date 4-1-40

Slab S1

Clear Span = 5.0'
Assume 8" Slab D.L. = 100 #/□'
L.L. = 300
Total = 400 #/□'

$M = \frac{1}{10} \times 400 \times 25 = 1000'\# \times 12 = 12000''\#$
for $f_s = 18000 \#/□''$ $f_c = 800 \#/□''$ $n = 12$ $K = 123.0$

$bd^2 = \frac{M}{K}$ $d = \sqrt{\frac{12000}{123 \times 12}} = 2.85''$ required

3" ϕ 3/4 Conduits in Slab = 4½" over all dimension
Using ½"ϕ bars 1½" conc. cover Use 8" Slab thickness
then $d = 8'' - 1\frac{1}{2}'' = 6\frac{1}{2}''$
Using ½"ϕ bars @ 12" c.c. $A_s = 0.197□''$ per ft. of slab
(Only 0.11□" required)
Max. End Shear: $\frac{5}{8} \times 400 \times 5.0 = 1250\#$
Unit Shear $v = \frac{1250}{\frac{7}{8} \times 12 \times 6.5} = 19 \#/□''$ OK.

Unit Bond Stress = $u = \frac{1250}{\frac{7}{8} \times 6.5 \times 1.57} = 140 \#/□''$ OK. Special Anchorage

Slab S1
Use 8" thickness
½"ϕ bars - 12" o.c. Straight top & bottom throughout

WAR DEPARTMENT

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

Project Call St. Pumping Sta.

Computation Engine Room Floor Slab

Computed by W. W. Z. Checked by ______ Date 4-1-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Slab S2 clear span = 8.33'

$M = \frac{1}{12} \times 400 \times (8.33)^2 \times 12 = 27800$ "#

$M = Kbd^2$ $K = 123.0$

$d = \sqrt{\frac{27800}{12 \times 123.0}} = 4.34$" required make d = 6.5"

Using $\frac{1}{2}$"φ bars 9" o.c. $A_s = 0.26$ □"

max end shear $= \frac{6}{10} \times 400 \times 8.33 = 2000$ #

unit shear $= \frac{2000}{\frac{7}{8} \times 12 \times 6.5} = 29$ #/□" ok

unit bond stress $= \frac{2000}{\frac{7}{8} \times 6.5 \times 1.57 \times 1.33} = 168$ #/□" ok Special Anchorage

Slab S2

8" thick

$\frac{1}{2}$"φ bars @ 9" o.c. Straight top & bottom

Project Call St. Pumping Sta.
Computation Engine Room Concrete Beams.
Computed by W. H. E. Checked by .... Date 4-1-40

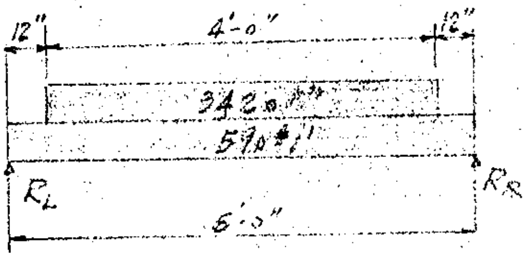
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Beams B2 & B3 span = 5'-0" clear

Beams B2 & B3 support Gas. Engines equally

Wgt of Gas. Eng.	6000 #
Conc. Slab 4.0' × 8.5' × 1.5'	7700
	13700
Impact 100 %	13700
(Movable load + Impact) Total	27400 #

Load per ft. per Beam = ½ × 27400 × ¼	=	3420 #/'	
D.L. Floor Slab (8") 100# × 3.93'	=	390	390
D.L. Beam 12" × 16" @ 150 #	=	195	195
		4000 #/'	590 #/'



span c. to c. = 5.0 + 1.0 = 6.0'

$R_L = R_R = 8610$ #

$M = 8610 \times 3.0 - 590 \times (3.0)^2 \times \frac{1}{2} - 3420 \times (2)^2 \times \frac{1}{2} = 16330$ '#

Width of T-bm flange = ¼ × 5'-0 = 15"

Depth req for shear = $\frac{8610}{12 \times 120} = 6.00$"

Make stem = 10" $d = 6.0 \times \frac{12}{10} = 7.2$" make $d = 14.5$"

$\frac{t}{d} = \frac{8.0}{14.5} = 0.55$

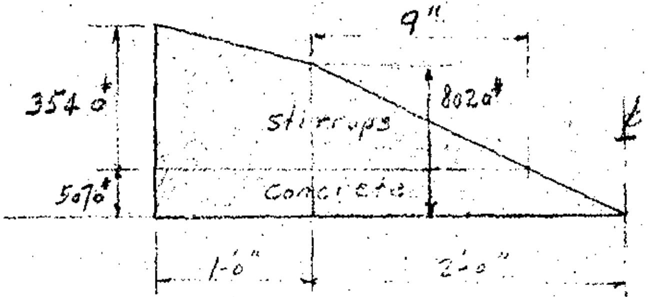
$A_s = \frac{16330 \times 12}{7/8 \times 14.5 \times 18000} = 0.86$ □" 2-¾"φ ($A_s = 0.88$ □")

$u = \frac{8610}{2 \times 2.36 \times 7/8 \times 14.5} = 145$ #/□" (Special Anchorage)

actual unit shear = $\frac{8610}{7/8 \times 10 \times 14.5} = 68$ #/□"

Project: Call St. Pumping Sta.
Computation: Engine Floor Concr. Bms.
Computed by: W. W. Z. — Checked by: ______ — Date: 4-2-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



$\frac{40}{68} \times 8610 = 5070\#$

$8610 - 5070 = 3540\#$

$x = 2 \times \frac{2950}{8020} = 0.74' = 9"$

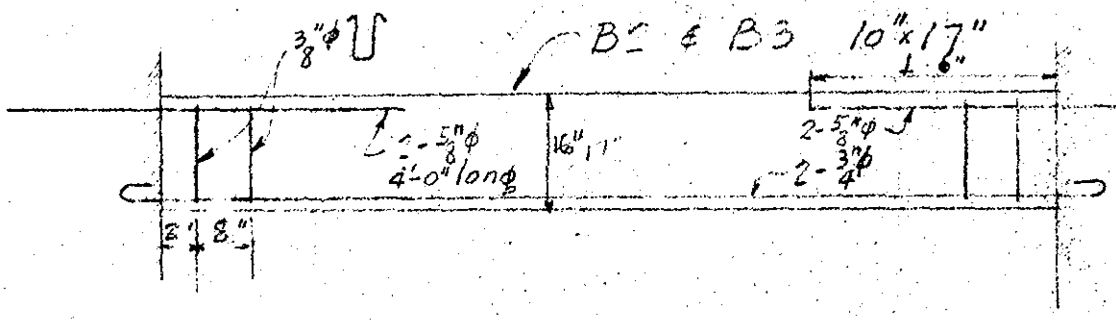
Use 3/8"φ Stirrups $A_s = 0.11^{\square"}$ Allow. Stress = 16000#/□"

Total shear taken by Stirrups = $\frac{1}{2} \times (3540 + 2950)\,12 = 38940\#$
$\frac{1}{2} \times 2950 \times 9 = 13300$
$= 52240\#$

No. of Stirrups required:

$\frac{52240}{2 \times \frac{7}{8} \times 0.11 \times 16000 \times 14.5} = 0.89$ say 2 each end

1 @ 3" from face of support } each end
1 @ 8" }



WAR DEPARTMENT

U. S. ENGINEER OFFICE, PROVIDENCE, R. I. — Page 33

Project: Call St. Pumping Sta

Computation: Engine Floor, Conc. Beams

Computed by: W. W. Z. — Checked by: — Date: 4-2-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

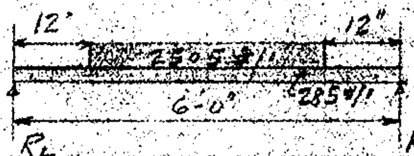
Beam B4 — span = 6'0 c. to c. = 4'-0" clear

Wgt. Prop. Pump	18 000 #	18 000 #
Thrust on pump (=Water in pump)	12 000	
Gear Reduct. Unit	5300 #	5300
Flap Valve, discharge pipe, etc.	7300	
Impact 100%		23300 #

Load on B4 –

$\frac{1}{4} \times 23300 =$	5825 #	
$\frac{1}{4} \times 12000 =$	3000	
$\frac{1}{4} \times (\frac{1}{2} \times 7300) =$	900	
D.L. 8" Slab = $\frac{1}{2} \times 2.25 \times 100 =$	460	115
Beam 10" x 16	680	170
	11150 #	285 #/'

Load per ft. = 11150 × $\frac{1}{4}$ = 2790 #/'

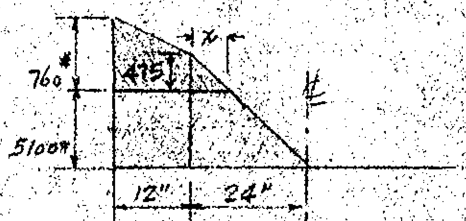


$R_L = R_R = 5860$ #

$M = 5860 \times 3 - 285 \times \frac{(3)^2}{2} - 2505 \frac{(2)^2}{2} = 11290$ '#

d required for shear = $\frac{5860}{\frac{7}{8} \times 10 \times 120} = 5.6$"

make d = 14.5"



$v = \frac{5860}{\frac{7}{8} \times 10 \times 14.5} = 46$ #/□"

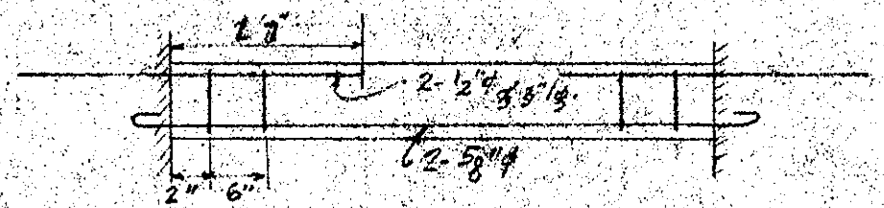
$A_s = \frac{11290 \times 12}{\frac{7}{8} \times 14.5 \times 18000} = 0.59$ □" Use 2-$\frac{5}{8}$"φ bars ($A_s = 0.61$□")

$x = \frac{415}{5575} \times 24 = 2.05$"

$u = \frac{5860}{\frac{7}{8} \times 2 \times 1.96 \times 14.5} = 118$ #/□" (Spec. Anchor.)

$\frac{3}{8}$"φ Stirrups $A_s = 0.11$□" $f_s = 16000$ #/□"

Use 2 stirrups each end



B4 - 10" x 17"

Make B5 like B4

WAR DEPARTMENT

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

Project: Call St. Pumping Sta.
Computation: Engine Room Conc. Bms.
Computed by: W.W.Z. Checked by: ______ Date: 4-3-40

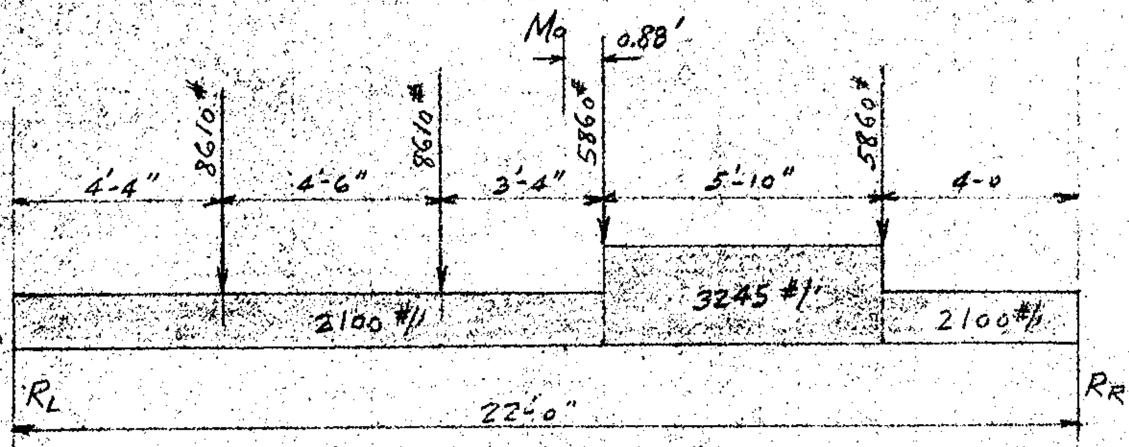
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bm. B1 span = 20'-0" clear or 22'-0" c to c

Loading: Reaction from B2 = 8610#
B3 = 8610
B4 = 5860
B5 = 5860

Prop. Pump + Impact = 5825#
Thrust = 3000
Valves, etc = 900
Total = 9725# or $\frac{9725}{5.83}$ = 1670 #/'

D.L. 8" Slab	100 × 5 = 500 #/'	100 × 3.25 = 325 #/'
L.L.	200 × 5 = 1000	200 × 3.25 = 650
Bm. 18×40	= 600	= 600
	2100 #/'	1575
		1670
		3245 #/'



R_L		R_R	
½ × 2100 × 22	= 23100#	½ × 2100 × 22	= 23100#
5.83 × 1145 × $\frac{6.83}{22.0}$	= 2080	5.83 × 1145 × $\frac{15.17}{22}$	= 4600
8610 × $\frac{17.67}{22}$	= 6910	8610 × $\frac{4.33}{22}$	= 1700
8610 × $\frac{13.17}{22}$	= 5160	8610 × $\frac{8.83}{22}$	= 3450
5860 × $\frac{9.83}{22}$	= 2620	5860 × $\frac{12.17}{22}$	= 3240
5860 × $\frac{4}{22}$	= 1070	5860 × $\frac{18}{22}$	= 4790
	40940#		40880#

Mo is 11'-4" from RL

Project: Call St. Pumping Sta.

Computation: Engine Room Conc. Bms.

Computed by: W.W.Z. Checked by: ________ Date: 4-3-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bm. #1 (cont'd.)

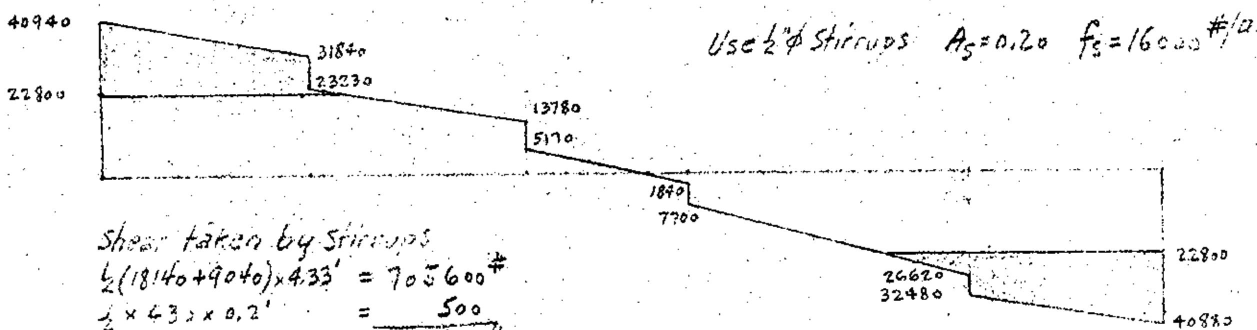
$$M = (40940 \times 11.33) - (8610 \times 7) - (8610 \times 2.5) - 2100 \times \frac{(11.33)^2}{2}$$

$$= 464000 - 60300 - 21500 - 135000 = 247200\text{'\#}$$

$M = Kbd^2$ $\quad d = \sqrt{\dfrac{247200 \times 12}{123 \times 18}} = 36.5''$ (make $d = 40''$) $\quad A_s = \dfrac{247200 \times 12}{\frac{7}{8} \times 18000 \times 40} = 4.72\,\square''$ 6-1"ϕ

$v_1 = \dfrac{40940}{\frac{7}{8} \times 18 \times 40} = 66\#/\square''$ @ R_L $\quad v_2 = \dfrac{40880}{\frac{7}{8} \times 18 \times 40} = 66\#/\square''$ @ R_R $\quad u = \dfrac{40940}{9.42 \times \frac{7}{8} \times 40} = 125\#/\square''$ @ R_L

Use ½"ϕ Stirrups $A_s = 0.20$ $f_s = 16000\#/\square''$



Shear taken by Stirrups

$\frac{1}{2}(18140 + 9040) \times 4.33' = 705600\#$

$\frac{1}{2} \times 430 \times 0.2' = 500$

$= 706100\#$

Stirrups req. $= \dfrac{706100}{2 \times 0.2 \times 16000 \times \frac{7}{8} \times 40} = 4$ each end

1 @ 4" 3 @ 10" each end

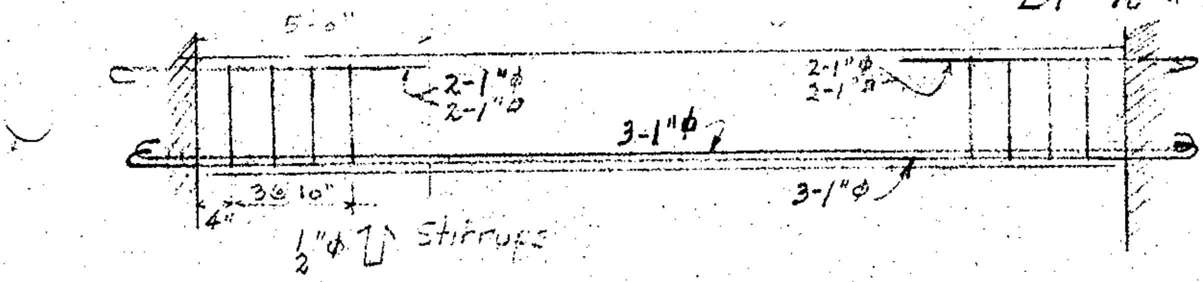
Points for bending up 2-1"$\square$: At R_L $18000 \times 3 \times 0.79 \times \frac{7}{8} \times \frac{40}{12} = 126000\text{'\#}$ } Do not bend bottom steel.

$40940x - 2100\frac{x^2}{2} = 126000\#$ $\quad x = 3.4'$ from R_L

$40880x - 2100\frac{x^2}{2} = 126000\text{'\#}$ $\quad x = 3.4'$ from R_R

Top Steel $= \frac{3}{4} \times 4.72 = 3.54\square''$ Use { 2-1"ϕ, 2-1"$\square$ }

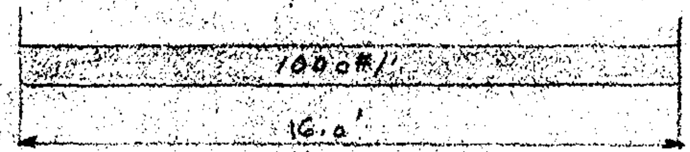
B1 18"x42"



Object: Call St. Pumping Sta.
Computation: Engine Room Conc. Bms.
Computed by: W. W. Z. Checked by ______ Date: 4-3-40

Beam B8 span = 14'-6" clear or 16'-0" c to c

Loading - D.L. 8" Slab 100 #/□'
L.L. 200
300 × 3' = 900 #/'
Beam 12 × 20 90
total say 1000 #/'



$R_L = R_R = 1000 \times 8 = 8000^{\#}$

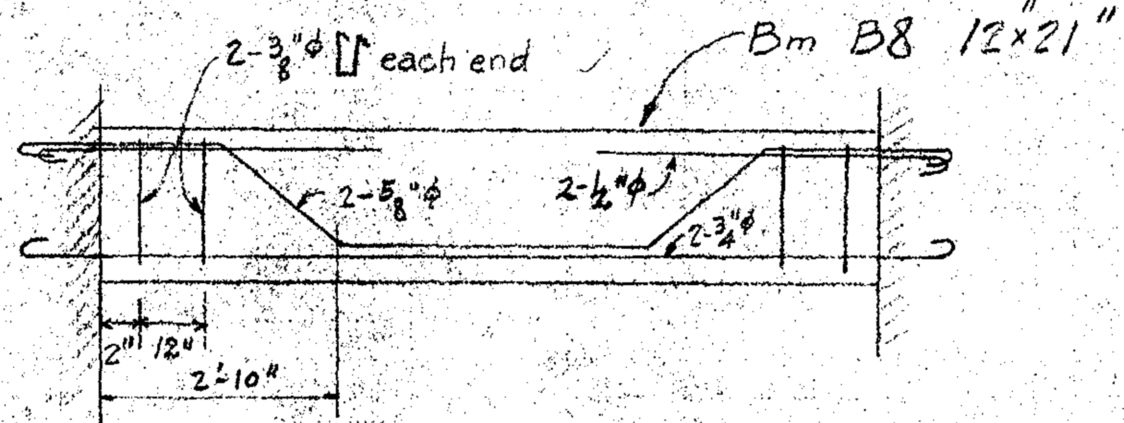
$M = \frac{1}{8} wL^2 = \frac{1}{8} \times 1000 \times 256 \times 12 = 384000$ "#

$d = \sqrt{\frac{384000}{123 \times 12}} = 16.1"$ say $d = 19"$

$A_s = \frac{384000}{\frac{7}{8} \times 18000 \times 19} = 1.30$ □" { 2-¾"φ bars ($A_s = 1.49$□")
2-⅝"φ bent

$v = \frac{8000}{\frac{7}{8} \times 12 \times 19} = 40$ #/□" OK

$u = \frac{8000}{\frac{7}{8} \times 19 \times 4.71} = 105$ #/□" OK (Spec. Anchor.)



WAR DEPARTMENT

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

Object: Call St. Pumping Sta.
Computation: Engine Room Conc. Bms.
Computed by: W. W. Z. Checked by .... Date: 4-3-40

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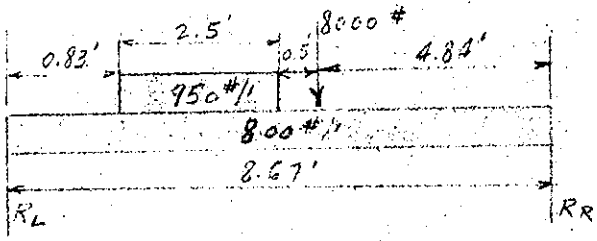
<u>Bm. B9</u> span = 7'-0" clear or 8'-8" c. to c.

Loading – L.L. (Cover Plates) 200 × 2.75 = 550 #/'
D.L. Beam 12 × 20½ = 250
Reaction Bm. 8 = 8000 #

Stair load = L.L. 50# × 14 × 2.5 × ½ = 900 #
D.L. 80# × 14 × 2.5 × ½ = 1500 #
2400 # = 950 #/'



$R_L = \frac{1}{2} \times 800 \times 8.67 = 3470$ #
$= \frac{4.84}{8.67} \times 8000 = 4460$
$= 2.5 \times 950 \frac{3.57}{8.67} = 1825$
9755 # R_L

$R_R = 7585$ #

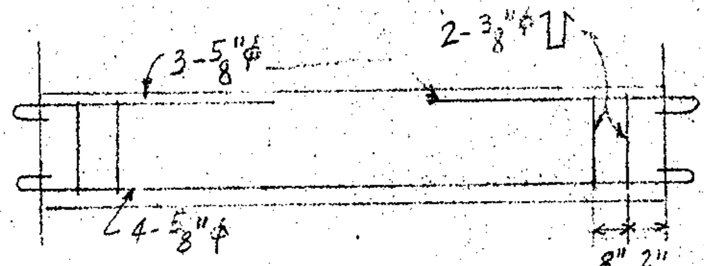
$M = 7585 \times 4.84 - 800 \times \frac{(4.84)^2}{2} = 36800 - 9400 = 329000$ "#

$d = \sqrt{\frac{329000}{123 \times 12}} = 15.$" make $d = 19$"

$A_S = \frac{329000}{\frac{7}{8} \times 19 \times 18000} = 1.10\square$" 4-⅝"φ Bars ($A_S = 1.23\square$")

$v_L = \frac{9755}{\frac{7}{8} \times 12 \times 19} = 50$#/□" @ R_R $v_R = \frac{7585}{9755} \times 50 = 40$#/□" @ R_L

$u = \frac{9755}{\frac{7}{8} \times 4.71 \times 19} = 125$#/□" @ R_R (Spec. Anchor)



Bm. 9 - 12" × 21"

Project Gall St. Pumping Sta

Computation Engine Room Conc. Bms

Computed by W. W. Z. Checked by ______ Date 4-3-40

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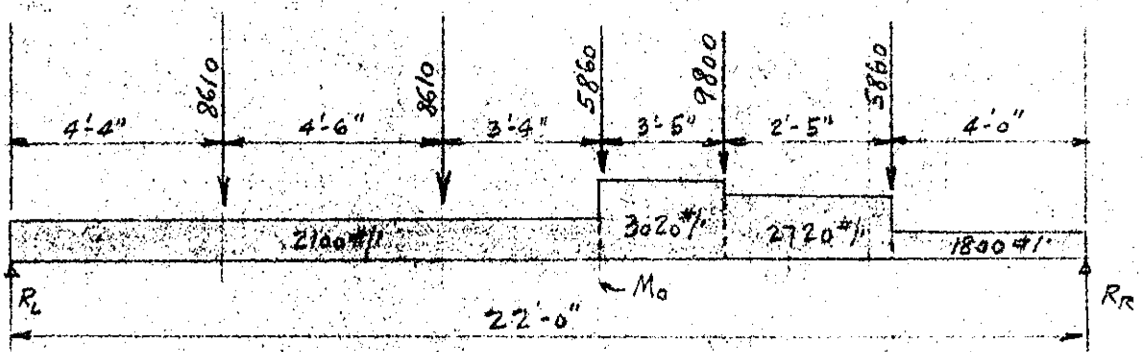
Bm. B6 — Span = 20'-0" clear or 22'-0" c to c

Loading –
- Reaction from B9 9800#
- Reaction from B2 8610#
- do. B3 8610#
- do. B4 5860#
- do. B5 5860#

Prop. Pump = 1670 #/'

D.L. 8" Slab	100 × 5 = 500	100 × 2.5 = 250	100 × 4 = 400	100 × 1.5 = 150
L.L.	200 × 5 = 1000	200 × 2.5 = 500	200 × 4 = 800	200 × 1.5 = 300
Bm 18 × 40	= 600	= 600	= 600	= 600
	2100	1350	1800	1050
		1670		1670
		3020		2720



R_L

$2100 \times 12.17 \times \frac{15.91}{22} = 18500\#$

$3020 \times 3.42 \times \frac{8.12}{22} = 3810$

$2720 \times 2.42 \times \frac{5.21}{22} = 1560$

$1800 \times 4.00 \times \frac{2.0}{22} = 650$

$5860 \times 4/22 = 1070$

$9800 \times 6.42/22 = 2860$

$5800 \times 9.83/22 = 2590$

$8610 \times 13.17/22 = 5150$

$8610 \times 17.67/22 = 6910$

$43100\#$

$R_R = 45030\#$

$M_o = 43100 \times 12.17 - 8610 \times 7.83 - 8610 \times 3.33 - 2100 \times \frac{(12.17)^2}{2}$

$= 524000 - 67400 - 28700 - 155500$

$= 272400\ '\#$

$M = Kbd^2 \quad d = \sqrt{\frac{272400 \times 12}{123 \times 18}} = 38.5"$ make d = 40

$A_s = \frac{272400 \times 12}{\frac{7}{8} \times 18000 \times 40} = 5.2^{\square}"$ Use 3-1"□ Bars Str. / 3-1"□ Bt

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Project Call St. Pumping Sta.
Computation Engine Floor Conc. Bms.
Computed by W. W. Z. Checked by .... Date 4-4-40

Bm # B6 (Cont'd)

$v_L = \frac{43100}{\frac{7}{8} \times 18 \times 40} = 70$ #/□" $v_R = \frac{45030}{43100} \times 70 = 75$ #/□"

Top steel = $\frac{3}{4} \times 5.2$□" = 3.9□" Use 5-1"ϕ

Bending up 3-1"□ Bars.

Moment taken by 3-1"ϕ = $18000 \times 3.0 \times \frac{40}{12} = 180000$ '#

At left end -

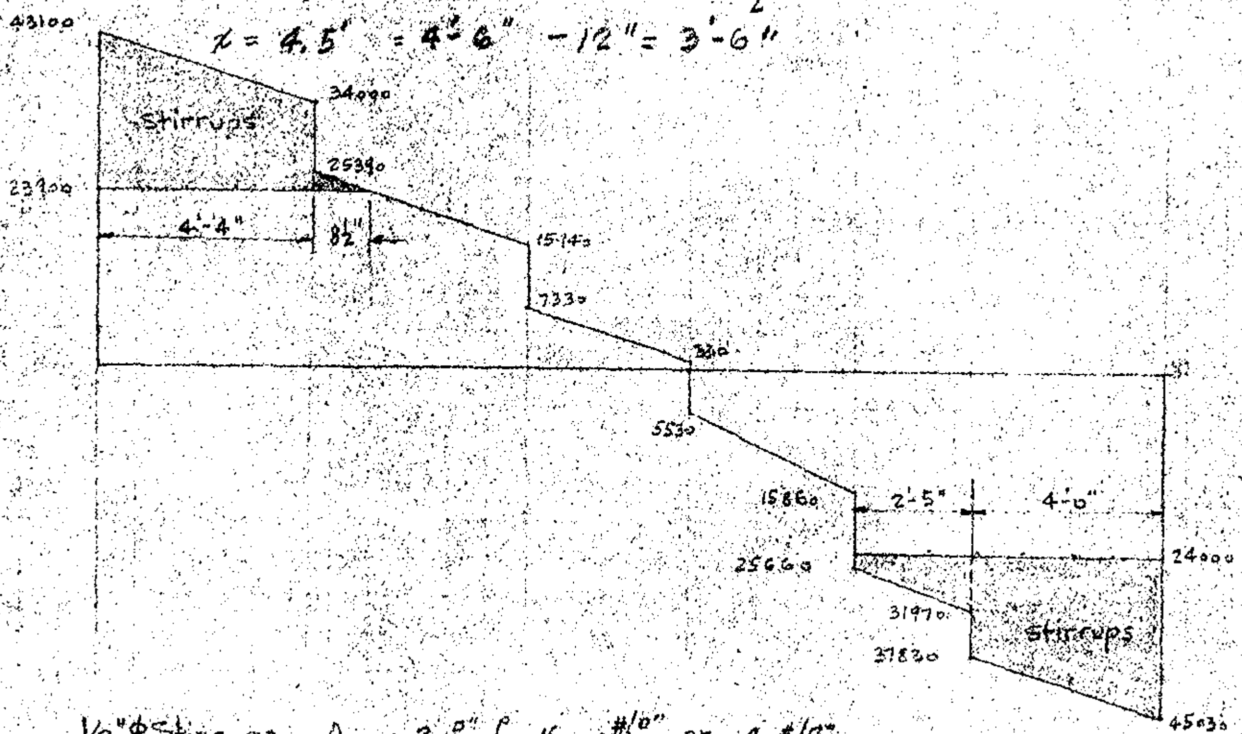
$43100x - 2100\frac{x^2}{2} - 8610(x-4.33) = 180000$ '#

$x = 4.4' = 4'5" - 12" = 3'5"$

At right end -

$45030x - (1800)(4)(x-2) - 5860(x-4) - 2720\frac{(x-4)^2}{2} = 180000$ '#

$x = 4.5' = 4'6" - 12" = 3'6"$



½"ϕ Stirrups $A_s = 0.20$□" $f_s = 16000$#/□" $v_c = 40$#/□"

Stress taken by Stirrups :-

At left end -

$\frac{1}{2}(19200 + 8610) \times 52 = 723000$ #
$\frac{1}{2} \times 1490 \times 8.5 = 6300$
729300 #

Stirrups req. = $\frac{729300}{2 \times 0.2 \times 16000 \times \frac{7}{8} \times 40} = 4$

2" from face support
1 @ 10"
2 @ 12"

Project: Call St. Pumping Sta.
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Bm. #B6 (cont'd)

at right end –

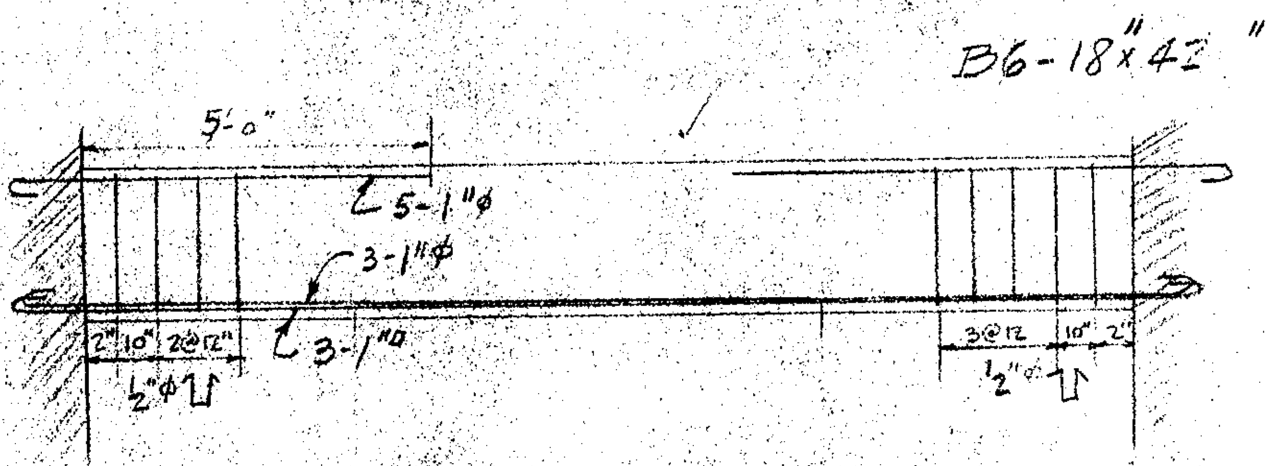
$\frac{1}{2}(21030 + 13830)\,48 = 838000\#$

$\frac{1}{2}(7970 + 1660)\,29 = 140000$

$978000\#$

No. Stirrups $= \frac{978000}{2 \times 0.2 \times 14000 \times 40} = 5$ { 1@2" from face of support; 1@10"; 3@12" }

Revision N.B. Do not bend bottom steel bars.
Provide 5-1"ϕ bars in top



Project Call St. Pumping Sta
Computation Engine Floor Conc. Bms.
Computed by W.W.Z. Checked by ______ Date 4-4-40

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Beam B7

span = 20'-0" cl. or 22'-0" c to c.

Loading -

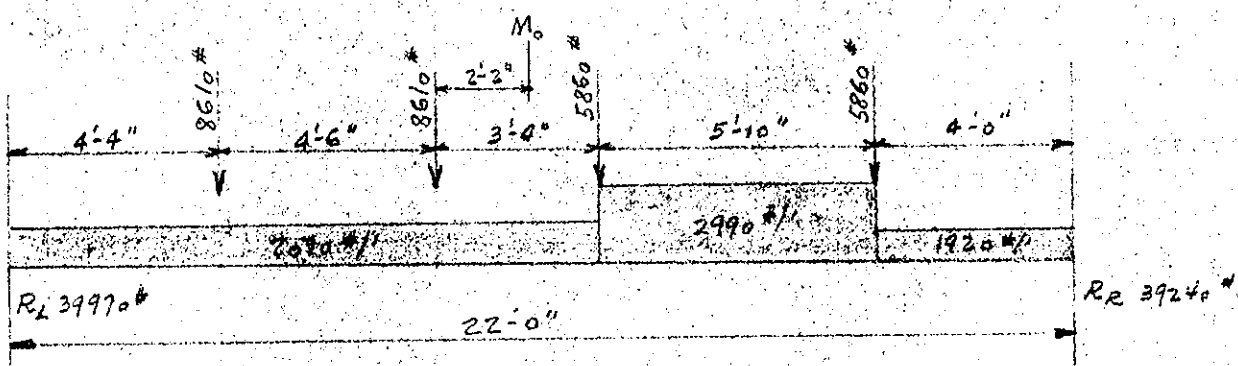
Reaction from B2 = 8610# Prop. Pump = 1670 #/' (page #7)

do B3 = 8610#

do B4 = 5860#

do B5 = 5860#

D.L. 8" Slab	100# × 4.88' = 490 #/'	100 × 2.38' = 240 #/'	100 × 4.38' = 440 #/'
L.L	200 × 4.88 = 980 #/'	200 × 2.38' = 480	200 × 4.38' = 880
Bm 18 × 40	= 600	= 600	= 600
	2070 #/'	1320 #/'	1920 #/'



R_L: 2070 × 12.17 × 15.91/22 = 18200#
2990 × 5.83 × 6.83/22 = 5420
1920 × 4.0 × 2.0/22 = 700
5860 × 4.0/22 = 1070
5860 × 9.83/22 = 2620
8610 × 13.17/22 = 5150
8610 × 17.67/22 = 6910
= 39970#

$M_o = 39970 \times 11 - 8610 \times 6.67 - 8610 \times 2.17 - 2070 \times \frac{(11)^2}{2}$
$= 439500 - 57400 - 18700 - 125500$
$= 237900$ '#

$M = Kbd^2 \quad d = \sqrt{\frac{237900 \times 12}{18 \times 123}} = 36"$ make d = 40"

$A_s = \frac{237900 \times 12}{7/8 \times 18000 \times 40} = 4.53$ □" { 3-1"φ Bt. / 3-1"φ St. } $A_s = 4.72$ □"

$v_L = \frac{39970}{7/8 \times 18 \times 40} = 55$ #/□" $\quad u = \frac{39970}{9.42 \times 7/8 \times 40} = 105$#

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Project: Call St. Pumping Sta.
Computation: Engine Floor Conc. Bms.
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Bm # B7 cont'd:

Top Steel $= \frac{3}{4} \times 4.58 = 3.40\square''$ $3.40 - 2.36 = 1.04\square''$ Use 3-$\frac{3}{4}''\phi$ Bars.

Bending up 3-1"φ Bars

Moment taken by 3-1"φ $= 18000 \times 2.36 \times \frac{40}{12} = 142000$ '#

Point where steel may be bent up —

at left end:

$$39970x - 2070\frac{x^2}{2} - 8610(x - 4.33) = 142000 \text{ '\#}$$

$$x_L = 3.8' = 46'' - 12'' = 34''$$

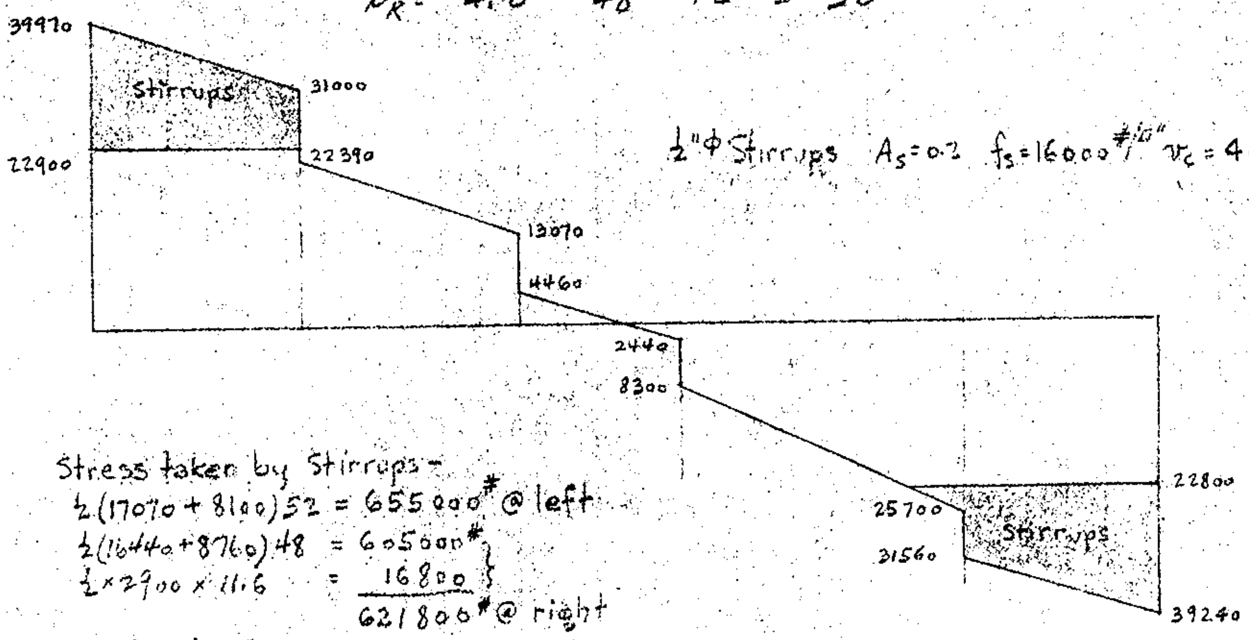
at right end

$$39240x - (1920)\frac{x^2}{2} = 142000$$

$$x_R = 4.0' = 48'' - 12'' = 36''$$

Do not bend bottom bars — provide 2-1"φ, 2-1"□ in top.

½"φ Stirrups $A_s = 0.2$ $f_s = 16000$ #/□" $v_c = 40$ #/□"



Stress taken by Stirrups =

$\frac{1}{2}(17070 + 8100)52 = 655000$ # @ left

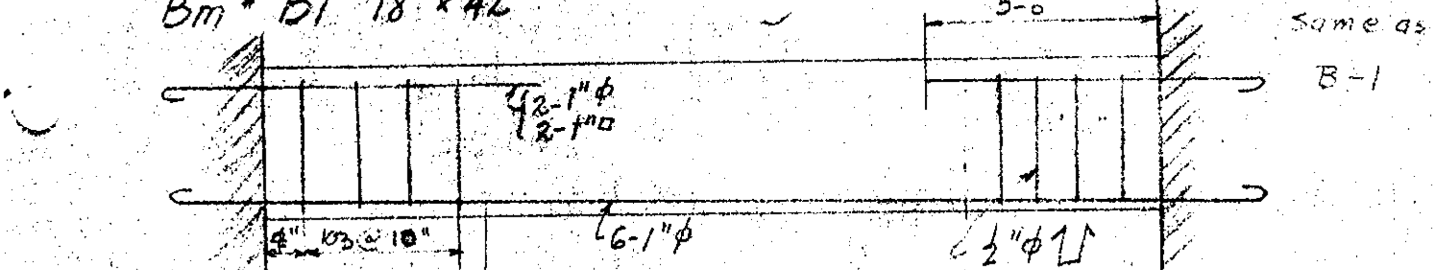
$\frac{1}{2}(16440 + 8760)48 = 605000$ #

$\frac{1}{2} \times 2900 \times 11.6 = 16800$

621800 # @ right

No. of Stirrups $= \frac{655000}{\frac{7}{8} \times 16000 \times 2 \times 0.2 \times 40} = 4$ each end 1@2", 3@12"

Bm # B7 18" x 42"



Subject: Call St. Pumping Sta.
Computation: Engine Room Conc. Bms.
Computed by: W. W. Z.   Checked by: Date: 4-5-40

U.S. GOVERNMENT PRINTING OFFICE 8—10528

Beam B14

Span = 10'-0" c to c

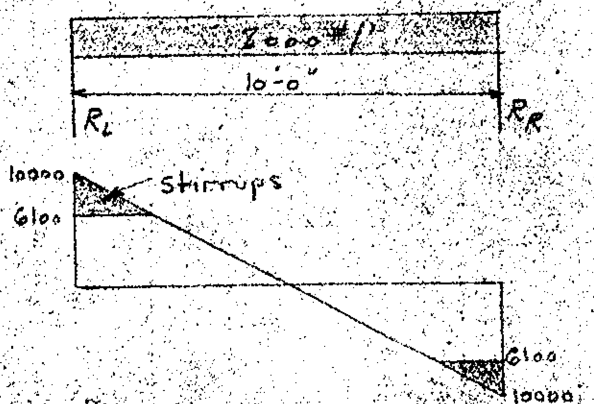
Load =
- Standby Unit = 14000#
- Conc. Block = 5000
- Impact 100% = 19000#
- total 38000#

Equally distributed between B13 & B14: $\frac{1}{2} \times 38000\# = 19000\#$

or $\frac{19000}{10} = 1900\#/'$

D.L. Bm 12"×18" say = 100

2000#/'



$R_L = R_R = \frac{1}{2} \times 2000 \times 10 = 10000\#$

$M = \frac{1}{8} \times 2000 \times 100 = 25000'\#$

$d = \sqrt{\frac{25000 \times 12}{12 \times 123}} = 14.3"$ say 15"

$A_s = \frac{25000 \times 12}{\frac{7}{8} \times 18000 \times 15} = 1.28^{\square"}$ Use {2-5/8"φ Str., 2-3/4"φ Bt.} $A_s = 1.49^{\square"}$

$v = \frac{10000}{\frac{7}{8} \times 12 \times 15} = 65\#/\square"$

$u = \frac{10000}{\frac{7}{8} \times 14.5 \times 4.71} = 165\#/\square"$ (Spec. Anchor.)

top steel $= \frac{3}{4} \times 1.28 = 0.96^{\square"}$ Use 2-1/2"φ Bars

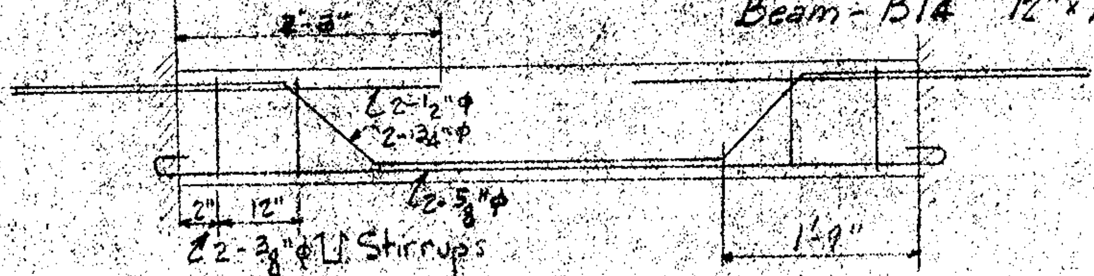
3/8"φ U Stirrups

$A_s = 0.11$ $f_s = 16000\#/\square"$ $v_c = 40\#/\square"$

Stirrup Stress $= \frac{1}{2} \times 3900 \times 36 = 70000$

No. of Stir. $= \frac{70000}{2 \times 0.11 \times 16000 \times \frac{7}{8} \times 14.5}$ = use 2 each end

Beam - B14 12"×17"



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Project Call St. Pumping Sta.

Computation Engine Floor Conc. Bms.

Computed by W. W. Z. Checked by .... Date 4-5-40

Beam B13 span = 10'-0" c to c

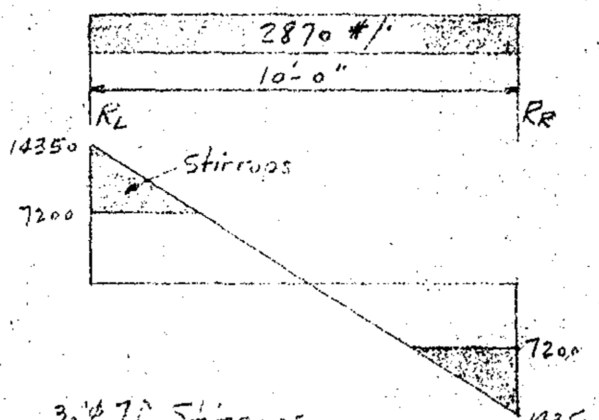
Loading = 2000 #/'
L.L. 200×4.3 = 870
total 2870 #/'

$R_L = R_R = \frac{1}{2} \times 2870 \times 10 = 14350$ #

$M = \frac{1}{8} \times 2870 \times 100 = 35900$ '#

$d = \sqrt{\frac{35900 \times 12}{123 \times 12}} = 17"$

$A_s = \frac{35900 \times 12}{\frac{7}{8} \times 17 \times 18000} = 1.61^{\square"}$ 4-$\frac{3}{4}$"φ ($A_s = 1.77^{\square"}$)



$v = \frac{14350}{\frac{7}{8} \times 12 \times 17} = 80$ #/□"

$u = \frac{14350}{\frac{7}{8} \times 17 \times 4.71} = 205$ #/□" too high

Use 3-$\frac{5}{8}$"φ Straight 2-$\frac{5}{8}$"φ Bent

$u = \frac{14350}{\frac{7}{8} \times 17 \times 5.89} = 165$ #/□" (Spec. Anchor.)

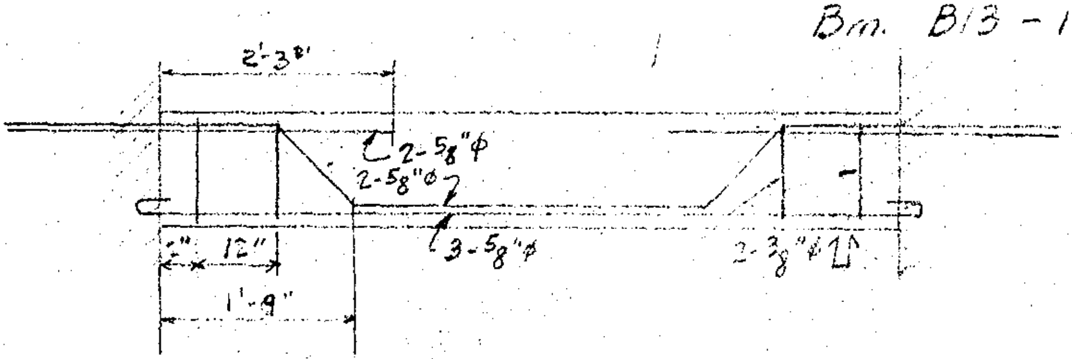
top steel = $\frac{3}{4} \times 1.61 = 1.21^{\square"}$ Use 2-$\frac{5}{8}$"φ

$\frac{3}{8}$"φ U Stirrups
$A_s = 0.11^{\square"}$ $f_s = 16000$ #/□" $v_c = 40$ #/□"

Stress taken by Stirrups —
$\frac{1}{2} \times 7200 \times 30 = 108000$ #

No. of Stirrups = $\frac{108000}{\frac{7}{8} \times 2 \times 0.11 \times 16000 \times 17} = 2$

Bm. B13 - 12"×19"



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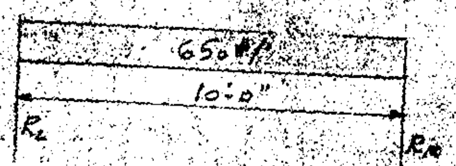
Beam B12 span = 10'-0"

Load – L.L. = 200 × 2.67 = 540 #/'
D.L. – 15# × 2.25 = 35 3/8" R.
Bm – 10 × 16 = 75
650 #/'



$R_L = R_R = \frac{1}{2} \times 650 \times 10 = 3250$ #

$M = \frac{1}{8} \times 650 \times 100 = 8200 = 98400$ "#

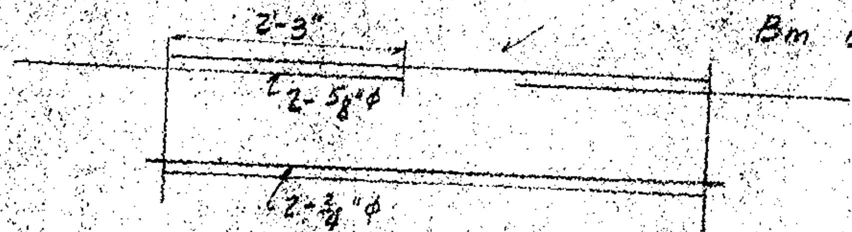
$d = \sqrt{\frac{98400}{123 \times 12}} = 8.2"$ Use $d = 10"$

$A_s = \frac{98400}{\frac{7}{8} \times 18000 \times 10} = 0.63$ □" Use 2-3/4"φ Bars

$v = \frac{3250}{\frac{7}{8} \times 10 \times 10} = 37$ #/□" no stirrups needed

$u = \frac{37 \times 10}{4.71} = 80$ #/□"

top steel = $\frac{3}{4} \times .63 = 0.47$ □" Use 2-5/8"φ



Bm B12 - 10"×12"

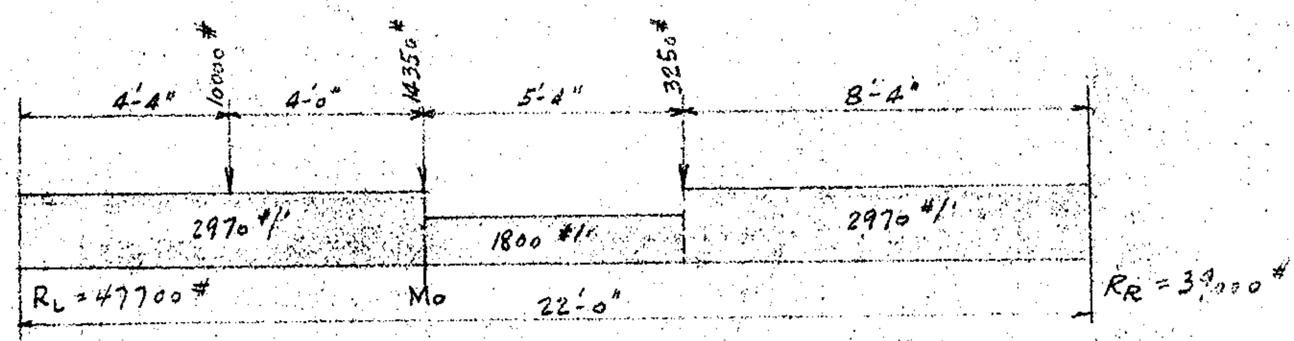
Object: Call St. Pumping Sta.
Computation: Engine Floor Conc. Bm.
Computed by: W. W. Z. Checked by: ______ Date: 4-5-40

Beam B10 span 22'-0" c to c.

Loading –

L.L.	= 200 × 7.87 = 1580 #/'	200 × 4 = 800 #/'
D.L.	= 8" slab 100 × 7.87 = 790	100 × 4 = 400
Bm.	18 × 40 = 600	600
	2970 #/'	1800 #/'

Reaction from B14 = 10000 #
do. B13 = 14350
do. B12 = 3250



R_L
$2970 \times 8.33' \times \frac{17.83}{22} = 20000\ \#$
$1800 \times 5.33 \times 11/22 = 4800$
$2970 \times 8.33 \times 4.17/22 = 4680$
$3250 \times 8.33/22 = 1230$
$14350 \times 13.67/22 = 8920$
$10000 \times 17.67/22 = 8030$
$= 47660\ \#$

$M_o = 47700 \times 8.33 - 10000 \times 4 - 2970 \times \frac{8.33^2}{2}$
$= 398000 - 40000 - 103000$
$= 255000\ '\#$

$d = \sqrt{\frac{255000 \times 12}{123 \times 18}} = 37.2"$ make $d = 40"$

$A_s = \frac{255000 \times 12}{\frac{7}{8} \times 18000 \times 40} = 4.85\square"$ {3-1"□ Str. / 2-1"□ Bt.}

Top steel = $\frac{3}{4} \times 4.85\square" = 3.64\square"$
Use 5-1"φ $A_s = 3.98\square"$

$u = \frac{47700}{\frac{7}{8} \times 40 \times 12.0} = 115\#/\square"$ (Spec. Anchor)

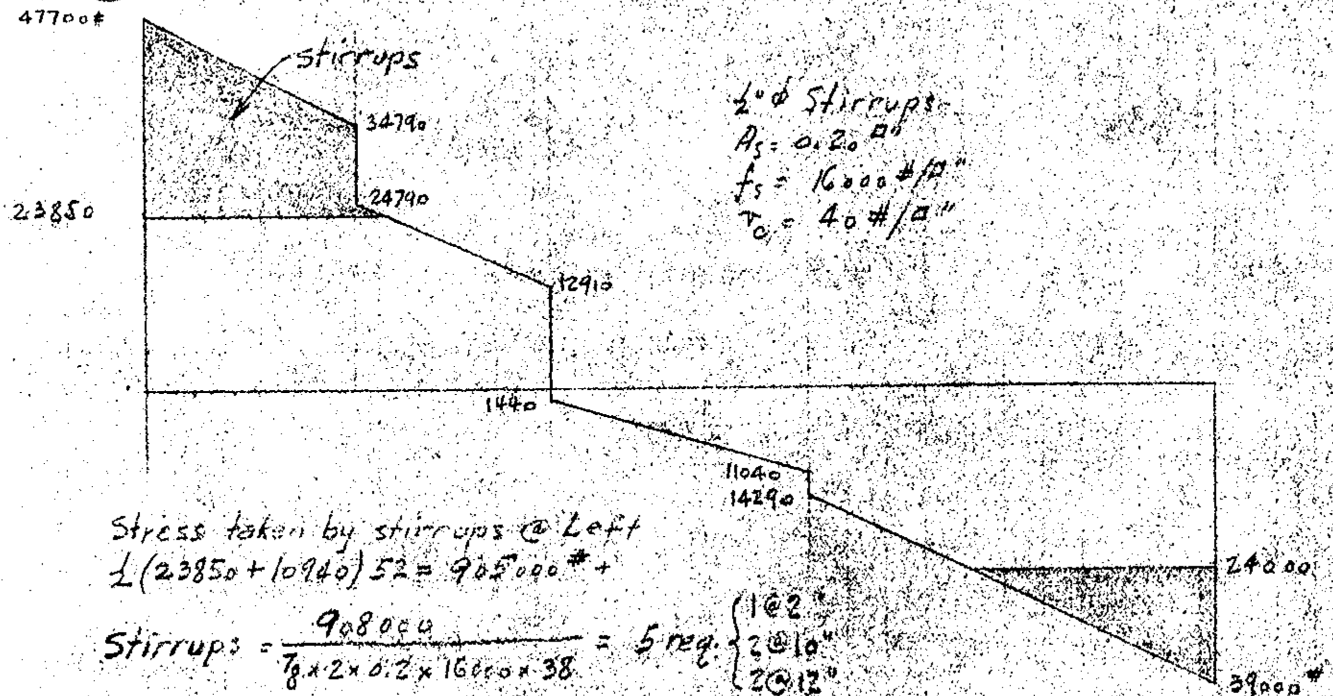
$v_c = \frac{47700}{\frac{7}{8} \times 18 \times 40} = 80\#/\square"$

Project: Cell St. Pumping Sta.

Computation: Engine Floor Conc. Bms.

Computed by: W. W. Z. Checked by: ______ Date: 4-5-40

Bm. B10 (cont'd)



½" ϕ Stirrups:
$A_s = 0.20$ □"
$f_s = 16000$ #/□"
$v_c = 40$ #/□"

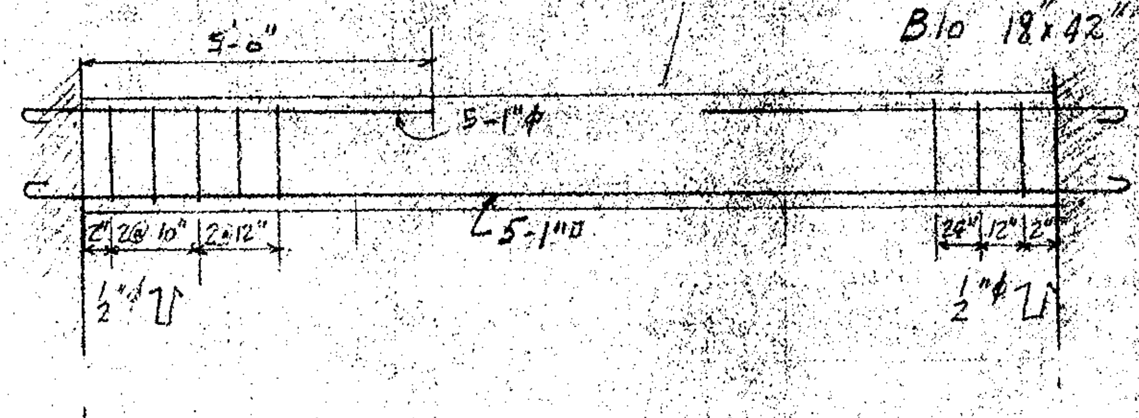
Stress taken by stirrups @ Left

$\frac{1}{2}(23850 + 10940)\,52 = 905000^{\#} +$

$$\text{Stirrups} = \frac{908000}{\frac{7}{8} \times 2 \times 0.2 \times 16000 \times 38} = 5 \text{ req.} \begin{cases} 1 @ 2" \\ 2 @ 10" \\ 2 @ 12" \end{cases}$$

@ Right –

$$\frac{1}{2} \times 15000 \times 5.37 \times 12 = \frac{483000}{\frac{7}{8} \times 6400 \times 38} = 3 \text{ req.} \begin{cases} 1 @ 2" \\ 1 @ 12 \\ 1 @ 24" \end{cases}$$



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Project Call St. Pumping Sta.

Computation Engine Room Conc. Bms.

Computed by N.W.Z. Checked by ______ Date 4-6-40

Bm. #11 span = 22'-0" c to c

Stairs — D.L. = 50#/□' L.L. = 50#/□'

15' × 100# × ½ = 750#/'

750 × 2.5'/2 = 1000#

Loading — L.L. 200 × 7.37 = 1475#/' 200 × 5 = 1000#/'

D.L. 100 × 7.37 = 740 100 × 5 = 500

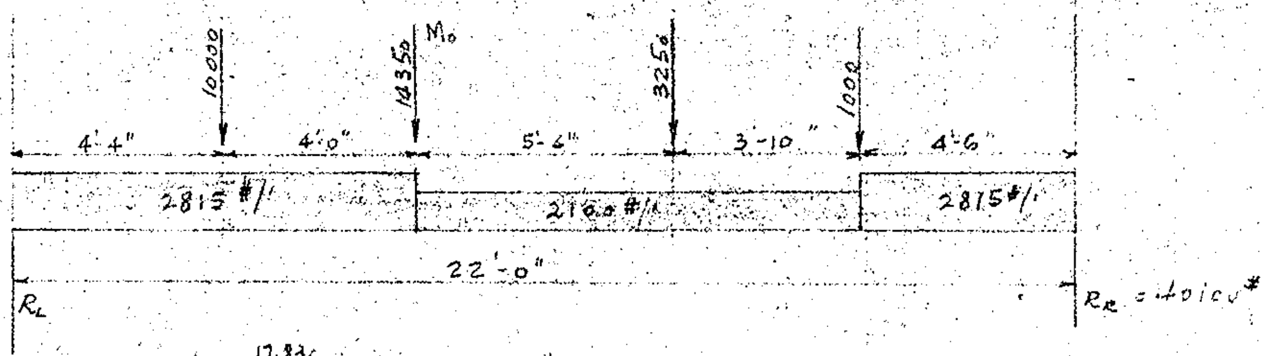
Bm. 18" × 40" = 600 = 600

2815#/' 2100#/'

React. from B12 = 3250#

do. B13 = 14350

do. B14 = 10000



R_L — 2815 × 8.33 × 17.83/22 = 19000#

2100 × 9.17 × 9.1/22 = 7900

2815 × 4.5 × 2.25/22 = 1300

1000 × 4.5/22 = 200

3250 × 8.3/22 = 1230

14350 × 13.67/22 = 8930

10000 × 17.67/22 = 8040

46600#

$M_0 = 46600 \times 8.33 - 10000 \times 4 - 2815 \times \frac{8.33^2}{2} = 252400$ '#

$d = \sqrt{\frac{252400 \times 12}{123 \times 18}} = 37''$ make d = 38"

$A_s = \frac{252400 \times 12}{\frac{7}{8} \times 18000 \times 38} = 5.07 \square''$ {3-1"□ Str. 2-1"φ Bt. top steel - 2-1"φ

Make Beam like B10.

Make Beam B15 10" × 17"

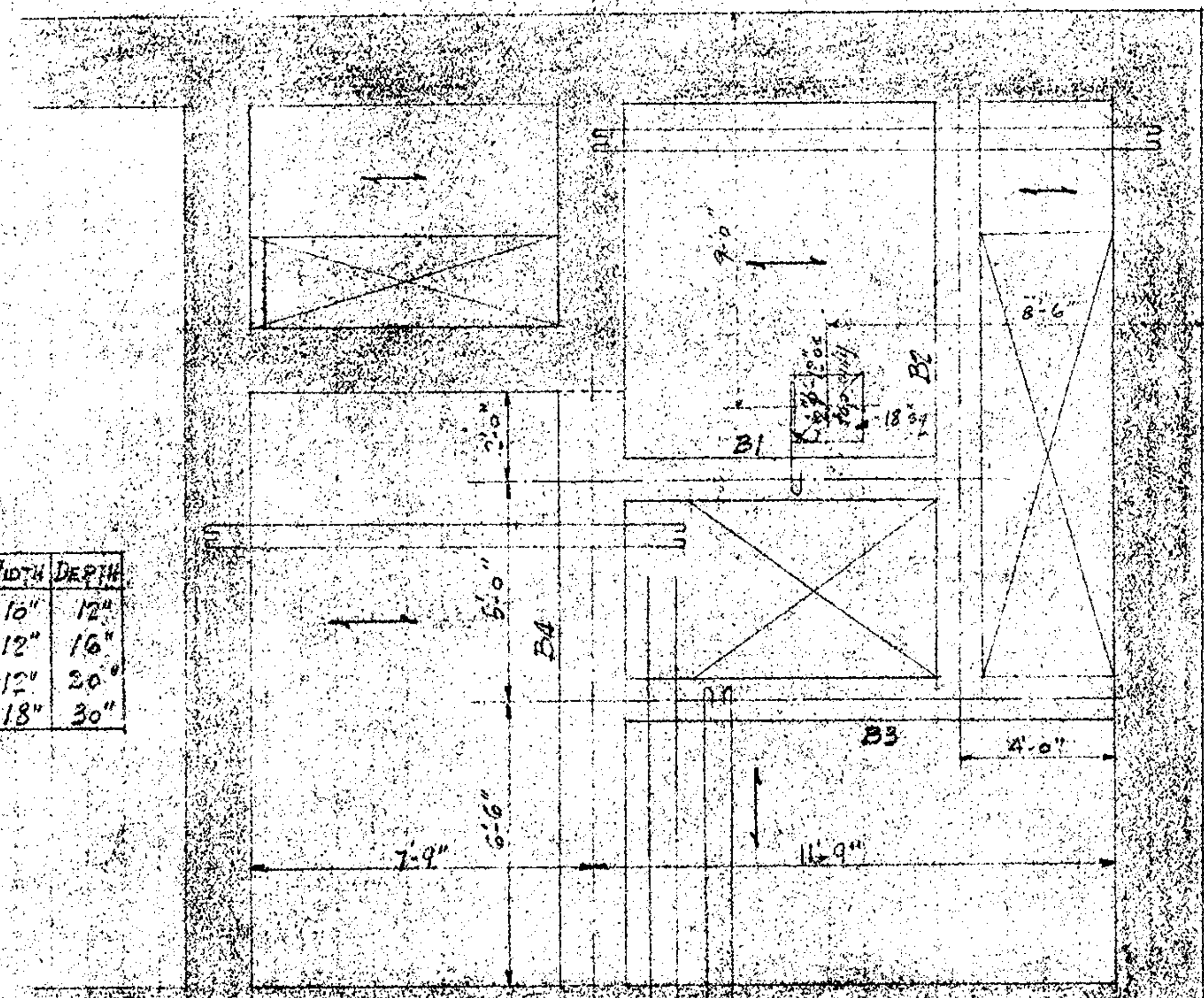
Use 2-⅝"φ Bars bottom (hook ends) } Str.
2-⅝"φ Bars top (hook one end) }

WAR DEPARTMENT

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

Object: Call St. Pumping Sta.
Computation: Boiler Room Floor Framing
Computed by: W. W. Z. Checked by: Date: 4-12-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

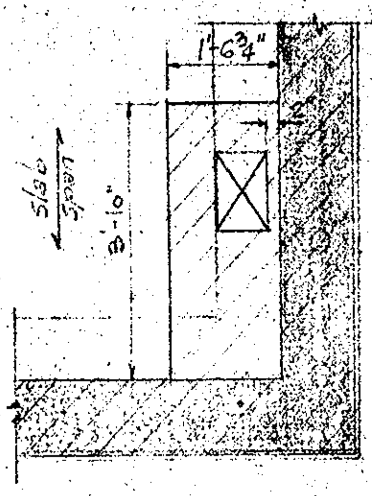


MK	WIDTH	DEPTH
B1	10"	12"
B2	12"	16"
B3	12"	20"
B4	18"	30"

SCALE ¼" = 1'-0"

Project: Call St. Pumping Sta.
Computation: Boiler Room Floor Slab under Chimney
Computed by: W. W. Z. Checked by: Date: 4-18-40

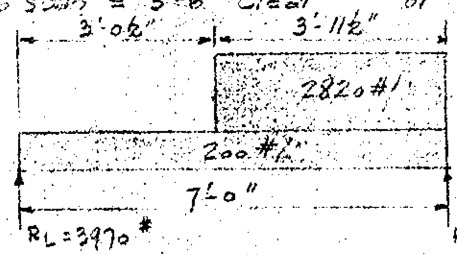
U. S. GOVERNMENT PRINTING OFFICE 3—10528



Elev. top of Chimney	97.18	97.18
do. Operating Fl.	72.50	-62.00
do. Boiler Floor	62.00	35.18

Wgt. of Brick = 35.18' × 8" × 10#/' = 2820#/'

Slab span = 5'-6" clear or 7'-0" c to c



R_L: 7.0 × 200 × ½ = 700
3.96 × 2820 × 1.18/7.0 = 3270
3970#

$M = 8590 \times 2.84 - 3020 \times \frac{(2.84)^2}{2} = 12200$ #/12" width

$d = \sqrt{\frac{12200}{125}} = 10"$

$A_s = \frac{12200 \times 12}{\frac{7}{8} \times 18000 \times 10} = 0.93$ □"/12" width

Assume 13" slab 9" wide $A_s = \frac{9}{12} \times 0.93 = .70$ □"

Use 3-½"φ bars

$v = \frac{8590}{\frac{7}{8} \times 10 \times 9} = 110$ #/□"

$u = \frac{8590}{\frac{7}{8} \times 10 \times 3.14} = 310$ #/□"

Chimney Load Supported by heavy belt course beam directly under 7" floor slab, therefore it is unnecessary to thicken the slab at this point.

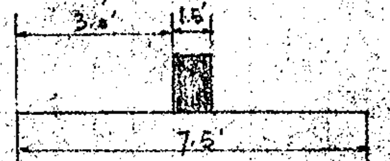
WAR DEPARTMENT

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

Project: Call St. Pumping Sta.
Computation: Boiler Room Floor Framing
Computed by: W. W. Z. Checked by: Date: 4-8-40.

– FLOOR SLAB –

Equivalent floor slab loading designed for gate weight.
Wgt. 5×5 gate = 2300# Size 5'×5'×1.5'
slab span = 7.5' c to c.



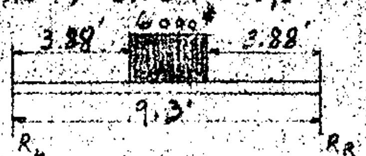
$\frac{2300}{5} = 460\#/'$ $R_L = 460 \times 1.5 \times \frac{1}{2} = 345\#$

$M = 345 \times 3.75 - 460 \times \frac{0.75^2}{2}$
$= 1295 - 130$
$= 1165'\#$

$M = \frac{1}{8} wL^2$ $w = \frac{8 \times 1165}{(7.5)^2} = 165\#/\square'$

Use 200 #/□' except for floor stand slab.

Wgt. floor stand, gate, etc. = 12000# $\frac{12000\#}{2'} = 6000\#/ft$ Width
Floor stand slab – span = 9.25' c. to c.
Assume 14" Slab = 175#/'



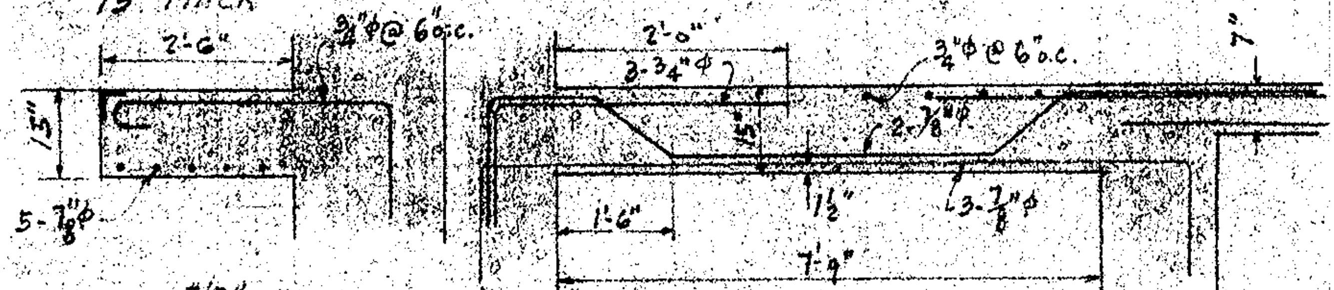
R_L: $\frac{1}{2} \times 6000 = 3000\#$
$\frac{1}{2} \times 9.3 \times 175 = 770$
$3770\# = R_R$

$M = 3770 \times 4.7 - 175 \times \frac{(4.7)^2}{2} - \frac{6000}{1.50} \times \frac{(0.75)^2}{2} = 14650'\#$

$d = \sqrt{\frac{14650 \times 12}{123 \times 12}} = 11"$ say 15" (3" conc. cover)

$A_s = \frac{14650 \times 12}{\frac{7}{8} \times 18000 \times 12} = 0.93\square"$ Use 5 - $\frac{7}{8}$"φ Bars

Slab under floor stand $0.75 \times 0.93 = 0.70\square"$ 3 - $\frac{3}{4}$"φ Bars
15" thick



$u = 55\#/\square"$
$v = \frac{55 \times 7.07}{12} = 30\#/\square"$

WAR DEPARTMENT

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

Subject: Call St. Pumping Sta
Computation: Boiler Room floor slab
Computed by: W. W. Z. Checked by: Date: 4-8-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Slab span = 7.67' c to c (longest span)

$$M = \frac{1}{8} \times 200 \times (7.67)^2 = 1470^{\#}$$

$$d = \sqrt{\frac{1470 \times 12}{123 \times 12}} = 3.5'' \quad \text{use } d = 4.5''$$

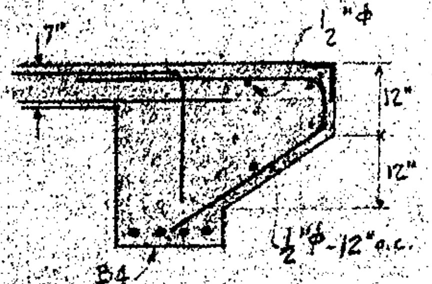
total depth of slab = $\left\{\begin{array}{l} d = 4.5'' \\ cov. = 1.5'' \\ cond. = 1.0'' \end{array}\right\} = 7''$

$$A_s = \frac{1470 \times 12}{7/8 \times 18000 \times 5.5} = 0.21^{\square''}$$

Use ½"ϕ bars 9" o.c. ($A_s = 0.26^{\square''}$)
Alt. Bars Bent

Use 7" Slab for Boiler Rm. Floor
½"ϕ bars @ 9" o.c. (Alt. Bars Bent.)

Slab between Bms B1 & B3 @ Bm. B4

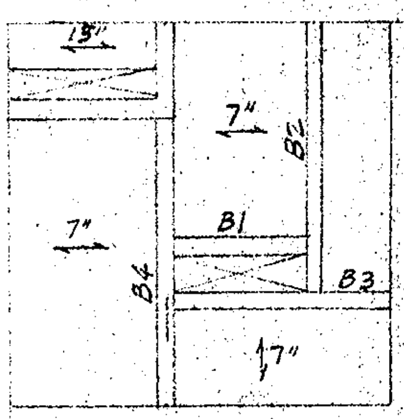


(At opening)

(Superseded)
Opening in floor has been moved over eliminating need for haunched cantilever slab.

Project Call St. Pumping Sta.
Computation Boiler Room Conc. Bms.
Computed by W. W. Z. Checked by ______ Date 4-8-40

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Bm. B1 span = 7.67 c to c

L.L. on beams designed for 80% L.L floor slab

Loading on B1 -

L.L. = 160 × 2 = 320 #/'

Bm D.L = 10×12 = 55

375 #/'

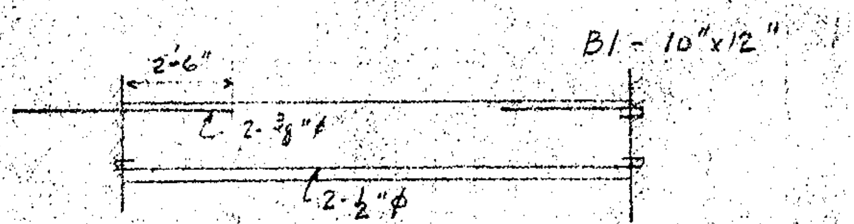
$R_L = R_R = 375 \times 7.67 \times \frac{1}{2} = 1450$ #

$M = \frac{1}{8} \times 375 \times (7.67)^2 = 2760$ '#

$d = \sqrt{\frac{2760 \times 12}{123 \times 12}} = 4.75"$ use 10"

$A_s = \frac{2760 \times 12}{\frac{7}{8} \times 18000 \times 10} = 0.21$ □" Use 2-½"φ

$v = \frac{1450}{\frac{7}{8} \times 10 \times 12} = 15$ #/□"



Object: Call St. Pumping Sta.
Computation: Boiler Room Conc. Bms
Computed by: W. W. Z. Checked by: Date: 4-8-40

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Bm B2 span = 14'-0" c. to c.

Reaction from B1 = 1450#

Reaction from stairs

L.L. = 50# × 10.5 √2 = 750#/'

D.L. = 50# × 10.5 √2 = 750

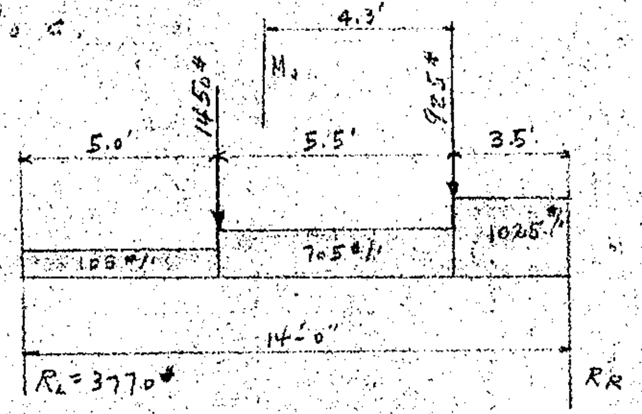
$\frac{1}{2} \times \frac{1}{2} \times 2.5$ 1500 = 925#

L.L. = 160 × $\frac{7.5}{2}$ = 600 #/'

L.L. = 160 × $\frac{4.0}{2}$ = 320 #/'

Bm = 12 × 16 = 105 #/'

7" slab = 90 #/'



R_R:

1025 × 3.5 × $\frac{12.25}{14.00}$ = 3150

705 × 5.5 × $\frac{7.75}{14.0}$ = 2140

105 × 5.0 × $\frac{2.5}{14.0}$ = 95

925 × $\frac{10.5}{14.0}$ = 695

1450 × $\frac{5.0}{14.0}$ = 520

6600#

$M_0 = 6600 \times 7.8 - 1025 \times 3.5 \times 6.0 - 925 \times 4.3 - 705 \times \frac{4.3^2}{2}$

$= 51500 - 21600 - 3980 - 6520 = 19400$ '#

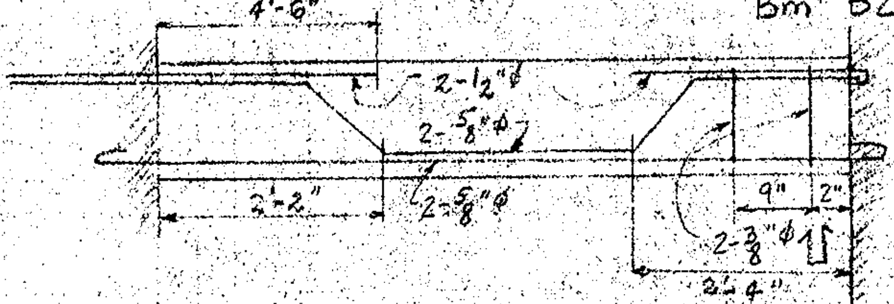
$d = \sqrt{\frac{19400 \times 12}{123 \times 12}} = 12.6"$ say 14"

$A_s = \frac{19400 \times 12}{\frac{7}{8} \times 18000 \times 14} = 1.06$ □" Use { 2- $\frac{5}{8}$"φ Str; 2- $\frac{5}{8}$"φ Bt

$v = \frac{6600}{\frac{7}{8} \times 12 \times 14} = 45$ #/□" $u = \frac{45 \times 12}{3.93} = 138$ #/□" Spec. Anchor.

top steel = $\frac{3}{4} \times 1.06 = 0.80$ □" Use 2-$\frac{1}{2}$"φ

Bm B2 - 12" × 16"



Object Call St. Pumping Sta.
Computation Boiler Room Conc. Bms
Computed by W.W.Z. **Checked by** .... **Date** 4-8-40

Bm. B3

Span = 12'-6" c to c.

Loading -

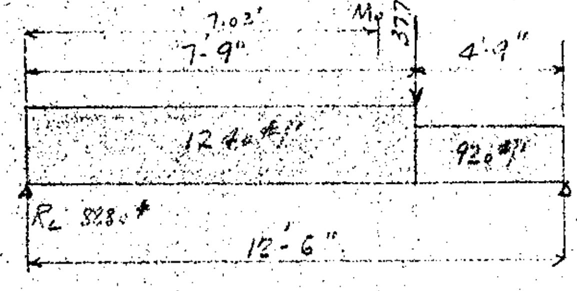
Reaction from B2 = 3770#

7" Slab = 12.5×7 × 3.25 = 285#/'

L.L. = 160 × 3.25 = 520#/'

L.L. = 160 × 2.0 = 320#/'

Bm = 12×16 = 115#/'



RL -

1240 × 7.75 × $\frac{8.62}{12.5}$ = 6620

920 × 4.75 × $\frac{2.38}{12.5}$ = 830

3770 × $\frac{4.75}{12.5}$ = 1430

8880# = R_R

$M_o = 8880 \times 7.03 - 1240 \times \frac{\overline{7.03}^2}{2} = 31800$ '#

$d = \sqrt{\frac{31800 \times 12}{142 \times 12}} = 16.1$" say 18"

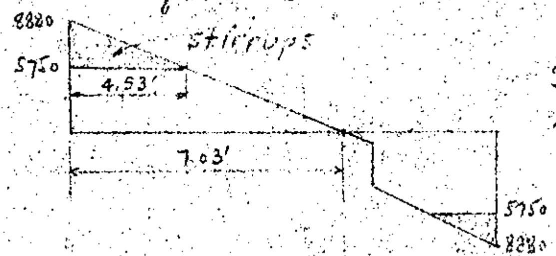
$A_s = \frac{31800 \times 12}{\frac{7}{8} \times 18000 \times 18.0} = 1.35$ □"

2-$\frac{3}{4}$"φ Str. (A_s = 1.49 □")
2-$\frac{5}{8}$"φ Str.

Top steel = $\frac{3}{4}$×1.35 = 1.01 □"
Use 4-$\frac{1}{2}$"□ bars

$v = \frac{8880}{\frac{7}{8} \times 12 \times 18} = 60$ #/□"

$u = \frac{62 \times 12}{4.71 \times 2} = 80$ #/□"

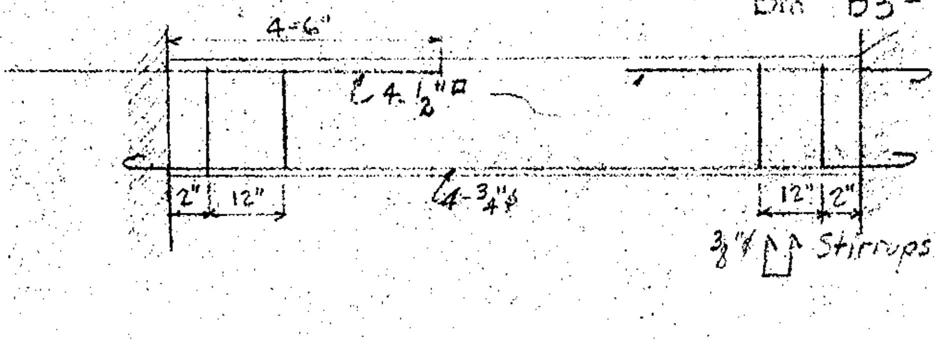


Stress taken by stirrups = 3130 × ½ × 54.4 = 85200#

No. of stirrups = $\frac{85200}{2 \times 0.11 \times 16000 \times \frac{7}{8} \times 16.5}$ = 2

Use 2-$\frac{3}{8}$"φ Stirrups each end

Bm B3 - 12×20"



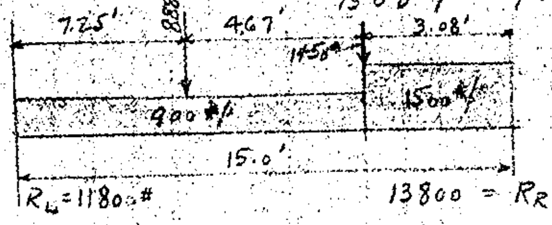
Project Call St. Pumping Sta.
Computation Boiler Room Conc. Bms.
Computed by W. W. Z. Checked by Date 4-8-40

Bm. B4

span = 13.25' clear or 15.0' c to c

Loading –
Reaction from B3 = 8880#
do B1 = 1450#

L.L. – 160 × 3.88 = 620 620
160 × 3.75 = 600
D.L. 7" Slab 7×12.5 = 90 90
Bm 14 × 24 = 190 190
1500#/' 900#/'



R_L –
900 × 11.92 × $\frac{9.04}{15}$ = 6470#
1500 × 3.08 × $\frac{1.54}{15}$ = 475
8880 × $\frac{7.25}{15.0}$ = 4550
1450 × $\frac{3.08}{15}$ = 300
11795#

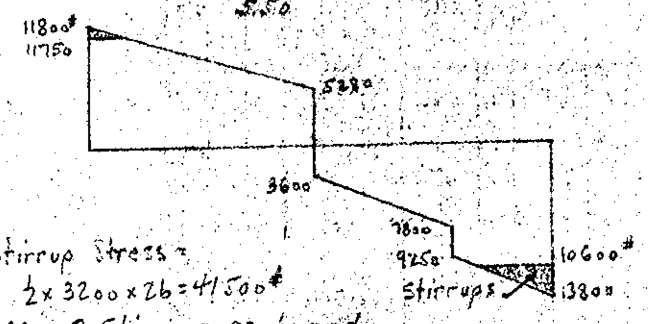
M_o = 11800 × 7.25 − 900 × $\frac{7.25^2}{2}$
= 61900'#

$d = \sqrt{\frac{61900 \times 12}{123 \times 14}}$ = 20.8" make d = 22"

$A_s = \frac{61900 \times 12}{\frac{7}{8} \times 18000 \times 22}$ = 2.15 □" { 2-⅞"φ Str. / 2-⅞"φ Bt. } (A_s = 2.41 □") ¾ × 2.15 = 1.61 □" Use 1-¾"φ

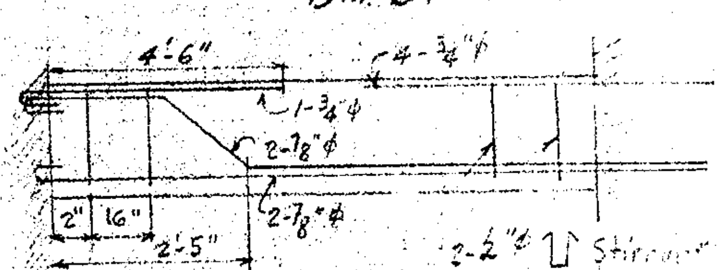
$v_L = \frac{11800}{\frac{7}{8} \times 14 \times 22}$ = 44#/□" $v_R = \frac{13.8}{11.8} \times 44$ = 52#/□" v_c = 40#/□"

$u_R = \frac{52 \times 14}{5.50}$ = 135#/□" (Spec. Anchor)



Stirrup Stress =
½ × 3200 × 26 = 41500#
Use 2 Stirrups each end

Bm. B4 – 14" × 24"



Bar bends: 11800x − $\frac{900x^2}{2}$ = 34600'# @ left support
x = 3.4'
(3'-5") − (1'-0") = 2'-5"

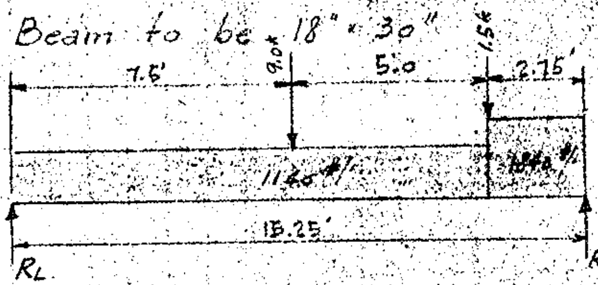
13800x − $\frac{1500x^2}{2}$ = 34600'# @ right support
x = 2.05'
(2'-1") − (9") = 1'-4" (Do not bend bars)

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

Subject Call St. Pumping Sta.
Computation Boiler Room Floor Framing
Computed by W. W. Z. Checked by ______ Date 4-12-40

Beam B4 (revision) Span = 13.50' clear

Beam to be 18" × 30"



Loading -
Reaction B3 = 9000#
do. B1 = 1500#
L.L. 160#/□' × 3.88 = 620#/'
160 × 4.37 = 700
D.L. 7" slab = 90
Bm. 18 × 30 = 430
1840#/'

$R_L = 1140 \times 12.5 \times \frac{9.0}{15.25} = 8400\#$

$1840 \times 2.75 \times \frac{1.38}{15.25} = 460$

$9000 \times \frac{7.75}{15.25} = 4570$

$1500 \times \frac{2.75}{15.25} = 270$

$13700\#$

$R_R = 16100\#$

$M_o = 13700 \times 7.5 - 1140 \times \frac{(7.5)^2}{2}$

$= 70800'\#$

$A_s = \frac{70800 \times 12}{7/8 \times 18000 \times 28} = 1.93\square''$ { 2-7/8"φ Str., 2-3/4"φ Bt.

At left bending up 2-3/4"φ -

$M_{steel} = 0.88 \times 18000 \times \frac{7}{8} \times \frac{28}{12} = 32300'\#$

$13700x - 1140\frac{x^2}{2} = 32300$

$x = 2.7' = 2'-8"$

At right -

$16100x - 1840\frac{x^2}{2} = 32300\#$

$x = 2.3' = 2'-4"$

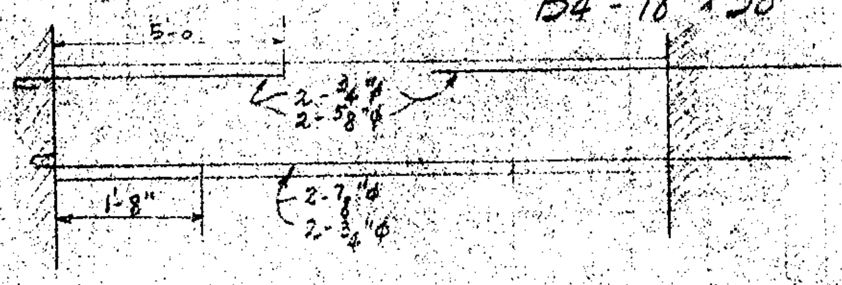
N.B. Do not bend bottom bars.

$u = \frac{16100}{7/8 \times 28 \times 5.50} = 120\#/\square''$

$v = \frac{16100}{7/8 \times 18 \times 28} = 37\#/\square''$ no stirrups req.

top steel $= \frac{3}{4} \times 1.93 = 1.45\square''$

B4 - 18" × 30"

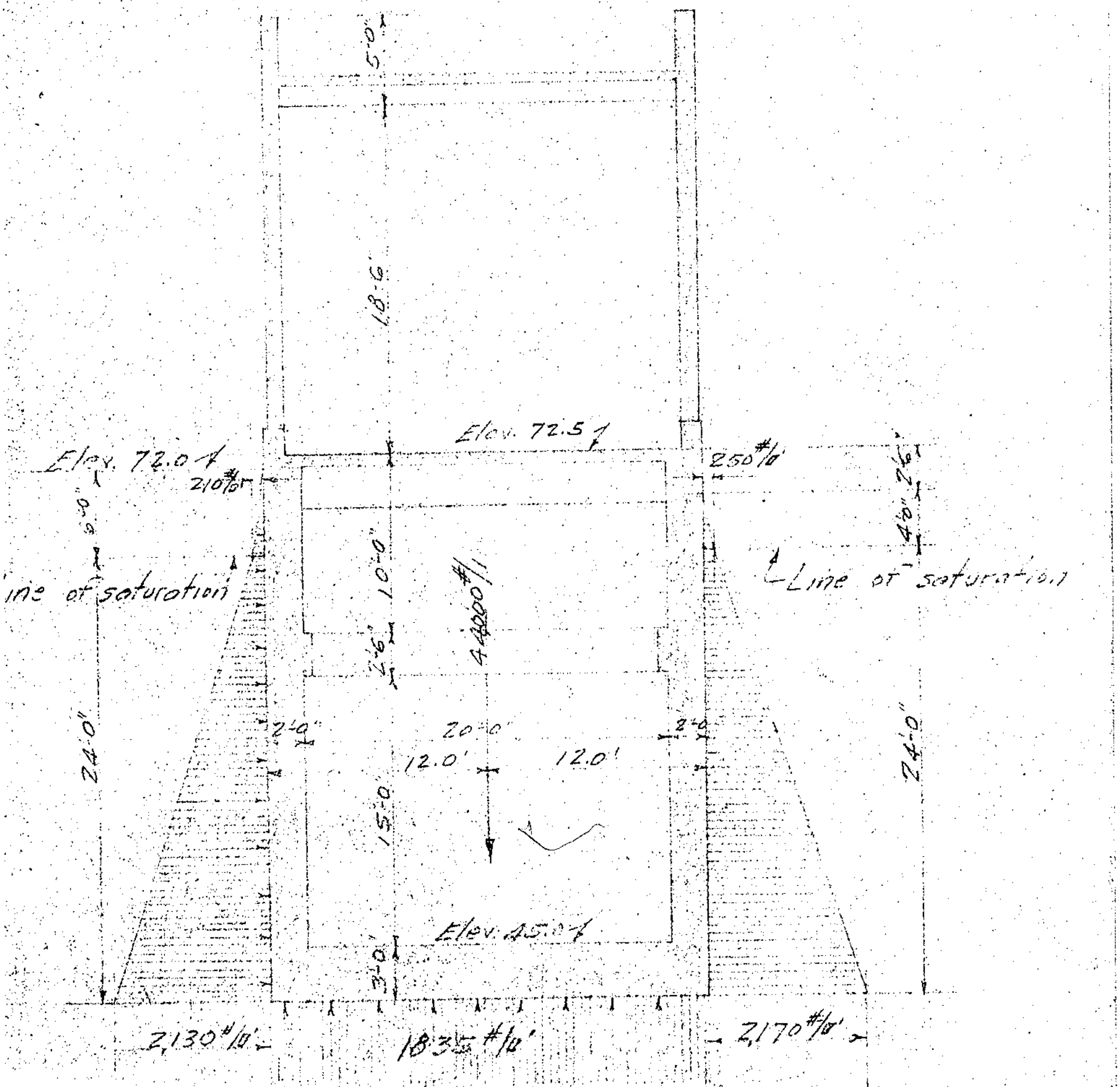


WAR DEPARTMENT

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

ject Call St. Pumping Station
mputation Stability of Structure
mputed by E.M.V. Checked by .... Date April 8, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Loading Diagram with River Up. Saturated Soil on Riverside & Landside

WAR DEPARTMENT

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

Project Call St. Pumping Station

Computation Stability of Structure

Computed by E. M. V. Checked by ______ Date April 5 1940

U. S. GOVERNMENT PRINTING OFFICE 8—10528

Description	Dimensions & Unit Weight	Weight in Kips	Arm "Y"	Moment Abt X-Axis	Arm "X"	Moment Abt Y-Axis
Roof Slab	21.5×58.5×0.42×150	79.2 ✓	12.0	950.0	31.3	2475.0
Roof Fill	21.5×58.5×0.33×90	37.3 ✓	12.0	447.0	31.3	1168.0
Roofing	21.5×58.5×6.0	7.5 ✓	12.0	90.0	31.3	234.5
Roof Bms.	5×45×22.0	5.0 ✓	12.0	60.0	32.0	160.0
Crane Bms.	2×60×33.0	4.0 ✓	12.0	48.0	32.0	128.0
" Cols.	10×18.5×33.0	6.1 ✓	12.0	73.2	32.0	195.0
End Cols.	2×18.5×24.0	0.9 ✓	12.0	10.8	60.5	54.4
" "	1×18.5×24.0	0.5 ✓	12.0	6.0	1.0	0.5
Spand. Bms	2×60.0×17.0	2.0 ✓	12.0	24.0	32.0	64.0
" "	2×22.5×17.0	0.8	12.0	9.6	32.0	25.6
Bm. Encasem't	1.0×1.33×5×22×150	22 ~~1.0~~	12.0	264.0 ~~12.0~~	32.0	705.0 ~~32.0~~
Crane Rails	2×60×3.0	3.6 ✓	12.0	43.2	32.0	115.0
Brick Walls	60.5×22×120×2	319.0 ✓	12.0	3830.0	32.0	10200.0
" "	21.5×22×120×2	113.5 ✓	12.0	1366.0	32.0	3640.0
Engine Fl. Slab	20.0×58.5×0.67×150	117.5 ✓	12.0	1410.0	32.0	3760.0
Boiler Rm "	18.5×20.0×0.67×150	37.2 ✓	12.0	447.0	52.0	1930.0
Foundation Walls	2×61.5×30×150×2	1106 ~~553.0~~	12.0	13,280.0 ~~6650.0~~	30.8	34060.0 ~~17030.0~~
" "	2×20.0×30×150×2	360 ~~180.0~~	12.0	2160.0	30.8	5550.0
		~~1468.1~~ 2,222.0		~~17,636.8~~ 24,518.8		~~46,762.0~~ 64,465

WAR DEPARTMENT

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

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Subject Call St. Pumping Station

Computation Stability of Structure

Computed by E. M. V. Checked by ______ Date April 5, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Description	Dimensions & Unit Weight	Weight in Kips	Arm "Y"	Moment Abt X-Axis	Arm "X"	Moment Abt Y-Axis
Transverse Wall	1.5×25.5×20.0×150	114.5	12.0	1,373.0	40.0	4580.0
Conduit "	1.5×6.0×20.0×150	27.0	12.0	324.0	46.5	1,256.0
" Roof	1.0×5.0×20.0×150	15.0	12.0	180.0	43.0	646.0
Base Slab	24.0×~~61.5~~ 60×3.0×150	~~664.0~~ 650.0	12.0	~~7975.0~~ 7800.0	30.8	~~20,450.0~~ 2,000.0
Op. Fl. Bms.	1.5×3.0×20.0×150×6	81.2	12.0	974.0	30.8	2,580.0
	1.0×1.04×14.0×150	2.2	9.0	19.8	5.0	11.0
	1.5×3.0×20.0×150×2	27.0	12.0	324.0	50.0	1,350.0
Gas Engines	3×6,000	18.0	8.0	144.0	22.0	396.0
Engine Bases	3×7,700	23.1	8.0	184.8	22.0	508.0
Gear Units	3×5,300	15.9	18.0	286.2	22.0	350.0
Pumps	3×18,000	54.0	18.0	972.0	22.0	1188.0
Pump Thrusts	3×12,000	36.0	18.0	648.0	22.0	792.0
Flap Valves, etc.	3×7,300	21.9	20.5	450.0	22.0	482.0
Vol. Pump & Motor	1×2900	2.9	16.5	47.8	52.0	150.8
Standby	1×19,000	19.0	6.0	114.0	50.0	950.0
Switchboard	1×4000	4.0	18.0	72.0	43.0	172.0
		~~1161.7~~ 1147.7		~~14,088.6~~ 13,913.6		~~35,861.8~~ 35,411.8

Subject: Call St. Pumping Station
Computation: Stability of Structure
Computed by: E.M.V. Checked by .... Date: April 5, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Description	Dimensions & Unit Weights	Weight in Kips	Arm "Y"	Moment Abt X-Axis	Arm "X"	Moment Abt Y-Axis
Crane	Assumed wt. 8,000#	8.0	12.0	96.0	30.0	240.0
Volute Pump	1×3000	3.0	15.0	45.0	52.0	156.0
Boiler	1×2,000	2.0	5.5	11.0	52.0	104.0
Gate Chamb. Wall	1.5×9.0×8.0×150	16.2	16.0	259.0	44.5	722.0
		29.7		411.0		1222.0
	Brought forward 1147.7	~~1151.7~~		13913.6 ~~24518.8~~		35411.8 ~~64465.6~~
	" 2222.	~~1468.1~~		~~21630.0~~		~~46762.0~~
		~~2659.0~~		~~22136.4~~		~~83845.8~~
	Revised wt.	3363.0		38,843.4		101,098.8

$\bar{X} = \frac{101,098 \; (\text{~~83,845.8~~})}{3363.0 \; (\text{~~2659.0~~})} = \text{~~31.5'~~} \; 30.3$

$\bar{Y} = \frac{38843.4 \; (\text{~~22136.4~~})}{3363 \; (\text{~~2659.0~~})} = 11.6 \; (\text{~~12.1', say 12.0'~~})$

Note: $\bar{X}$ is measured from outside face of west wa[ll]
$\bar{Y}$ " " " " " " south "

WAR DEPARTMENT

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

[Subj]ect: Call St. Pumping Station

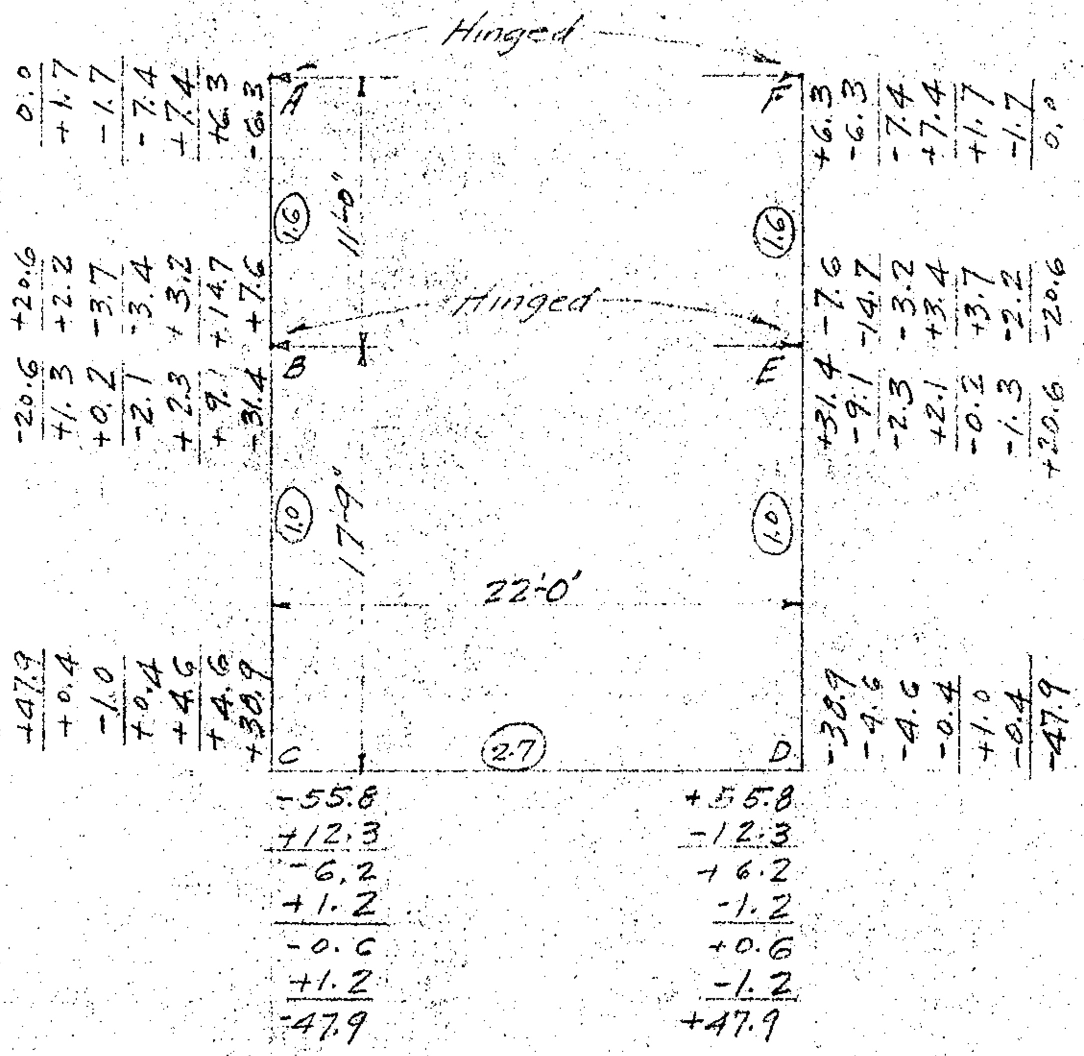
[C]omputation: Transverse Section

[C]omputed by: E. M. V. Checked by: ______ Date: April 9, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

I for walls = 13,824"⁴

I " base = 46,656"⁴



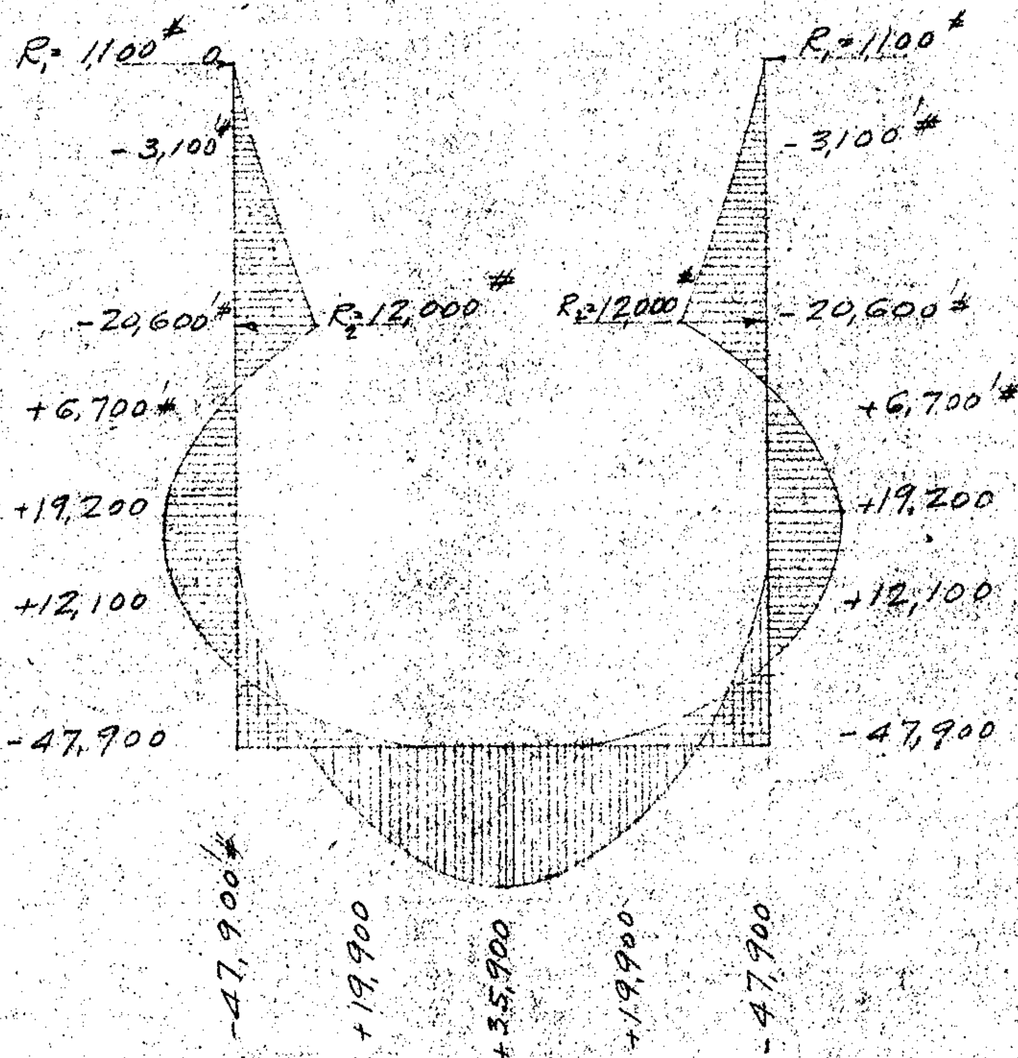
Moment Distribution Diagram

...ect Call St. Pumping Station
...mputation Transverse Section
...mputed by E. M. V. Checked by .... Date April 9, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #62)

Member A-B - Shear at "A" = -1,100 #
" " " B = +3,800 #
" B-C - " " B = +8,200 #
" " C = 14,900 #
" C-D " " C = 15,200 #



Bending Moment Diagram

ject Call St. Pumping Station
mputation Transverse Section
Date April 10, 1940
mputed by E.M.V. Checked by

(Continued from sheet #63)

1. Design of base slab -

Max. pos. mom. = 35,900'#

" neg. " = 47,900'#

" shear = 15,200#

$"d" = \sqrt{\frac{47900}{123}} = 19.7"$ Make slab 3'-0" thk. d = 31.5"

A_s for pos. mom. = $\frac{35900 \times 12}{\frac{7}{8} \times 31.5 \times 18,000} = 0.87 \square"$

A_s for neg. mom. = $\frac{47,900 \times 12}{\frac{7}{8} \times 31.5 \times 18,000} = 1.16 \square"$

2. Lower part of wall -

Max. pos. mom. = 20,000'#

" neg. " = 47,900'#

" shear = 14,900#

Required "d" for neg. mom. = 19.7" Make wall 2'-0" thk.

Unit shear = $\frac{14900}{12 \times \frac{7}{8} \times 19.7} = 72\#/\square"$ O.K. with special anchorage

A_s for pos. mom. = $\frac{20,000 \times 12}{\frac{7}{8} \times 19.7 \times 18,000} = 0.78 \square"$

" " neg. " = $\frac{47,900 \times 12}{\frac{7}{8} \times 19.7 \times 18,000} = 1.85 \square"$

WAR DEPARTMENT

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

bject Call St. Pumping Station

mputation Transverse Section

mputed by E.M.V. Checked by .... Date April 10, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #64)

For pos. mom. in base slab use 1" bars 12" c.c.

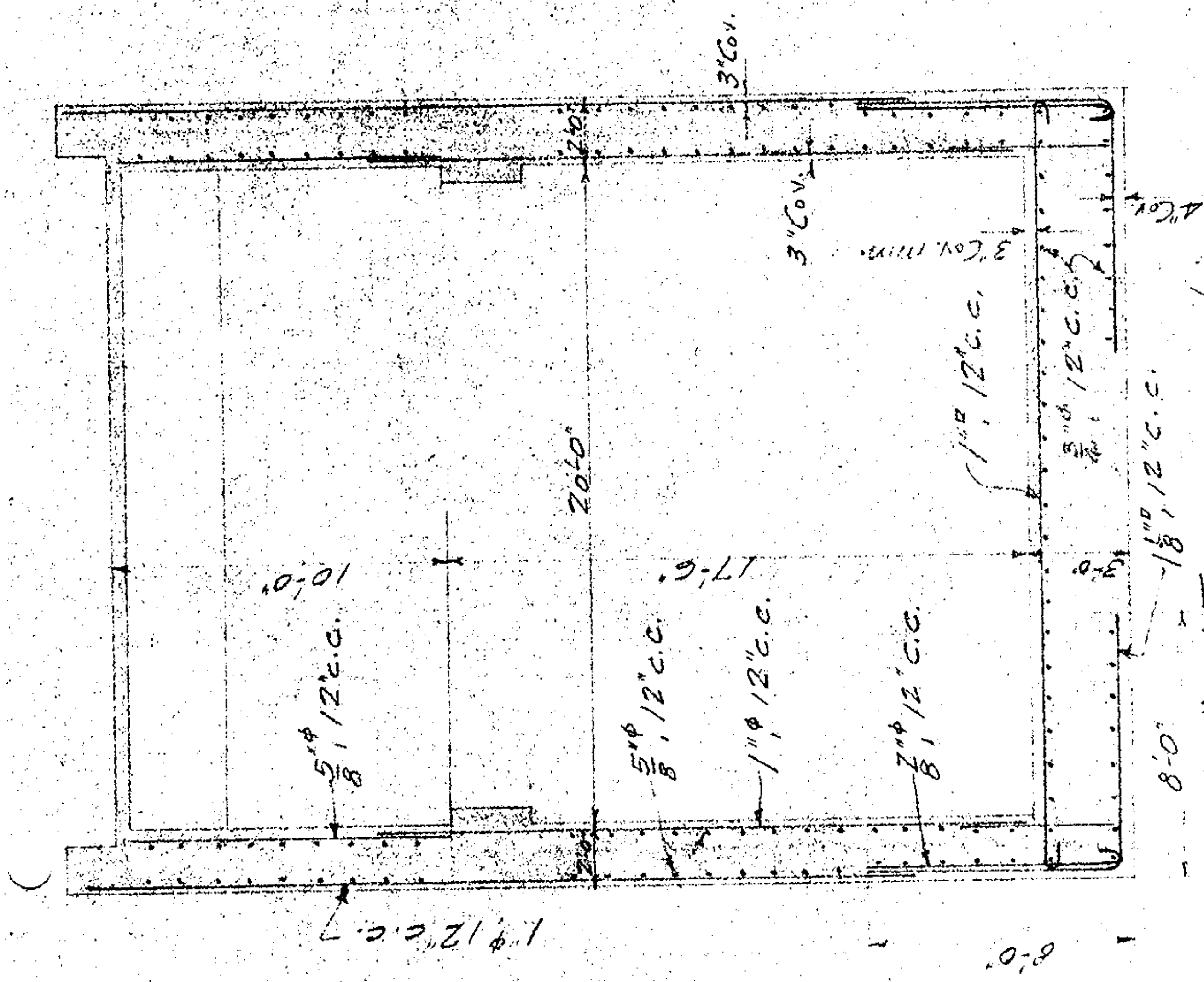
" pos. " " walls " 1"φ " 12" c.c.

" neg. " " " at top " 1"φ " 12" c.c.

" " " " " " bot. " 1 1/8"φ " 12" c.c. } Alternate to give 6" spacing

7/8"φ " 12" c.c.

" " " " base use 1 1/8"φ " 12" c.c.



Typical Transverse Section

WAR DEPARTMENT

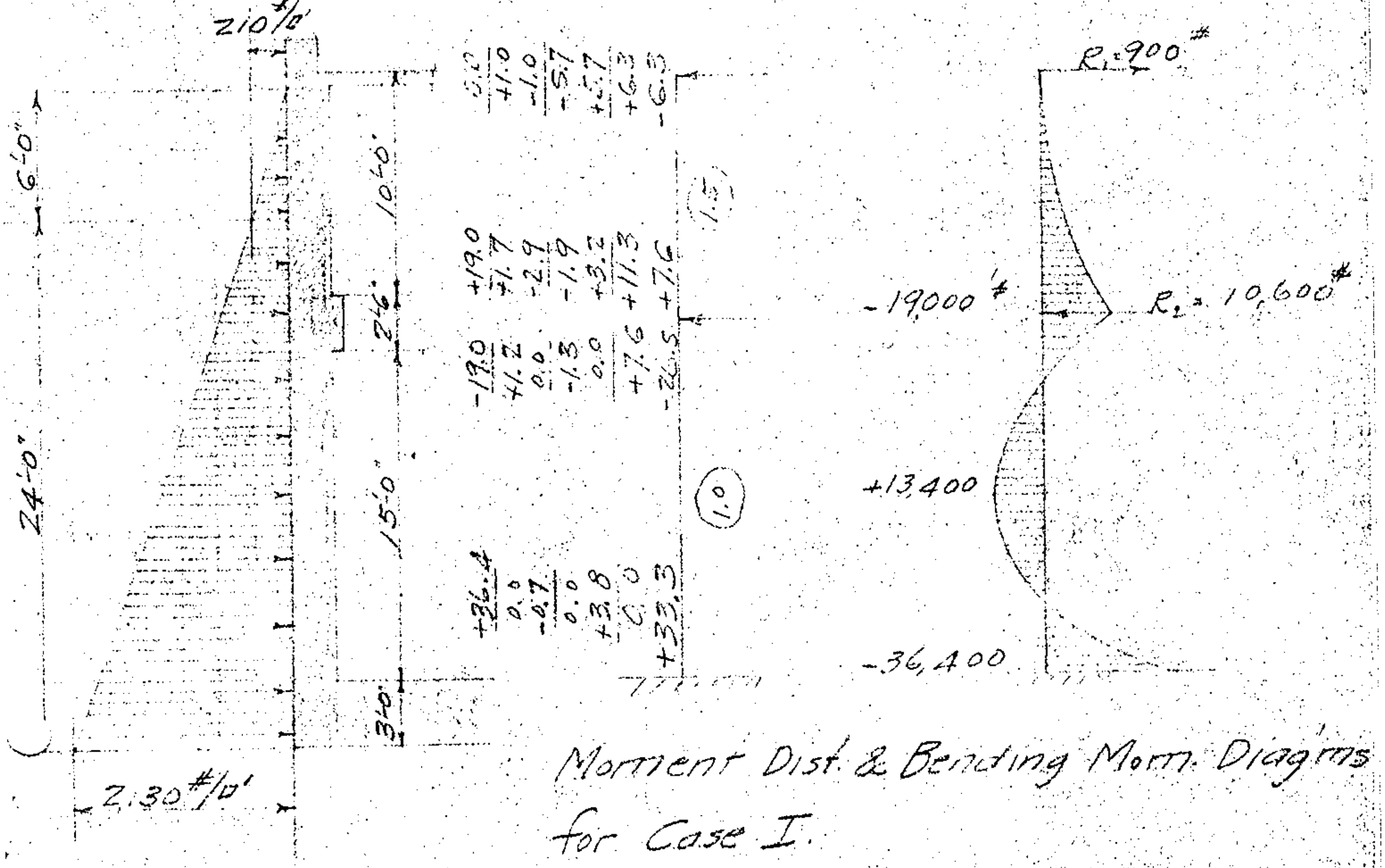
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject Call St Pumping Station
Computation End Walls
Computed by E.M.V. Checked by .... Date April 11, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

The end walls will be considered for 2-cases, namely:
Case I will assume the walls supported at the upper edge, supported at an intermediate point 16'3" above the base slab, and fixed at the base.
Case II will assume 75% fixity at the base.

Earth assumed saturated to Elev. 66.0



Moment Dist. & Bending Mom. Diagrams for Case I.

Subject: Call St. Pumping Station
Computation: End Walls
Computed by: E.M.V. Checked by: Date: April 11, 1940

(Continued from sheet #9)

Design of end walls –

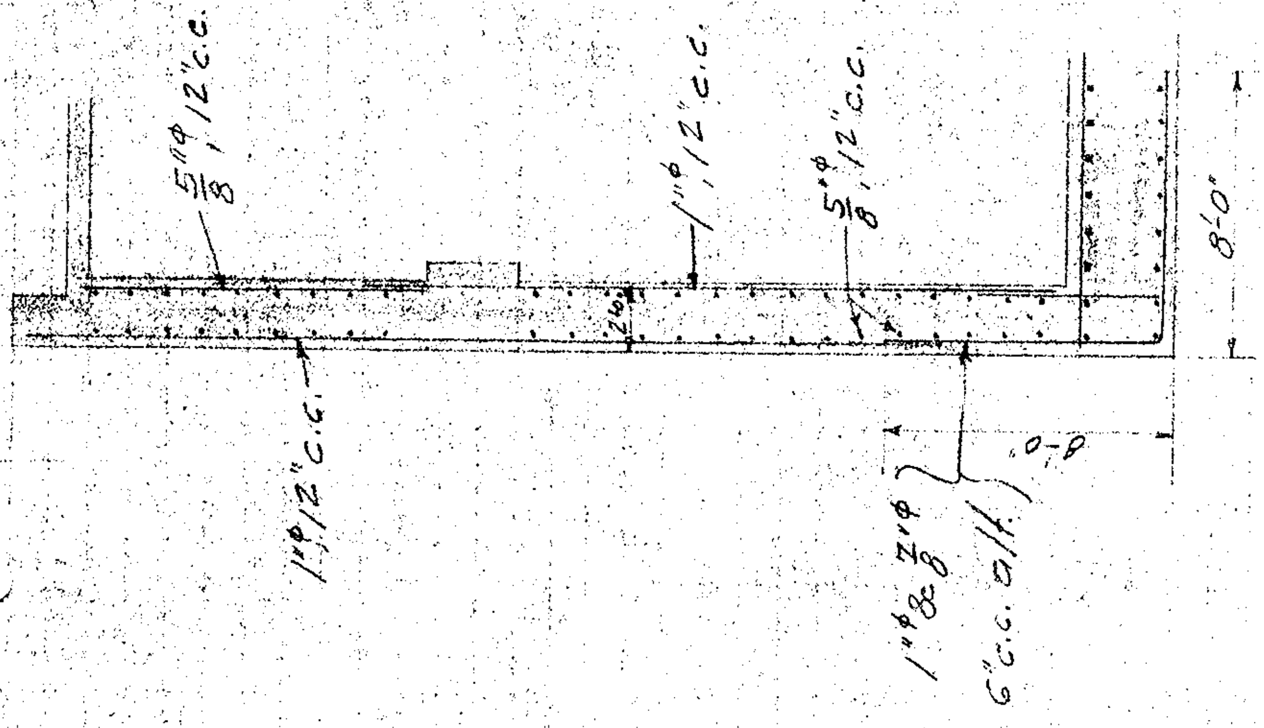
In the design of the end walls it will be assumed that full fixity at the base maintains for max. neg. mom. and 75% fixity at the base maintains for pos. mom.

Max. neg. mom. = 36,400'#.

" pos. " = 17,900'#.

A_s for neg. mom. = $\frac{36{,}400 \times 12}{\frac{7}{8} \times 20.5 \times 18000}$ = 1.35□" = 1"φ & 7/8"φ 6" c.c.

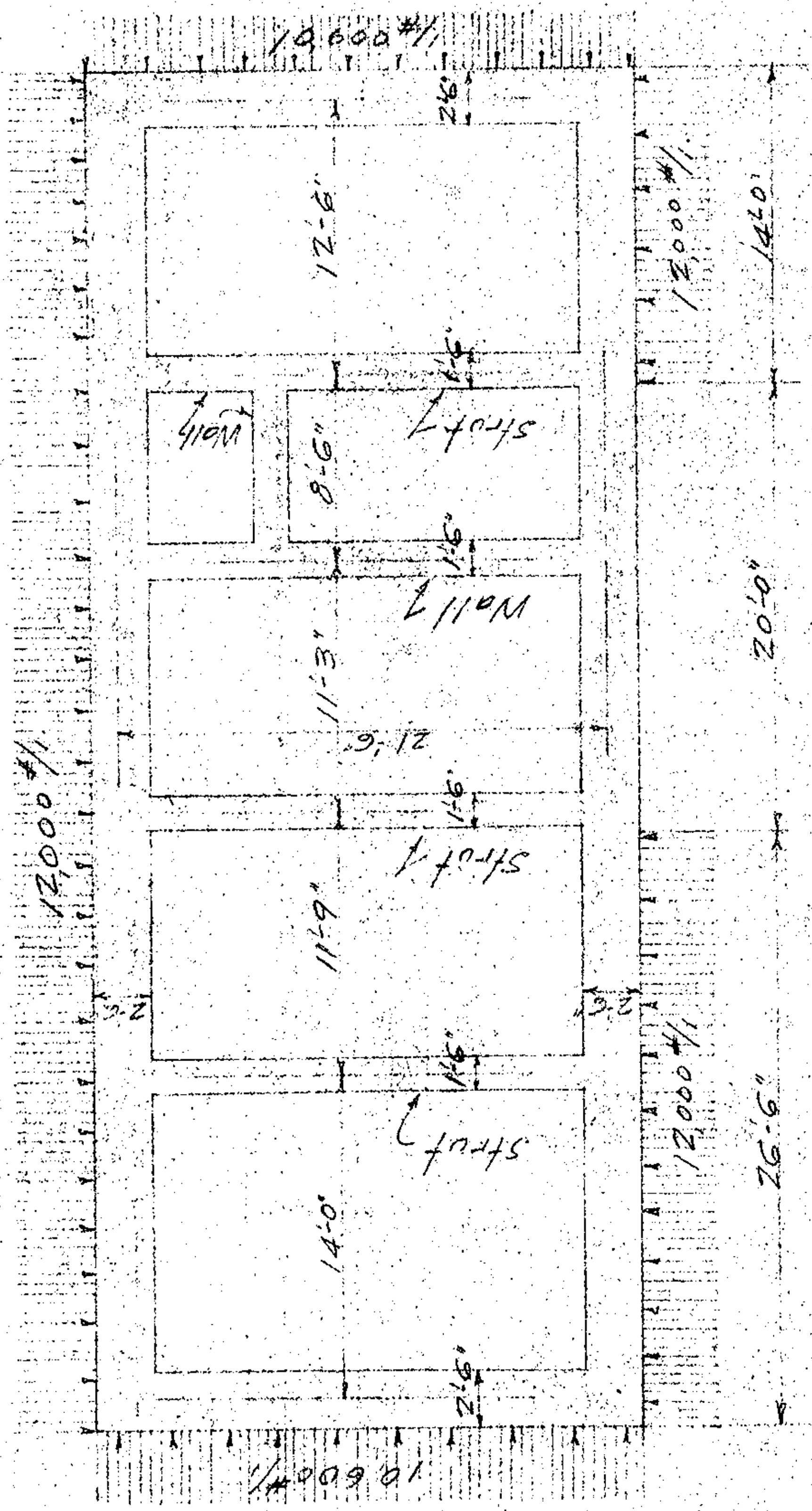
" " pos. " = $\frac{17900 \times 12}{\frac{7}{8} \times 20.5 \times 18000}$ = 0.67□" Use 1"φ, 12" c.c.



WAR DEPARTMENT

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

Subject: Call St Pumping Station
Computation: Horizontal Wales & Cross Bms
Computed by: E.M.V. Checked by: Date: April 11, 1940.



Plan of Framing & Loading on Horizontal

Frame at Elev. 60.75

Assuming Wales 30"x30", I = 67,500 "4

Transverse bms 18"x30", I = 40,500 "4

WAR DEPARTMENT

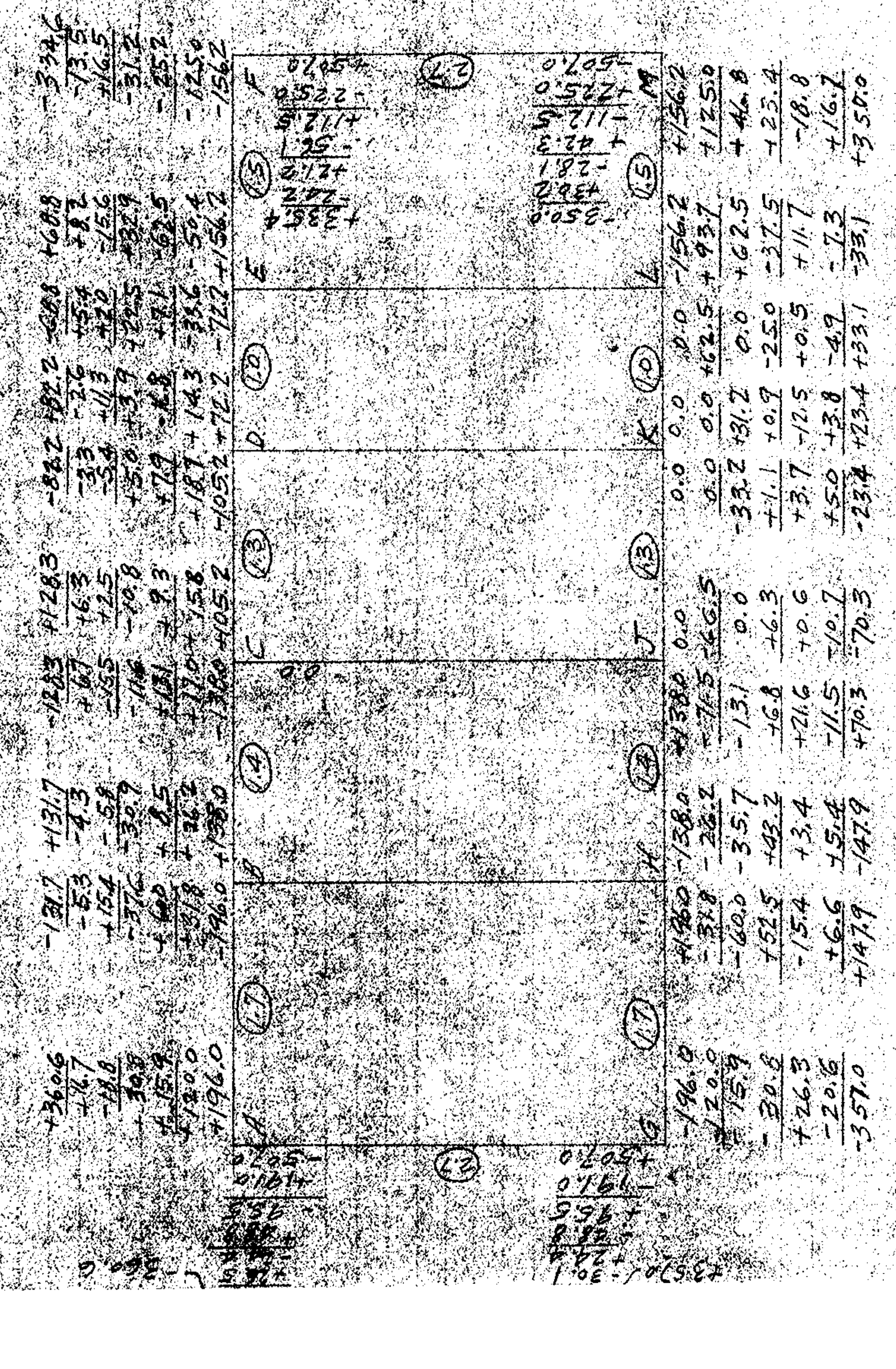
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project: Colt St. Pumping Station

Computation: Horizontal Wales & Cross Bras

Computed by: E. M. V. Checked by: ______ Date: April 15, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Moment Distribution Diagram

Note: Intersections between interior transverse members and wales assumed hinged.

WAR DEPARTMENT

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

Project Call St. Pumping Station

Computation Horizontal Wales & Cross Bms.

Computed by E. M. Y. Checked by Date April 15, 1940.

U.S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #12)

Member A-B	Shear at	A =	100,400 #
"	"	B =	67,600
B-C	" "	B =	70,600
"	"	C =	70,000
C-D	" "	C =	71,500
"	"	D =	63,300
D-E	" "	D =	52,600
"	"	E =	49,400
E-F	" "	E =	53,700
"	"	F =	96,300
G-H	" "	G =	98,900
"	"	H =	67,100
H-J	" "	H =	77,000
"	"	J =	63,800
J-K	" "	J =	8,300
"	"	K =	8,300
K-L	" "	K =	6,700
"	"	L =	6,700
L-M	" "	L =	49,600
"	"	M =	100,400

WAR DEPARTMENT

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

Project Call St. Pumping Station
Computation Horizontal Wales & Cross Bms.
Computed by E. M. V. Checked by ______ Date April 15, 1940

(Continued from sheet #13)

Member A-G. Shear at A = 119,400#

" " G = 119,000

" F-M. " " F = 118,500

" " M = 119,900

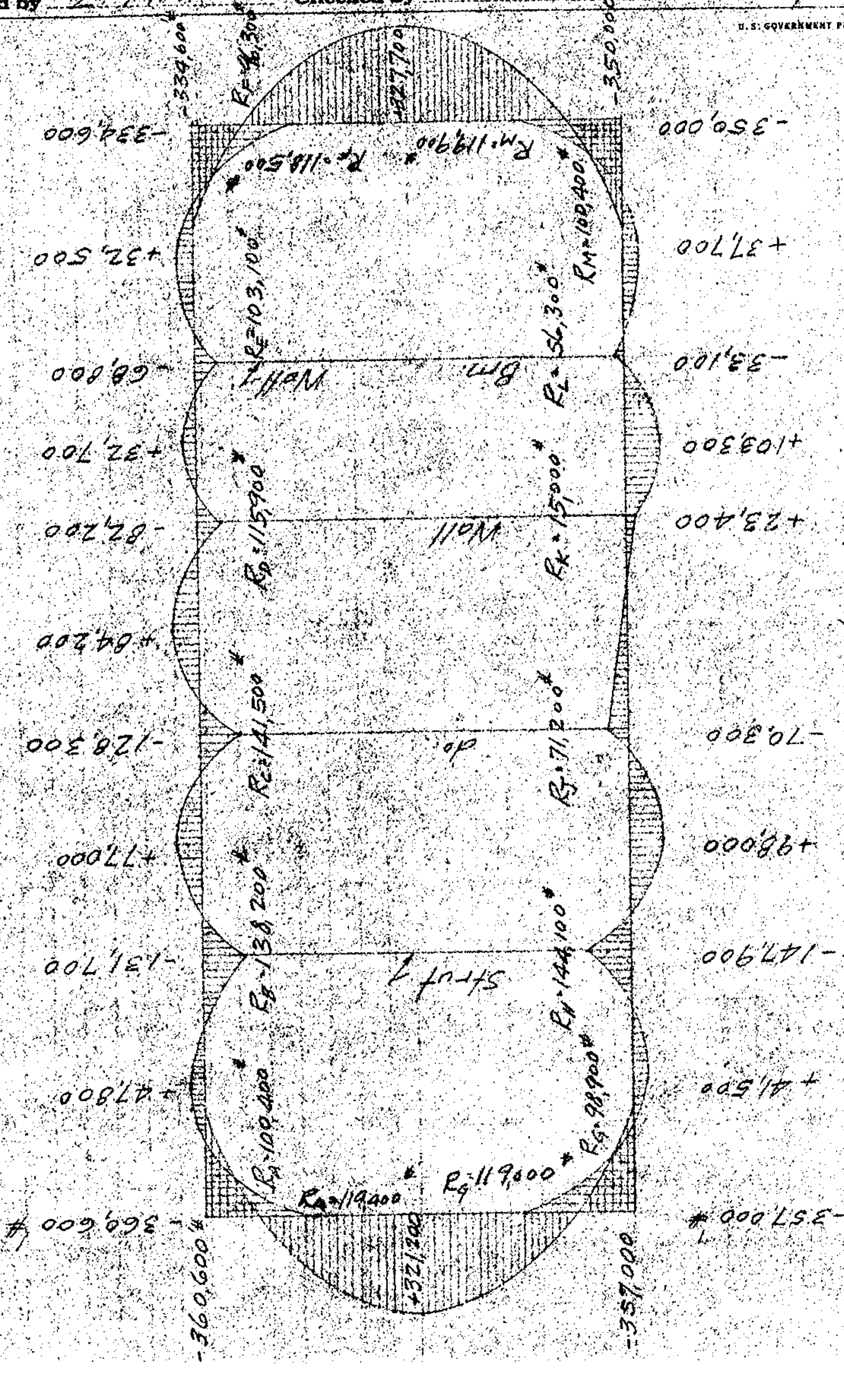
WAR DEPARTMENT

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

Project Call St. Pumping Station

Computation Horizontal Wales & Cross Bms

Computed by E.M.V. Checked by ______ Date April 16, 1940



Bending Moment Diagram

Note: The difference in thrust between the riverside and landside wales is taken up by the transverse walls at the conduit and by strengthening the wales where required

Project Call St Pumping Station
Computation Horizontal Wales & Cross Bms.
Computed by E.M.V. Checked by Date April 16, 1940

U.S. GOVERNMENT PRINTING OFFICE 3—10628

(Continued from sheet #15)

Design of wales in end walls—

Max. neg. mom. = $360,600 - 100,400 \times 0.4 \times 2.5 \times \frac{1}{2} = 310,400$ '#

Effective depth reqd = $\sqrt{\frac{310,400 \times 12}{123 \times 30}} = 31.7$" Make d = 32.5"

Unit shear = $\frac{119,400 - 10,600 \times 0.4 \times 2.2}{\frac{7}{8} \times 30 \times 32.5} = 129$ #/□"

A_s for pos. mom. = $\frac{327,700 \times 12}{\frac{7}{8} \times 32.5 \times 18,000} = 7.68$ □"

Use 6-1⅛"□ bars @ 1.26 = 7.56 □"

A_s for neg mom. = $\frac{(360,600 - 119,400 \times 0.4 \times 2.7 \times \frac{1}{2})12}{\frac{7}{8} \times 32.5 \times 18,000} = 6.96$ □"

Use 6-1⅛"□ bars @ 1.26□ = 7.56□"

Unit bond stress = $\frac{110,100}{6 \times 4.5 \times \frac{7}{8} \times 32.5} = 143$ #/□ O.K. with special anchorage.

Shear taken by conc. = $60 \times 30 \times \frac{7}{8} \times 32.5 = 51,200$ #

" " by stirrups = $110,100 - 51,200 = 58,900$ #

No. of ½"φ stirrups reqd = $\frac{58900 \times 64 \times \frac{1}{2}}{0.19 \times 2 \times 14,000 \times 32.5} = 11$.

Space stirrups 1½", then 5@3", 3@5", 1@8", 1@10".

WAR DEPARTMENT

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

ject Call St. Pumping Station
omputation Horizontal Wales & Cross Bms.
omputed by E. M. Y. Checked by Date April 16, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10523

(Continued from sheet #16)

Design of walers A-B, E-F, G-H, & L-M.

Max. pos. mom. = 47,800 '#

" neg. " = 360,600 - 119,400 × 0.4 × 2.7 × $\frac{1}{2}$ = 296,100 '#.

Make "d" = 32.5"

A_s for pos. mom. = $\frac{47,800 \times 12}{\frac{7}{8} \times 32.5 \times 18,000}$ = 1.12 □"

A_s for neg. mom. = $\frac{296,100 \times 12}{\frac{7}{8} \times 32.5 \times 18,000}$ = 6.94 □"

Use 6-1⅛" □ bars for neg. mom.

Max. shear at "A" = 100,400 - 12,000 × 0.4 × 2.7 = 87,400 #.

" " " "B" = 67,600 - 12,000 × 0.75 = 58,600 #.

Unit shear at "A" = $\frac{87,400}{\frac{7}{8} \times 30 \times 32.5}$ = 103 #/□"

" " " "B" = $\frac{58600}{87,400}$ × 103 = 69 #/□"

No. of ½" φ stirrups req'd at "A" = $\frac{(87400 - 51,200)\, 36 \times \frac{1}{2}}{0.19 \times 2 \times 14,000 \times 32.5}$ = 4.

Space stirrups 3", then 2 @ 6", 1 @ 9"

Subject Call St. Pumping Station
Computation Horizontal Wales & Cross Bms.
Computed by E.M.V. Checked by Date April 17, 1940.

(Continued from sheet #17)

Design of wales "B-C", "H-J" & "C-D"

Member B-C. Max. pos. mom. = 77,000'#
" " neg. " = 131,700'#
" C-D " pos. " = 84,200'#
" neg. " = 128,300'#
" H-J " pos. " = 98,000'#
" neg. " = 147,900'#

For M = 147,900'# effective depth = $\sqrt{\frac{147900 \times 12}{123 \times 30}} = 21.9''$

Make walers 2'-6" deep; 26.5" effective.

A_s for neg. mom. = $\frac{147900 \times 12}{\frac{7}{8} \times 26.5 \times 18,000} = 4.25^{\square}$"

A_s for pos. " = $\frac{98,000 \times 12}{\frac{7}{8} \times 26.5 \times 18000} = 2.81^{\square}$"

Use 6-1"□ bars for neg. mom.
" 6-¾"□ " " pos.

Max. shear = $\frac{77000 - 0.75 \times 12,000}{30 \times \frac{7}{8} \times 26.5} = 98$ #/□"

Shear taken by conc. = $60 \times \frac{7}{8} \times 30 \times 26.5 = 41,700$#
" " " steel = 68,000 − 41,700 = 26,300#

WAR DEPARTMENT

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

Project: Call St. Pumping Station

Computation: Horizontal Wales & Cross Bms.

Computed by: E.M.V. Checked by ______ Date: April 17, 1940

(Continued from sheet #18)

No. of $\frac{3}{8}$" stirrups req'd = $\frac{26,300 \times \frac{1}{2} + 26}{0.11 \times 2 \times 14000 \times 26.5} = 4$

Space stirrups 2" then 2@4", 1@6".

Design of wales "D-E", "J-K", & "K-L".

Member D-E. Max. pos. mom. = 32,700'#

" neg. " = 82,200'#

" J-K. " pos. " = 23,400'#

" neg. " = 70,300'#.

" K-L " pos. " = 103,300'#.

" neg. " = 33100'#.

A_s req'd for neg. mom. of 82,200'# = $\frac{82,200 \times 12}{\frac{7}{8} \times 26.5 \times 18,000} = 2.36$□"

Provide 4-$\frac{3}{8}$"φ stirrups at each end of each beam and space them same as at top of this sheet.

Design of transverse struts.

Max. direct thrust = 144,000#

Assuming strut 1'6" × 2'6" wt. per ft. = 562#.

Project Call St. Pumping Station
Computation Horizontal Wales & Cross Bms.
Computed by E.M.V. Checked by Date April 17, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #19)

$M = \frac{1}{8} \times 562(22.0)^2 = 34{,}000'\#.$

$d = \sqrt{\frac{34000 \times 12}{123 \times 18}} = 13.6''$ Make bm. 18"×30"

Radius of gyration $= \frac{h}{\sqrt{12}} = \frac{18}{3.46} = 5.2$
Unsupported length of strut = 228". } $\frac{l}{r} = 44$

Allowable load on normal col. $= 0.225 \times 3000 \times 540(1+11)0.005$
$= 484 \#/\square''$

Allowable load on the strut $= \left(1.33 - \frac{228}{120 \times 5.2}\right) 484 = 465 \#/\square''$

f_c due to bm. action $= \frac{2 \times 34000 \times 12}{0.4 \times \frac{7}{8} \times 18 \times (26.5)^2} = 184 \#/\square''$

f_c due to col. action $= \frac{144{,}000}{18 \times 30} = 267 \#/\square''$

Combined stress $= 267 \pm 184 = 451 \#/\square''$ max.
$83 \#/\square''$ min. } No tension.

Assuming bm. action only $A_s = \frac{34000 \times 12}{\frac{7}{8} \times 26.5 \times 18{,}000} = 0.98 \square''$

Use 6-$\frac{7}{8}''\phi$ bars as col. reinforcement with 2-bars in top, 2-bars in bot. & 2-bars halfway between top & bot.
Use $\frac{3}{8}''\phi$ ties 1'-0" c.c.

WAR DEPARTMENT

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

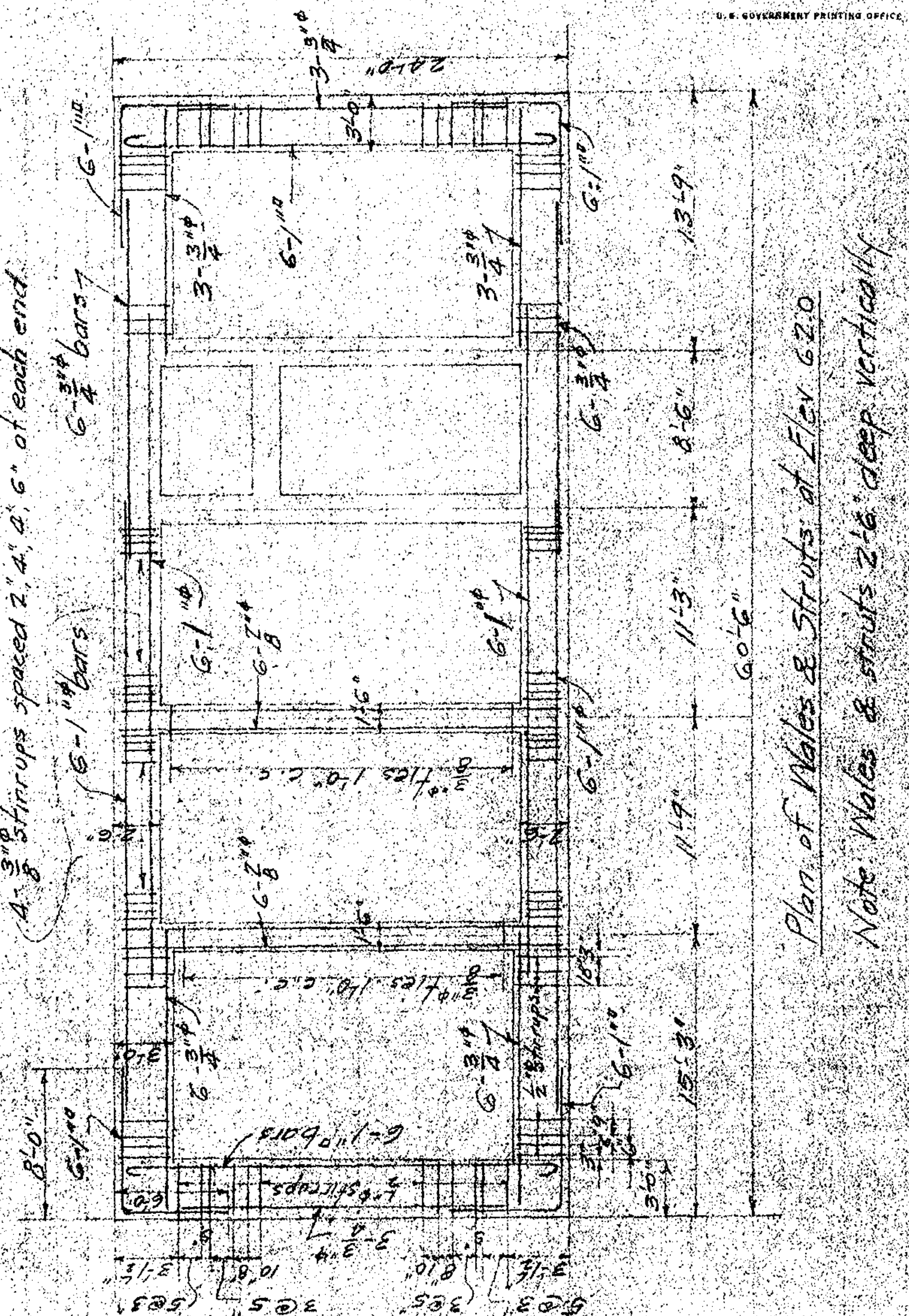
Page *78*

Subject *Call St Pumping Station*

Computation *Horizontal Wales & Cross Bms.*

Computed by *E.M.V.* Checked by ________ Date *April 17, 1940*

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Subject Call St. Pumping Station
Computation Gate Chamber at Inlet
Computed by E. M. V. Checked by Date April 18, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

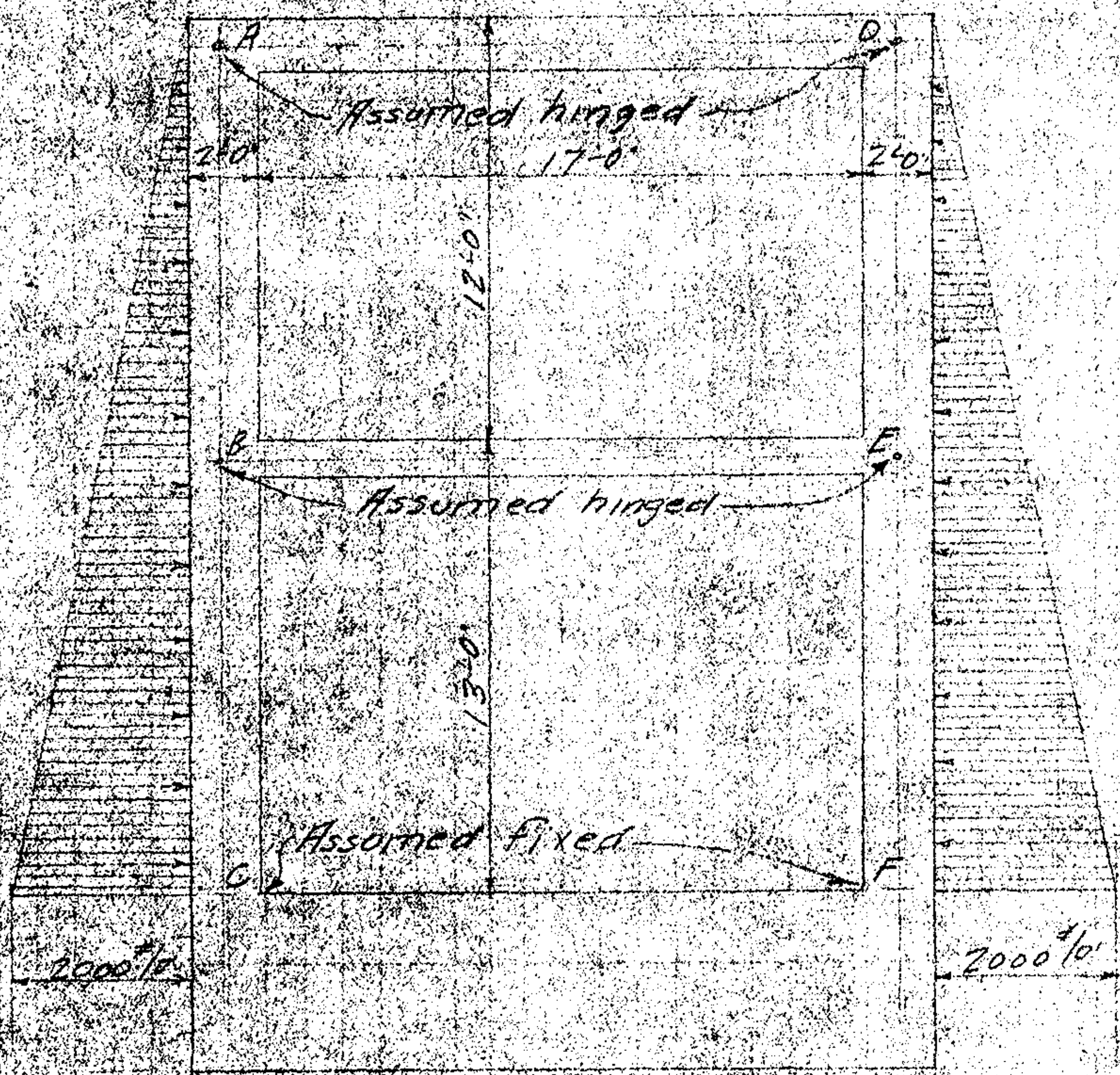


Diagram of Assumed Loading and Assumed End Conditions

WAR DEPARTMENT

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

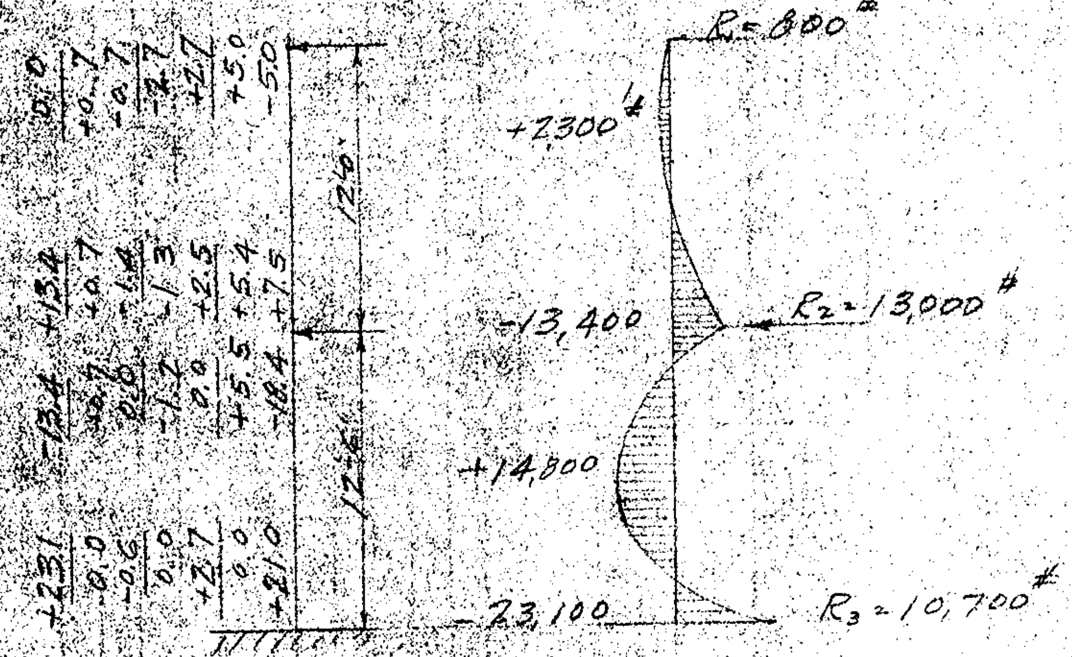
Object: Call St. Pumping Station

Computation: Gate Chamber at Inlet

Computed by: E.M.V. Checked by ______ Date: April 19, 1940.

U.S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #22)



Mom. Dist. Diagram. Bend. Mom. Diagram.

Effective "d" $= \sqrt{\frac{23100}{123}} = 13.7"$

Make wall 2'-0" thk, "d" = 20.5"

A_s for max. pos. mom. $= \frac{14800 \times 12}{\frac{7}{8} \times 20.5 \times 18,000} = 0.55^{\square''}$

A_s for max. neg. " $= \frac{23100 \times 12}{\frac{7}{8} \times 20.5 \times 18,000} = 0.86^{\square''}$

Subject: Call St Pumping Station
Computation: Gate Chamber at Inlet
Computed by: E. M. V. Checked by: Date: April 20, 1940.

U.S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #23)

For pos. mom. use $\frac{7}{8}$"φ bars 12" c.c.

For neg. mom. " $\frac{3}{4}$"φ " 6" c.c.

Unit bond stress $= \frac{10,700}{2\times 2.36\times \frac{7}{8}\times 20.5} = 127$ #/□" O.K.

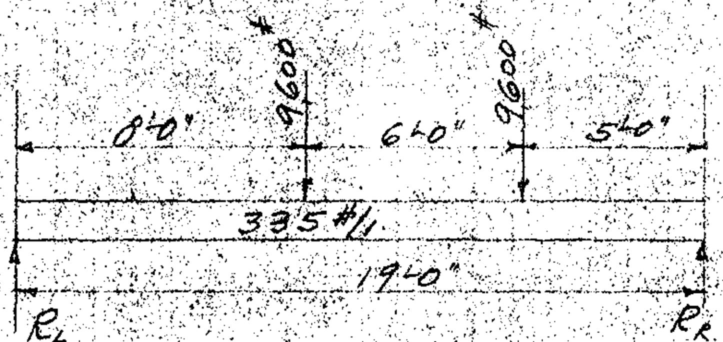
Unit shear $= \frac{10,700}{12\times\frac{7}{8}\times 20.5} = 50$ #/□" O.K.

Top member "A-D"

Assume that Live Load = 1-12 ton truck. No impact.

Effective span = 19'-0".

Assumed beam = 18"×18".



$R_L = 335\times 9.5 + 2\times 9600\times\frac{8.0}{19.0} = 11,300$#

$R_R = 14,300$#

Max. mom. $= 11,300\times 8.0 - 335\frac{(8.0)^2}{2} = 79,700$ '#.

$d = \sqrt{\frac{79700\times 12}{123\times 18}} = 20.8$". Make bm 2'-0" deep.

ect Call St. Pumping Station
mputation Gate Chamber at Inlet.
mputed by E.M.V. Checked by Date April 22, 1940.

U.S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #24)

Unit shear $= \frac{14,300}{12 \times \frac{7}{8} \times 20.8} = 66^{\#}/\square''$ O.K., special anchorage

$A_s = \frac{79,700 \times 12}{\frac{7}{8} \times 20.8 \times 18,000} = 2.92\square''$. Use 4-1"ϕ bars @ 0.785 = 3.14□".

With 2-bars bent up, bond stress $= \frac{14,300}{2 \times 3.14 \times \frac{7}{8} \times 20.8} = 125^{\#}/\square''$ O.K.

Portion of slab between pump house wall and checkered floor pls.

Assuming that slab will be supported by the pump house wall and by the bm. "A-D" previously designed, effective span = say 6'6".

Wt. of slab = 150 #/□'
L.L. = 300
Total = 450 #/□'

$M = \frac{1}{8} \times 450 \times \overline{6.5}^2 = 2,400'\#$, Make slab 1'0" thk.

$A_s = \frac{2,400 \times 12}{\frac{7}{8} \times 10.2 \times 18,000} = 0.18\square''$.

Use ½"□ bars 12" c.c.

WAR DEPARTMENT

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

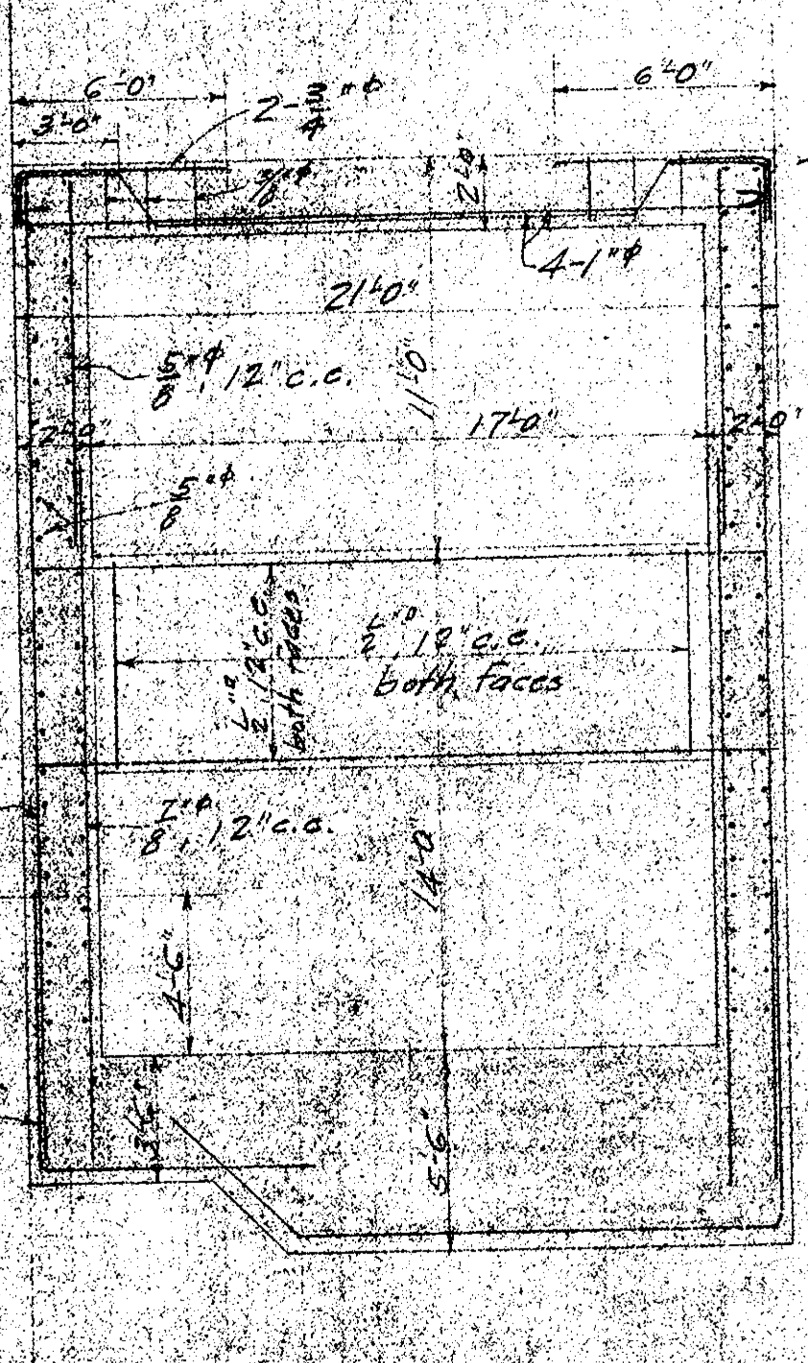
Subject Call St Pumping Station

Computation Gate Chamber at Inlet

Computed by E.M.V. Checked by Date April 22, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

(Continued from sheet #25)



Note: - Beam stem 1'6" wide

WAR DEPARTMENT

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

Object Call St. Pumping Station
Computation Sluice Gate Support at Intake to Wet Sump
Computed by E. M. V. Checked by ________ Date April 23, 1940.

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Load from gate = 15,000#

Assume that load will distributed over a width of 3'-0"

M = 15000 × 1.5 = 22,500'#.

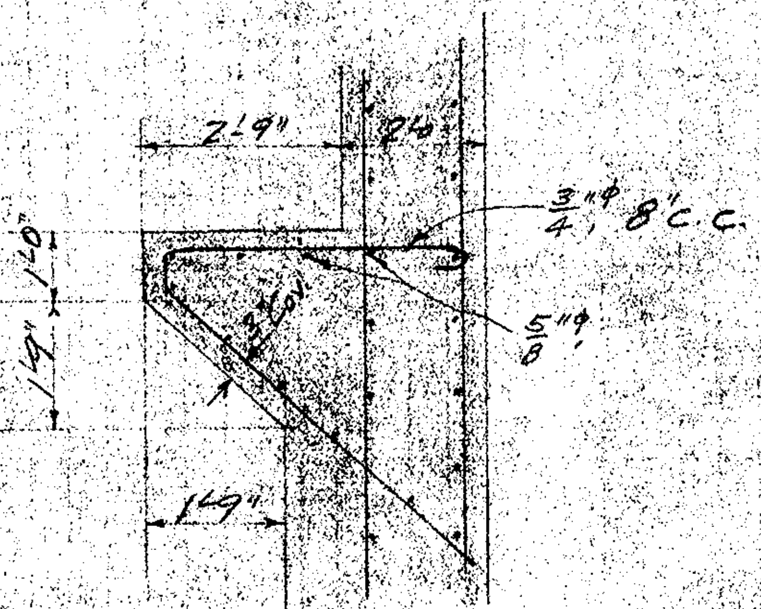
$d = \sqrt{\frac{22,500 \times 12}{123 \times 36}} = 7.8"$ Make d = 27"

$A_s = \frac{22,500 \times 12}{\frac{7}{8} \times 27 \times 18,000} = 0.64\square"$ Try $\frac{3}{4}$"φ bars 8" c.c.

Unit bond stress = $\frac{15000}{4 \times 2.36 \times \frac{7}{8} \times 27} = 67 \#/\square"$

Unit shear = $\frac{15000}{36 \times \frac{7}{8} \times 27} = 18 \#/\square"$

Use $\frac{3}{4}$"φ bars 8" c.c.



WAR DEPARTMENT

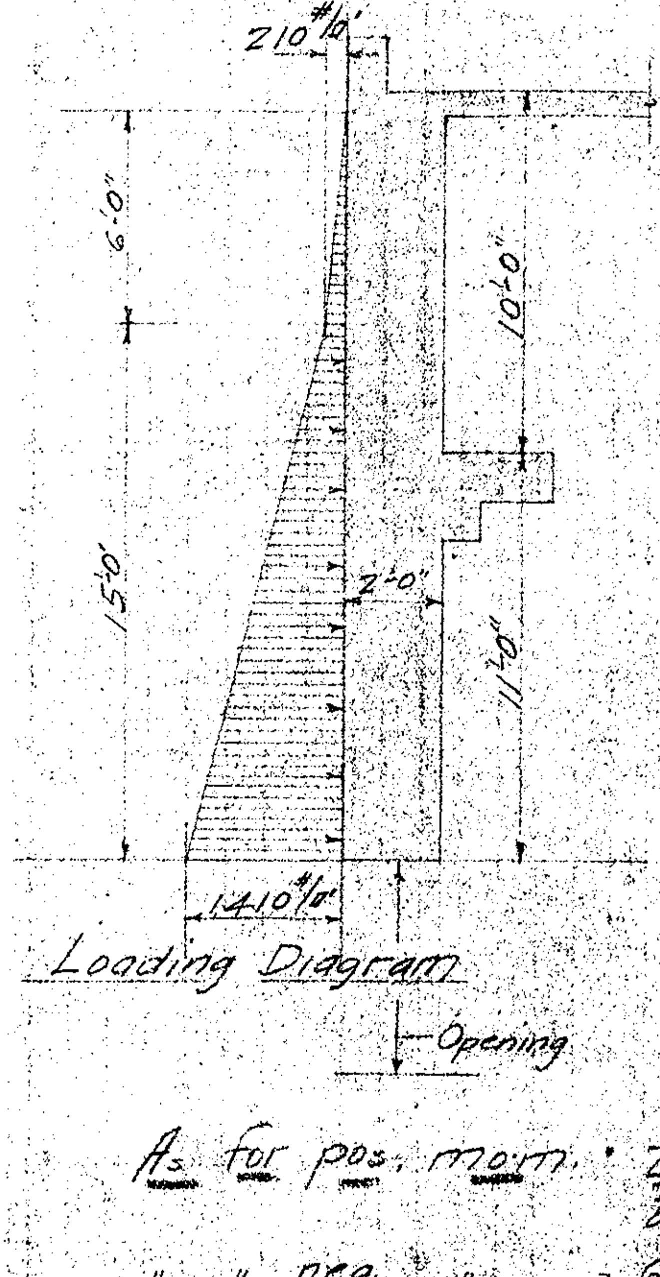
U. S. ENGINEER OFFICE, PROVIDENCE, R. I. Page 85

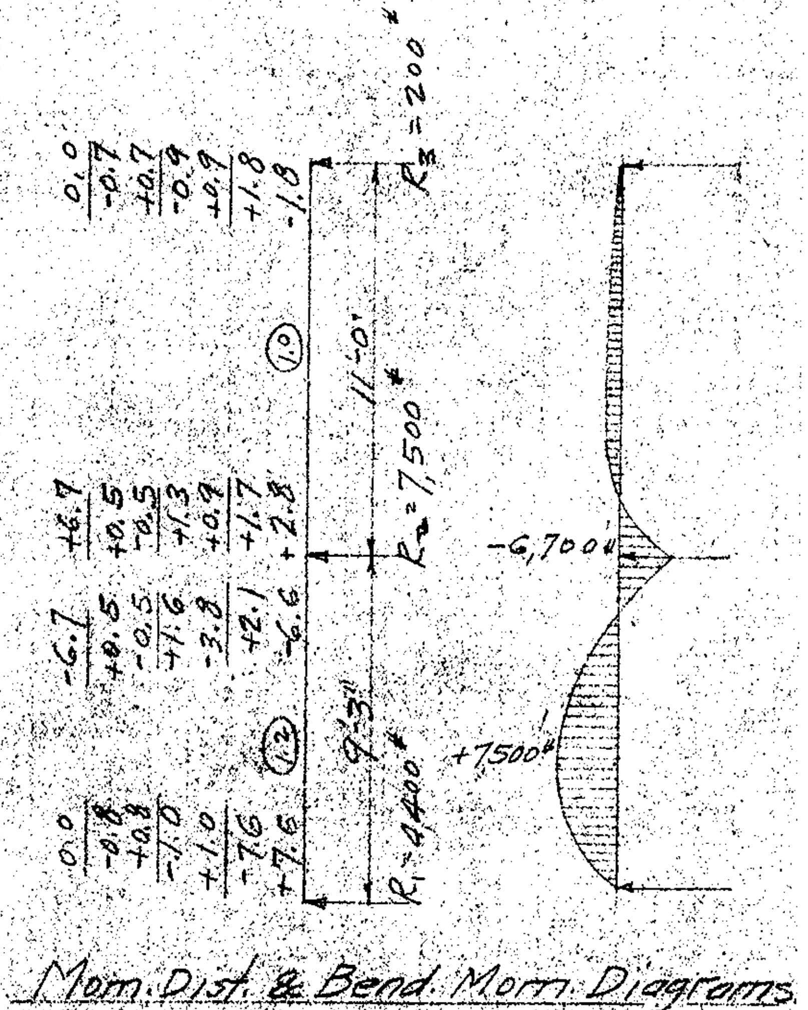
Project Call St. Pumping Station

Computation Wall Design at Inlet & outlet Openings in Substructure

Computed by E.M.V. Checked by ________ Date May 2, 1940

U. S. GOVERNMENT PRINTING OFFICE 3—10328





A_s for pos. mom. $= \frac{7500 \times 12}{\frac{7}{8} \times 20.5 \times 18,000} = 0.28^{\square''}$

" " neg. " $= \frac{6.7}{7.5} \times 0.28 = 0.25^{\square''}$

Use $\frac{3}{4}$"φ 12" c.c. inside & outside faces.

" 3-$\frac{5}{8}$"φ bars over the opening, inside & outside.

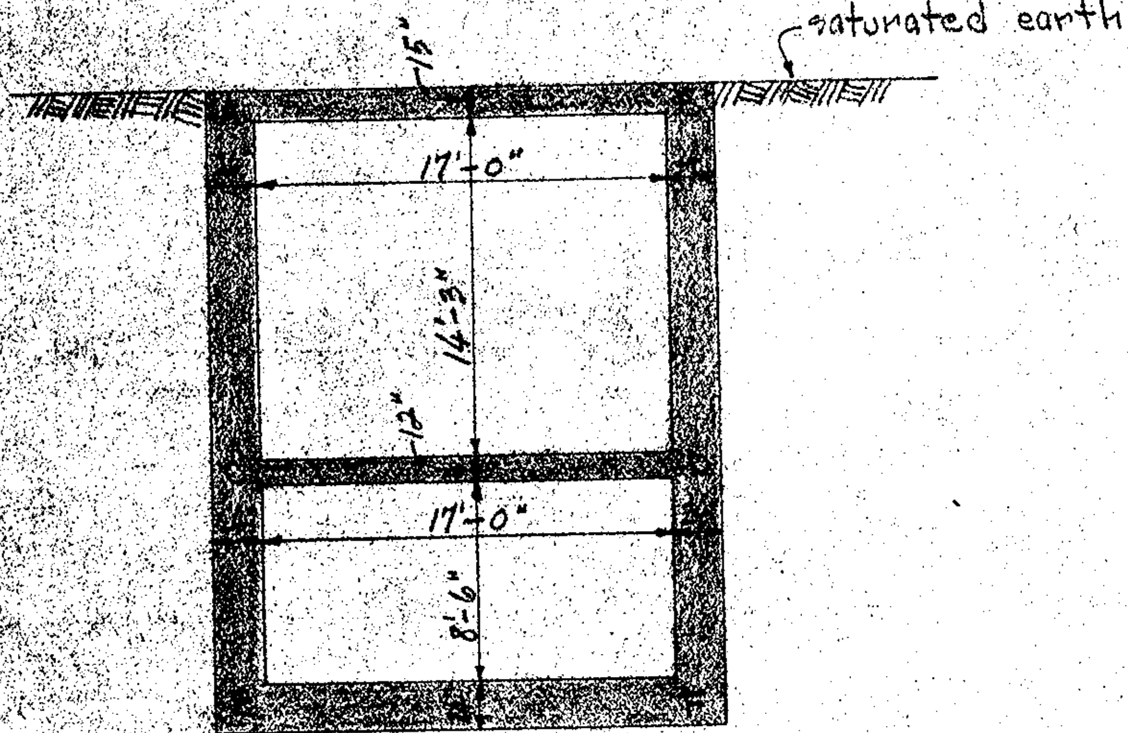
Project Call St. Pumping Sta.
Computation Inlet conduit
Computed by W.C.O. Checked by Date 4/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Investigate:

1.) Transverse section thru raking platform.
2.) Longitudinal section thru hoisting platform.
3.) Longitudinal section thru conduit headwall.
4.) Transverse section thru conduit at headwall.
5.) Transverse section thru conduit at brick sewer.
6.) Longitudinal section thru gate hoisting platform.

1.) Section thru raking platform.



Transverse section
thru raking platform

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Subject Call St. Pumping Sta.
Computation Inlet conduit (section 1)
Computed by W.C.O. Checked by Date 4/17/40

assume H-20 loading on deck slab $\left\{ \begin{array}{l} w = \frac{640}{9} = 71 \#/\text{ft} \\ P = \frac{18000}{9} = 2000\# \end{array} \right\}$ page 174 of Stand. specs. for highway bridges

assume 100#/ft on raking platform

assume walls carry an extra 1' width of earth per foot to allow for horizontal action of wall across bearing slot.

uniform load on deck slab = 71#/ft.

wt. of deck slab = 1.25×150 = 188#/ft.

total load on deck slab = 260#/ft.

uniform load on raking platform = 100#/ft.

wt. of raking platform = 1×150 = 150#/ft.

total load on raking platform = 250#/ft.

wt. of walls per ft. of base slab = $\frac{2\times2\times150\times25}{19}$ = 790#/ft.

total load on base slab = 1300#/ft.

earth pressure on sidewalls at raking platform = 2×16×80 = 2560#/ft

earth pressure on sidewalls at base slab = 2×26×80 = 4160#/ft

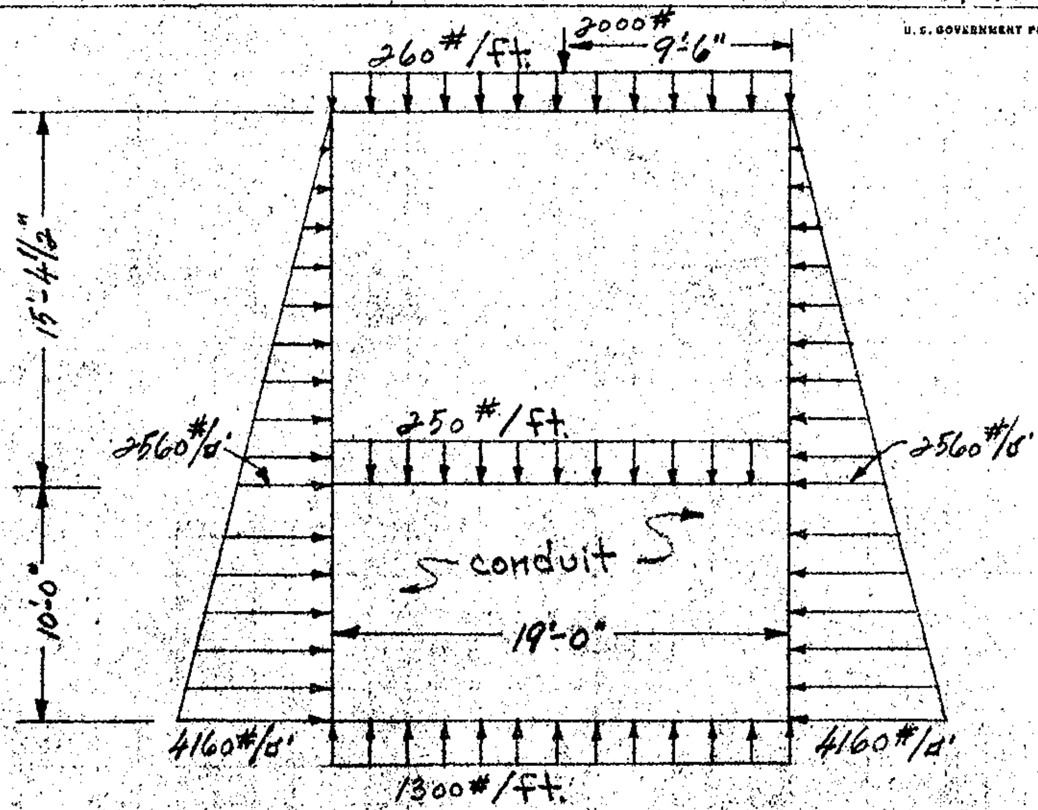
WAR DEPARTMENT

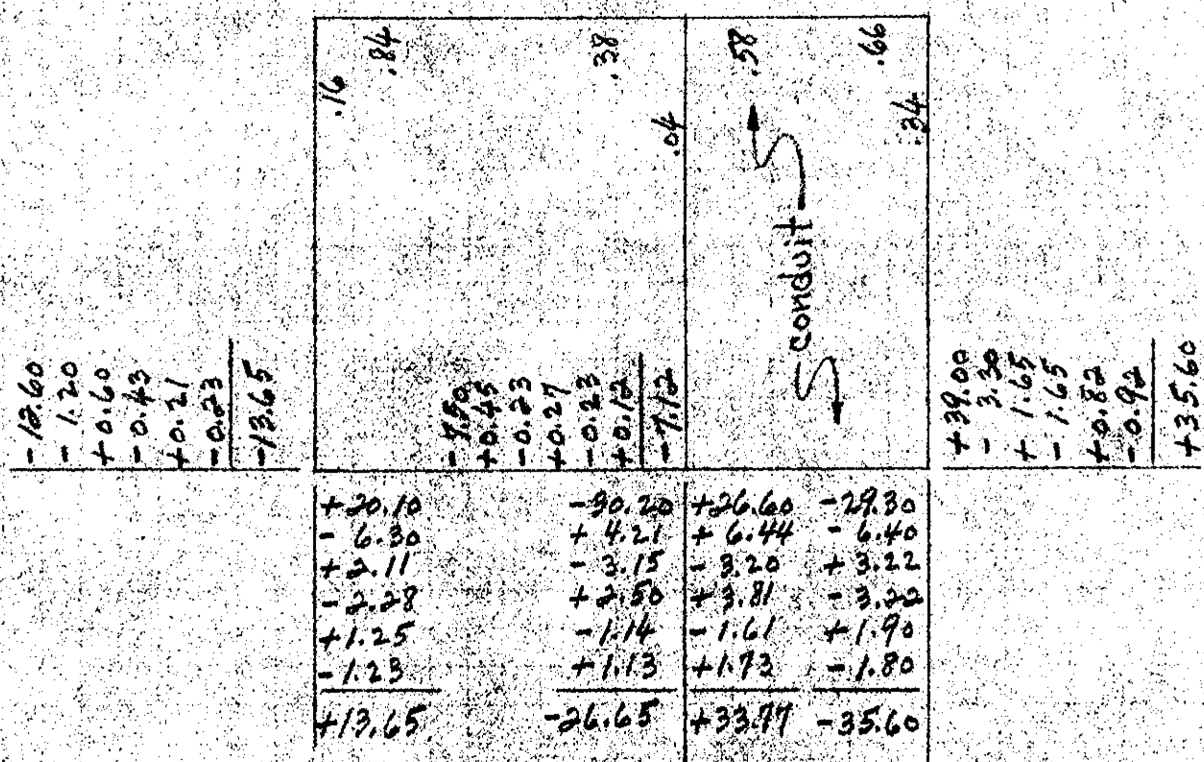
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Project Call St. Pumping Sta.

Computation Inlet conduit (section 1.)

Computed by W. C. O. Checked by ______ Date 4/17/40





WAR DEPARTMENT

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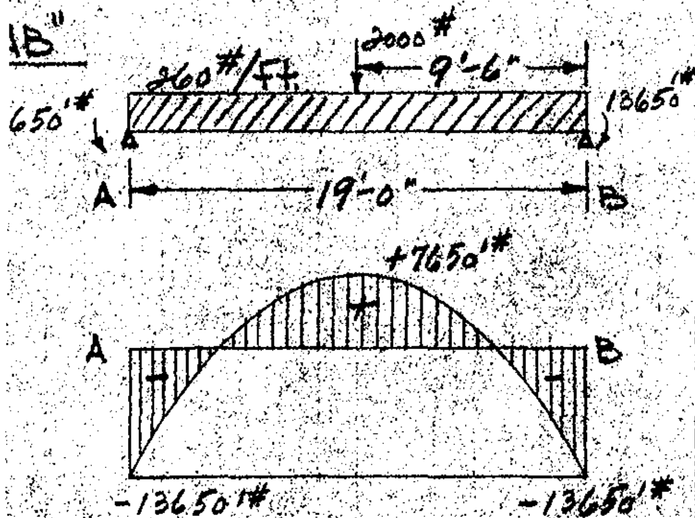
Project Call St. Pumping Sta.

Computation Inlet conduit (section 1.)

Computed by W.C.O. Checked by Date 4/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

"AB"



$d = \sqrt{\frac{13650}{137.2}} = 10"$ (15" slab o.k.)

positive steel

$A_s = \frac{7650 \times 12}{18000 \times 7/8 \times 12} = 0.49 \square"$

use 3/4" ϕ @ 10"

negative steel

$A_s = \frac{13650 \times 12}{18000 \times 7/8 \times 12} = 0.87 \square"$

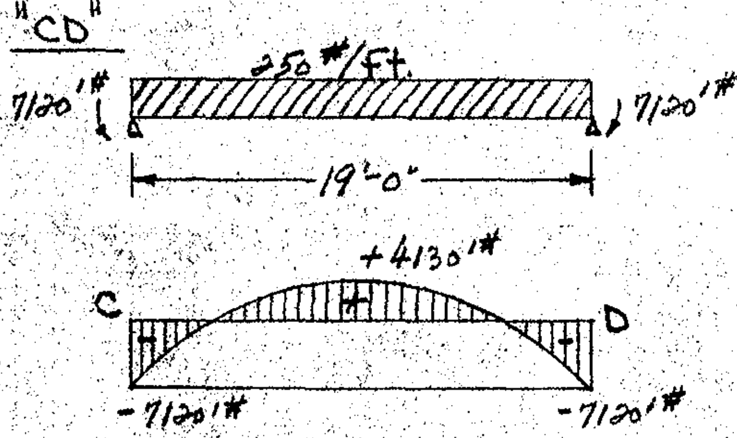
use 1" ϕ @ 10"

temperature steel

$A_s = .0025 \times 12 \times 15 = 0.57 \square"$

use 5/8" ϕ @ 12" both faces

"CD"



$d = \sqrt{\frac{7120}{137.2}} = 7.15"$ (12" slab o.k.)

positive steel

$A_s = \frac{4130 \times 12}{18000 \times 7/8 \times 9} = 0.35 \square"$

use 3/4" ϕ @ 12"

negative steel

$A_s = \frac{7120 \times 12}{18000 \times 7/8 \times 9} = 0.61 \square"$

use 7/8" ϕ @ 12"

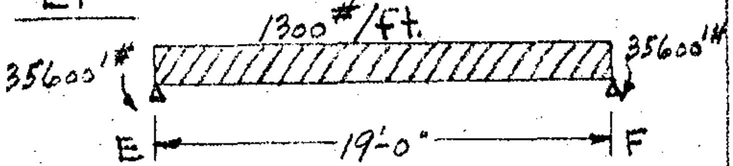
temperature steel

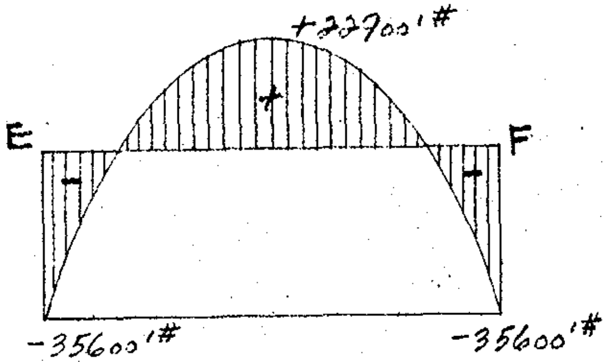
use 5/8" ϕ @ 12" both faces

Project: Call St. Pumping Sta.
Computation: Inlet conduit (section 1.)
Computed by: W.C.O. Checked by: Date: 4/17/40

U. S. GOVERNMENT PRINTING OFFICE 3—10533

"EF"





$d = \sqrt{\frac{35600}{137.2}} = 16.1''$ (24" slab O.K.)

positive steel

$A_s = \frac{22900 \times 12}{18000 \times 7/8 \times 21} = 0.83 \square''$

use 1" ϕ @ 12"

negative steel

$A_s = \frac{35600 \times 12}{18000 \times 7/8 \times 20} = 1.36 \square''$

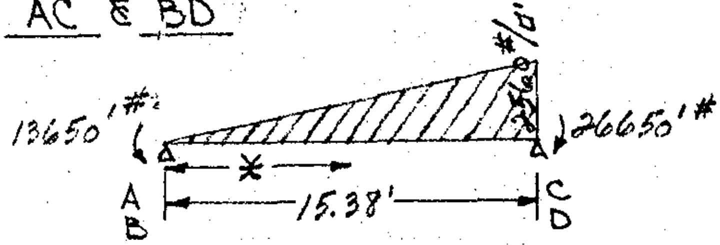
use 1" ϕ @ 9"

temperature steel

$A_s = .0025 \times 12 \times 24 = 0.72 \square''$

use 5/8" ϕ @ 12" both faces

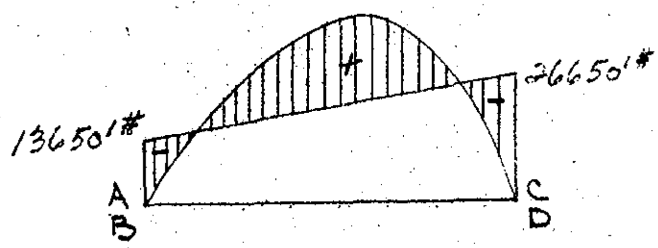
"AC" & "BD"

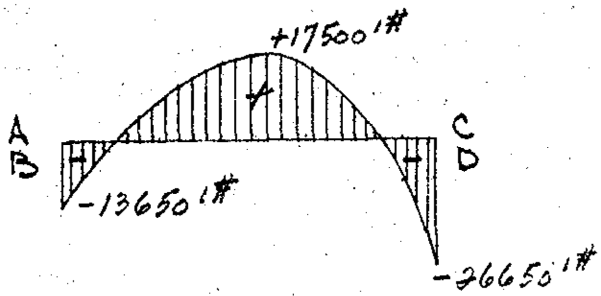


$M_x = 6550x - 2560 \times \frac{x}{15.38} \times \frac{x}{2} \times \frac{x}{3}$

$x = 5: M = 32750 - 3480 = 29270'\#$

$x = 10: M = 65500 - 27800 = 37700'\#$





positive steel

$A_s = \frac{17500 \times 12}{18000 \times 7/8 \times 21} = 0.64 \square''$

use 7/8" ϕ @ 12"

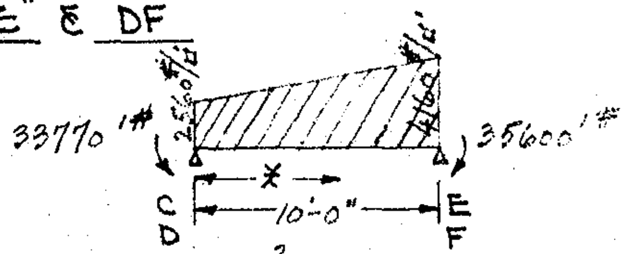
negative steel

$A_s = \frac{26650 \times 12}{18000 \times 7/8 \times 21} = 0.97 \square''$

use 1" ϕ @ 12"

Project: Call St. Pumping Sta.
Computation: Inlet conduit (section 1)
Computed by: W.C.O.   Checked by: Date: 4/18/40

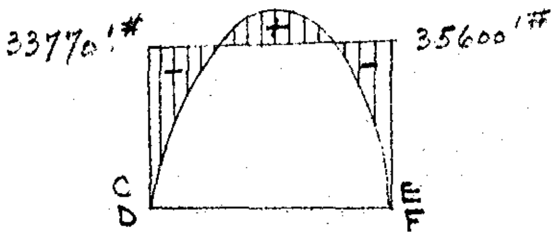
"CE" & "DF"

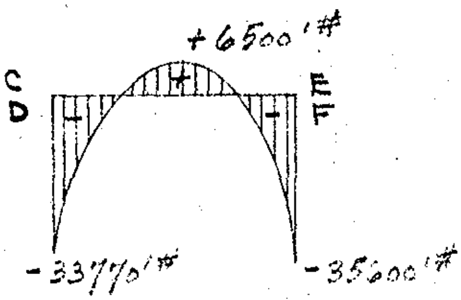


$M_x = 15470x - 2560 \times \frac{x^2}{2} - 1600 \times \frac{x}{10} \times \frac{x}{2} \times \frac{x}{3}$

$x = 3: M = 46400 - 11500 - 720 = 34180$ '#

$x = 6: M = 92800 - 46000 - 5800 = 41000$ '#





positive steel

$A_s = \frac{6500 \times 12}{18000 \times 7/8 \times 21} = 0.24\square''$

use 5/8" φ @ 12"

negative steel

$A_s = \frac{35600 \times 12}{18000 \times 7/8 \times 21} = 1.33\square''$

use 1" # @ 9"

temperature steel

use 5/8" φ @ 12" both faces

WAR DEPARTMENT

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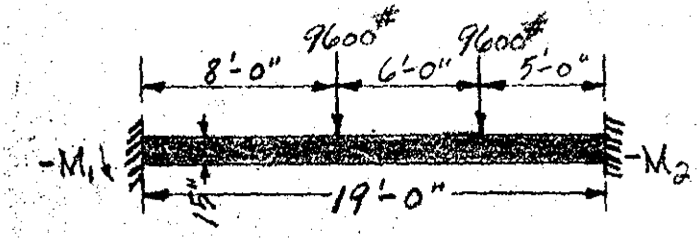
Subject Call St. Pumping Sta.

Computation Inlet conduit (section 2)

Computed by W.S.O. Checked by .... Date 4/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Check deck slab between openings acting as a restrained beam 3' wide and supporting the 2 rear wheels of a 12 ton truck.



for negative bending assume full restraint at the supports: for positive bending assume 3/4 restraint at the supports.

<u>negative bending</u>

$M_1 = 9600 \times 8\left(\frac{11}{19}\right)^2 + 9600 \times 14\left(\frac{5}{19}\right)^2 = 35040$ '#

$M_2 = 9600 \times 11\left(\frac{8}{19}\right)^2 + 9600 \times 5\left(\frac{14}{19}\right)^2 = 44750$ '#

$d = \sqrt{\frac{44750}{3 \times 137.2}} = 10.5"$ (15" slab o.k.)

$A_s = \frac{44750 \times 12}{3 \times 18000 \times 7/8 \times 12} = 0.95$ □"

<u>use 1" # @ 12"</u>

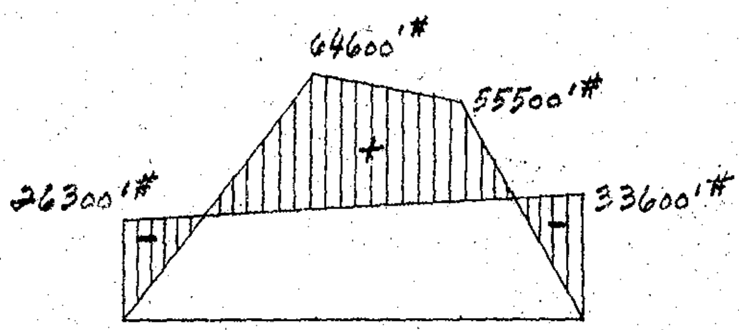
<u>positive bending</u>

$3/4 \times 35040 = 26300$ '#

$3/4 \times 44750 = 33600$ '#

$M_8 = 8\left(\frac{11}{19} + \frac{5}{19}\right)9600 = 64600$ '#

$M_5 = 5\left(\frac{14}{19} + \frac{8}{19}\right)9600 = 55500$ '#



max. +M = 43000 '#

$A_s = \frac{43000 \times 12}{18000 \times 3 \times 7/8 \times 12} = 0.91$ □"

<u>use 1" # @ 12"</u>

WAR DEPARTMENT

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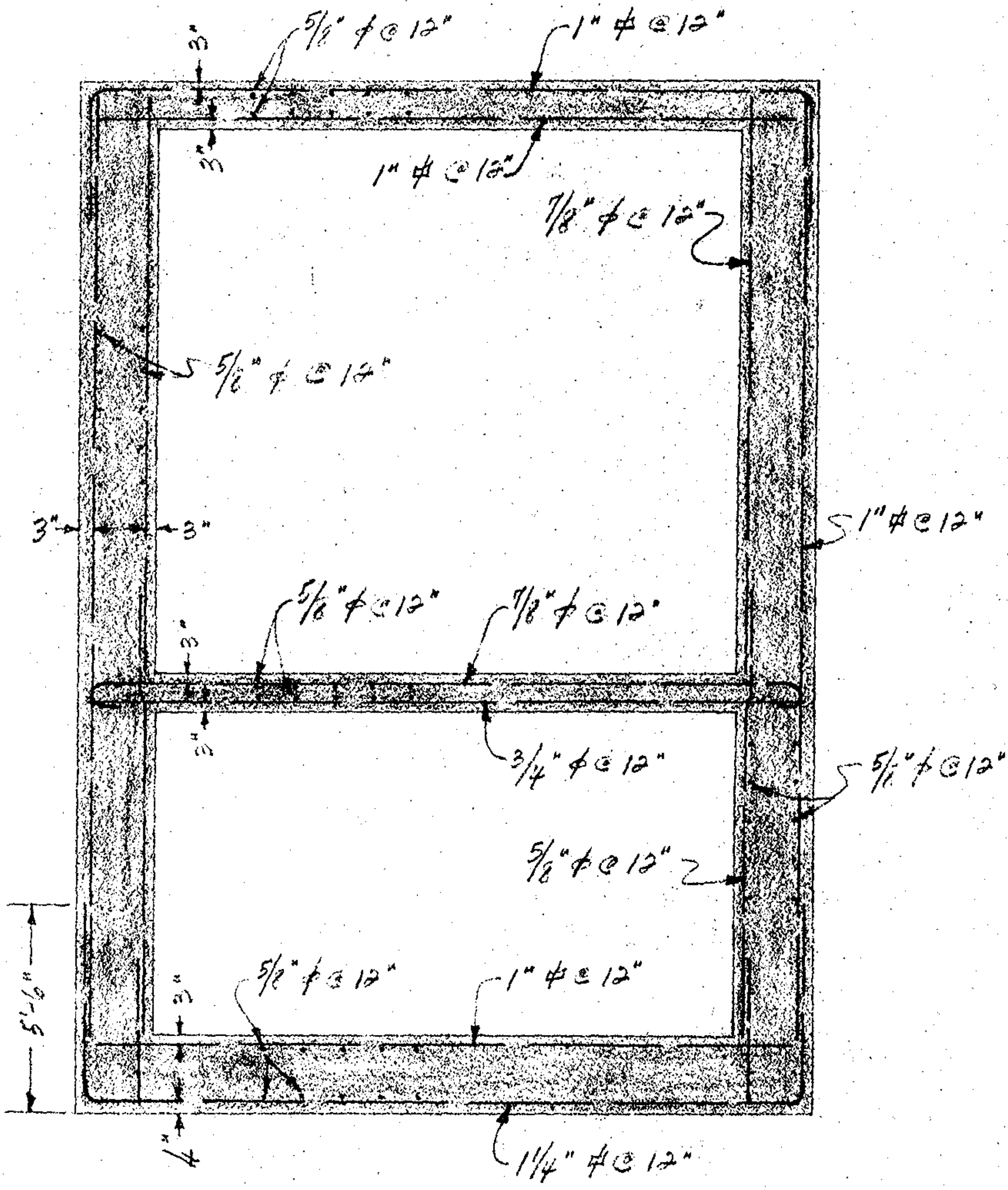
Subject Call St. Pumping Sta.

Computation Inlet conduit (section 2)

Computed by W.C.J. Checked by ______ Date 4/18/42

U.S. GOVERNMENT PRINTING OFFICE 3—10528



BAR DIAGRAM

WAR DEPARTMENT
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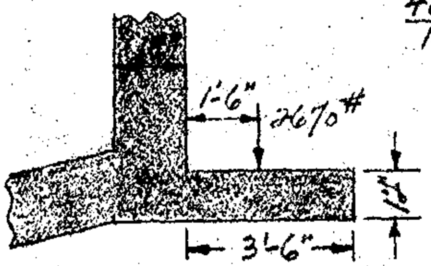
Project: Call St. Pumping Sta.
Computation: Inlet conduit (section 2 & section 3)
Computed by: W.S.O. — Checked by: — Date: 4/18/40

2) Section thru hoisting platform

Assume platform is cantilevered off the headwall and loaded with hoist pull over a width of 18".

$\frac{4000}{1.5} = 2670^{\#}$



$M_p = 2670 \times 1.5 = 4000'^{\#}$

$M_w = 150 \times \overline{3.5}^2 \times 1/2 = 920'^{\#}$

$M = 4000 + 920 = 4920'^{\#}$

$d = \sqrt{\frac{4920}{123}} = 6.4"$ (12" slab O.K.)

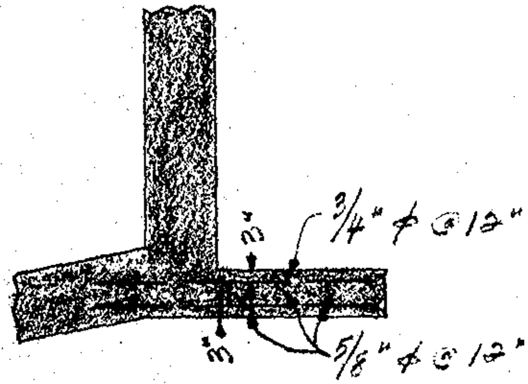
$A_s = \frac{4920 \times 12}{18000 \times 7/8 \times 9} = 0.42^{\square"}$

use 3/4" φ @ 12"

temperature steel

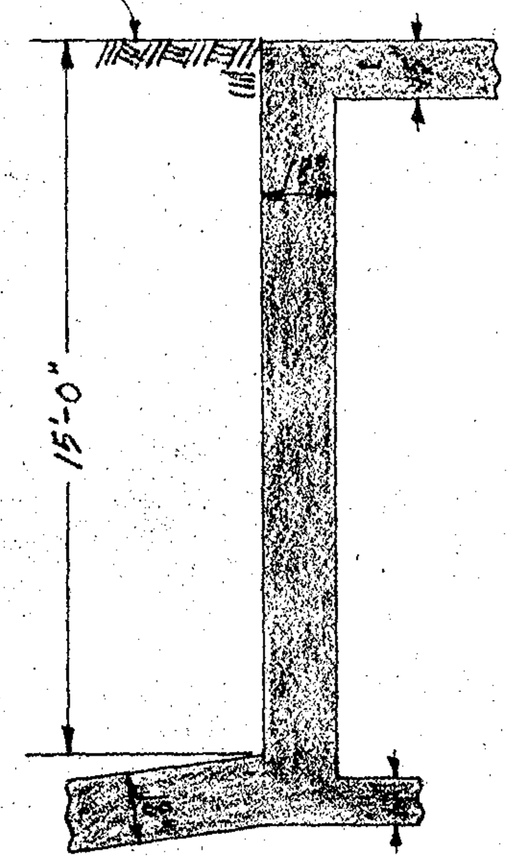
$A_s = .0025 \times 12 \times 12 = 0.36^{\square"}$

use 5/8" φ @ 12"



Section thru hoisting platform

3) Section thru conduit headwall



WAR DEPARTMENT

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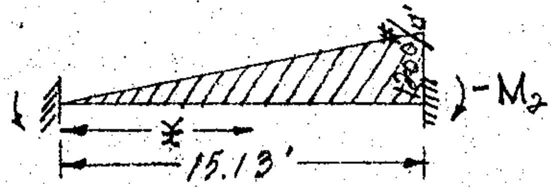
Project: Call St. Pumping Sta.
Computation: Inlet conduit (section 3)
Computed by: W.C.O. — Checked by: — Date: 4/18/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528

for negative moment, assume full restraint at the ends; for positive moment, assume 3/4 restraint at the ends.



$-M_1 = \frac{wl^2}{30} = \frac{1200 \times \overline{15.13}^2}{30} = 9180\ '\#$

$-M_2 = \frac{wl^2}{20} = \frac{1200 \times \overline{15.13}^2}{20} = 13700\ '\#$

<u>negative bending</u>

$d = \sqrt{\frac{13700}{137.2}} = 10''$ (18" wall o.k.)

$A_s = \frac{13700 \times 12}{18000 \times 7/8 \times 15} = 0.70\ \square''$

<u>use 1" φ @ 12"</u>

<u>positive bending</u>

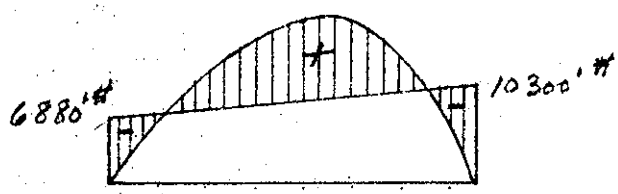
$3/4 \times 9180 = 6880\ '\#$ (restraint at top)

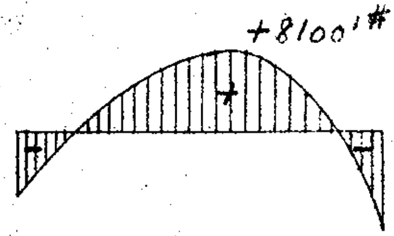
$3/4 \times 13700 = 10300\ '\#$ (restraint at bottom)

$M_x = 3020x - 1200 \times \frac{x}{15.13} \times \frac{x}{2} \times \frac{x}{3}$

$x = 5: M = 15100 - 1650 = 13450\ '\#$

$x = 10: M = 30200 - 13200 = 17000\ '\#$





$A_s = \frac{8100 \times 12}{18000 \times 7/8 \times 15} = 0.41\ \square''$

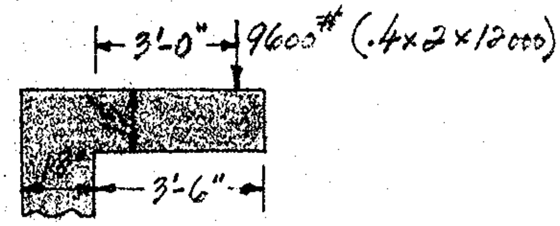
<u>use 3/4" φ @ 12"</u>

<u>temperature steel</u>

$A_s = .0025 \times 12 \times 18 = 0.54\ \square''$

<u>use 5/8" φ @ 12" both faces</u>

<u>Check deck platform as a cantilever loaded by one wheel of a 12 ton truck.</u>



WAR DEPARTMENT

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Project: Hull St. Pumping Sta.
Computation: Inlet conduit (section 3.)
Computed by: W. C. O. Checked by: Date: 4/19/40

U.S. GOVERNMENT PRINTING OFFICE 3—10528

$M_p = 3 \times 9600 = 28800'^{\#}$

$M_w = 1.25 \times 150 \times \overline{3.5}^2 \times 1/2 = 1150'^{\#}$

$M = 28800 + 1150 = 29950'^{\#}$

$d = \sqrt{\frac{29950}{137.2}} = 14.7''$ (15" slab not o.K.)

try an 18" slab

$M_p = 28800'^{\#}$

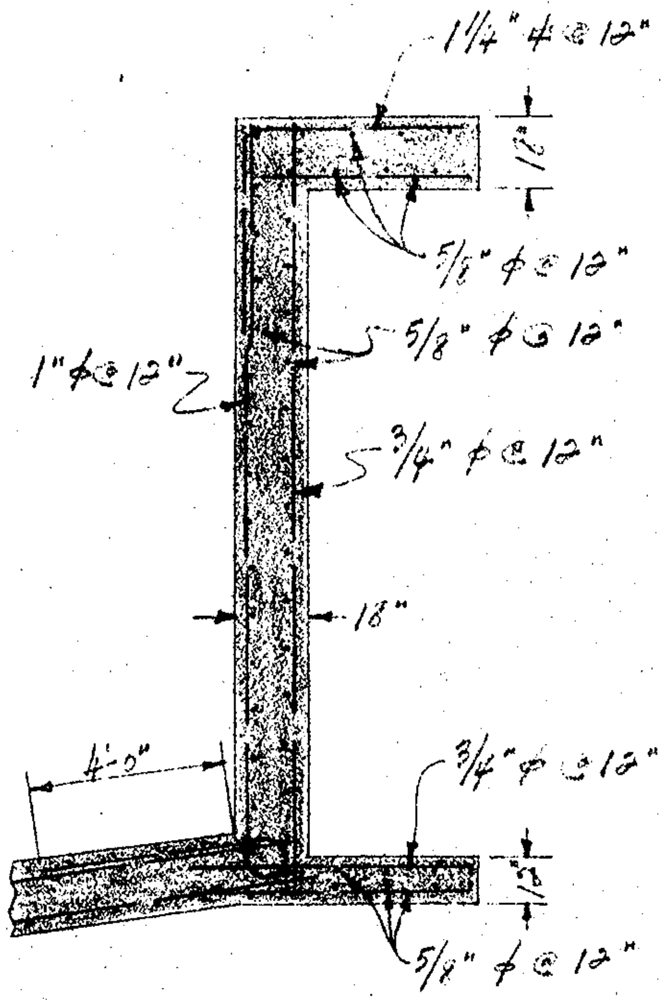
$M_w = 1.5 \times 150 \times \overline{3.5}^2 \times 1/2 = 1380'^{\#}$

$M = 28800 + 1380 = 30180'^{\#}$

$d = \sqrt{\frac{30180}{137.2}} = 14.82''$ (18" slab o.K.)

$A_s = \frac{30180 \times 12}{18000 \times 7/8 \times 15} = 1.53^{\square''}$

use 1¼" # @ 12"



Note: Bond transverse steel in top faces of deck and hoisting slabs into sidewalls.

Use 3" cover all faces.

WAR DEPARTMENT

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

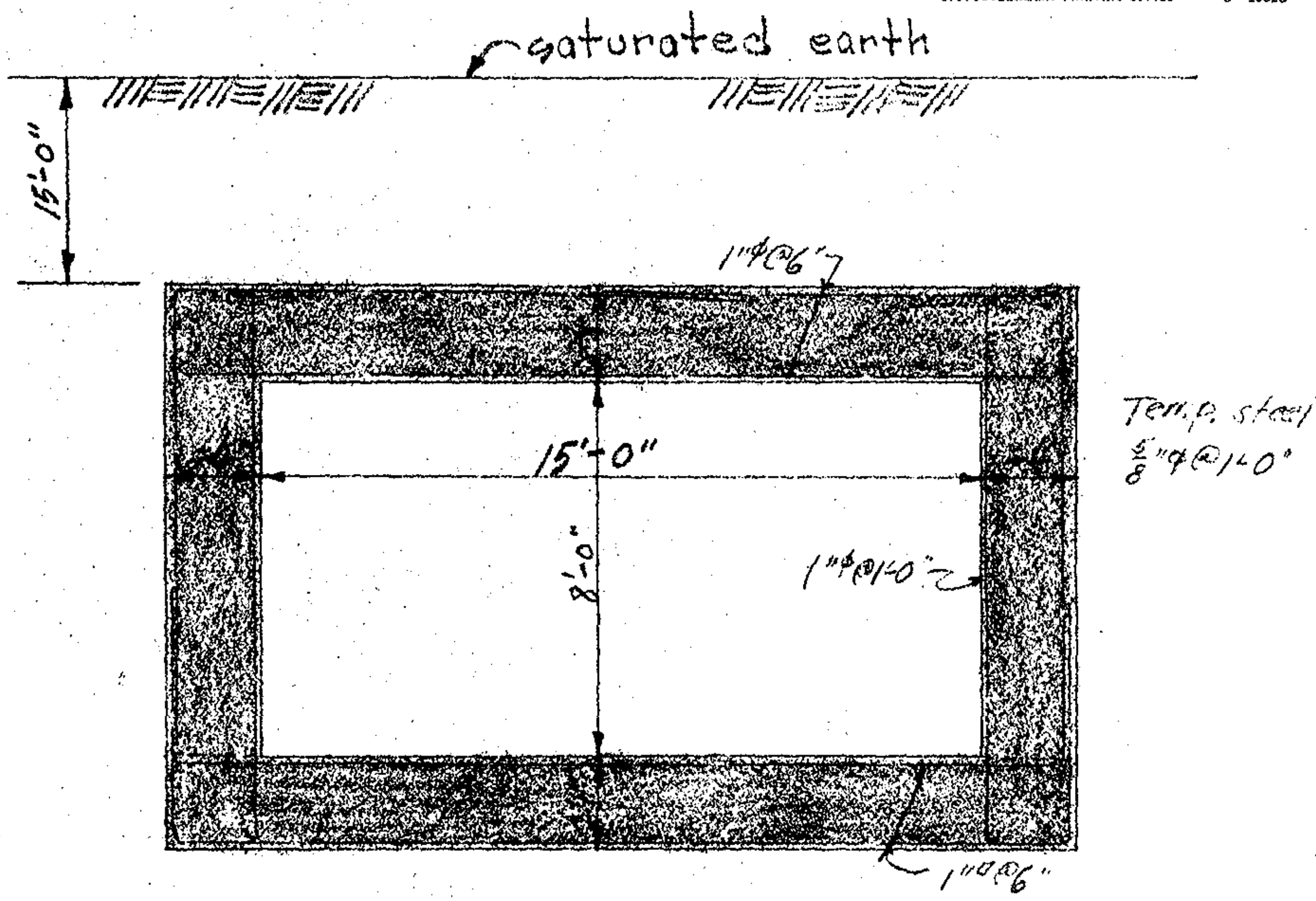
Page

Project Call St. Pumping Sta.

Computation Inlet conduit (section 4)

Computed by W.C.O. Checked by Date 4/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10523



wt. of earth on roof slab = 15 × 125 = 1875 #/□'

wt. of roof slab = 2 × 150 = 300 #/□'

load on roof slab = 2175 #/□'

wt. of walls /□' of base = 2 × 2 × 8 × 150 × $\frac{1}{17}$ = 282 #/□'

load on base slab = 2460 #/□'

pressure at top of sidewalls = 16 × 80 = 1280 #/□'

pressure at bottom of sidewalls = 26 × 80 = 2080 #/□'

WAR DEPARTMENT

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

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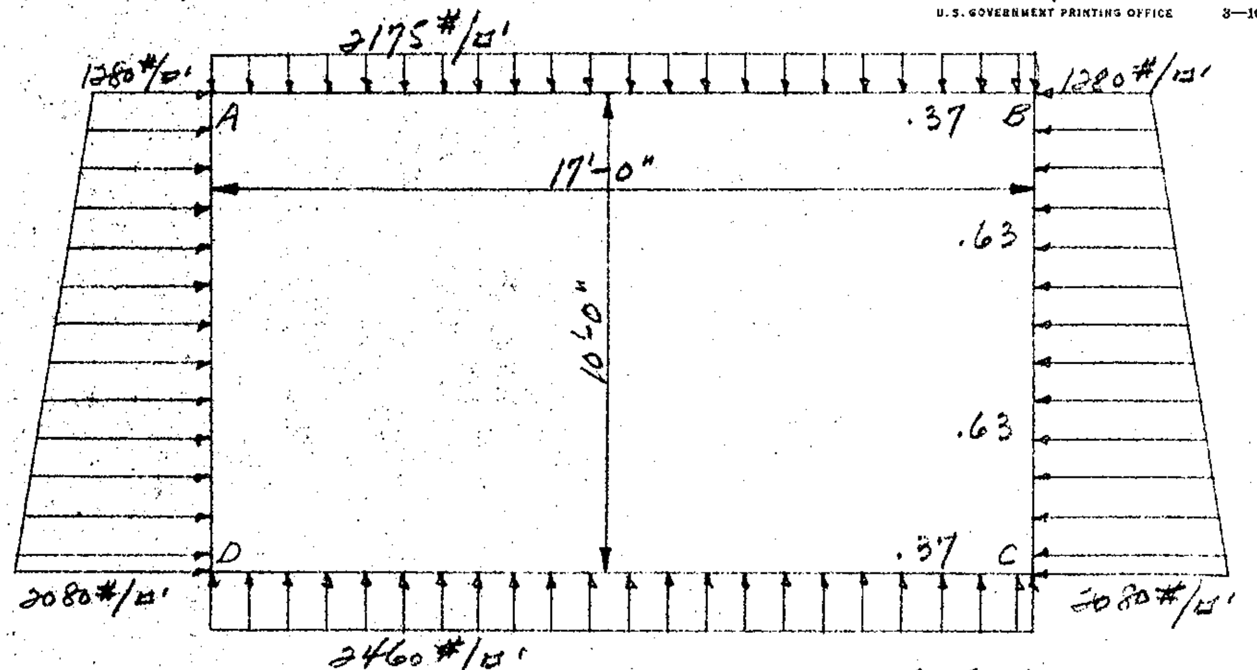
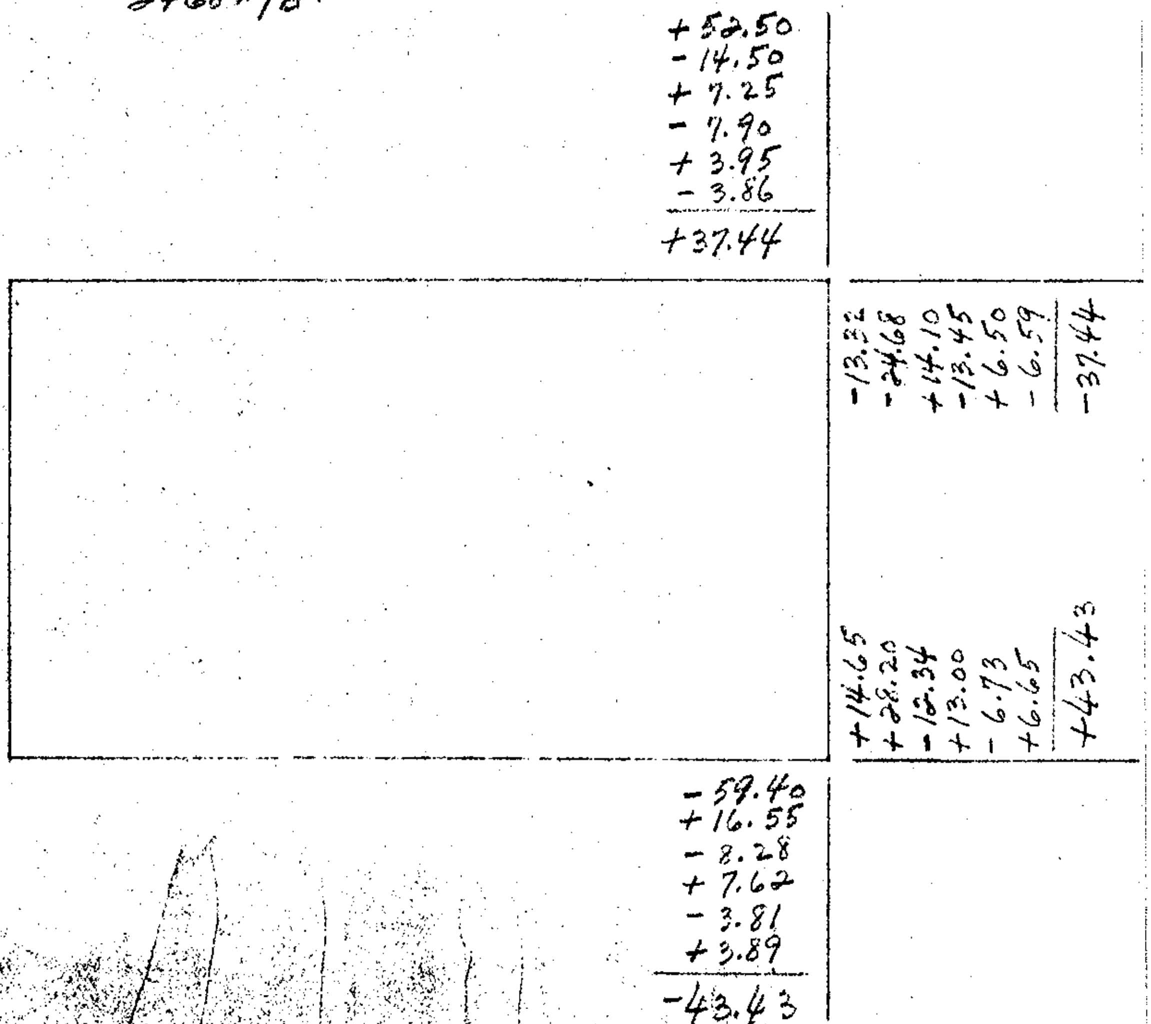
Object: Call St. Pumping Sta.

Computation: Inlet conduit (Section 4)

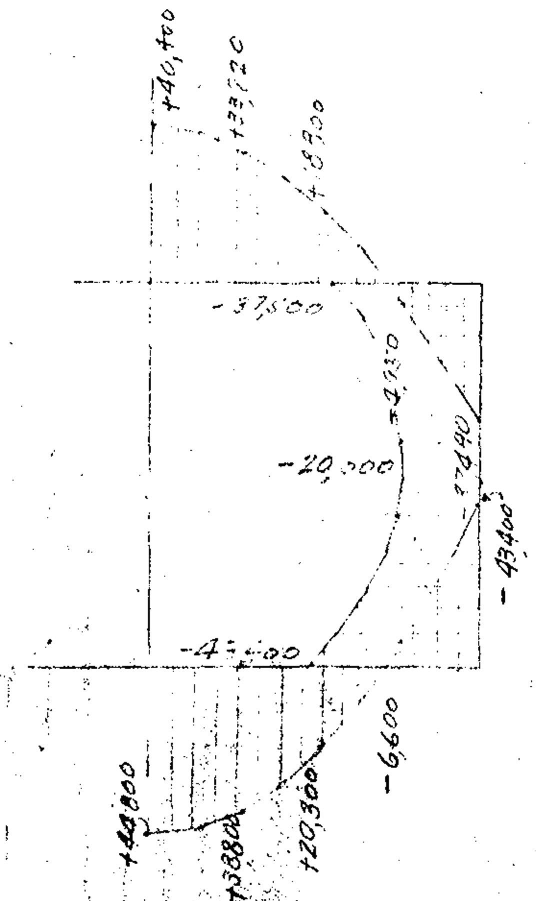
Computed by: W. C. O. Checked by: Date: 4/19/40

U. S. GOVERNMENT PRINTING OFFICE 3—10528





Project: Call St. Pumping Sta.
Computation: Inlet Conduit (Sec. 4)
Computed by: RSM Checked by: Date: 4/29/42



SHEAR

BC @ B: $1280 \times 5 + \frac{800 \times 10}{2}/3 - 5990/10$ = 7130#

@ C: $1280 \times 5 + 800 \times 10 \times \frac{2}{3} + 5990/10$ = 9670#

AB @ B: 2175×8.5 = 18420#

CD @ C: 1460×8.5 = 20850#

AB

$d = \sqrt{\frac{40400}{123}} = 18.2''$ reqd. 20.5" supplied

$+A_s = 40400 \times 12 / 18000 \times .884 \times 20.5 = 1.50\square''$

$-A_s = 37400 \times 12 / 18000 \times .884 \times 20.5 = 1.39\square''$

$v = (18420 - 2175) / 12 \times .884 \times 20.5 = 75.5\#/\square''$ Anchor negative steel

WAR DEPARTMENT

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

ject Call St. Pumping Sta.

Computation Inlet conduit (Sec. 4)

Computed by RSM Checked by .... Date 4/20/40

BC

$d = \sqrt{\frac{43400}{123}} = 18.9''$; 20.5" supplied.

$+A_s =$ nominal

$-A_s = 43400 \times 12 / 18000 \times .884 \times 20.5 = 1.61^{\square''}$

$v = 7430/12 \times .884 \times 20.5 = 35\#/\square''$

CD

$d = \sqrt{\frac{44800}{123}} = 19.1''$; 19.5" supplied

$v = (10850-2460)/12 \times .884 \times 19.5 = 89.5\#/\square''$. Anch. negative steel

$+A_s = 44300 \times 12/18000 \times .884 \times 20.5 = 1.67^{\square''}$

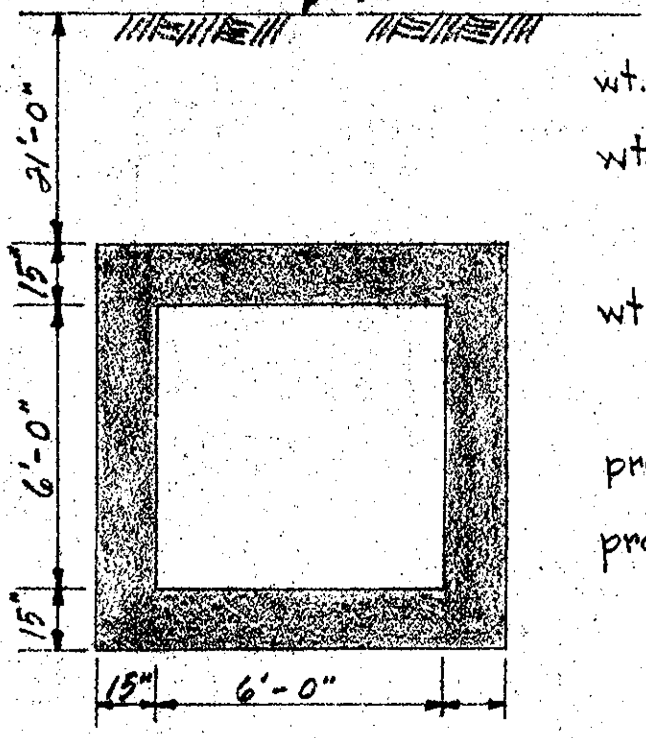
$-A_s = 43400 \times 12 / 18000 \times .884 \times 19.5 = 1.70^{\square''}$

$u = 18390 / .884 \times 19.5 \times$

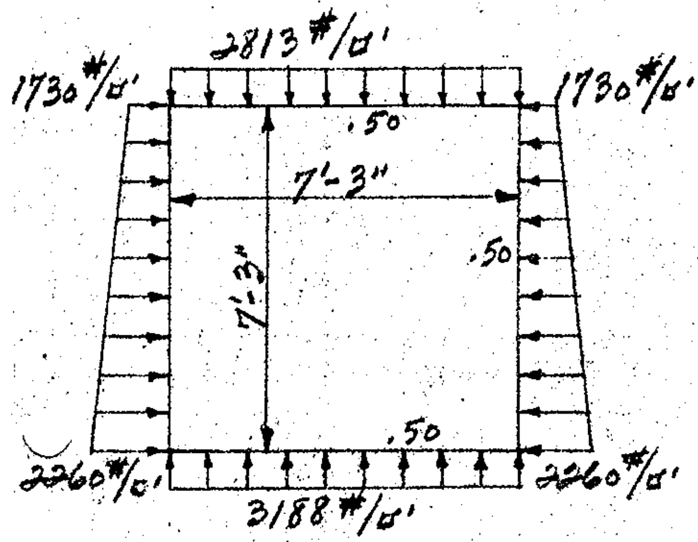
Project: Call St. Pumping Sta.
Computation: Discharge conduit
Computed by: W. C. O. Checked by: Date: 4/22/40

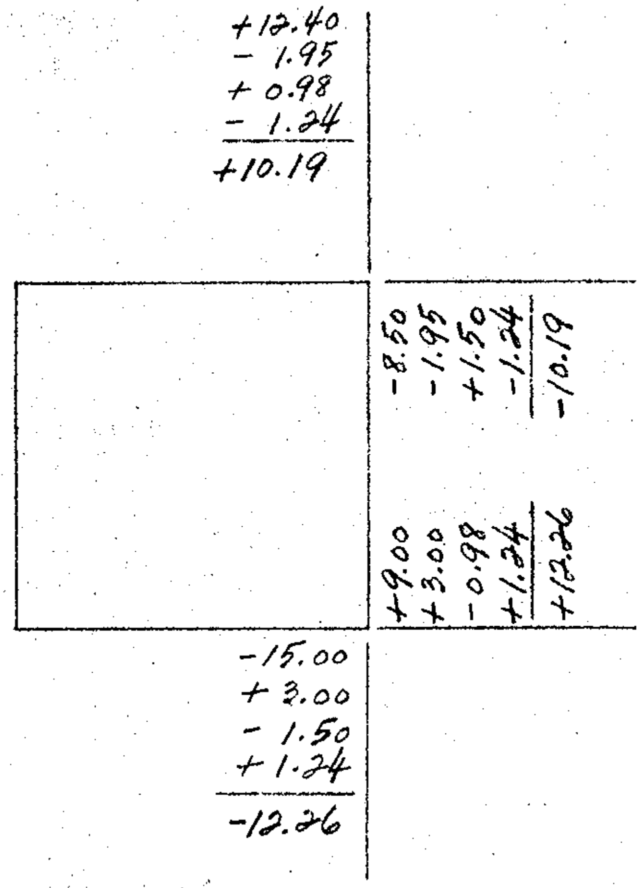
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design section next to north wall of station and assume dike completely saturated - no internal water pressure.



wt. of earth on top slab = 21 × 125 = 2625 #/□'
wt. of top slab = 1.25 × 150 = 188 #/□'
load on top slab = 2813 #/□'
wt. of walls on base = 2 × 150 × 1.25 = 375 #/□'
load on base slab = 3188 #/□'
pressure at top of walls = 21.62 × 80 = 1730 #/□'
pressure at base of walls = 28.25 × 80 = 2260 #/□'





ect Call St. Pumping Sta.
omputation Discharge conduit
omputed by W. C. O. Checked by Date 4/22/40

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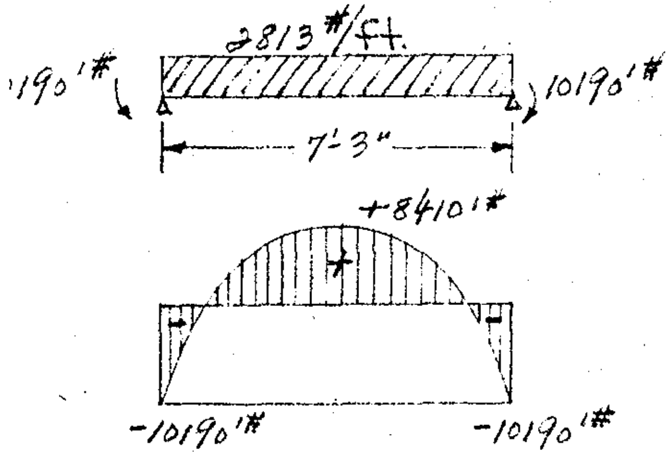
Roof slab



$$d = \sqrt{\frac{10190}{137.2}} = 8.6" \text{ (15" slab o.K.)}$$

positive steel

$$A_s = \frac{8410 \times 12}{18000 \times 7/8 \times 12} = 0.54^{□"}$$

use 7/8" ϕ @ 12"

negative steel

$$A_s = \frac{10190 \times 12}{18000 \times 7/8 \times 12} = 0.65^{□"}$$

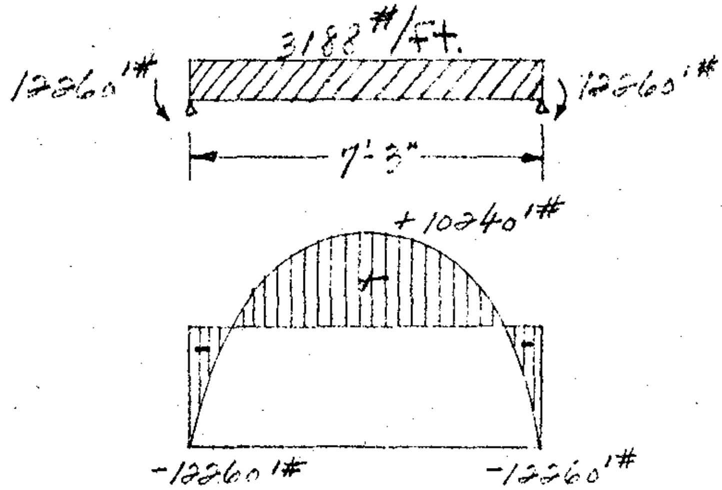
use 1" ϕ @ 12"

temperature steel

$A_s = .0025 \times 12 \times 15 = 0.45^{□"}$

use 1/2" ϕ @ 12" both faces

Base slab



$$d = \sqrt{\frac{12260}{137.2}} = 9.5" \text{ (15" slab o.K.)}$$

positive steel

$$A_s = \frac{10240 \times 12}{18000 \times 7/8 \times 12} = 0.65^{□"}$$

use 1" ϕ @ 12"

negative steel

$$A_s = \frac{12260 \times 12}{18000 \times 7/8 \times 12} = 0.78^{□"}$$

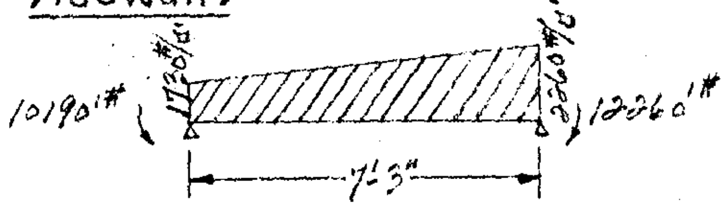
use 1" ϕ @ 12"

temperature steel

use 1/2" ϕ @ 12" both faces

Subject: Call St. Pumping Sta.
Computation: Discharge conduit
Computed by: W.C.O. Checked by: Date: 4/22/40

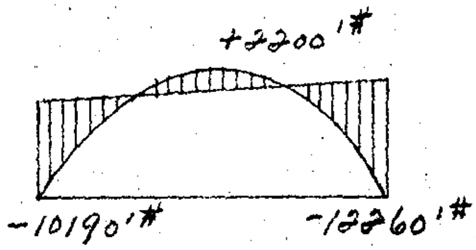
Sidewalls



$$M_x = 6900x - 1730 \times \frac{x^2}{2} - 530 \times \frac{x}{7.25} \times \frac{x}{2} \times \frac{x}{3}$$

$x=2$: $M = 13800 - 3460 - 98 = 10240$'#

$x=4$: $M = 27600 - 13840 - 780 = 12980$'#



positive steel

$$A_s = \frac{2200 \times 12}{18000 \times 7/8 \times 12} = 0.14 \square''$$

use 5/8" φ @ 12"

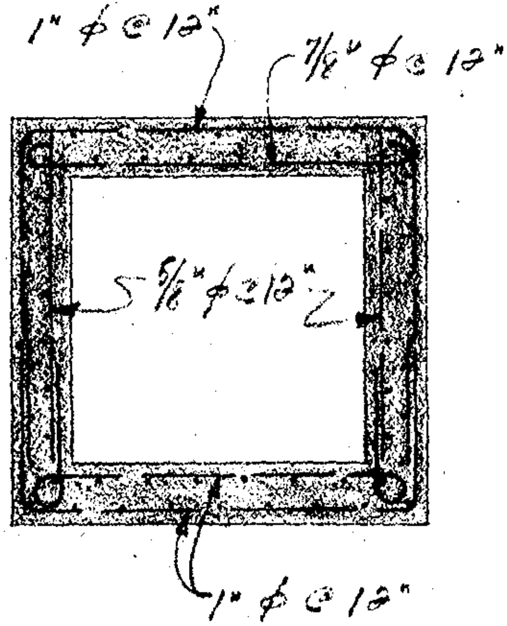
negative steel

$$A_s = \frac{12260 \times 12}{18000 \times 7/8 \times 12} = 0.78 \square''$$

use 1" φ @ 12"

temperature steel

use 1/2" φ @ 12" both faces



Note: all longit. steel is 1/2" φ @ 12"

WAR DEPARTMENT

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

Project Call St. Pumping Sta.

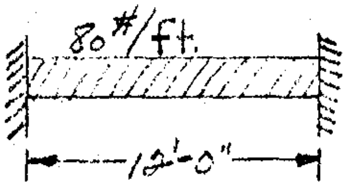
Computation Discharge conduit outlet

Computed by W.C.O. Checked by ______ Date 4/22/40

U. S. GOVERNMENT PRINTING OFFICE 3—10628

Design walls as beams supported at the headwall and floor slab. Assume load is saturated earth.

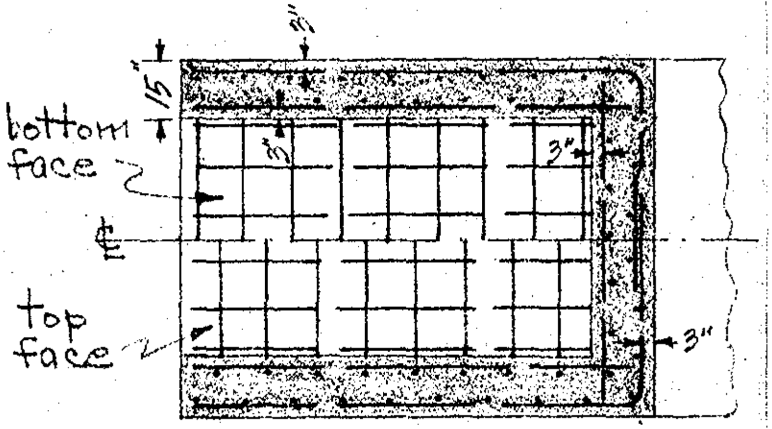
For negative bending assume full restraint at the supports; for positive bending assume 3/4 restraint at the supports.



$$-M = \frac{80 \times 12^2}{12} = 960'\#$$

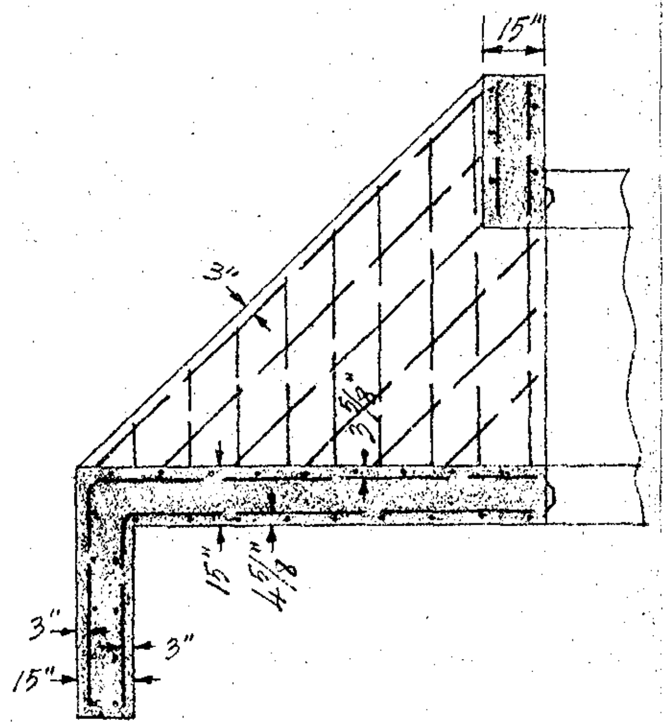
Note: minimum allowable thickness of walls is 15".

use 5/8" φ @ 12" both ways both faces in sidewalls, headwall and floor slab.



Plan of Outlet

Note: All steel is 5/8" φ @ 12"



Section of Outlet