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CONNECTICUT RIVER FLOOD CONTROL

HARTFORD, CONN.

PARK RIVER, CONNECTICUT

ANALYSIS OF DESIGN
FOR
BUSHNELL PARK PUMPING STATION

ITEM Ht.6b CONTRACT

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CORPS OF ENGINEERS, U.S. ARMY

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

PART II

I. INTRODUCTION

ANALYSIS OF DESIGN

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PART II

BUSHNELL PARK PUMPING STATION

I. INTRODUCTION

A. AUTHORIZATION AND PAST REPORTS. - The Bushnell Park Pumping Station is a part of the local protection works for the City of Hartford, as recommended by the District Engineer on "Report of Survey and Comprehensive Plan for Flood Control on the Connecticut River Valley," dated March 20, 1937, approved by the Chief of Engineers, November 29, 1937, and published as House Document No. 455, 75th Congress, 2nd Session. The project is authorized under the Flood Control Act approved June 28, 1938.

B. NECESSITY FOR THE NEW STATION. - The construction of Park River Conduit will prevent the overflow of the Park River Interceptor sewer from discharging into Park River. The Park River Interceptor collects the sewage and storm run off from an area of approximately 230 acres. During normal low flow the Park River Interceptor sewage will lead to a disposal plant by way of the Commerce Street Sewer near Keeney Lane Pumping Station. During heavy runoff, overflow at several points on the Park River Interceptor sewer will occur leading to an overflow conduit which will discharge at Bushnell Park Pumping Station into the Park River Conduit. During high stages of the Connecticut and Park Rivers this sewage overflow will be pumped into the Park River Conduit.

Although the war emergency prevents the construction of a permanent pumping station structure, a temporary pumping station using an available pump from North Meadows Pumping Station is necessary to provide partial protection from natural drainage during flood periods to

the vital war industries located in the drainage area.

C. CONSULTATION WITH CITY OF HARTFORD. - During the design of the temporary pumping station, consultations were held with officials representing the City of Hartford and the Flood Commission of Hartford. The proposed station layouts were studied by them, and in conference, the relative merits of the layouts and the equipment to be used were discussed in detail. The design of the temporary pumping station as finally developed meets with the approval of the Flood Commission of the City of Hartford.

D. BRIEF DESCRIPTION OF THE STATION. - The temporary station which will house the pump and other equipment will consist of a reinforced concrete substructure and a one-story wooden superstructure.

The War Production Board permitted the use of rail steel reinforcing rods and other small amounts of critical materials. One 36-inch volute pump will be housed in the substructure. The temporary trash rack will be of wood. The inlet structure will be incorporated in the permanent larger pumping station which will be built following the war emergency and the small pumping station substructure will be abandoned.

The adopted layout of the temporary pumping station was determined as being the most economic, and meeting the requirements of pumping the drainage from the area as well as using a minimum of critical materials.

II. SELECTION OF THE SITE

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The pumping station is located on the north side and adjacent to the Park River Conduit at a point approximately 250 feet west of the intersection of Wells and Hudson Streets. This location was chosen for the following principal reasons; first, it is the lowest point on the drainage area; second, it is near to the farthest downstream Park River interceptor overflow chamber; third, the location is adaptable for gravity flow into Park River Conduit and, fourth, it is the most economical site.

III. SOILS INVESTIGATIONS AND FOUNDATION

III. SOILS INVESTIGATIONS AND FOUNDATION

Foundation conditions were determined by one 2-1/2" bore hole, BH-23, located as shown on Plate No. 4. Additional foundation information was obtained from three nearby 2-1/2" bore holes, also shown on Plate No. 4. Numbers in boring logs on profile shown on Plate No. 4 are those of the Providence Soil Classification described on the above noted plate and shown graphically on Plate No. 5 (S.L.Form 91). Soil at time of exploration consisted of 0.5 ft. of topsoil resting over 11 ft. of variable soil graded from gravel to fine silt and clay. Beneath this material is 3 ft. of soft, red, varved clay, which in turn rests upon about 7 ft. of reddish-brown cohesive glacial till. Beneath the till is shale and sandstone.

Construction of Park River Conduit has resulted in partial excavation of pumping station site. This excavation will be left open upon completion of conduit construction to prevent the necessity of rehandling waste soil.

The bottom of pumping station base slab will be founded upon firm shale or sandstone after removal of thin upper layer of soft stone. No foundation difficulties are expected.

IV. HYDROLOGY

IV. HYDROLOGY

A. DRAINAGE AREA. - The Bushnell Park Pumping Station will serve a tributary drainage area of 257 acres, in traversed by Park River and extends north and west from Capitol Avenue and the State Capitol in Hartford, Connecticut to Walnut Street and Spring Street, and is bounded on the east by Main Street.

1. Present conditions. - 85 percent of the area (219 acres) is fully developed by industrial and commercial interests, and the remaining 15 percent (38 acres) is park area.

2. Possible future conditions. - It is not expected that any future development in this area will either materially increase the drainage area contributing to the pumping station or the rate of run-off from the area.

B. SEWER FACILITIES.

1. Existing sewers. - The entire area is provided by a sewer system which drains through the Park River Intercepting Sewer to the present Potter Street Pumping Station of the City of Hartford. The dry-weather flow in this sewer is diverted at Commerce Street into the Connecticut River Interceptor through which it flows to the South Meadows sewage treatment plant. A plan of the combined sewer system is shown on Plate 3.

2. Existing pumping station. - The existing Potter Street Pumping Station of the City of Hartford has two 12-inch pumps which handle sewage flow only, and three 24-inch pumps for storm water flow. These pumps are electrically driven. At the present time there are two outlets from this station to the river, a 56-inch brick and a 7-foot 6-inch concrete conduit. It is proposed to discontinue the smaller conduit when the Keeney

Lane Pumping Station is constructed. The two 12-inch sewage pumps pump sewage flow from the East Side Interceptor, through a force main in Potter Street, into the Connecticut River Interceptor in Commerce Street (a sewage line which flows to the South Meadows sewage treatment plant). When the Connecticut River is high, the storm water flow in both the East Side interceptor and the Park River Interceptor is pumped to the river by the three storm water pumps. The capacity of these pumps falls off rapidly at heads corresponding to river elevations above 30 m.s.l. Because of the obsolescence, worn condition, and poor operating characteristics of the pumps, the Potter Street Station is considered inadequate for internal drainage of the Connecticut River dike project. The presence of this station may, however, be regarded as an added factor of safety in the over-all drainage scheme.

3. Future development. - It is improbable that any future changes in the existing sewer system will greatly increase the rate of run-off from the drainage area. The Bushnell Park Pumping Station will be located adjacent to and on the north side of the Park River Conduit near the intersection of Elm Street and Hudson Street. During flood stages it will pump the combined sanitary and storm drainage from its tributary area, shown on Plate 1, into the Park River Conduit.

4. Time of concentration. - A study of the drainage system of the area shows that the probable time of concentration at the pumping station would be one hour.

C. CHANGES. - The Gully Brook conduit, which drains a tributary area of approximately 1.9 square miles, will be made tight south of Walnut Street. A gate is to be placed in the Gully Brook Interceptor at this

point, and a connection made between the Gully Brook Interceptor and the Gully Brook conduit. During periods of high water the gate in the Gully Brook Interceptor will be closed and the flow in this sewer from the area north of Walnut Street will be diverted into the Gully Brook conduit. During periods of high water the gate in the Gully Brook Interceptor will be closed and the flow in this sewer from the area north of Walnut Street will be diverted into the Gully Brook conduit. The Gully Brook conduit will be extended across Bushnell Park to the Park River Conduit. The Park River Intercepting sewer will be connected with the Bushnell Park Pumping Station as shown on Plate 3.

A gate will be placed in the Park River Intercepting Sewer at Main Street. This gate will be closed during high stages, thereby preventing drainage from the Bushnell Park area reaching the Potter Street and Keeney Lane pumping stations and insuring its being pumped by the Bushnell Park station.

D. STORAGE. - Natural surface storage is negligible and it is not feasible to create a basin for storage of peak flows from the tributary area which is urban in character.

V. DETERMINATION OF DISCHARGE CAPACITY

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A. REQUIREMENTS FOR DISCHARGE CAPACITY. - The Bushnell Park Pumping Station will be of sufficient capacity to meet the following requirements:

1. Discharge the storm run-off from the total tributary drainage area. Design criteria are as follows:

a. Runoff caused by a 1-hour storm (time of concentration of this area is approximately 1 hour) with a probable frequency of occurrence of once in 10 years, occurring in any month, when pumping against a head in the Park River Conduit with a probable frequency of occurrence of once in 10 years for that month.

b. Discharge 40 percent of the run-off from a 1-hour storm with a probable frequency of occurrence of once in 10 years, occurring in any month, when pumping against a head in the Park River Conduit with a probable frequency of occurrence of once in 1000 years, for that month.

2. Discharge the sanitary sewage from the area (computation indicates that this quantity is very small, and it would be inconsistent with the over-all accuracy of the problem to include it - hence, no further consideration is given to sanitary sewage flow).

3. Maintain the water-surface elevation in the sewers at the pumping station at or below elevation 17 feet above mean sea level, under conditions outlined in Paragraph 1 above.

B. RAINFALL. - Monthly rainfall intensity-frequency curves, Plate 6, were drawn for 1-hour storms from the 35 years of record of rainfall at Hartford. These records are complete for all months except the three winter months of December, January, and February. Rainfall intensity-frequency values for these months were taken from the record of 1-hour storms at Providence, Rhode Island.

Month	1-hour storm 10-year frequency	inches
January		0.55*
February		0.44*
March		0.43
April		0.53
May		0.63
June		1.20
July		1.50
August		1.45
September		1.10
October		0.76
November		0.52
December		0.52*

* Rainfall intensity from Providence, R. I., records.

C. RUN-OFF COEFFICIENTS. - Coefficients of run-off were assigned to the drainage area according to the type of development and the season as shown in the following table, and a weighted run-off coefficient was obtained for each season to be applied to the drainage area as a whole.

Season	Run-off coefficient: Fully developed commercial and industrial 219 acres	Run-off coefficient: Park 38 acres	Weighted run-off coefficient 257 acres
December through April	0.80	0.45	0.75
May and November	0.70	0.35	0.65
June through October	0.65	0.30	0.60

D. FREQUENCY OF RIVER STAGES. - Monthly stage-frequency curves, Plate 7, were drawn for the Connecticut River at Hartford from the 44 years of record. In order to obtain the 10-year monthly stage at the pumping station it was necessary to increase the Connecticut River stage by an amount corresponding to the 10-year monthly discharge of the Park River. Since discharge records of the Park River were available only for the period from October 1936 to June 1939, inclusive, it was impossible to determine, directly, reliable monthly discharge-frequency relations. Run-off-frequency studies, by months, of several streams tributary to the Connecticut River had previously been made by this office. Four of these streams, whose drainage areas are similar to the Park River drainage area, were chosen, and the 10-year values of one-day and two-day run-off by months were compared. A discharge-frequency curve for the Park River was drawn from the available record, and 10-year discharge values by months were obtained by comparison with the values obtained from the studies on similar streams. Using the discharge thus obtained, and starting with the appropriate Connecticut River stage at the mouth of the Park River Conduit, backwater computations were made to the site of the proposed pumping station. In the case of the 1000-year river stages, the 1000-year Connecticut River stage was arbitrarily increased 0.5 foot to obtain the stage in the Park River opposite the pumping station.

E. REQUIRED DISCHARGE CAPACITY. - The amount of sanitary sewage from the area is a negligible quantity, therefore the required discharge capacity is based on surface runoff. The run-off from the area was determined by use of the formula:

$$Q = C\ I\ A$$

Q = discharge from the total drainage area, in c.f.s.;

C = the run-off coefficient

I = intensity of rainfall in inches per hour for the 1-hour storm;

A = total drainage area tributary to the pumping station, in acres.

The following table shows the relationship between the rate of run-off and the corresponding river stage.

Month	1-hr. 10-yr. intensity, inches per hr.	Run-off coeff.	Run-off c.f.s.	Stage (m. s. l.) 10-year	Stage (m. s. l.) 1000-year	40% of 10-yr. run-off c.f.s.
January	0.55*	0.75	106	14.0	23.8	42
February	0.44*	0.75	85	16.0	28.3	34
March	0.43	0.75	83	23.7	40.7	33
April	0.53	0.75	102	24.0	29.4	41
May	0.63	0.65	105	18.7	22.7	42
June	1.20	0.60	185	14.0	22.0	74
July	1.50	0.60	232	10.0	21.8	93
August	1.45	0.60	224	8.5	20.8	90
September	1.10	0.60	170	10.0	35.4	68
October	0.76	0.60	117	12.0	33.8	47
November	0.52	0.65	87	14.0	31.3	35
December	0.52*	0.75	100	16.0	25.9	40

* Rainfall intensity from Providence, R. I., records.

The values given in the above table are plotted on Plate 11.

F. REQUIRED PUMP CAPACITY. - The required pump capacity is determined by means of the envelope curve, Plate 12. The required discharge

capacity of the pumps, based on the design requirements used, is as follows:

River elevation m. s. l.	Discharge capacity c. f. s.
17	155
25	108
35	68

G. INSTALLED PUMP CAPACITY. - The size of pumps to be installed is dependent upon several factors. Naturally, the maximum estimated inflow is the first consideration. However, flexibility of operation, a factor of safety to insure mechanical reliability, and available or developed pump sizes also influence the selection. The characteristics of the pumps to be installed for the case at hand are shown on Plate 17. For temporary service during the present war emergency there will be installed only one 36-inch pump, transferred from the existing North Meadows Pumping Station which is located on the bank of the Connecticut River north of Hartford.

H. OPERATION. - During periods of low water (when Connecticut River stage is below elevation 10 m.s.l.) the dry weather flow from the Park River Interceptor and the Gully Brook Interceptor is carried by the Park River Interceptor to the Commerce Street sewer and thence to the South Meadows Sewage Disposal Plant. If a storm occurs on the area, the diluted mixed flow will be diverted into the Park River Conduit through overflows (including one at the Bushnell Park Pumping Station) without treatment.

When the Connecticut River stage exceeds elevation 10 m.s.l., a gate on the Park River Interceptor at Main Street is closed, and the sewage from the Bushnell Park Area discharges into the Park River Conduit by gravity at the Bushnell Park Pumping Station. When the Connecticut River stage increases so as to back the water level in the sewers at this point

up to elevation 17 m.s.l., the pumping station will begin to operate.

In the completed project the Gully Brook conduit will be extended to and connected with the Park River Conduit. Provision will be made for diverting flow in the Gully Brook Interceptor into the Gully Brook conduit at Walnut Street. A similar arrangement will allow the flow in the Park River Interceptor to be diverted into the Park River Conduit near the conduit entrance. Such diversion of flow makes it possible to reduce the area tributary to the Bushnell Park Pumping Station to that shown on Plate 1. The Gully Brook Interceptor and the Park River Interceptor will serve to carry all drainage to the pumping station.

VI. MECHANICAIL DESIGN

VI. MECHANICAL DESIGN

A. GENERAL. - As noted in the introduction, the equipment for the Bushnell Park Pumping Station is equipment designed for the North Meadows Pumping Station, Hartford, Connecticut; therefor, the following is not an analysis of design but a statement of performance and capacities to be expected of equipment already manufactured.

B. PUMP. - One 36-inch pump is to be installed in this station. The pump is a vertical, mixed-flow pump of the bottom-suction, horizontal-discharge, volute type designed for handling sewage and storm water. The pump was manufactured by De Laval Steam Turbine Company, Trenton, New Jersey. Test curves for this pump are shown on Plate 18.

C. PUMP DRIVE. - The pump will be driven by a gasoline engine connected to the pump through a right angle gear unit. The engine is of the heavy duty industrial type capable of continuously driving the pump at rated speed under any head conditions developed. It will be mounted on a concrete base and direct connected through a flexible coupling to the right angle gear unit. The engine will be water cooled by circulating City water at low pressure through the engine cooling jacket.

D. RIGHT ANGLE GEAR UNIT. - Power will be transmitted from the horizontal engine shaft through a set of spiral bevel gears to the vertical pump shaft. The gears are inclosed in a cast iron housing and are supported on anti-friction, radial thrust type bearings. The entire unit was designed to have a service factor of not less than 1.25 times the maximum power required to drive the pump under any condition of head.

E. SUMP PUMP. - A sump pump of small capacity will be provided for the purpose of keeping the pump room dry.

F. SLUICE GATE. - A motor operated sluice gate will be located in the gravity discharge conduit. This gate will normally be kept open to permit water to flow by gravity to the river. It will be closed only at such times as it is necessary to prevent back flow.

G. HEATING SYSTEM. - The heating system will consist of a coal fired forced warm air furnace designed to maintain a temperature of 60°F. in the engine room with an outside temperature of 0°F.

H. ELECTRIC LIGHTING SYSTEM. - Electric power for lighting the pumping station will be supplied at 240/120 volts, 2 phase, 5 wire, 60 cycles, A. C. from the Hartford Electric Light Company distribution system. The 240 volt, 2 phase power will operate an electric hoist for the sluice gate through a separate entrance switch. The lighting system will be 240/120 volt, single phase and will provide for flood lights, interior lights, convenience outlets, battery charger for the engine batteries, sump pump and heater blower. All circuits except the hoist will be fed from an 8-circuit circuit breaker or switch and fuse panelboard. The wiring will be exposed and of temporary types for removal at a later date.

VII. STRUCTURAL DESIGN

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A. SPECIFICATIONS FOR STRUCTURAL DESIGN.

1. General. - The structural design of the Bushnell Park 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 only structural steel involved is that for the steady beam, anchor bolts and some steel for the trash rack.

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_a). - 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 200

Where special anchorage is provided 250

The above stresses are for deformed bars.

e. Bearing (f_c). -

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..... 24,000

Web reinforcement..... 24,000

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. Superstructure. - The superstructure is to be of frame construction, designed to withstand a wind load of 20# per sq. ft. on the exposed vertical projection of the roof and walls and a 20# snow load on the horizontal projection of the roof. No actual design computations were made for this framing. A typical mobilization type of roof stress, the truss slightly modified to suit the required span, was used. Spacing of the trusses is 3' 0" center to center. No crane of any kind is provided. Should it become necessary to move any of the heavy equipment, a temporary A-frame will be erected as needed. All timber used is of 1200# per sq. inch grade.

2. Substructure. -

a. The substructure is to be of reinforced concrete. It

is so located that the south wall of the substructure is in contact with the north wall of the Park River Conduit. Openings in the Park River Conduit had previously been provided for connecting this pumping station to the conduit. The pumping station will be founded on rock. It was therefore assumed in the design that all downward vertical load, except the dead weight of the base slab, will be taken on the perimeter walls. The walls and base slab, however, being designed as a monolithic structure with walls hinged at the top and continuous with the base, uplift was assumed to be uniformly distributed over the entire base. For the transverse section at right angles to the Park River conduit, the hydrostatic pressure for the pump room wall adjacent to and in contact with the Park River conduit wall was assumed to be of half the intensity of that against the opposite wall. This assumption seemed fair in view of the close contact between station and conduit walls.

b. The continuous frames were investigated for the condition of loading of a hydrostatic head from Elev. 1.50 to Elev. 17.0, the walls being designed for saturated earth pressure to Elev. 17.00 and for dry earth pressure from Elev. 17.00 to grade.

c. The floor beams have been assumed as simply supported and are designed to carry dead load, the equipment loads (plus 100% impact) and live load at 200# per sq. ft. from the part of the floor not occupied by machinery. The floor slab is designed to carry the equipment loads plus a uniform load of 300# per sq. ft. on the remaining floor area.

3. Intake structure and trash rack chamber. - The intake structure and trash rack chamber will be built integrally with the pumping station substructure. In the design, the chamber in back of the trash rack

was designed as continuous with the pumping station, while the chamber in front of the trash rack was designed as a closed rectangular section.

4. Discharge. - The station is built so that its south wall is in direct contact with the north wall of the Park River conduit. When the Connecticut River is at normal stage, discharge takes place directly into the Park River conduit through an open sluice gate. When the Connecticut River reaches Elev. 17.0, the sluice gate will be closed and pumping will take place into the Park River conduit through the pipe opening previously provided.

5. Trash rack. - The trash rack consists of wood slats 2" x 8", 5" center to center. It is designed to revolve about a 4" in diameter steel pipe at its upper end. Its normal position will be out of the water and horizontal, one end being supported by the steel pipe and the other end suspended from a steel cable operated by a small hoist. The lower end of the trash rack is weighted down with sufficient steel to prevent flotation when the trash rack is down.

6. Stairways and ladder. - A concrete stairway leads from the engine room floor to the pump room. Cast iron steps set into the concrete provide access to the trash rack chamber.

7. Steady beam. - A steady beam is required to support the shaft from the right angle gear unit to the pump. The beam is made up of 2-10inch steel channels connected with batten plates and lattice bars to form a stiff horizontal girder. The component parts of the steady beam are bolted together throughout. Riveting was not considered necessary because of the temporary nature of the station.

C. ARCHITECTURE. - The present design of the Bushnell Park Pumping

Station is for a temporary structure only. Its purpose is to provide protection for important industries during the war emergency. A permanent station of a much greater capacity is to be built in the future after which this station will be abondoned. For this reason, a temporary wooden superstructure was deemed sufficient for the present purpose. The superstructure was therefore designed of wood framing, mobilization type, with enough architectural treatment to make the building harmonize somewhat with its surroundings. Heat, supplied by a hot-air furnace, was provided at the request of the City of Hartford since the City expects to have a guard on duty at the station at all times. The house is 28' 0" by 29' 6" and is provided with a main entrance door and a service door. The interior of the building is lined with gypsum to make it fire-resistant. The roof consists of 1 1/2 inches of gypsum plank covered with asphalt shingles. The walls have drop siding exterior finish.

VIII. CONSTRUCTION PROCEDURE

VIII. CONSTRUCTION PROCEDURE

A. SEQUENCE OF OPERATIONS. - It is expected that the pumping, inlet conduit and appurtenant structures will be completed in 60 calendar days after receipt by the contractor of notice to proceed. The entire structure, pumping station and inlet conduit may be constructed at the same time. Control of any flow of water through the existing Park River conduit opening at the pumping station will be maintained by the contractor to eliminate flooding of the site during construction.

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 base slab 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 will be tested by the Central Concrete Laboratory, Mount Vernon, N. Y.

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 branch 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.

2. 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 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. - The only structural steel construction involved in the Bushnell Park Pumping Station will be in the steady beam and the small amount of steel required in connection with the wooden trash rack.

1. Steady beam. - The steady beam consists of 2-10 inch steel channels tied together with lattice bars and batten plates to make a stiff horizontal girder which will provide necessary sidewise support for the vertical shaft. Bolting will be used throughout, both because of ease of erection and because of the temporary nature of the construction.

2. Trash rack. - The trash rack is of wood, consisting of 2" x 8" slats 5" center to center. A small amount of steel plate is used at the top to provide a bearing for the rack. An additional amount of steel plate is used at the bottom of the screen to provide sufficient weight against flotation. The upper end of the rods will turn on a 4" diameter steel pipe set into the concrete walls of the trash rack chamber.

D. CONSTRUCTION PERIOD. - A study of hydrographs of the Connecticut River plotted from data recorded by the United States Weather Bureau from 1917 to 1938, a total of 22 consecutive years, shows that the majority of the floods at Hartford occur in the spring months of March, April and May. Any rise in the stage of the Connecticut is reflected in a rise in the stage of Park River at the Bushnell Park Pumping Station site. The ground elevation at the site of the Pumping Station is about 23.0 m.s.l. With the exception of 1930, it will be noted that floods have reached elevation 18.0 m.s.l. or more, every spring. However, between May 15 and December 1 only twice has the peak of any flood reached elevation 20.0 m.s.l. as follows:

Date	Elevation of High Water
November 8, 1927	29.2
September 23, 1938	35.4

Consideration of this matter including a study of the flash floods which occur throughout the year on Park River leads to the conclusion that protection of the construction work to elevation 26.0 m.s.l. will probably be sufficient. ~~The contractor will be responsible for all damage by floods to elevation 26.0 while the Government will be responsible for damage by floods which may exceed elevation 26.0; the contractor being required to repair all such damage at contract unit prices.~~ It is proposed to have the work carried out approximately in accordance with the following construction table:

Designation	Quantity Cu. Yd.	Time limit of Operation	No. of working days	Daily rate of construction Cu. yds.	Remarks
Common Excavation	2150 c.y.	Sept. 15 - Sept. 22	7	310 c.y.	
Rock Excavation	87 c.y.	Sept. 23 - Sept. 30	7	13 c.y.	
Concrete in Substructure, etc.	450 c.y.	Oct. 2 - Oct. 12	10	45 c.y.	
Backfill	1800 c.y.	Oct. 16 - Oct. 23	7	160 c.y.	
Structural Steel construction	none	---			
Wooden superstructure		Nov. 12			
Installation of equipment		Nov. 12			
Job completed		Nov. 15			

E. INSTALLATION OF EQUIPMENT. - The installation of the electrical and mechanical equipment will be completed within the 60 days allowed for the construction of the station.

F. INSPECTION AND TESTS. - Field inspection of all portions of the construction work will be made. Progress reports including log of work accomplished and of the number of workers on the job will be made. Field and laboratory tests of concrete and other materials will be made in order to control the quality of the work.

IX. SUMMARY OF COST

IX. SUMMARY OF COST

The total construction cost of the Bushnell Park Pumping Station including the inlet conduit and mechanical equipment has been estimated to be $41,900, including 15 percent for engineering and 10 percent for contingencies. This amount has been distributed as follows:

(1)	Pumping station:	
	a. Concrete features	$ 23,100
	b. Superstructure	4,300
	c. Miscellaneous	1,500
		$ 28,900
(2)	Mechanical equipment	13,000
	TOTAL	$ 41,900

(1) a. - The "concrete features" consist of intake structure and foundation of pumping station.

(1) b. - "Superstructure" consists of the complete wooden 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 above.

(2) - "Mechanical equipment" consists of pump, gas engine, gear unit, valves and piping and miscellaneous items.

X. PLATES

ANALYSIS OF DESIGN

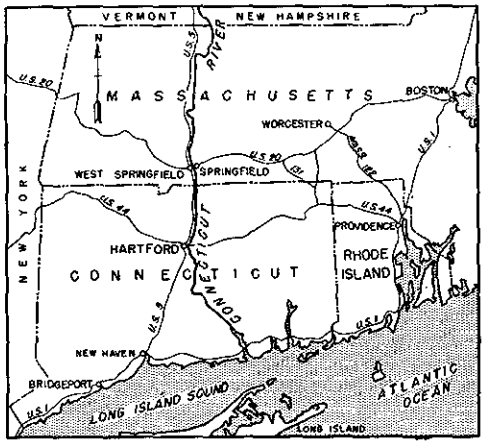
BUSHNELL PARK PUMPING STATION

INDEX OF PLATES

Plate No.	Title
1	Project, Location & Drainage Areas
2	General Plan
3	Sewer Interceptors Plan
4	Geologic & Soil Section
5	Providence District Soils Classification
6	Rainfall Intensity Frequency Curve
7	Stage Frequency Curves
8	Hydrograph No. 1
9	Hydrograph No. 2
10	Hydrograph No. 3
11	Stage Duration Curve
12	Required Pump Capacity Curve
13	Operating Floor Plan (Architectural)
14	Pumping Station Elevation (Architectural)
15	General Arrangement of Equipment No. L
16	General Arrangement of Equipment No. 2
17	Proposed Pump Capacity
18	Output of One 36" Volute Pump

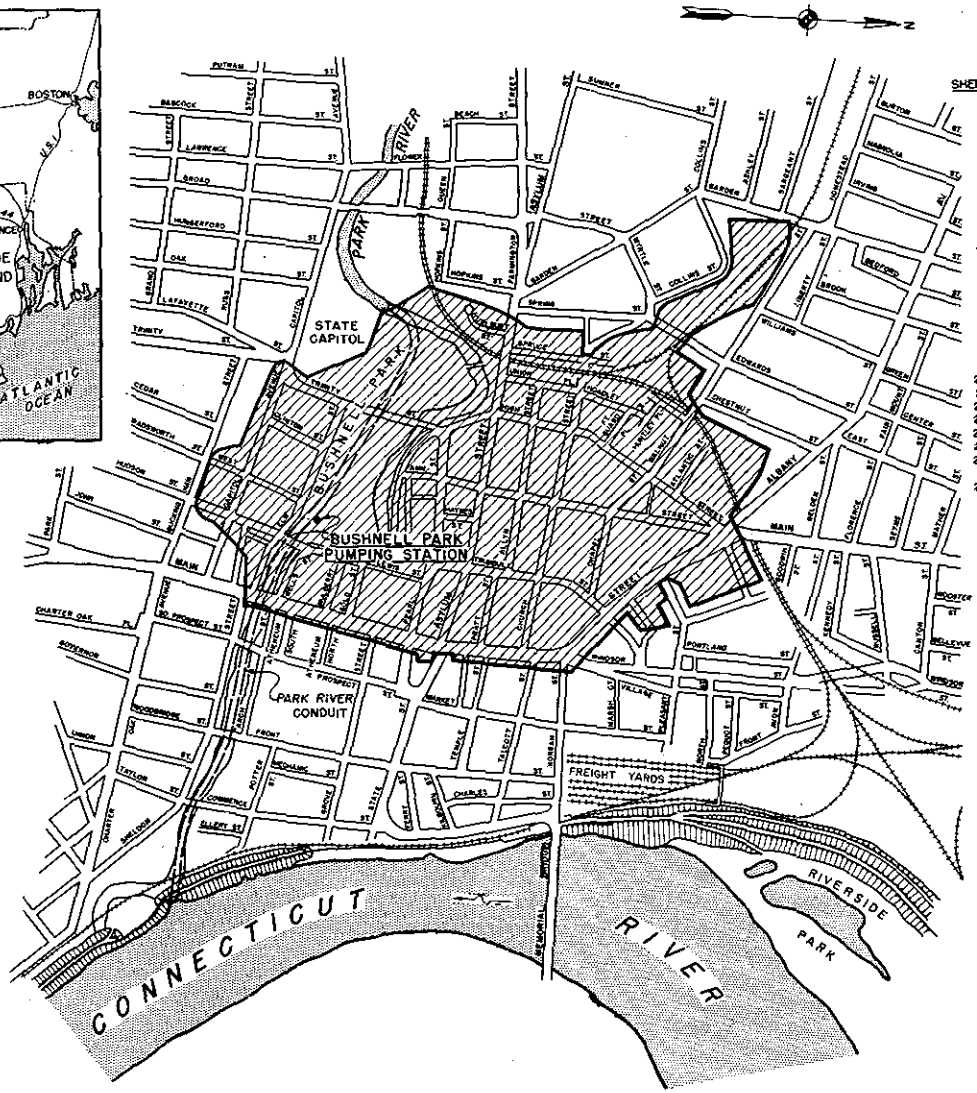
WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



LOCATION MAP

SCALE OF MILES 0 10 20 30



INDEX TO DRAWINGS

SHEET NO.	DESCRIPTION	FILE NO.
1	PROJECT LOCATION AND INDEX	CT-4-3159
2	HYDROGRAPH NO. 1 - CONNECTICUT RIVER	CT-3-1222
3	HYDROGRAPH NO. 2 - CONNECTICUT RIVER	CT-3-1223
4	HYDROGRAPH NO. 1 - PARK RIVER	CT-3-1221
5	SUBSURFACE EXPLORATIONS	CT-2-1385
6	GENERAL PLAN	CT-4-3160
7	INTAKE, DRY WELL AND OUTLET	CT-4-3161
8	PLANS AND ELEVATIONS - ARCHITECTURAL	CT-4-3162
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11	TRUSS DETAIL - ARCHITECTURAL	CT-4-3165
12	MISCELLANEOUS DETAILS - ARCHITECTURAL	CT-4-3166
13	ENGINE ROOM FLOOR SLAB	CT-4-3167
14	FLOOR BEAMS AND STAIRWAY DETAILS	CT-4-3168
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16	NORTH AND EAST WALLS	CT-4-3170
17	SOUTH AND WEST WALLS	CT-4-3171
18	HORIZONTAL SECTIONS	CT-4-3172
19	VERTICAL SECTIONS	CT-4-3173
20	CONDUIT WALL AND DETAILS	CT-4-3174
21	PUMPING EQUIPMENT FOUNDATIONS	CT-4-3175
22	TRASH RACK, STEADY BEAM AND TANK SUPPORT	CT-4-3176
23	EQUIPMENT - GENERAL ARRANGEMENT NO. 1	CT-4-3177
24	EQUIPMENT - GENERAL ARRANGEMENT NO. 2	CT-4-3178
25	GASOLINE AND WATER PIPING AND HEATING PLAN	CT-4-3179
26	DETAILS OF ENGINE BASE, PIPING AND REINFORCING STEEL	CT-4-3180
27	ELECTRIC LIGHT AND POWER SYSTEM	CT-4-3181

LEGEND

Limits of Drainage Area for Bushnell Park Pumping Station.

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

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

PROJECT LOCATION AND INDEX

PARK RIVER — CONNECTICUT

IN 27 SHEETS — SCALE: 1 IN. = 500 FT. — SHEET NO. 1

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — AUG. 1943

SUBMITTED: Chief, Design Section — APPROVAL RECOMMENDED: Principal Engineer, Chief, F.C. Planning Division — APPROVED: Lt. Col., Corps of Engineers, District Engineer

DESIGN SECTION: F.C. Planning Section — DRAWN: H. B. RC — TRACED: H. B. R. — CHECKED: R.R.C.

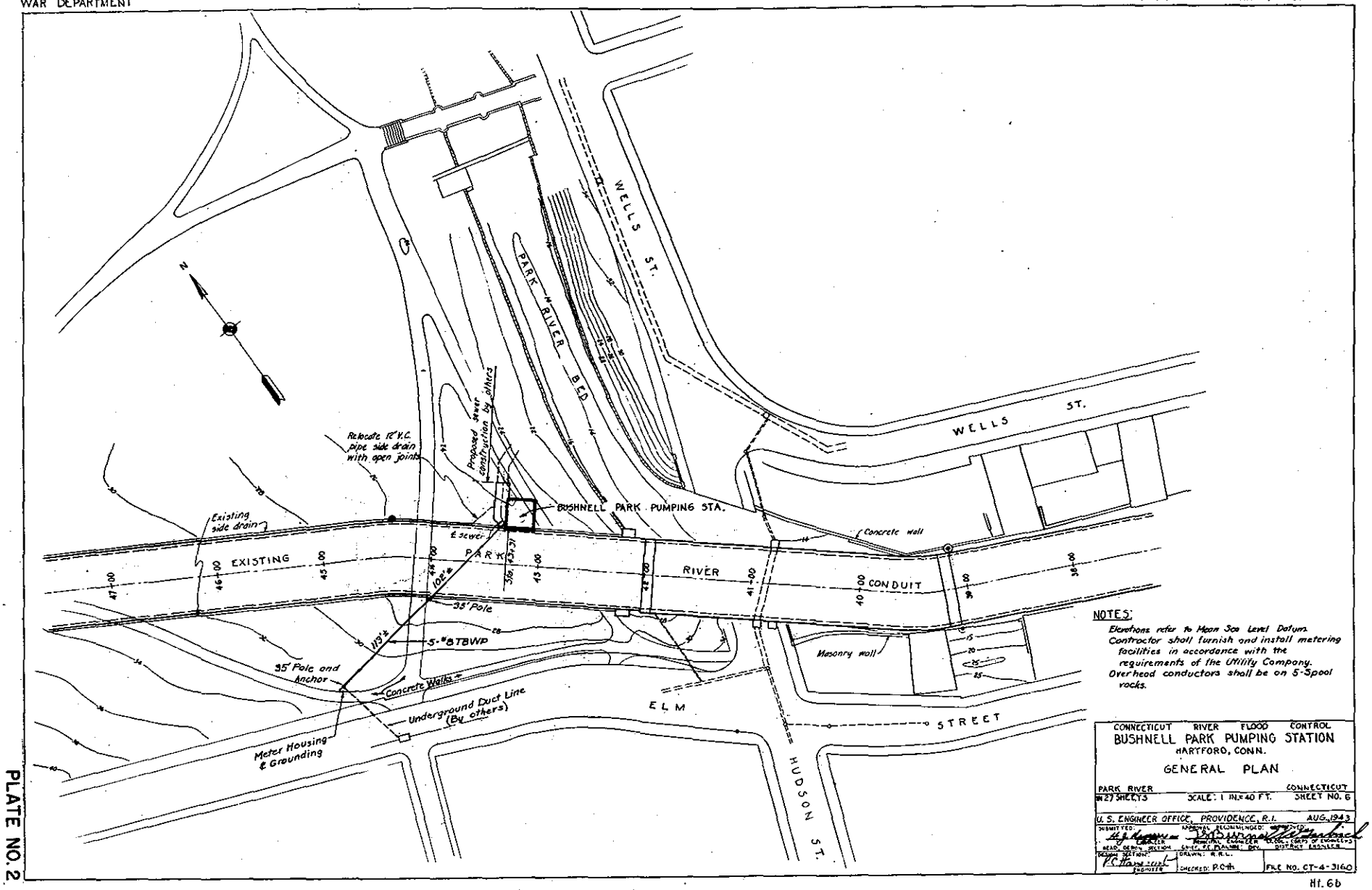
FILE NO. CT-4-3159

PLATE NO. 1

Ht. 6b

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



NOTES:

Elevations refer to Mean Sea Level Datum.
Contractor shall furnish and install metering facilities in accordance with the requirements of the Utility Company.
Overhead conductors shall be on 5-Spool racks.

CONNECTICUT RIVER FLOOD CONTROL
BUSHNELL PARK PUMPING STATION
HARTFORD, CONN.

GENERAL PLAN

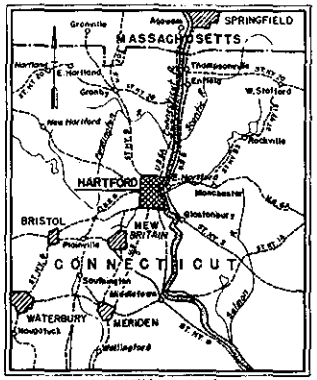
PARK RIVER — CONNECTICUT
IN 27 SHEETS — SCALE: 1 IN.=40 FT. — SHEET NO. 6

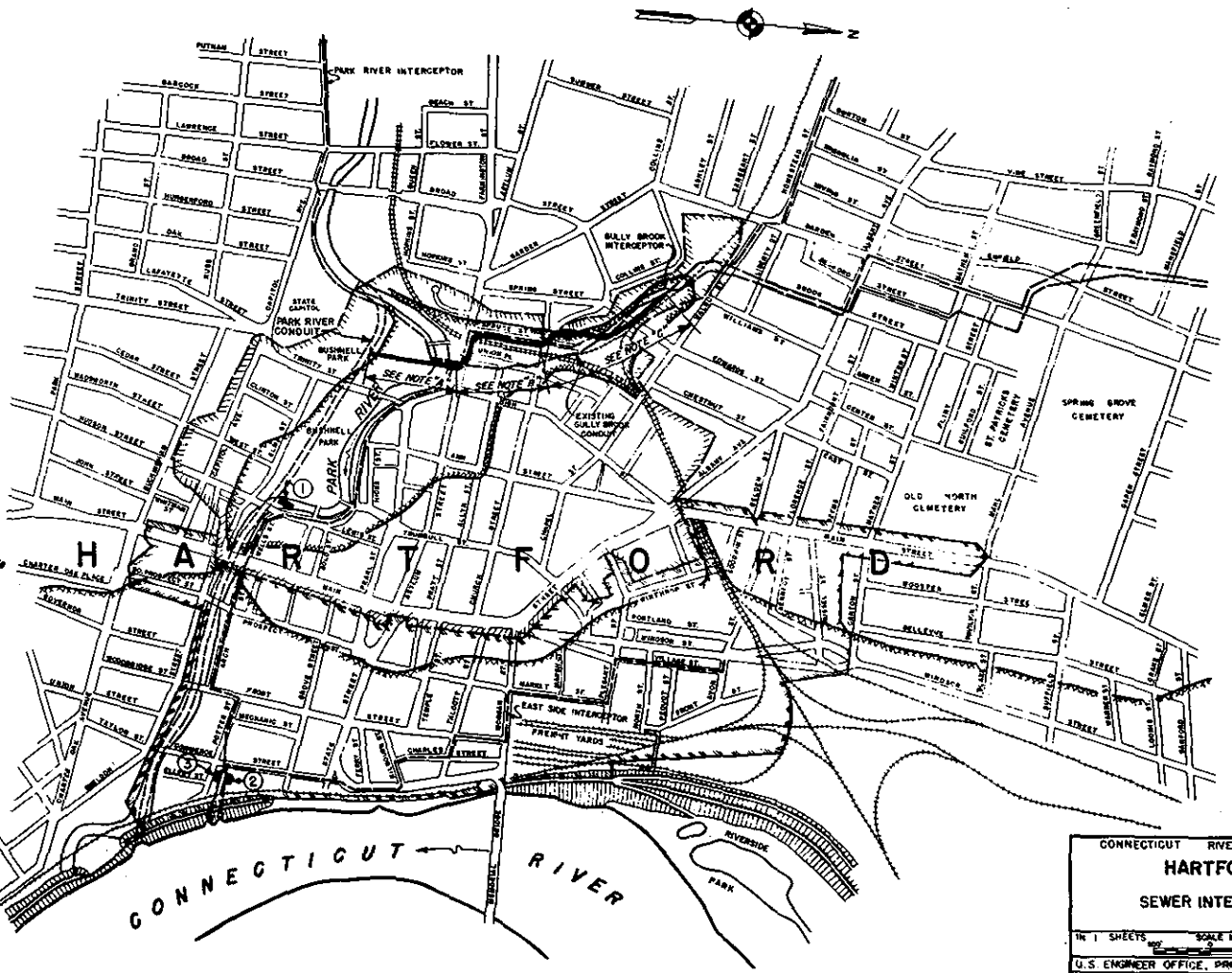
U. S. ENGINEER OFFICE, PROVIDENCE, R.I. — AUG., 1943

SUBMITTED: [signature] ENGINEER, HEAD, DESIGN SECTION
APPROVAL RECOMMENDED: [signature] PRINCIPAL ENGINEER, CHIEF, PE PLANNING DIV.
APPROVED: [signature] LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER
DESIGN SECTION: [signature] ENGINEER
DRAWN: R.R.L.
CHECKED: P.C.th
FILE NO. CT-4-3160

Ht. 6b

PLATE NO. 2





NOTE

A: 845 feet of twin conduit, 9'x7' @ 0.15% grade, built by City of Hartford

B&C: Bully Brook as proposed by the City of Hartford:
B: 904 feet of 11'x8.5' conduit @ 0.64% grade
C: 1370 feet of 11'x9.5' conduit @ 0.38% grade

LEGEND

- Area subject to flooding
- Limits of area served by Bushnell Park Pumping Station
- Limits of area served by Keeney Lane Pumping Station

① Proposed Bushnell Park Pumping Station
② Proposed Keeney Lane Pumping Station
③ Existing Potter Street Pumping Station

CONNECTICUT RIVER FLOOD CONTROL

HARTFORD, CONN.

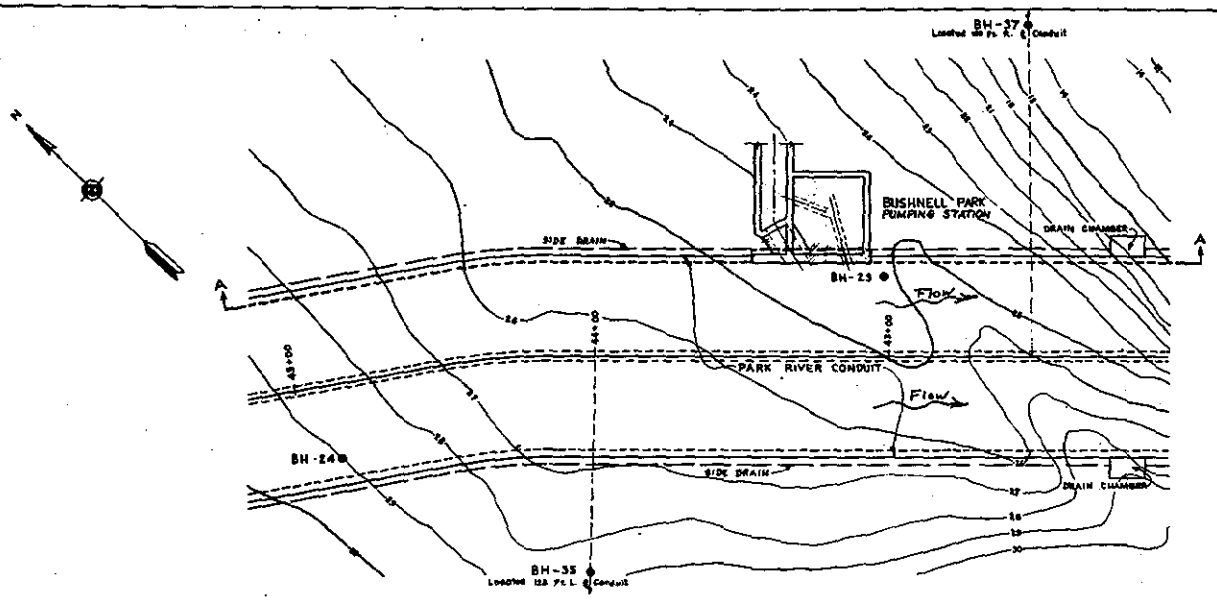
SEWER INTECEPTER PLAN

IN 1 SHEETS — SCALE 1IN.=500 FT. — SHEET NO. 1

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — JUNE, 1941

WAR DEPARTMENT

CORPS OF ENGINEERS, U. S. ARMY



PLAN

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.

NOTES

Samples, logs, and test results may be inspected at U.S. Engineer Office, Providence, R.I.

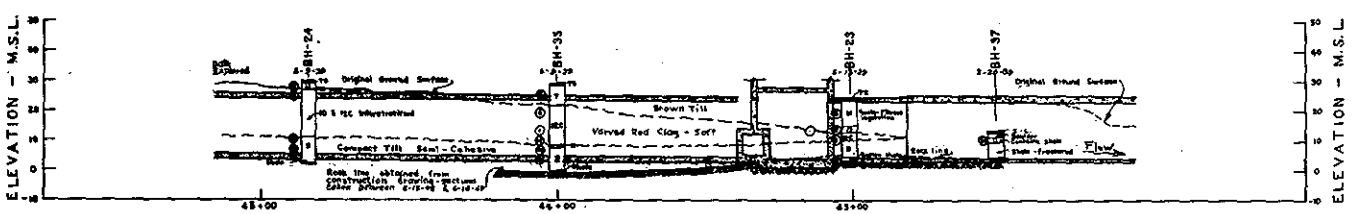
Soils having classifications of two soil classes (i.e. 4-2) have coarser portion of soil in initial class (4) and finer portion in final class (2).

BH = Bore Hole

Contours shown are those taken at time of exploration and before construction operations.

LEGEND

- Water table at time of exploration.
- AV — Numerical class (Providence District Soil Classification)
  Letter V indicates visual classification
  TS — Top soil
- Penetration in blows per foot of 350# hammer falling 18" on sampling spoon.



PROFILE
SECTION A-A

CONNECTICUT RIVER FLOOD CONTROL
BUSHNELL PARK · PUMPING STATION
HARTFORD, CONN.

GEOLOGIC AND SOIL SECTION

PARK RIVER — CONNECTICUT

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

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., JULY 1943

SUBMITTED: ENGINEER, HEAD, SOILS LABORATORY — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. PLANNING DIV. — APPROVED: LT. COL. CORPS OF ENGINEERS, DISTRICT ENGINEER

ANALYSIS BY: ASST. ENGINEER — DRAWN: H.D.L. TRACED: CHECKED: — S.L. NO. Ht. 6b-A1d — FILE NO. CT-2-1386

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

PLATE NO. 4

PROVIDENCE DISTRICT SOIL CLASSIFICATION

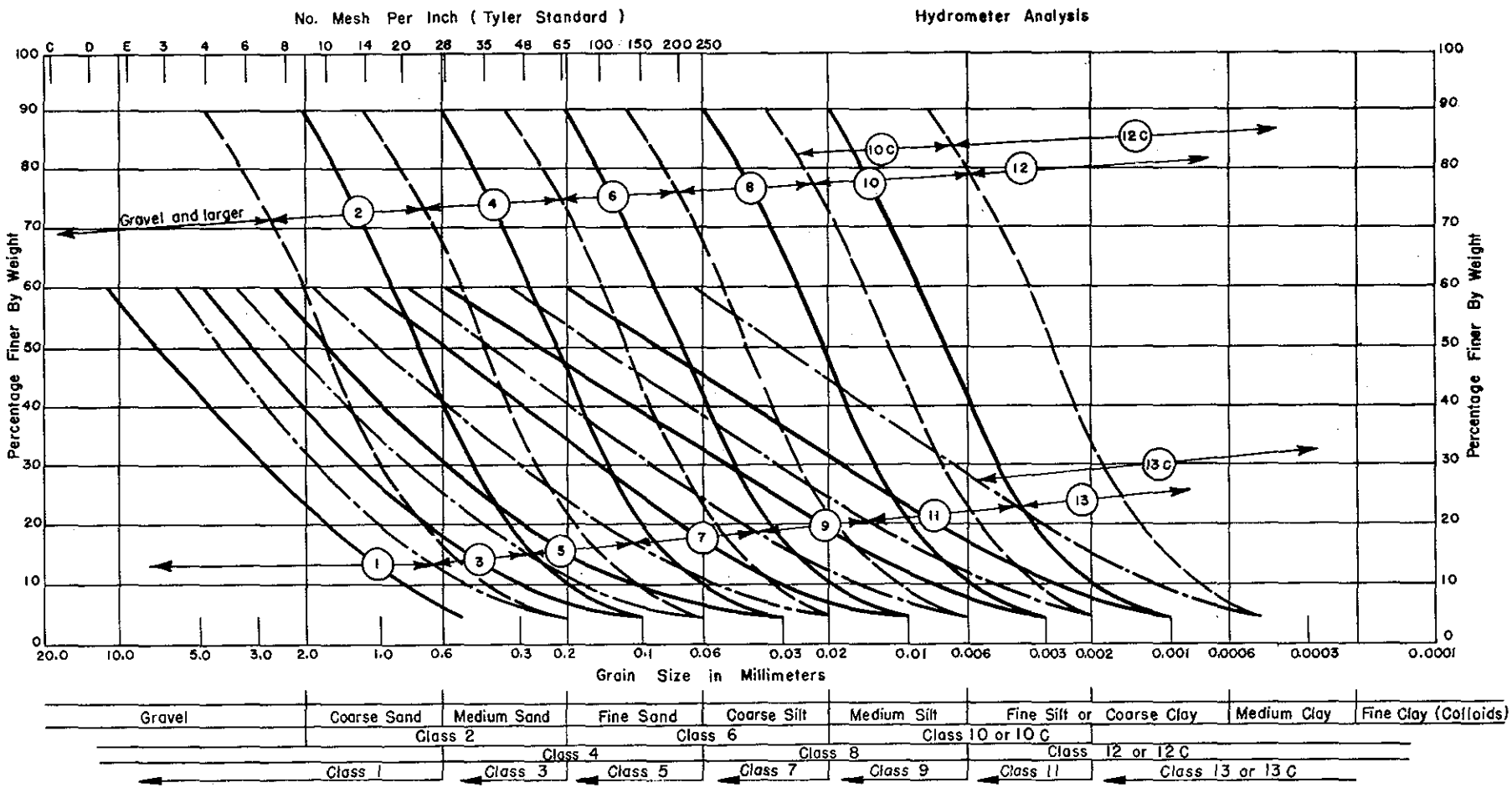
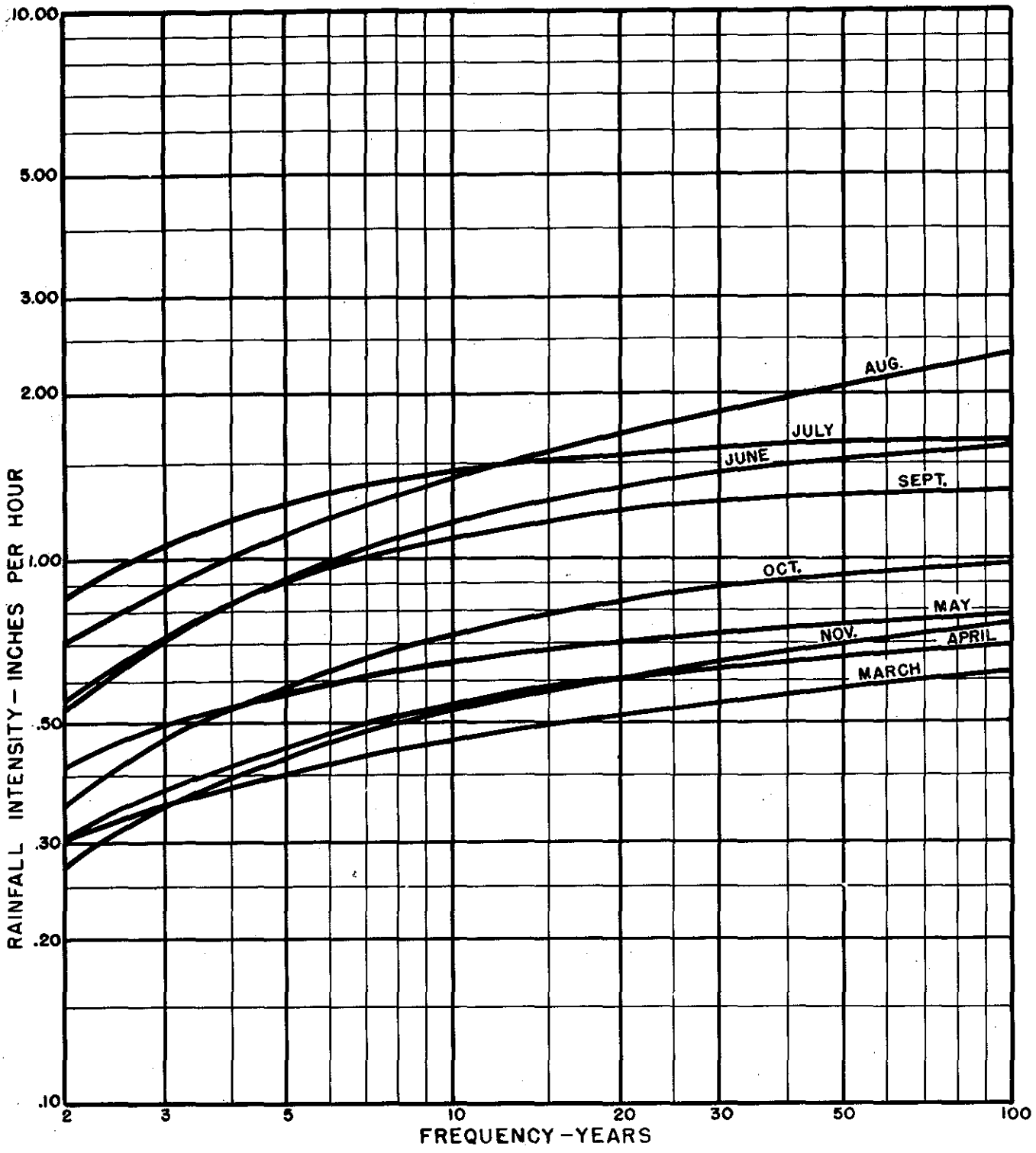


DIAGRAM SHOWING LIMITS OF SOIL CLASSES

H16b PLATE NO. 5



CONNECTICUT RIVER FLOOD CONTROL

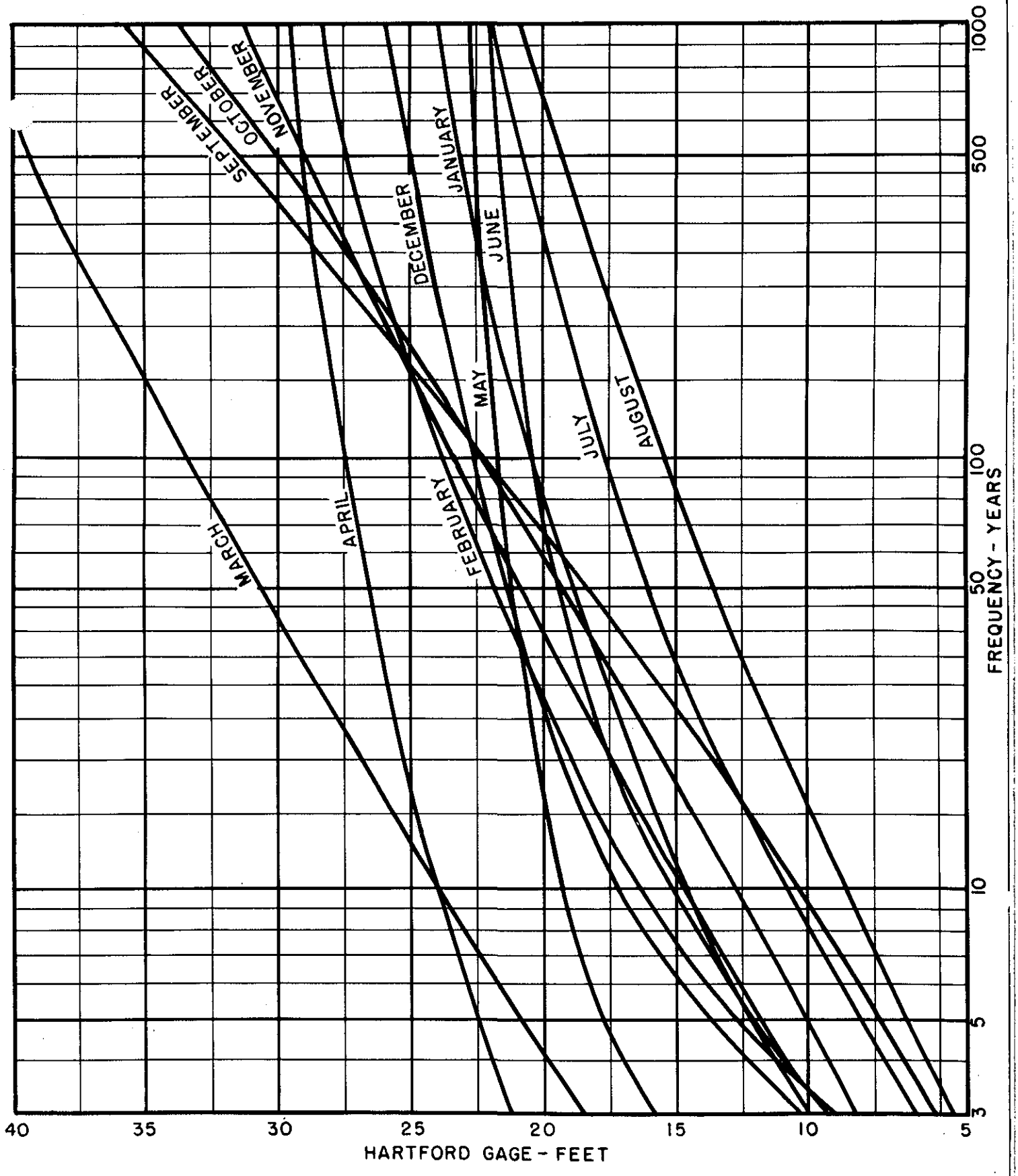
RAINFALL INTENSITY — FREQUENCY CURVES

1-HOUR STORM

HARTFORD, CONNECTICUT

35 YEARS OF RECORD — 1905 TO 1939 INCL.

Ht. 6b PLATE NO. 6



CONNECTICUT RIVER

STAGE - FREQUENCY CURVES

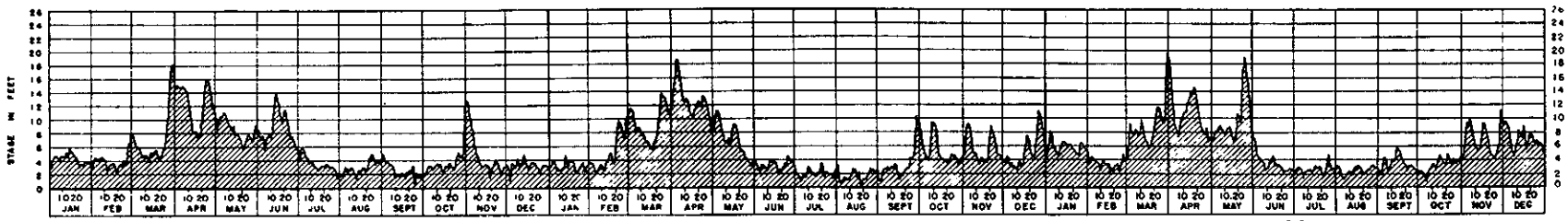
HARTFORD, CONNECTICUT

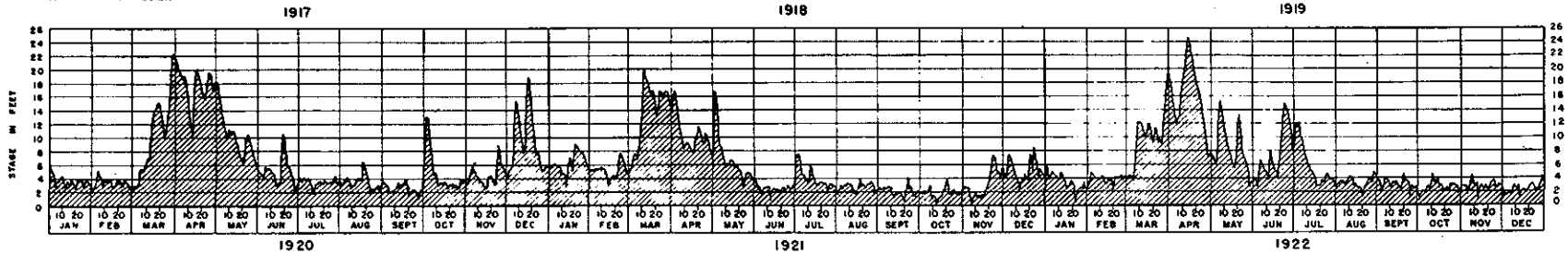
ZERO HARTFORD GAGE = MINUS 0.55 M.S.L.

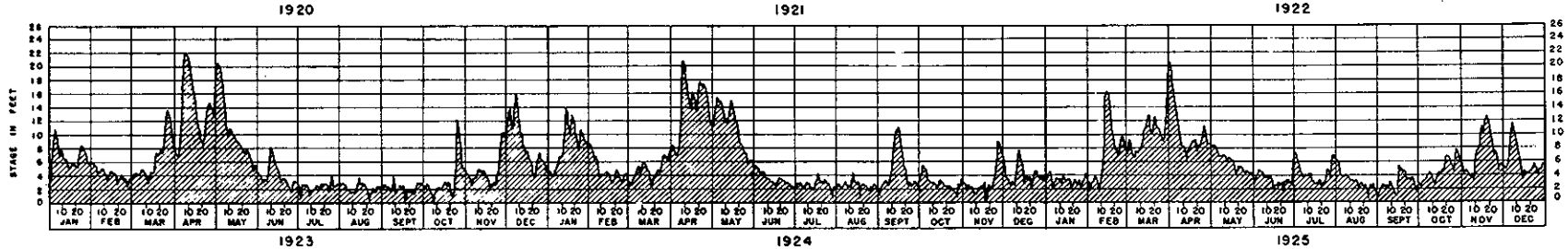
Ht. 6b PLATE NO. 7

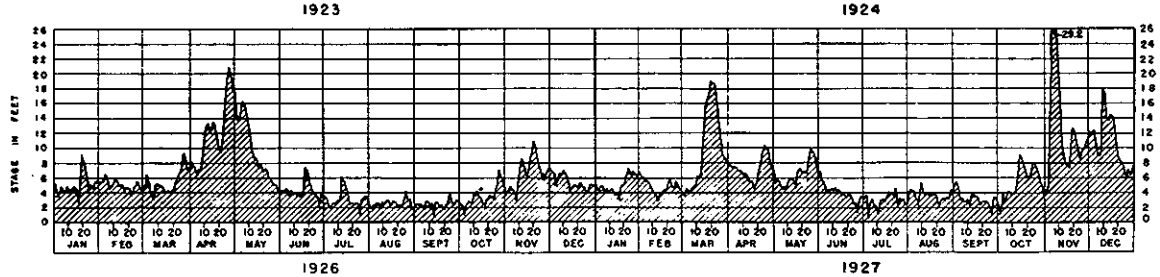
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY.









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

STAGE-ELEVATION RELATION

NOTES:

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

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

Data supplied by U. S. Weather Bureau.

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

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

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

CONNECTICUT RIVER-HYDROGRAPH NO. 1

CONNECTICUT RIVER — CONNECTICUT

IN 27 SHEETS — SCALE AS SHOWN — SHEET NO. 2

U.S. ENGINEER OFFICE, PROVIDENCE, R.I., AUG. 1943

SUBMITTED: SENIOR ENGINEER, HEAD, HYDRAULICS SECTION

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

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

COMPILED: ASST. ENGINEER

DRAWN BY: P.W.Y. & F.C.T.; TRACED BY: P.J.; CHECKED BY: W.C.H.

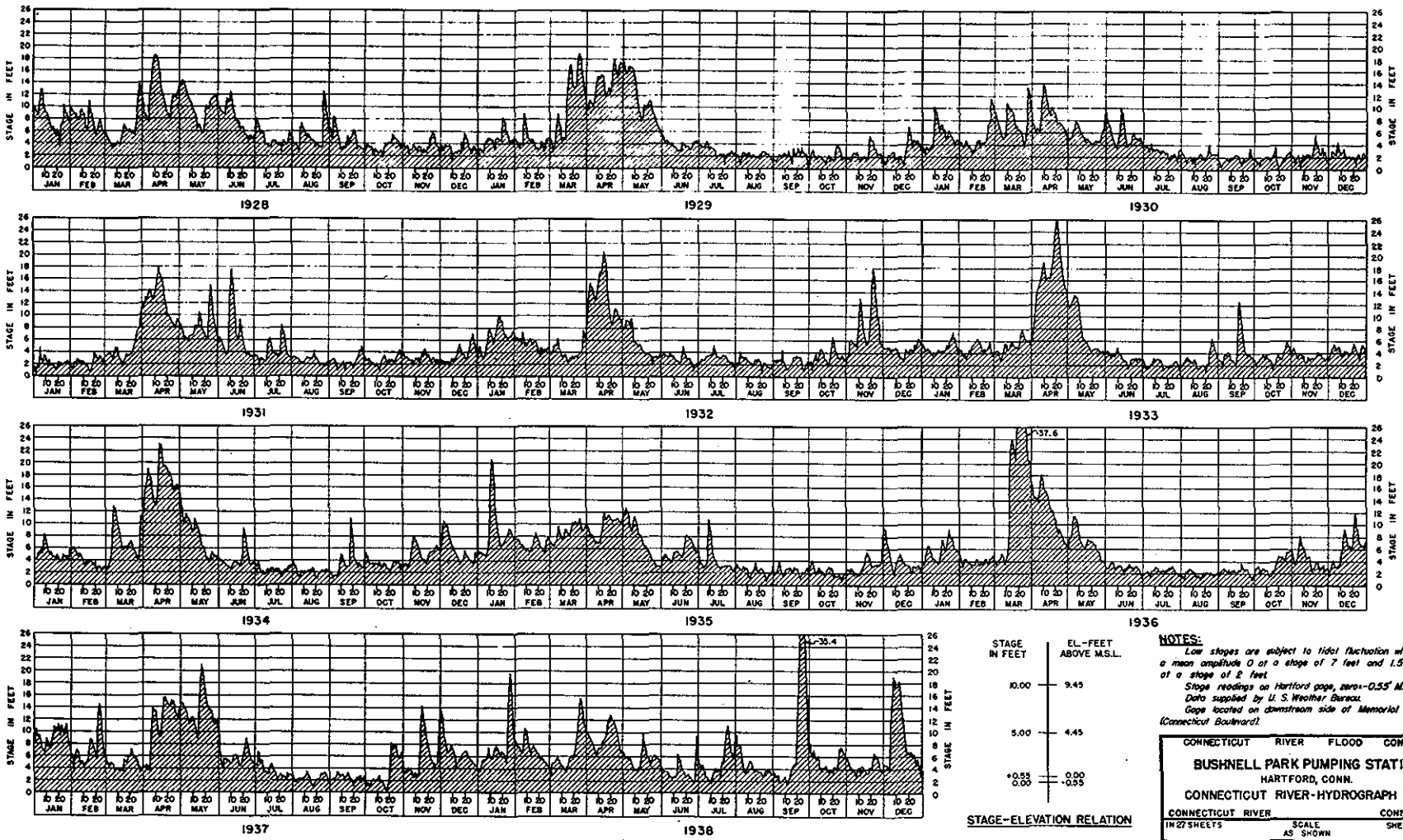
FILE NO. CT-3-1222

PLATE NO. 8

Ht. 6b

WAR DEPARTMENT

CORPS OF ENGINEERS, U S ARMY



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

STAGE-ELEVATION RELATION

NOTES:

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

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

Data supplied by U. S. Weather Bureau.

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

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

CONNECTICUT RIVER-HYDROGRAPH NO. 2

CONNECTICUT RIVER — CONNECTICUT

IN 27 SHEETS — SCALE AS SHOWN — SHEET NO. 3

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. AUG 1943

SUBMITTED: SENIOR ENGINEER, HEAD, HYDRAULICS SECTION — APPROVAL RECOMMENDED: PRINCIPAL ENGINEER, CHIEF, F.C. PLANNING DIVISION — APPROVED: L.T. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

COMPILED: ASST. ENGINEER — DRAWN BY: A.R.V. & F.C.T. TRACED BY: W.H.M. CHECKED BY: TP C.R.

FILE NO CT-3-1223

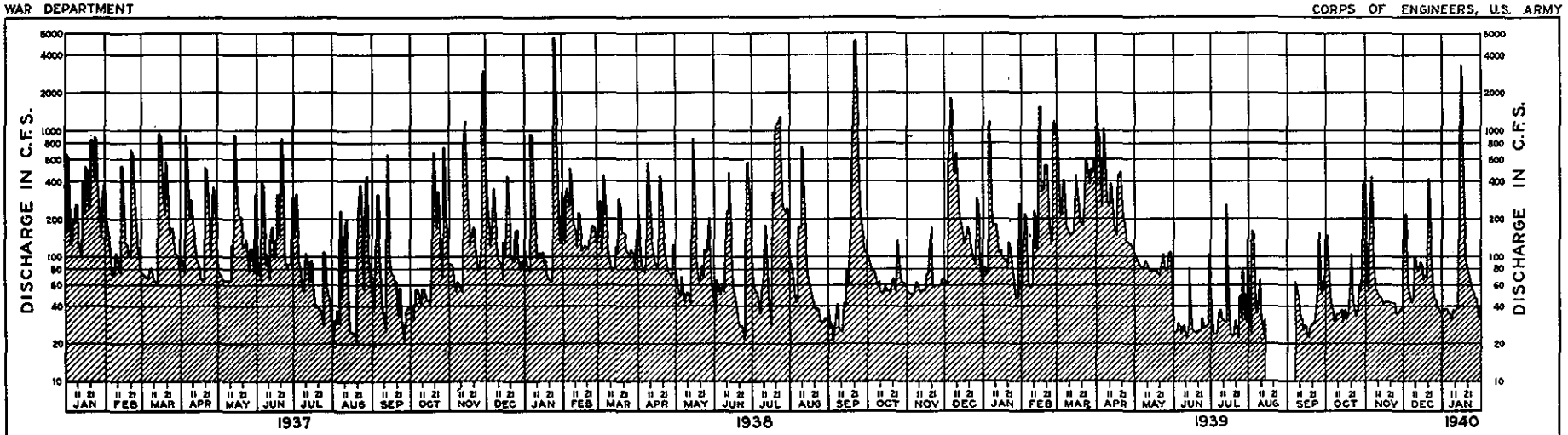
KEY	DATE	REVISION (Indicated by Δ)	REV. BY	CK. BY	AP. BY

Ht. 6b

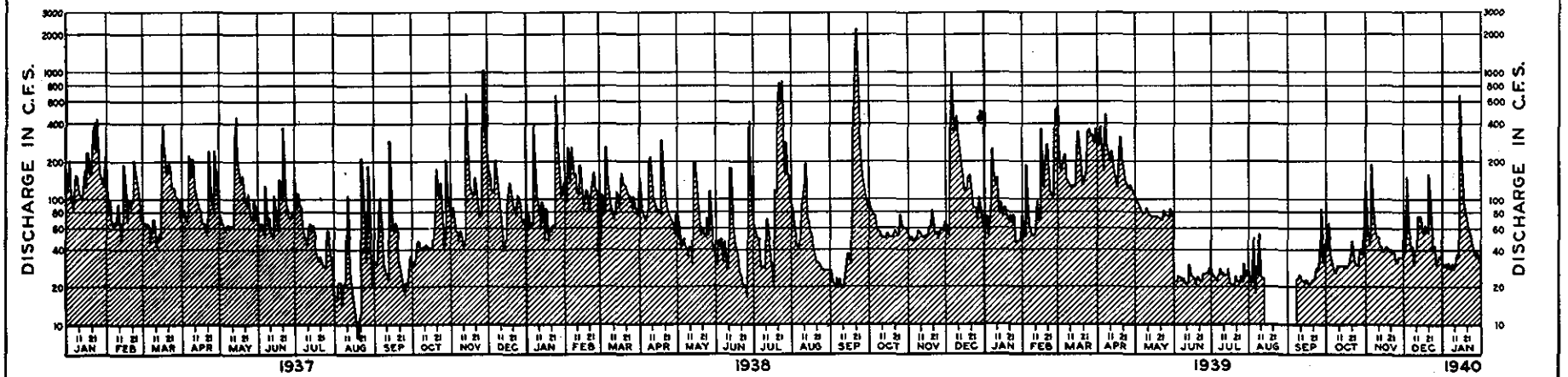
PLATE NO. 9

WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY



DAILY MAXIMUM DISCHARGES



DAILY MINIMUM DISCHARGES

NOTES

Daily maximum and minimum discharges are computed from readings taken at Riverside St.

Data for this sheet furnished by the Department of Engineering of the City of Hartford, Conn.

Drainage areas :-

At gaging station at Riverside St. just below junction of North and South Branches = ... 74.0 Sq. Mi.

At inlet of proposed conduit = ... 75.2 " "

At junction of Park River and Conn. River = 77.8 " "

METCALF & EDDY
ENGINEERS
BOSTON, MASS.

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

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

PARK RIVER-HYDROGRAPH NO. 1

PARK RIVER — CONNECTICUT

IN 27 SHEETS — SCALE AS SHOWN — SHEET NO. 4

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. — AUG. 1943

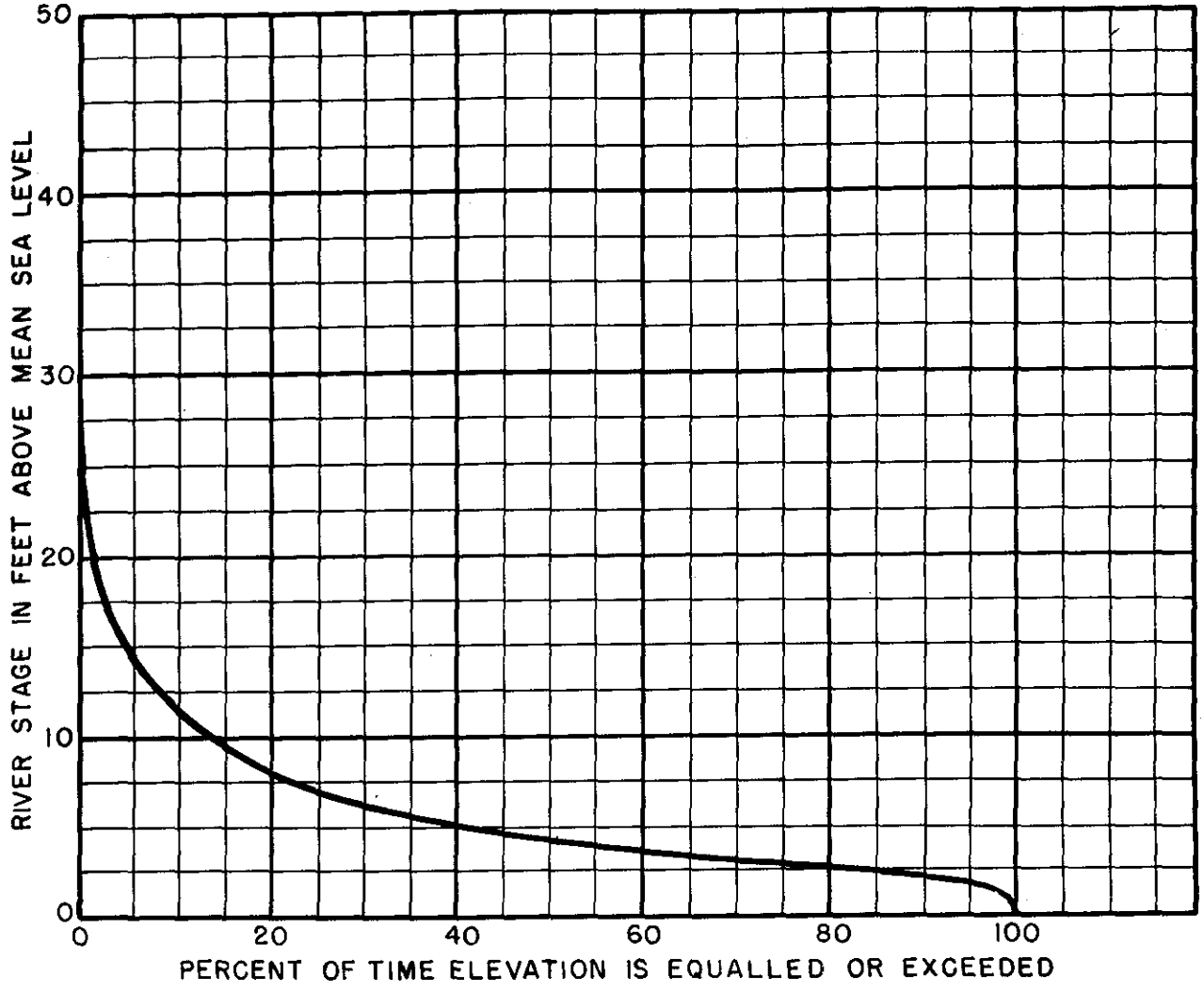
DESIGNED BY: HEAD, HYDRAULICS SECTION — APPROVAL RECOMMENDED: CHIEF, F.C. PLANNING DIV. — APPROVED: LT. COL., CORPS OF ENGINEERS, DISTRICT ENGINEER

DRAWN BY: A.W.V. & H.C.T. — TRACED BY: H.C.T. — CHECKED BY: P.W.T.

FILE NO. CT-3-1221

Ht. 6b

PLATE NO. 10

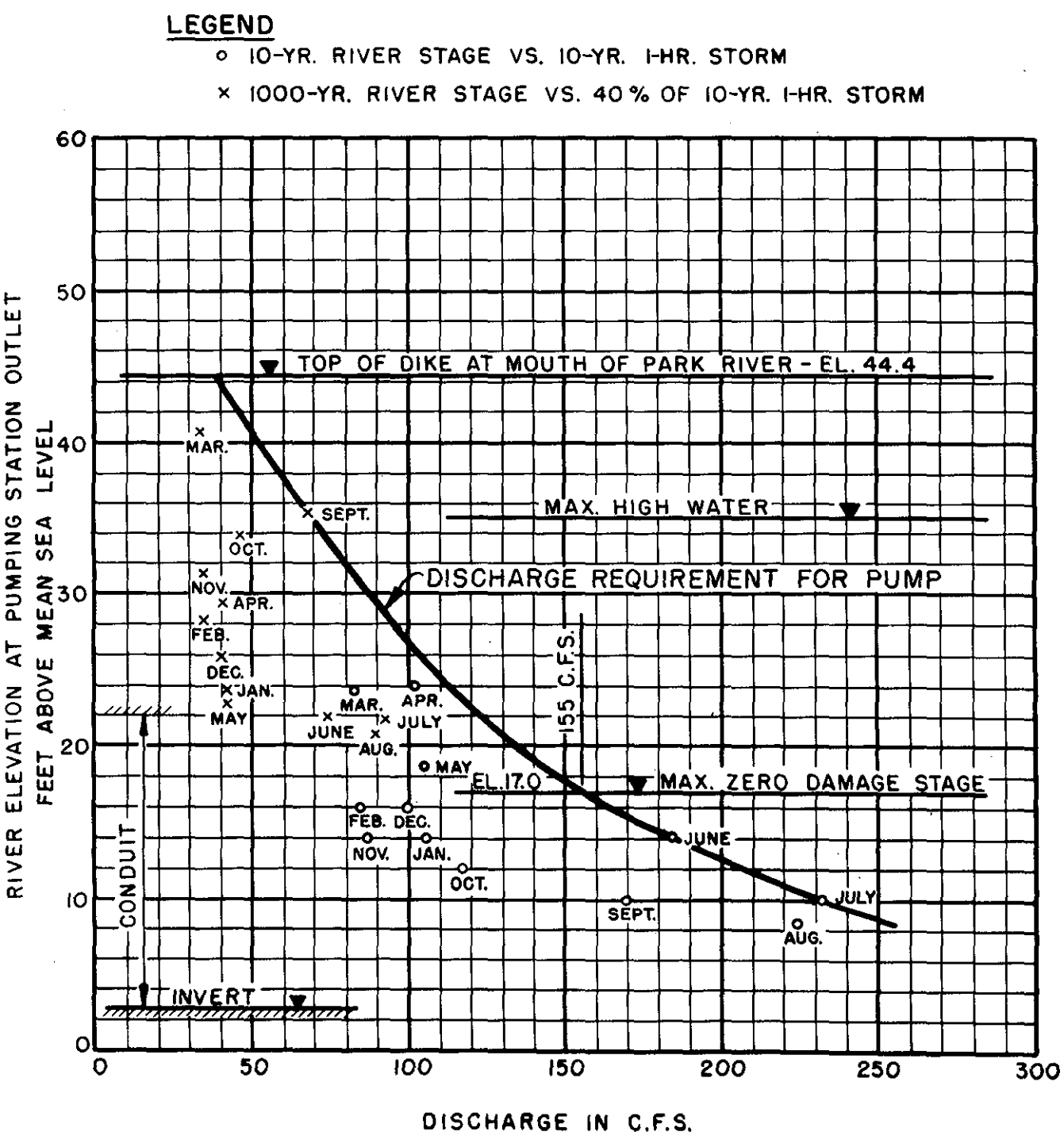


CONNECTICUT RIVER

STAGE — DURATION CURVE

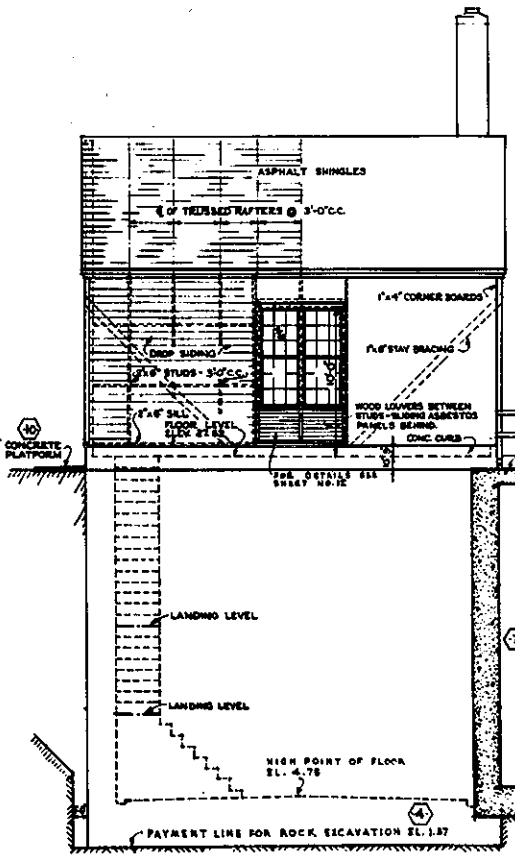
AT

HARTFORD, CONN.



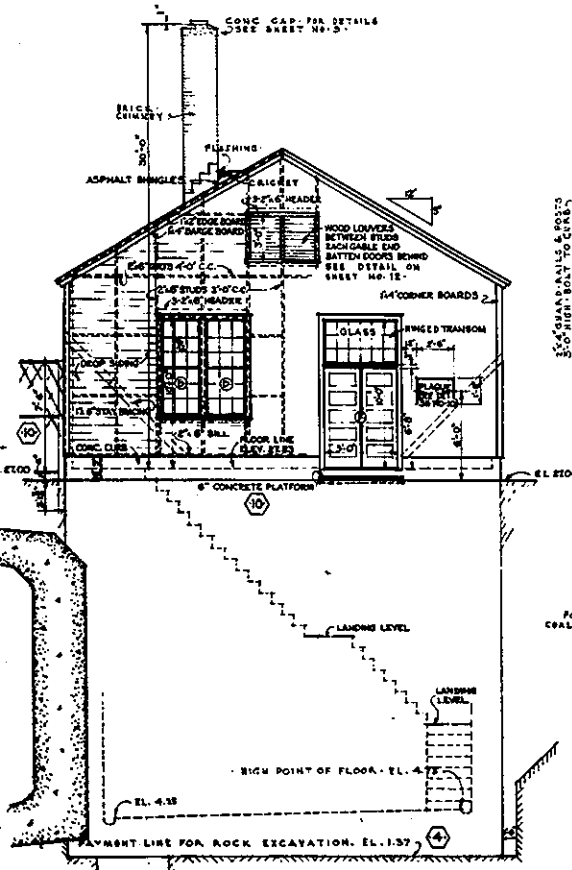
REQUIRED PUMP CAPACITY

BUSHNELL PARK PUMPING STATION



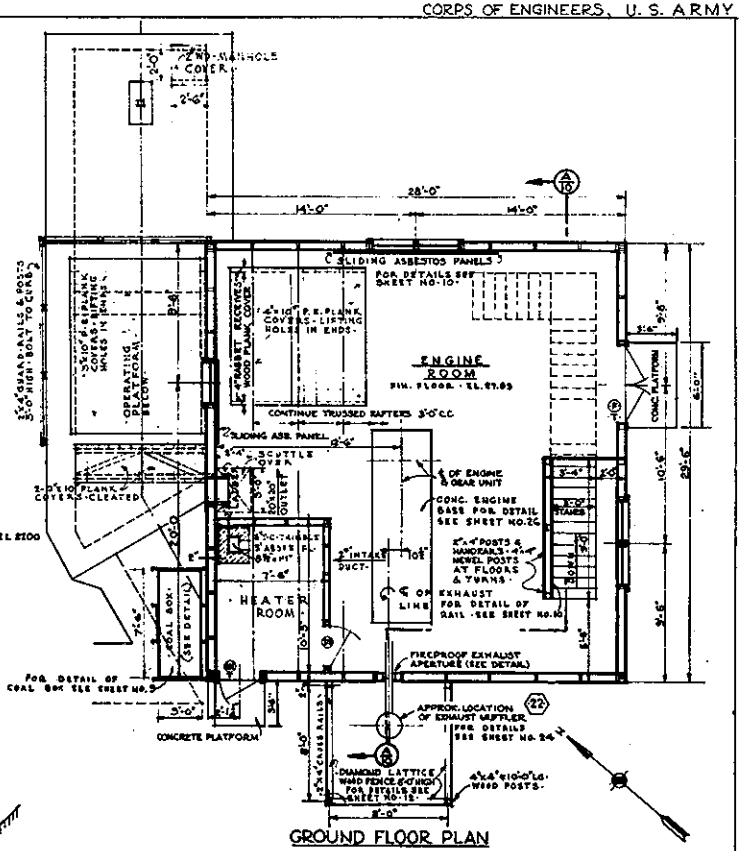
NORTH ELEVATION

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



EAST ELEVATION

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



GROUND FLOOR PLAN

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

NOTES:

BRICK DIMENSIONS ARE BASED ON STANDARD BRICK 2 5/8" x 3 5/8" x 8" WITH 3/8" JOINTS.

FOR ELECTRIC CIRCUITS AND FIXTURES SEE SH. NO. 17

ALL ITEMS ABOVE TOP OF CONCRETE CURB WILL BE PAID FOR UNDER ITEM NO. 10 EXCEPT AS NOTED BY NUMBERS IN HEXAGONS.

KEY	DATE	REVISION (Indicated by △)	REV. BY	CK. BY	AR BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

PLAN AND ELEVATIONS

ARCHITECTURAL

PARK RIVER — CONNECTICUT

IN 17 SHEETS — SCALE 1/4" IN. = 1 FT. — SHEET NO. 6

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. AUG. 1943

SUBMITTED: [illegible] — APPROVED RECOMMENDED: [illegible] — APPROVED: [illegible]

CHIEF, DESIGN SECTION — CHIEF, CONST. & PLANTING DIV. — CHIEF, ENGINEERING DIVISION — DISTRICT ENGINEER

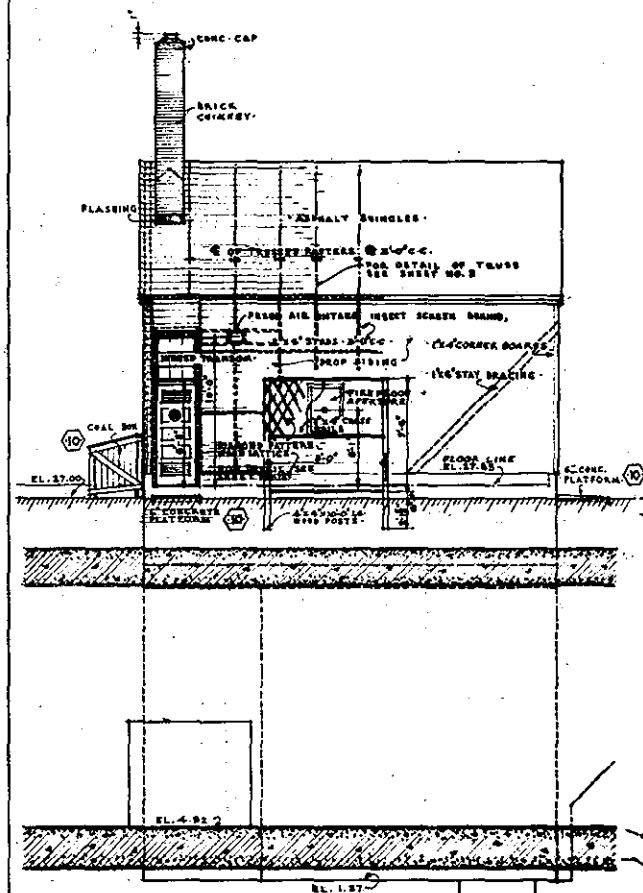
DESIGN SECTION — DESIGNED: R.R.E. — DRAWN: — CHECKED: — CHECKED: [illegible]

BY DIRECTION OF THE SECRETARY OF WAR

FILE NO. CT-4-3163

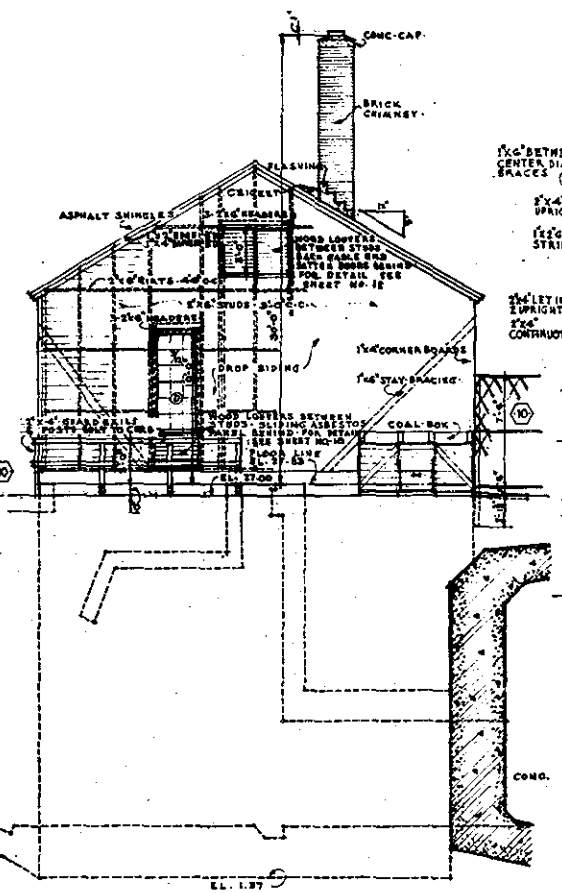
H.T. 6b

PLATE NO. 13



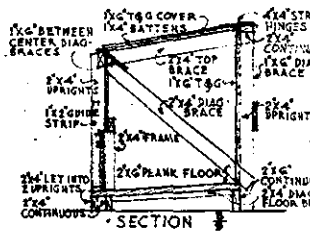
· SOUTH ELEVATION ·

· SCALE · 1/4" = 1'-0" ·

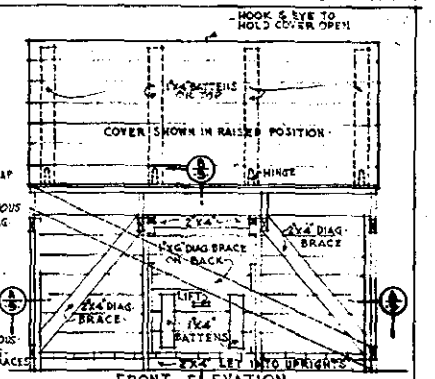


WEST ELEVATION

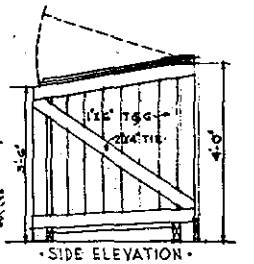
· SCALE · 1/4" = 1'-0" ·



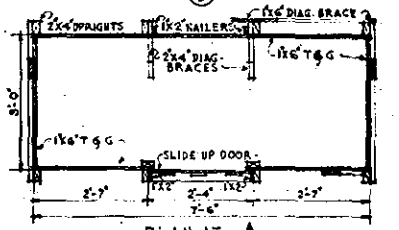
· SECTION



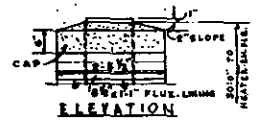
· FRONT ELEVATION ·



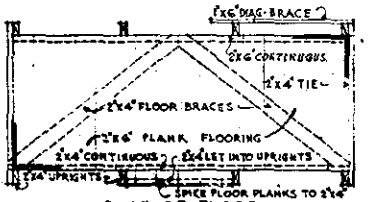
· SIDE ELEVATION ·



· PLAN AT



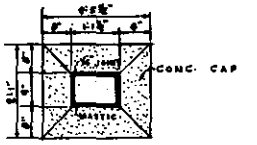
ELEVATION



· PLAN OF FLOOR ·

· COAL BOX DETAILS ·

· SCALE · 3/4" = 1'-0" ·



PLAN

DETAIL · OF · CHIMNEY TOP

· SCALE: 1/4" = 1'-0"

NOTE: FOR GENERAL NOTES APPLYING TO THIS SHEET SEE SHEET NO. 6

KEY	DATE	REVISION (Indicated by △)	REV-BY	CK-BY	AP-BY

· CONNECTICUT RIVER FLOOD CONTROL ·

BUSHNELL PARK PUMPING STATION

HARTFORD-CONN.

· ELEVATIONS AND DETAILS ·

· ARCHITECTURAL ·

PARK RIVER CONNECTICUT

NO. 2 SHEETS · SCALE · 1/4 IN = 1 FT. SHEET NO. 5

U. S. ENGINEER OFFICE · PROVIDENCE · R.I. AUG · 1945

SUBMITTED: APPROVED: RECOMMENDED: APPROVAL:

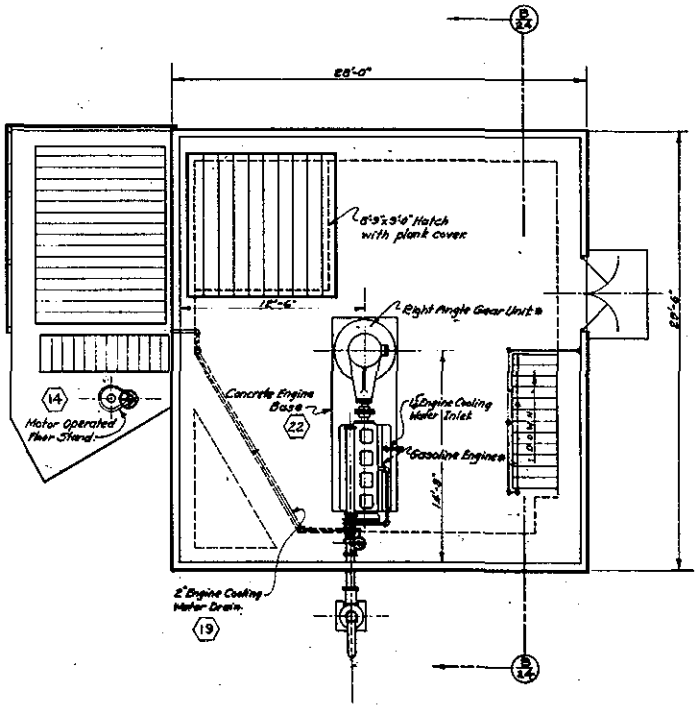
DRAWN: TRACED: CHECKED: FILE NO. CT-4-5183

PLATE NO. 14

H-66

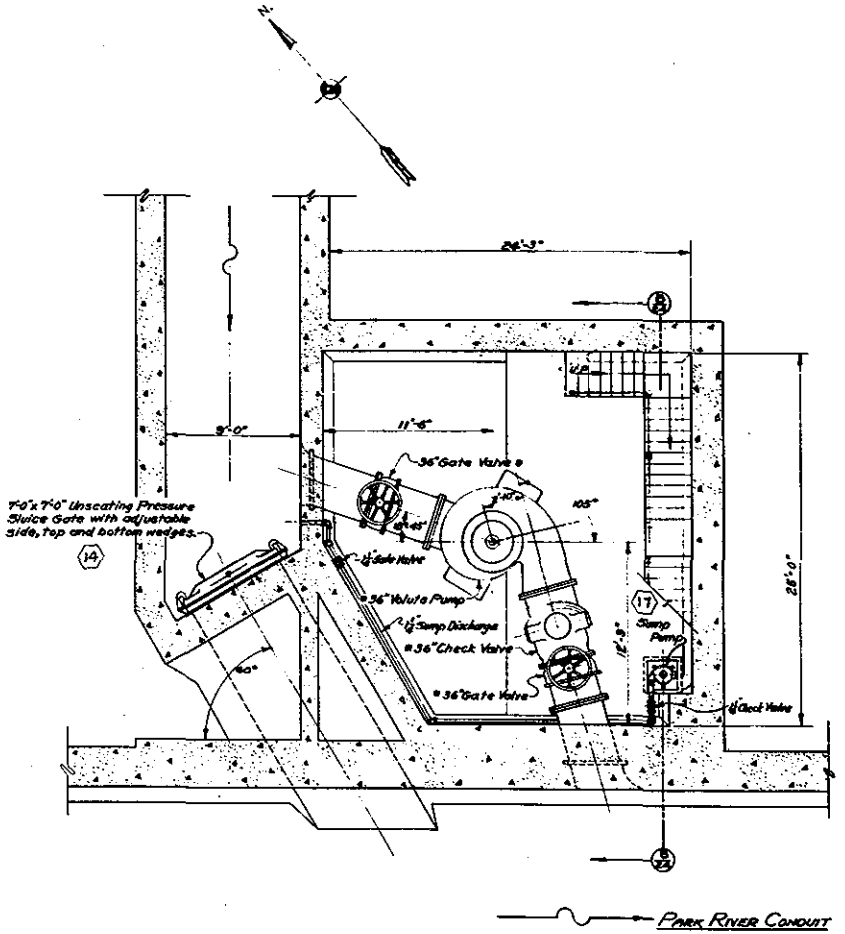
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY.



ENGINE ROOM-PLAN

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



PUMP ROOM PLAN

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

NOTE:

* Indicates equipment to be taken from North Meadows Pumping Station.

Removing from present location and installing pump, valves, engine and cylinder will be paid for under Item No. 2.2.

KEY	DATE	REVISION (Indicated by △)	DR. BY	CK. BY	AR. BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

EQUIPMENT

GENERAL ARRANGEMENT NO. 1

PARK RIVER CONNECTICUT

SHEET 23 OF 27 SHEETS — SCALE 1/4"=1'-0"

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. AUG. 1945

SUBMITTED: J. Hussey, SURVEYOR, NORTH ATLANTIC DIVISION, CORPS OF ENGINEERS

APPROVED: RECOMMENDED: Frank W. Barbour, PRINCIPAL ENGINEER, NORTH ATLANTIC DIVISION, CORPS OF ENGINEERS

APPROVED: Frank W. Barbour, LOCAL CORPS OF ENGINEERS DISTRICT ENGINEER

DESIGN BY: J.R.D.

TRACED BY:

CHECKED BY:

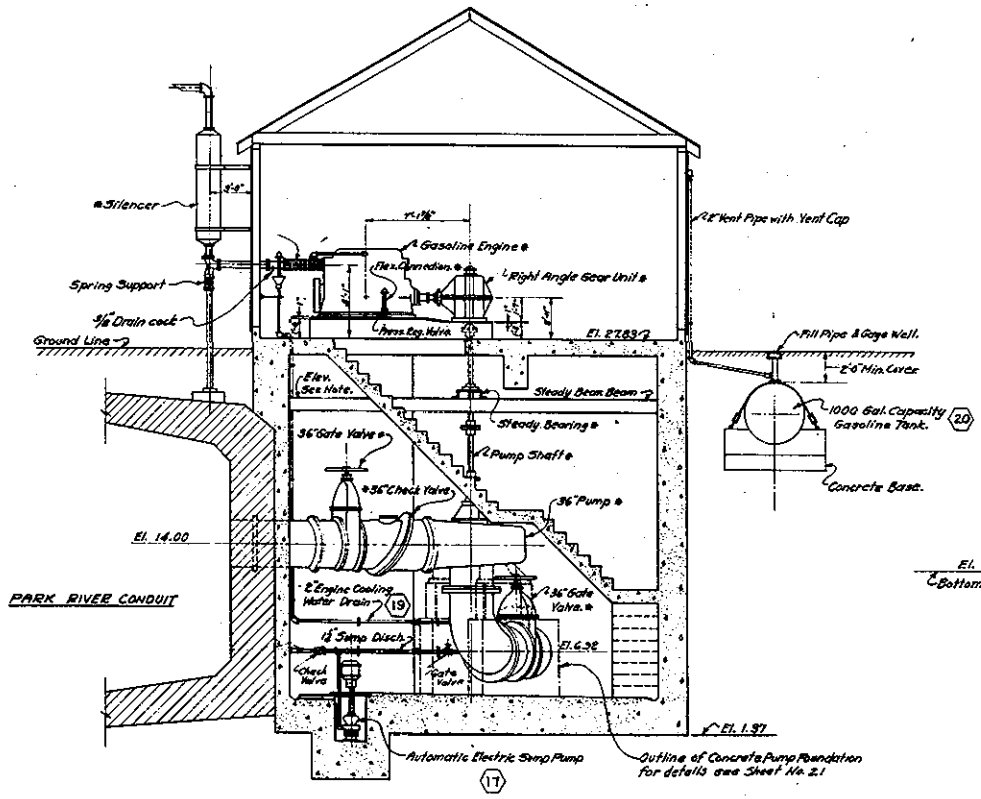
FILE NO. CT-4-3177

H1.6b

PLATE NO. 15

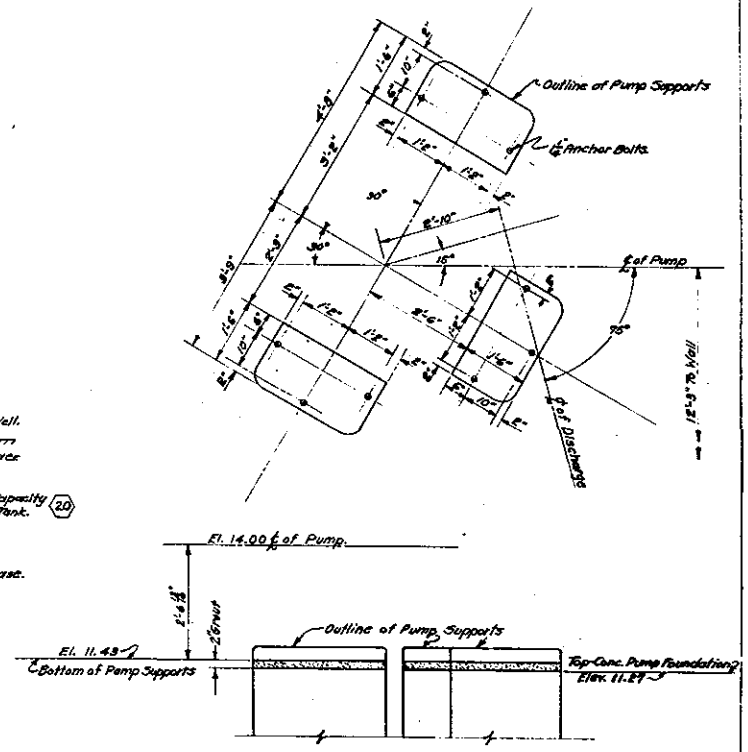
WAR DEPARTMENT

CORPS OF ENGINEERS, U.S. ARMY.



SECTION B/B

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



LAYOUT & ELEVATION OF PUMP SUPPORTS

SCALE: 3/16"=1'-0"

NOTES:

Elevation of steady beam to suit conditions of installation.

* Indicates equipment to be taken from North Meadows Pumping Station.

KEY	DATE	REVISION (Indicated by △)	DR. BY	CK. BY	AP. BY

CONNECTICUT RIVER FLOOD CONTROL

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

EQUIPMENT

GENERAL ARRANGEMENT NO. 2

PARK RIVER CONNECTICUT

IN 27 SHEETS SCALE: 3/16"=1'-0" SHEET NO. 24

U.S. ENGINEER OFFICE, PROVIDENCE, R.I. AUG. 1943

SUBMITTED: H. L. Nelson CHIEF, DESIGN SECTION

APPROVAL RECOMMENDED: F. J. Burns PRINCIPAL ENGINEER CHIEF, DESIGN BRANCH

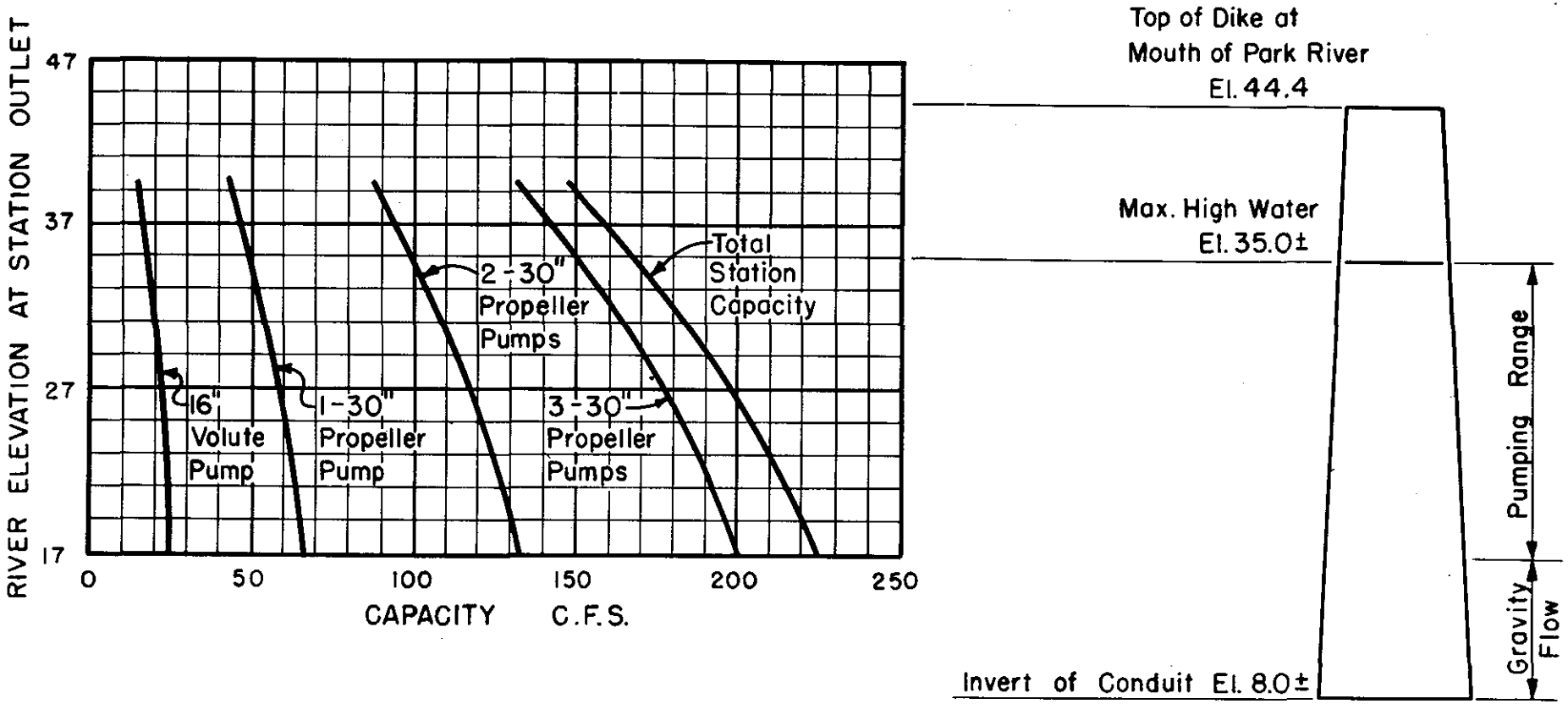
APPROVED: W. A. Prudhomme LT. COL. CORPS OF ENGINEERS DISTRICT ENGINEER

DESIGN SECTION: DRAWN BY: JDV TRACED BY: CHECKED BY:

FILE NO. CT-4-3178

PLATE NO. 16

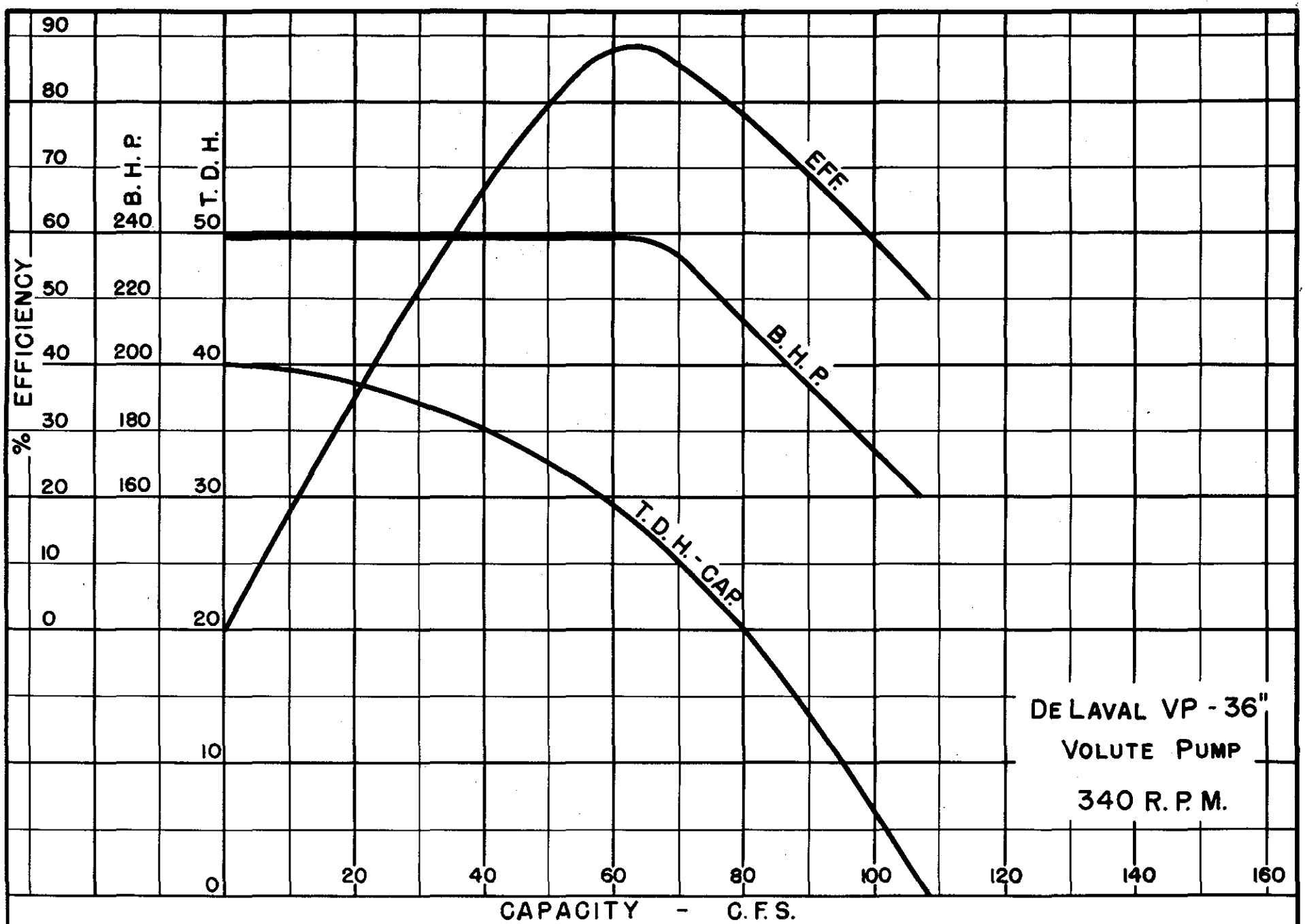
Ht. 6b



PROPOSED PUMP CAPACITY

BUSHNELL PARK PUMPING STATION

Ht. 6b PLATE NO. 17



KEENEY LANE AND BUSHNELL PARK PUMPING STATIONS

Ht. 6b PLATE NO. 18

BUSHNELL PARK PUMPING STATION

HARTFORD, CONN.

APPENDIX A

Analysis of Detailed Structural Computations

U. S. Engineer Office

Providence, R. I.

February, 1939

BUSHNELL PARK PUMPING STATION
APPENDIX "A" COMPUTATIONS

	PAGE
ENGINE ROOM FLOOR	1 - 6
ENGINE ROOM FLOOR BEAMS	7 - 16
BASE PRESSURE	17 - 19
SECTION A-A THRU STATION & CONDUIT	20 - 33a
SECTION B-B PERPENDICULAR TO PARK RIVER CONDUIT	34 - 38a
SECTION C-C THRU RACKING CHAMBER	39 - 47
CONCRETE STAIRWAY	48 - 50
END WALL IN RACKING CHAMBER	51
GATE STAND BEAM	52
WOOD COVER PLATES	53
GASOLENE STORAGE TANK SUPPORT	54
STABILITY OF TRASH RACK	55

WAR DEPARTMENT

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

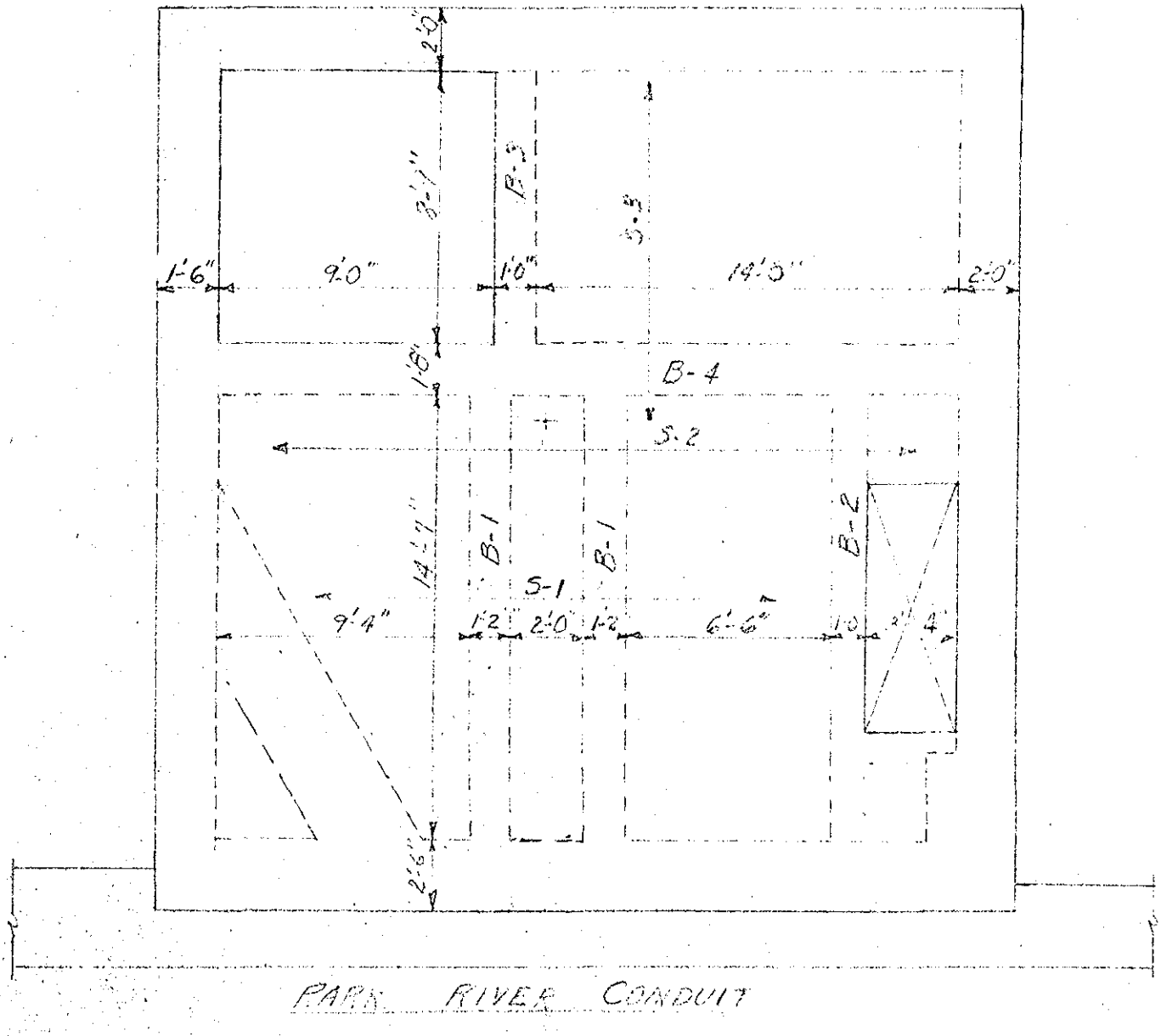
Page 1

Subject: Bushnell Park Pumping Stn.

Computation: Engine Rm. Floor

Computed by: H. [illegible] Checked by: [illegible] Date: [illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528



PARK RIVER CONDUIT

WAR DEPARTMENT

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

Page 2

Subject: Bushnell Park Pumping Station

Computation: Engine Room Floor

Computed by: H. E. W. Checked by: [illegible] Date: 5/31/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

WEIGHTS OF FLOOR EQUIP

Gas. Eng. for 36" pump	=	6000#
Concrete Eng. base	=	10,800#
Gear Unit	=	5,000#

Uniform Live Load for slab design

Assume span = 7'-0" c.c.

Eng wt = $\frac{6000}{6}$ = 1000#/'

Moment = 500 x 3.5 - 500 x $\frac{2.5}{4}$ = 1440'#

$\frac{1}{8} w (7)^2 = 1440$ w = 236 #/□' use 300#/□'

Slab will be designed for L.L. = 300#/□'

For beam design floor load = 200#/□'

Assume Slab thickness = 8" w = 100#/□'

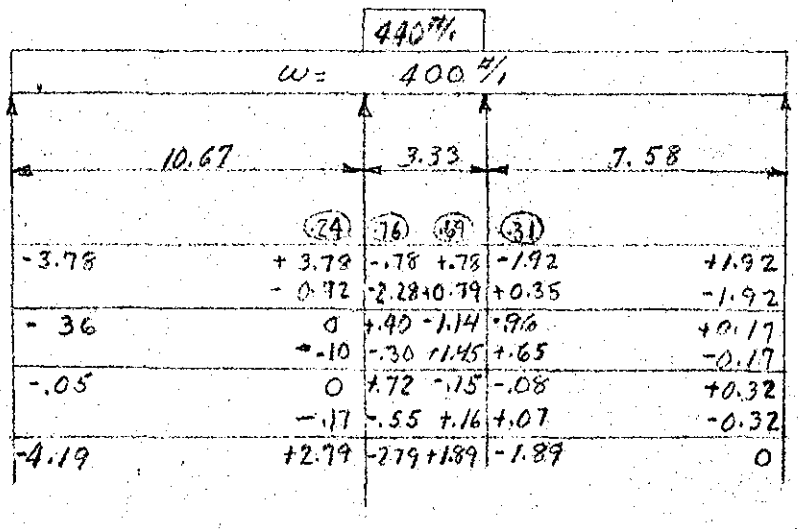
Load at Engine

Engine =	6000#
Impact =	6000#
Conc. base =	5250#
Total =	17250#

Load per □' = $\frac{17250}{7 \times 3.33}$ = 740#/'

Floor slab = 100#/'

840#/'



$\frac{400 \times 10.67^2}{12}$ = 3.78 'K

$\frac{840 \times 3.33^2}{12}$ = .78 'K

$\frac{400 \times 7.58^2}{12}$ = 1.92 'K

WAR DEPARTMENT

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

Page 3

Bushnell Park Pumping Sta.

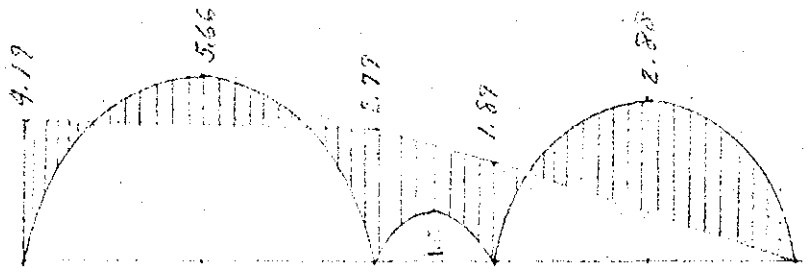
putation Engine Room Floor

puted by ..... Checked by ..... Date 6-1-4[illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Slab 3-1 - (Cont.)

Design values used
f_s = 24000 #/□"
f_c = 800 at center & 900 at supports
n = 12, j = .9



	+ 1.67	0	+ 1.93		+ Mom.
4.19		-2.79	-1.89	0	- Mom.
2.27		2.00 1.67	1.13 1.76	1.27	Shears
2.27		3.67	2.89	1.27	React

Required $d = \sqrt{\frac{4190}{125}} = 5.78''$

Make slab 8" thick for conduits $d = 6.25''$

$A_s = \frac{4,190 \times 12}{24,000 \times .9 \times 6.25} = .37''^{\square''}$ use $\frac{5}{8}''\phi$ @ 10"cc

$A_s = \frac{2,790 \times 12}{24,000 \times .9 \times 6.25} = .25$ use $\frac{5}{8}''\phi$ @ 12"cc

$V = \frac{2,270}{12 \times .9 \times 6.25} = 34$ #/□"

bond $= \frac{10 \times 2270}{12 \times 1.76 \times .9 \times 6.25 \times}$ 173 #/□" OK with special anchorage

WAR DEPARTMENT

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

Page 4

Subject: Bushnell Park Pumping Sta.

Computation: Engine Beam Floor

Computed by: ____ Checked by: ____ Date: 6-1-43

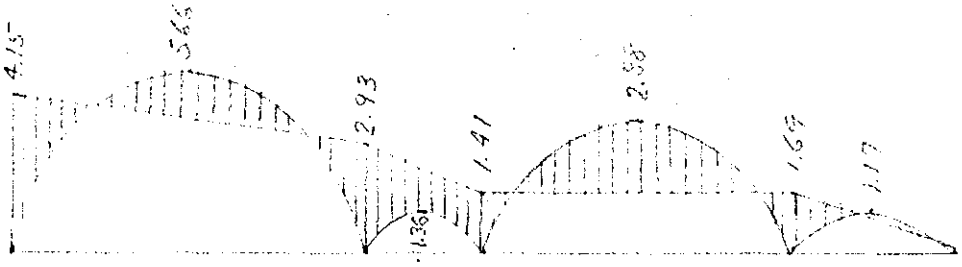
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Slab S-2

Gear Unit = 5000#
Impact = 5000#
Conc. Base = 1800#
Total = 11800
11800 / 3×4 = 9×0# = 1000# / 1035#

685#/'
w = 4.0 #/'

10.67		3.17		7.58		4.83
	(23)	(1)	(30)	(39)	(61)	
-3.78	+3.78	-0.91	+0.91	-1.92	+1.92	-.78	+.78
	-0.66	-2.21	+0.79	+0.30	-.44	-.76	
-0.33	0	1035	-1.10	-0.22	+0.15	0	-0.35
	-0.08	-0.27	+.92	+0.41	-0.06	-0.09	
-0.04	0	+0.36	-0.13	-0.03	+0.01	0	-0.04
	-0.11	+0.35	+0.12	+0.05	-0.09	+0.12	
4.15	+2.93	+1.41	-1.41	+1.69	-1.69	0.39	



+ Mom.		+2.15		0	+1.33		
− Mom.	-4.15		-2.93	-1.41		-1.69	0.39
Shear	2.25		2.02 2.19	1.23 1.48		1.55 1.24	.70
Reaction	2.25		4.21	2.71		2.79	.70

$A_s = \frac{4150 \times 12}{24{,}000 \times .9 \times 6.25} = .37^{\square''}$ use $\frac{5}{8}''\phi$ @ 10" c.c.

$A_s = \frac{2.150 \times 12}{24{,}000 \times .9 \times 6.25} = .19^{\square''}$ use $\frac{5}{8}''\phi$ @ 12" c.c.

$A_s = \frac{2.930 \times 12}{24{,}000 \times .9 \times 6.25} = .26^{\square''}$ use $\frac{5}{8}''\phi$ @ 12" c.c. for bond.

$v = \frac{2250}{12 \times .9 \times 6.25} = 34\ \#/\square''$

bond: $\frac{10 \times 2250}{12 \times 9.42 \times .9 \times 6.25} = 179\ \#/\square''$ use special anchorage

Subject: Bushnell Park Pumping Sta.

Computation: Engine Room Floor

Computed by: H. E. W. Checked by: [illegible] Date: 6-2-42

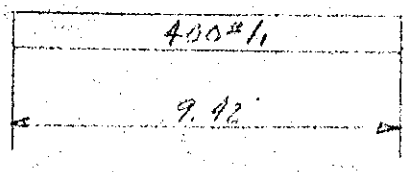
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Slab S-2 (cont.)

$$bond = \frac{2190}{1.964 \times .9 \times 6.25} = 200\ \#/\square''$$

Slab S-3

Moment



$$Max\ M = \frac{1}{12} w l^2 = \frac{1}{12} \times 400 \times 9.42^2$$

$$= 2,950'^{\#}$$

Shear

$$Max = 400 \times \frac{9.42}{2} = 1880^{\#}$$

$$v = \frac{1880}{12 \times .9 \times 5.25} = 33\ \#/\square''\ OK$$

$$A_s = \frac{2950'^{\#}}{24000 \times .9 \times 5.25} = .31''^2 \quad use\ \tfrac{5}{8}''\phi\ @\ 1'-0''\ c.c$$

$$bond = \frac{1880}{1.964 \times .9 \times 5.25} = 202\ \#/\square''\quad use\ special\ anchorage$$

WAR DEPARTMENT

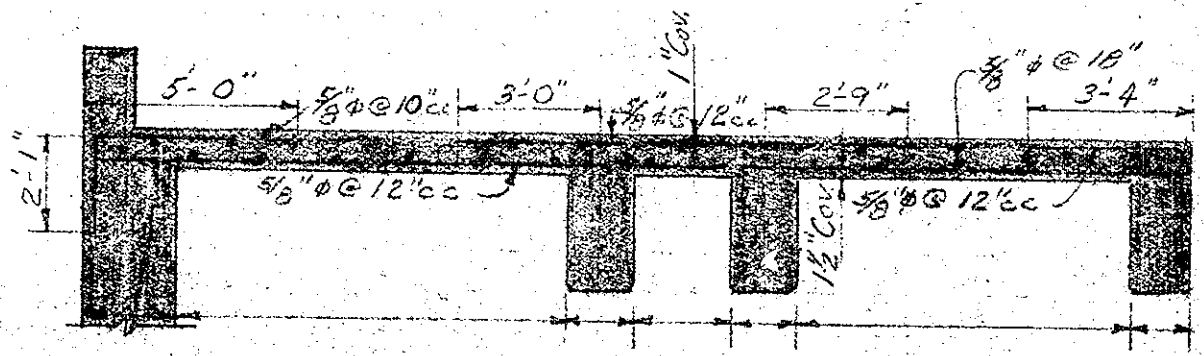
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Sta.

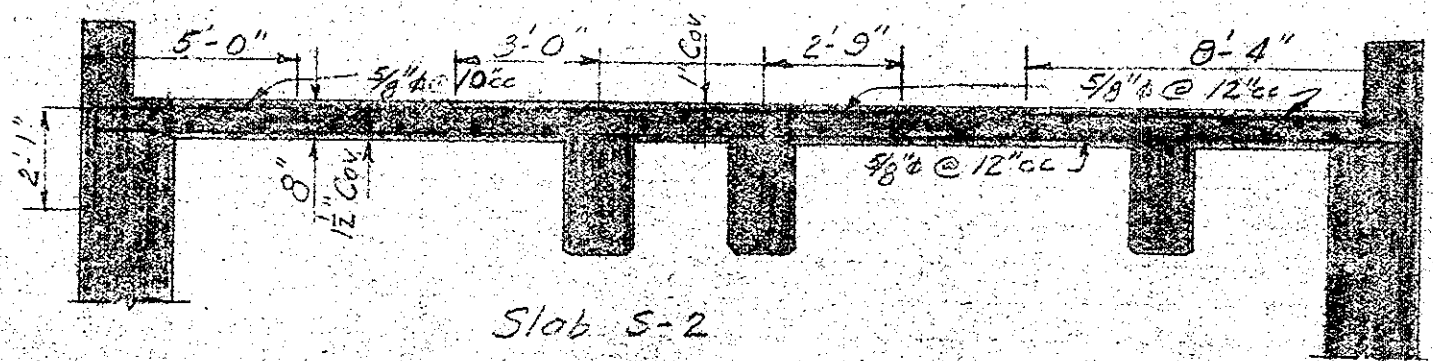
Computation: Engine Room Floor

Computed by: H.E.W. Checked by: WWZ Date: 1-3-43

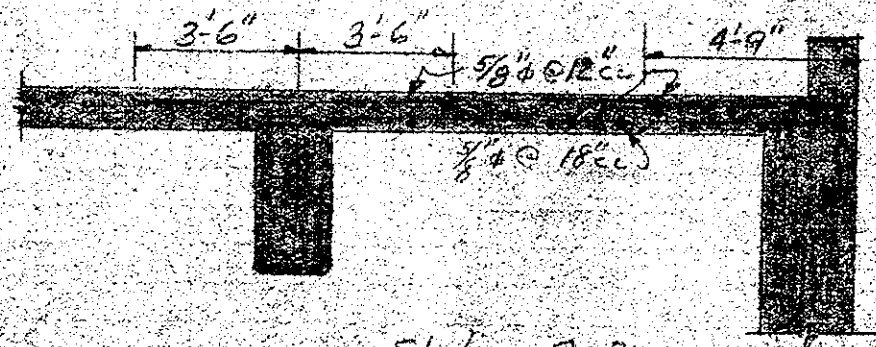
Page 6



Slab S-1



Slab S-2



Slab S-3

U. S. GOVERNMENT PRINTING OFFICE 3—10628

WAR DEPARTMENT

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

Page 7

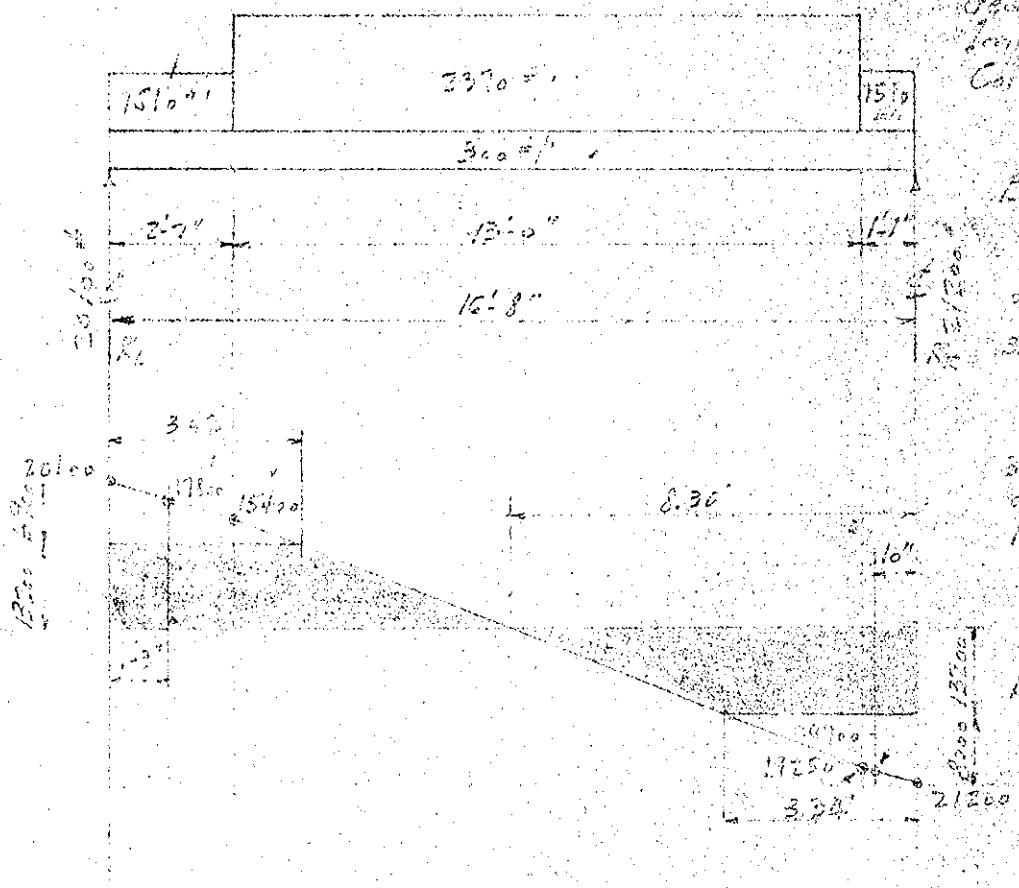
Subject [illegible]

Computation Engine Room Floor Beams

Computed by [illegible] Checked by [illegible] Date [illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Bm. 3V



Bm. 14×20 wgt = 300 #/'

Engine Load	6000 #
Gear Unit	5000
Impact 100%	11000
Conc. Base	10800
Total =	32800 #

Bm. Load =

$\frac{4 \times 32800}{13.0} = 1260$ #/'

Bm. Load =

3.25 × 400 = 4.25 × 300 = 1275 #/'

0.17 × 200 = 235

1510

3.25 × 300 = 975 #/'

0.17 × 200 = 35

1.00 × 400 = 100

1110 #/'

1250

2370 #/'

R_L 1810 × 2.58 × 1.29 = 71750

2670 × 13.00 × 2.58 = 262000

1810 × 1.08 × 0.54 = 1050

335800

$R_L = \frac{335800}{16.67} = 20100$ #

R_R 1810 × 2.58 × 1.29 = 6030

2670 × 13.00 × 9.08 = 315400

1810 × 1.08 × 16.12 = 31500

352530

$R_R = \frac{352530}{16.67} = 21200$ #

WAR DEPARTMENT

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

bject [illegible]

Computation Engine Room Floor Beams

Computed by [illegible] Checked by [illegible] Date [illegible]

U.S. GOVERNMENT PRINTING OFFICE 3—10528

dist. x_0 $21200 - 1810 \times 1.08 - 2670x = 0$ $x_0 = 8.30'$ [illegible]

$x = 7.22'$

$M_0 = 21200 \times 8.30 - 1810 \times 1.08 \times 7.76 - 2670 \times 7.22^2 \times \frac{1}{2}$

$= 176000 - 15200 - 68500 = 91300'$ #

Assuming [illegible] 14 [illegible] $d = 20'' - 2\frac{1}{2}'' = 17.5''$ ✓

$k = \frac{1}{1 + \frac{f_s}{n f_c}} = \frac{1}{1 + \frac{24000}{12 \times 800}} = \frac{1}{3.5} = 0.286$ ✓

$kd = 0.286 \times 17.5 = 5.0''$ ✓ [illegible]

$A_s = \frac{91300 \times 12}{0.9 \times 24000 \times 17.5} = 2.88$ □"

$v = \frac{21200}{0.9 \times 14 \times 17.5} = 96$ #/□" ✓

Try [illegible] 4-1" [illegible]

$\mu = \frac{21200}{0.9 \times (12.57) \times 17.5} = 108$ #/□" ✓

Shear [illegible] $= 0.905 \times 60 \times 14 \times 17.5 = 13200$ #

At left [illegible] =

$\frac{1}{2}(8640 + 2230) \times 16 = 55000$

$\frac{1}{2} \times 2230 \times 16 = 11200$

66200 #

No. of $\frac{3}{8}$" Stirrups $= \frac{66200}{2 \times 0.7 \times 24000 \times 0.15 \times 17.5} = 1.8$ say 1

At right end of [illegible] =

$\frac{1}{2}(8640 + 6050) 3 = 18800$

$\frac{1}{2} \times 6050 \times 27 = 81700$

100500

No. of $\frac{3}{8}$" Stirrups $= \frac{100500}{2 \times 0.7 \times 24000 \times 0.15 \times 17.5} = 1.2$ say 2

WAR DEPARTMENT

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

bject Bushnell Park Pumping Sta.

Computation Engine Room Floor Beams

Computed by H. E. W. Checked by WW 2/6 Date 5/31/43

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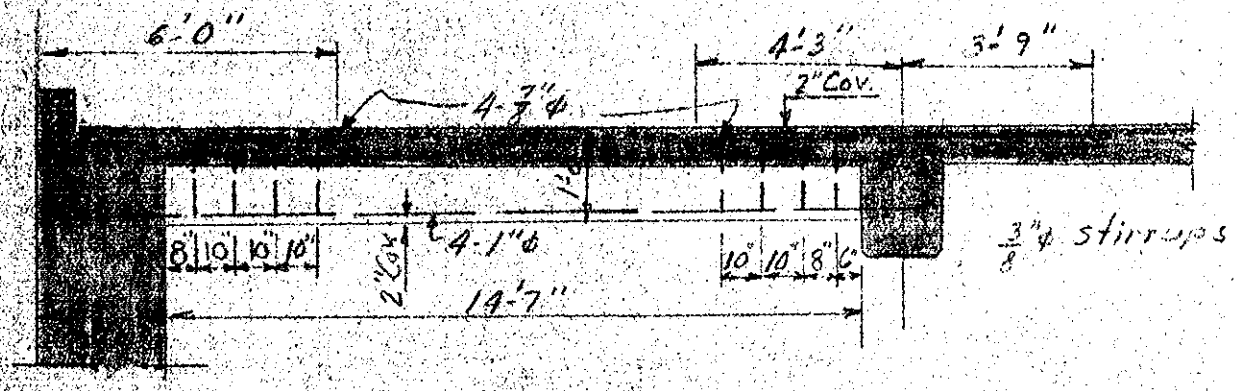

Beam B-1 14" x 20"

WAR DEPARTMENT

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

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Subject: Bushnell Park Pumping Station

Computation: Engine Room Floor Beams

Computed by: H.E.W. Checked by: N.H.S. Date: 6/5/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

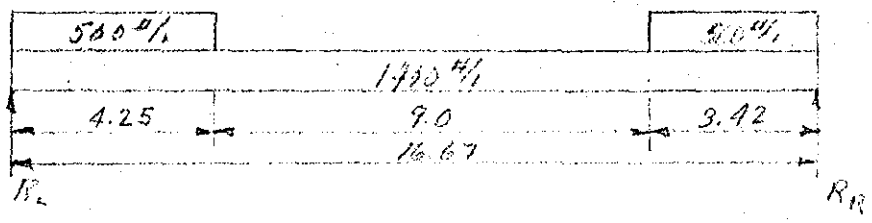
Beam B-2

Try a beam 12" x 18" d = 15.5"

Wt beam = 1 x .83 x 150 = 125 #/'

Fl. Id = 4.25 x 300 = 1275 #/'

Fl. Id = 1.67 x 300 = 501 #/'



$$R_R = 1400 \times 8.33 + \frac{500 \times 4.25 \times 2.12 + 500 \times 3.42 \times 14.96}{16.67} = 13{,}465$$

$$R_L = 1400 \times 8.33 + \frac{500 \times 4.25 \times 14.55 + 500 \times 3.42 \times 1.71}{16.67} = 13{,}690$$

Point 0 shear

$13690 - 500 \times 4.25 - 1400X = 0 \qquad X = 8.26'$

$$\text{Max } M = 13690 \times 8.26 - \frac{1400 \times 8.26^2}{2} - 500 \times 4.25 \times 6.14 = 53{,}000''^{\#}$$

d req'd by shear $= \dfrac{13690}{12 \times .9 \times 120} = 13.55$ make d = 15.5"

Investigation for T beam action

k = 0.286 kd = 0.286 x 15.5 = 4.4" NA in flange design as rect. bm.

$$A_s = \frac{53000 \times 12}{24000 \times .9 \times 15.5} = 1.90'' \quad \text{use } 3\text{-}1''\phi \text{ bars}$$

$$u = \frac{13690}{9.42 \times .9 \times 15.5} = 104 \ \#/\square''$$

Shear taken by conc = .9 x 60 x 12 x 15.5 = 10,000#

Stirrups are req'd

WAR DEPARTMENT

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

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Subject: Bushnell Park Pumping Sta.

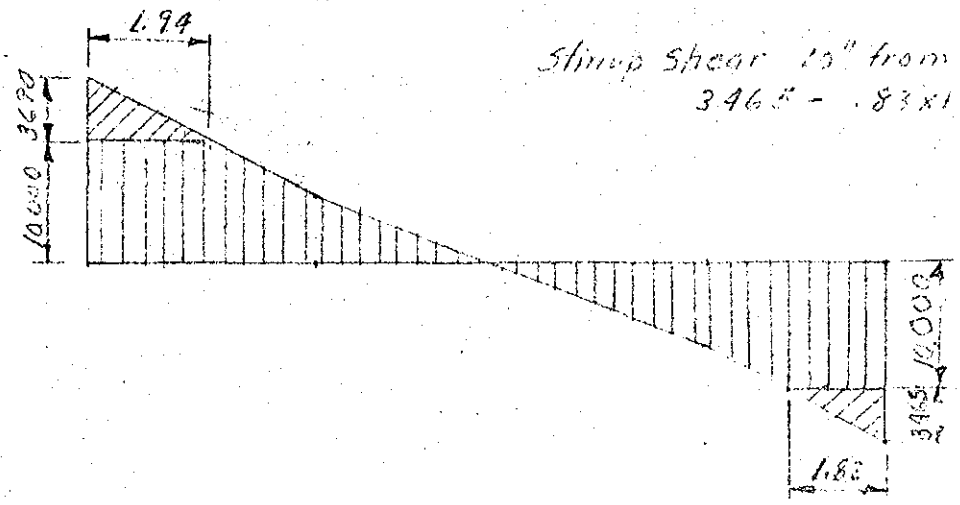
Computation: Engine Room Floor Beams

Computed by: H. E. W. Checked by: W.H.S. Date: 6/7/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Beam Beam B-2

Shear Diagram



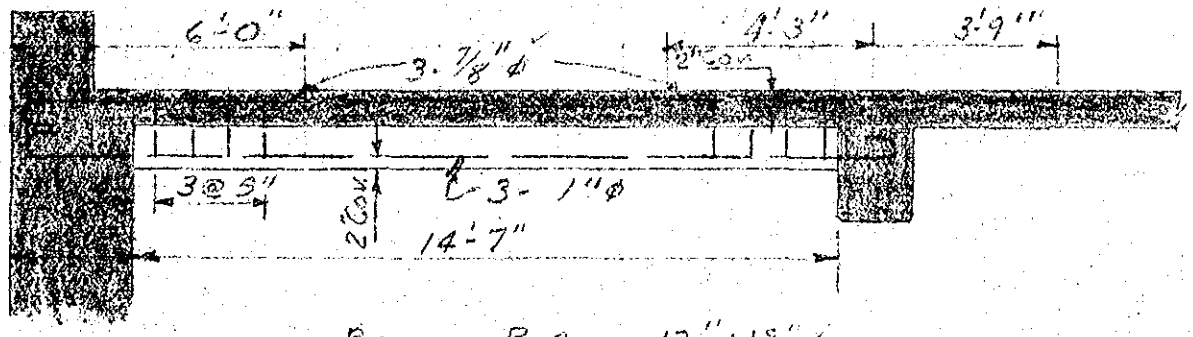
Stirrup Shear 10" from rt. support

3465 - .83 x 1900 = 1885#

Stirrup Spacing

$$\frac{.22 \times 24000 \times .9 \times 15.5}{1885} = 39''$$

Spacing at 4", 9", 9", 9" both sides



Beam B-2 12" x 18"

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Sta.

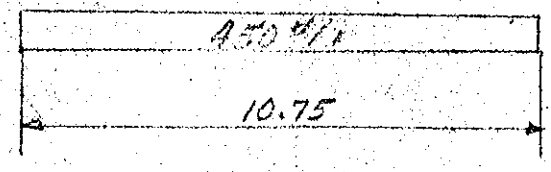
Computation: Engine Room Floor Beams

Computed by: H.E.W. Checked by: [illegible] Date: 6/7/43

U. S. GOVERNMENT PRINTING OFFICE 3—10128

Beam B-3

Assume 2'-0" slab load
Load per ft = 200×2 = 400
bm. = 50
450 #/'



React = $450 \times \frac{10.75}{2} = 2{,}420^{\#}$

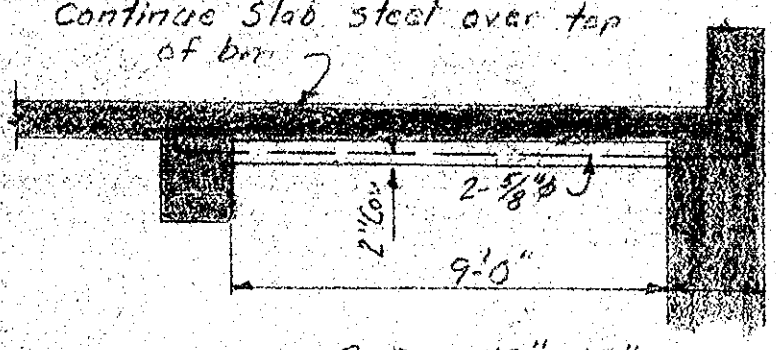
Max M = $\frac{1}{8} \times 450 \times 10.75^2 = 6500'^{\#}$

$d = \sqrt{\frac{6500}{103}} = 7.9''$ use 9.75"

$A_s = \frac{6500 \times 12}{24000 \times .9 \times 9.75} = .37^{\square''}$ use 2-5/8"⌀ bars

$v = \frac{2420}{12 \times 9.75 \times .9} = 23\ ^{\#}/\square''$

$u = \frac{2420}{3.93 \cdot 9 \times 9.75} = 70\ ^{\#}/\square''$



B-3 12"×12"

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Station

Computation: Engine Room Floor Beams

Computed by: H.E.W. Checked by: [illegible] Date: 6-7-43

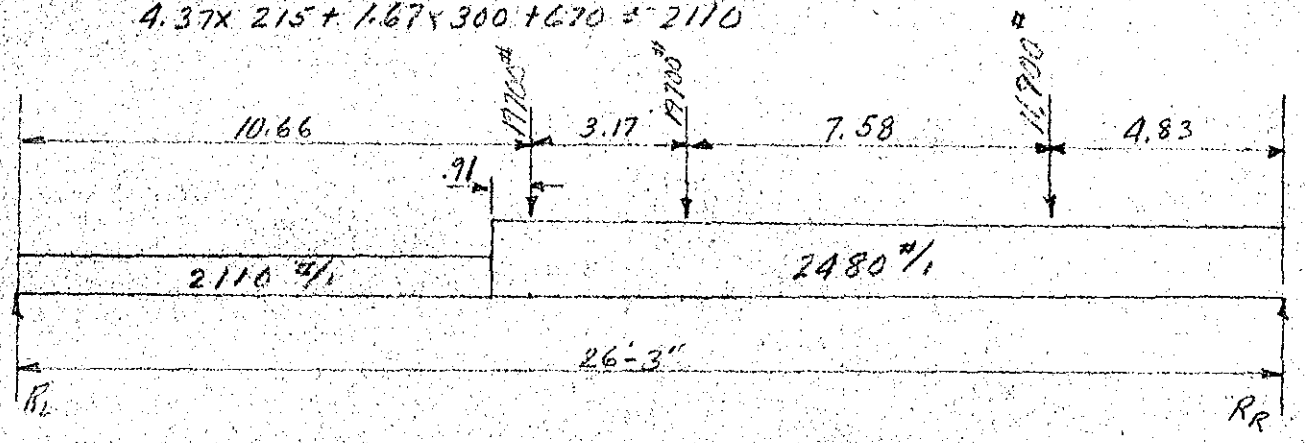
U. S. GOVERNMENT PRINTING OFFICE 3—10328

Beam B-4

Assume Beam 20"x40" wt = 1.67 x 2.67 x 150 = 670 #/'

(4.37 + 1.67) 300 + 670 = 2470 #/'

4.37 x 215 + 1.67 x 300 + 670 = 2110



React from B-1 = 21,200 - 1810 x .83 = 19,700#

" " B-2 = 13,465 - 1900 x .83 = 11,885#

$$R_L = \frac{2110 \times 9.75 \times 21.37 + 2480 \times 16.5 \times 8.25 + 19{,}700 \times 15.58 + 19{,}700 \times 12.41 + 11{,}900 \times 4.83}{26.25}$$

R_L = 52,800#

$$R_R = \frac{2110 \times 9.75 \times 4.88 + 2480 \times 16.5 \times 18. + 19700 \times 10.66 + 19{,}700 \times 13.83 + 11{,}900 \times 21.42}{26.25}$$

R_R = 60,000#

Point of Shear = 12.41 from R_R.

$$\text{Max. Mom.} = 60{,}000 \times 12.41 - 11{,}900 \times 7.58 - \frac{2480 \times 12.41^2}{2} = 469{,}000'^{\#}$$

T-Beam Design

$k = 0.286$ $kd = 36.5 \times 0.286 = 10.5$ $\frac{t}{d} = \frac{8}{36.5} = .219$

$b = \frac{1}{12} \times 26.25 \times 12 + 20 = 46''$

$$K = 800 \times .213 \left(\frac{.572 - .213}{.572}\right)\left[1 - .213\left(\frac{.858 - .426}{1.716 - .639}\right)\right] = 106$$

req'd $d = \sqrt{\frac{469{,}000 \times 12}{106 \times 46}} = 33.7''$ use $d = 36.5''$ (two layer of steel)

$v = \frac{60{,}000}{.9 \times 20 \times 36.5} = 91.5$ #/□"

WAR DEPARTMENT

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

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ubject Bushnell Park Pumping Station

omputation Engine Room Floor Beams

omputed by H.E.W. Checked by W.H.Z. Date 6-7-43

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Beam B-4 cont.

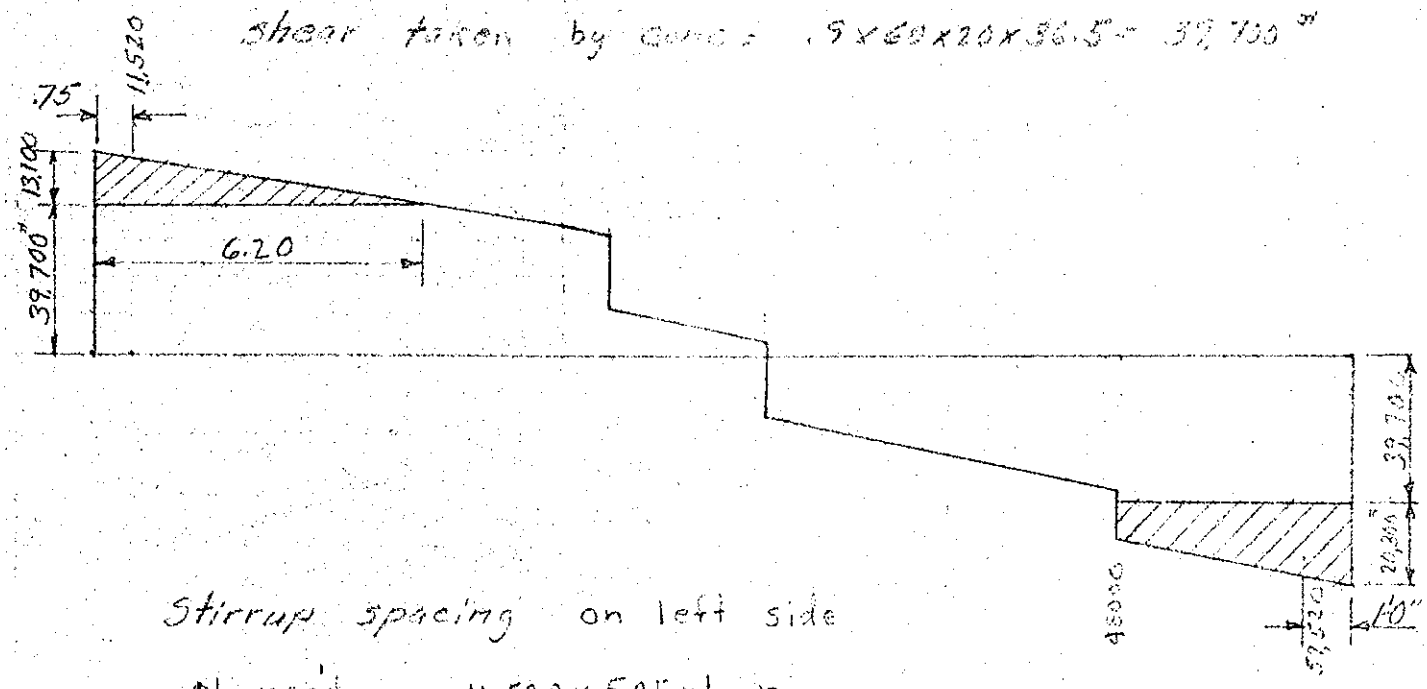
$$p = \frac{800}{24{,}000} \cdot .213 \left(\frac{.572 - .213}{.572}\right) = .00445$$

$$A_s = .00445 \times 46 \times 36.5 = 7.50 \text{ □''} \quad \text{use } 8 \cdot 1\text{''□ bars}$$

$$u_o = \frac{60{,}000}{16 \times .9 \times 36.5} = 114 \text{ □/□''}$$

Shear Diagram

shear taken by conc = .9 × 60 × 20 × 36.5 = 39,700 #



Stirrup spacing on left side

$$\text{No reqd} = \frac{11{,}520 \times 5.45 \times \frac{1}{2} \times 12}{.22 \times 24000 \times .9 \times 36.5} = 2.2$$

Spacing 7", 17", 20", 20"

Stirrup Spacing on right side

$$\text{No reqd} = \frac{(8300 \times 3.83 + 9{,}520 \times 3.83 \times \frac{1}{2})12}{.22 \times 24000 \times .9 \times 36.5} = 3.4$$

Spacing 5", 10", 12, 18", 20"

WAR DEPARTMENT

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

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Subject: Pushnell Park Pumping Sta.

Computation: Engine Room Floor Beams

Computed by: M.K.W. Checked by: W.H.J. Date: 6/8/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Points of bending

$$4.00 = \frac{\left(52{,}800X - \frac{2110X^2}{2}\right) \div 2}{\cancel{24000}\ 2000 \times .9 \times 36.5}$$

$$1055X^2 + 52{,}800X = 4 \times 2000 \times .9 \times 36.5$$

$$X^2 - 50X + 256 = 0$$

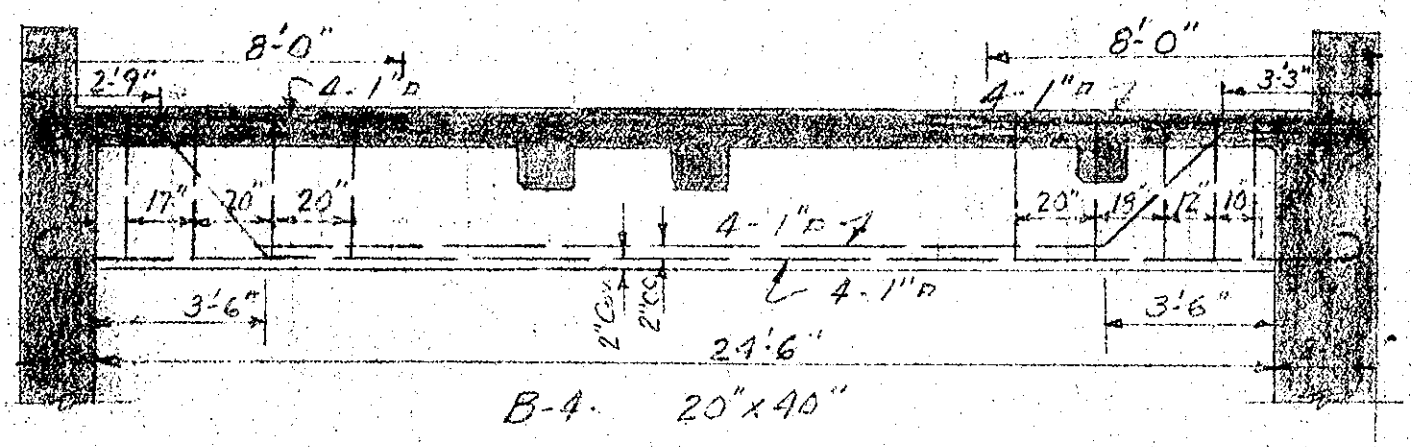
$$X = \frac{50 \pm \sqrt{50^2 - 4 \times 256}}{2} = 5.8'$$

$$4.00 = \frac{\left(60{,}000X - \frac{2480X^2}{2}\right) \div 2}{\cancel{24000}\ 2000 \times .9 \times 36.5}$$

$$1240X^2 - 60{,}000X = -25250$$

$$X^2 - 48.3X + 203 = 0$$

$$X = \frac{48.3 \pm \sqrt{2330 - 812}}{2} = 4.6'$$



B-4. 20"x40"

WAR DEPARTMENT

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

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ect Bushnell Park Pumping Sta.

omputation Engine Room Floor Beams

omputed by [illegible] Checked by [illegible] Date 6-26-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Removable Beam in hatchway

Loading = LL 200 #/□' ; 2½" Plank 10 #/□' } 210 #/□' × 8.75 × ½ = 920 #/'

$M = f \times 920 \times 10^2 = 11500$ '#

$S = \frac{11500 \times 12}{1200} = 115$ in³

Bm 8" × 12" { $f_s = 830$ #/□" ; $S = 165.3$

Use 4" Plank to span 8'-1" hatchway in place of beam

Load = 200 × 5 = 710 #/□'

$M = f \times 715 \times 10.0^2 = 2680$ '#

$S = \frac{2680 \times 12}{1200} = 26.8$ in³

S for 4" Plank = 24.6

$f = \frac{26.8}{24.6} \times 1200 = 1250$ #/□" ok

Use 4" Plank

WAR DEPARTMENT

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

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Subject Bushnell Park Pumping Sta.

Computation Engine Room Floor Beams

Computed by W. W. Z. Checked by [illegible] Date 6-26-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Removable Bm. in Hatchway

Loading = L.L. 200 #/□' ; 2½" Plank 10 #/□' } 210 #/□' × 8.75 × ½ = 920 #/'

$M = f \times 920 \times \overline{10}^2 = 11500$ '#

$S = \frac{11500 \times 12}{1200} = 115$ ins³

Bm 8" × 12" { $f_s = 830$ #/□" ; $S = 165.3$

Using 4" Plank to span 8'-9" hatchway in place of beam

Load = 200 + 15 = 215 #/□'

$M = f \times 215 \times \overline{10.0}^2 = 2680$ '#

$S = \frac{2680 \times 12}{1200} = 26.8$ ins³

S for 4" Plank = 25.6

$f = \frac{26.8}{25.6} \times 1200 = 1250$ #/□" ok

Use 4" Plank

WAR DEPARTMENT

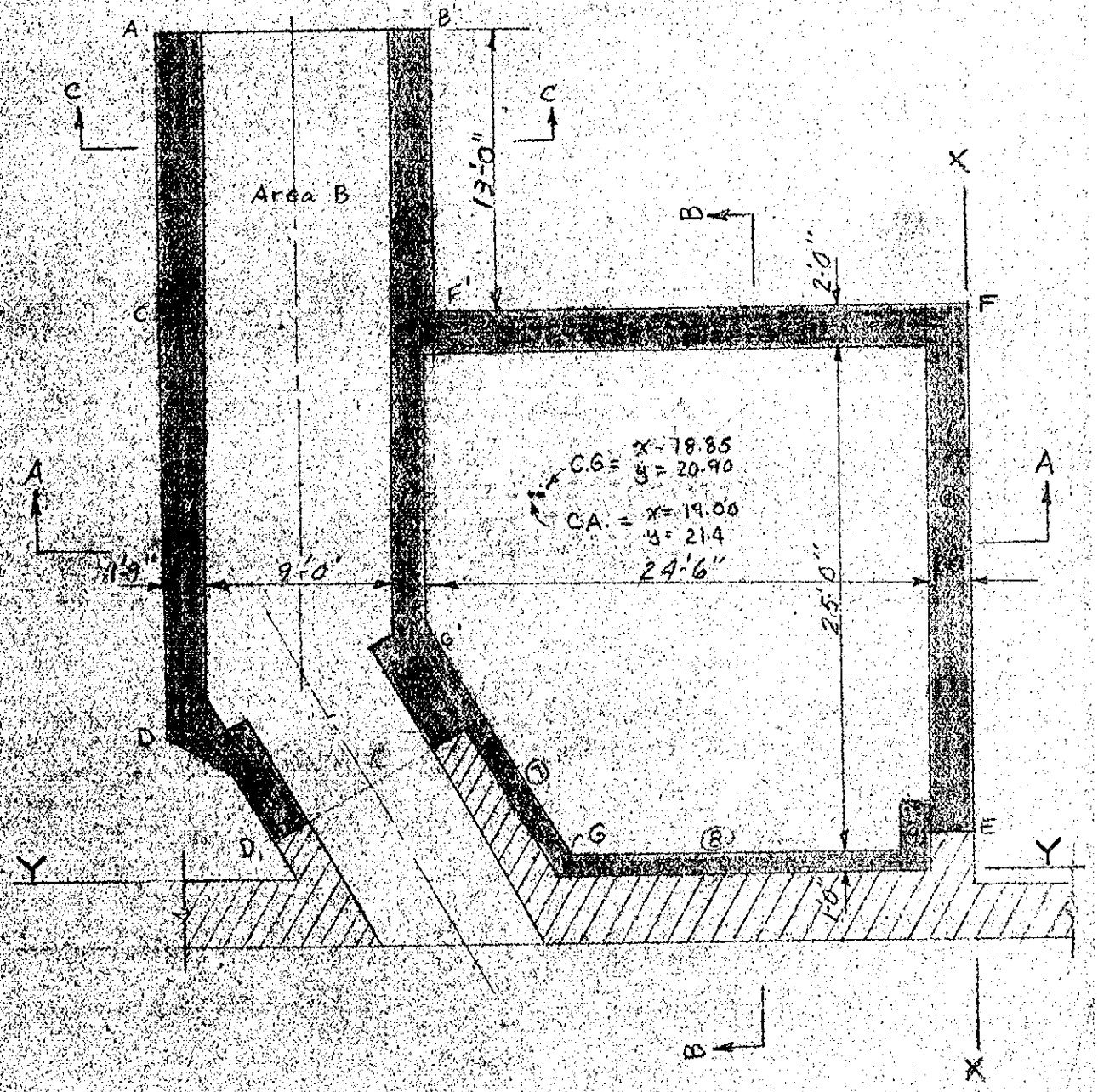
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

Subject: Bushnell Park Pumping Station

Computation: Base Pressure

Computed by: H.E.W. Checked by: W.H.P. Date: 6/10/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528



WAR DEPARTMENT

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

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Subject: Bushnell Park Pumping Station

Computation: Base Pressure

Computed by: H. E. W. Checked by: [illegible] Date: 6/26/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Description	Dimensions + Unit. Wt.		Weight	Arm Y		Moment X-Axis	Arm X		Moment Y Axis
Fl. Slab	25.0 x 24.5 x .67 x 150	+	61.5	14.25	+	875	13.5	+	830
" "	8.75 x 9 x .85	-	6.7	21.25	-	142	21.6	-	144
" "	5.5 x 10 x .67 x 150	-	5.5	24.2	-	134	4.3	-	24
" "	3.3 x 9 x .67 x 150	-	3.0	3.67	-	11	8.75	-	26
Beam B-1	14.6 x 1.17 x 1 x 150	+	2.6	13.42	+	35	8.3	+	22
" "	14.6 x 1.17 x 1 x 150	+	2.6	16.5	+	43	8.3	+	22
Beam B-2	1 x .83 x 14.6 x 150	+	1.8	5.83	+	11	8.3	+	15
Beam B-3	1 x .33 x 8.75 x 150	+	0.4	17.0	+	7	21.6	+	9
Beam B-4	2.67 x 1.67 x 24.5 x 150	+	16.4	14.25	+	233	16.4	+	268
Stairs	14 x 3.33 x .67 x 150	+	4.7	8.5	+	40	24.4	+	115
"	28 x 3.33 x .67 x 150	+	9.3	1.6	+	15	14.5	+	135
Wall FE	2 x 28 x 26.33 x 150	+	223	1.0	+	223	14.0	+	3120
Wall FF'	2 x 26 x 26.33 x 150	+	205	15.0	+	3080	27.0	+	5540
Wall EG	1 x 18 x 26.33 x 150	+	71.2	11.0	+	784	0.5	+	36
Wall FG'	1.5 x 14 x 26.33 x 150	+	83	27.25	+	2260	19.0	+	1580
Wall G'G	13 x 1 x 26.33 x 150	+	51.2	23.5	+	1200	6.0	+	307
" G'G	6 x 2 x 26.33 x 150	+	47.4	27.5	+	1300	9.0	+	427
Wall F'B	13 x 1.75 x 24 x 150	+	82.0	27.1	+	2215	34.5	+	2830
Wall AD	35 x 1.75 x 24 x 150	+	220	37.83	+	8320	24.5	+	5400
Wall AB	9 x 1.5 x 15 x 150	+	30.9	32.5	+	990	40.25	+	1225
Wall DG	9 x 1.5 x 13 x 150	+	26.2	31.0	+	813	9.0	+	235
Wall DD'	2 x 11 x 6 x 150	+	19.9	35.0	+	695	5.0	+	99
Rak. Pl.	6 x 1 x 9 x 150	+	8.1	32.5	+	264	21.5	+	175
" "	9 x 1.5 x 10.5 x 150	+	21.3	32.5	+	692	15.0	+	320
Cond. Rf.	9 x 1 x 13 x 150	+	17.5	32.5	+	572	34.5	+	606
" "	4 x 7 x 2 x 150	+	4.2	30.3	+	128	6.5	+	27
Wt. Eac	4 x 11 x 13.0 x 100	+	58.7	30.3	+	1780	6.5	+	381
Build Wall	150 x 26	+	3.9	.3	+	1	15.0	+	59
" "	150 x 28	+	4.2	14.0	+	59	28.0	+	108
" "	150 x 22	+	3.3	28.0	+	92	17.0	+	48
Gear Unit		+	5.0	15.0	+	75	13.25		66
Gas. Eng		+	6.0	15.0	+	90	6.25		38
Eng. Base		+	10.8	15.0	+	162	7.75		83
Sl. Gate		+	10.4	33.0	+	343	11.0	+	114
S.G. Stand		+	1.5	33.0	+	50	11.0	+	17
Trash Rack		+	2.0	33.0	+	66	24.0	+	48
			1300.3			27,226			24,499

$Y = \frac{27,226}{1300} = 20.9$ $X = \frac{24,500}{1300} = 18.85$

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Station

Computation: Base Pressure

Computed by: H. E. W. Checked by: [illegible] Date: 6-26-4[illegible]

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Position of C.A

Descript.	Dimensions	Area	Arm Y	Moment X Axis	Arm X	Moment Y Axis
Area 1	2 x 26	52	1.0	52	15.0	780
Area 2	2 x 24.5	49	14.25	697	27.0	1325
Area 3	15 x 1.75	25.3	26.83	708	32.5	855
Area 4	1.75 x 34	59.5	37.83	2250	24.0	1430
Area 5	2 x 6	12	35.0	420	5.0	60
Area 6	6 x 3	18	26.5	477	10.0	180
Area 7	9 x 1	9	22.0	198	4.0	36
Area 8	17 x 1	17	12.0	204	0.5	9
Area 9	3.5 x 1.5	5.2	2.75	14	1.75	9
Area 10	1.5 x 13.5	20.3	27.25	553	19.25	390
		267.3		5571		5074

$$Y = \frac{5571}{267.3} = 21.4 \qquad X = \frac{5074}{267.3} = 19.00$$

Center of small areas is almost in the same position as center of gravity of load. It will be assumed that there will be an even distribution of load over the base areas.

$$P = \frac{1,300,300}{267.3} = 4,860\ \#/\square'$$

WAR DEPARTMENT

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

Project: Bushnell Park Pumping Station

Computation: Section A-A thru Station & Conduit

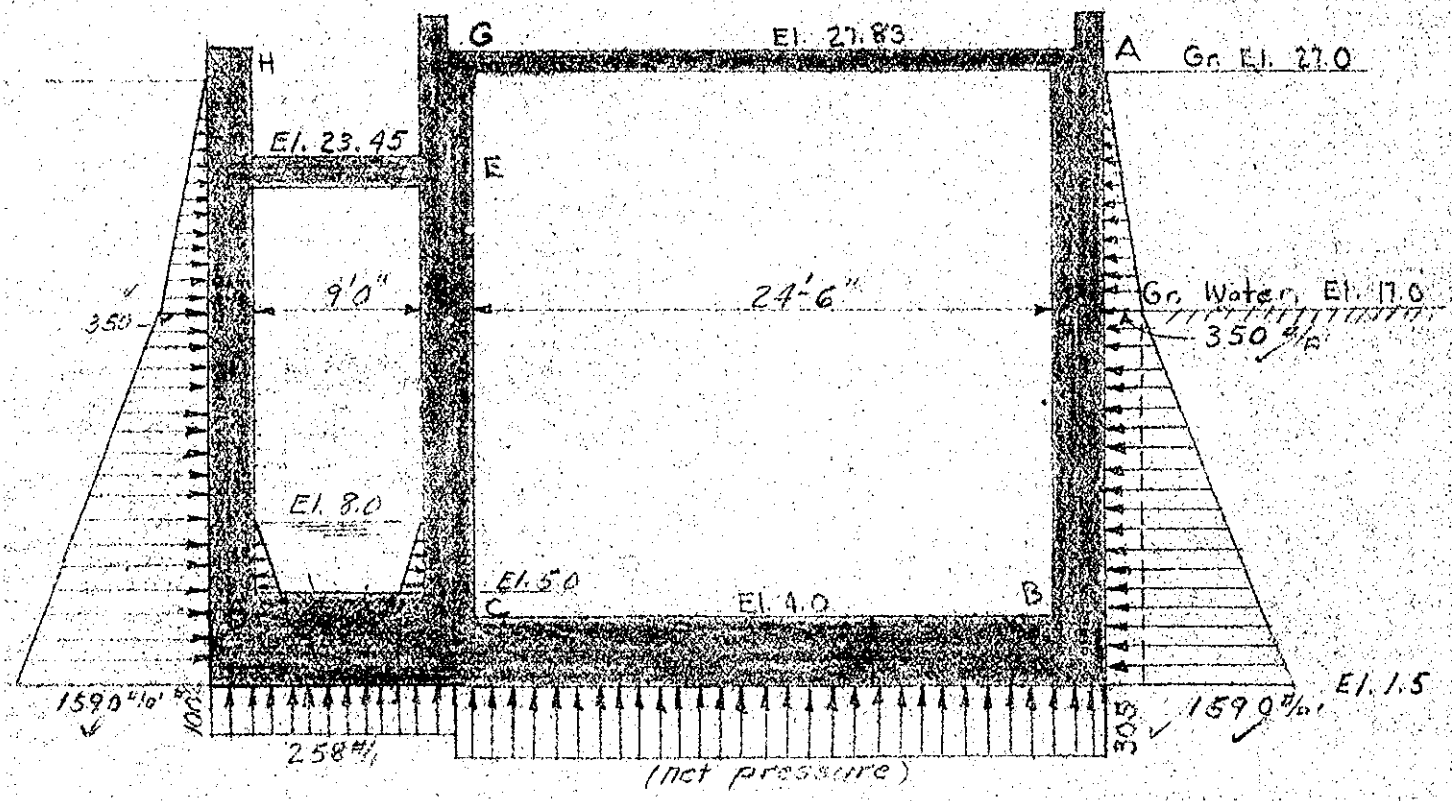
Computed by: H.E.W. Checked by: W.D.P. Date: 6/12/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Uplift due to water at El. 17.0 & considering bottom of base slab at El. 1.0 = 15.5 x 62.5 = 969 #/□'

There is no neg. pressure at base of walls. Assume base slab supported at walls & subjected to an uplift equal to hydrostatic head.

CASE I Water at El. 8.0 in conduit



LOADING DIAGRAM

Base Pressure = $(62.5 \times 15.5 - 150 \times 2.5)\frac{25}{49}$ = 309 #/□'

" " 970 - [3.5 x 150 + 3 x 62.5] =

970 - 712 258 #

Dry Earth Press. = 10 x 35. = 350 #/□

Sat. Earth Press. 15.5 x 80 = 1240 #/□'

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Subject: Bushnell Park Pumping Station
Computation: Section A-A thru Station & Conduit
Computed by: H.E.W. Checked by: [illegible] Date: 6/12/43

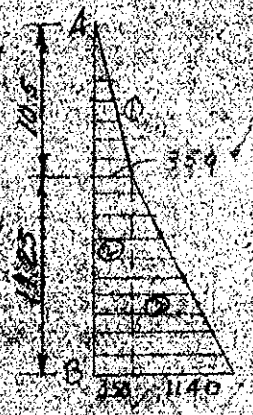
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I cont.
Stiffness

Member	d	I	L	I/L	K
AB	24"	13824	297	46.6	3.5
BC	30"	27000	315	86.0	6.4
CD	42"	74088	128	573.0	42.7
DF	21"	9261	243	38.1	2.8
CE	18"	5832	243	23.9	1.8
EG	18"	5832	52	112.0	8.4
EF	12"	1728	128	13.4	1
FH	21"	9261	52	178	0

Fixed End Moments

Member AB



$$M^F_{A_1} = \frac{.435(10 - 15 \times .435 + 6 \times .435^2)}{15} \times \left(10.5 \times \frac{350}{2}\right)(24.75) = 6.35^{1K}$$

$$M^F_{B_1} = \frac{.435^2(5 - 4 \times .435)}{10} \times \left(10.5 \times \frac{350}{2}\right)(24.75) = 2.75^{1K}$$

$$M^F_{A_2} = \frac{.576^2(4 - 3 \times .576)}{12} \times (14.25 \times 350)(24.75) = 7.76^{1K}$$

$$M^F_{B_2} = \frac{.576(6 - 8 \times .576 + 3 \times .576^2)}{12} \times 14.25 \times 350 \times 24.75 = 14.25$$

$$M^F_{A_3} = \frac{.576^2(5 - 3 \times .576)}{30} \times \frac{14.25 \times 1140}{2} \times 24.75 = 7.28$$

$$M^F_{B_3} = \frac{.576(10 - 10 \times .576 + 3 \times .576^2)}{30} \times \frac{14.25 \times 1140}{2} \times 24.75 = 20.20$$

$$M^F_A = 6.35 + 7.76 + 7.28 = 21.39^{1K}$$

$$M^F_B = 2.75 + 14.25 + 20.20 = 37.20^{1K}$$

Member CB

$$M^F_B = M^F_C = \frac{1}{12} \times 305 \times 26.25^2 = 17.50^{1K}$$

Member CD

$$M^F_C = M^F_D = \frac{1}{12} \times 258 \times 11.25^2 = 2.72^{1K}$$

WAR DEPARTMENT

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

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Project: Bushnell Park Pumping Sta.

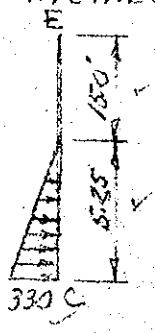
Computation: Section A-A thru Sta. + Conduit

Computed by: H. E. W. Checked by: W.W.Z. Date: 6/14/43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I cont.

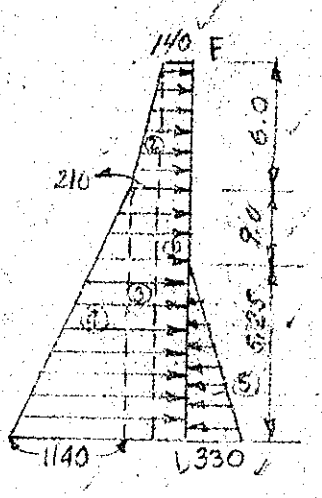
Member CE



$M_C^F = .260\left(\frac{10 - 10 \times .260 + 3 \times .260^2}{30}\right) \times \frac{5.25 \times 330}{2} \times 20.25 = 1.08^{1K}$

$M_E^F = \frac{.260^2(5 - 3 \times .260)}{30} \times \frac{5.25 \times 330}{2} \times 20.25 = 0.17^{1K}$

Member FD



$M_{D_1}^F = M_{F_1}^F = \frac{1}{12} \times 140 \times 20.25^2 = 4.80^{1K}$

$M_{D_2}^F = \frac{.296^2(5 - 4 \times .296)}{10} \times \frac{210 \times 6}{2} \times 20.25 = 0.42^{1K}$

$M_{F_2}^F = \frac{.296(10 - 15 \times .296 + 6 \times .296^2)}{15} \times \frac{210 \times 6}{2} \times 20.25 = 1.54^{1K}$

$M_{D_3}^F = \frac{.704(6 - 8 \times .704 + 3 \times .704^2)}{12} \times 14.25 \times 210 \times 20.25 = 6.63^{1K}$

$M_{F_3}^F = \frac{.704^2(4 - 3 \times .704)}{12} \times 14.25 \times 210 \times 20.25 = 4.72$

$M_{D_4}^F = \frac{.704(10 - 10 \times .704 + 3 \times .704^2)}{30} \times \frac{1140 \times 14.25}{2} \times 20.25 = 17.15^{1K}$

$M_{F_4}^F = \frac{.704^2(5 - 3 \times .704)}{30} \times \frac{1140 \times 14.25}{2} \times 20.25 = 7.85^{1K}$

$M_{D_5}^F = \frac{.260(10 - 10 \times .260 + 3 \times .260^2)}{30} \times \frac{330 \times 5.25}{2} \times 20.25 = 1.08^{1K}$ (1.16)

$M_{F_5}^F = \frac{.260^2(5 - 3 \times .260)}{30} \times \frac{330 \times 5.25}{2} \times 20.25 = 0.17^{1K}$

$M_D^F = 4.80 + 0.42 + 6.63 + 17.15 - 1.08$ (1.16) $= 27.92^{1K}$ (27.81)

$M_F^F = 4.80 + 1.54 + 4.72 + 7.85 - 0.17 = 18.74^{1K}$

Member FH

$M_F^F = \frac{140 \times 4}{2} \times 1.33 = .36^{1K}$

$M_H^F = 0$

-0.10	+0.08
+0.12	+0.04
+7.55	-0.92

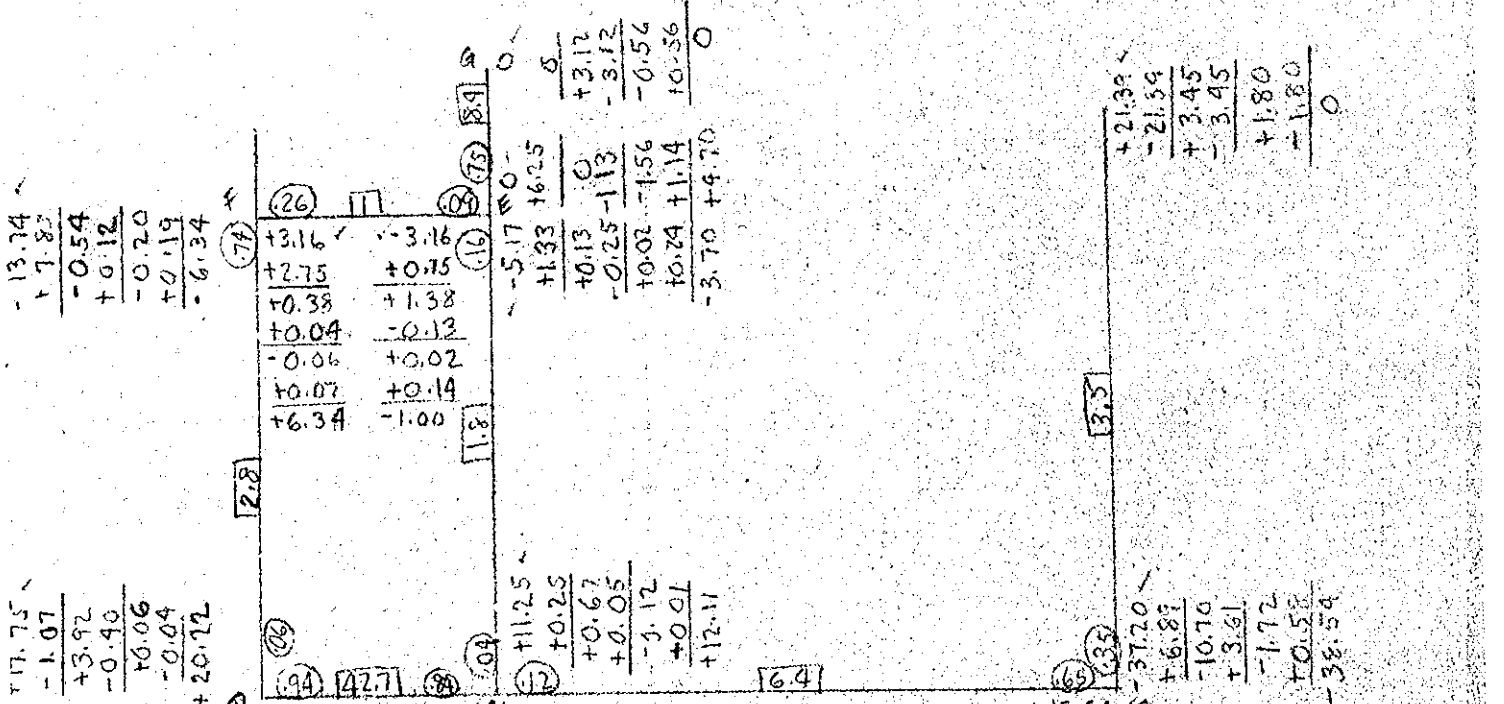
Project: Bushnell Park Pumping Station

Computation: Section A-A thru Station & Conduit

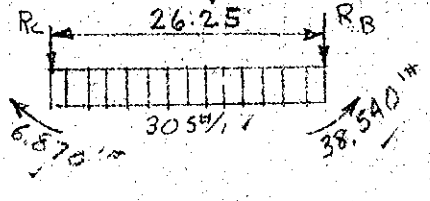
Computed by: H.E.M. Checked by: WWY Date: 7-3-43

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Case II (cont.)



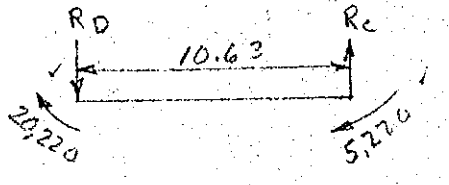
Shears Member CB



$$R_C = \frac{6870 - 38,540 + 305 \times 26.25 \times 13.12}{26.25} = 2,770$$

$$R_B = \frac{38,540 - 6870 + 305 \times 26.25 \times 13.12}{26.25} = 5,200$$

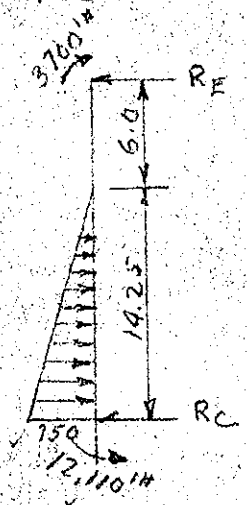
Member CD $R_D = R_C = \frac{5,220 + 20,220}{10.63} = 2,390$



Project: Bushnell Park Pumping Station
Computation: Section A-A thru Station & Conduit
Computed by: H.E.W. Checked by: W.W.Z. Date: 7-2-43

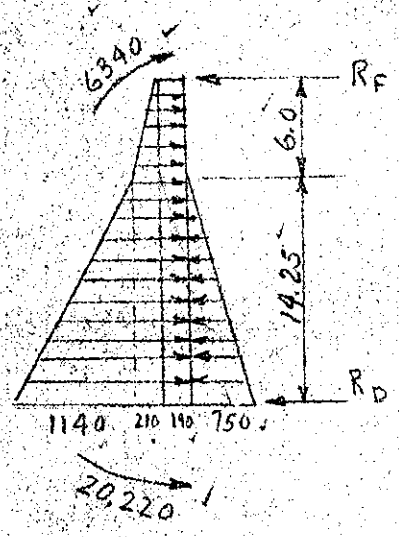
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Shears Case II (cont.)
Member CE



$$R_C = \frac{12,110 - 3,700 + \frac{750 \times 14.25 \times 15.50}{2}}{20.25} = 4,500^{\#}$$

$$R_E = \frac{3,700 - 12,110 + \frac{750 \times 14.25 \times 4.75}{2}}{20.25} = 840^{\#}$$

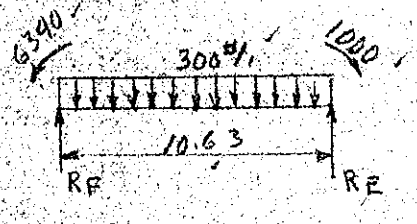


$$R_D = \frac{20,220 - 6340 + 140 \times 20.25 \times 10.12 + 3 \times 210 \times 4 + 210 \times 14.25 \times 13.12 + 1140 \times 7.12 \times 15.5 - 750 \times 7.12 \times 15.5}{20.25}$$

$R_D = 6,275^{\#}$

$$R_F = \frac{6340 - 20,220 + 1140 \times 7.12 \times 4.75 + 210 \times 14.25 \times 7.12 + 210 \times 3 \times 16.25 + 140 \times 20.25 \times 10.12 - 750 \times 7.12 \times 4.75}{20.25}$$

$R_F = 2,930^{\#}$



$$R_E = \frac{1000 - 6340 + 300 \times 10.63 \times 5.31}{10.63} = 1090^{\#}$$

$$R_F = \frac{6340 - 1000 + 300 \times 10.63 \times 5.31}{10.63} = 2095^{\#}$$

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Station

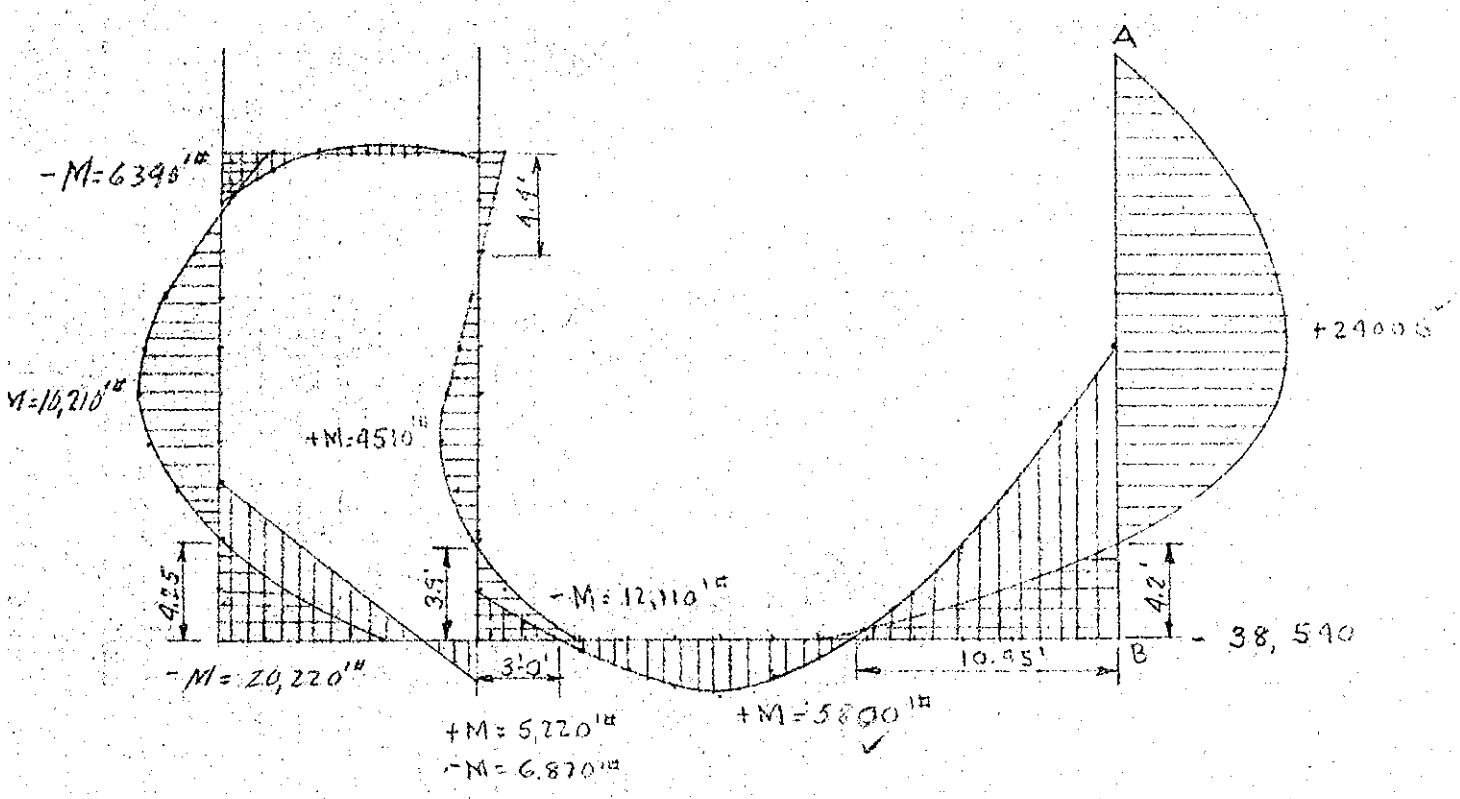
Computation: Section A-A- thru Station & Conduit

Computed by: H.E.W. Checked by: Date: 7-3-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

CASE II (cont.)

Moment Diagram



WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Subject: Bushnell Park Pumping Station
Computation: Section A-A thru Station & Conduit - Design of Members
Computed by: H. E. W. Checked by: [illegible] Date: June 24, 1943

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Wall AB

Max pos mom = 24000 '#
" neg. mom = 38,770

Assumptions:
At Support
$f_c = 900$ $k = .31$ $K = 125$
$f_s = 24000$ $j = .9$

At Center
$f_c = 800$ $k = .286$ $K = 108$
$f_s = 24000$ $j = .9$

d req'd $= \sqrt{\frac{38,770}{125}} = 17.6$
make $d = 20.5''$

Neg. steel $= \frac{38770 \times 12}{24,000 \times .9 \times 20.5} = 1.05$ □" use 7/8" φ @ 6" cc

Pos steel $= \frac{24000 \times 12}{24,000 \times .9 \times 20.5} = 0.65$ □" use 7/8" φ @ 11" cc.

Shear at top of base slab
$12,200 - \frac{1490 + 1370}{2} \times 1.25 = 10,400$ #

$v = \frac{10,400}{12 \times 20.5 \times .9} = 47$ #/□" OK

$u_o = \frac{10,400}{5.50 \times .9 \times 20.5} = 103$ #/□" OK

Base Slab BC
Max pos mom. = 7,100 #
" neg mom at B = 38,770 '# at C 5,870 '#

d req'd $= \sqrt{\frac{38,770}{125}} = 17.6$ make $d = 26.5$

neg steel at B $= \frac{38,770 \times 12}{24000 \times .9 \times 25.5} = .85$ □" use 7/8" @ 6" cc

pos. steel $= \frac{7100 \times 12}{24000 \times .9 \times 25.5}$ 0.14 □" use 3/4" φ @ 12" cc

Shear at face of wall AB
$5280 - 305 \times 12 = 4975$ #

$v = \frac{4975}{12 \times .9 \times 25.5} = 18.1$ #/□"

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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Subject: Bushnell Park Pumping Station
Computation: Section A-A thru Station & Conduit - Design of Members
Computed by: H. E. W. Checked by: [illegible] Date: June 29, 1943

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Base Slab BC

$u_o = \frac{4975}{5.50 \times .9 \times 25.0} = 44\ \#/\square''$

$u_o = \frac{2790}{2.356 \times .9 \times 25.5} = 52\ \#/\square''$

Wall CE Max neg. M = 12,110'# + M = 4510

req'd $d = \sqrt{\frac{12110}{125}} = 9.85''$ make d = 14.5"

$A_s = \frac{12,110 \times 12}{24,000 \times .9 \times 14.5} = .46\ \square''/''$ use $\frac{3}{4}''\phi$ @ 1'-6" cc at base on cond. side & $\frac{5}{8}''\phi$ in both faces after that

Base Slab CD Max Neg. M = 31,550

$A_s = \frac{31550 \times 12}{24000 \times .9 \times 37.5} = .47\ \square''$ use $\frac{7}{8}''\phi$ @ 1'-0" cc

$u_o = \frac{4020}{2.356 \times .9 \times 37.5} = 50\ \#/\square''$

Wall DF Max Neg. M = 31,550'# pos M = 15,550'#

req'd $d = \sqrt{\frac{31,550}{125}} = 15.9''$ make d = 17.5

neg steel $= \frac{31,550 \times 12}{24,000 \times .9 \times 17.5} = 1.00\ \square''$ use $\frac{3}{4}''\phi$ + $\frac{7}{8}''\phi$ @ 6" cc

pos steel $= \frac{15500 \times 12}{24,000 \times .9 \times 17.5} = .49\ \square''$ use $\frac{3}{4}''\phi$ @ 11" cc

Shear = 10,000 - 1400 × 2.25 + 2.25 × 190 = 6420#

$v = \frac{6420}{12 \times .9 \times 17.5} = 34\ \#/\square''$ OK

$u_o = \frac{6420}{5.105 \times .9 \times 17.5} = 80\ \#/\square''$ OK

A_s at F $= \frac{7550 \times 12}{24000 \times .9 \times 17.5} = .24\ \square''$ use $\frac{5}{8}''\phi$ @ 1'-0" cc

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Station

Computation: Section A-A thru Station & Conduit

Computed by: H.E.W. Checked by: W.M.S. Date: 6-25-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Trash Rack Slab

reqd $d = \sqrt{\frac{7550}{125}} = 7.75''$ Make $d = 9.5''$

Neg. $A_s = \frac{7550 \times 12}{24{,}000 \times .9 \times 9.5} = .44 \square''$ use $\frac{3}{4}''\phi$ @ $12''$ cc

Pos. A_s = $\frac{5}{8}''\phi$ @ $12''$ cc

$u_0 = \frac{2210}{2.356 \times .9 \times 9.5} = 105$ #/□''

$v_0 = \frac{2210}{12 \times .9 \times 9.5} = 21.5$ #/□'' OK

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Station

Computation: Section A-A - thru Station & Conduit

Computed by: H.E.W. Checked by: [illegible] Date: 6/25/42

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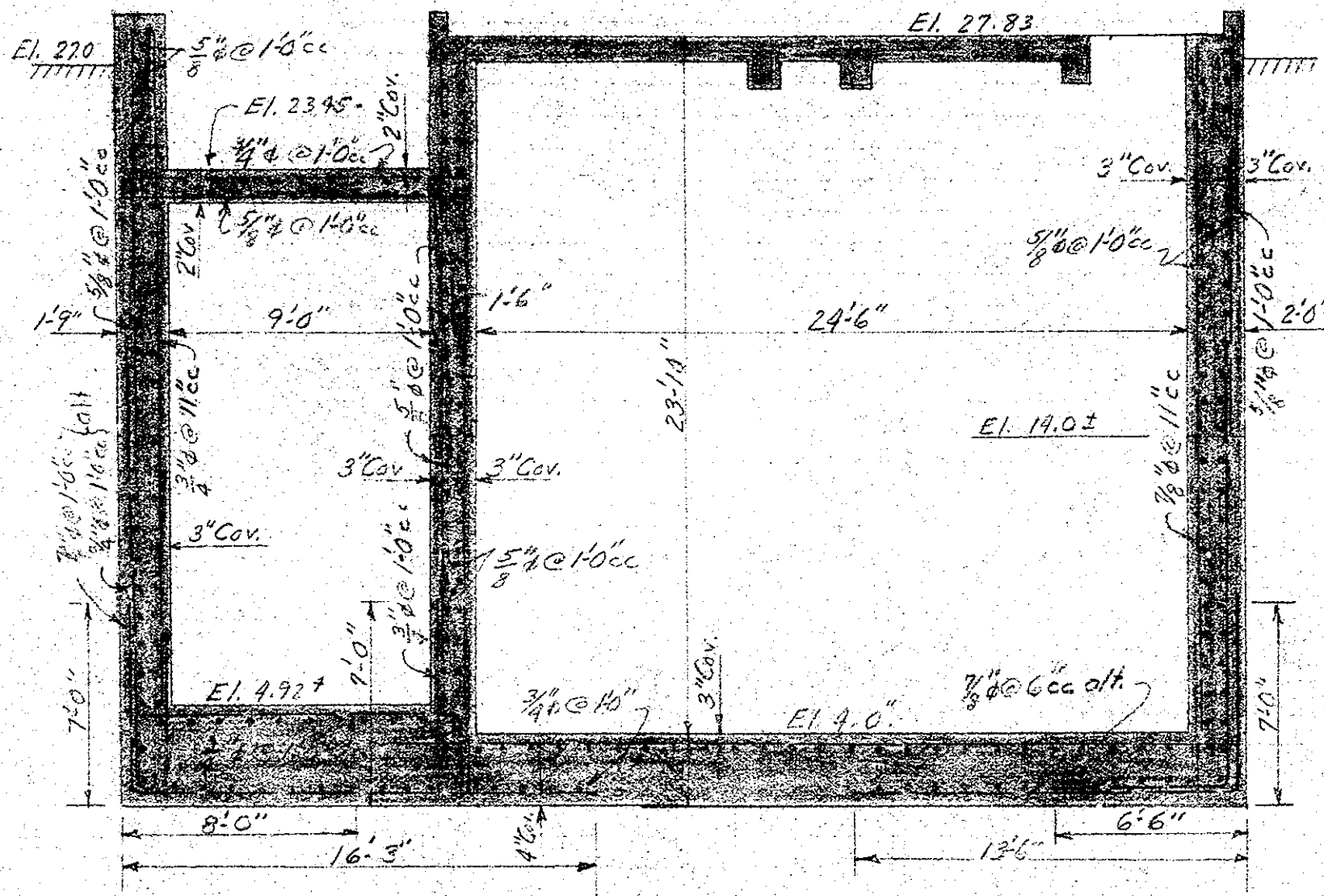

SECTION - A-A
(Base slab on rock)

U. S. GOVERNMENT PRINTING OFFICE 3—10528

WAR DEPARTMENT
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.
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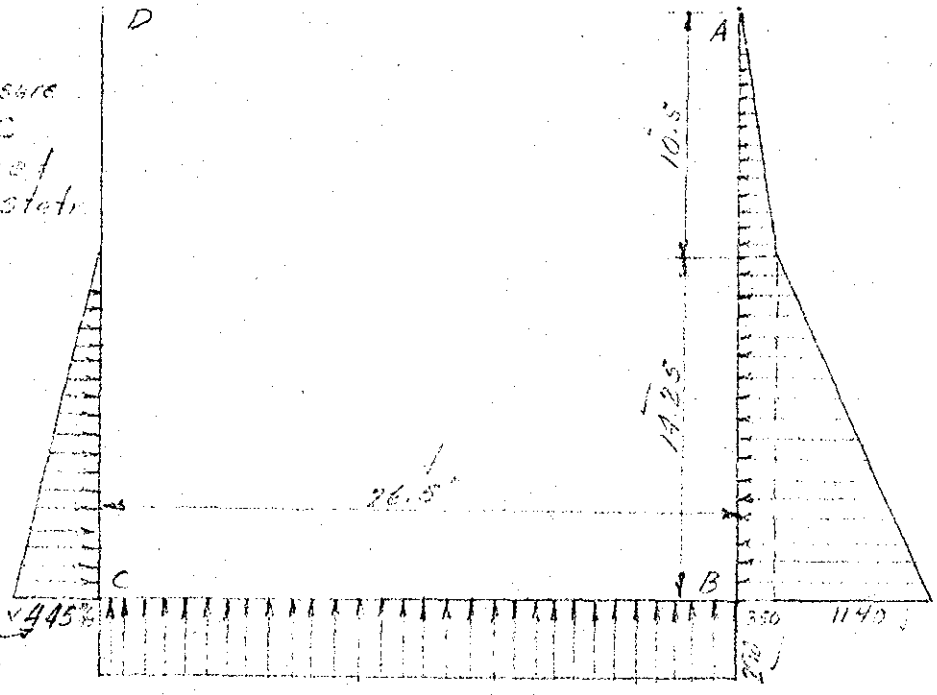
Subject: Bushnell Park Pumping Station
Computation: Section B-B ⊥ to Park River Conduit
Computed by: H.E.W. Checked by: WWZ Date: 6-21-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Loading Diagram

Note
Water pressure on wall DC to be figured at ½ hydrostatic head



$\frac{.25 \times 62.5}{2} =$

Base Pressure
$(62.5 \times 15.5 - 150 \times 2.5)\frac{28}{49} = 290$ #/□"

Fixed End Moments
Member AB
$A = 21.39^{'k}$ $B = 37.20^{'k}$ (See page 20)

Member BC
$M_B^F = M_C^F = \frac{1}{12} \times 290 \times 26.5^2 = 17.0^{'k}$

Member CD
$M_C^F = \frac{.575(10 - 10 \times .575 + 3 \times .575^2)}{30} \times \frac{\cancel{328}\,445 \times 14.25}{2} \times 24.75 = 7.90^{'k}$

$M_D^F = \frac{.575^2(5 - 3 \times .575)}{30} \times \frac{\cancel{328}\,445 \times 14.25}{2} \times 24.75 = 2.83^{'k}$

WAR DEPARTMENT

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

Project: Bushnell Park Pumping Station

Computation: Section B.B.1 to Park River Conduit

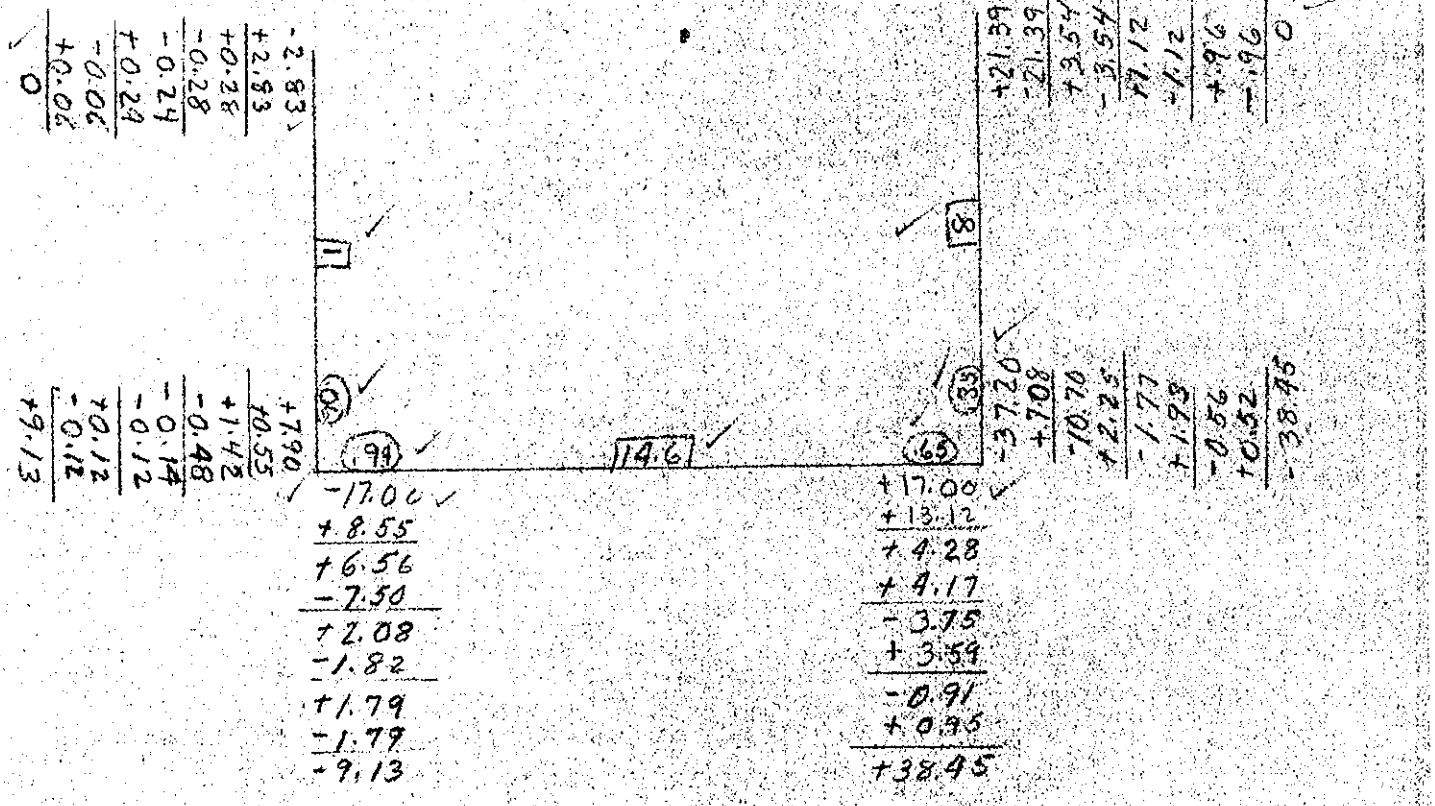
Computed by: H.E.W. Checked by: W.W.Z. Date: 6/21/43

U.S. GOVERNMENT PRINTING OFFICE 3—10528

Stiffness

Member	d	I	L	I/L	K
AB	24"	13824	297	46.6	8
BC	30"	27000	318	85.0	14.6
CD	12"	1728	297	5.82	1

Moment Distribution



WAR DEPARTMENT

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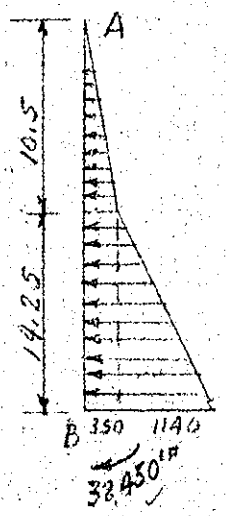
Subject: Bushnell Park Pumping Station

Computation: Section B-B ⊥ to Park River Conduit

Computed by: H.E.W. Checked by: [illegible] Date: 6-21-43

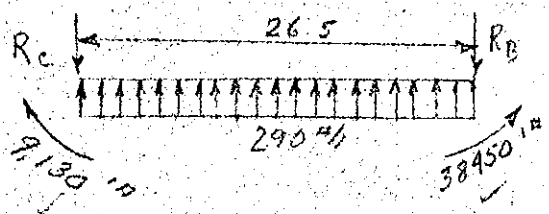
U. S. GOVERNMENT PRINTING OFFICE 3—10528

Shears



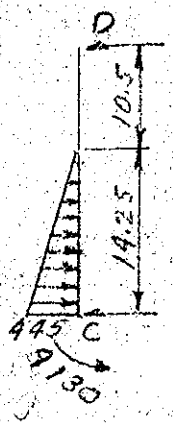
$$R_B = \frac{10.5 \times 350 \times \frac{1}{2} \times 7.00 + 14.25 \times 350 \times 17.62 + 14.25 \times 1140 \times 20 \times \frac{1}{2}}{24.75} + \frac{38,450}{24.75} = 12,180^{\#}$$

$$R_A = \frac{10.5 \times 350 \times \frac{1}{2} \times 17.75 + 14.25 \times 350 \times 7.12 + 14.25 \times 1140 \times \frac{1}{2} \times 4.75}{24.75} - \frac{38,450}{24.75} = 2760^{\#}$$



$$R_B = \frac{38460 + 290 \times 26.5 \times 13.25 - 6,830}{26.5} = 5,160$$

$$R_C = \frac{6830 + 290 \times 26.5 \times 13.25 - 38,460}{26.5} = 2,520$$



$$R_C = \frac{9130 + \frac{445 \times 14.25}{2} \times 20.0}{24.75} = 2,930^{\#}$$

$$R_D = \frac{\frac{445 \times 14.25 \times 4.75}{2} - 9130}{24.75} = 240^{\#}$$

WAR DEPARTMENT

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

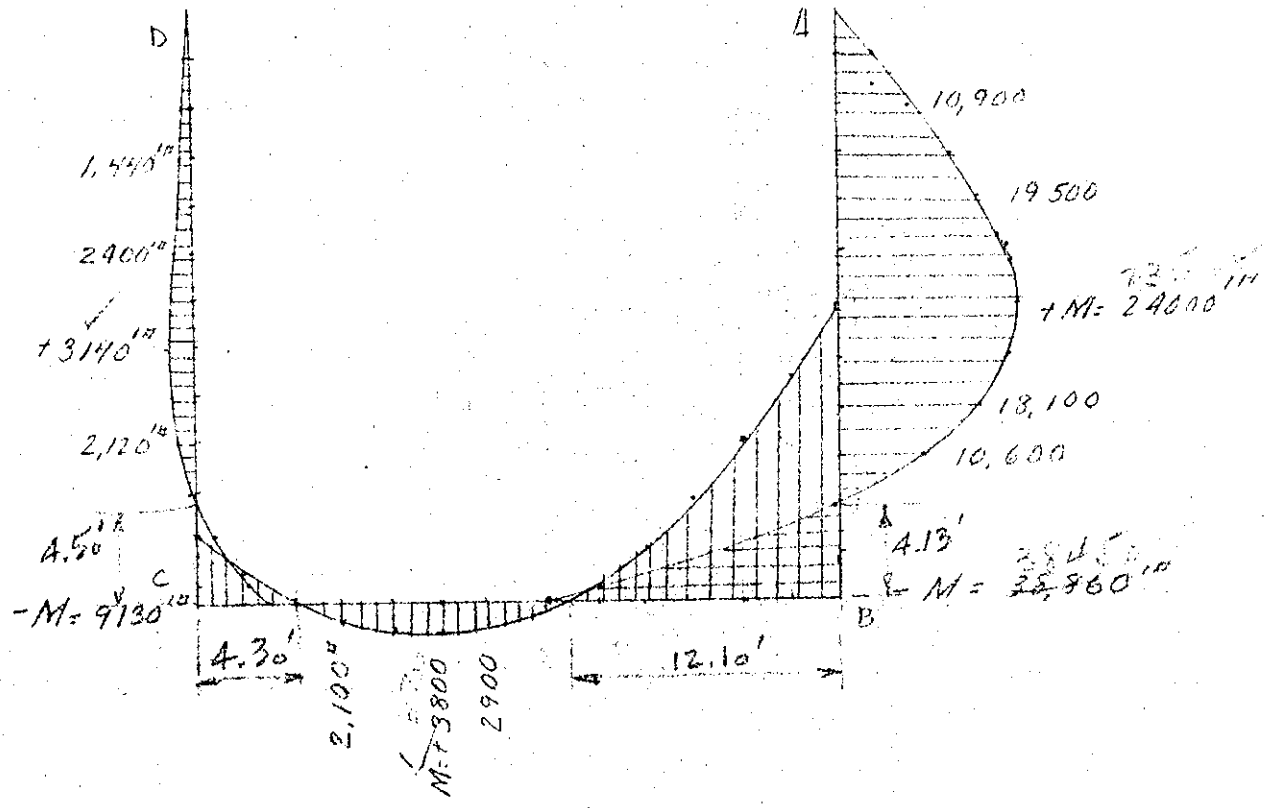
Subject: Bushnell Park Pumping Station

Computation: Section B-B 1 to Park River Conduit

Computed by: H.E.W. Checked by: W.W.P. Date: 6-22-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Moment Diagram



WAR DEPARTMENT
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Project: Bushnell Park Pumping Station
Computation: Section B-B ⊥ to Park River Conduit -
Computed by: H.E.W. Checked by: W.W.Z. Date: 6-25-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Design of Members:

Wall AB

pos mom = 24000 ''' } Moments + shear are the
neg mom = 38,860 ''' } Same as AB in Sect A-A

Use same steel as wall AB Sect. A-A

Base Slab BC

neg mom = -38,860 at B + 9130 ''' at C
pos " = 3000 ''' 3700

A_s at C = $\frac{9130''' \times 12}{24000 \times .9 \times 24.7}$ = .20 □" use $\frac{3}{4}$"φ @ 1'-6" cc

for pos mom use $\frac{3}{4}$"φ @ 1'-0" cc

$v = \frac{5160}{12 \times .9 \times 24.7}$ = 18 #/□"

$u_0 = \frac{5160}{2.356 \times .9 \times 24.7}$ = 97 #/□" OK

Wall CD

pos. mom = 3140 '''

reqd d = $\sqrt{\frac{3140}{104}}$ = 5.5" make d = 8.5"

pos. A_s = $\frac{3140 \times 12}{24000 \times .9 \times 8.5}$ = .265 □" use $\frac{5}{8}$"φ @ 12" cc

neg A_s = $\frac{9130 \times 12}{24000 \times .9 \times 8.5}$ = .60 □" use $\frac{5}{8}$"φ + $\frac{3}{4}$"φ alt. 6" cc

shear = 2,930 - 425 × 1.25 = 2400 #

$v = \frac{2400}{12 \times .9 \times 8.5}$ = 26 #/□"

$u_0 = \frac{2400}{(1.96 + 2.35)(.9)(8.5)}$ = 73 #/□" OK

WAR DEPARTMENT

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

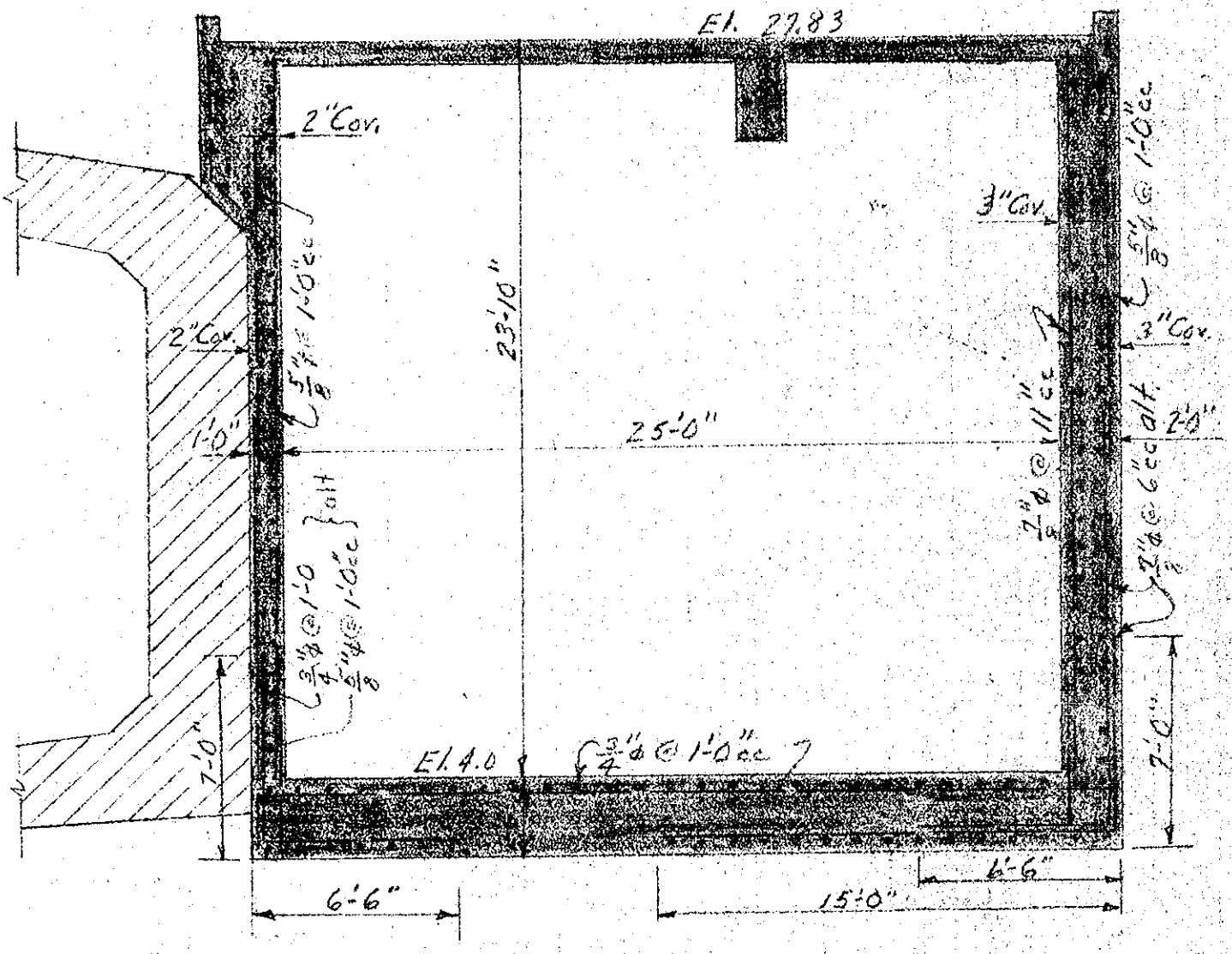
Page 389

Subject: Bushnell Park Pumping Station

Computation: Section B-B 1 to Park River Conduit

Computed by: H.E.W. Checked by: Date: 6-25-43

U.S. GOVERNMENT PRINTING OFFICE 3—16528



SECTION B-B
(Base Slab on Rock)

WAR DEPARTMENT

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

Subject: Bushnell Park Pumping Station

Computation: Section CC thru Packing Chamber

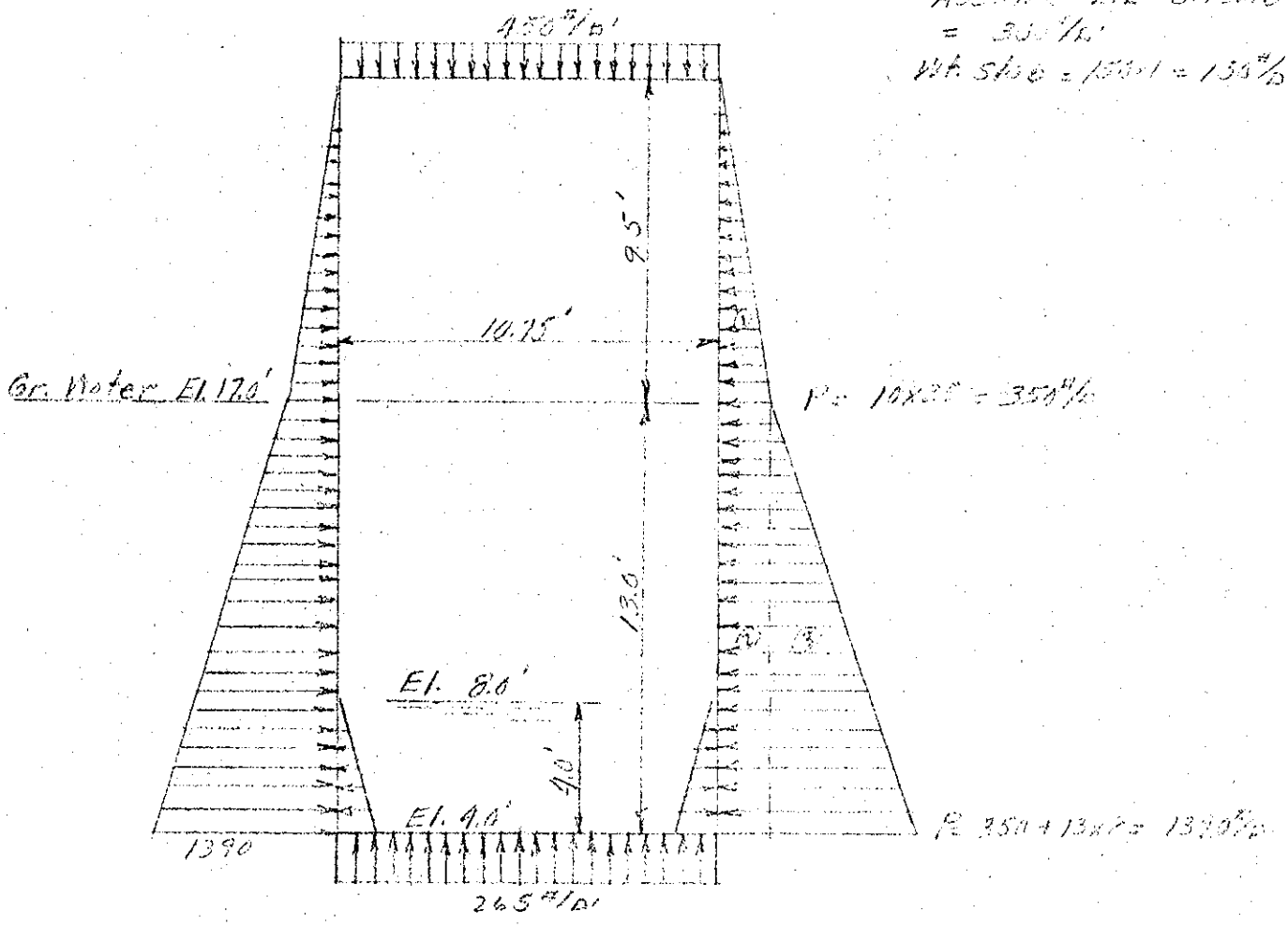
Computed by: H.E.W. Checked by: Date: 6-22-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Case I - Water in Conduit at El. 8.0'

Loading Diagram

Assume L.L. on slab = 200 #/□'
Wt. slab = 150×1 = 150 #/□'



Base Pressure

Hydrostatic P = 62.5 × 13 = 813 #/□'

Wt. Water = 4×62.5 = 250
" Slab = 2×150 = 300
550 #/□'

Net upward P = 263 say 265 #/□'

Subject: Bushnell Park Pumping Station
Computation: Section C.C. thru Racking Chamber
Computed by: H.E.K. Checked by: Date: 6-22-43

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Fixed End Moments:
Member DA

$M_A^F = M_D^F = \frac{1}{12} \times 450 \times 10.75^2 = 4.84^{1K}$

Member AB

$M_{A_1}^F = \frac{.422(10-15\times.422+6\times.422^2)}{15} \times 9.5 \times \frac{350}{2} \times 22.5 = 9.98^{1K}$

$M_{B_1}^F = \frac{.422^2(5-4\times.422)}{} \times 9.5 \times \frac{350}{2} \times 22.5 = 2.20^{1K}$

$M_{A_2}^F = \frac{.58^2(4.3\times.58)}{12} \times 13 \times 350 \times 22.5 = 6.5^{1K}$

$M_{B_2}^F = \frac{.58(6-8\times.58+3\times.58^2)}{12} \times 13 \times 350 \times 22.5 = 11.75^{1K}$

$M_{A_3}^F = \frac{.58^2(5-3\times.58)}{30} \times \frac{1040}{2} \times 13 \times 22.5 = 5.56$

$M_{B_3}^F = .58(10-10\times.58+3\times.58^2) \times \frac{1040}{2} \times 13 \times 22.5 = 15.32^{1K}$

$M_{A_4}^F = \frac{0.178^2(5-3\times0.178)}{30} \times \frac{1}{2} \times 250 \times 4 \times 22.5 = .06^{1K}$

$M_{B_4}^F = \frac{0.178(10-10\times0.178+3\times0.178^2)}{30} \times \frac{1}{2} \times 250 \times 4 \times 22.5 = 0.56^{1K}$

$M_A^F = 4.98 + 6.50 + 5.56 - .06 = 16.98$

$M_B^F = 2.20 + 11.75 + 15.32 - 0.56 = 28.71$

Member BC

$M_B^F = M_C^F = \frac{1}{12} \times 265 \times 10.75^2 = 2.55^{1K}$

Stiffness

Member	d	I	L	I/L	K
AB	21"	9261	270	34.3	2.57
BC	24"	13824	129	107.0	8.0
CD	21"	9261	270	34.3	2.57
DA	12"	1728	129	13.25	1

WAR DEPARTMENT

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Subject: Bushnell Park Pumping Station

Computation: Section C-C Thru Racking Chamber

Computed by: H.E.W. Checked by: Date: 6-23-43

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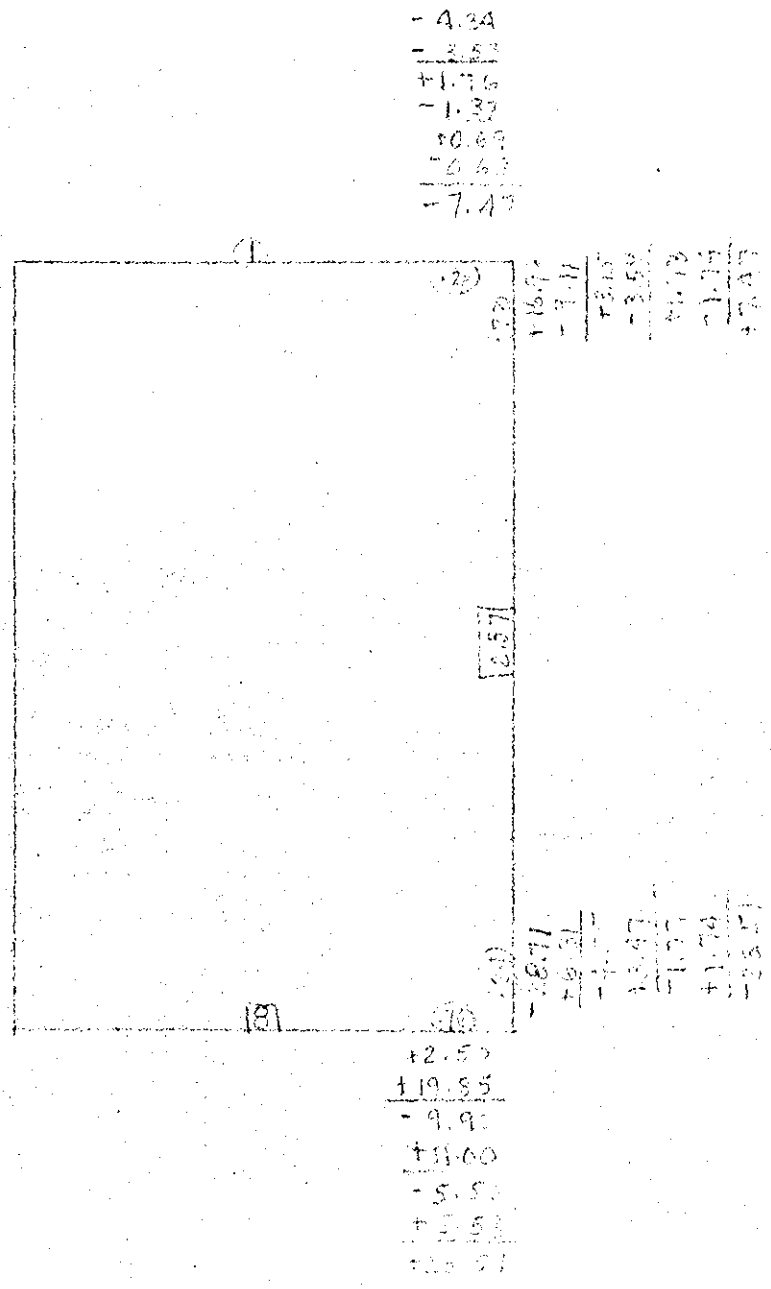

Subject: Bushnell Park Pumping Station

Computation: Section C-C thru Packing Chamber

Computed by: H.E.W. Checked by: Date: 6-23-43

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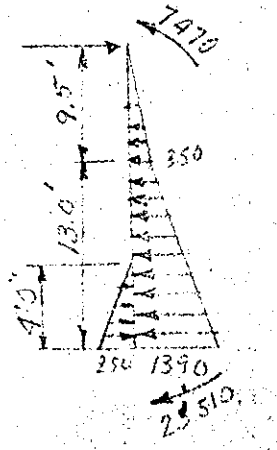
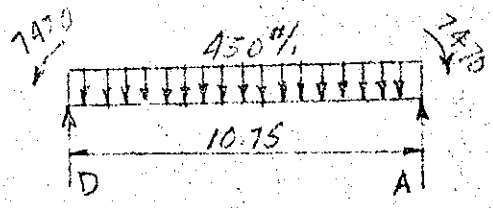
Case I (cont.)

End Shears

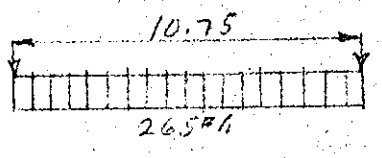


$$V_B = \frac{\frac{1}{2}\times 350\times 9.5\times 6.33 + 350\times 13\times 16 + 1040\times 13\times 18.17\times\frac{1}{2}}{22.5} + \frac{23510 - 7470 - \frac{1}{2}\times 250\times 4\times 21.17}{22.5} = 9400^{\#}$$

$$V_A = \frac{\frac{1}{2}\times 350\times 9.5\times 16.17 + 350\times 13\times 6.5 + 1040\times 13\times 4.33\times\frac{1}{2}}{22.5} + \frac{7470 - 23510 - \frac{1}{2}\times 250\times 4\times 1.33}{22.5} = 8670^{\#}$$



$$V_D = V_A = \frac{450\times 10.75}{2} = 2420^{\#}$$



$$V_C = V_B = \frac{265\times 10.75}{2} = 1420^{\#}$$

WAR DEPARTMENT

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Subject: Bushnell Park Pumping Station

Computation: Section C-C thru Racking Chamber

Computed by: H.E.W. Checked by: [illegible] Date: 6-23-43

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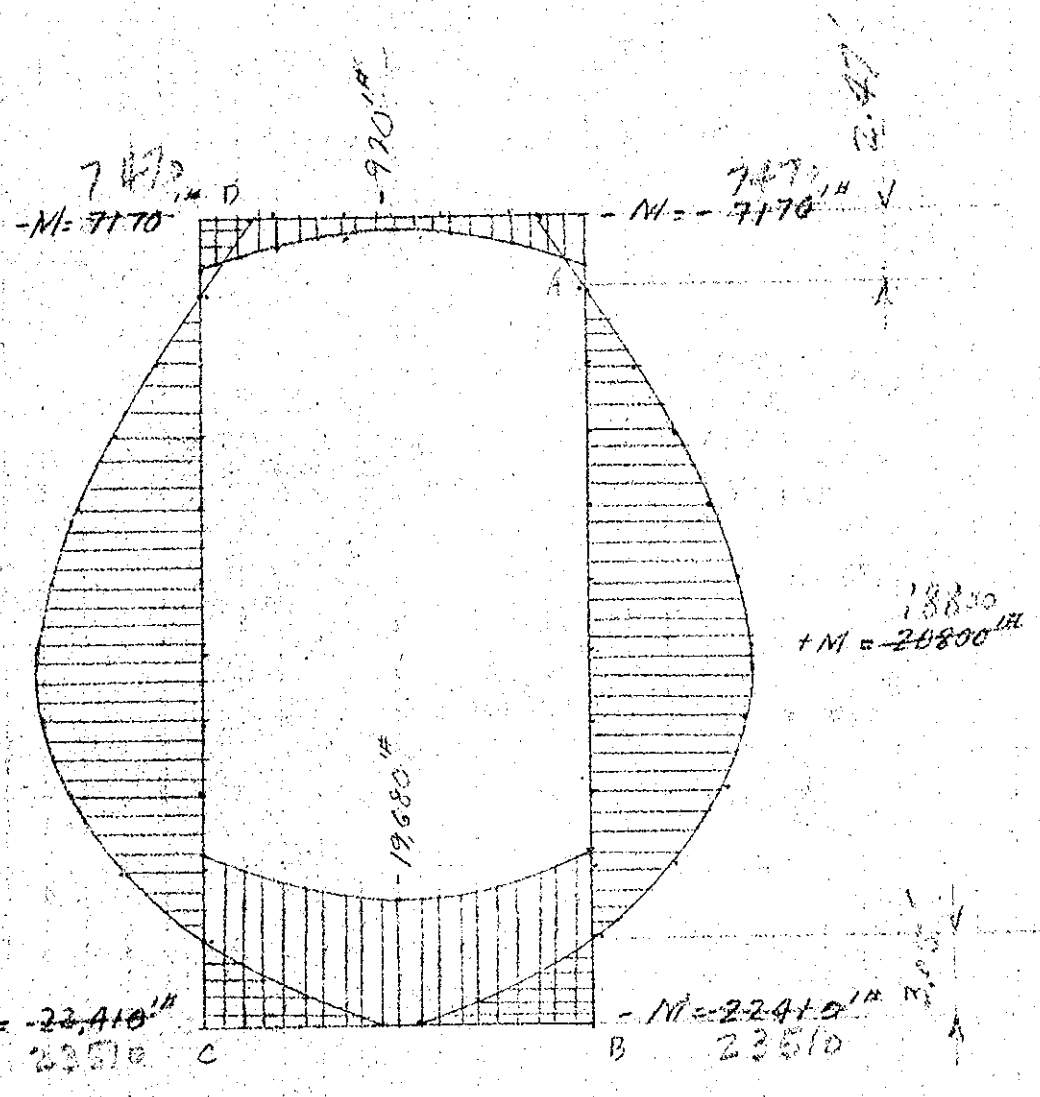
Moment Diagram



WAR DEPARTMENT

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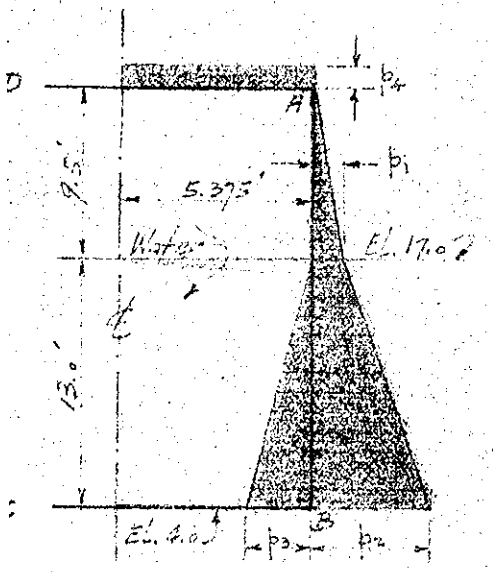
Project Bushnell Park Pumping Sta.

Computation Section thru Rack Chamber

Computed by W.W.Z. Checked by H.E.W. Date 7-3-43

U. S. GOVERNMENT PRINTING OFFICE 3—10528



Assumptions:-

1. Water in Conduit @ El. 17.0
2. Ground water @ El. 17.0
3. Base slab loaded downward with uniformly distributed load of 175 #/□' (Wgt. of water in conduit plus wgt. of base slab minus hydrostatic uplift on base slab). Since base slab rests directly on rock no bending takes place in slab due to this loading, but it will be assumed that bending can be induced from action of external forces acting on side walls.
4. Base slab will be assumed in place but moving no external forces acting on it.
5. Base slab assumed 24" thick
   Walls assumed 21" thick
   Top slab assumed 12" thick

Water in Conduit = 12 × 62.5 = 750 #/□'
Conc. Base Slab = 2 × 150 = 300
1050 #/□'
Hydro. Uplift = 14 × 62.5 = 875
Loading on base = 175 #/□'

p_1 = 35 × 10 = 350 #/□'
p_2 = 350 + 13 × 80 = 1390 #/□'
p_3 = 12 × 62.5 = 750 #/□'
p_4 = 300 + 150 = 450 #/□'

F.E.M. of Members

Member AD @ A = $\frac{1}{12} \times 450 \times \overline{10.75}^2 = 4.34^{'k}$

Member AB @ A (1) $\frac{0.42(10 - 15 \times 0.42 + 6 \times \overline{0.42}^2)}{15} \frac{1}{2} \times 9.5 \times 350 \times 22.5 = 4.98^{'k}$

(2) $\frac{\overline{0.58}^2(4 - 3 \times 0.58)}{12} \times 13 \times 350 \times 22.5 = 6.50$

(3) $\frac{\overline{0.58}^2(5 - 3 \times 0.58)}{30} \times \frac{1}{2} \times 1040 \times 13 \times 22.5 = 5.56$

(4) $\frac{\overline{0.58}^2(5 - 3 \times 0.58)}{30} \times \frac{1}{2} \times 750 \times 13 \times 22.5 = -4.00$

$13.04^{'k}$

@ B (1) $\frac{\overline{0.42}^2(5 - 3 \times 0.42)}{30} \times \frac{1}{2} \times 9.5 \times 350 \times 22.5 = 2.26^{'k}$

(2) $\frac{0.58(6 - 8 \times 0.58 + 3 \times \overline{0.58}^2)}{12} \times 13 \times 350 \times 22.5 = 11.75$

(3) $\frac{0.58(10 - 10 \times 0.58 + 3 \times 0.58^2)}{30} \times \frac{1}{2} \times 1040 \times 13 \times 22.5 = 15.32$

(4) $\frac{0.58(10 - 10 \times 0.58 + 3 \times \overline{0.58}^2)}{30} \times \frac{1}{2} \times 750 \times 13 \times 22.5 = -11.05$

$18.22^{'k}$

WAR DEPARTMENT

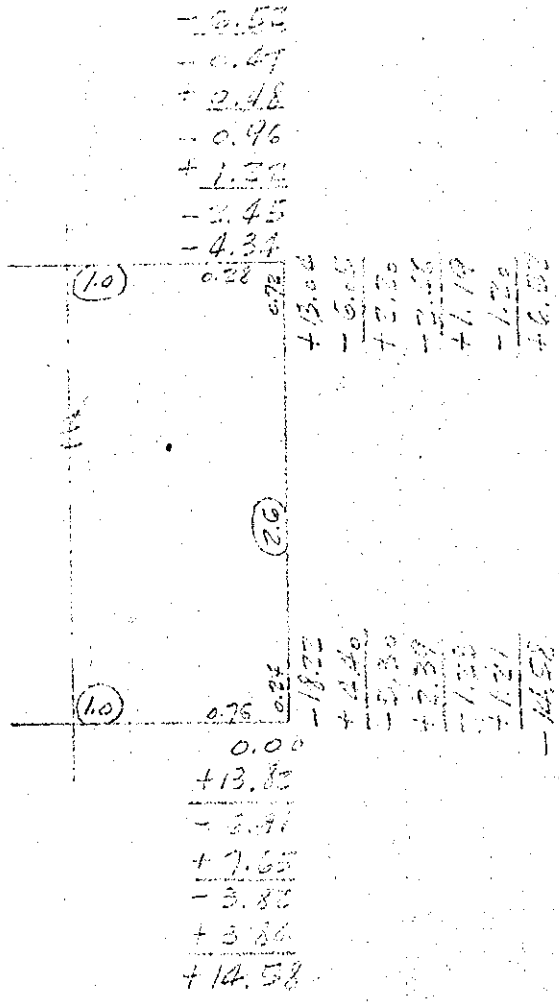
U. S. ENGINEER OFFICE, PROVIDENCE, R. I.

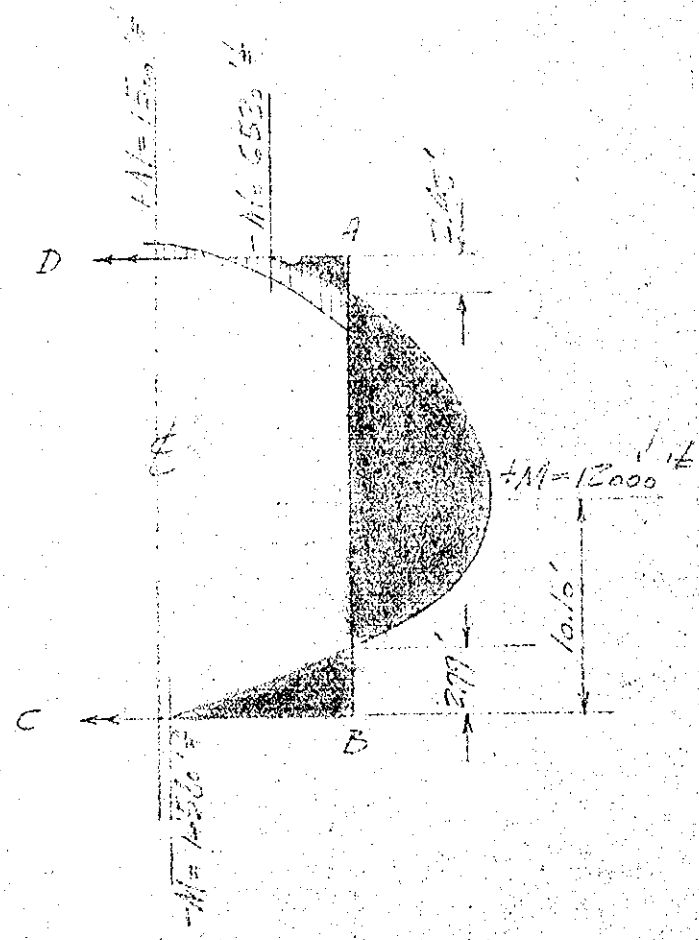
Subject: Bushnell Park Pumping Sta.

Computation: Section thru Rack Chamber

Computed by: [illegible] Checked by: H.E.W. Date: 7-3-43

U. S. GOVERNMENT PRINTING OFFICE 3—10523





$V_B = (0.5 \times 350 \times 8.5 \times 6.33 + 350 \times 13 \times 12 + 1040 \times 13 \times 18.17 \times 0.5 - 0.5 \times 750 \times 13 \times 18.17 + 14580 - 6520)\frac{1}{22.5}$

$= \underline{5570}$ #

$V_A = (0.5 \times 350 \times 8.5 \times 16.17 + 350 \times 13 \times 6.5 + 1040 \times 13 \times 4.33 \times 0.5 - 0.5 \times 750 \times 13 \times 4.33 + 6520 - 14580)\frac{1}{22.5}$

$= \underline{2480}$ #

$5570 + (1500 - 62.5x)0.5x = (2780 - 80x)0.5x$ $\quad x = 10.1'$

$V_0 = 5570 \times 10.1 + 1500 \times 10.1^2 \times 0.5 + 0.5 \times 631 \times 10.1^2 \times 0.67 - 582 \times 10.1^2 \times 0.5 - 8 \times 0.5 \times 10.1^2 \times 0.67 - 14580$

$= \underline{12000}$ #

$V_0 = 2480x - 0.33 \times 17.5x^3$ $\quad x = 2.42'$

$5570x + (750 - 62.5x)0.5x + 0.5 \times 62.5 \times 0.67x^3 - (1390 - 80x)0.67x^3 = 14580$ $\quad \underline{x = 2.79'}$

Project: Bushnell Park Pumping Station
Computation: Section C-C thru Packing Chamber
Computed by: H. E. W. Checked by: Date: 7-3-43

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Design of Members

Walls AB & CD

pos. mom. = 18,800'# neg mom at A = 7970'# B = 23510'#
max shear = 9410#

req'd d = $\sqrt{\frac{23510}{125}}$ = 13.7 make d = 17.5"

As at A = $\frac{7970 \times 12}{24000 \times .9 \times 17.5}$ = .24 □" use 5/8"φ @ 1'-0" cc

As at B = $\frac{23510 \times 12}{24000 \times .9 \times 17.5}$ = .75 □" use 3/4"φ @ 6" cc

pos As = $\frac{18,800 \times 12}{24000 \times .9 \times 17.5}$ = .60 □" use 3/4"φ @ 8" cc

Shear at top of base slab
9410 − 1 × 1350 = 8060#

$v = \frac{8060}{12 \times .9 \times 17.5}$ = 43 #/□"

$u_0 = \frac{8060}{9.71 \times .9 \times 17.5}$ = 109 #/□"

Base Slab CD

neg. mom = 23,510'# no pos mom
max shear = 1420#

req'd d = $\sqrt{\frac{23510}{125}}$ = 13.7" make d = 19.5" slab 2'-0" thick

As = $\frac{23510 \times 12}{24000 \times .9 \times 19.5}$ = 0.67 □" use 3/4"φ @ 6" cc

Shear and bend are negligible

Top slab AB

+M = 1500'# neg M = 7970'# shear = 2420

req'd d = $\sqrt{\frac{7970}{125}}$ = 7.75" use 12" slab d = 9.5"

As $\frac{7970 \times 12}{24000 \times .9 \times 9.5}$ = 4.4 □" use 3/4"φ @ 1'-0" cc

Subject: Buckwell Park Pumping Station
Computation: Section C-C thru Racking Chamber
Computed by: H.E.W. Checked by: Date: 5-26-13

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Design of Members (cont.)

Roof Slab D A

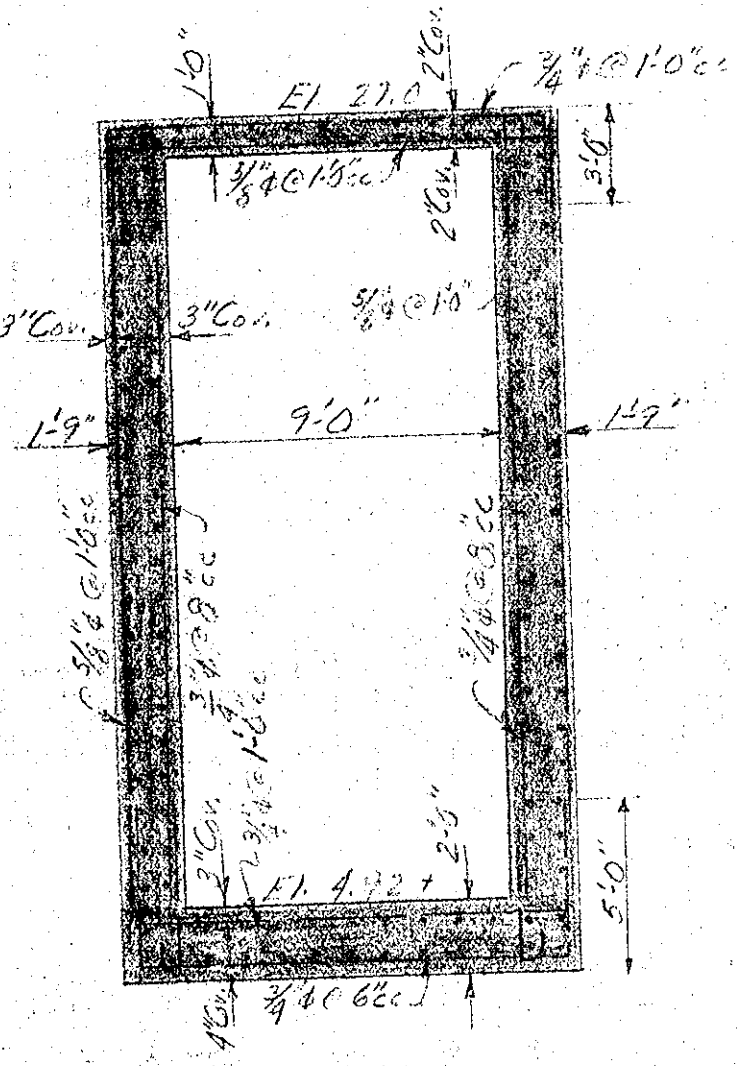
Max neg mom. = 7170

reqd $d = \sqrt{\frac{7170}{125}} = 7.55''$ make $d = 9.5''$

$A_s = \frac{7170 \times 12}{24000 \times .9 \times 9.5} = .53$ □" use $\frac{5}{8}''\phi$ @ 6" c.c.

$V = \frac{2150 - 300 \times .83}{12 \times .9 \times 9.5} = 12.5$ #/□"

$u_o = \frac{1900}{3.93 \times .9 \times 9.5} = 57$ #/□" ok



WAR DEPARTMENT

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Subject: Bushnell Park Pumping Station

Computation: Concrete Stairway

Computed by: H.E.W. Checked by: Date: 7-1-45

U. S. GOVERNMENT PRINTING OFFICE 3—10528

Stairway - Top Span

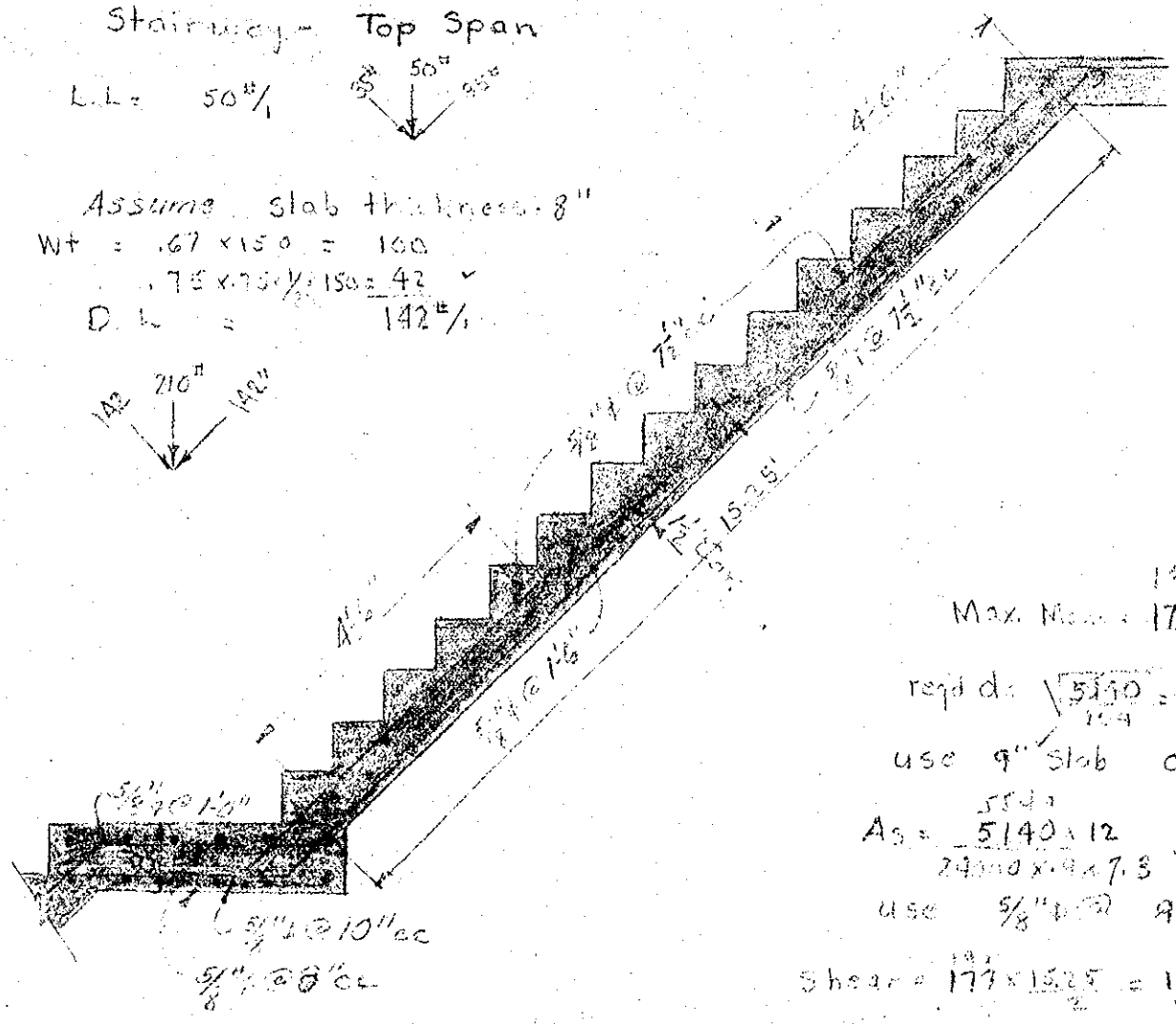
L.L. = 50#/1

Assume slab thickness = 8"

Wt = .67 × 150 = 100

.75 × .75 × 1/2 × 150 = 42

D.L. = 142#/1



Max. Mom. = $\frac{177 \times 15.25}{8}$ = 5140'#

reqd d = $\sqrt{\frac{5140}{104}}$ = 7.0"

use 9" slab d = 7.3"

$A_s = \frac{5140 \times 12}{24000 \times .9 \times 7.3}$ = 39 □"

use 5/8"φ @ 9" cc

Shear = $\frac{177 \times 15.25}{2}$ = 1350#

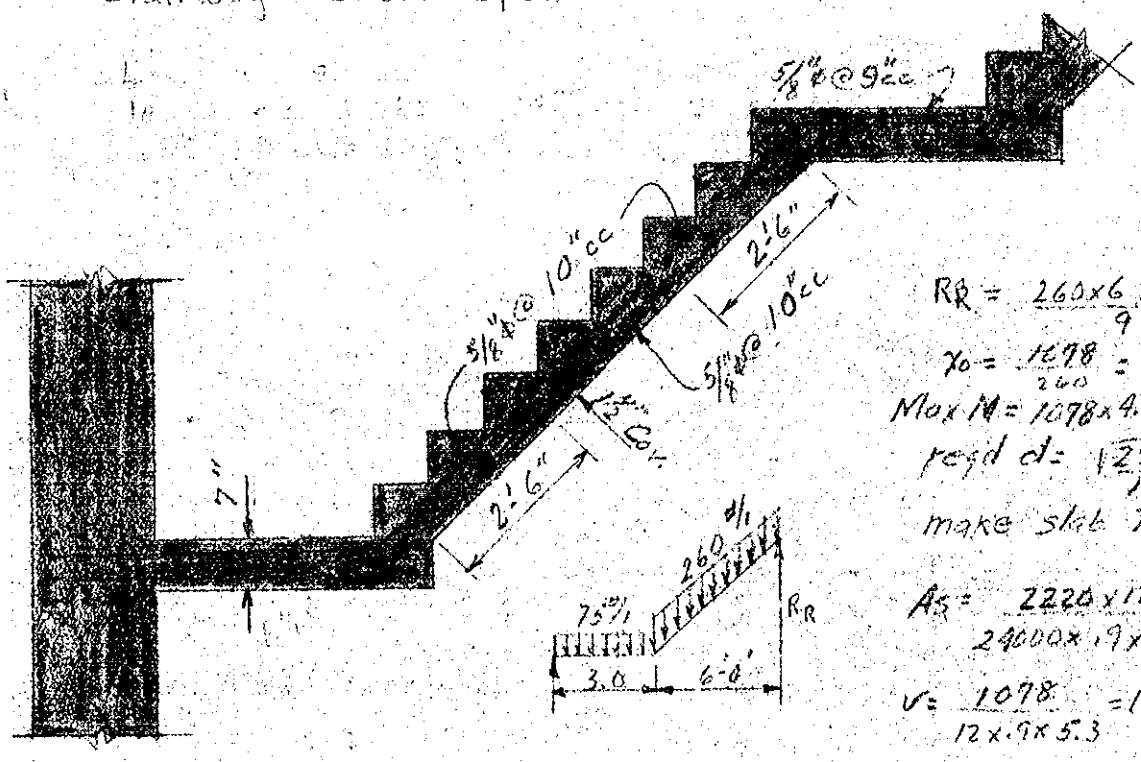
$v = \frac{1350}{12 \times .9 \times 6.6}$ = 19 #/□"

$v_u = \frac{1350}{\frac{12}{10} \times 1.764 \times .9 \times 6.6}$ = 96 #/□"

Subject: Bushnell Park Pumping Station
Computation: Concrete Stairway
Computed by: H.E.W. Checked by: Date: 7-1-43

U. S. GOVERNMENT PRINTING OFFICE 3—10523

Stairway - Short Span



$R_R = \frac{260 \times 6 \times 6}{9} + \frac{75 \times 3 \times 1.5}{9} = 1078^{\#}$ ✓

$x_0 = \frac{1078}{260} = 4.15'$

$Max\ M = 1078 \times 4.15 - 260 \times \frac{4.15^2}{2} = 2220'^{\#}$

$reqd\ d = \sqrt{\frac{2220}{104}} = 4.63$

make slab 7" $d = 5.3''$

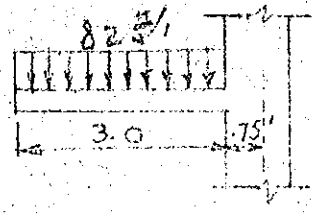
$A_s = \frac{2220 \times 12}{24000 \times .9 \times 5.3} = .23$ use 5/8" ϕ @ 1'-0"

$v = \frac{1078}{12 \times .9 \times 5.3} = 19\ ^{\#}/\square''$

Design of upper landing

Load from long. span	=	$177 \times \frac{15.25}{2} \times 1.414 \times 3.0$	= 5720#
" " short span	=	3×1078	3234
Wt. 8" slab	=	$100 \times 3 \times 4.33$	= 1300#
Live Load	=	$50 \times 3 \times 3$	450#
			10704# ✓

Uniform Load per sq. ft $= \frac{10704}{3 \times 4.33} = 825\ ^{\#}/\square'$ ✓



Max M $= 825 \times 3 \times 2.25 = 5560'^{\#}$

Shear at wall $= 825 \times 3 = 2475^{\#}$

$reqd\ d = \sqrt{\frac{5560}{125}} = 6.85''$ ✓

use $8\frac{1}{2}$ slab $d = 6.8''$

$A_s = \frac{5560 \times 12}{24000 \times .9 \times 6.8} = .45\ \square''$ use 5/8" ϕ @ 8" cc ✓

WAR DEPARTMENT

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Subject: Bushnell Park Pumping Station

Computation: Concrete Stairway

Computed by: H.E.W. Checked by: Date: 6-6-42

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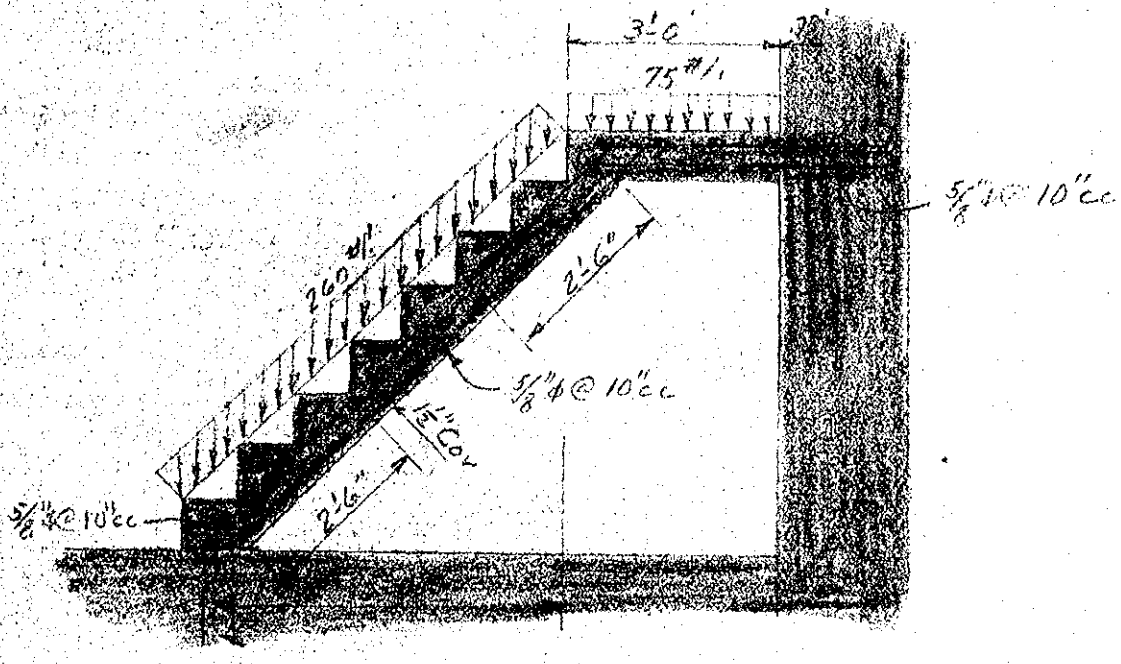

Wall React = $\frac{260 \times 5 \times 2.5 + 75 \times 3 \times 6.5}{8.75}$ = 540# ✓

x_0 = $\frac{540 - 75 \times 3}{260}$ = 1.21 = 4.96 from R.R. ✓

Max. M = $540 \times 4.96 - 75 \times 3 \times 2.21 - 260 \frac{1.21^2}{2}$ = 1880'# ✓

reqd d = $\sqrt{\frac{1880}{104}}$ = 4.25" make d = 5.3" slab = 7"

A_s = $\frac{1880 \times 12}{24000 \times .9 \times 5.3}$ = .20 □" use 5/8"φ @ 1'-0" cc

WAR DEPARTMENT

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Project: Bushnell Park Pumping Sta.

Computation: End Wall in Raking Chamber

Computed by: H. E. W. Checked by: [illegible] Date: 6-30-42

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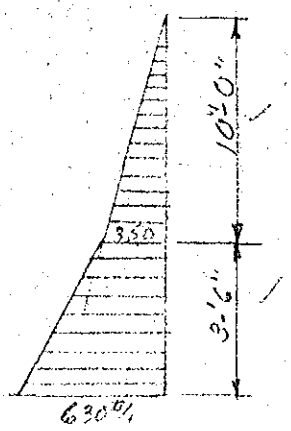
Loading Diagram



Intake End

Span of wall = 10.75 $w = 630$ #/'

$M = \frac{1}{12} \times 630 \times 10.75^2 = 6,160$ '#

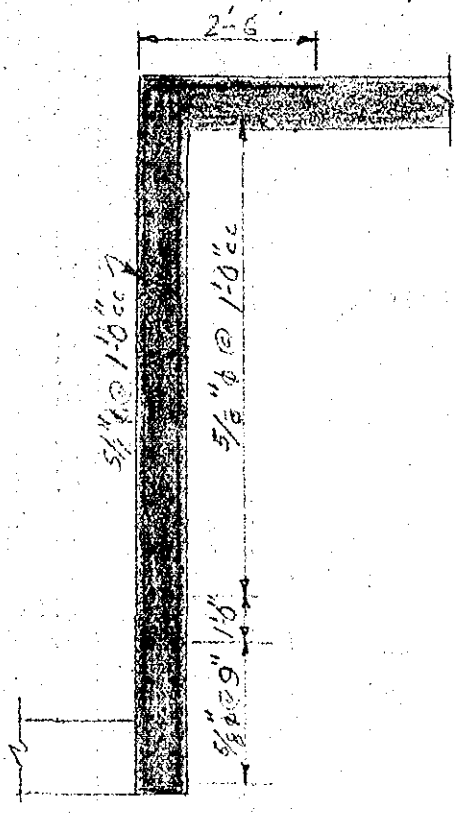
End shear $= 630 \times \frac{9}{2} = 2840$ #

reqd $d = \sqrt{\frac{6160}{104}} = 7.7''$ make $d = 8.7''$

$A_s = \frac{6160 \times 12}{24000 \times .9 \times 8.7} = .39$ #/' use $\frac{5}{8}$" ϕ @ 9" cc

$u_o = \frac{2840}{\frac{12}{8} \times 1.964 \times .9 \times 8.7} = 132$ #/□"

$v = \frac{2840}{12 \times .9 \times 8.7} = 30$ #/□"



WAR DEPARTMENT

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

Project: Bushnell Park Pumping Station

Computation: Gate Stand Beam

Computed by: H. E. W. Checked by: Date: 1-7-15

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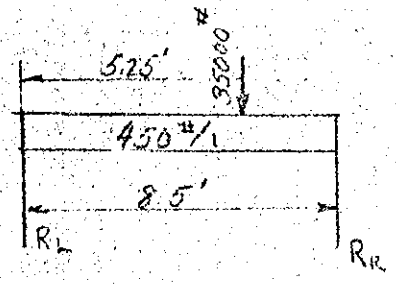

Assume b = 18" approx. width of stand

$$R_R = \frac{\frac{450 \times 8.5^2}{2} + 35000 \times 5.25}{8.5} = 23500^{\#}$$

$$M = 23500 \times 3.25 - \frac{450 \times 3.25^2}{2} = 74{,}100^{'\#}$$

$$\text{req'd } d = \sqrt{\frac{74100 \times 12}{18 \times 104}} = 21.7'' \quad 2'\text{-}0'' \text{ depth OK}$$

$$A_s = \frac{74{,}100 \times 12}{24000 \times .9 \times 21.6} = 1.90^{\square''} \quad \text{use } \tfrac{3}{4}''\phi \text{ @ } 6'' \text{ c.c.}$$

$$v = \frac{23500}{18 \times .9 \times 21.6} = 67^{\#/\square''}$$

$$u_0 = \frac{23{,}500}{9.42 \times .9 \times 21.6} = 128^{\#/\square''}$$

End wall at Gate Stand

Max M = 6070# (same as wall on page)

End Shear = 2840# 18" wall d = 19.7"

$$A_s = \frac{6070 \times 12}{24000 \times .9 \times 19.7} = .23^{\square''} \quad \text{use } \tfrac{5}{8}''\phi \text{ @ } 1'\text{-}0'' \text{ c.c. both faces}$$

WAR DEPARTMENT

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

Subject Bushnell Park Pumping Station

Computation Wood Cover Plates for Racking Chamber

Computed by H.E.W. **Checked by** W.W.Z. **Date** July 7 1943

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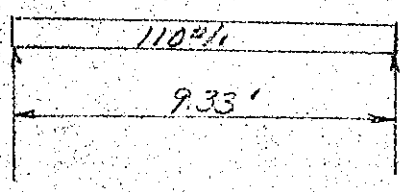
Loose boards over racking platform



Assume 3" plank wt = 8.4#
" 100# L.L = 100.0#
Uniform Load = 108.4#

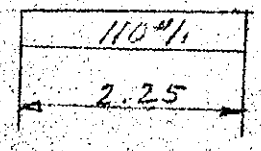
Max M = $\frac{110 \times 9.33^2}{8}$ = 1200'#

S = $\frac{1200 \times 12}{1200}$ = 12 #S

S for 3" plank = 13.21 "³ OK

Use 3" Plank floor

Cover Plate at Gate Stand



Max M = $\frac{110 \times 2.25^2}{8}$ = 70 '#

S = $\frac{70 \times 12}{1200}$ = .70 use 2" Plank

WAR DEPARTMENT

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Subject: Bushnell Park Pumping Station

Computation: Gasoline Storage tank Support

Computed by: H.B.W. Checked by: Date: July 7 1943

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Wt. of tank full of water = 1000 x 8.345 = 8345#

" " " = 1500#

Wt of cradles = 1.5 x 1 x 7 x 150 = 1580#

Wt of earth on tanks 4.25 x 9 x 5 x 100 = 11450#

Wt of truck load = 15700#

Total net on soil = 38575#

Load per sq. ft = $\frac{38575}{7 \times 9}$ = 610 #/□'

$M = \frac{1}{10}\, 610 \times 25 = 1530'^{\#}$

$d = \sqrt{\frac{1530}{104}} = 3.8''$ Make slab 1'-0" thick d = 7.5"

$A_s = \frac{1530 \times 12}{24000 \times .9 \times 7.5} = .11^{\square''}$ use 5/8" ϕ @ 1'-0" c.c. both faces

WAR DEPARTMENT

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

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Subject: PUSHNECK PARK PUMPING STATION

Computation: STABILITY OF TRASH RACK

Computed by: E. J. H. Checked by: Date: JULY 15, 1943

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VOLUME OF RACK

2x8	12.19 x 160 x 21 =	41800 cu. in
4x4	13.14 x 7.5 x 20 =	1973
4x6	28.33 x 7.5 x 40 =	6160
		49070 cu. in

49070 ÷ 1728 = 28.4 cu. ft.

Weight of water displaced = 28.4 x 62.5 = 1775 #

Weight of rack =

Wood = 28.4 x 30 =	852 #	
5 5/8" ϕ x 8.33 rods =	43	
Creosote 28.4 x 12	340	1235
		540 #

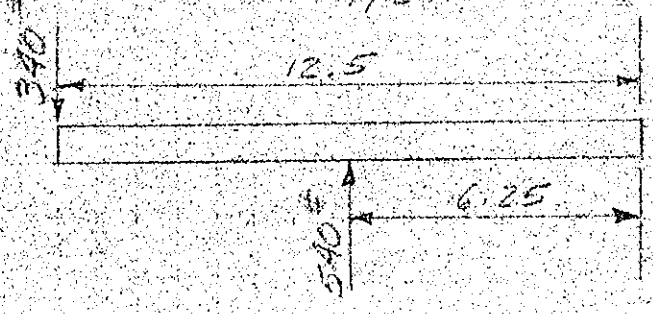
To overcome this upward force 4: 5 1/2" x 5/8" plates will be used at bottom of rack.

Weight of plates 11.7 x 2.33 x 4 = 390 #

Weight of water displaced =

5.5 x .625 x 100 x 4 / 1728 x 62.5 = 50

340 #



Moment =

340 x 12.5 =	4250 '#
540 x 6.25 =	3370 '#

O.K.