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**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
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Project C-431-A Production Facility

Design Computations on Outfall

Structure 1900-C

TO

J.W. Conley

FROM

R.K. Patterson

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GENERAL ELECTRIC COMPANY
HANFORD WORKS
SUB CONTRACT NO. G-363

THIS DOCUMENT CONSISTS OF 14 PAGES

PROJECT C-431-A
PRODUCTION FACILITY - SECTION "A"

Classification Cancelled and Changed To

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CG-NMP-1, 6-27-94
By J. E. Savely 7-7-94
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7-27-94

DESIGN COMPUTATIONS
ON
OUTFALL STRUCTURE
1900-C

Chas. T. Main, Inc.
141 Milk St.
Boston, Mass.

91-24

July 30, 1951

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GENERAL ELECTRIC CO.

CHAS. T. MAIN, INC.

BOSTON, MASS.

Job No. 01-24

HANFORD WORKS

PROJECT C-431-A

DESIGN OF C WATER PLANT

Sheet No. 1 of 14

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Subject

Division

OUTFALL STRUCTURE

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PROJECT C-431-A
DESIGN OF G WATER PLANT

Sheet No. 2 of 14
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OUTFALL STRUCTURE

GENERAL PLAN: The general arrangement of the proposed outfall structure is shown on pages 1 and 5. This arrangement provides maximum flexibility.

DESIGN ASSUMPTIONS: The spillway capacity is to be 268,000 gpm with a crest elevation at 429.0. This flow of 268,000 gpm is assumed to be composed of the following:

Retention Basin C-105-C	80,000 gpm
Retention Basin 105-B	45,000 gpm
Main Sewer from 190-C Area	143,000 gpm

The outfall sewers (the two 54 inch sewers from the outfall structure to the river) are to have a capacity of 82,000 gpm each when the water surface in the outfall structure is at elevation 428.7; this will permit a maximum river stage of 421.0 which is the highest recorded flood stage. Submergence of the outlet of the main sewer from 190-C Area and the submergence of the outlets of the retention sewers is not considered objectionable.

SPILLWAY: A weir with a net length of 24 feet whose crest is at elevation 425.0 is provided; this crest may be raised to any desired elevation by use of stop logs. The maximum elevation the crest can reach and still carry the design quantity (268,000 gpm) with adequate freeboard is elevation 432.0. It is to be noted that at this crest elevation (432.0) that only 42,000 gpm can be removed through the retention tank outlet since the head required to remove 80,000 gpm would submerge the retention tank weir. In order to remove 80,000 gpm from the retention tank and still discharge 268,000 gpm over the spillway, the crest of the spillway would have to be at elevation 430.2 or lower. If the crest of the spillway is held at elevation 432.0 and 80,000 gpm are to be removed from the retention tank, then the capacity of the spillway is reduced to 120,000 gpm. With the flexibility allowed by the use of stop logs, the crest elevation can be adjusted to accommodate a wide range in flow variation. Page 7 is a rating curve for the spillway weir as proposed.

OUTFALL SEWERS: Two 54 inch outfall sewers are provided to handle the normal drainage from the outfall structure to the river. The capacity of these sewers is influenced by the river stage. At normal stage (assumed elevation 405) they will carry a minimum of 134,000 gpm each if the stage in the outfall structure is 422.0 or higher. At maximum high water (elevation 421.0) these sewers will carry a minimum of 82,000 gpm each if the stage in the outfall structure is 428.7 or higher. Page 9 is a rating curve for the outfall sewers.

SPILLWAY CHUTE: The spillway chute is designed to carry 268,000 gpm on a minimum slope of 0.1089. The depth of water at the entrance to the chute will be 4.80 feet and will be continually drawn down until it discharges into the river regardless of the river stage. At normal water (elevation 405) the discharge depth at the river would be 2.30 feet. The flow in the chute is being accelerated continually and will reach a velocity of approximately 30 fpm when the depth is 2.30 feet.

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TRASH RACKS: Trash racks having a total gross area of 580 square feet are provided to screen the inflow into the 54 inch outfall sewers. These racks are to be 2" x 3/8" steel bars spaced on 3 inch centers. The trash racks are battered to facilitate hand raking.

WALKWAYS: Walkways are provided for access to the stop log slots and the trash racks. These walkways shall be equipped with suitable guard rails.

STOP LOG AND TRASH RACK SLOTS: The outer faces of the stop log and trash rack slots shall be protected with steel angles imbedded in the concrete.

MAIN SEWER: The main sewer from the 190-C Area will have a submerged outlet when a stage of 429.8 is reached. The submergence of the outlet will create flow under pressure in the lower end of the main sewer. As a result of this a hydraulic jump may form in the sewer some distance upstream of the outlet. However, this will not affect the capacity of the sewer since the control point in the sewer is some distance upstream from both the outlet and the point at which the hydraulic jump will form.

RETENTION SEWERS: The outlets of the retention sewers at the outfall structure will be submerged when a stage of 428.0 is reached. This submergence of the outlets will create flow under pressure for the entire distance from the retention tanks. At the maximum stage of 436.1 the water surface in the outfall structure will be 6.1 feet above the bottom of the retention tanks, hence allowing only 5.2 feet difference in elevation between the retention tank weir crest and the water surface in the retention tank outlet; this head is sufficient to produce a flow of 42,000 gpm. To maintain a flow of 80,000 gpm from the retention tanks while the weir in the outfall structure is discharging 268,000 gpm, the spillway weir crest would have to be lowered to elevation 430.2.

The flow from the retention tank weir will probably entrain air that may be carried the full length of the retention sewer. At stages in the outfall structure below 426.8 the retention sewer will discharge freely into the outfall structure and hence not flow full, thus providing an area above the water for the entrained air to escape. When the outlet of the retention sewer is submerged the air cannot escape as before but must rise through the water in the form of bubbles which can do no harm structurally or hydraulically so long as adequate freeboard is maintained.

The operation of the 24" retention tank drains through the retention sewers will have to be suspended during stages of high water. The retention tanks can still be drained into the cribs, however, the time of draining may be increased.

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DESIGN OF C WATER PLANT

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Oct Fall Structure

General Plan

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Sheet No. 5 of 14
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Outfall Structure

Section AA

Section BB

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6
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D.H.

Outfall Structure

Rating Curve for Spillway

Net Length of Spillway

Use 3 End Contractions

At Max flow $D = 4 \text{ ft}$

$$24 - (3 \times 4 \times 0.05) = 23.4 \text{ ft.}$$

Min Discharge Assume Broad Crest

$$Q = 3.1 \times 23.4 H^{3/2}$$

$$= 72.54 H^{3/2} \text{ in cfs}$$

$$= 32643 H^{3/2} \text{ in gpm}$$

H (ft)	Q (gpm)
0.2	2920
0.5	11540
1.0	32650
1.5	59950
2.0	92300
3.0	169600
4.0	261150

Probable Discharge Assume Sharp Crest

$$Q = 3.3 \times 23.4 H^{3/2}$$

$$= 77.22 H^{3/2} \text{ cfs}$$

$$= 34750 H^{3/2} \text{ gpm}$$

H (ft)	Q (gpm)
0.2	5110
0.5	12290
1.0	34750
1.5	63850
2.0	98250
3.0	180550
4.0	278000

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DESIGN OF C WASTE PLANT

Sheet No. 8

Date 26 July 1967

Drawn by [signature]

Checked by [signature]

Scale

Date

Outfall Structure

Rating Curve for 54" Sewer 550 ft long

Losses

Entrance

Exit

Pipe

$f = 0.15$

$0.015 \frac{550}{4.5}$

1.0

1.0

1.83

3.83

$V^2/2g$

"

"

$V^2/2g$

Total

$$h_f = 3.83 \frac{V^2}{2g}$$

$$V = \sqrt{\frac{h_f \cdot 2g}{3.83}} = 4.10 \sqrt{h_f}$$

$$Q = 4.10 A \sqrt{h_f} = 65.19 \sqrt{h_f} \text{ in cfs}$$

$$Q = 1845 A \sqrt{h_f} = 29335 \sqrt{h_f} \text{ in gpm}$$

H	Q gpm
0.25	18667
0.62	23468
1.00	29335
4.00	58670
9.00	88005

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PROJECT C-481-A
DESIGN OF WATER PLANT

DATE: 20th July 1951
BY: [Signature]

Outfall Structure

Spillway Chute

$$Q = 268,000 \text{ gpm } \text{ say } 600 \text{ cfs}$$

$$Q/ft = 600/10 = 60$$

$$\text{Critical Depth} = \sqrt[3]{\frac{60^2}{32.2}} = 4.82'$$

Normal Depth in Chute (Approx.)

$$Q/ft = \frac{1.486}{2.48} d \cdot R^{2/3} S^{1/2} \quad \text{Now let } R = d$$

$$d = \left(\frac{60 \times 0.012}{1.486 \times 1.087} \right)^{3/2} = 1.375 \text{ ft.}$$

Check 1.50 as normal depth.

$$Q = 15 \times \frac{1.486}{0.012} (1.115)^{2/3} 0.33 = 584 \text{ cfs.}$$

$$\text{Normal Depth} = \underline{1.55 \text{ ft}}$$

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PROJECT C-431-A
DESIGN OF WATER PLANT

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BY 27 July 1956
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Division

Outfall Structure

Spillway Chute

Drawdown Curve by Breese's Method.

Normal Depth 1.55 ft.
Critical Depth 4.82 ft.

$$X = \frac{y}{S_0} z - \frac{y}{S_0} \left(\frac{1}{S_0} - \frac{C^2}{g} \right) \Phi(z) \quad z = \frac{y}{h}$$

$$X = \frac{1.55}{0.1089} z - 1.55 \left(\frac{1}{0.1089} - \frac{112^2}{32.2} \right) \Phi(z)$$

$$X = 14.22 z - 1.55 (9.78 - 401) \Phi(z)$$

$$X = 14.22 z - 619 \Phi(z)$$

$z = \frac{y}{h}$	$\Phi(z)$	$14.22z$	$619 \Phi(z)$	X	Dist. from Structure
3.1	0.0527	44.08	32.62	+ 11.46	0
2.6	0.0757	36.97	46.86	+ 9.89	157
2.1	0.1186	29.86	73.41	- 43.45	54.91
1.8	0.1462	25.60	102.87	- 77.30	88.76
1.5	0.2548	21.33	157.72	- 136.4	147.9
1.4	0.3039	19.92	182.21	- 162.3	179.7
1.3	0.3731	18.50	230.95	- 212.5	224.0
1.2	0.4798	17.06	297.80	- 280.8	291.5
1.15	0.5608	16.25	347.8	- 331.6	352.6
1.12	0.6260	15.94	391.00	- 375.1	403.0
1.10	0.6685	15.64	417.20	- 401.6	430.0
1.05	0.8957	14.93	554.10	- 539.2	560.0
1.01	1.0192	14.36	628.20	- 614.8	635.0

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PROJECT C-431-A
DESIGN OF C WATER PLANT

Sheet No. 12 of 17
Date 2/2/51
Checked 1/2/51

Subject

Division

Outfall Structure

Trash racks:

Length of racks - $124' 12" = 2474"$

Make Net Length $24' 6"$

Use Two Rack @ $12' 3"$ each

Width

$12' 3"$

$$M = \frac{1}{8} w l^2 = \frac{1}{8} w \times 12.33^2 = 19.00 w$$

$$S = \frac{19.00 \times W \times 12}{20,000}$$

Allowable stress
 $= 20,000 \text{ psi}$

$$W = \frac{20,000 \times S}{19 \times 12} = 92.65$$

$$4" \text{ Std I @ } 7.7 = 72.6 \times 3.0 = 217.8$$

$$5" \text{ Std I @ } 10.0 = 72.6 \times 4.8 = 348.5$$

$$5" \text{ Std I @ } 14.75 = 72.6 \times 6.0 = 435.6$$

$$\frac{535.6}{3} = 178.5 \text{ #/ft. } \approx 3 \text{ differential Head}$$

Use $5" \text{ I @ } 14.75$

Estimated wt

48 bars $2 \times \frac{3}{8} \times 121.3 = 1500 \text{ #}$
4-5L @ $9.00 \times 121.3 = 441 \text{ #}$
3-5I @ $14.75 \times 121.3 = 540 \text{ #}$

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DOWN ON C WATER PLANT

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Outline Structure

Touch Packs

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PROJECT C-431-A
DESIGN OF C WATER PLANT

Sheet No. 14 of 14
Date 2-2-59
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Division

Outfall Structure

Trash Rack Guides

Scale 3" = 1'-0"
Trash Rack Guide

For Stop End Slot
Use 24x3x1/2" and
make Dimension (A) 9"
Use Suitable Anchors
for anchoring to concrete

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