UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

HYDRAULIC MODEL STUDIES OF THE SILVER JACK DAM OUTLET WORKS BYPASS, BOSTWICK PARK PROJECT, COLORADO

Report No. Hyd-568

Hydraulics Branch
DIVISION OF RESEARCH

OFFICE OF CHIEF ENGINEER
DENVER, COLORADO

December 12, 1966

CONTENTS

ABSTRACT

A 1:2.857 scale model of the 12-in. outlet works bypass pipe, controlled by a 10-in. jet-flow gate, for Silver Jack Dam, Colorado, operated satisfactorily when positioned correctly with relation to the stilling basin. Surface flow and penetration in the main outlet works stilling basin caused by the jet from the bypass pipe were observed. Air demand immediately downstream of the gate, supplied by flow upstream through the main pipe and by flow through the air vent pipe, was investigated.

DESCRIPTORS-- small structures/ stilling basins/ *wave action/ *air demand/ closed conduits/ hydraulic models/ jets/ *penetration/ model tests/ outlet works/ energy absorption/ hydraulic gates and valves
IDENTIFIERS-- Silver Jack Dam, Colo/ Bostwick Park Project, Colo/ *jet-flow gates/ *bypass pipes

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

Office of Chief Engineer
Division of Research
Hydraulics Branch
Denver, Colorado
December 12, 1966

Report No. Hyd-568
Author: W. F. Arris
Checked by: T. J. Rhone
Reviewed by: W. E. Wagner
Submitted by: H. M. Martin

HYDRAULIC MODEL STUDIES OF THE SILVER JACK DAM OUTLET WORKS BYPASS, BOSTWICK PARK PROJECT, COLORADO

PURPOSE

The model study was made to determine the operating characteristics of the outlet works bypass discharging a maximum design flow of 36 cfs (cubic feet per second) into the main outlet works stilling basin. Air demand immediately downstream of the jet-flow gate was also investigated.

CONCLUSIONS

1. The preliminary lateral angle of 9° with a 30° vertical deflection angle, centered the impact of the jet in the basin and created a minimum of turbulence and spray, Figure 6. There was adequate clearance between the jet and the blockout floor for all discharges, Figure 7. Penetration occurred well upstream in the basin for the 30° angle.

2. The gate was adequate to pass all discharges, and the downstream pipe was large enough to contain the diffused flow and form a smooth jet.

3. Sand and rock placed in the basin was either carried out of the basin or lodged at the base of the sloping floor of the basin.

4. Most of the air demand was satisfied by airflow upstream through the discharge pipe. Gate openings from 80 to 100 percent of maximum created a sharp rise in airflow through the air vent pipe, but tests showed that a large percent of the total air was still flowing up the discharge pipe.

INTRODUCTION

Silver Jack Dam, a feature of the Bostwick Park Project in western Colorado, is located on Cimarron Creek about 25 miles southeast of Montrose, Figure 1. The earthfill dam has a height of 138 feet above the creek bed, a length of 1,070 feet at the crest, and a fill volume of 1,260,000 cubic yards. The hydraulic features include a spillway, an outlet works, and an outlet works bypass, the subject of this report.

The 12-inch-diameter outlet works bypass, controlled by a 10-inch jet-flow gate, 1/ will be used to discharge small quantities of water to satisfy downstream water rights during the winter. The bypass extends from the side of the right outlet conduit just downstream of the wye branch, Figure 2, bypasses the 2-foot 3-inch square main outlet works high-pressure slide gates, and discharges into the right half of the main outlet works stilling basin, Figure 3. The jet-flow gate is in the outlet works control house near the downstream end of the bypass. A 16-inch (prototype dimensions) inside-diameter pipe extends 19.5 inches downstream from the gate and connects to a 32.5-inch length of 17.62-inch-inside-diameter pipe. This pipe carries the flow through the control house wall and directs the jet into the right half of the stilling basin through a blockout in the right sidewall of the basin. A 2.76-inch-inside-diameter vent pipe attached at the top centerline of the discharge pipe 3.56 inches downstream of the face of the jet-flow gate provided air to the gate.

THE MODEL

The model was built to a scale ratio of 1:2.857 so that an available 3.5-inch-diameter jet-flow gate could be used to represent the 10-inch-diameter prototype gate. The model included the jet-flow gate, the downstream pipe, and a portion of the right half of the outlet works stilling basin, Figure 4. The pipe bends upstream of the jet-flow gate were not modeled; instead, a straight 30-inch-long section of 3.5-inch-diameter pipe was attached to the upstream face of the gate; the straight pipe was attached to the permanent laboratory supply system with 8 feet of 3-inch-inside-diameter flexible hose.

The gate and pipe assembly was pivoted for vertical movement at the pipe centerline 1-foot (model) downstream of the gate; horizontal movement could be made by shifting the baseplate on its mount. Pressure head was measured 1 diameter upstream from the gate by four piezometer taps connected to a common line leading to a mercury manometer. Discharges were measured with volumetrically calibrated Venturi meters. Airflow through the air vent pipe was measured by a sharp-edged orifice and an open-tube water manometer.

1/ Refers to reference at end of report.

Water surface levels in the stilling basin were controlled by an adjustable tailgate, and the elevations were measured by a staff gage on the wall of the basin near the downstream end of the model. The portion of the basin represented in the model extended from Station 9+30 downstream 53.5 feet to the tailgate which was 23.5 feet upstream from the end of the prototype basin. A glass window mounted in the right basin sidewall extended 23 feet downstream from Station 9+54, and vertically 7 feet above the basin floor to allow an area below the water surface to be viewed. All model data presented in prototype form were computed according to Froudian relationships.

THE INVESTIGATION

Operating Conditions

The normal design discharge for the outlet works bypass is 8 cfs, and the maximum discharge is 36 cfs; intermediate discharges of 9, 18, and 27 cfs were also observed in the model. The pressure head, measured 1 diameter upstream of the jet-flow gate, was computed and set in the model. With the computed pressure head, the maximum design discharge of 36 cfs could be obtained with a 100 percent gate opening.

The water surface elevation in the stilling basin for the range of bypass discharges and assuming no flow from the outlets is shown on Figure 5.

Alinement of the Gate and Pipe Assembly

The model gate and pipe assembly was adjustable so that the alinement which would provide the smoothest flow in the basin could be determined. In the preliminary design, the gate and pipe assembly was set to direct the jet into the basin at a lateral angle of 9° relative to the basin centerline. This angle was satisfactory and was not changed during the tests.

20° vertical deflection angle. --The preliminary vertical deflection angle for the gate and pipe assembly was 20° below the horizontal. Surface flow for this arrangement was generally very turbulent with high waves, foam, and splashing extending far down the length of the basin. The high boil due to the impact of the jet against the water surface struck the center wall, Figures 6A and B. There was only a small clearance between the jet and the right basin wall for all discharges.

The point of impact of the jet on the water surface varied from Station 9+52 at 36-cfs discharge to Station 9+55 at the 8-cfs discharge. The maximum depth of the jet penetration varied from 10 feet below the average water surface at Station 9+69 for 36 cfs to 3 feet below the average water surface at Station 9+59 for the 8-cfs discharge.

The 20° vertical deflection angle was considered undesirable because of the turbulent surface flow conditions. Therefore, other angles were tested to obtain more efficient energy dissipation.

30° vertical deflection angle (approved). --Increasing the vertical deflection angle to 30° caused the jet to hit the water surface near the center of the basin pool and provided smoother flow conditions for all discharges, Figures 6C and D. Surface roughness, waves, foam, and splashing were less than for the previous test and did not extend as far downstream. The boil at the jet impact area rose about 3 feet above the water surface at 36-cfs discharge, but the waves along either side of the basin and downstream from the boil were 1 foot high or less. The pool upstream of the jet was smooth but surged about 6 inches vertically with the average water surface about a foot lower than the tailwater. There was adequate clearance between the jet and the sidewall and between the jet and the floor of the blockout under the jet for all discharges, Figure 7.

The depth of penetration was the same for the 30° deflection as it was for the 20° deflection for corresponding discharges. The 10° increase in vertical deflection angle caused the location of jet impact to move upstream about 8 feet for all discharges and the region of maximum jet penetration to move upstream about 9 feet at 8-cfs discharge and about 14 feet at 36-cfs discharge. On striking the stilling pool, the jet was centered in the basin with no impingement on the center wall.

Sand and rock placed in the basin was either carried out of the basin or lodged at the bottom end of the sloping floor at the upstream end of the basin.

A 35° vertical deflection angle for the gate and pipe assembly was also tested; however, the lower surface of the jet hit the floor of the blockout. It was not desirable to lower the bottom of the blockout, so this test was not continued.

Satisfactory flow conditions in the basin were obtained with the 9° lateral angle (from the preliminary design) and the 30° vertical deflection angle derived from the investigation; therefore, this arrangement of the gate and pipe assembly was approved for prototype installation.

Air Demand

The prototype air vent pipe extended from the downstream side of the gate about 3 feet through the control house wall to the atmosphere; however, in the model only a short stub was placed on the pipe on the downstream side of the gate, Figure 4. The rate of airflow through this pipe stub connection was measured with a sharp-edged orifice placed in the end of a 2.2-inch-inside-diameter air chamber. The differential head of air across the orifice was measured with a U-tube water manometer and the quantity of airflow was computed from the equation

$$Q = CA\sqrt{2gH}$$

where C = coefficient of discharge (0.60)
A = area of orifice
H = differential head in feet of air corrected for temperature and barometric pressure

Airflow through the air vent pipe was negligible for gate openings of 60 percent or less. For these gate openings the aerated water did not fill the pipe downstream of the gate, and the air required at the gate flowed up the unfilled portion of the discharge pipe. There was airflow through the vent pipe for gate openings greater than 60 percent and air demand data were obtained for gate openings of 80 and 100 percent for both the 20° and 30° vertical deflection angles. The air demand at the large gate openings was directly proportional to the water discharge and was greater for the 20° vertical deflection angle than for the 30° angle, Figure 8.

Although the discharge pipe downstream of the gate flowed nearly full of air-saturated water at or near maximum discharge, air was observed moving upstream through the pipe against the main flow, even during the maximum design discharge and also with a 100 percent gate opening. The end of the discharge pipe was partially blocked to prevent air from entering by this access. This partial restriction caused a sharp increase in airflow through the vent pipe, indicating that a large amount of the total air demand was normally supplied through the discharge pipe.

Previous model tests2/ of jet-flow gate discharging into a horizontal conduit showed the effect of lengthening the downstream conduit on the airflow through a vent pipe. Although the airflow in the downstream conduit was erratic, generally the flow of air through the vent increased as the conduit length was increased. In the cited test for a downstream length of 3.72 D (D = downstream conduit width) the vent airflow was 0.5 cfs, or less, up to 80 percent gate opening but rose sharply as the gate was opened to 100-percent full open.

> "An appreciable, but unmeasured portion of the total air demand of the system was supplied by air entering at the outlet end of the conduit and moving upstream along the top of the fluidway. This re-entrant air was particularly noticeable with the shortest conduits; however, even with a conduit length of 18.58 D_2, a small part of the total air demand appeared to be obtained in this manner."2/

The Silver Jack tests indicated that the bypass air vent pipe was more than adequate and probably would never be required to supply more than a small percent of the total air demand. The pipe downstream of the jet-flow gate was of adequate size to carry the air-saturated water jet and to provide partial aeration at all discharges.

REFERENCES

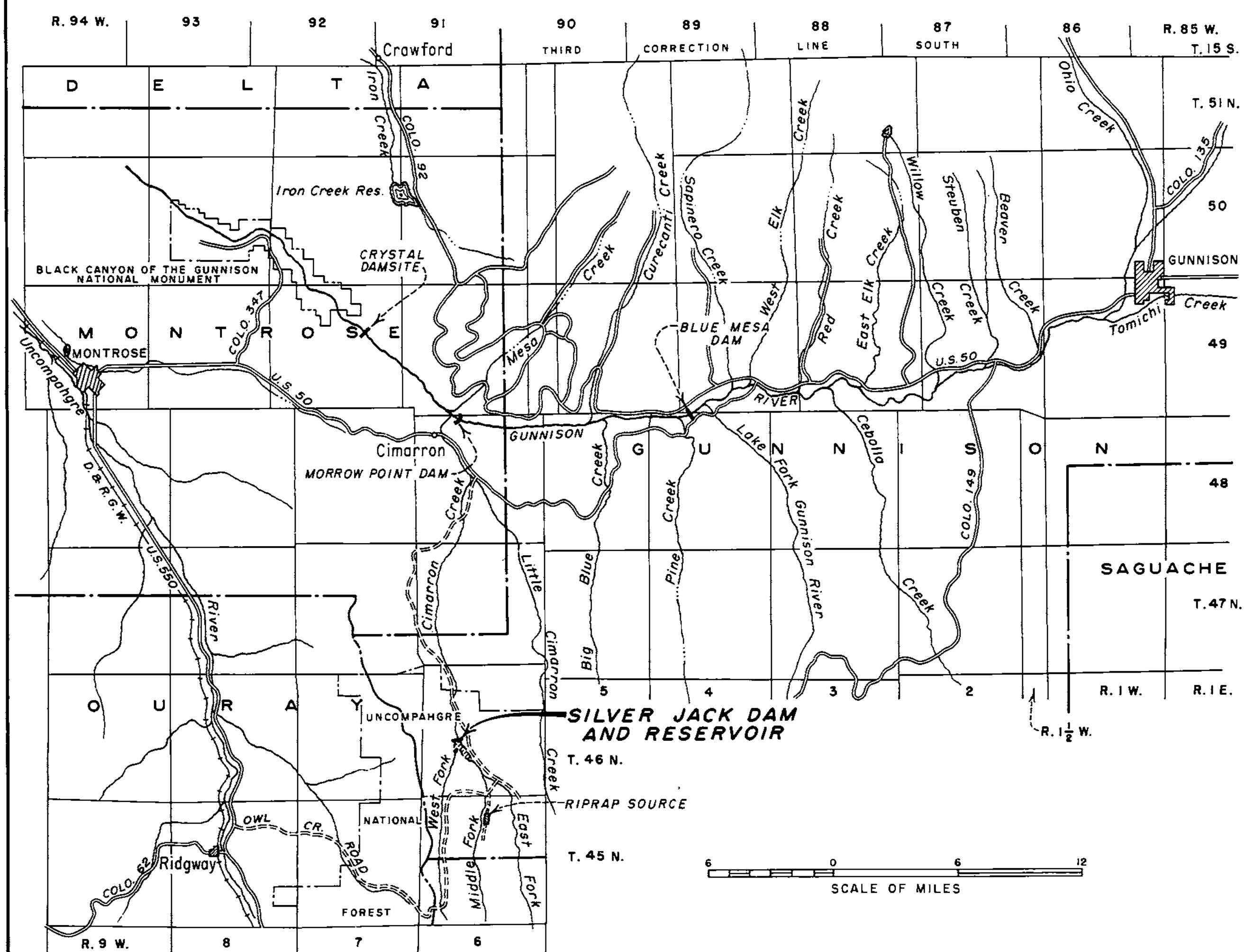
1. "The Hydraulic Design of a Control Gate for the 102-Inch Outlets in Shasta Dam," by F. C. Lowe, Report No. Hyd-201, USBR.

2. "Hydraulic Model Studies of the Trinity Dam Auxiliary Outlet Works Jet-Flow Gate--Central Valley Project, California," by W. P. Simmons, Jr., Report No. Hyd-472, USBR.

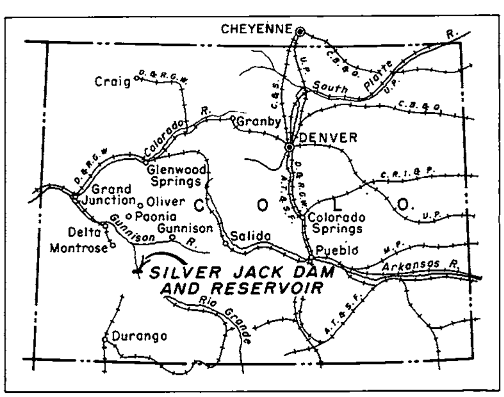
Table 1

DIMENSIONS OF IMPORTANT FEATURES

Feature	English units	Metric units
Height of dam	138 feet	42.06 meters
Length of dam at crest	1,070 feet	326.14 meters
Outlet works bypass pipe, diameter	12 inches	30.48 centimeters
Jet-flow gate, diameter	10 inches	25.40 centimeters
Air pipe, diameter	2.76 inches	7.01 centimeters
Basin length (downstream of sloping floor)	53 feet	16.15 meters
Basin width (right half)	8 feet	2.44 meters
Maximum design discharge	36 cfs	1.02 cms



NOTE: Cimarron Creek is also known as
Cimarron River and Big Cimarron River.



KEY MAP

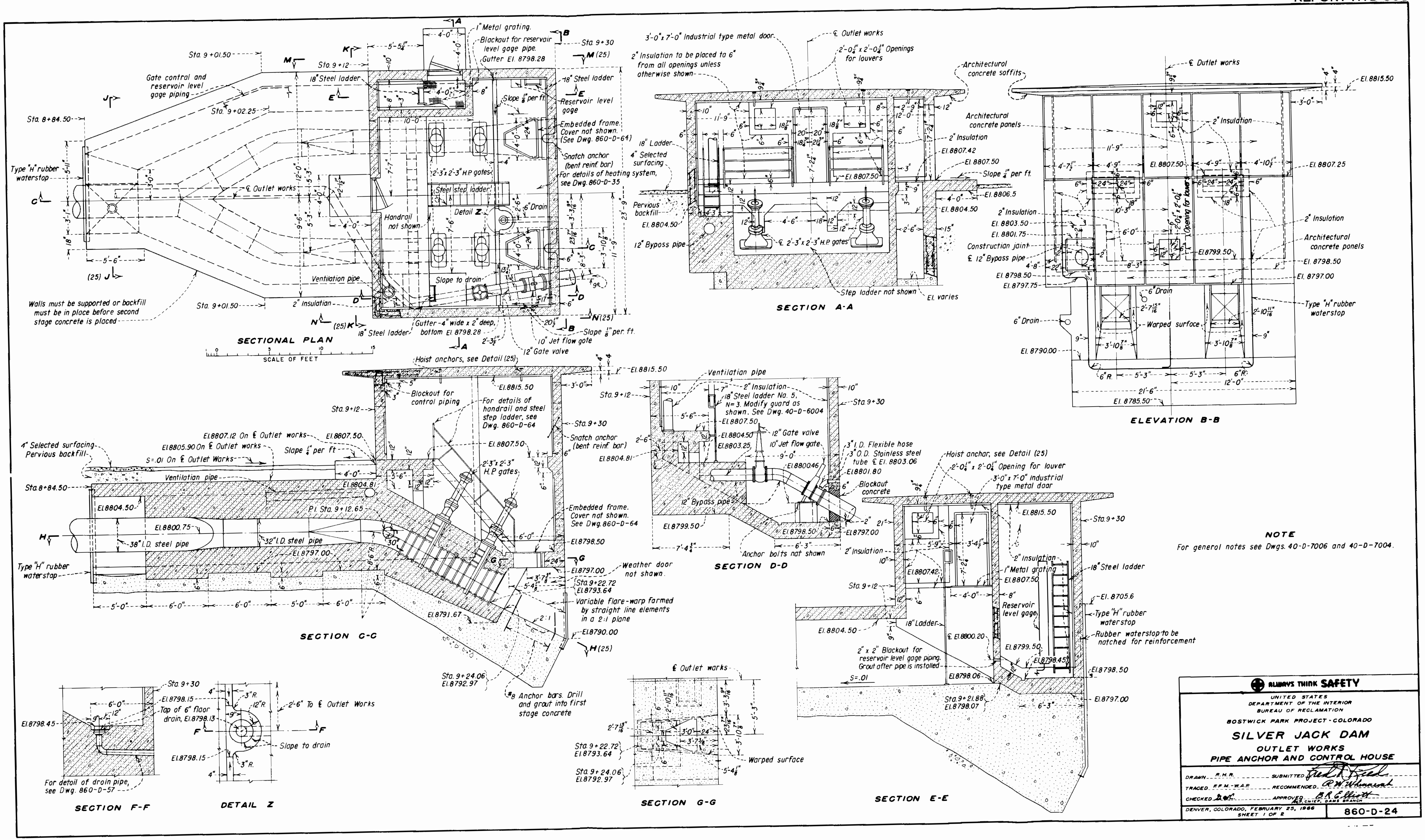
ALWAYS THINK SAFETY

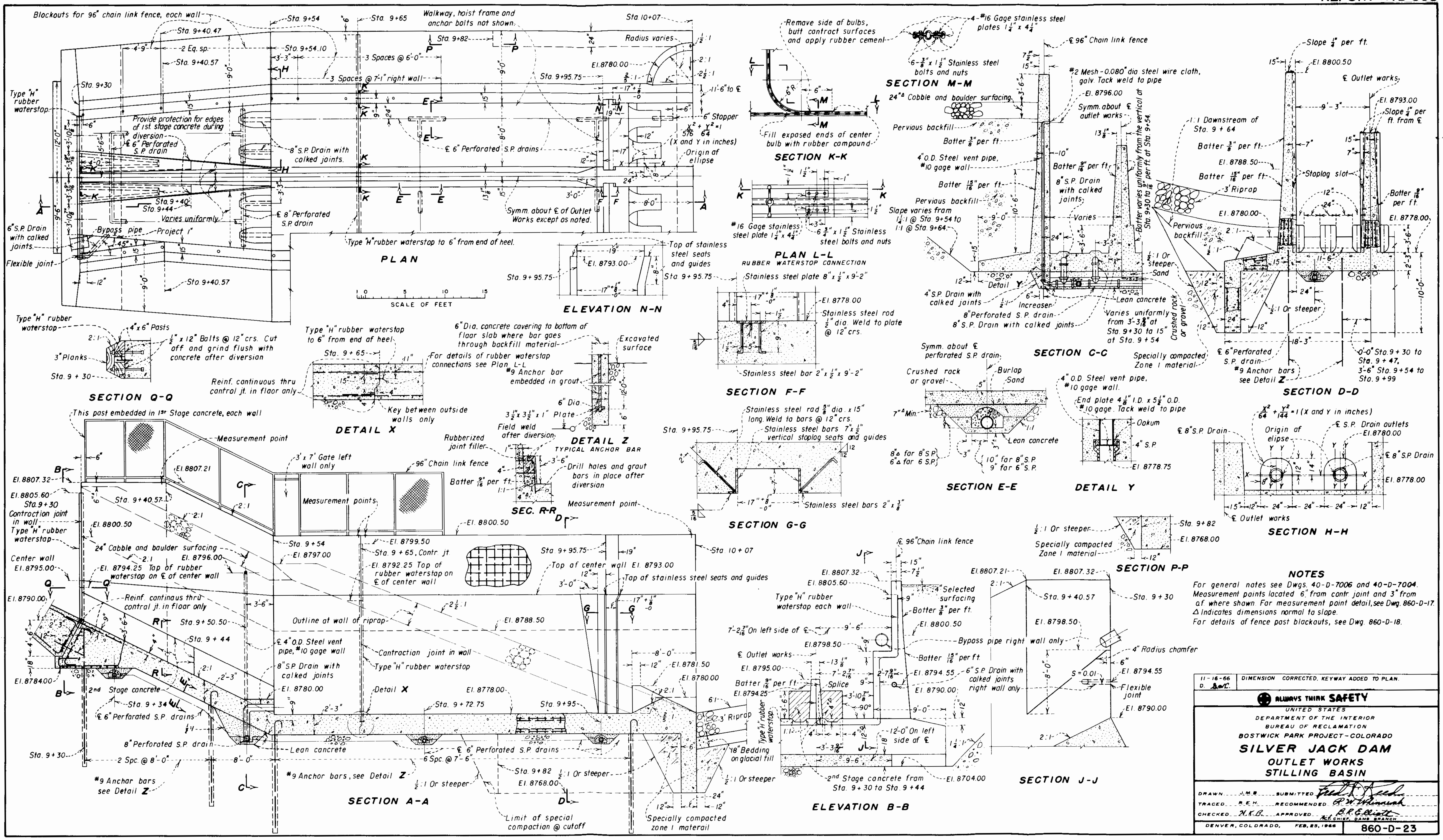
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOSTWICK PARK PROJECT - COLORADO

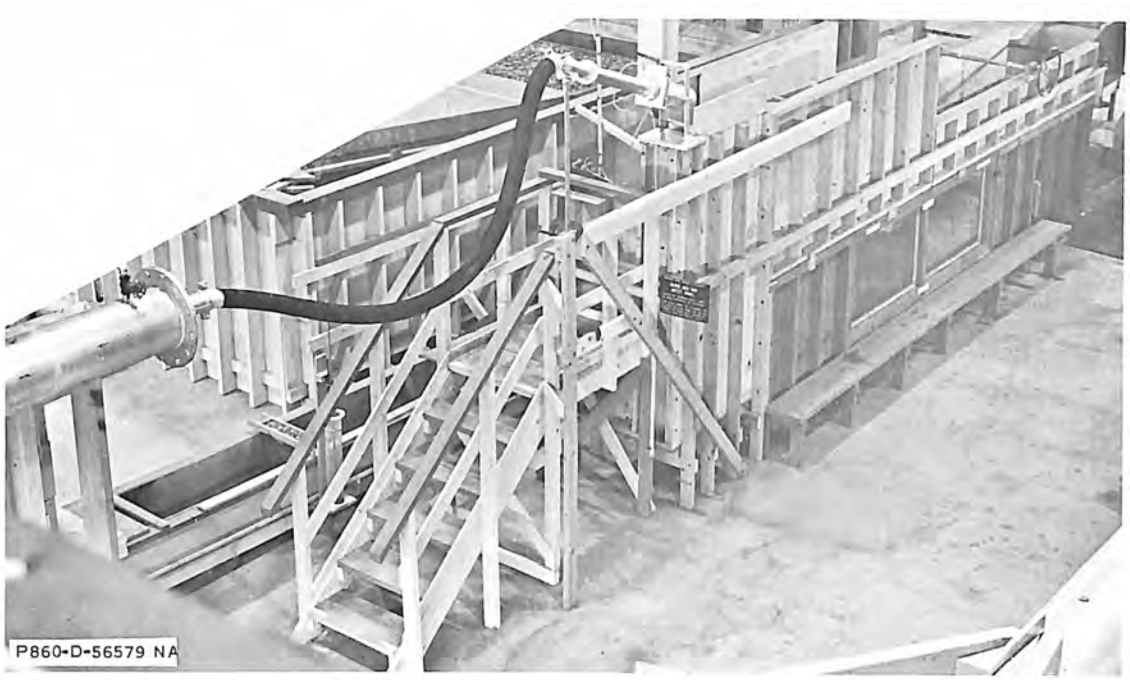
SILVER JACK DAM
LOCATION MAP

DRAWN R.W.K. SUBMITTED R. J. Larsen
TRACED G.L.S. RECOMMENDED
CHECKED APPROVED
ACTING CHIEF ENGINEER
DENVER, COLORADO, FEB. 1, 1966 860-D-3

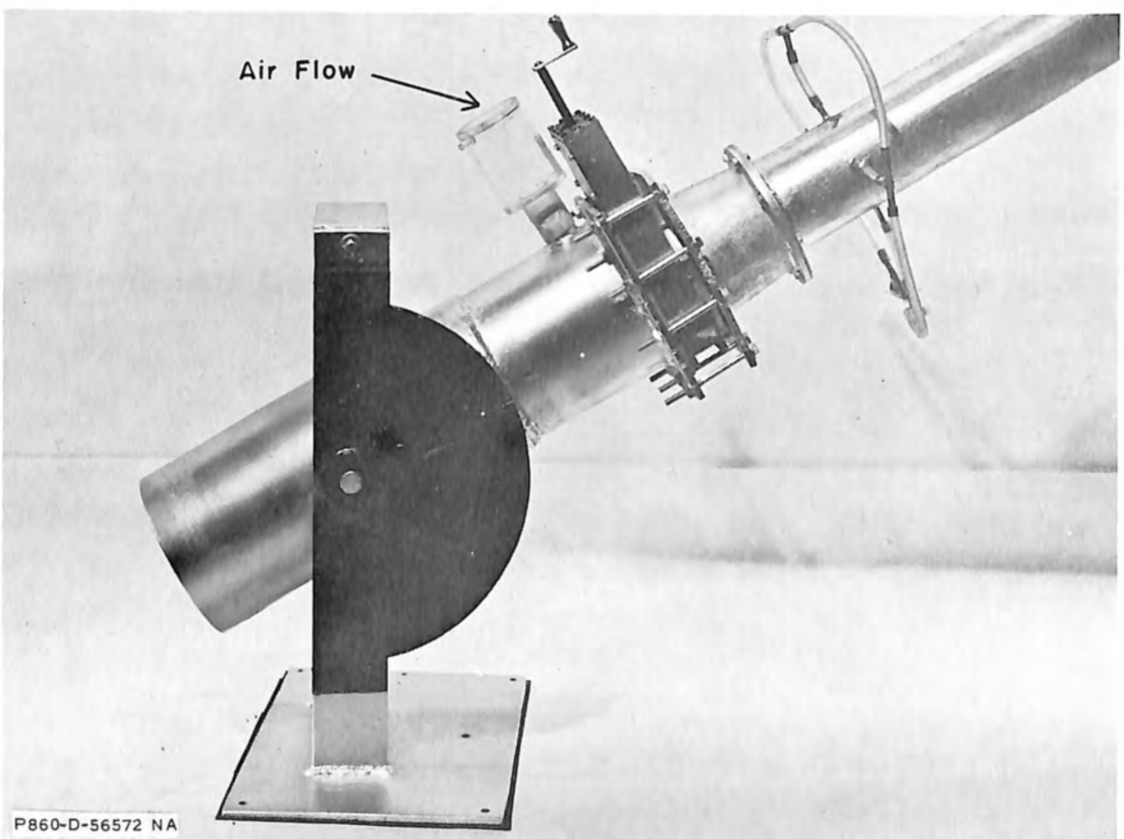
FIGURE 2
REPORT HYD-568




PLAN
ELEVATION N-N
SECTION M-M
SECTION K-K
PLAN L-L
RUBBER WATERSTOP CONNECTION
SECTION C-C
SECTION D-D
SECTION Q-Q
DETAIL X
DETAIL Z
TYPICAL ANCHOR BAR
SEC. R-R
SECTION F-F
SECTION G-G
SECTION E-E
DETAIL Y
SECTION H-H
SECTION P-P
SECTION A-A
ELEVATION B-B
SECTION J-J
SCALE OF FEET
NOTES
For general notes see Dwgs. 40-D-7006 and 40-D-7004.
Measurement points located 6" from contr joint and 3" from ℄ where shown. For measurement point detail, see Dwg. 860-D-17.
Δ Indicates dimensions normal to slope.
For details of fence post blockouts, see Dwg. 860-D-18.
11-16-66 DIMENSION CORRECTED, KEYWAY ADDED TO PLAN.
ALWAYS THINK SAFETY
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOSTWICK PARK PROJECT-COLORADO
SILVER JACK DAM
OUTLET WORKS
STILLING BASIN
DRAWN J.M.B. SUBMITTED
TRACED R.E.M. RECOMMENDED
CHECKED H.K.B. APPROVED
DENVER, COLORADO, FEB. 25, 1966
860-D-23



Overall view of model.

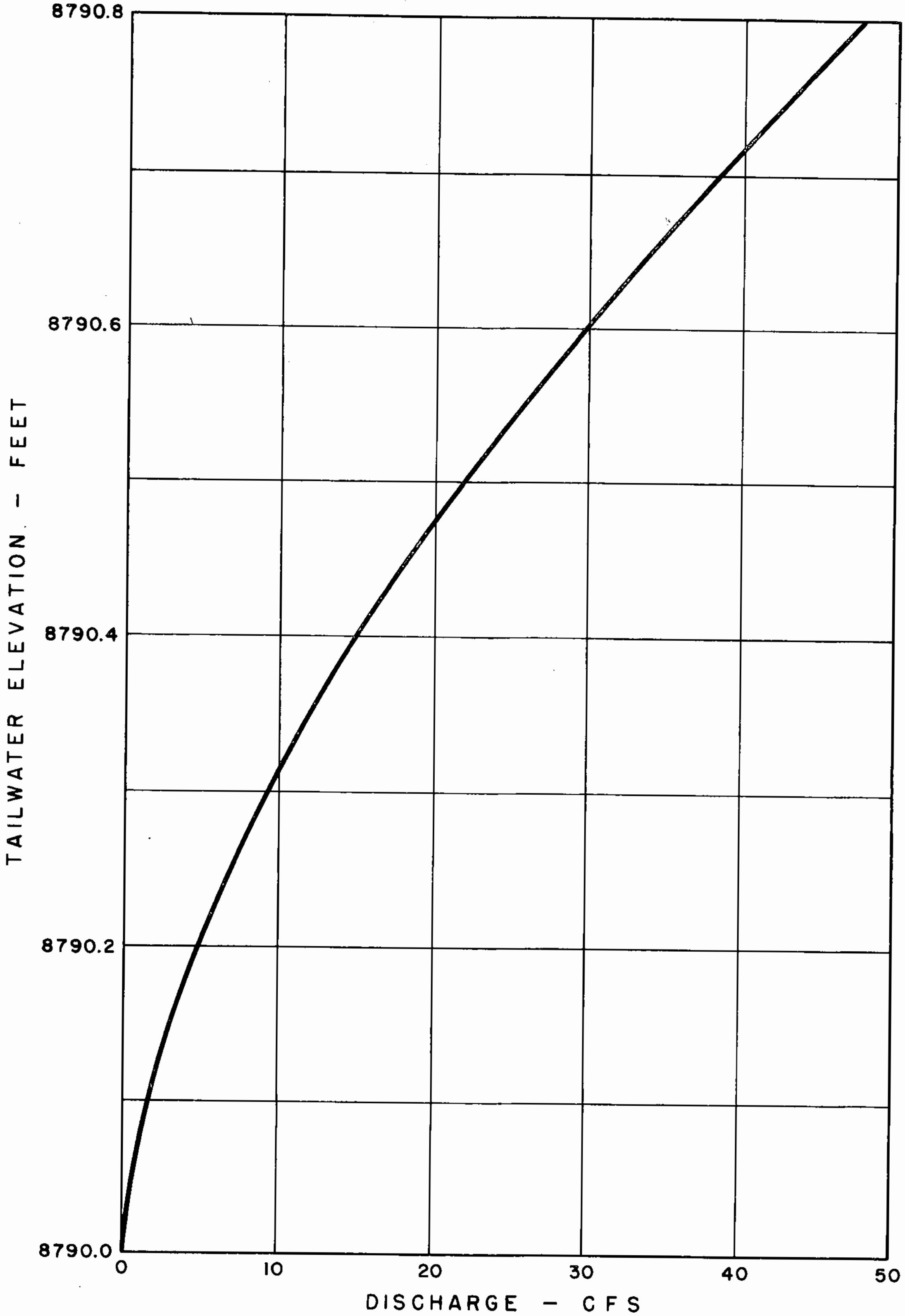


Jet-flow gate, downstream pipe, and air supply vent.

SILVER JACK DAM
OUTLET WORKS BYPASS

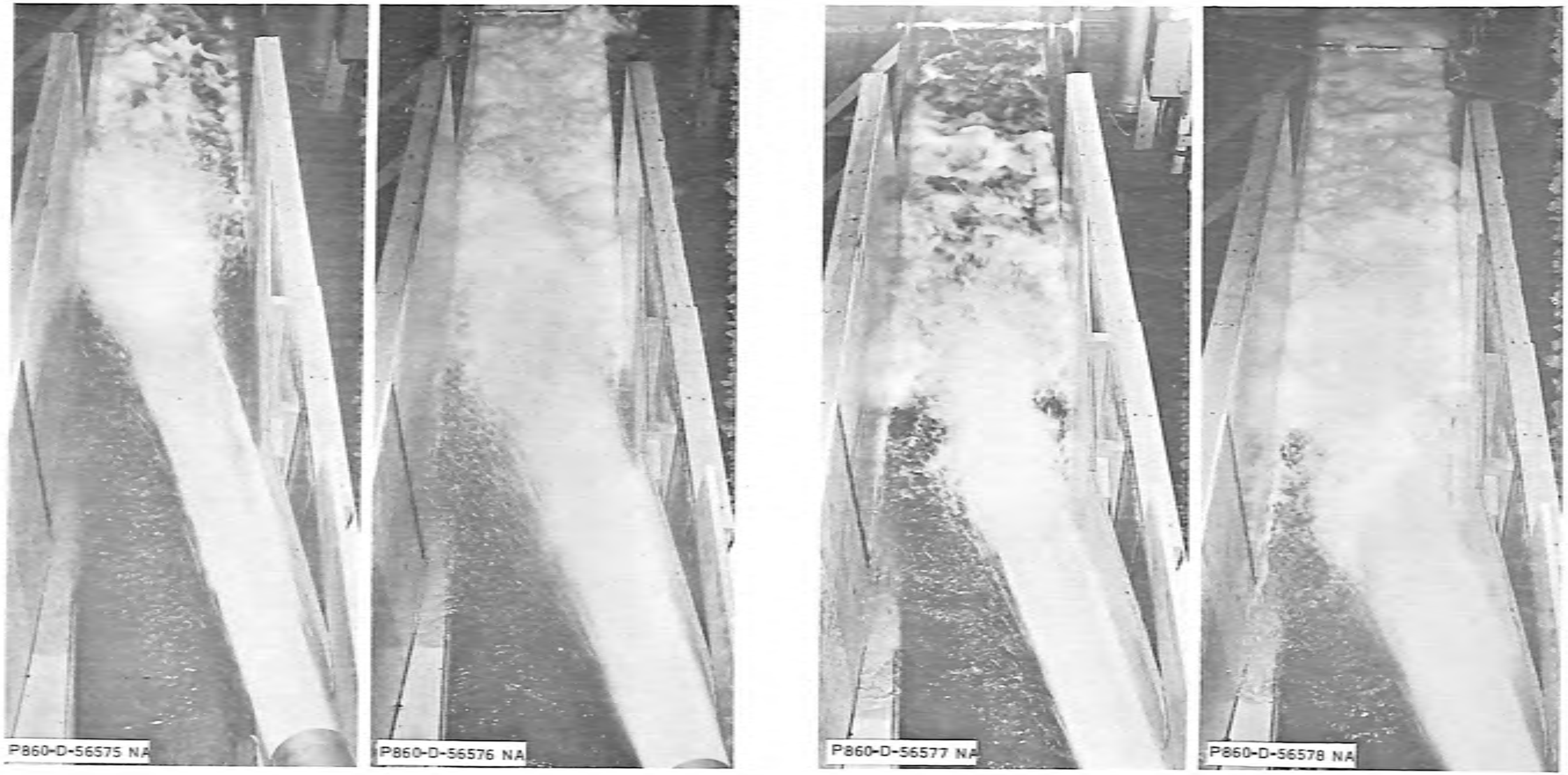
The 1:2.857 Scale Model

FIGURE 5
REPORT HYD-568



SILVER JACK DAM
OUTLET WORKS BY-PASS
TAILWATER ELEVATION VS. DISCHARGE
1:2.857 SCALE MODEL

714



A. Discharge 8 cfs 98 feet of head

B. Discharge 36 cfs 59 feet of head

C. Discharge 8 cfs 98 feet of head

D. Discharge 36 cfs 59 feet of head

Gate and pipe assembly set at 20-degree vertical deflection angle.

Gate and pipe assembly set at 30-degree vertical deflection angle.

SILVER JACK DAM
OUTLET WORKS BYPASS

Surface flow in stilling basin

1:2.857 scale model

Above - Discharge 36 cfs
59 feet of head

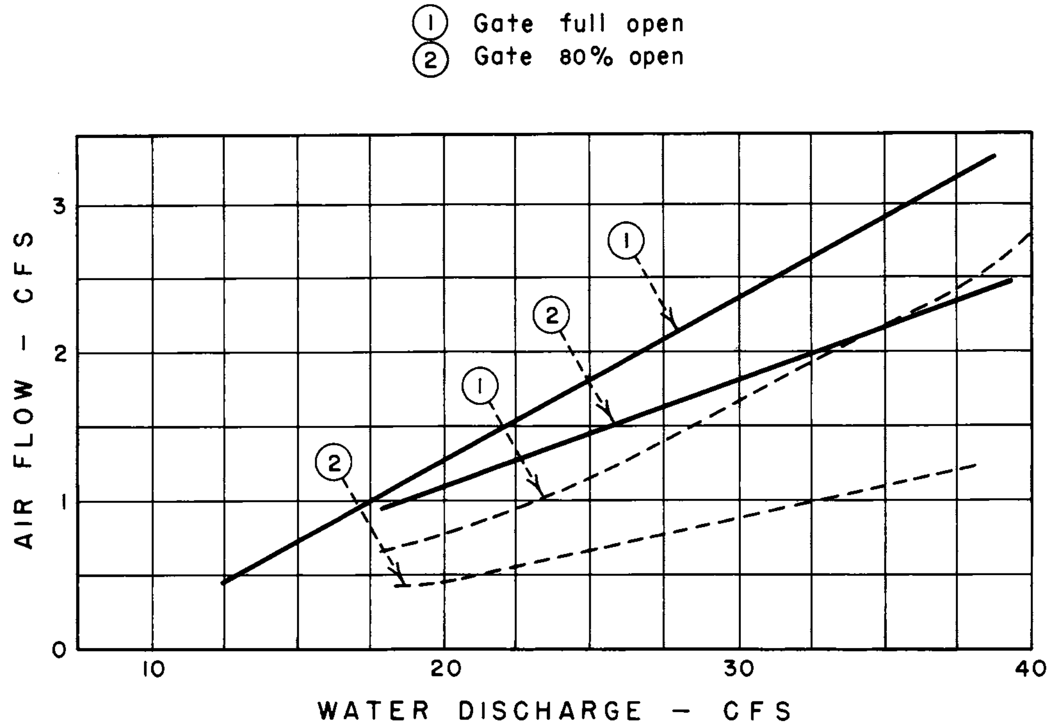
Right - Discharge 8 cfs
98 feet of head

Gate and pipe assembly set at
30-degree vertical deflection angle.

SILVER JACK DAM
OUTLET WORKS BYPASS

Clearance between jet and blockout floor

1:2.857 scale model



——— Gate and pipe assembly set at 20-degrees vertical deflection angle below horizontal.

- - - - Gate and pipe assembly set at 30-degrees vertical deflection angle below horizontal.

The above curves show the effect on the quantity of air flow through the air vent pipe by changing the vertical deflection angle of the gate and pipe assembly.

SILVER JACK DAM
OUTLET WORKS BY-PASS

AIR FLOW THROUGH AIR VENT PIPE

1:2.857 SCALE MODEL

CONVERSION FACTORS--BRITISH TO METRIC UNITS OF MEASUREMENT

The following conversion factors adopted by the Bureau of Reclamation are those published by the American Society for Testing and Materials (ASTM Metric Practice Guide, January 1964) except that additional factors (*) commonly used in the Bureau have been added. Further discussion of definitions of quantities and units is given on pages 10-11 of the ASTM Metric Practice Guide.

The metric units and conversion factors adopted by the ASTM are based on the "International System of Units" (designated SI for Systeme International d'Unites), fixed by the International Committee for Weights and Measures; this system is also known as the Giorgi or MKSA (meter-kilogram (mass)-second-ampere) system. This system has been adopted by the International Organization for Standardization in ISO Recommendation R-31.

The metric technical unit of force is the kilogram-force; this is the force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 9.80665 m/sec/sec, the standard acceleration of free fall toward the earth's center for sea level at 45 deg latitude. The metric unit of force in SI units is the newton (N), which is defined as that force which, when applied to a body having a mass of 1 kg, gives it an acceleration of 1 m/sec/sec. These units must be distinguished from the (inconstant) local weight of a body having a mass of 1 kg; that is, the weight of a body is that force with which a body is attracted to the earth and is equal to the mass of a body multiplied by the acceleration due to gravity. However, because it is general practice to use "pound" rather than the technically correct term "pound-force," the term "kilogram" (or derived mass unit) has been used in this guide instead of "kilogram-force" in expressing the conversion factors for forces. The newton unit of force will find increasing use, and is essential in SI units.

Table 1

QUANTITIES AND UNITS OF SPACE

Multiply	By	To obtain
	LENGTH	
Mil	25.4 (exactly)	Micron
Inches	25.4 (exactly)	Millimeters
	2.54 (exactly)*	Centimeters
Feet	30.48 (exactly)	Centimeters
	0.3048 (exactly)*	Meters
	0.0003048 (exactly)*	Kilometers
Yards	0.9144 (exactly)	Meters
Miles (statute)	1,609.344 (exactly)*	Meters
	1.609344 (exactly)	Kilometers
	AREA	
Square inches	6.4516 (exactly)	Square centimeters
Square feet	929.03 (exactly)*	Square centimeters
	0.092903 (exactly)	Square meters
Square yards	0.836127	Square meters
Acres	0.40469*	Hectares
	4,046.9*	Square meters
	0.0040469*	Square kilometers
Square miles	2.58999	Square kilometers
	VOLUME	
Cubic inches	16.3871	Cubic centimeters
Cubic feet	0.0283168	Cubic meters
Cubic yards	0.764555	Cubic meters
	CAPACITY	
Fluid ounces (U.S.)	29.5737	Cubic centimeters
	29.5729	Milliliters
Liquid pints (U.S.)	0.473179	Cubic decimeters
	0.473166	Liters
Quarts (U.S.)	9,463.58	Cubic centimeters
	0.946358	Liters
Gallons (U.S.)	3,785.43*	Cubic centimeters
	3.78543	Cubic decimeters
	3.78533	Liters
	0.00378543*	Cubic meters
Gallons (U.K.)	4.54609	Cubic decimeters
	4.54596	Liters
Cubic feet	28.3160	Liters
Cubic yards	764.55*	Liters
Acre-feet	1,233.5*	Cubic meters
	1,233,500*	Liters

Table II

QUANTITIES AND UNITS OF MECHANICS

Multiply	By	To obtain
MASS		
Grains (1/7,000 lb)	64.79891 (exactly)	Milligrams
Troy ounces (480 grains)	31.1035	Grams
Ounces (avdp)	28.3495	Grams
Pounds (avdp)	0.45359237 (exactly)	Kilograms
Short tons (2,000 lb)	907.185	Kilograms
	0.907185	Metric tons
Long tons (2,240 lb)	1,016.05	Kilograms
FORCE/AREA		
Pounds per square inch	0.070307	Kilograms per square centimeter
	0.689476	Newtons per square centimeter
Pounds per square foot	4.88243	Kilograms per square meter
	47.8803	Newtons per square meter
MASS/VOLUME (DENSITY)		
Ounces per cubic inch	1.72999	Grams per cubic centimeter
Pounds per cubic foot	16.0185	Kilograms per cubic meter
	0.0160185	Grams per cubic centimeter
Tons (long) per cubic yard	1.32894	Grams per cubic centimeter
MASS/CAPACITY		
Ounces per gallon (U.S.)	7.4893	Grams per liter
Ounces per gallon (U.K.)	6.2362	Grams per liter
Pounds per gallon (U.S.)	119.829	Grams per liter
Pounds per gallon (U.K.)	99.779	Grams per liter
BENDING MOMENT OR TORQUE		
Inch-pounds	0.011521	Meter-kilograms
	1.12985×10^{6}	Centimeter-dynes
Foot-pounds	0.138255	Meter-kilograms
	1.35582×10^{7}	Centimeter-dynes
Foot-pounds per inch	5.4431	Centimeter-kilograms per centimeter
Ounce-inches	72.008	Gram-centimeters
VELOCITY		
Feet per second	30.48 (exactly)	Centimeters per second
	0.3048 (exactly)*	Meters per second
Feet per year	0.965873×10^{-6}*	Centimeters per second
Miles per hour	1.609344 (exactly)	Kilometers per hour
	0.44704 (exactly)	Meters per second
ACCELERATION*		
Feet per second^2	0.3048*	Meters per second^2
FLOW		
Cubic feet per second (second-feet)	0.028317*	Cubic meters per second
Cubic feet per minute	0.4719	Liters per second
Gallons (U.S.) per minute	0.06309	Liters per second

Multiply	By	To obtain
FORCE*		
Pounds	0.453592*	Kilograms
	4.4482*	Newtons
	4.4482×10^{-5}*	Dynes
WORK AND ENERGY*		
British thermal units (Btu)	0.252*	Kilogram calories
	1,055.06	Joules
Btu per pound	2.326 (exactly)	Joules per gram
Foot-pounds	1.35582*	Joules
POWER		
Horsepower	745.700	Watts
Btu per hour	0.293071	Watts
Foot-pounds per second	1.35582	Watts
HEAT TRANSFER		
Btu in./hr ft^2 deg F (k, thermal conductivity)	1.442	Milliwatts/cm deg C
	0.1240	Kg cal/hr m deg C
Btu ft/hr ft^2 deg F	1.4880*	Kg cal m/hr m^2 deg C
Btu/hr ft^2 deg F (C, thermal conductance)	0.568	Milliwatts/cm^2 deg C
	4.882	Kg cal/hr m^2 deg C
Deg F hr ft^2/Btu (R, thermal resistance)	1.761	Deg C cm^2/milliwatt
Btu/lb deg F (c, heat capacity)	4.1868	J/g deg C
Btu/lb deg F	1.000*	Cal/gram deg C
Ft^2/hr (thermal diffusivity)	0.2581	Cm^2/sec
	0.09290*	M^2/hr
WATER VAPOR TRANSMISSION		
Grains/hr ft^2 (water vapor transmission)	16.7	Grams/24 hr m^2
Perms (permeance)	0.659	Metric perms
Perm-inches (permeability)	1.67	Metric perm-centimeters

Table III

OTHER QUANTITIES AND UNITS

Multiply	By	To obtain
Cubic feet per square foot per day (seepage)	304.8*	Liters per square meter per day
Pound-seconds per square foot (viscosity)	4.8824*	Kilogram second per square meter
Square feet per second (viscosity)	0.02903* (exactly)	Square meters per second
Fahrenheit degrees (change)*	5/9 exactly	Celsius or Kelvin degrees (change)*
Volts per mil	0.03937	Kilovolts per millimeter
Lumens per square foot (foot-candles)	10.764	Lumens per square meter
Ohm-circular mils per foot	0.001662	Ohm-square millimeters per meter
Millicuries per cubic foot	35.3147*	Millicuries per cubic meter
Milliamps per square foot	10.7639*	Milliamps per square meter
Gallons per square yard	4.527219*	Liters per square meter
Pounds per inch	0.17858*	Kilograms per centimeter

GPO 845-237

ABSTRACT

A 1:2.857 scale model of the 12-in. outlet works bypass pipe, controlled by a 10-in. jet-flow gate, for Silver Jack Dam, Colorado, operated satisfactorily when positioned correctly with relation to the stilling basin. Surface flow and penetration in the main outlet works stilling basin caused by the jet from the bypass pipe were observed. Air demand immediately downstream of the gate, supplied by flow upstream through the main pipe and by flow through the air vent pipe, was investigated.

ABSTRACT

A 1:2.857 scale model of the 12-in. outlet works bypass pipe, controlled by a 10-in. jet-flow gate, for Silver Jack Dam, Colorado, operated satisfactorily when positioned correctly with relation to the stilling basin. Surface flow and penetration in the main outlet works stilling basin caused by the jet from the bypass pipe were observed. Air demand immediately downstream of the gate, supplied by flow upstream through the main pipe and by flow through the air vent pipe, was investigated.

ABSTRACT

A 1:2.857 scale model of the 12-in. outlet works bypass pipe, controlled by a 10-in. jet-flow gate, for Silver Jack Dam, Colorado, operated satisfactorily when positioned correctly with relation to the stilling basin. Surface flow and penetration in the main outlet works stilling basin caused by the jet from the bypass pipe were observed. Air demand immediately downstream of the gate, supplied by flow upstream through the main pipe and by flow through the air vent pipe, was investigated.

ABSTRACT

A 1:2.857 scale model of the 12-in. outlet works bypass pipe, controlled by a 10-in. jet-flow gate, for Silver Jack Dam, Colorado, operated satisfactorily when positioned correctly with relation to the stilling basin. Surface flow and penetration in the main outlet works stilling basin caused by the jet from the bypass pipe were observed. Air demand immediately downstream of the gate, supplied by flow upstream through the main pipe and by flow through the air vent pipe, was investigated.

Hyd-568
Arris, W F
HYDRAULIC MODEL STUDIES OF SILVER JACK DAM OUTLET WORKS BYPASS--BOSTWICK PARK PROJECT, COLORADO. USBR Lab Rept Hyd-568, Hyd Br, Dec 1966. Bureau of Reclamation, Denver, 7 p, 8 fig, 1 tab, 2 ref

DESCRIPTORS-- small structures/ stilling basins/ *wave action/ *air demand/ closed conduits/ hydraulic models/ jets/ *penetration/ model tests/ outlet works/ energy absorption/ hydraulic gates and valves
IDENTIFIERS-- Silver Jack Dam, Colo/ Bostwick Park Project, Colo/ *jet-flow gates/ *bypass pipes

Hyd-568
Arris, W F
HYDRAULIC MODEL STUDIES OF SILVER JACK DAM OUTLET WORKS BYPASS--BOSTWICK PARK PROJECT, COLORADO. USBR Lab Rept Hyd-568, Hyd Br, Dec 1966. Bureau of Reclamation, Denver, 7 p, 8 fig, 1 tab, 2 ref

DESCRIPTORS-- small structures/ stilling basins/ *wave action/ *air demand/ closed conduits/ hydraulic models/ jets/ *penetration/ model tests/ outlet works/ energy absorption/ hydraulic gates and valves
IDENTIFIERS-- Silver Jack Dam, Colo/ Bostwick Park Project, Colo/ *jet-flow gates/ *bypass pipes

Hyd-568
Arris, W F
HYDRAULIC MODEL STUDIES OF SILVER JACK DAM OUTLET WORKS BYPASS--BOSTWICK PARK PROJECT, COLORADO. USBR Lab Rept Hyd-568, Hyd Br, Dec 1966. Bureau of Reclamation, Denver, 7 p, 8 fig, 1 tab, 2 ref

DESCRIPTORS-- small structures/ stilling basins/ *wave action/ *air demand/ closed conduits/ hydraulic models/ jets/ *penetration/ model tests/ outlet works/ energy absorption/ hydraulic gates and valves
IDENTIFIERS-- Silver Jack Dam, Colo/ Bostwick Park Project, Colo/ *jet-flow gates/ *bypass pipes

Hyd-568
Arris, W F
HYDRAULIC MODEL STUDIES OF SILVER JACK DAM OUTLET WORKS BYPASS--BOSTWICK PARK PROJECT, COLORADO. USBR Lab Rept Hyd-568, Hyd Br, Dec 1966. Bureau of Reclamation, Denver, 7 p, 8 fig, 1 tab, 2 ref

DESCRIPTORS-- small structures/ stilling basins/ *wave action/ *air demand/ closed conduits/ hydraulic models/ jets/ *penetration/ model tests/ outlet works/ energy absorption/ hydraulic gates and valves
IDENTIFIERS-- Silver Jack Dam, Colo/ Bostwick Park Project, Colo/ *jet-flow gates/ *bypass pipes