ANNUAL PROJECT HISTORY

BOULDER CANYON PROJECT

BOULDER DAM

* * *

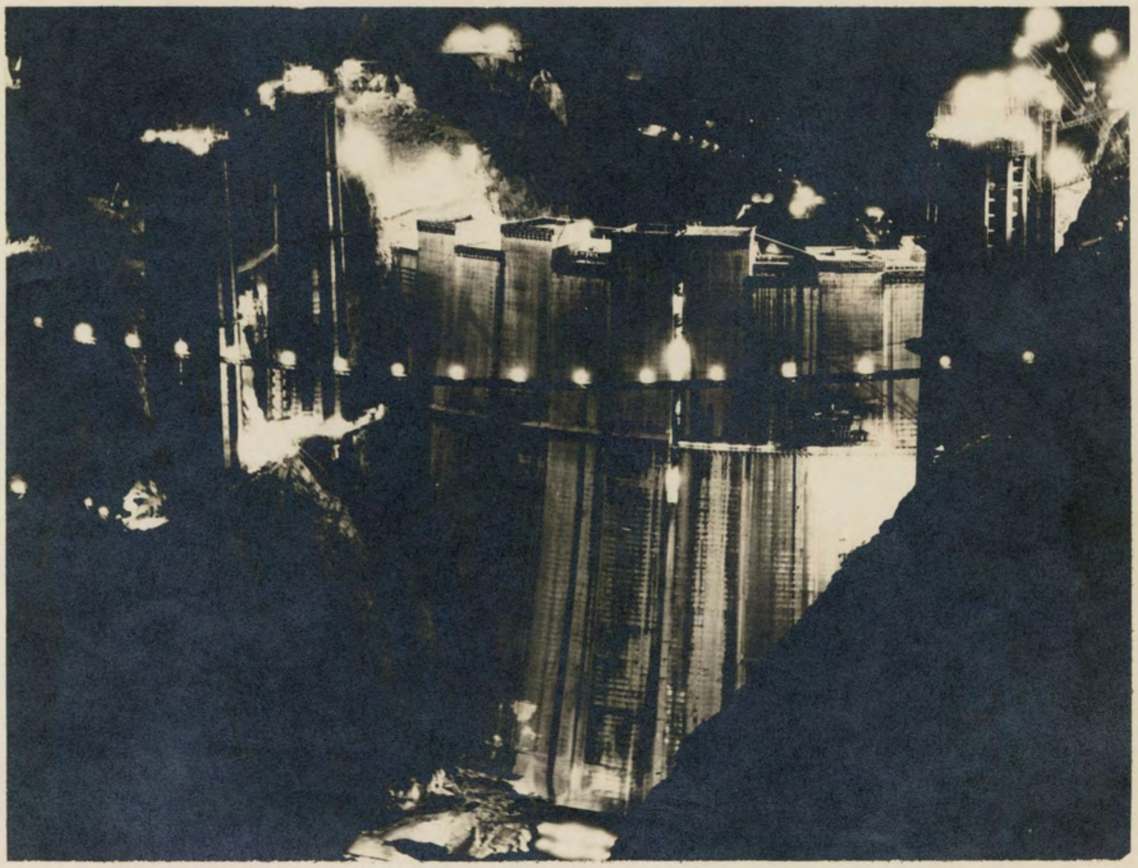
1934

PREVIOUS HISTORIES SUBMITTED

This volume is the fourth history of the Boulder Canyon Project that has been written. The previous volumes described the establishment of the project and the construction operations from the beginning to December 31, 1933.

FRONTISPIECE

Night View - October 1934



WORK CONTINUED BOTH DAY AND NIGHT

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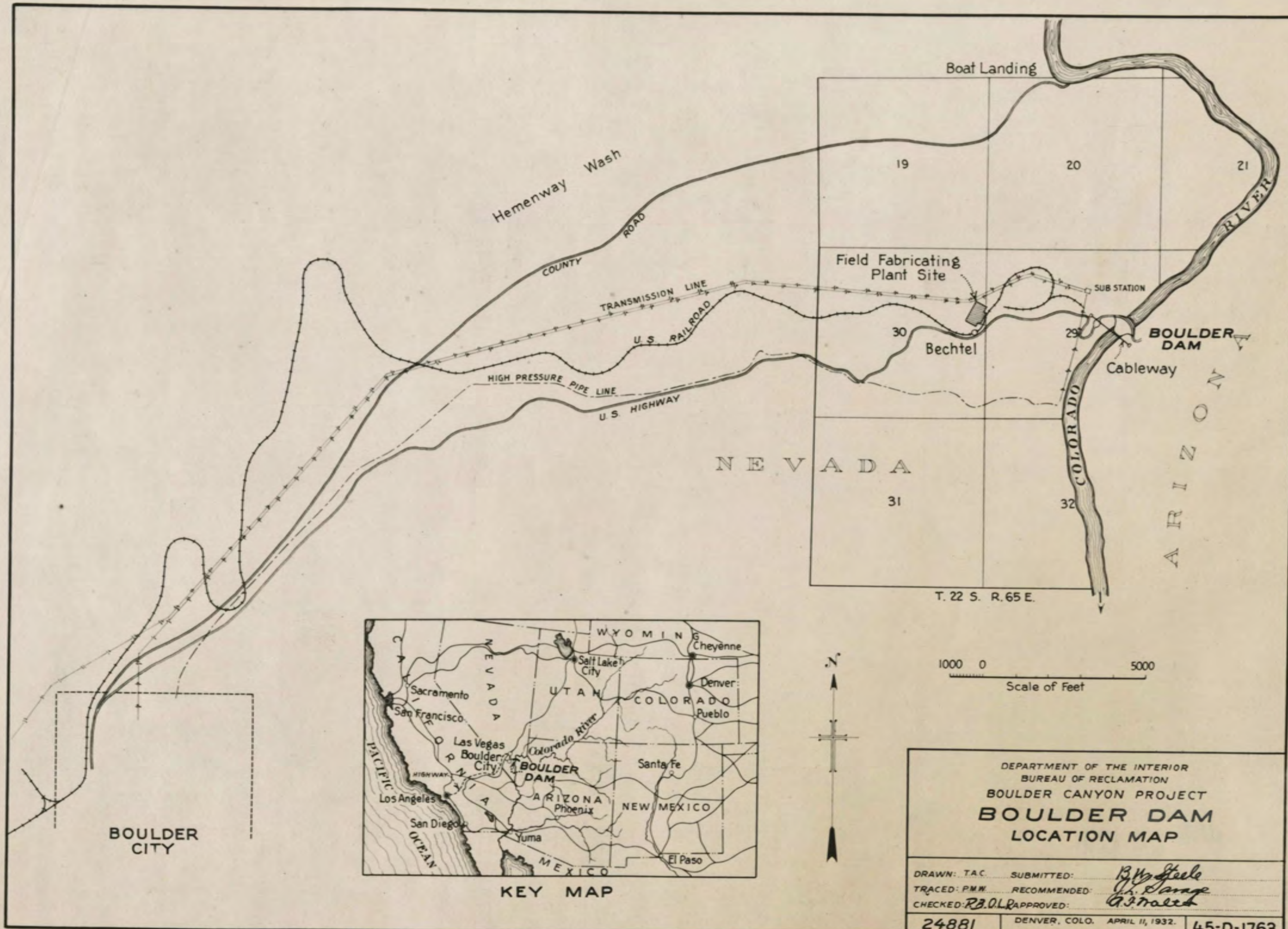

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT

BOULDER DAM
LOCATION MAP

DRAWN: T.A.C. SUBMITTED:
TRACED: P.M.W. RECOMMENDED:
CHECKED: R.B.O.L. APPROVED:

24881 | DENVER, COLO. APRIL 11, 1932. | 45-D-1763

6

CHRONOLOGY OF IMPORTANT EVENTS

1934

January

The crane runway extension and government warehouse at the fabrication plant of The Babcock & Wilcox Company were completed.

Excavation was practically completed for the Arizona spillway inclined tunnel.

All of the 8½' diameter pipe were placed in approximate positions in the Arizona outlet tunnels.

Assembly of the lower gate in the Nevada downstream tower was practically completed, and assembly was started for the lower gates in the other three towers.

January 7

Placing of the millionth cubic yard of concrete in the dam was commemorated.

January 27

The first concrete was poured for the powerhouse, in the cutoff wall, opposite Arizona Unit No. 5.

February

Arch lining was completed at the upstream plugs of tunnels No. 2 and No. 3.

Concrete was placed for the cradle pit of the cableway rim landing.

February 5

Mr. E. H. Wattis, President of Six Companies Inc., died unexpectedly of a heart attack at his home in Ogden, Utah.

February 15

The first concrete was poured for the adit to the downstream plug of tunnel No. 3.

February 20

Mr. H. W. Morrison of the Morrison-Knudsen Contracting Company, Boise, Idaho, was elected President of Six Companies Inc.

March

Excavation was practically completed for the powerhouse, Nevada valve house bench, and lower cableway landings.

Arch lining was finished at the plug of No. 4.

The wall around the Nevada spillway transition was finished.

The total number of visitors for the month was 30,371, traveling in 9,328 vehicles.

March 1

The first concrete was poured in the upper plug of tunnel No. 3.

March 9

The new aluminum streamlined train of the

March 9 (cont.)

Union Pacific Railroad visited the project.

The first concrete was poured for the Arizona lower cableway landing.

March 20

A new record was set for pouring concrete when 10,462 cubic yards were placed in project construction, of which 8,904 cubic yards were sent to the dam.

March 21

Assembly of drum gates was started at the Arizona spillway.

March 22

Lining of the inclined tunnel to the Nevada upstream intake tower was completed.

March 24-25

Visitors numbering 5,461 passed thru the reservation gate in the two-day period.

April

Chipping concrete, damaged by fire, was started in the linings at the intersection of the inclined tunnel and diversion tunnel No. 1.

The shafts between construction adits for the oil purification system were holed through.

April (cont.)

Drilling for pier excavations was started in tunnel No. 3.

A total of 29,162 visitors entered the reservation in 8,987 vehicles.

April 6

The first concrete was poured for the Nevada lower cableway landing.

April 25

Lining of the inclined tunnel to the Arizona upstream intake tower was completed.

April 27

The control circuit tunnel was holed thru.

May

Installation of 8½' pipes in Arizona outlet tunnels was completed by The Babcock & Wilcox Company.

All 8½' pipes were placed in approximate positions in the Nevada outlet tunnels.

Assembly of the upper gates was started in the downstream intake towers.

May 7

The cement screening plant was placed in operation.

May 8

Lining of the Nevada spillway inclined tunnel was resumed.

May 12

Concrete was placed in the Arizona lower cableway landing to the base of the parapet wall.

May 18

Lining was practically completed for the 37' Arizona penstock header tunnel.

Employees listed on government and contractors payrolls numbered 5,196.

The maximum discharge of the Colorado River occurred, amounting to 24,450 c.f.s.

May 20

The first concrete was poured for the adit to the downstream plug of tunnel No. 2.

May 21

Concrete was placed in the Nevada lower cableway landing to the base of the parapet wall.

May 22

Lining was practically completed for the 37' Nevada penstock header tunnel.

May 24

The first grout was placed in dam contraction joints, starting in radial joints IJ and KL.

May 25

Lining the adit to the downstream plug of tunnel No. 3 was practically completed.

May 26

The first section of floor was poured for the Arizona upper construction adit.

June

Assembly of the upper gates for the downstream intake towers was practically completed, and assembly was started for the upper gate in the Nevada upstream tower.

June 2

The first concrete was poured for the Nevada upper construction adit.

June 3

The last concrete was placed in the floor of the Arizona upper construction adit, except a small section at the canyon wall portal.

June 5

Gate installations were started for the Nevada spillway.

June 6

Pouring the second millionth yard of concrete in the dam was commemorated.

June 7

Lining was practically completed for the adit to the downstream plug in tunnel No. 3.

Assembly of the drum gates for the Nevada spillway was started.

June 8

Installation was started of the upper gate for the Arizona downstream intake tower.

June 10

The project was without power or light for four hours twenty-two minutes, due to insulators on transmission line being shot down by high power rifle fire near Victorville, California.

June 21

The last pour of concrete was placed in the floor of the Nevada upper construction adit, except at the canyon wall portal.

June 26

Lining of the Arizona spillway inclined tunnel was started.

June 27

Installation was started of the upper gate for the Nevada upstream intake tower.

July

All 8½' pipe were installed in Nevada outlet tunnels.

July (cont.)

Assembly of the drum gates for the Arizona spillway was 93 per cent completed.

The upper gate for the Nevada upstream intake tower was practically installed.

July 3

The Arizona sand and gravel deposit was shut down.

July 4-5

Six Companies Inc. declared a two-day holiday, and The Babcock & Wilcox Company halted work on July 4.

July 10

The first 30' diameter steel pipe, No. UN1, was transported from fabrication plant to tunnel.

July 13

The first concrete was poured for the control circuit tunnel.

July 18

Installation of the upper gate was started in the Arizona upstream intake tower.

July 20

The peak of employment was reached, employees listed on government and contractors payrolls numbering 5,251.

July 24

The first concrete was placed in the upstream plug of diversion tunnel No. 2.

The last concrete was poured for lining the adit to the downstream plug of tunnel No. 2, except at the plug entrance.

July 27

The maximum project temperature for 1934 of 123° F was reached in Black Canyon.

August

Removal of the rock barrier and lower cofferdam was started.

Installation of the upper gate in the Arizona upstream tower was practically completed.

August 7

The Eddy-Frazier Expedition by boat down the Colorado River finished its journey at Boulder Dam.

August 9-10

Miss M. A. Schnurr, Assistant to the Commissioner, visited the project.

August 11

Practically all lining has been placed for the 18' Arizona penstock tunnels.

August 14

The "all-time" minimum discharge of the

August 14 (cont.)

Colorado River in Black Canyon was recorded, amounting to 1,780 c.f.s.

September

Erection was completed of the first 30' pipe in the upper Arizona tunnel and the first 13' pipe in the Nevada penstocks (N4).

Drilling of grout and drainage holes was completed in upper Arizona tunnel No. 6.

September 2-3

Practically all construction activities were shut down for the Labor Day Holiday.

September 5

The first section of 13' pipe (UN 106) for the Nevada penstocks was shipped to the tunnels.

September 5-24

Excessive and fine silt in river water caused shut down of precooling system, so that water from sumps could be used for Boulder City supply.

September 11

First Assistant Secretary of Interior T. A. Walters visited the project.

September 17 to 19

A group from RKO Studios, Hollywood, California, made photographic sequences on the

September 17 to 19 (cont.)

project for the film "The Silver Streak".

September 18

The first section of 30' pipe (UA 1) for penstock header tunnel No. 6 was shipped to the tunnels.

September 20

The adit between the plug in tunnels 1 and 2 was holed thru.

September 25

Pouring of mass concrete in the upper plug of tunnel No. 3 was completed.

September 29

The first concrete was placed in the trash-rack of tunnel No. 1.

October

Excavations were completed for the valve chambers in the plug of tunnel No. 1.

Guniting of the damaged area at plug No. 1 was completed.

October 1

Practically all lining had been placed for the 18' Nevada penstock tunnels.

October 3

The first concrete was poured for the Arizona lower construction adit.

October 5

Lining of the adit to the upstream plug of tunnel No. 2 was started.

October 9-13

The precooling plant was shut down so that Boulder City could use water from sump.

October 10

The first concrete was poured for the Nevada lower construction adit.

October 14

Paving was practically completed in the lower Arizona construction adit.

October 20

Approximately 3,000 Shriners held a ceremonial on the upper cofferdam.

October 23

Cooling of the upstream plug in tunnel No. 3 was started, using precooling water.

November

Assembly of the drum gates for the Nevada spillway was practically completed.

All low pressure grouting and the drilling of drain holes were completed in the penstock tunnels.

Visitors during the month numbered 32,525, traveling in 9,645 vehicles.

November 1

Lining of the Nevada spillway inclined tunnel was completed.

November 2

Concreting of the trashrack at the inlet of tunnel No. 1 was finished.

November 9-10

A total of 9,296 people in 2,666 cars visited the project, 5,794 people and 1,689 cars arriving on November 10.

November 16

The first psychrometer readings of humidity were taken at the Black Canyon gaging station.

November 26

The first concrete was placed in the plug of tunnel No. 1.

November 27

Paving was practically completed in the Nevada lower construction adit.

The last pour of mass concrete was made in the upstream plug of tunnel No. 2.

November 28

The sand and gravel screening and washing plant suspended operations.

December

Installation was started and practically completed for the gates and conduit in tunnel No. 1 plug.

The earth fill at the upstream toe of the dam was about 80 per cent completed.

The copper grounding mat was placed in the fill at the upstream face of the dam.

Placing Hemenway Wash material on the reservoir side of the Arizona spillway was started.

Guniting of the rock in front of the Nevada spillway weir was completed.

Lining of the Arizona spillway inclined tunnel was resumed, starting at the diversion tunnel intersection.

A new monthly record for visitors to the project was established, when 34,306 persons in 10,440 cars were checked thru the reservation gate.

December 2

The Lo-Mix concrete plant was shut down permanently.

December 5

The three-millionth cubic yard of concrete was poured in the dam.

<u>December 6</u>

The first concrete pour was made for the Arizona spillway bridge.

<u>December 8</u>

The first concrete was poured in the adit between the plugs of tunnels No. 1 and No. 2.

<u>December 22</u>

Fire of undetermined origin destroyed the office building of The Babcock & Wilcox Company.

<u>December 24-25</u>

Practically all construction activities were suspended by Six Companies Inc., The Babcock & Wilcox Company shutting down on the 25th.

<u>December 27</u>

The Hi-Level mixing plant established a record for one plant production of concrete, mixing 3,001 cubic yards in eight hours.

<u>December 30</u>

Refrigeration was started in the upstream plug of tunnel No. 2.

A record in cableway transportation was established when Six Companies Inc. cableway No. 7 carried 277 buckets of concrete to the dam in eight hours.

The minimum project temperature for 1934 of 30°F occurred in Boulder City.

December 31

The Nevada spillway was nearing completion, the channel of the Arizona spillway was practically completed, and the Arizona inclined tunnel was being lined.

Concrete was placed in the downstream intake towers to the elevation of the crest of the dam (1232), and the other two structures were poured nearly to that elevation.

The dam slot had been poured to elevation 955, and the highest concrete in the dam was at elevation 1185.

Dam cooling had been completed to elevation 1030 and grouting of contraction joints to 825.

Practically all concrete had been poured in the powerhouse up to elevation 642.92.

VISITORS - 1934

Visitors passing through the reservation gate in 1934 numbered 266,436. Some of the more prominent are listed in the following pages, and an index is given below:

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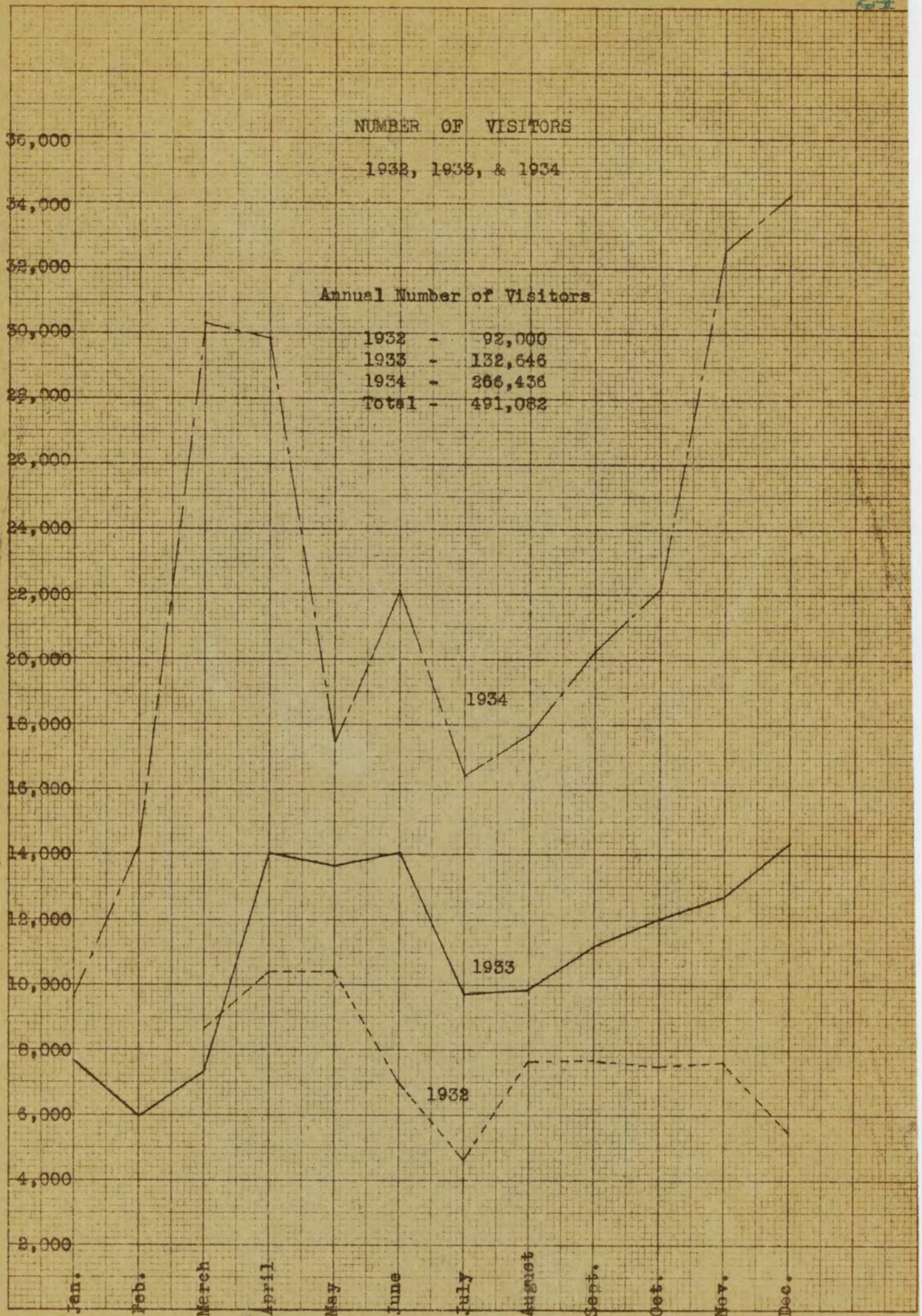
NUMBER OF VISITORS
1932, 1933, & 1934
Annual Number of Visitors
1932 - 92,000
1933 - 132,646
1934 - 266,436
Total - 491,082
36,000
34,000
32,000
30,000
28,000
26,000
24,000
22,000
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
1934
1933
1932
Jan.
Feb.
March
April
May
June
July
August
Sept.
Oct.
Nov.
Dec.

DUE TO ERROR IN NUMBERING

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PROJECT VISTORS

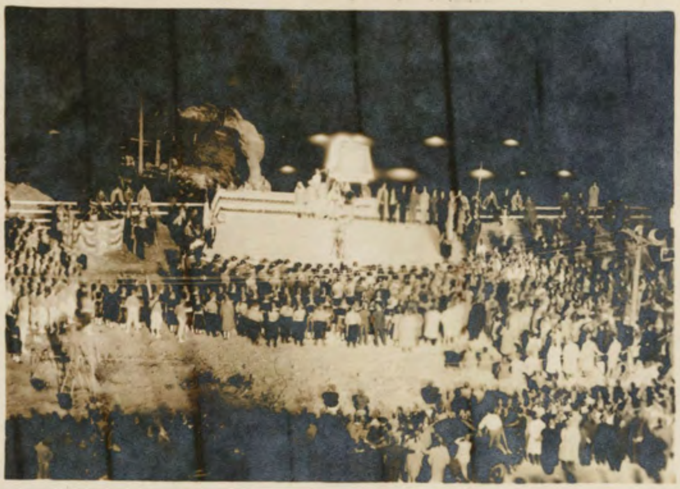
1934

Visitors at Lookout Point

Members of the Portland Cement Association

Union Pacific Streamlined train
at dam face

Shrine Ceremonial on
Upper Cofferdam



VISITORS - 1934

UNITED STATES GOVERNMENT

Department of Interior

Burdick, D. G.	Special Agent, Division of Investigations, P.W.A., San Francisco, Calif.	April 20-23 Dec. 3-5
Butraw, Preston	In Charge Zion National Park	Feb. 18
Callaghan, Eugene	Geologist Industrial Survey	Mar. 2 May 31
Caldwell, George W.	General Road Master, Alaskan R. R.	Apr. 5
Fleming Phillip B.	Deputy Public Works Administrator, Washington, D. C.	Dec. 10
Gibbs, Major George	National Park Service, San Francisco, Calif.	Nov. 15
Goodwin, T. R.	Superintendent, Death Valley National Park	Feb. 18
Hewett, D. F.	Industrial Survey Boulder Dam Area	Mar. 2 May 14
Haker, W. L.	Formerly Res. Engineer Alaskan R. R.	Apr. 5
Haw, John W.	One of committee appointed by the Secretary of the Interior for Reporting on Reclamation Projects	Oct. 13-14
Jones, Ralph C.	Office Engineer, Bureau of Public Roads, Denver, Colo. (Dept. of Agriculture)	Oct. 17
Kramer, E. W.	Regional Engineer, U. S. Forest Service, Washington, D. C.	July 11
Kittridge, Frank A.	National Park Service, San Francisco, California	Feb. 18
Lautz, E. H.	Assistant Chief Engineer, U. S. Forest Service, Washington, D. C.	July 11

VISITORS - 1934 (cont.)

UNITED STATES GOVERNMENT

Department of Interior

Lyon, H. L.	Engineer, Bureau of Public Roads, San Francisco, Calif.(Dept. of Agriculture)	Oct. 5
Moore, B. N.	Industrial Geologist, Industrial Survey of Boulder Dam Area	Mar. 2 Febr. 14
Nolan, T. B.	Industrial Geologist, Industrial Survey of Boulder Dam Area	Mar. 2
Rubey, W. W.	Industrial Survey of Boulder Dam Area	Mar. 2
Schaller, W. T.	Industrial Survey of Boulder Dam Area	Mar. 2
Schmitt, F. E.	One of Committee appointed by the Secretary of the Interior for reporting on Reclamation Projects	Oct.13-14
Weir, R. S.	Engineer in Charge Alaskan R. R.	Apr. 5
Walker, Curtis	Appraiser, Department of the Interior, Washington, D. C.	May 13-15
Walters, T. A.	First Assistant to Secretary of the Interior	Sept. 11
White, John R.	Superintendent, Sequoia National Park and Death Valley National Monument	Sept.25-26

Bureau of Reclamation

Boden, Oscar	Engineer from Owyhee Project	Mar. 15
Coffey, Richard J.	District Counsel, Los Angeles, Calif.	May 9-11 Nov.22-23
Day, C. M.	Chief Mechanical Engineer, Denver, Colo.	Feb.27-28 Oct.14-21

VISITORS - 1934 (cont)

UNITED STATES GOVERNMENT

Bureau of Reclamation

Dysart, Arthur	Architect, Grand Coulee Project	Sept. 9
Fiock, L. R.	Superintendent, Rio Grande Project	June 2
Foster, L. E.	Project Superintendent, Carlsbad, New Mexico	Oct. 2
Harper, S. O.	Assistant Chief Engineer, Denver, Colo.	Mar.15-17 Mar.22-23 Nov.25-29
Harris, D. D.	Supervisor, Salt Lake Basin Project	Jan. 15
Hunt, D. T.	Denver Office	Sept. 3-8
Kubach, William F.	Chief Accountant, Washington, D. C.	Dec. 15-16
Laurgeard, Olaf	Construction Engineer, Parker Dam	June 26-27 Aug.29-30
Lieurance, L. S.	Denver Office	Dec. 15-17
McClellan, L. N.	Chief Electrical Engineer, Denver, Colo.	Apr.12-13
Moore, Mr.	Yuma Project	Apr. 14-15
Moritz, E. A.	Parker Dam	June 26-27
Mead, Dr. Elwood	Commissioner	July 3-4
Mitchell, L. H.	Director of Reclamation Economics, Washington, D.C.	Aug. 19
Monroe, R. A.	Denver Office	Sept. 12-14
McPhail, L. J.	Denver Office	Dec. 5
McConaughy, D. C.	Engineer, Denver Office	Dec. 21

VISITORS - 1934 (cont.)

UNITED STATES GOVERNMENT

Bureau of Reclamation

Nalder, W. H.	Assistant Chief Designing Engineer, Denver, Colo.	Aug.29-30
Noble, Myron	Parker Dam	Sept. 9
Priest, Ray	Superintendent, Yuma Project	Apr.14-15 Mar. 10
Preston, Porter J.	Engineer, Colorado River Investigations	Mar.15-16 May 7
Paul, D. G.	Construction Engineer, Hyrum Project	Dec. 24
Ruettgers, Arthur	Denver Office	Sept.12-14
Steele, B. W.	Designing Engineer, Denver, Colo.	Jan.15-17 Apr.12-13 Oct.15-16
Smith, L. R.	Chief Clerk, Denver, Colo.	Feb. 13 Dec.15-16
Schlopcole, M.	Engineer, Owyhee Project	Mar. 15
Savage, J. L.	Chief Designing Engineer	Apr.12-13
Schnurr, Mae	Assistant to Commissioner, Washington, D. C.	Aug.9-10
Weber, R. C. E.	Yuma Project	Apr.14-15 Nov.10-11
Walter, R. F.	Chief Engineer, Denver,Colo.	Feb.16-20 July 3-5 July 10-12 Oct. 4-8
Williams, R. B.	Construction Engineer All-American Canal	Dec.15-16
Westerhouse, E. J.	Engineer, All-American Canal	Dec. 24

VISITORS - 1934 (cont.)

UNITED STATES GOVERNMENT

Congressmen

Burnham, George	Congressman, San Diego, Calif.	Nov. 21
Cummings, Fred	Congressman, Fort Collins, Colo.	Aug. 4
Pittman, Key	Nevada Senator	Aug. 22
McCarren, Pat	Nevada Senator	Aug. 9
Scrugham, J. G.	Congressman, Nevada	July 14 Nov. 14
Sutrin, Mr.	Congressman, New Jersey	July 14
Swing, Phil D.	Ex-Congressman, Los Angeles	Dec. 1
Thomas, Sen. Elbert D.	Utah	Dec. 8

Army & Navy

Brumby, Admiral F.H.	Pacific Battle Fleet	Feb. 15
Conger, Lt. E. B. & 11 Naval Reserve Fliers		Apr. 5
Connolly, Major Donald H.	Corps of Engineers, U. S. Army	Apr. 28
Fitzmaurice, Major	U.S.A. Retired	Jan. 31
Gardenhire, Colonel W. C.	March Field, Riverside, Calif.	Mar. 31
Gorlinsk, Lt. J. S.	Bonneville Dam, Portland, Oregon	May 14
Giroux, C. N.	U. S. Engineers Office, Washington, D. C.	July 30
Hardy, Capt. C. P.	Office Engineers Division Bonneville Dam, Portland, Oregon	May 14
Jarvis, C. S.	U. S. Army, Washington, D.C.	Mar. 19

VISITORS - 1934 (cont.)

UNITED STATES GOVERNMENT

Army & Navy

Kuhn, Major General Joseph E.	U.S.A. Retired, Coronado, California	Feb. 17
Krosby, Colonel W.W.	U.S.A.Retired, Coronado, California	Feb. 17
Miller, Colonel T. W.	Camp Superintendent, CCC Overton, Nevada	Jan. 21
Noyes, Lt. John R.	U. S. Army Engineers, Seattle, Washington	Mar. 20
Peterson, Lt. Col. V. L.	Corps of Engineers, U. S. Army, Los Angeles, Calif.	Jan. 31
Ridley, Lt. Col. C.S.	Corps of Engineers, U.S.A., Engineer of Maintenance, Panama Canal	May 22-24
Rockwell, Lt. Commander C. R.	U.S.Navy	May 28
Reinecke, Major Paul S.	Corps of Engineers, U.S.A. Fort Humphreys, Virginia	Aug. 7
Sellers, Admiral David F.	Command U. S. Navy Fleet	Mar. 1
Staten, Captain A.	Captain U.S.S. Nevada	Apr. 5
Scheffauer, F. C.	Principal Engineer, Office Engineers Division, Bonneville Dam, Portland, Oregon	May 14
Scout Planes (4)	From U.S.S. Saratoga, Lieut. R. S. Taylor in Charge	Dec. 20
Waterhouse, Lt. Com. R. D.	U.S.N. Camp Surgeon CCC Overton, Nevada	Jan. 21
Williams, Major C.F.	Construction Engineer, Bonneville Dam	Mar. 20
Young, Lt. Franklin & 7 fliers	Air Forces U.S.N.R.	May 2

VISITORS - 1934 (cont.)

UNITED STATES GOVERNMENT

Other Federal Officials

Bates, T. H.	Bureau of Standards, Washington, D. C.	Jan.17-20
Burdick, M. D.	Bureau of Standards, Riverside, California	Jan. 20
Ballard, G.	Legal Advisor NRA, Reno, Nevada	Oct. 3
Clark, H. H.	NRA Field Adjuster, Reno, Nevada	June.27-28 Oct. 3
Donoghue, J. J.	Bureau of Standards, Riverside, Calif.	Jan. 20
DeFremery, Adolph	Land Planning Consultants The National Resources Board, Berkeley, Calif.	Nov. 12
Ingram, Frank	State Director of National Emergency Council and State NRA Compliance Director, Reno, Nevada	Mar. 27 Oct. 3
Jones, Judge Geo. P.	Special Assistant to Attorney General, Washington, D.C.	Aug. 14
McWhorter, Mr.	Chief Engineer Federal Power Commission, Washington, D. C.	June 11
Miner, E. F.	Engineer of Federal Power Commission, Washington, D.C.	Nov. 7
St.Sure, Federal Judge	San Francisco, Calif.	May 2
Thompson, Samuel	Engineer of Federal Power Commission, Washington, D.C.	Nov. 5
Webster, Phillip J.	Resources Board, Berkeley, Calif.	Nov. 12
Williams, Sidney J.	Representative of Dept. of Labor, Washington, D. C.	Dec.14-15

VISITORS - 1934 (cont.)

UNITED STATES GOVERNMENT

Other Federal Officials

Young, Leonard T.	Supervising Engineer, U.S., Coast and Geodetic Survey, San Francisco	Apr. 2

FOREIGN

Foreign Representatives, Engineers & Visitors

Abe, Shizuo	Hydraulic Engineer Japanese Government Railways	June 18-20
Ballot, Marcel	Entrepreneur de Travaux Publics, Paris France	Apr. 30
Cothran, F. H.	Engineer in Charge of Construction of St. Lawrence Waterway, Montreal, Canada	Jan. 26
Coyne, Andre	Chief Engineer of Bridges & Highways, French Govt. Paris, France	Nov.15-17
Christy, Frank	Electrical Engineer, Chelmsford, England	Nov. 17
Einwashler, Dr. Josph J.	Technical University, Budapest, Hungary	June 1
Gandur, Mahmut	Syria	June 28
Gadre, N. B.	Dept. of Public Works, Bombay, India	Oct. 1
Iquchi, Dr. S.	Hokkaido Kaiserliche University, Sapporo, Japan	May 14
Jemale, Oran	Turkey	June 28
Key, Maurice	Secretary General, Chamber of Commerce, Hong Kong, China	May 19
Kehale, Noureddin	Syria	June 28

VISITORS - 1934 (cont.)

FOREIGN

Foreign Representatives, Engineers & Visitors

Kenyon, James M.	Civil Engineer, London, England	July 12
Lungereis, Arjar S.	Amsterdam, Holland	Sept. 29
Luther, Dr. Hans	German Ambassador to the United States	Nov. 26
Libacqz, Jean V.	Brussels, Belgium	Dec. 28
Molero, Federico	Engineer of Roads, Canals and Ports, Government of Spain	June 27
MacGregor, Rafael Fernandez	Mexico City, Mexico	Nov.26-27
Nishioka, H.	Construction Engineer, Japanese Government Railways	June 6
Pasini, Albino, Gr. de Uff. le Dre. Engr.	Professore Al R. Politecnico, Depitato al Parlamento, Milan, Italy	Dec. 22
Ruech, Dr. H.	Engineer with German Firm of Dycherhoff and Widman Buenos Aires, Argentina	Jan. 2
Santa Cruz, Sr. Engr. Armando, Jr.	Commissioner Mexican International Boundary Commission, Juarez, Mex.	Nov.26-27
Struve, Gustave	Secretary to German Ambassador, Washington, D. C.	Nov. 26
Tedero, Jan	Association of Directors of the Electrical Industry of the Netherland, Amsterdam, Holland	Oct. 2
Templin, J. R.	Consulting Engineer, New Zealand	Dec. 8
Urias, J. Franco and Party of Engrs.	Mexican Boundary Commission	Oct. 13

VISITORS - 1934 (cont.)

Foreign

Foreign Representatives, Engineers & Visitors

Villou, Carlos Ramerez	In charge of drainage work of the Valley of Mexico near Mexico City	Jan.11-13
Verhoogen, Jean	Brussels, Belgium	Dec. 28
Zokovetz, N. G.	Soviet Civil Engineering Student, University of Wisconsin	Mar.21-28

STATES, COUNTY, CITY & DISTRICT OFFICIALS

State & County and City Officials

Bolin, Harry W.	District Structural Engineer, State of California, Los Angeles	Oct. 27
Bakke, Norris	Assistant Attorney General, State of Colorado	May 5
Cannon, Frank	Senior Structural Engineer, State of California, Los Angeles	Oct. 27
Diggs, Charles A.	Director, Los Angeles County Regional Planning Commission	Nov. 12
Griswold, Morley	Carson City, Nevada	May 10
Humphrey, T. H.	Utah State Engineer	Mar. 11
Jerman, Reid	Assistant State Engineer, Salt Lake City	Mar. 11
Johnson, Frank A.	Division of Architecture, State of California	Oct. 27
Keener, Mr.	Arizona Industrial Commission	May 10
Knapp, George S.	State Engineer of Kansas	Dec. 8
Malone, George	State Engineer, Carson City, Nevada	April 10 May 10

VISITORS - 1934 (cont.)

STATE, COUNTY, CITY & DISTRICT OFFICIALS

State, County and City Officials

Quinn, John R.	Chairman, Board of Supervisors, Los Angeles County Flood Control District	Feb. 10
Seaver, E. S.	Division of Architecture State of California	Oct. 27
Taylor, Ralph T.	Associate Engineer, State of California, Division of Architecture, Los Angeles	Oct. 27
Tannahill, Alex	Nevada Industrial Commission	May 10
Burton, H. K.	Supt. Water Supply and Water Works, Salt Lake City, Utah	Oct. 31
Clough, F. H.	City Engineer, So. Pasadena	Jan. 20
Forward, Hon. John F., Jr.	Mayor of San Diego, Calif.	Mar. 10
Keyser, George D.	In Charge Dept. of Water Supply, Salt Lake City, Utah	Jan. 20
Morris, Sam & Party of Pasadena City Officials	Engineer and Manager of Water Dept., Pasadena, Calif.	Dec. 1
Plowman, E. G.	Executive Assistant, Denver, Colorado, Water Board	May 1
Stenzel, R. W.	Pasadena Water Department, Pasadena, California	Jan. 20

Water Districts

Branch, Lester V.	Senior Engineer, Metropolitan Water District of Southern California	Dec. 11
Collings, W. T.	Engineer for the Imperial Irrigation District	Feb. 8

VISITORS - 1934 (cont.)

STATE, COUNTY, CITY & DISTRICT OFFICIALS

Water Districts

Houser, H. A.	Pres. Blythe, Irrigation District, Los Angeles	Mar. 17
Members of the Imperial Irrigation District	El Centro, California	Nov. 11
Norwood, J. L.	Director of Metropolitan Water District of Southern California	Mar. 11
Weymouth, Frank E.	Chief Engineer and General Manager Metropolitan Water District of Southern California	Apr.3-4

BOULDER DAM BOARD

Durand, W. F.	Consulting Engineer, Stanford University, California	Feb. 28 Mar.26 Dec.12
Hill, L. C.	Consulting Engineer, Los Angeles	Nov. 18

ENGINEERS

Bannon, Thomas C.	Geologist and Petroleum Engineer, Los Angeles	Jan. 15
Boswell, John W.	Mining Engineer, Fairbanks, Alaska	Jan. 24
Crozier, H. W., and Party of 60 Engrs.	San Francisco, California	Apr.7-8
Code, W. H.	Consulting Engineer, Los Angeles	Dec. 1
Crozier, H. W., and Party of 65 Engrs.	San Francisco, California	Dec.1-2
Dennis, Harry W.	Chief Civil Engineer, Southern California Edison Company, Los Angeles	Jan. 6
Davis, Raymond	Consulting Engineer, Univ.of Calif., Berkeley	Feb. 26

VISITORS - 1934 (cont.)

ENGINEERS

Fifer, Frank	Hydraulic Engineer with U. L. Copper Co., New York City	Mar. 12
Flannigan, Pierce J.	Civil Engineer, Baltimore, Md.	July 24
Gillian, S. L., and 150 Engineers	Members of Engineers Club, Los Angeles	Apr. 21
Hanna, F. W.	Chief Engineer and General Manager, East Bay Municipal Utility District, Oakland, Calif.	Mar. 8
Kaufman, Gordon	Consulting Architect, Los Angeles	Jan. 27 May 3 Nov. 10
Lazell, E. W.	Consulting Engineer Bonneville Dam, Portland, Ore.	Apr. 30
Lippincott, J. B.	Consulting Engineer, Los Angeles	Dec. 7
Lyman, R. A.	Consulting Engineer, Salt Lake City, Utah	July 3-5
Mead, Charles	Past Director of the American Society of Civil Engineers	July 21
Rickey, J. W.	Chief Hydraulic Engineer Aluminum Co. of America	Apr.11-12
Traber, Charles K.	Chief Engineer, A. Leschen and Sons Rope Company	Jan. 6

REPRESENTATIVES OF EDUCATIONAL INSTITUTIONS

Buwalda, J. P.	Head of Geology Dept., California Institute of Technology, Pasadena	Mar. 24
Bakmetaff, Dr. Boris	Professor Civil Engineering Columbia University, New York City	June 29

VISITORS - 1934 (cont.)

REPRESENTATIVES OF EDUCATIONAL INSTITUTIONS

Creel, Cecil W.	Director of Agriculture, Extension Service, University of Nevada	Dec. 28
Eckeland, Prof. Ray and Engineering Students (Eighteen)	University of Colorado Boulder, Colorado	Mar.19-22
Evans, T. H.	Professor of Applied Mechanics, Yale University, New Haven, Conn.	Aug. 1
Fulton, John A.	Director Mackay School of Mines, Reno, Nevada	Mar. 28
Ferris, M. E.	University of New Mexico	Apr. 2-3
Hitchcock, Dean E.A.	College of Engineering, Ohio State University	Mar. 7
Hatton, Dr. A. R.	Head of Department of Political Science, Northwestern University	Apr. 7
Huntington, Prof. Whitney	Head of Civil Engineering Dept., University of Illinois	Aug. 16
Kelly, Joe E.	Research Engineer, Engineering Materials Laboratory, University of California, Berkeley	Oct. 30
Lacey, W. W.	Professor Chemical Engineering, California Institute of Technology	Jan. 20
Longwell, C. R.	Geologist Yale University made a three months Geological Survey of the floor of the Boulder Canyon Reservoir for the Geological Society.	Feb.13 - May 31
Lory, Chas. A.	President Colorado Agriculture College, Fort Collins	Sept.24-25

VISITORS - 1934 (cont.)

REPRESENTATIVES OF EDUCATIONAL INSTITUTIONS

McCaughey, William J.	Head of Dept. of Mineralogy, Ohio State University	Dec. 31
Pretious, C. S.	Instructor, Civil Engineering Dept. University of British Columbia, Canada	July 24
Reynolds, Leon B. & 25 Students	Stanford University	Mar. 26
Riggs, Henry Earl	Honorary Professor of Civil Engineering, University of Michigan, Ann Arbor	July 24
Tieje, A. T., Prof.	Head of Geology Dept., University of Southern California	Mar. 24
Van Leer, Blake	Dean of the College of Engineering, University of Florida	July 23
Ward, Dr. Henry B.	Secretary American Association for Advancement of Science, Urbana, Ill.	June 8
Wiskocil, C. T., Prof.	Dept. of Civil Engineering, University of California, Berkeley	Dec. 20
35 Members	Engineering Society of Santa Clara University, California	Jan. 5
70 Engineering Students and Professors	University of Southern California	Mar. 25
60 High School Students	Glendale, California	Mar. 25
30 Students & Members of Faculty	Scripps College, Calif.	Apr. 21
48 Sophomores	Dixie Junior College, St. George, Utah	Apr. 30
10 Students	California State Junior College, Modesto	June 17

VISITORS - 1934 (cont.)

REPRESENTATIVES OF EDUCATIONAL INSTITUTIONS

18 Students and one Faculty Member	Antioch College, Yellow Springs, Ohio	July 18
10 Students and one Faculty Member	"	July 21
14 Students	Santa Ana Junior College Santa Ana, California	Nov. 30

INDUSTRIAL

Anthoney, H. F.	Representative Stone & Webster Co., Seattle, Washington	Jan. 31 Nov. 19
Banning, Joseph B.	General Superintendent of Matson Navigation Co., Los Angeles	Feb. 1?
Braun, Fred	Representative of W. S. Tyler Co.	Apr. 2-3
Bailey, Z. G.	Vice President, The Babcock & Wilcox Company, New York	May 15
Byers, Harry	In Charge Denver Office of The Babcock & Wilcox Co.	May 15
Burnett, J. W.	General Superintendent of Motive Power and Equipment Union Pacific System	July 5
Beckett, Garner O.	Riverside Cement Co., Riverside, California	Oct. 19
Cremly, J. H. M.	London Office of The Babcock & Wilcox Co.	May 15
Condon, E. J.	General Traffic Manager Interstate Traffic Lines	July 30
Doolittle, H. L.	Chief Designing Engineer, Southern California Edison Co., Los Angeles	Nov. 24

VISITORS - 1934 (cont.)

INDUSTRIAL

Eames, Alred W.	Vice President California Packing Co., San Francisco	Mar. 12
Gray, Carl	President Union Pacific System	July 5
Garrison, Fred	Commercial Engineer, G. E. Co., Los Angeles	Sept. 8
Gaylord, J. C.	Hydraulic Engineer Southern California Edison Co., Los Angeles	Oct. 31
Haugh, J. L.	Vice President and Assistant to the President of the Union Pacific System	Mar. 9 July 5
Harter, Isaac	Vice President, The Babcock & Wilcox Co., New York	May 15
Hicks, R. E.	District Passenger Agent Interstate Transit Lines	July 30
Hale, C. N.	General Agent, Chicago & Northwestern R. R., Chicago, Illinois	Sept. 10
Holderness, H. C.	Designing Engineer, Transformer Dept., General Electric Co., Schenectady, New York	Oct. 31
Hurst, W. C.	Senior Vice Pres., Chicago & Illinois Midland R. R. Co., Springfield, Ill.	Nov. 19
Irwin, Mr.	President, U. S. Steel Corporation	Feb. 24
Jones, Randal L.	Lecturer for L. A. and S.L.R.R.	Feb. 9
Jeffers, W. M.	Executive Vice-President Union Pacific System	Mar. 9 July 5
Knickerbocker, F. H.	General Manager Union Pacific System	Mar. 9

VISITORS - 1934 (cont.)

INDUSTRIAL

Lyon, Charles L.	General Organizer, International Association of Bridge, Structural and Ornamental Iron Workers	Aug. 14
Lewis, W. W.	Transmission Engineer, General Electric Co., Schenectady, N. Y.	Sept. 8
Myers, D. B.	Chief Geologist, Union Oil Company, Los Angeles, California	Mar. 26
Mann, H. C.	Chief Engineer, Union Pacific System	July 5
McMillen, Frank	Portland Cement Association, Chicago, Ill.	Sept. 4
Morrow, Baird	Supt. of Concentration Anaconda Copper Mining Co., Anaconda, Mont.	Oct. 30
Nash, C. W.	President Nash Motors Co.	Feb. 20
Party of 550 Old Timers	Employees of the Union Pacific System in Utah	Sept. 23
Odell, L. W.	Odell Construction Company, Los Angeles	Dec. 8
Patten, W. N.	Vice Pres. Stone & Webster Co., Boston, Mass.	Jan. 31
Party of 100	Portland Cement Association	May 7
Pelton, H. E.	Pelton Motor Company, Los Angeles	May 14
Pratt, A. G.	President, The Babcock & Wilcox Company, New Jersey	May 15
Prater, B. M.	Chief Engineer, O.S.L.R.R.	July 5
Porter, T. G.	Manager, Department of Natural Resources, Canadian Pacific Railway Co., Calgary, Alberta, Canada	July 21

VISITORS - 1934 (cont.)

INDUSTRIAL

Robinson, F. W.	Vice President in Charge of Traffic, Union Pacific System	Mar. 9 July 5
Rogers, F. H.	Chief Engineer, I. P. Morris Division of Baldwin-Southwark Corp. Philadelphia, Pa.	June 29
Strandberg, G. R.	Hydraulic Engineer, Stone & Webster Co., Boston, Mass.	Jan. 31
Seagraves, C. L.	In Charge of Agriculture Development Work for Santa Fe Railroad	Mar. 31
Spalding, W. L.	American Cyanimid Company New York City, N. Y.	May 28
Schmidt, E. C.	Director of Publicity Union Pacific System	July 5
Terteling, J. A.	Contractor, Spokane, Wash.	Jan. 23
Thompson, G. J.	Erection Engineer, General Electric Company, Schenectady, New York	June 1
Treanor, J. A.	Riverside Cement Company, Riverside, Calif.	Oct. 19
Uhl, W. F.	Charles T. Main Inc., Boston, Mass.	Jan. 31
White, Lazarus	Contractor, St. Paul, Minn.	Feb. 23
Williams, Vance H.	Traffic Manager, Chicago & Illinois Midland Railroad Company, Springfield, Ill.	Nov. 19
Younger, R.	Trading Auditor Interstate Transit Lines	July 30

VISITORS - 1934 (cont.)

ASSOCIATIONS, NEWSPAPERS, AND MOVING PICTURE REP.

Associations

Osborne, John T.	President Topeka Chamber of Commerce, Topeka, Kansas	Jan. 11

Newspapers & Magazines

Arthur, W. K.	"Daily Sun" San Bernardino, Calif.	Feb. 3
Bowers, N. A.	Pacific Coast Editor, Engineering-News Record, San Francisco, Calif.	April 4-5
Carr, Frederick W.	Christian Science Monitor Chicago, Illinois	Dec. 7
Gurley, Boyd	Los Angeles Post, Los Angeles, Calif.	Aug. 18
Hovey, D. C.	Chief Engineer, Los Angeles Examiner	Sept. 17
Kleiser, Geo. W.	President Foster Kleiser Advertising Company, Los Angeles	Mar. 5
Manning, R.	Cartoonist, Arizona Republic, Pheonix	Apr. 17
Mott, H. L.	Writer, Arizona Republic, Pheonix	Apr. 17
McMollum, Carl	Vice-President, Kansas City Star, Kansas City, Mo.	Sept. 5
Newcomer, E. D.	Photographer, Arizona Republic, Pheonix	Apr. 17
O'Brien, Vincent	Literary Editor, Chicago Daily News	May 2
Rhodes, H. W.	Los Angeles Examiner	Sept. 17
Stingle, John	Los Angeles Examiner	Mar. 10

VISITORS - 1934 (cont.)

ASSOCIATIONS, NEWSPAPERS, AND MOVING PICTURE REP.

Newspapers & Magazines

Schmitt, F. E.	Editor, Engineering-News Record, New York City	June 11-13
Shippey, Lee	Columnist, Los Angeles Times	July 2
Timmons, Joe	Los Angeles Examiner	Mar. 10
Wilmot, Sidney	Manager of Publications, A.S.C.E., New York City	July 19
Waldron, Webb	Writer for American and Colliers Magazines	Aug. 2-3
Wheeler, Stanley A.	Marine Editor, Los Angeles Evening Herald and Express	Sept. 27

Moving Picture Representatives

Allvine, Glendon	Executive Producer, R.K.O. Film Studios, Hollywood	July 21 Sept.17-19
Barry, Joseph J.	Location Department, Warner Bros. and First National Studios, Hollywood	Sept. 13
Davis, Bette	Movie Actress, Hollywood, California	May 21
Fernstrom, Ray	Hearst Metrotone News	Sept.22-23
Lubin, Arthur	Associate Producers Pictures, Los Angeles	Apr. 28
O'Donnell John	Director R.K.O. Film Studios, Hollywood	July 21 Sept.17-19
Wheeler, Roger	Scenarist, R.K.O. Film Studios	July 21

OTHER PROMINENT PERSONS

Breyer, R. S.	Los Angeles, California	Feb. 20
Bagnall, Mrs. Blanche A., and party	San Francisco, California	Mar. 10

VISITORS - 1934 (cont.)

OTHER PROMINENT PERSONS

Baldwin, A. R.	San Francisco, Calif.	Mar. 15
Brownell, Dr. E. C.	San Francisco, Calif.	Mar. 15
Booth, Edwin	Plainfield, New Jersey	Apr. 30
Crain, Harry	Cheyenne, Wyoming	Jan. 11
Fletcher, Ed.	San Diego, California	Nov. 11
Heikes, Geo. C.	Giesche Spotka Akeyjina, Katowice, Poland, Geologist on Staff of Anaconda Copper Co., Polish Subsidiary	Apr. 10
Hanks, Stedman S.	Manchester by the Sea, Mass.	Jan. 13
Koshland, Jesse	San Francisco, Calif.	Mar. 6
Lee, Dr. Willis T.	Reno, Nevada	Nov. 14
McNaughton, Malcolm	Los Angeles, Calif.	Apr. 23
Neel, W. E.	Los Angeles, Calif.	Sept. 30
O'Shaughnessy, M. M.	San Francisco, Calif.	Mar. 15
3500 Shriners	Arizona, California, Utah, and Nevada	Oct.20-21
70 Knights of Templar	Lansing, Michigan	July 6
Woodruff, J. L.	Dodge City, Kansas	May 31

CHAPTER I

INTRODUCTORY AND GENERAL

Containing

ARTICLES AND ILLUSTRATIONS

DESCRIPTIVE OF

A. General Description of Project

B. Summary of Important Events

C. Summary of Reports of Boards of Engineers

D. Orders & Public Notices

E. Major Routine Features

F. Future Needs of the Project

A

GENERAL DESCRIPTION

OF THE PROJECT

By

Walker R. Young, Construction Engineer

1. Establishment of Project.

Development in the Colorado River Basin

Summary: The creation of the project has been described in Chapter I, Volume I, of the history "From Beginning to December 31, 1931" and is briefly reviewed in the following paragraphs.

The project was created by the Boulder Canyon Project Act (CH 42, 45 Stat. 1057), which was signed by President Coolidge on December 21, 1928, and became effective by proclamation of President Hoover on June 25, 1929, after the required number of states had ratified the Colorado River Compact.

In April, 1930, contracts for purchase of power from the dam were executed with the City of Los Angeles, Metropolitan Water District of Southern California and the Southern California Edison Company insuring repayment of all construction costs within 50 years after the dam was built. Execution of these contracts was followed by the passage of an appropriation by Congress and the signing of the Second Deficiency Bill by President Hoover on July 3, 1930, which made available $10,660,000 for commencing construction.

On May 19, 1930, Construction Engineer Walker R. Young of the Kittitas Division of the Yakima Project was appointed Construction Engineer of the Boulder Canyon Project. In August of that year the project office was installed on the third floor of the Beckley Building in Las Vegas, and government construction camp No. 1 was erected at "Summit" near the present site of Boulder City.

During September, 1930, Superintendent John C. Page of the Grand Valley Project, Construction Engineer Ralph Lowry of the Cle Elum Dam, Storage Division, of the Yakima Project, and Chief Clerk Earle R. Mills of the Kittitas Division of the Yakima Project were transferred to the Boulder Canyon Project to act in the respective positions of Office Engineer, Field Engineer and Chief Clerk. In March, 1929, Mr. Louis C. Cramton was appointed as Special Representative by the Secretary of the Interior to establish policies in connection with the leasing of lots in Boulder City. Mr. Cramton completed this work in September, 1931, and Mr. Sims Ely of Berkeley, California, was appointed as City Manager of Boulder City to carry on Mr. Cramton's work and to be in charge of matters pertaining to the administration of the town.

2. Location of the Project

Location

Damsite: The site of the dam in Black Canyon was chosen, following extensive drilling and geological investigations of sites in Black Canyon and Boulder Canyon (20 miles upstream from Black Canyon) which were started in December, 1920, under the direction of Engineer Walker R. Young.

Black Canyon is 440 miles from the entrance of the Colorado River into the Gulf of California, 100 miles above Needles, California, and 155 miles upstream from the Parker Damsite of the Los Angeles aqueduct. The mouth of the Virgin River is 30 miles upstream, and the Bright Angel crossing in the Grand Canyon National Park is 270 miles upstream from the damsite.

Reservoir: The reservoir back of the dam will be nearly 115 miles in maximum length and have a bay extending 35 miles up the Virgin River. The area of the reservoir when full to elevation 1229 will be approximately 145,000 acres, or 227 square miles, with a shore line 550 miles in length. The larger part of the storage, amounting at high water surface to 30,500,000 acre feet, will be obtained from the valley of the Virgin River and Las Vegas Wash on the Nevada side and in the Detrital Valley on the Arizona side. Approximately

12,500 acres of patented land will be inundated by the reservoir, including the towns of St. Thomas and Kaolin, Nevada.

Power Plant: The hydro electric plant at Boulder Dam will produce 663,000 continuous horse power, amounting to 4,333,000,000 KWH of electrical energy per annum. Contracts have been signed for purchase of this power by districts, municipalities and firms of Southern California. The transmission lines will be built by the power contractors. The distances by highway from Boulder City to Southern California cities are 258 miles to San Bernardino, 323 miles to Los Angeles and 393 miles to San Diego.

Boulder City: Boulder City, the town established as headquarters for construction of Boulder Dam and appurtenant works and for the operation of the power plant and reservoir when completed, is 6 miles southwest of the damsite and 23 miles southeast of Las Vegas, Clark County, Nevada. It is situated on a branch line of the Los Angeles and Salt Lake Railroad (Union Pacific System) extending from Boulder Junction on the main line seven miles south of Las Vegas to the townsite. An oil surfaced highway connects Boulder City to U. S. Highway 91 at Las Vegas. Other highway connections are via Searchlight, Nevada, to U. S.

Highway 66 at Bannock, California, 78 miles from Boulder City; or by way of a ferry across the Colorado River at the mouth of Black Canyon and a road now being improved to Chloride and thence to Kingman, Arizona, on Highway 66, 95 miles from Boulder City.

<u>All-American Canal:</u> The All-American Canal, proposed to divert water from the Colorado River at a location above Yuma, Arizona, and convey the water altogether in the United States to the Imperial Valley, has been made a part of the Boulder Canyon Project by the act which established the project, but is not properly a part of the construction described in this history and will not be discussed further in this volume.

3. Principal Features of Boulder Dam and Appurtenant Works.

<u>Introduction:</u> The Boulder Dam and power plant, the reservoir back of the dam and the All-American Canal constitute the principal features of the Boulder Canyon Project. As previously mentioned, construction of the All-American Canal does not come under the direction of the Boulder City office.

Features of greatest importance in the construction at Black Canyon include the dam, power plant, diversion works, spillways, intake towers and penstock system. Accessory features directly connected with construction are transportation facilities to the project and dam, transmission to the project of electrical energy for construction purposes, the town of Boulder City, the 150-ton government cableway, and the equipment and plants of the principal contractors, Six Companies, Inc., and The Babcock & Wilcox Company.

The principal structures connected with the dam have been described in the preceding histories and further description will be confined to those for which pronounced changes in design have been made in 1934. Other features will be described in Chapter II--"Construction".

Changes in Design

The principal change in design during the year was in the location of the controlled diversion outlets in the upstream plug of a diversion tunnel, which was moved from the Nevada inner tunnel to the Nevada outer tunnel. In this regard, an adit was driven between the two tunnels, and a trashrack structure built at the inlet of the outer tunnel.

The revision will also require the closing of the steel bulkhead at the inlet of the Nevada outer tunnel under balanced water pressure, but under a head of possibly 300'. It was deemed advisable to hold the bulkhead gate in open position by means of the steel supporting beams, until the time of lowering, and a retractive device was therefore designed to withdraw the beams at the desired time. This consisted generally of three 6' wide by 7' high by 15' long counter weights of concrete and scrap steel which were held in suspension at the top of and in front of the trashrack by steel chain connections to the supporting beams. When it is desired to lower the gate, it will first be raised slightly by means of hydraulic cylinders in order to remove its weight from the supporting beams, which will then be automatically pulled out from under the gate by the sinking of the counter weights. The submerged weight of the counter weights is nearly three times that of the submerged weight of the supporting beams.

Drawings that show details of the changes in design described above include 45-D-3203, 6' x 7'6" High Pressure Gate Installation; 45-D-5745, Nevada Spillway Tunnel Plug; 45-D-5747, Nevada Spillway Trashrack and Tunnel Plug; 45-D-5875, Trashrack Structure, Nevada Spillway Tunnel; 45-D-7309, Proposed Changes in Control Mechanism of Bulkhead Gate; and 45-D-7322, Concrete Details of Deck over Trashrack.

Construction Program: Work that is expected to be finished early in 1935 comprises the construction of the intake towers, spillways, spillway inclined tunnels, dam, canyon wall valve houses, and the upstream or gate section of the Nevada spillway tunnel plug.

According to latest data, the downstream plugs in the inner diversion tunnels are expected to be finished in 1935, the Arizona spillway plug in May 1935, the powerhouse by June 1935, and installation of the first five units in the power plant by January 1936.

Completion dates for installation of steel pipes in the penstock and outlet system are August 1935 for the upper Nevada tunnels, November 1, 1935, for the upper Arizona tunnels, June 1936 for the lower Nevada system, and November 1, 1936, for the lower Arizona system.

If controlled diversion of the river is started in February 1935 and the river discharge is normal, the elevation of the reservoir will be at 900', where the lower gates of intake towers are located, by May 15, 1935. The first power is expected to be generated by the end of 1935.

B

SUMMARY OF IMPORTANT EVENTS

By

Walker R. Young, Construction Engineer

Construction

At the end of 1934, Six Companies Inc. had completed approximately 91 per cent of its contract for building the dam, power plant and appurtenant works, and The Babcock & Wilcox Company had finished 35 per cent of the work to be accomplished under its contract for the fabrication, erection and painting of the pipe for the penstock and outlet systems.

Structures that were completed, or nearly so, in 1934 were the spillways, intake towers, upstream plugs in inner diversion tunnels, all adits to the plugs, the tunnels of the penstock and outlet systems, and the control circuit tunnel.

Excavations were finished for the Nevada canyon wall outlet works, the Arizona spillway inclined tunnel, the powerhouse, and the oil purification shafts between construction adits. Concrete lining was placed in all the penstock and penstock header tunnels, the raises to the upstream intake towers, the spillway inclined tunnels, except from Station 7+10 to Station 9+72 on the Arizona side, the adits to the downstream plugs, and the control circuit tunnel. The floors were paved in the construction adits and in the adits to the Nevada spillway plug.

The dam was raised to average elevation 1172, the slot was poured to elevation 955, cooling was completed to elevation 940, and grouting to 825. Approximately 3,099,000 cubic yards of concrete had been poured in the dam on December 31, of which 2,153,057 were placed during 1934. The last bucket of the first millionth yard was poured on January 7, the second millionth on June 2, and the third on December 5.

Of the structures practically finished, the work uncompleted comprised in general: Pouring the remaining 13 per cent of the concrete, placing the trashracks and installing the gate operating machinery in the intake towers; placing a small amount of lining in the channels and approximately 400 lineal feet of lining in the inclined tunnels of the spillways; pouring of concrete around the steel pipes when installed and in the downstream ends of the upper plugs; lining the passageways from powerhouse to and between penstocks; and the installation of metal work in the control circuit tunnel.

Construction also was in progress at the end of the year for the powerhouse canyon wall valve houses, the gate section of the Nevada spillway plug, the piers for steel pipe in diversion tunnel No. 2 and the Arizona spillway bridge. The lower cofferdam and rock barrier were being removed, and the earth fills were being placed at the upstream toe of the dam and on the reservoir side of the Arizona spillway weir.

The Babcock & Wilcox Company at the end of the year had completed fabrication of 146 sections of 30' diameter pipe, one of 25', 107 of 13', 57 of 8½', four of 9', and 12 special sizes. This contractor had installed 129' of 30' pipe in Nevada penstock header No. 5, 122' of 13' pipe in the Nevada penstock tunnels (UN 4 and 6), 832' of 8½' pipe in the Nevada outlets, and 960' in the Arizona outlets. The first 30' section, No. UN 1, for Nevada penstock header No. 5, was transported to the tunnels on July 10, and the first 13' section, UN 106, on September 5. The amount of steel used in fabrication was 20,640.1 tons, of which 1,754.1 tons were installed in the tunnel.

A tabulation is given on the following two pages of significant dates in the construction of the various features.

Feature	Excavation Practically Completed	Concreting Started	Concreting Practically Completed	Pipe or Gate Installation Started	Pipe or Gate Installation Practically Completed
Diversion Tunnels	May 1932	Mar.1932	Mar.1933	Nov.1932	Nov.1933
Tun. No. 1 Plug	Oct.	Nov. 26		Dec.	
" " " " Adit	Sept.	Dec. 7			
Tun.No. 2 - U.S.Plug	1932	July 24	Nov. 27		
" " " " "Adit	May 1933	Oct. 5			
Tun. No. 2 - D.S.Plug	January				
" " "-D.S.PLUG Adit	June 1933	May 20	July 24		
Tun. No. 3-U.S.Plug	1932	Mar. 1	Sept. 25		
" " " " " Adit	Sept. 1933		Plugged Dec. 1933		
Tun. No. 3-D.S.Plug	March				
" " " " " Adit	June 1933	Feb. 2	May 25		
Dam	June 1933	June 6 '33			
Nev.Spillway channel	1933	1933		June 5	November
" " tunnel	1932	1933	Nov. 1		
Ariz.Spillway channel	1933	1933		Mar. 21	July
" " tunnel	January	June 26			
Nev. U.S. Tower	1933	1933		Lower Jan. Upper June	Lower Mar. Upper July
Nev. D.S. Tower	1933	1933		Lower 1933 Upper May	Lower Jan. Upper June
Ariz. U.S.Tower	1933	1933		Lower Jan. Upper July	Lower Mar. Upper Aug.
" D.S.Tower	1933	1933		Lower Jan. Upper May	Lower Mar. Upper June
Nev.Incline to U.S. Tower	1933	1933	March 22		
Ariz.Incl.to U.S.Tower	1933	1933	April 25	Nov. 6	

Feature	Excavation Practically Completed	Concreting Started	Concreting Practically Completed	Pipe or Gate Installation Started	Pipe or Gate Installation Practically Completed
Nev. Header Tun. No. 5	1933	1933	May 22	July 10	
Ariz. " " No. 6	1933	1933	May 18	Sept. 18	
Nev. Upper Constr. Adit	1933	June 2	June 21		
Ariz. " " "	1933	Oct. 3	Nov. 27		
Nev. Lower Constr. Adit	1933	May 26	June 5		
Ariz. " " "	1933	Oct. 10	Oct. 14		
Nev. Penstocks	1933	1933	Oct. 1	Sept. 5	
Ariz. "	1933	1933	Aug. 11		
Nevada Valve House	March				
Arizona " "	1933				
Nevada Outlets	1933			Apr. 25	July
Arizona Outlets	1933			Dec. 11	May
Powerhouse	March	Jan. 27			
Nev. Lower Cableway Landing	March	Apr. 6	(not paved) May 21		
Ariz. " " "	March	Mar. 9	(not paved) May 12		
Control Circuit Tun.	Apr. 27	July 15	Oct. 17		

All dates given in the table above are in 1934, unless stated otherwise.

Detailed discussions of the construction in progress during the year will be found in Chapter II under the headings "A" - "Construction of Boulder Dam, Power Plant and Appurtenant Works" and "B" - "Fabrication and Erection of Steel Penstock and Outlet Pipes".

No river floods of importance occurred during the year, and according to the records at this office, the river established a new low flow. The highest discharge was 24,450 c.f.s. on May 18, and the lowest 1,780 c.f.s. on August 14. The maximum temperature on the project was 123° in Black Canyon on July 27 and the minimum 30° in Boulder City on December 29.

The First Assistant Secretary of the Interior T. A. Walters visited the project on September 11, Commissioner Elwood Mead was here on July 3 and 4, Miss M. A. Schnurr, Assistant to the Commissioner, on August 9 and 10, and Chief Engineer R. F. Walter on February 16-20, July 3-5, July 10-12, and October 4-8.

Data of various features and activities on the project in 1934 will be found in the charts on the two following pages.

Month	Water to Storage	Water Hardness: River	Water Hardness: Storage	Atmospheric Temperatures: Max.	Atmospheric Temperatures: Min.	Atmospheric Temperatures: Mean	Rainfall	Project Employees at end of Month	Project Visitors: Persons	Project Visitors: Vehicles
Jan.	15,151,000	587	135	75	32	52.4	0.30	3,575	9,633	3,256
Feb.	16,379,500	564	122	77	41	57.5	0.25	3,881	14,190	4,554
March	19,928,000	497	116	96	45	70.1	0.00	4,839	30,371	9,328
April	24,368,000	406	108	105	41	76.3	0.40	5,068	29,162	8,987
May	31,720,000	219	116	113	52	84.7	0.00	5,102	17,521	6,165
June	31,800,000	260	130	122	50	85.4	0.19	5,218	22,113	7,151
July	37,792,000	400	125	123	64	96.4	1.18	5,119	16,398	5,752
Aug.	30,736,000	589	142	116	68	92.4	0.30	5,065	17,788	6,008
Sept.	25,576,000	587	156	115	51	86.2	0.00	4,846	20,249	6,874
Oct.	22,432,000	592	139	103	49	74.7	0.06	4,653	22,180	6,983
Nov.	16,520,000	664	152	90	37	62.1	0.01	4,459	32,525	9,645
Dec.	15,040,000	696	128	75	30	50.7	0.44	4,257	34,306	10,440
Total	287,442,500	6,061	1,557				3.11		266,436	85,142
Ave.	23,953,541	505	131			74.1				

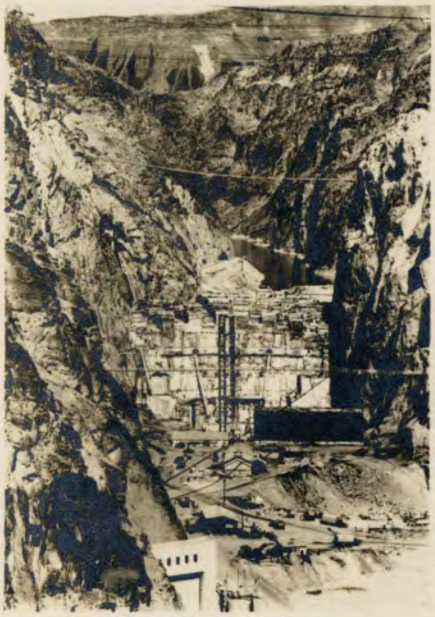
93

Month	Aggregate Yield in Cars		Concrete Production in Cubic Yards		Electricity Used by Project	River Discharge			
	Pit	Screening Plant	Lo-Mix	Hi-Mix		Max.	Min.	Mean	Runoff
January	7,189	6,898	102,474	103,776	5,059,000	7,900	4,590	5,850	359,700
February	7,112	6,799	94,275	117,741	4,789,000	7,030	5,480	6,076	337,000
March	8,316	7,940	113,636	148,238	5,385,000	6,860	5,360	6,035	370,900
April	7,752	7,595	108,791	153,100	5,572,000	12,300	5,290	7,294	434,000
May	7,814	7,075	105,376	144,065	6,096,000	24,450	12,300	17,678	1,087,000
June	6,968	6,688	97,372	119,795	5,755,000	19,150	4,120	10,300	614,700
July	828	7,456	101,905	108,904	6,059,000	4,120	2,000	2,776	170,700
August	0	7,626	75,697	135,389	6,101,000	7,950	1,780	2,565	157,700
September	0	4,832	62,196	140,409	5,272,000	8,730	2,000	3,149	187,400
October	0	7,030	67,333	145,915	5,532,000	4,150	2,510	3,071	188,800
November	2,196	4,467	2,632	172,335	5,013,000	4,180	2,950	3,435	204,400
December	0	0	0	147,496	4,497,000	5,050	3,450	4,227	259,900
Total	48,175	74,404	928,685	1,635,099	65,130,000				4,372,200
Ave.					5,427,500			6,039	

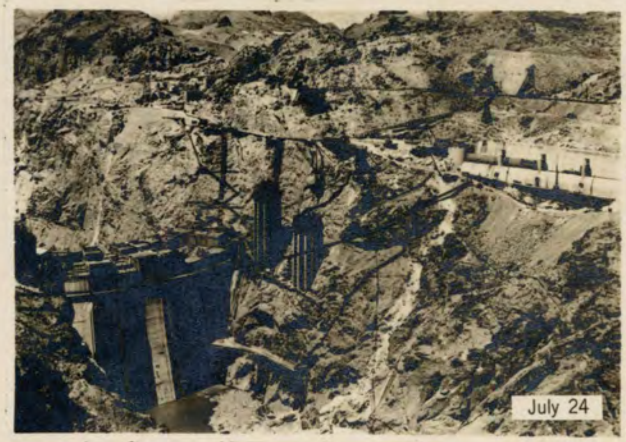
CANYON VIEWS, 1934

June 25

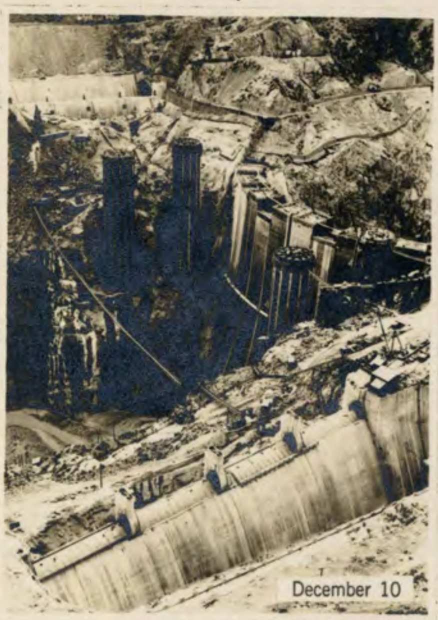
January 26



February 21



July 24



December 10

November 20

C

SUMMARY OF REPORTS OF BOARDS OF ENGINEERS

By

Walker R. Young, Construction Engineer

The reports of Consulting Boards for 1934 are briefly summarized in the following paragraphs:

Board of Engineers

Dr. W. F. Durand, Consulting Engineer, and Chief Mechanical Engineer C. M. Day comprised a board for examination of re-welded cracks in the first two sections of 30' steel pipe, Nos. UN 1 and UN 2, that were fabricated by The Babcock & Wilcox Company. The cracks occurred in a transverse direction across some of the circumferential and butt strap seams, spread from the weld into the plate, and in most instances extended through the plate. All appeared prior to stress relieving, and after the first two pipe sections were completed, little trouble was experienced in the fabrication of the following sections.

The board made its inspection on February 28, after the cracks had been chipped out and re-welded. It examined the X-rays of the re-welds and visually inspected the joints which had been ground down and cleaned to the virgin metal. After further X-raying of the joints of UN 1 under the board's direction and examination of the film, the board in its report dated March 2, 1934, recommended acceptance of the section. Further X-rays were to be made of section UN 2, and the recommendation of the board was that it be accepted, provided that the film gave the same general evidence of satisfactory conditions as for section UN 1.

Survey of Mineral Resources

Members of the U. S. Geological Survey made an investigation of the region within a 200-mile radius of the dam, starting the field work in February and completing it in May. The investigation was made possible by a grant of $25,000 from the Public Works Administration to the Bureau of Reclamation for an Industrial Survey. Subsequent arrangements were made with the U. S. Geological Survey for the work under discussion. The survey in the field was conducted by specialists in their professions, Dr. D. F. Hewett being in charge of the study of ferrous metal deposits, Mr. T. B. Nolan reporting on non-ferrous metal deposits, and Mr. W. T. Schawler on borate minerals in the Cramer District, Messrs. W. B. Rubey and Eugene Callahan investigating the magnesite deposits of the Muddy Mountains and elsewhere, and B. N. Moore making a study of the non-metallic minerals.

The following reports have been submitted to Secretary of the Interior Ickes as a result of the geological survey and in connection with the industrial survey:

"Field study of the Mineral Resources in the Region Tributary to Boulder Dam" by the U. S. Geological Survey dated August 24, 1934.

"Cost of Electrical Energy at Boulder Dam and Delivered at Points 100 and 200 Miles Distant" by Mr. L. N. McClellan, Chief Electrical Engineer, Bureau of Reclamation, dated September 13, 1934.

"Economic Factors to be Considered in the Development of Minerals Tributary to Boulder Dam" by Professor C. K. Leith, Mineral Economist, University of Wisconsin and Mr. H. N. Eavenson (President of American Institute of Mining Engineers), dated November 6, 1934.

D

ORDERS AND PUBLIC NOTICES

By

Walker R. Young, Construction Engineer

Orders and Memoranda issued from the project office include extra work orders and orders for changes transmitted to contractors concerning construction, and notices and orders sent to government employees regarding the designations of holidays, the rental of sleeping accommodations to transient visitors, the protection of visitors being taken over the job, the nomenclature for construction features, and other matters.

The Public Notice of most importance was City Order No. 13 "Motor Vehicle Traffic Regulations for the Boulder Canyon Project" which was published in pamphlet form by the U. S. Government Printing Office for general distribution.

Project Memoranda were issued during the year from No. 118 to 133 and City Orders from No. 13 to 15, all inclusive. Copies of the following notices and orders will be found in the Appendix at the end of the history:

1. Protection of Visitors being taken over the Job.
2. Nomenclature for Construction Features.

3. Plan to be followed in assigning sleeping quarters to project visitors in private homes.
4. Preparation of Project History for 1934.

U. S. B. R. EMPLOYEES

Office Forces

Left to Right -
Back Row: J. W. Dodson, F. C. Quantrell, J. O. Reeves, L. L. Mapes, C. S. Lawson, R. C. Thaxton, Walter Seyfarth, F. C. Lewis, Otto Littler, J. A. McArthur, J. P. Jones, B. D. Glaha;

Center Row: W. B. Radford, M. C. McKeever, C. C. Darden, E. H. Schoppe, R. S. Calland; S. H. Moore, C. S. Hoag, C. F. Weinkauf, W. R. Nelson, R. L. Brown, B. G. Sucher, G. H. Baird, John E. Soehrens, G. E. Chambers, R. B. Spearman;

Front Row: Mrs. Cora Trimble, Mrs. C. J. Blake, Mrs. Hattie Petersen, Marguerite B. Riswold, C. H. Tornquist, Sims Ely, John C. Page, Walker R. Young, Ralph Lowry, T. S. Martin, Earle R. Mills, Miss Martin, Hannah Iiles, Mrs. Cecile M. Crowe.

Municipal Forces

Left to Right -
Back Row: L. N. Farris, E. E. Randall, W. R. McSpadden, Roy K. Suders, Clarence Arp, Lewis Gear, J. F. Grau, A. J. Fisher, Thomas P. O'Neill, M. G. Harman, W. A. Wallace, Paul R. Mitchell;

Center Row: R. A. Cowan, T. M. Godbey, Leo Courtney, M. H. Shelton, Angus C. Joplin, R. E. Hopper, H. M. Younger, Harry Sanford, Robert Parker, Otto Krening, Roy Shipp, Chester Hamby, E. A. Savage;

Front Row: Harvey Johns, T. M. Strawn, Everett Sharpe, A. R. Morton, David Armstrong, I. D. Wolfe, G. G. Walter, W. W. Weed, A. G. Boynton, A. R. Martin, W. H. Walker, Alexander Kallin, A. Gayle Fleury, A. R. Doud.

Portion of Day Shift

Left to Right -
Fifth Row: Kenneth Hydorn, George Tank, Leslie Nunez, William Reeves, Donald S. Walter, Unknown, Harold Page, Dean W. Davis, Unknown;

Fourth Row: Frank T. Cummings, Byrd Glenn, Walter C. Chubbuck, Clifford Mutch, Woodrow Eaton, Orville I. Craft, R. K. Durant, R. F. Nesalhous, Edward Heinemann, Frederick Coffin, Donald Morgan;

Third Row: Stanley Bohman, Virgil Haugse, Hugh L. P. Stewart, Bruce G. Davis, Fred H. Nichols, H. L. McBirney, Homer Mills, James Gwyn, Royal Randall, L. J. Chatwin;

Second Row: Gilbert Yetter, A. A. Brownson, A. Cruttenden, Lloyd Hudlow, Alfred Ellerman, W. T. Moody, R. E. Hewes, Horace D. Taylor, Hobart Blair, Lyndell Lewis;

First Row: George Tarleton, John A. Custer, C. Wm. Burningham, Lawrence Barnson, William Price, Robert Hewes, Jr., C. T. Douglass, Paul A. Jones, O. C. Johnson, Emerald Johns, E. E. Long, A. R. Mead, Louis A. Chadburn, Royal Barnson, V. P. Folmsbee, Manuel Aaron.

Portion of Day Shift

Left to Right -
Fourth Row: Max Hedges, Donald Brooks, Albert R. Soliss, W. R. Green, Earle C. Smith, Alvin I. Stortroen, Charles LeMoyne Jr., T. H. Wall;

Third Row: Carl A. Schuppenies, J. M. Cooney, G. A. Griffith, M. E. Dastrup, Major O. Simons, George D. Atkinson Jr., Stanley Elcock, Walter Sanford, Unknown;

Second Row: Charles L. Price, D. H. Norbeck, Sherman O. Decker, Earl Salter, Van O. Eastland, Harold V. Jenkins, Elmer Chapman, E. L. Moore, R. L. Scarborough, Leo Dunbar, W. A. Dexheimer, G. E. Belden;

First Row: Grant Bloodgood, Nathan R. Laden, Stephen Chubbs, Theodore Zabrowski, Lee Dana, Carlo P. Christensen, Leroy Snyder, Hollis Sanford, John K. Rohrer, John I. Duffey, C. C. McCarthy, E. H. Sutherland.

PROJECT PERSONNEL, BUREAU OF RECLAMATION

Office Force

Operation and Maintenance

Group from Day Shift

Group from Day Shift

Federal Rangers

Left to Right -
W. Corley, Charles F. Peterson, Fred Parkerson, W. H. Trimble, Fred Jensen, John R. Weiler, D. M. Laughery, H. F. Doud, O. P. Senter, L. H. Tyson.

Group from Day Shift

Left to Right -
H. A. Glidden, R. F. Skinner, V. J. Peterson, C. R. Brim, W. W. Woodson, R. E. Walker, W. I. Winner, E. L. Howard, W. D. Wood, L. H. Compton.

Swing Shift

Left to Right -
Back Row: Kenneth MacDonald, Byron Boston, C. Stover, W. B. Evans, Kenneth H. Rankin, G. Waddell, Harry Hugill, Edward Craig, Wilbur Roush.

Center Row: W. Wheeler, L. D. Purdin, R. T. Cooney, Robert Johnson, Howard McBirney, Garland Gray, R. J. Hannon, Albert Rankin, Frank S. Dallon, Roy McNeill, D. M. Kime.

Front Row: M. O. Dodge, C. R. Bilderback, C. W. Counts, Norval Unger, G. A. Warning, J. R. Granger, L. Wylie, William Parks, Cecil D. Scott, J. W. Goodman, Walker Wilferth.

Graveyard Shift

Left to Right -
Back Row: Everett Pelkey, C. M. Jackson, W. J. Quinn, Ernest Burke, G. N. Ball, L. J. Tobler, H. L. Perkins, J. A. Roeschlaub, G. C. Wright.

Front Row: C. H. Jackson, Lynn Parker, R. Edwards, H. C. Bowman, Norval Walker, W. T. Mulkey, James Peasley, J. H. Lyon, John C. Bowman, Lawrence J. Morand.

PROJECT PERSONNEL, BUREAU OF RECLAMATION

Federal Rangers

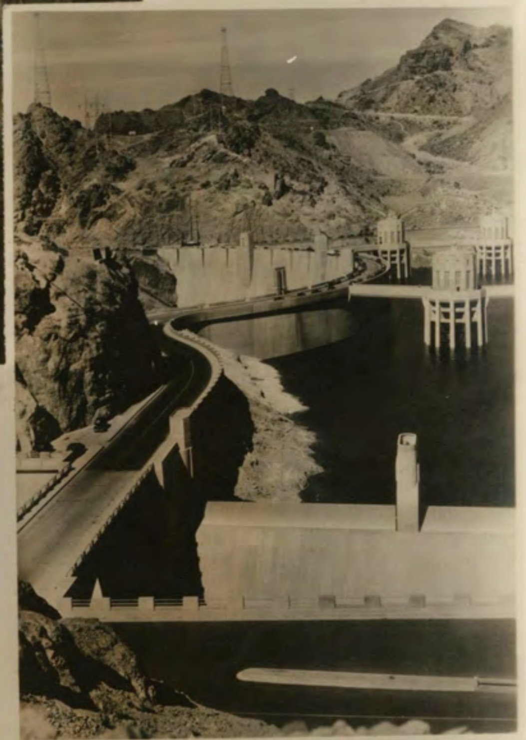
Group from Day Shift

Swing Shift

Graveyard Shift

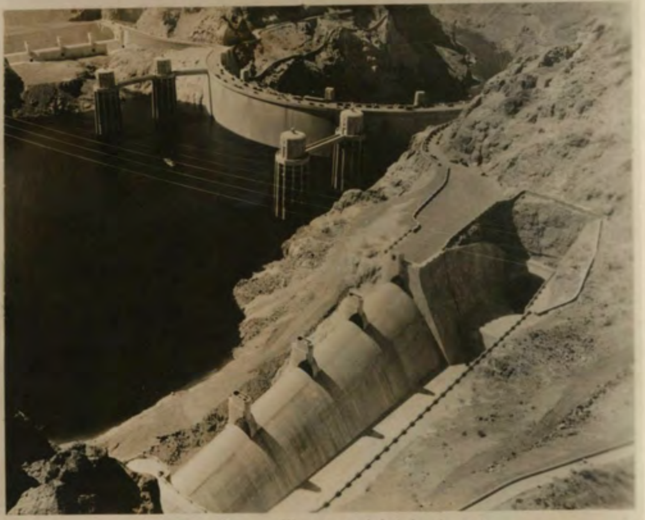
BOULDER DAM

Boulder Dam by night



Boulder Dam
from point above Arizona spillway

Boulder Dam, Nevada Intake Towers,
and Spillway from Point on the
Arizona rim of the canyon



Upstream face, spillways and intake towers

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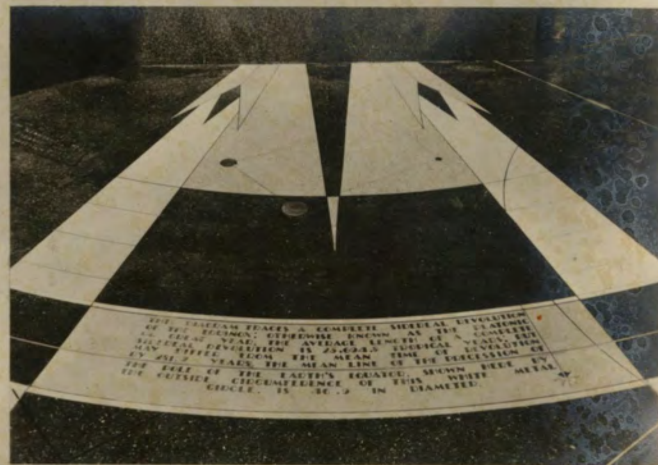
FRC-42896

MONUMENTS

Two tiny visitors view the bronze winged figures



Portion of the star map

Part of star map

The National Emblem and three of the seven state seals in the star map at the Nevada end of the dam

Section of the star map

Portion of star map, showing moon

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E

MAJOR ROUTINE FEATURES

I - Clerical

By Earle R. Mills, Chief Clerk

Organization:

The clerical force was increased by two employees and decreased by four employees during the year, a net decrease of two. At the close of 1934 the organization consisted of 15 employees, including three employees in the City Manager's Office. Of the total number four were engaged in storehouse operations. The heavy influx of construction material and equipment necessitated increasing the storehouse force by two men.

Effective January 25, Erle W. Shepard, Senior Clerk, performing the duties of Purchasing Agent, was transferred to the Carlsbad Project and assigned to the duties of Chief Clerk at Carlsbad, New Mexico. Senior Clerk, Charles S. Lawson, was assigned as Purchasing Agent as Mr. Shepard's successor. As of April 16, Mrs. Dorothy M. Kreutzer, Assistant Clerk, engaged in stenographic duties at the City Manager's Office, was transferred to the District Counsel's Office at Salt Lake City, Utah. Effective June 22, Senior Clerk George H. Bolt, previously assigned to the duties of City Clerk at the

City Manager's Office, was transferred to the Parker Dam Project for assignment to the position of Chief Clerk. Assistant Clerk Earl M. Petersen, performing the duties of Police Clerk at the Police Station in Boulder City, was transferred to the Denver Office, effective February 13. The position vacated by Mr. Petersen was abolished upon his transfer to Denver.

Clerical Work and Records:

Several reassignments of duties, involving a partial reorganization of the force, were accomplished during the year. Upon the transfer of Senior Clerk George H. Bolt to the Parker Dam Project, Senior Clerk Gail H. Baird, previously performing the duties of bookkeeper at the Project Office, was transferred to the City Manager's Office and reassigned to the duties of City Clerk. Charles C. Darden, previously employed as Clerk at the City Manager's Office, succeeded Employee Baird as Bookkeeper. All reports were submitted promptly, and all records were kept up-to-date currently.

Charles F. Weinkauf, bonded in the penal sum of $25,000.00, disbursed $14,238,640.70, stated on 1219 vouchers, during the year. His cash collections amounted to $87,400.62, covered by 83 bills for collection. Weinkauf handled $11,208.67 in his special deposit account during the year. Until his transfer to the Parker Dam Project, Special Fiscal Agent George H. Bolt, bonded in the amount of $5,000.00, disbursed $2,585.18, involving 196 vouchers. This amount was restricted to refunds and transfers from his special deposit account. Bolt's collections, all taken into special deposit account, totaled $2,913.65 for the year.

Storehouse and Mercantile Stores:

No mercantile stores were operated. The volume of storehouse operations is shown below:

Total operating cost ....$	21,172.39
Value of stock issued.................	7,896,061.74
Value of stock on hand 12/31/34......	2,459,420.23

Two storehouses were operated during the entire year.

Mess House Operations:

No mess houses were operated.

Purchasing and Transportation:

Purchases made by the Project Office amounted to over seventy five thousand dollars. This involved purchases of practically every commodity required on the project with the exception of food stuffs and heavy equipment. Among the items purchased locally were all types of building materials, trees and shrubbery, grass seed, fertilizer, pipe and pipe fittings, plumbing supplies, chemical and laboratory supplies, sheet metal work, motion picture laboratory service, first aid supplies, fire department equipment, engineering and drafting equipment, automobile and tractor repair parts, gasoline, lubricating oils, reinforcement steel, conduit cable and numerous types of electrical fittings.

Approximately 1000 local purchase orders were placed, involving the preparation of specifications, invitations for bids, and purchase contracts. Several thousand bills of lading were issued to cover transportation of the articles purchased. In addition to the local orders, a number of requests for purchase were prepared and forwarded to the Denver Office for handling.

During the year 2933 invoices, covering purchases accomplished by the Denver and Boulder City Offices, were checked; the actual receipt of the articles verified, the invoices assigned liability register numbers and taken into the project books.

The bulk of the incoming shipments was received at Boulder City via rail, comparatively little difficulty being encountered by damaged shipments enroute. Shipments were received from 24 states. Some difficulty was experienced in the checking of cement shipments and checking of various materials purchased on specifications; the first difficulty, as mentioned, having been caused by differences in tare weights as indicated by the Los Angeles and Salt Lake Railroad Company as compared with the net weights billed by the various cement companies. The last mentioned difficulty was caused by delays in the receipt of checking lists from the manufacturers.

Incoming carload shipments for the year totaled 10,593 cars, the contents of which are indicated in more detail by the following tabulation:

Bulk Cement	9282 cars
Sacked Cement	67 "
Skelp	352 "
Structural Steel and Machinery	419 "
Reinforcement Steel	315 "
Conduit, Pipe and Pipe Fittings	83 "
Miscellaneous	75 "
Total	10,593 "

Local Civil Service Board:

At the beginning of the year the personnel of the Board was as follows:

Erle W. Shepard - Secretary

Gail H. Baird - Vice-Secretary

John C. Page - Member

No examination announcements were issued and no examinations were conducted. On February 6, 1934, after Mr. Shepard's transfer to the Carlsbad Project, this office recommended to the Manager of the 12th U. S. Civil Service District at San Francisco, California, that the Board be disbanded because of the fact that the project was being constructed by Public Works Funds under NIRA regulations permitting Emergency Non-Civil Service employments. On February 20, 1934, the Manager replied to the effect that he was agreeable to permit the Board to remain status quo with the understanding that if the condition of the work on this project at a later date required an active board of examiners that action would be initiated to accomplish the designation of a new secretary vice Mr. Shepard. The Board remained in a status quo during the remainder of the year and by correspondence with the District Manager in December, it was mutually agreed to continue in this status until July 1, 1935.

Visits and Recommendations of Fiscal Inspectors and Others:

Field Representative C. A. Lyman from the Denver Office visited the project in the early part of December, (December 4 to 8, inclusive). Accompanied by Chief Clerk J. C. Thrailkill of the Yuma Project, the main purpose of their visit was to set up a system of field accounting for the All-American Canal Project similar to the system in vogue on the Boulder Canyon Project and to coordinate the two methods of procedure. Chief Clerk L. R. Smith of the Denver Office made two brief visits to the project in February and December. In December he was accompanied by Chief Accountant

William F. Kubach. No audits or examinations of fiscal affairs other than local project audits were conducted.

Cemetery Operations:

Prior to filling Boulder Canyon Reservoir, it will be necessary to remove the dead from the site. Approximately 91 known graves were located within the confines of the reservoir site. The majority of the deceased persons were buried in the Kaolin and St. Thomas Cemeteries. However, a few of the graves were located in more or less isolated locations along the Colorado River above Boulder Dam, mainly in the vicinity of the junction of the Virgin and Colorado Rivers. An advance decision from the Comptroller General of the United States was rendered to the effect that the removal of the remains from the reservoir site to new locations above the high water line, at government expense, would be a proper charge to the Boulder Canyon Project as a portion of the cost of clearing the reservoir site.

During the last six months of the year, much work, principally of a preliminary character, was necessary in connection with this undertaking which involves opening of the old graves, excavating new graves in five new locations as selected by surviving relatives of the deceased persons, removing, encasing, transporting and reinterring the remains in other burial grounds in the vicinity. Three drafts of combined invitation for bids and contract, the latter including detailed specifications for performance of the undertaking, were drafted and submitted to the District Counsel at Los Angeles, California, for legal advice and approval. Field examinations of the old and new cemeteries were made, and maps showing the original layout of the Kaolin and St. Thomas Cemeteries were prepared. State and County Representatives of the Nevada State Board of Health were contacted as were the County Commissioners of Clark County, Nevada, and Mojave County, Arizona. All of the graves were located within the boundaries of these two counties. Local morticians were interviewed, and many of the surviving relatives contacted personally and by correspondence. Insofar as practicable, the relatives were given their choice of new locations in the vicinity. Most of the dead were members of the Church of Jesus Christ of Latter Day Saints. Many of the graves in the St. Thomas Cemetery contained the remains of early pioneers of Southern Nevada buried in the early sixties. The highest officials of the Church were contacted and invited to cooperate with the Bureau in identifying the unmarked graves and to contact the surviving relatives to obtain from them an expression of their wishes with reference to the removals. A Committee of five members residing at St. George, Utah, Las Vegas, Logandale, Overton and

St. Thomas, Nevada, was appointed for this purpose. The first invitation for bids for this considerable undertaking was issued by this office November 21, and bids were opened on December 7. Schedule I of this advertisement called for removal of the remains of persons buried along the Colorado River at isolated points at a maximum elevation of only approximately 30' above the bottom of the reservoir at Boulder Dam.

Due to the contemplated storage of water early in 1935, it was essential that these removals be accomplished promptly. Therefore, Schedule No. I was awarded to Mr. C. R. Van Marter, licensed mortician and embalmer of Kingman, Arizona. Award to Mr. Van Marter was made on December 8, and the remains of four persons, all that could be located within the area, were removed from the old graves and reinterred in the Kingman and Hackberry Cemeteries in Mojave County, Arizona. Mr. Van Marter's contract was completed satisfactorily on December 19, 1934.

Mainly due to the fact that State and County Health Officials insisted on all encasements being accomplished in hermetically sealed receptacles lined with tin, copper or zinc and the misinterpretation of certain bidders concerning this requirement, also due to our failure to secure permission to utilize the so-called Museum Site in the vicinity of the old burial grounds for new cemetery purposes, all bids as received on December 7 on Schedule II, which comprised the main undertaking and which covered removals from the Kaolin and St. Thomas Cemeteries, were rejected, and another invitation for bids, revised to cover the latest developments, was issued in January of 1935.

Continued narrative concerning the result of the second advertisement and the ensuing operations thereunder will appear in the Project History for next year.

2. OFFICE ENGINEERING

By

John C. Page, Office Engineer

General

Office engineering for the project was handled by an organization containing four departments and a personnel of 18 men. The departments were for:

1. Drafting and Designing.
2. Monthly Estimates, Contractors' Orders, Statistics, and Public Contacts.
3. Checking of Materials.
4. Photography.

A force of eight men was also employed in the field office in connection with field surveys and preparation of the contractors' estimates.

Drafting and Design

The duties of the Department of Drafting and Design comprised the checking of drawings submitted by contractors, the preparation of project maps, making prints of project drawings, maintaining complete map files, reviewing Denver drawings in relation to actual field construction, and the accomplishment of a certain amount of design.

Detailed drawings were made of the location of reinforcing steel in the powerhouse footings, and many right of way plats were drawn for land purchases in the reservoir site. Cutting lists were prepared of the reinforcing steel in the dam and powerhouse. Progress maps were maintained, and drawings received from Denver were filed and distributed. In this latter work, as many as 3,400 prints were sorted, catalogued, distributed, and filed in one day.

Orders and Estimates, Statistics and Public Contacts

This department compiled the monthly estimates to form the basis for payments to contractors and assisted in the preparation of extra work orders and orders for changes of construction contracts for transmittal to the Denver and Washington offices for approval.

Orders for Changes Nos. 10 to 13 and Extra Work Orders Nos. 15 to 19, all inclusive, were sent to Six Companies Inc., and Order for Change No. 5 and Extra Work Order No. 2 were given to The Babcock & Wilcox Company. The gross earnings of Six Companies Inc. for 1934 amounted to $8,590,140.02, and for The Babcock & Wilcox Company $3,064,269.86.

Other work of the department included the preparation of monthly and 10-day reports of construction progress, compiling statistical data for lectures and other purposes, maintaining a Public Information Bureau, conducting prominent engineers and other distinguished visitors to points of interest on the project, answering routine correspondence, preparing miscellaneous project reports, and compiling the project history.

Checking Materials

The amounts of materials ordered and received for project construction increased to a great extent and necessitated a considerable increase in the number of men required for handling and checking materials, nine men being employed on this work during most of the year.

To prevent duplication of duties, secure thorough inspection of all incoming materials, and more easily check the advance requirements for construction, the work was divided into four departments. One of these was responsible for the handling of miscellaneous materials, another for structural steel and machinery, the third for reinforcement steel, and the fourth for electrical materials.

All incoming materials were inspected for loss and damage in transit, purchase orders and drawings were checked against actual receipts, and reports were made of discrepancies.

Reinforcement steel was frequently received cut to lengths that would not conform to prepared cutting schedules. In these instances it was necessary to make new cutting lists and regroup the various sizes in a manner to avoid waste.

The electrical materials received were numerous and of varied types, demanding special attention to determine if all the contract requirements were fulfilled and that the materials were correctly allocated to positions in construction. As previously mentioned, cars of freight arriving on the project in 1934 numbered 10,593 which included 9,282 cars of cement, 352 cars of steel plates, 315 of reinforcement steel, 391 of structural steel, and 83 cars of pipe and fittings.

Field Office

A force of eight men was employed in this department under the general supervision of the Field Engineer. The duties of this force were to prepare all staking or lay-out data from construction drawings for the use of field parties, to compile and prepare all field data and maps for reports, designs, or other office purposes, and to compute and prepare all quantities involved in construction.

The nature of the locality required that practically all staking out be done from triangulation rather than straight line surveying. To this end, an intricate triangulation system was kept up from which all block corners, curve and off-set points of the dam, as well as critical points of all other structures, were located by intersection. Advance directional data were prepared for each point from at least two triangulation stations.

For all intricate geometric shapes, notably tunnel intersections and transition surfaces, ingenious three-dimension charts were devised and prepared, for both excavation and concrete lining, to afford field men simple and ready means for staking out work. There were prepared some 50 charts for these purposes.

Practically all topography for sites and completed excavations were taken with two transits by the method of intersection. This entailed a great deal of unusual work in compiling data for maps. Similarly, the nature of the work required that most excavation quantities be derived from these maps. This necessitated extreme care and the preparation of large scale drawings.

The third function of this office was to compute all quantities from drawings, field data, and daily inspector's reports involved in the project, for payment of the contractor monthly and finally. All field records were assimilated and compiled in this office.

<u>Photography</u>

The pictorial history of Boulder Dam construction by means of still and motion pictures was continued through the year. The organization, under which this feature functions, was outlined in detail in the

Project History for the year 1933.

During 1934, 569 still photographs were made and catalogued. These pictures form the general pictorial record for the year, and from them the monthly reports were illustrated. Numerous photographs from this file were utilized as illustrations for special articles and reports, both for official use and for publication in technical journals. A selection of representative photographs was furnished eight news associations monthly. These pictures appeared in newspapers throughout this and foreign countries. A number of special exhibits, consisting of enlarged photographs, were prepared, including one shown before the annual convention of the American Association of Mechanical Engineers in Denver in June, one which was hung in the Eastman galleries in Los Angeles in January and February, and one which was prepared for exhibition at the M. H. de Young Memorial Museum in San Francisco in January, 1935. In addition to the photographs included in the catalogue, some 150 pictures were made for special studies and other purposes.

In recording construction progress in motion pictures, some 8,000 feet of 35 mm film were exposed. This material was used in making up a six reel picture in June which was revised and re-edited later in the year. These films have been widely circulated through official channels for showing before technical and civic groups, and engineering schools and colleges. Short subjects edited from this material were distributed both by sale and rental through the Boulder Dam Service Bureau under permit from the Department of the Interior. A substantial repayment was made into the motion picture fund in the form of royalties under the contract through which the films are distributed by the Boulder Dam Service Bureau.

3. ADMINISTRATION OF BOULDER CITY

By

Sims Ely - City Manager

Introduction

The City Manager supervises the following public activities: The collection of City Revenues and the clerical and accounting duties connected therewith; Public Works (light and power operations, water and filtration plant, sewage treatment, maintenance of streets and government-owned buildings, sanitation); Enforcement of Law and Order; Landscaping; Public Health.

City Revenues

The clerical force in the City Manager's office during the past year was as follows:

Name	Designation	Period
George H. Bolt	City Clerk	Jan.1 to June 21, 1934
Gail H. Baird	" "	June 22 to Dec.31, 1934
Charles C. Darden	Clerk	Jan.1 to May 31, 1934
Robert L. Brown	"	June 1 to Dec.31, 1934
Mrs.Dorothy Kreutzer	Asst. Clerk	Jan. 1 to April 15, 1934
Emilee J. Bingham	" "	Apr.11 to June 16, 1934
Mrs.Christine J.Blake	" "	June 11 to Dec.31, 1934

The revenues were classified as follows:

Assignment and approval fees
Building rentals
Lease rentals
Dog License fees
Penalties and interest
Permit and occupation fees
Sales of electricity
Sales of water
Miscellaneous

Wherever appropriate, the revenues were further subdivided in the General Ledger controlling accounts to show totals for cash collections, contract and payroll deductions, and government interactivity charges. A summary statement showing all revenues accrued during this year and the cumulative totals to date will be found at the end of this chapter.

Individual accounts were maintained with 1,481 consumers of water and electricity. This is an increase of 149 consumers over the total accounts on December 31, 1933. One hundred and sixty-nine accounts were kept with lessees of ground in Boulder City for commercial and residence purposes. Two leases (one to Walter Alkire and the other to Noel Bullock) were cancelled because of inability of the lessees to pay the ground rental, with attendant loss of $27 and $75, respectively. The water and electric accounts are billed monthly, and the lease rental accounts are billed quarterly. There were no changes in rates charged for water or electrical energy during the year.

Collections

Payments of water and electric services are secured by the deposit of $5.00 for each service; but in a few instances (of large consumers) an additional deposit is required. There was no loss from non-payment of light and water bills during the year.

There were 5,667 separate cash collections made during the past year - an increase over 1933 of 1,139 collections. The total amount of cash collections, $64,760.60, was an increase over 1933 of $18,814.06. All cash collections are transmitted to C. F. Weinkauf, Special Fiscal Agent, every few days, the City Clerk being bonded in the sum of $5,000. From January 1 to June 9, 1934, Mr. G. H. Bolt acted as Special Fiscal Agent in the receipt and disbursement of Special Deposits; from June 10 to December 31, 1934, this work was done by Mr. C. F. Weinkauf, as Mr. G. H. Baird was not authorized to act as Fiscal Agent until after the end of 1934.

Most of the permits which have no lease connected therewith are issued for the calendar year. This entails a large amount of work, covering approximately fifty new contracts at the end of the year.

<u>Business Callers</u>

A large number of business callers were received daily in connection with the operation of the city's water, light and power systems, issuance of business permits, transfer of leases, payment of light and water bills, the activities of the ranger force and many other matters directly connected with the administration of the city and the welfare of its residents.

Water Supply and Sewage Disposal Systems

Descriptions of the operations of the water supply and sewage disposal systems will be found in Chapter III "Operation and Maintenance, Boulder City and Federal Reservation".

Law Enforcement

A force of nine Rangers supervised by a Chief Ranger maintained law and order on the Reservation during the year. Excepting one burglary, no crime of major importance was committed, most of the law violations being automobile and petty thefts. On account of the large number of workmen on the project quite a little difficulty is encountered with drunken and reckless drivers. The number of persons arrested or temporarily detained for investigation was 499, while the number expelled from the reservation by the City Manager was 383.

Public Health

A report of health and sanitation in Boulder City and on the Project will be found in Chapter I, Section E-8.

BOULDER CITY

1934

Aerial View, November 20, 1934

Camp of Los Angeles Bureau of Power and Light

Residential Area, Hospital in Background

150--man Transport

Northeast section

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION - BOULDER CANYON PROJECT

Report to the Construction Engineer showing Boulder City Revenues accrued by the City Manager's Office to Dec. 31, 1934

Name of Account	Previous Balance 12/31/33	This Year Debit	This Year Credit	Subtotal	Total to Date
DEBITS:					
Cash on hand					
Cash in S.D.acc't					
Water service	1,590.12	885.00	796.37	1,678.75	
Elec. "	2,535.00	2,182.00	1,684.00	3,033.00	
Miscellaneous	372.50	2,167.65	2,072.15	468.00	5,179.75
Acc'ts rec'ble:					
Lease rentals	5,394.83	25,614.90	24,947.48	6,062.25	
Miscellaneous	3,573.49	62,017.99	60,852.37	4,739.11	
Deferred	172,863.60	6,813.50	26,277.90	153,399.20	164,200.56
Colorado River					
Dam Fund	101,069.38	84,760.60			185,829.98
Voucher deductions:					
Contract	907,445.38	715,816.90			1,623,262.28
Payroll	24,961.06	18,136.18			43,097.24
Interactivity					
charges	104,515.37	76,803.87			181,319.24
TOTAL DEBITS	1324,320.73	995,198.59	116,630.27		2,202,889.05
CREDITS:					
Lease rentals					
unaccrued	172,863.60	26,277.90	6813.50		153,399.20
Special deposits	4,497.62	4,552.52	5,234.65		5,179.75
REVENUES:					
Approval fees	110.00		46.00	156.00	
Building rentals	3,900.00		5,171.00	9,071.00	
Service deposits	20.00			20.00	
Lease rentals	182,546.11		110,423.86	292,969.97	
Dog licenses	589.25		696.00	1,285.25	
Miscellaneous	53.39		12.71	66.10	
Penalties	257.27		318.10	575.37	
Permit fees	2,443.88		2,494.75	4,938.63	
Sales of elec.	828,512.07		687,352.34	1515,864.41	
Sales of water	128,527.54		90,810.73	219,338.27	
Film Rent & Sales			25.10	25.10	2,044,310.10
TOTAL CREDITS	1324,320.73	30,830.42	909,398.74		2,202,889.05
Trial Balance		1,026,029.01	1,026,029.01		

Approved: Sims Ely
City Manager

Prepared by: G. H. Baird
City Clerk

Date ____________

4. LEGAL WORK

A. General Features

By

Richard J. Coffey, District Counsel

Since the passage of the Boulder Canyon Project Act on December 21, 1928, preparation, negotiation and consummation of major water and power contracts has been and still is handled under the direction and supervision of District Counsel Richard J. Coffey, with present headquarters at Los Angeles, California. Project office headquarters were established at Las Vegas, Nevada, in August, 1930, and on January 1, 1931, District Counsel James R. Alexander was transferred from Montrose, Colorado, to Las Vegas, and assigned to handle the field legal work arising on the project. This arrangement continued until December 24, 1933, at which time Mr. Alexander was transferred to Salt Lake City, Utah; and since that time all legal work of the project has been handled by Mr. Coffey, except that completion of purchases of land required for reservoir right of way is to be effected by Mr. Alexander, who will make separate report on this work.

Miscellaneous Work

During the calendar year 1934, the usual routine work of preparation of contract forms, permits and other legal documents, as well as examination and legal approval of the executed documents, was carried on. Legal advice upon various subjects was given upon request of the Construction Engineer.

Power Contracts

The following major power contracts for the Boulder Canyon Project proper were prepared and negotiated during the year 1934, but none of them had been executed by the Secretary of the Interior up to the end of the year:

The Nevada-California Power Company and The Southern Sierras Power Company, dated November 1, 1934, covering use by the companies of machinery and power plant facilities at Boulder Dam power plant from the time when water for the generation of electrical energy is first available and machinery and equipment are installed, to the time when Southern California Edison Company Ltd. is entitled or obligated to take energy under the provisions of the several contracts with the City of Los Angeles and Southern California Edison Company Ltd., dated April 26, 1930, as amended.

The City of Los Angeles (and its Department of Water and Power), dated October 22, 1934, covering use by the City of machinery and power plant facilities at Boulder Dam power plant from the time when water for the generation of electrical energy is first available and machinery and equipment are installed, to the time when electrical energy may be generated under the provisions of the several contract with the City of Los Angeles (and its Department of Water and Power) and Southern California Edison Company Ltd., of date April 26, 1930.

The City of Los Angeles (and its Department of Water and Power), dated October 22, 1934, granting the municipalities of Burbank, Glendale and Pasadena, an absorption period for power.

The City of Burbank, supplemental contract, dated October 30, 1934, amends contract of November 10, 1931, covering sale of Boulder Dam power.

The City of Glendale, supplemental contract, dated November 1, 1934, amends contract of November 12, 1931, covering sale of Boulder Dam power.

The City of Pasadena, supplemental contract, dated October 30, 1934, amends contract of September 29, 1931, covering sale of Boulder Dam power.

Litigation

State of Arizona vs. the States of California, Colorado, Nevada, New Mexico, and Utah, Secretary of the Interior Harold L. Ickes, Palo Verde Irrigation District, Imperial Irrigation District, Coachella Valley County Water District and The Metropolitan Water District of Southern California. On February 14, 1934, the State of Arizona moved for leave to file in the Supreme Court of the United States original bill of complaint to perpetuate testimony in an action or actions arising out of the Boulder Canyon Project Act which "at some time in the future" it proposes to commence against California and the other defendants named therein. The prayer was for process to take depositions for use in connection with future anticipated litigation concerning Arizona's rights to the use of Colorado River waters. On February 20, 1934, rule issued to the defendants to show cause why leave to file the bill should not be granted. All defendants filed returns. On May 21, 1934, leave to file the bill was denied.

United States vs. Peter Pansey. In June, 1934, Mr. Peter Pansey erected certain buildings on first-form withdrawn lands near Railroad Pass, within the SE$\frac{1}{4}$ of Sec. 34, T. 22 S., R. 63 E., M. D. M. The buildings and premises are designated the "Boulder Inn" and are operated as a resort of the most objectionable character. On July 18, 1934, formal notice was served on Mr. Pansey to vacate the premises. The notice was ignored, and on October 23, 1934, Acting Secretary of the Interior T. A. Walters requested the Attorney General of the United States to instruct the United States Attorney for Nevada to institute proceedings to remove the trespasser and his possessions from the lands. On November 28, 1934, action was commenced in the United States District Court for Nevada for removal of Pansey.

B. ACQUISITION OF LANDS

By

J. R. Alexander, District Counsel

During the year 1934 the purchasing of right of way for the Boulder Canyon Project was carried on by District Counsel J. R. Alexander of Salt Lake City, Utah. A total of 17 tracts was acquired during the year, purchases being made from 10 owners involving 1717.395 acres of land at a total cost of $24,445.50. With this land 23 shares of preferred stock of the Muddy Valley Irrigation Company were acquired, together with 30 shares of common stock of said company, the appraised prices of $100 and $6 per share, respectively, being paid for said stock.

At the end of the year the land and shares of stock which have been purchased from the beginning of operations were as follows:

198 tracts had been purchased from
95 owners, comprising a total of
9216.753 acres, for which a total amount of
$563,008.12 had been paid, which amount included
payment for
775.81 shares of preferred stock and
2402.97 shares of common stock of the Muddy
Valley Irrigation Company.

Two other contracts involving the purchase of two additional tracts were entered into during 1934, but the transactions had not been closed at the end of 1934.

The total of 198 tracts purchased at the end of December, 1934, is approximately 75½% of the number of tracts to be acquired. On an estimated area of 12,646.99 acres required to be purchased with an estimated expenditure of $616,369.30, at the end of 1934 there had been acquired approximately 73% of the required acreage at an expenditure of approximately 91% of the total estimated cost. Approximately 75% of each class of stock of the Muddy Valley Irrigation Company had been acquired.

Most of the land remaining to be acquired is of low value, being that valued in the appraisal at $2.50 per acre or slightly higher. Letters have been sent by the project office to all owners who have not yet contracted to sell their land in an effort to get as much of the area under land purchase contracts as possible, but at the end of the year few replies had been received to these inquiries.

RESERVOIR SITE IN AND NEAR ST. THOMAS, NEVADA

Hotel

Abandoned school building

Excavations at Lost City

Abandoned and dismantled homesite

Part of restored section of Lost City

5. SURVEYS

By

Grant Bloodgood, Engineer

Principal Surveys

From 75 to 90 employees were engaged in surveys during the year. In general, the work was carried on under four departments classified by locations at

1. Intake Towers, Spillways and Spillway Tunnels
2. Tunnels and Outlet Works
3. Powerhouse
4. Dam

The duties of the four groups are described in the following paragraphs.

Surveys at Intake Towers, Spillways and Spillway Tunnels: For each five-foot lift on the intake towers, a center point was set on the center platform and from this the centerline set on each fin with an elevation given on each. These points were used both for building the forms and for checking before the concrete was placed. When the operating floors were reached, points were set at all angle points.

On the spillways, points were set in the rock, with elevations noted so that on the slopes the correct location could be obtained by plumbing up the desired distance from the tack. This practice was followed to eliminate the necessity of the carpenters using slope boards or plumbing up and measuring out to set the screeds.

The Arizona spillway excavation was completed, and here an isometric chart was used to mark out and check the excavation. On the lining of the spillway tunnels in the circular section the center point was set on the ends of the forms. In the transition sections, false work was first built, and the curve centers set on this.

Surveys in Tunnels and for Outlet Works: The headings were pointed before each round in all tunnels, adits, and shafts that were excavated. In the lining of these, points were set for the construction of the forms and all forms checked before the concrete was placed.

The excavation was marked out for the piers, anchors and thrust blocks in diversion tunnels No. 2 and No. 3.

All grout holes were located and the depths checked after being drilled.

All materials forming a permanent part of the structures, such as grout pipe, cooling pipe, reinforcing steel and various metal work, were checked and material records maintained.

Points were set in the finished tunnels for installation of the penstock and outlet pipes.

<u>Surveys for Powerhouse:</u> Due to the lack of space in many of the forms, it was necessary to check much of the work as the building progressed. After the form proper was in place, it was carefully checked so that corrections could be made before the steel conduits, inserts and other materials were placed. Points were also set at this time to locate the conduits, inserts and any recesses or metal work required.

After the material was all installed, it was checked both by the survey party for location and by the material men regarding quantity and the possibility of something being omitted.

As new plans were received, they were checked by the material men and all material noted for each pour. It was also necessary for them to check the installation as the work progressed.

<u>Surveys for Dam:</u> One party on each shift checked the forms for line and grade, checked and measured all materials, and laid out, installed and checked the cooling pipe. All lines and grades were set on the day shift. The corners of the blocks were

established from transits set up at two triangulation points and the points located by intersection. From these points the transit party set points for the curves on both faces, located all galleries and shafts and all drain and grout holes. A level party took elevations on all points which were plotted on a sketch of each block and given to the contractor.

Curve points on the dam faces were located to fit the lift above so that the correct location was obtained by measuring directly above the points the distance given by the levelman.

In addition to the work on the forms, all grout hole drilling was checked and cross sections taken of all rock covered.

Miscellaneous Surveys

Among the more important of the miscellaneous surveys were: The location and cross sectioning of the Arizona section of the Black Canyon Highway; preliminary locations and topography of transmission tower sites between the pumping plant and switch yards; and various surveys to secure data desired by the Boulder City or Denver offices for design data.

6. HYDROMETRY AND METEOROLOGY

By

Leo E. Dunbar - Senior Hydrographer

Hydrometry

Hydrographic operations were carried on at the gaging station throughout the year. The total run-off was 4,372,200 acre feet or 27% of normal. This figure establishes a new record for minimum runoff according to records of the U. S. Geological Survey, and is accounted for by the very light snowfall over the watershed the preceding winter and also to the fact that practically no rain fell during the summer.

The maximum discharge for the year was 24,450 cubic feet per second and occurred on May 18. The high water period came approximately one month earlier than usual, beginning on April 20 and lasting to July 1. During July, August and September, the flow was considerably below even that of the normal winter months. The minimum discharge was 1,780 cubic feet per second, occurring on August 14. The mean discharge for the year was 6,000 cubic feet per second. One-fifth of the total runoff came in May.

One hundred sixty nine current meter measurements were made during the year. No difficulties were experienced due to driftwood, such as usually occurs in normal flood season.

The river was diverted through tunnels Nos. 1 and 4 during the high water period, after which No. 1 was closed, No. 4 diverting the rest of the year.

A chart and graph of the daily gage heights and river discharges for this station will be found at the end of this article.

Silt observations have been taken at the gaging station since June 13, 1933. Results show the silt content for the year July 1, 1933, to July 1, 1934, to be 1.1%. This figure is based on the percentage of solids carried to total discharge by weight.

Meteorology

Weather records were secured from the Cooperative Weather Bureau Station located near the filtration plant in Boulder City and from two recording thermometers at Black Canyon, one of which was placed at the Nevada-California substation and the other in Black Canyon. This latter thermometer was located between the cooling plant tower and refrigeration plant from January to July and was then moved downstream approximately 600'.

The weather during 1934 was even more favorable for working conditions than 1933. The winter, fall and spring months were warmer than usual, but the expected hot weather of May and June was ameliorated to some extent by cooling winds. July temperatures were approximately normal, and August and September were cooler than usual. No damaging winds occurred during the year. The maximum temperature for 1934 recorded in Boulder City was 112° on July 12, and in Black Canyon 123° on July 27. The minimum for the year was 30° at Boulder City on December 29, and 37° in the canyon on December 31.

The total precipitation for the year was 3.11". No rain fell during the months of March, May and September, and less than .10" total in October and November. The heaviest rainfall was in July when 1.18" fell in a two-day storm.

There were 280 days of clear sky during the year, 57 partly cloudy, and 27 were classed as cloudy.

Charts descriptive of weather conditions at Boulder City, Mountain (Substation) and in Black Canyon will be found in the Appendix.

7-192 (March, 1928)

DEPARTMENT OF THE INTERIOR—BUREAU OF RECLAMATION

DAILY GAUGE HEIGHT, IN FEET, AND DISCHARGE, IN SECOND-FEET, OF *Colorado* RIVER AT *Boulder Dam* FOR 1934

Drainage area, ______ square miles. ______, Observer.

Day	January Gauge height	January Discharge	February Gauge height	February Discharge	March Gauge height	March Discharge	April Gauge height	April Discharge	May Gauge height	May Discharge	June Gauge height	June Discharge	Day
1	642.26	5060	642.52	5590	642.81	6670	642.58	5930	644.69	12700	645.74	16900	1
2	42.32	5700	42.57	5690	42.80	6640	42.59	5940	44.96	13800	46.14	18450	2
3	43.16	7340	42.54	5680	42.87	6810	42.52	5790	45.14	14400	45.86	17400	3
4	42.89	6830	42.51	5660	42.89	6760	42.45	5600	45.21	14670	45.63	16650	4
5	42.90	6910	42.46	5590	42.86	6660	42.39	5460	45.23	14720	46.00	18000	5
6	42.98	7130	42.43	5610	42.79	6450	42.38	5440	45.10	14250	45.98	17950	6
7	42.90	6910	42.42	5640	42.68	6150	42.54	5810	45.40	15500	45.53	16050	7
8	42.85	6770	42.38	5550	42.60	5950	42.62	6020	45.62	16600	45.17	15100	8
9	42.92	6960	42.43	5530	42.56	5830	42.69	6160	45.25	15450	44.75	13900	9
10	42.95	7020	42.44	5510	42.52	5760	42.68	6140	44.97	14550	44.54	13250	10
11	42.86	6810	42.48	5620	42.49	5680	42.67	6120	44.76	13950	44.25	12450	11
12	42.80	6630	42.54	5780	42.47	5620	42.63	6060	44.75	13900	44.06	11800	12
13	42.76	6510	42.60	5930	42.45	5570	42.66	6110	45.30	15550	43.87	11070	13
14	42.66	6270	42.75	6350	42.39	5450	42.60	6000	46.30	19200	43.61	10140	14
15	42.54	5920	42.82	6560	42.43	5560	42.55	5840	47.18	22100	43.43	9460	15
16	42.40	5410	42.89	6650	42.45	5600	42.47	5650	47.87	23550	43.25	8900	16
17	42.28	4930	42.97	6790	42.47	5690	42.47	5650	48.03	24100	43.10	8400	17
18	42.18	4760	42.92	6680	42.51	5780	42.47	5660	48.08	24200	42.95	7900	18
19	42.10	4630	42.87	6550	42.50	5750	42.70	6240	47.90	23000	42.85	7580	19
20	42.09	4640	42.80	6360	42.52	5800	43.28	7990	47.25	21500	42.68	7000	20
21	42.13	4780	42.72	6190	42.58	5940	43.32	8120	46.72	20050	42.54	6530	21
22	42.17	4840	42.68	6070	42.63	6050	43.95	9550	46.55	19450	42.45	6150	22
23	42.29	5000	42.66	6050	42.62	6030	43.97	9610	46.55	19350	42.35	5710	23
24	42.45	5290	42.62	5960	42.65	6090	43.82	9400	46.53	19300	42.27	5400	24
25	42.50	5400	42.70	6220	42.72	6230	43.68	9060	46.36	18950	42.18	5070	25
26	42.51	5450	42.81	6570	42.71	6220	43.69	9080	46.14	18430	42.12	4720	26
27	42.45	5320	42.94	6900	42.69	6170	43.90	9750	46.04	18190	42.11	4700	27
28	42.49	5410	42.83	6640	42.64	6060	44.18	10900	45.82	17300	42.10	4600	28
29	42.57	5620	-	-	42.62	6020	44.38	11600	45.53	16300	42.08	4460	29
30	42.56	5600	-	-	42.61	6010	44.54	12140	45.28	15450	42.02	4210	30
31	42.51	5490	-	-	42.62	6020	-	-	45.88	17550	-	-	31
TOTAL,		181340		169920		187020		218820		548010		309900	
Mean,		5850		6076		6033		7294		17678		10330	
Sec.-ft. per square mile,													
Run-off, depth in inches,													
Run-off in acre-feet,		359700		337000		370900		434000		1087000		614700	
Maximum,	1/2	7900	2/27	7030	3/3	6860	4/30	12300	5/18 *	24450	6/2	19150	
Minimum,	1/20	4590	2/9	5480	3/14	5360	4/6	5290	5/1	12300	6/30	4120	
Accuracy,													

DEPARTMENT OF THE INTERIOR—BUREAU OF RECLAMATION

DAILY GAUGE HEIGHT, IN FEET, AND DISCHARGE, IN SECOND-FEET, OF *Colorado* RIVER AT *Boulder Dam* FOR 1934

Drainage area, ______ square miles. ______, Observer.

Day	July Gauge height	July Discharge	August Gauge height	August Discharge	September Gauge height	September Discharge	October Gauge height	October Discharge	November Gauge height	November Discharge	December Gauge height	December Discharge	Day	Year period
1	641.97	4020	642.09	2380	643.02	6270	641.58	3880	641.16	2970	641.72	4150	1	
2	41.91	3800	41.91	2100	43.47	7320	41.65	4110	41.20	2960	41.72	4130	2	
3	41.91	3610	41.93	2150	43.90	8340	41.66	4120	41.20	2960	41.72	4100	3	
4	41.90	3520	42.23	3030	43.08	6180	41.29	3440	41.19	2960	41.67	4230	4	
5	41.93	3410	42.05	2750	42.38	4830	41.27	3400	41.21	2950	41.61	4290	5	
6	42.08	3720	41.95	2580	42.00	4080	41.47	3590	41.22	2960	41.65	4360	6	
7	42.04	3450	41.95	2580	41.49	3180	41.44	3560	41.20	2970	41.68	4180	7	
8	42.02	3370	41.77	2530	41.26	2780	41.28	3420	41.20	2990	41.60	3990	8	
9	42.02	3260	41.68	2370	41.28	2760	41.20	3310	41.20	3010	41.57	3950	9	
10	42.00	3190	41.71	2340	41.29	2680	41.11	3160	41.22	3030	41.50	3880	10	
11	42.01	3230	41.51	2060	41.18	2480	41.07	3070	41.20	3000	41.45	3810	11	
12	41.94	2980	41.40	2010	41.06	2350	41.10	3100	41.19	2980	41.36	3690	12	
13	41.88	2820	41.22	1870	41.01	2300	41.07	3060	41.24	3050	41.24	3530	13	
14	41.82	2690	41.21	1840	41.00	2280	41.02	2980	41.28	3090	41.21	3490	14	
15	41.80	2600	41.41	2050	41.00	2290	41.01	2940	41.37	3180	41.19	3460	15	
16	41.78	2540	41.46	2180	40.99	2280	40.95	2680	41.40	3230	41.55	3920	16	
17	41.77	2530	41.43	1970	40.91	2210	40.92	2520	41.40	3360	41.65	4050	17	
18	41.74	2420	41.51	2000	40.83	2200	40.94	2600	41.47	3500	41.56	3930	18	
19	41.74	2200	41.52	2070	40.77	2150	40.97	2700	41.57	3620	41.67	4150	19	
20	41.76	2320	41.46	2160	40.71	2080	40.96	2670	41.66	3890	41.70	4400	20	
21	41.81	2450	41.41	2140	40.68	2010	40.93	2560	41.71	4060	41.85	4700	21	
22	41.81	2230	41.38	2120	40.72	2610	40.97	2630	41.70	4040	41.92	4840	22	
23	41.82	2080	41.84	3350	40.77	2670	41.02	2730	41.60	3890	41.86	4790	23	
24	41.82	2120	41.65	3050	40.90	2800	41.00	2700	41.60	3740	41.85	4740	24	
25	41.81	2210	41.62	3000	40.87	2650	41.02	2730	41.69	3960	41.93	4850	25	
26	41.74	2100	41.70	3330	40.80	2370	41.08	2830	41.69	4100	41.93	4950	26	
27	41.92	2160	41.45	2840	40.75	2180	41.12	2900	41.71	4120	41.82	4640	27	
28	41.98	2290	41.42	2660	40.72	2050	41.10	2950	41.72	4130	41.80	4600	28	
29	41.92	2130	41.46	2740	40.72	2050	41.12	2960	41.77	4160	41.72	4380	29	
30	41.97	2290	41.50	2830	40.71	2030	41.11	2950	41.79	4180	41.70	4340	30	
31	42.05	2330	42.90	6450	-	-	41.12	2960	-	-	41.77	4510	31	
TOTAL,		86070		79530		94460		95210		103040		131030		
Mean,		2776		2565		3149		3071		3035		4227		6039
Sec.-ft. per square mile,														
Run-off, depth in inches,														
Run-off in acre-feet,		170700		157700		187400		188800		204400		259900		4372200
Maximum,	7/1	4120	8/31	7950	9/3	8780	10/3	4150	11/30	4180	12/25	5050		24450
Minimum,	7/23	2000	8/14	1780	9/21	2000	10/17	2510	11/5	2950	12/15	3450		1780
Accuracy,														

* Peak of 25600 cfs. at midnight May 7th when Tunnel 4 was opened - Lowered Sur. Elev. 7 ft. at Upper Portals.

Gauge hts. checked from obs. book ______

Gauge hts. copied by ______

Gauge hts. checked by ______

Eng.

Discharge applied by ______

Discharge checked by ______

Computed by LED

Checked by LED

Image
Coming
Soon

***

Oversized
Material

Image
Coming
Soon

***

Oversized
Material

CONCRETE CONTROL

By

W. D. Wood, Associate Engineer

Introduction

The discussion of concrete control in the following paragraphs will be divided into the major features of sand and gravel pits, screening plant, finished storage, mixing plants, cement blending plant, cement screening plant, porous drain tile plant, testing laboratories, and miscellaneous.

Sand and Gravel Pits

Arizona Deposit: Pits 1 and 3 were worked three shifts daily, except for occasional shutdowns for repairs, until June 22 when Pit No. 1 was abandoned. Pit No. 3 continued to operate three shifts daily until the final shutdown on July 4.

One 5-yard and one 3-yard Marion dragline operated until Pit No. 1 was discontinued, at which time the small Marion was dismantled and taken from the pit. At the time both were in operation, the small dragline at times was used for stripping ahead of the larger machine. At other times it loaded cars from one of the pit.

The crews employed at the pit were practially the same as for 1933. No delays have occurred from floods or washouts during the year.

Both pits produced an exceptionally good grade of material, although occasional streaks of clay were encountered where rigid inspection was maintained to keep the material out of the shipments to the screening plant. In a few instances it was necessary to add fine material at the pit in order to save the coarse sand at the screening plant and visa versa. Since the quantity of sand excavated at the pit was more than necessary to fulfill the final requirements, no particular pains were taken to save much of the undesirable material.

On July 4, when the Arizona deposit was abandoned, it was thought the equipment would be left on the ground until a final decision was reached as to the quantity of material to be left in finished storage after the contract was completed. Before this decision was made, the contractor was successful in obtaining the construction contract at Parker Dam, Arizona, where the equipment was needed. The equipment was moved from the pit the latter part of July, and the bridge across the river was dismantled and shipped to Parker in August.

The Arizona pits have yielded the following records:

Year	Shifts Operated	Cars Shipped Out
1932	680	42,053
1933	798	51,737
1934	731	46,162
Total	2,209	139,952

Highest production for one shift - 1934 Day shift - March 17	116 cars
Highest production for one shift - 1933 Swing - August 6	96 "
Highest production for one calendar day - 1934 April 3	315 "
Highest production for one calendar day - 1933 December 8	260 "
Average number of cars per day - 1934	272
Average number of cars per day - 1933	177
Highest production for one calendar month - 1934 March	8,423 cars
Highest production for one calendar month - 1933 August	5,933 "

Nevada Deposit: In September, the contractor decided that the amount of material on hand in finished storage was insufficient to allow the required quantity of aggregates to be left on hand after the main portion of the concrete placing contract was completed. Also, the Bureau of Reclamation decided to have the contractor, by special work order, treat enough material to make at least 40,000 cubic yards of concrete in addition to that required for construction by Six Companies Inc., and to leave it in storage to be used as needed. Arrangements were made to have material excavated from a deposit on the Nevada side so that the contractor might move the excavating machinery from the Arizona side and allow the river bridge to be salvaged for use at the Parker Dam Site.

The material in the Nevada deposit used is of the same type as found in the Arizona pit. It was probably a part of the same deposit at one time, but has been cut off from the main body by the river. The Nevada portion was not used before because it was not as easy to work as the Arizona portion. Material was taken from six different locations on the Nevada side where the gravel banks varied from two to twenty-five feet in depth and the stripping varied from two to six feet or more. In most locations, the sand was too fine for use, and sometimes appeared to be as high as 35 per cent of the excavated material.

The first portion of the Nevada pit was opened on October 3, using a Marion model 490 electric dragline with a 3-cubic yard bucket; this machine was operated two shifts a day most of the time until October 17. Operations were then discontinued until more of the raw storage had been worked out and the contractor had learned more definitely how much gravel would be needed. The dragline was left in place until work was started again on November 1. During November, the pit was worked on a three-shift basis every day until it was abandoned on November 29, although, due to delays for stripping and moving to new locations, material was loaded on only fifty shifts. Material was taken from the Nevada pit on a total of 77 shifts.

The total production for the Nevada pit was 3,292 cars or approximately 200,000 tons.

Screening Plant

Except for a few short shutdowns for repairs, holidays, or occasional trouble, the plant operated three shifts every day until November 14; then two shifts a day until the plant shut down on November 29.

Raw material was supplied by the Arizona pit from the beginning of the year until the pit was shut down on July 4. The raw storage pile was then used exclusively until the Nevada pit was opened on October 3. From then until November 14, the Nevada pit and the raw storage were used together, the raw storage supplying all the material while the pit was shut down from October 17 to November 1. On November 14, the raw storage was exhausted, and from then on until the plant shut down on November 29, all the material came from the Nevada pit. The plant operations had to be cut to two shifts a day during this period, because the pit operations could not supply enough gravel to keep the plant running three shifts.

There were a few shifts lost because of high river water turbidity, which happened twice during the year. Once was on May 8 and 9 when the level of the water in the supply sump was lowered due to the opening of the No. 4 diversion tunnel. The pump was moved and normal operations resumed again until in September when considerable trouble was experienced during most of the month, probably due to heavy rains in the upper portion of the river. During the first and last parts of the month, addition of chemicals made the water usable, but from the 4th to 19th, acceptable wash water could seldom be obtained. During this period, gravel was washed clean enough for use in concrete, but the sand was wasted except on two shifts each on the 9th and the 18th. River water turbidities of of 70,000 to 80,000 parts per million were common at this time and on September 8, 150,000 p.p.m. was recorded. Under such conditions the clarifier was able to reduce the turbidity only a few thousand p.p.m., if any. Dosing with chemicals in any commercially feasible quantities did not help. Ordinarily no attempt was made to process the sand when the wash water registered above 20,000 p.p.m. To save handling costs, a conveyor was installed to load the condemned sand direct into cars without running it through the classifiers. Fortunately this waste was not serious, for the pit had produced an excess of sand large enough to more than offset the loss.

At times, small quantities of clay came in from the pit. The larger particles were removed by hand from the conveyor belt before the material entered the plant. The small particles that escaped detection were usually softened by the sprays on the plant storage piles and removed by the washing and rescreening process. The times when clay was found in the finished product were few. In the majority of cases, the plant inspectors and foremen were notified by the pit inspector of the presence of clay or other deleterious material in the raw gravel being shipped from the pit, and proper precautions were taken to eliminate it. If, in spite of these precautions, objectionable material got into the finished product, it was condemned and either wasted or run through the plant again.

The following data are shown for comparison from the time the plant started operating on February 6, 1932, to the shutdown on November 29, 1934:

Year	Shifts	Hours Operated	Cars Thru Plant	Cars from Plant & Storage to: Himix	Lomix
1932	513	2771	20293	--	14,560
1933	978	5536	50632	8866	32,637
1934	873	5800	74572	49008	28,736
Total	2364	14,107	145497	57874	75,933

The following high production records were obtained during 1934. They are shown compared with similar records obtained last year:

High production for one shift - 1934 Night shift - March 16	6850 tons -	109 cars
High production for one shift - 1933 Swing shift - October 16	6300 tons -	100 "
High production for one calendar day 1934 - February 7. 22½ hours operation	18590 tons -	295 "
High production for one calendar day - 1933 - December 19, 23 hours operation	16440 tons	216 "
High production, one month - 1934 - March, 93 shifts, 666-3/4 hours operation	500300 tons	7942 cars
High production, one month - 1933 - October, 93 shifts, 534-3/4 hours operation	394,760 "	6266 "

Before the plant was shut down, the plant storage piles were filled nearly to capacity. They were left there to be used in case a failure of the loading equipment at the finished storage piles should prevent getting materials from there. The plant storage piles are soaked twice a week so that they will be kept wet enough to allow materials to be drawn from them on short notice. Up to the end of the year, none of this emergency storage had been used.

When the plant was shut down, it was not dismantled but left in place to be used for treating the material scraped off the ground when the final cleanup is made at the Harte storage piles, near the plant.

Finished Storage

According to the original plans for construction of the project, the gravel plant site was expected to be flooded before the completion of the dam. The plant was therefore built with a capacity large enough to process all the material needed for the project before the storage of water was started. The material to be needed after that date was stored above high water line at Crowe. The storage of finished material was started soon after the plant began to operate in 1932, and was carried on whenever the plant processed material faster than it could be used. When enough finished material had been accumulated to finish the job with the desired amount left over, the gravel plant was shut down. Due to changes in the construction schedule, this condition occurred about two months before storage of water was due to start, although the concrete work was about ninety per cent completed.

The main storage piles were located at Crowe, an area in the central portion of Hemenway Wash and adjacent to the main line of the contractor's railroad to the gravel plant about 1.2 miles from the junction with the main line between Boulder City and the concrete plant. Finished material that was not expected to be needed for the Himix was stored near the gravel plant at

Harte, to save the cost of the haul uphill to Crowe. The Harte piles were intended for use by the Lomix in case the gravel plant broke down or was not able to keep up with the demand. Excess material was also dumped on these piles when equipment was not available for hauling it to Crowe. Due to changes in operating plans, the Harte piles were not emptied by the time the Lomix was closed down on November 2. They contained about 190,000 tons distributed among all the sizes used. By the time the gravel plant closed down on November 29, all the cobbles and coarse gravel had been removed, and the total amount had been reduced to about 60,000 tons. Not much of this remaining material had been taken out by the end of the year.

Material was taken from the Crowe storage piles whenever the gravel plant was shut down or could not supply material fast enough to keep the mixing plants running. When the gravel plant was shut down on November 29, loading of the material at Crowe was put on a steady three-shift basis, except for a two-day holiday at Christmas. Prior to the Christmas shutdown, the railroad hauled materials from finished storage three shifts a day. Starting December 26, the railroad hauling operations were reduced to two shifts a day, although the loading and mixing plant operations were continued at the three-shift rate. The railroad shifts were from 7:00 A.M. to 3:00 P.M. and from 7:00 P.M. to 3:00 A.M. During the time between the railroad shifts, the material loaded at finished storage was left in the cars until it could be hauled away, and the Himix was able to operate from the storage in the bins.

A summary of the quantities handled through finished storage to date is shown below:

Cars from Gravel Plant to:

	Harte	Crowe
1932	---	12,253
1933	12,607	14,724
1934	1,320	2,562

Cars from finished storage to:

	Low Mixing Plant	High Mixing Plant
1932	116	---
1933	1,766	79
1934	1,881	11,636

Mixing Plants

Low Level Mixing Plant (Lomix): Except for occasional shutdowns of a day or two, this plant operated three shifts a day until it was closed down on November 2. The methods of manufacturing and hauling the concrete were the same as last year, except that on February 2, work was started on removing the D mixer and the CD batchers, conveyor belt, and recorder for use at the high level mixing plant. From then on, the three remaining mixers were all supplied with water and aggregates from the AB battery. A shuttle conveyor, no longer needed on top of the plant to distribute aggregates to the CD supply bins, was installed to carry the aggregates from the AB batcher conveyor to the C mixer. This arrangement caused a little confusion at first, but with a few days practice, the operators were able to keep all three mixers running to capacity. No other major changes were made in any of the plant equipment.

Eight series of test weight checks were made on the batcher scales. Throughout the entire time the plant was in operation, the scales and cut-offs were easily kept operating within the allowable limits.

During the year the low level plant manufactured 928,685 cubic yards of concrete and grout and used 359,690,350 pounds of cement. Of this amount, 99.74 per cent was placed in the dam, and the balance was used in Intake Towers Nos. 3 and 6 and in Nos. 1 and 3 Trashracks.

A total of 892 eight-hour shifts were operated, averaging 1,041 cubic yards per shift. Production records established for the year at this plant were as follows:

One Shift - Night of February 21	1,649 c.y.
One Day - 3 shifts, Night, Day, Swing, March 20	4,750 "

One Month - March 113,636 c. y.

The yearly production was greater than for 1933 by 5,877 cubic yards.

Removal of the low level plant was started on November 2, the day it was shut down. The work was not carried on continuously, hence not quite all of the plant had been hauled away at the end of the year.

High Level Mixing Plant (Hi-Mix): Except for occasional shutdowns of a day or two, this plant was in practically continuous operation throughout the year. In general, the methods of manufacture and transportation of the concrete were the same as during the latter part of last year. Two additional mixers were moved up from the low mixing plant, one being put into operation on February 21, and the other on November 12.

The first mixer moved from the low mixing plant was the D mixer. The CD conveyor belt and battery of batchers were taken with it to make an independent mixing unit to be used mostly for furnishing concrete for the powerhouse and tunnel plugs. In its new location, the unit was called the E battery and the E mixer. It sets on a higher elevation than the main mixer floor. A special track has been built on a trestle to take concrete from this mixer to the No. 9 cableway, the only one that can conveniently reach the plug adits and most of the powerhouse. A chute has also been built so that concrete from the E mixer can be delivered to trains on the main track.

The second mixer taken from the low mixing plant was the C mixer. The mixer was removed when the Lomix plant was shut down and was installed alongside of the D mixer at the high level plant and rigged to get cement, water, and aggregates from the D battery. In the new location, the mixer was known as the F mixer, and the name of battery serving it was changed to the DF battery. The F mixer was mounted on a heavy timber foundation and located on a lower level than the D mixer so that it could dump directly into buckets on the trains. It was used mostly to mix mass concrete for the dam when the other mixers were needed for more diversified work.

The high level plant was prepared to supply any of ten different mixes at any time during the year. The greatest number used in any one shift was six. This condition occurred on the nigh shift of April 24 and on day shift of August 26. Mixers C, D, and E were used for all mixes, including the mass mix; A, B, and F were used only for mass concrete for the dam. The greatest number of structures supplied in any one shift was eight on swing shift of October 12, and on fifteen different occasions, six different structures were supplied during one shift.

The high level mixing plant operated a total of 1,070 shifts, producing 1,625,190 cubic yards of concrete and grout; it used 672,530,000 pounds of cement and 49,008 cars of aggregates. The average production per shift for the year was 1,519 cubic yards.

During the year, the high mixing plant established the following records: Some of the high records established last year are also shown for comparison:

Highest production for one shift at high mixing plant in 1934 - Night of December 27	3,001 cu. yds.
Highest production for one shift at high mixing plant in 1933 - Day of December 30	1,118 cu. yds.
Highest production for one shift at one mixing plant in 1933 - Low level plant - Night shift of September 30	2,462 " "
Highest production for one calendar day at high mixing plant in 1934 - December 27	6,494 " "
Highest production for one calendar day at high mixing plant in 1933 - December 30	3,233 " "
Highest production for one calendar day at one mixing plant in 1933 - Low level plant - September 30	7,013 " "
Highest production for one calendar month at high level plant in 1934 - November	172,325 " "
Highest production for one calendar month at high level plant in 1933 - November	142,316 " "

Highest production for one calendar month at one mixing plant in 1933 - October (Low Level)	182,784 cu. yds.

On night shift of December 27, the same time the high one-shift record was made at the high mixing plant, the contractor's records show that the No. 7 cableway placed 240 buckets in the dam, which was claimed a world record. This record stood until day shift of December 30 when the contractors reported that the same cableway placed 277 buckets in the dam.

Data Pertaining to Both Mixing Plants:

High records for the combined production of both plants during the year are shown below compared with similar records made last year:

High record for one shift in 1934. Swing of March 20	3,534 cu.yds.
High record for one shift in 1933. Night of September 30	3,020 " "
High record for one calendar day-1934. March 20	10,417 " "
High record for one calendar day-1933. September 30	8,477 " "
High record for one calendar month-1934. March	261,847 " "
High record for one calendar month-1933 October	214,392 " "
Total produced - 1934	2,563,784 " "

Total produced - 1933	1,149,393 cu. yds.
Total produced - 1932 (Low level mixing plant only)	363,385 " "
Grand Total	4,076,562 " "

All the cement used by both plants was unloaded from the cars, blended, and transported to the mixing plants in the same manner as last year. Also, the same procedure as last year was followed in emptying the cement bins to eliminate the dead storage every 60 days. Both low heat and standard cements were used as described in the next section.

A summary of all concrete produced by both mixing plants is shown below:

	Lomix		Himix		Total for both plants	Accumulative Total
Month	Shifts	Cu.Yds.	Shifts	Cu. Yds.	Cu. Yds.	Cu. Yds.
1932						
March	55	3,973			3,973	3,973
April	76	12,369			12,369	16,342
May	89	27,514			27,514	43,856
June	90	44,567			44,567	88,423
July	87	65,896	Not yet operating		65,896	154,319
August	92	63,747			63,747	218,066
September	85	46,261			46,261	264,327
October	93	41,542			41,542	305,869
November	90	34,893			34,893	340,762
December	87	22,623			22,623	363,385
Total for yr.	844	363,385			363,385	
1933						
January	95	27,110			27,110	390,495
February	84	13,153			13,153	403,648
March	29	2,387	38	5,900	8,287	411,935
April	23	3,488*	78	20,678	24,166*	436,101*
May	20	4,403	90	25,307	29,710	465,811
June	69	24,725	90	18,040	42,765	508,576
July	86	81,214	85	17,158	98,372	606,948
August	93	145,544	76	13,549	159,093	766,041
September	84	153,277	73	22,231	175,508	941,549
October	93	182,784	91	31,608	214,392	1,155,941
November	86	25,035	90	142,316	167,351	1,323,292
December	87	141,820	87	47,666	189,486	1,512,778
Total for yr.	847	804,940	798	344,453	1,149,393	
Total to date	1691	1168,325	798	344,453	1,512,778	1,512,778
1934						
January	93	102,474	93	103,776	206,250	1,719,028
February	74	94,275	74	117,741	212,016	1,931,044
March	93	113,636	93	148,238	261,874	2,192,918
April	88	105,791	90	153,100	258,891	2,451,809
May	93	105,376	93	144,003	249,379	2,701,188
June	83	97,372	90	119,793	217,165	2,918,353
July	87	101,903	87	108,904	210,807	3,129,160
August	93	75,697	93	133,389**	209,086**	3,338,246**
September	84	62,196	84	140,409	202,605	3,540,851
October	88	67,333	93	145,915	213,248	3,754,099
November	4	2,632	90	172,335	174,967	3,929,066
December	--	Shut down	87	147,496$	147,496$	4,076,562$
Total for yr.	880	928,685	1,067	1,635,099	2,563,784	
Tot. to date	2571	2,097,010	1,865	1,979,552	4,076,562	4,076,562

*615 C.Y. deducted, waste and Six Companies Inc. charge.

**26 C.Y. deducted from #4 Spillway Raise to correct yardage.

$ 65 C.Y. deducted, Six Companies Inc. charge.

Cement Blending Plant

With the exception of occasional shutdowns of a day or two, the blending plant operated seven days a week throughout the year in the same manner as last year. At the beginning of the year the plant was being operated three shifts a day. By July 15, the amount of cement used had decreased until the blending operations were cut to two shifts. On October 28, when the Fluxo pump quit pumping cement to the low level mixing plant preparatory to draining the bins for the final shutdown, operations were cut to one shift. After cutting to two and one-shift operations, the plant was operated occasionally on other shifts, but only when needed to keep a mixer from running out of cement.

From January 1 to April 17, both low heat and standard cements were blended. Five different brands were used, a high heat and a standard cement being supplied under each brand name. From April 17 to November 9, the same five brands were continued, but only the low heat cements were used. Starting November 9, Red Devil standard cement was blended with the five brands of low heat cement. The last of the Red Devil cement supplied on the low heat contract was blended on November 25. From then on to the end of the year, only the four remaining brands were blended with the standard cement. Throughout the year, whenever standard cement was blended, the proportions used were 40 per cent standard and 60 per cent low heat, except during the first 25 days of December when the proportion had to be cut to 35-65 per cent to fit the shipments received. The control obtained was usually within 5 per cent of the blend desired.

During the year, 7,837 cars of low heat and 1,538 cars of standard cement were blended. Inspection was the same as in 1933.

Cement Screening Plant

This plant was constructed and operated by the contractor on a cost plus basis under Extra Work Order No. 11. The original purpose was to screen cement for use in grouting the contraction joints on the dam, although later it was decided to use the screened cement for grouting the dam foundation and abutments.

The plant is located adjacent to the high level mixing plant. The screening equipment consists of three type 31, single surface, Hum-mer screening units made by the W. S. Tyler Company of Cleveland, Ohio. Each unit is equipped with a 170-mesh bronze screen having the same size openings as a 200-mesh testing screen. The plant is supplied with unscreened cement by an 8-inch pipe running from the nearest cement silo of the mixing plant. Two of the screening units are mounted side by side so that the overflow from them goes on to the third screen, mounted on the floor below. The overflow from the third screen goes into the intake of the Fluxo pump and is pumped into the bulk cement storage over the mixers. The screened cement is caught in a small tank above a Bates sacker which puts the cement into paper sacks. From the sacker, the sacked cement is carried by a chain and wooden slat conveyor to a warehouse located on the ground level and across the railroad tracks from the plant.

Construction of the plant was completed about February 1, although regular production of screened cement was not started until May 7. A few trial runs were made during February, March, and April but the small amount of cement screened was used for general work to avoid too great age in storage. The plant was operated only when cement was needed for grouting; hence it was shut down during the last part of June, all but the first day of September, and 15 days in October. Likewise the number of shifts per day was varied from one to three as the demand for cement varied. The plant operated 352 shifts during the year.

The following summary shows the progress made in production rates since the plant started operating:

Month	Shifts Worked	Sacks Screened	Average Sacks per Shift	Remarks
May	50	3,045	61	
June	36	2,323	65	
July	77	3,505	45	More than usual amount of trouble with feed pipe.
August	66	5,728	87	New feed pipe installed August 1.
September	1	51	-	Shut down on Sept. 1.
October	22	2,006	91	New feeder and chain drive in operation.
November	54	7,216	134	
December	46	7,164	156	
Total	352	31,038	-	

The highest production records to date were made on December 13. They are shown below:

Total for one 3-shift day	638 sacks
Average rate per operating hour over a 3-shift day	27.8 "
Total for one shift - Swing	224 "
Average rate per hour - Swing	28.0 "

Tests of the screened cement were made by washing it over a 200-mesh testing screen. The results of 786 tests taken during the year showed an average of 0.78 per cent retained. Any cement that showed more than 2.5 per cent retained was rejected for screened cement grouting.

Three times during the year the cement

screening plant was used to sack unscreened cement when it was not convenient to obtain cement already sacked. In such cases, the sacker was protected from stray bolts, nuts, pieces of steel balls, etc., by operating the plant with screen sections that had only the guard screens in place. A total of 2,100 sacks of unscreened cement was sacked through the plant during the year.

Porous Drain Tile Plant

The plant for making porous concrete drain tile operated one shift a day, seven days a week during the time it operated. After closing down on November 6, 1933, the plant started operations again on April 10; a force varying from five to two men was employed and only 8" round and 8" flat half-round tile were made until the plant closed down again on July 16. The plant was started again on December 20, employing a crew of 6 to 7 men and making 3" flat half-round tile in addition to the other two sizes. Operations were expected to continue until all the tile needed to finish the job were made, probably some time in February 1935.

During the first operations of the plant, Riverside standard cement in sacks was used, but due to the expiration of the contract for sacked cement, low heat and standard cement, that had been blended 60 -

40 per cent for the mixing plant, was used when the plant resumed operations in December. It was sacked through the cement screening plant along with other cement for miscellaneous use.

The forms were usually used to make two sets of tile a day. In December hot mixing water had to be used to make this procedure possible because of the colder weather and the naturally lower early strength of the low heat cement.

The same mix that was used in 1933 has been continued--one part cement to four parts of 1/4" maximum size gravel. The average water-cement ratio for the year has been .297 by weight.

The porosity and strength tests were made in the same manner as in 1933. The 8" round tile averaged 44.5 gallons per minute with a 12-inch head; the 8" flat half-round tile averaged nine seconds. Strength of the 6" x 12" cylinders made from the tile concrete averaged 1,824 pounds per square inch. An average of one cylinder was made for every 34 tile pieces manufactured.

During the period from April 10 to July 16, the tile were cured with sprays kept playing on the storage piles 24 hours a day. During the shutdown, the spray system was dismantled; hence, when the plant was started again in December, the tile were cured with wet burlap and kept wet with a hose. Due to the comparatively low evaporation rate in the colder weather, this method has been satisfactory.

Production data for all tile made are shown below:

Number of Tile Made

	8" Round	8" Half-round	3" Half-round
1934	4,634	2,175	316
1933	9,997	5,484	26,939
1932 (Dec.only)	--	--	7,598
Total to date	13,631	7,659	34,853

Testing Laboratories

A total of 14,844 concrete specimens was made and tested during 1934. Of these 14,596 were of regular concrete mixes, 38 of porous concrete mixes, and 210 of porous drain tile mixes. All tests were made using 6" x 12" cylinder molds, and wet screening out all gravel larger than 1½". The tests made averaged one cylinder for each 172 years of regular concrete run - one cylinder for each 41 yards of porous concrete run and one cylinder for each 34 porous tile pieces manufactured.

At the low level mixing plant as many as two test batches were taken per shift, while at the high level mixing plant as many as five have been taken on a single shift. Each test batch represents three cylinders - one 8-hour accelerated and two 28-day, except when porous concrete was being manufactured; then only two 28-day cylinders were made for each test batch. Each test included sampling of aggregates going into the batch, and securing therefrom moisture and grading analyses. Two 28-day porous concrete cylinders were made from material being produced at the drain tile plant on each shift when operating.

When the low level mixing plant was closed down on November 2, construction of a curing room at the high level laboratory was started, using a portion of the low level laboratory and inspection crews. The curing room was not completed until November 17, but it was far enough along by November 7 to commence storage of 28-day cylinders in it.

After all equipment having salvage value had been removed from the low level laboratory, the building was offered for sale; the successful bidder started dismantling on December 23, but did not completed the contract by the end of the year.

A summary of all concrete cylinders tested during the year, together with other data pertaining to the tests, will be found on the following three pages.

ANNUAL SUMMARY OF CONCRETE TEST CYLINDERS, 1934.

Cement	Mix		Max. Agg.	Ave. Slump (ins)	Ave. W/C (wt)	Number Sample Batches	Number Cylinders 28 D.	Compressive Strengths 28 Day	28D/8H Factor
(A) 60-40% Lo-hi	1-2.45-7.05	Std.	9"	3.07	.570	436	868	4,126	4.28
(B) Low heat	1-2.45-7.05	Std.	9"	3.57	.569	117	236	3,538	4.56
(C) 60-40% Lo-hi	1-2.37-7.13	Std.	9"	3.76	.574	236	472	3,951	3.92
(D) Low heat	1-2.37-7.13	Std.	9"	4.14	.594	1,132	2,240	3,446	4.38
(E) 60-40% Lo-hi	1-2.10-7.40	Spec.	9"	4.71	.536	7	14	4,117	4.48
(F) 60-40% Lo-hi	1-2.32-5.68	Std.	3"	5.43	.582	118	256	3,689	4.70
(G) Low heat	1-2.32-5.68	Std.	3"	5.35	.603	144	278	3,263	4.59
(H) 60-40% Lo-hi	1-2.32-5.30	P-crete	3"	5.76	.618	35	70	3,740	4.32
(I) Low heat	1-2.32-5.30	P-crete	3"	5.79	.624	52	104	3,285	4.69
(J) 60-40% Lo-hi	1-2.04-4.76	Spec.	3"	5.91	.505	3	7	4,415	4.82
(K) Low heat	1-2.04-4.76	Spec.	3"	4.97	.531	81	160	3,896	4.10
(L) 60-40% Lo-hi	1-1.85-4.45	Spec.	3"	5.75	.499	9	18	4,319	4.60
(M) 60-40% Lo-hi	1-2.46-4.44	Std.	$1\frac{1}{2}$"	5.66	.597	164	328	3,535	4.82
(N) Low heat	1-2.46-4.44	Std.	$1\frac{1}{2}$"	5.65	.614	302	601	3,037	4.85
(O) 60-40% Lo-hi	1-2.46-4.04	Spec.	$1\frac{1}{2}$"	5.61	.634	11	22	3,250	5.62
(P) 60-40% Lo-hi	1-2.05-4.10	Spec.	$1\frac{1}{2}$"	6.95	.556	13	26	3,464	4.19
(Q) Low heat	1-2.05-4.10	Spec.	$1\frac{1}{2}$"	6.25	.544	17	34	3,184	4.44
(R) 60-40% Lo-hi	1-1.94-4.20	Spec.	$1\frac{1}{2}$"	7.93	.530	7	14	3,566	5.28

Continued - ANNUAL SUMMARY OF CONCRETE TEST CYLINDERS 1934

Cement	Mix		Max. Agg.	Ave. Slump (ins)	Ave. W/C (wt)	Number Sample Batches	Number Cylinders 28 Day	Compressive Strengths 28 Day	28D/8H Factor
(S) 60-40% Lo-hi	1-2.04-4.26	Spec.	1½"	6.34	.555	73	146	3,610	4.60
(T) Low heat	1-2.04-4.26	Spec.	1½"	5.82	.536	163	325	3,513	4.60
(U) Low heat	1-1.76-3.44	Spec.	3/4"	6.17	.549	3	6	3,466	4.20
(V) 60-40% Lo-hi	1-2.20-3.50	Std.	3/4"	7.00	.618	1	2	2,870	4.22
(W) Low heat	1-2.20-3.50	Std.	3/4"	6.88	.566	3	6	3,258	5.13

POROUS CONCRETE

Cement	Mix	Max. Agg.	AVE. W/C (wt)	Number Sample Batches	Number Cylinders 28 Day	Compressive Strengths 28 Day
(X) 60-40% Lo-hi	1-0.00-5.5	3/4"	.342	15	30	2,016
(Y) Low heat	1-0.00-5.5	3/4"	.338	4	8	1,880
(Z) Riverside Std	1-0.00-4.0	1/4"	.297	105	210	1,824

See next page for list of structures in which tested mixes were placed.

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LIST OF STRUCTURES IN WHICH MIXES WERE PLACED

9" Maximum

(A-B)*	Dam, Plugs and Power House.
(C-D)*	Dam, and Cableway Landings.
(E)*	Power House.

3" Maximum

(F-G)*	Dam, Plugs, Power House, Penstocks, Spillway Raises, Spillways, Adits, and Channel Lining.
(H-I)*	Plugs.
(J-K)*	Spillway Raises, Intake Towers, and Plug Sections.
(L)*	Intake Towers.

$1\frac{1}{2}$" Maximum

(M-N)*	Power House, Plugs, Circuit Control Tunnel, Diversion Tunnels, Bulkheads, Plug Sections, Inclines, Spillways, Penstocks, Spillway Raises, and Adits.
(O)*	Power House and Plugs.
(P-Q)*	Tunnel Arches, Penstocks, and Plugs.
(R)*	Plugs, Spillway Raises, and Adits.
(S-T)*	Intake Towers, Spillway Raises, Plug Arches, and Diversion Tunnels.

3/4" Maximum

(U)*	Intake Towers and Spillway Raises.
(V-W)*	Intake Towers, Spillway Raises, and #4 Stoney Gate.

Porous- 3/4" Spillways. (X-Y)*

Porous- 1/4" Drain Tile. (Z)*

*See "Summary of Concrete Test Cylinders" for mixes.

Miscellaneous

Special tests made during the year included: Adjustment of the consistency meters in the concrete plants by comparison with the Plumb consistency meter; a series of tests to determine the relative characteristics of seven different types and the brands of asphalt for use in cementing cork board to concrete and the contraction joints of powerhouse; the determination of the effect of varying sequence of material going into the concrete mixers; a study of the staining effect on concrete of curing water that had run through iron or copper pipe; a series of tests to learn the temperature effect of transporting cement from railroad cars to mixers; and a determination of the effect of time in the removing of the cone when making slump tests.

An Inspector's Handbook of Concrete Control was prepared under the direction of Engineer O. G. Patch. The manual contained general and detailed instructions for inspectors' laboratory helpers and office men in all branches of the concrete organization.

8. HEALTH AND SANITATION

By

D. M. Forester, Sanitary Engineer

Public Health

General public health conditions were good throughout the year as adequate living accommodations and other facilities conducive to better living were stabilized.

The death rate from both industrial and natural causes was below that of 1933. The total deaths of project employees reported for the year was 36. There were 20 deaths from industrial accidents, nine from pneumonia, three from miscellaneous accidents, two from septecemia, and one each from heart disease and typhoid. The total deaths reported to the project office from the beginning of activities in 1922 has been 191, of which 87 were from industrial accidents, and 13 resulted from heat prostration while at work. During 1934 no fatalities occurred from heat prostration.

No epidemics were experienced other than a mild outbreak of measles. The various illnesses for the project, from all reports filed for 1934, were as follows:

Measles	167 cases
Pneumonia	24 "
Scarlet Fever	17 "
Mumps	13 "
Gonorrhea	12 "
Diptheria	5 "
Influenza	4 "
Whooping Cough	3 "
Tuberculosis	3 "
Chicken Pox	3 "
Typhoid	2 "
Bronchitis	2 "
Syphilis	1 "

There have not been any cases of water-borne disease attributable to the municipal water supply or general unsanitary conditions of the project. Two cases of typhoid, one fatal, occurred during the year, one of which the source of infection was located outside the State, the other isolated and non-traceable. In all cases of contagious disease, rigid quarantine was effected and rigidly enforced. Insofar as possible, rigid control was maintained of infectious diseases.

Frequent and thorough inspections were made of sanitary conditions in mess halls, restaurants, kitchens, meat markets, fruit stands, drink stands, drinking fountains, water supply, toilet facilities and sanitary conditions on the work throughout the reservation. The infrequent departures from the rules of the Board of Health and Sanitation that were found were promptly corrected.

Rigid bacteriological control was maintained of the drinking water supplies furnished by the various contractors to their employees, as well as the municipal supplies. The raw water from the Colorado River in every examination gave confirmed tests of Coli-Aerogenes organisms varying from an Index of 11.00+ to 0.13 with a yearly average of 2.95+. The yearly average Coli-Aerogenes Index for the treated water, as delivered to the user, was 0.00226 which was well within the limits of the U.S.P.H.S. Standard.

The Board of Health and Sanitation consists of Mr. Sims Ely, City Manager, Dr. R. O. Schofield, Chief Surgeon of Six Companies Inc., and Mr. D. M. Forester, Sanitary Engineer. Dr. Schofield is also Health Officer for the Board.

<u>Sanitation</u>

All residences, business houses, and eating places were required to keep, maintain and use covered garbage cans for deposition of garbage and for wet and dry waste. The disposal was handled by the Boulder City Company and was collected at least semi-weekly, hauled to the municipal dumping grounds and burned.

The garbage collection service charges were $1.00 per month for residences and as high as $20.00 per month for business establishments, depending upon the amount collected.

All buildings and residences were required to make connections with the water and sewer service. All installations were required to conform to standard codes and practices before being placed in service. The residents of "McKeeversville", a tent colony, did not have access to sewer lines and therefore outdoor toilets and cesspools were permitted, but were under rigid inspection and control by the Board of Health and Sanitation.

9. FUTURE WORK PROPOSED

By

John C. Page, Office Engineer

All features to be constructed under the contract with Six Companies Inc. are expected to be completed in 1935 with the principal exceptions of the lower plugs in inner diversion tunnels, the downstream portion of the plug in the Nevada outer tunnel, and the concrete anchors and thrust blocks around the steel penstock and outlet pipes.

The Babcock & Wilcox Company plans in 1935 to complete the fabrication of steel pipes for all except the lower Arizona tunnels and to install all pipes in the upper Nevada and upper Arizona penstock and outlet systems.

The installation in the powerhouse of four of the 115,000 h.p. turbines, one of 55,000 h.p., and two of 3,500 h.p. is expected to be started by government force account in February 1935, and by the end of the year all of these turbines, one of the four 82,500 kva generators, the 40,000 kva generator, and the two 3,000 kva generators for station service are expected to be in operating condition.

The Los Angeles Bureau of Power & Light will complete both of its 275,000 volt transmission lines in 1935, and work will be started on the

230,000 volt line of the Metropolitan Water District of Southern California.

F

FUTURE NEEDS OF THE PROJECT

By

Walker R. Young, Construction Engineer

Appropriations will be required to continue construction during the Fiscal Year of 1935-1936, but the future needs of the project to be most stressed at this time are those relating to development of the region around the dam for industrial and recreational purposes.

In order to insure the maximum use of electricity from the power plant, attention should be drawn to regions favorable for industrial development and information disseminated of the beneficial climatic conditions, transportation facilities, near-by population centers, the low cost of power, and other qualifications to bring factories and mills into this territory.

Policies should be formulated with regard to mining on withdrawn lands around the reservoir, locating pleasure resorts and cabins near the lake shore, and boating, fishing, and swimming in the reservoir. To enclose the reservoir, dam, Boulder City and adjacent lands, including the river several miles downstream from the dam, in a National Park would probably simplify the enforcement of regulations that are to be put into effect.

CHAPTER II

CONSTRUCTION

Containing

Articles and Illustrations

Descriptive of

A. Construction of Boulder Dam, Power Plant and Appurtenant Works

B. Fabrication and Erection of Steel Penstock and Outlet Pipes

A

Construction of Boulder Dam, Power Plant & Appurtenant Works

By

Ralph Lowry
Field Engineer

Equipment of Six Companies Inc.

General: The equipment of the contractor was reduced to a great extent by sales, transfers to other projects, and razing of plants and buildings. Many of the trucks, draglines, and other equipment used for excavation, were sold or moved to other work.

After producing 139,952 cars of materials, the Arizona sand and gravel deposit was shut down on July 4. The equipment was taken from the pit that month, and the pile trestle bridge across the river was removed and shipped to Parker, Arizona, in August. The gravel screening plant suspended operations on November 29, but probably will not be dismantled until the spring of 1935. The plant has processed 145,497 cars of classified aggregates.

The low level mixing plant manufactured the last of 2,097,010 cubic yards of concrete on November 2, and the plant had practically been demolished by the end of the year. Of the four 4-cubic yard mixers in place on January 1, 1934, one was moved to the high level concrete plant on February 21 and another on November 12, the two others being taken to the warehouse yards by Six Companies Inc. at Boulder City. The high level mixing plant produced 1,635,099 cubic yards of concrete in 1934, establishing a plant record on December 27 of 3,001 cubic yards in eight hours from its six 4-cubic yard mixers.

The blending plant was operated throughout the year, but pumping cement through the 9" pipe line to the low mix concrete plant was stopped on October 28. Cars of cement passing through the blending plant numbered 7,837 of low heat and 1,538 of standard.

Acting under government orders, the contractor constructed a plant for screening cement through 200-mesh openings for use in grouting dam abutments and contraction joints in the dam. A description of the plant will be found in Chapter I of this History under article "E" - 7. "Concrete Control".

All of the five 25-ton cableways were operated throughout the year primarily for the placing of concrete. A record for eight-hour performance was established on December 27 when 240 buckets of concrete (1,891 cubic yards) were placed in the dam by No. 7 cableway, and this record was broken on December 30 when, according to records of Six Companies Inc., the same cableway conveyed 277 buckets of concrete (2,181 cubic yards) to the dam. In December the contractor erected another small cableway of 10-ton normal operating capacity at a location above the canyon wall valve houses.

The steel derrick near the base of the Nevada downstream intake tower, for transporting concrete from Lo-Mix trains to the dam, was kept in operation until the Lo-Mix plant closed down. The derrick transferred the buckets of concrete from the trains to a platform fastened to the upstream face of the dam where cableway No. 5 or No. 6 picked up the buckets and carried them to the pouring sites.

Practically the only railroad lines removed in 1934 were the tracks in and near the Arizona deposit, and most of those along the river from the site of the Lo-Mix plant to the upstream face of the dam.

Materials used by Six Companies Inc.

As a matter of interest, a list is given below of the quantities of certain materials used by the contractor for construction purposes:

Materials and Minor Equipment Used by Six Companies Inc.

Acetylene, 300 c.f. tanks	6,549
Axes	744
Bags, water	32,664
Belts, safety	5,240

Bits, Jack Hammer, Elliott	23,300
Bit, Lyner "	11,062
Blades, Hacksaw	86,968
Blocks, small tackle	3,756
Bolts, small	1,706,340
Boots, rubber	21,144 pair
Brooms, warehouse	3,420
Brushes, paint	19,384
Canvas	6,949 yards
Caps, No. 6, blasting	181,000
Clips, Crosby cable	66,745
Conduit, electric	208,270'
Crayon, metal workers and lumber	470 gross
Dish pans	3,048
Dynamite	8,551,300 pds. - (171,026) cases
Exploders, 10' x 28'	1,139,500
Flash lights	7,360
Frames, Hacksaw	930
Fuse	915,000'
Hammers	7,583
Hats, hard boiled	13,046
Hoists, chain blocked	96
Hose, air 3/8" to 4"	168,770'
Hose, acetylene, water grout, etc.	142,869'
Jacks, auto, track, etc.	417

Keys, cotter	536,000
Line, chalk	778,624'
Lumber	2,215 car loads
Nails	18,111 kegs
Nuts, square and hexagon	166,310 pounds
Oakum	11,650 "
Oxygen, 220 c.f. tanks	32,306
Pails, water	12,912
Paper, Emery and sand	34,296 sheets
Picks	2,864
Pipe, black	218.5 miles
Pipe, scrap	660,000 pounds
Pliers	4,444
Poles, fish	96
Preservers, life	30
Rags and waste	220,250 pounds
Rakes	360
Respirators	572
Rod, welding	379,940 pounds
Rope, Manila	495 miles
Rope, wire	363 miles
Sacks, burlap	355,000
Saws, hand	548
Screws, machine and wood	3,232 gross
Screws, lags, cap and set	344,134
Screw Drivers	2,170

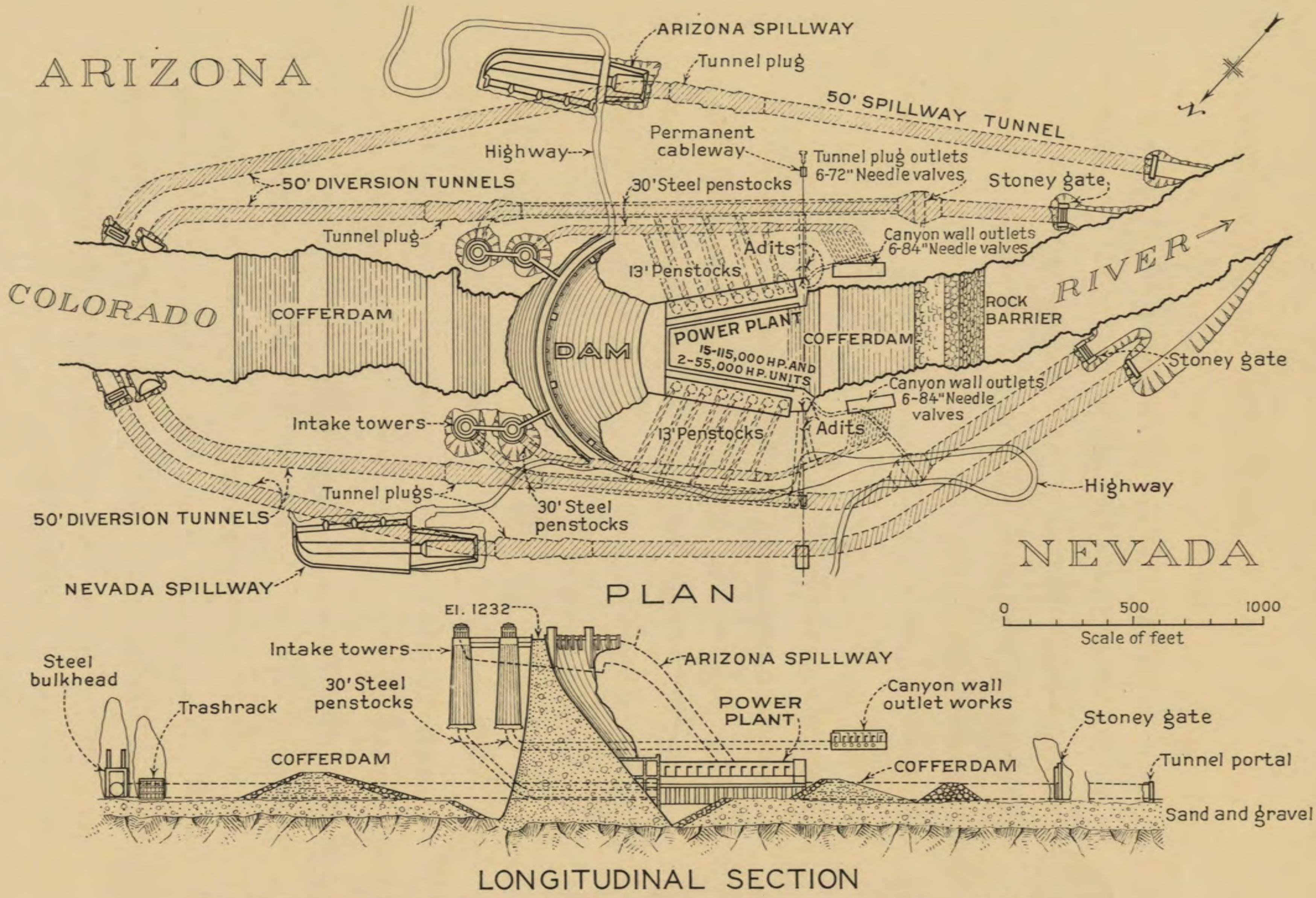
Shovels	13,356	
Slickers	2,256	
Sponges	5,348	
Steel, 7/8" to 1¼"	1,516,276	pounds
Sulphur	2,300	sacks
Tape, electric, ½ pound rolls	50,250	
Telephones	386	
Tubing, copper	14,609	
Veneer, ¼", 3-ply	9,510,000	sq.ft.
Vises	190	
Washers, cut and malleable	250,100	pounds
Washers, lock	647,900	
Wheelbarrows	168	
Whistles, police	588	
Wrenches	12,226	
Wire, black tie	9,396	coils

Government Equipment

Much of the machine shop equipment to be installed in the power plant was received at the government warehouse during the latter months of the year, but none was placed in position.

A car transfer cradle was built for the government by Six Companies Inc. at the loading platform of the 150-ton cableway. The cradle rests on sole plates in the pit, its plan dimensions are 14' x 52', and it possesses sufficient size and strength to carry a fully loaded freight car. The outside stringers are composed of 30" 108# I-beams, the middle stringers beneath the rails of 15" 35#, and the cross beams, spaced at 6' centers, of 24" 70#. Connections to the evener beams of the cableway fall blocks are made at four points on each side of the platform by steel links, shackles, 2" steel rope, and brackets. Details of construction are shown on drawings numbered 45-D-3114, 45-D-4148 and 45-D-3702 to 3705, inclusive.

The 150-ton cableway was operated throughout the year by Six Companies Inc., using the installation primarily for its own work up to July 10 when The Babcock & Wilcox Company commenced sending the 30' diameter steel pipe to the tunnels.



BOULDER DAM AND APPURTENANT WORKS

7-7-33

45-D-3230

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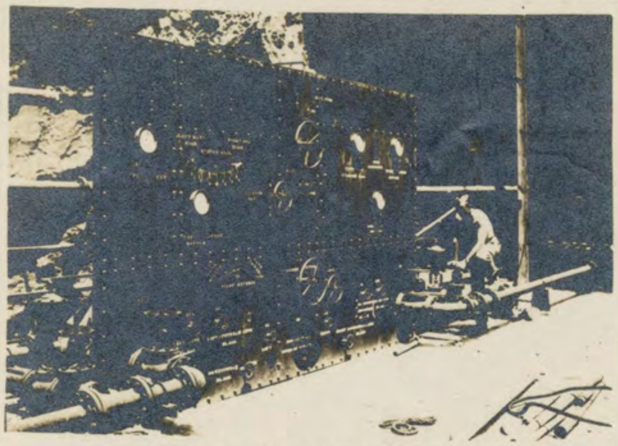
Construction of Diversion Tunnels

General: All tunnel lining at plugs and tunnel intersections not previously placed was completed in 1934. The concrete lining at the intersection with the Nevada spillway incline tunnel, which was damaged by fire in 1933, was removed by chipping and partly replaced by guniting. The remainder of the chipped area will be poured at the time the lower end of the tunnel plug is built.

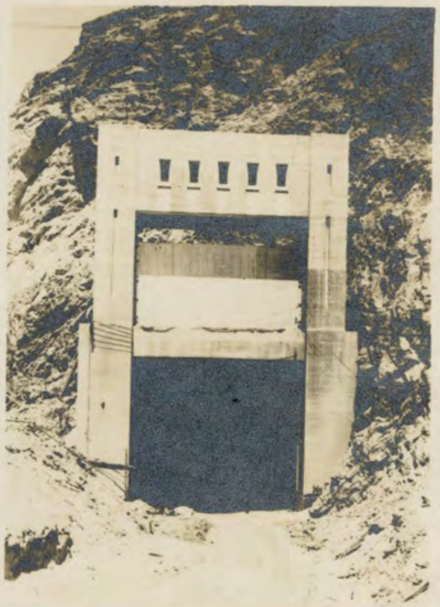
Practically all grouting in back of the linings was completed, including the rings of deep holes (150' maximum) opposite the dam abutments. Drawing No. 45-D-4598 shows the locations of the deep holes, and project drawing No. 25.1-17 gives the results of drilling--the depths of holes and sacks of cement used in each hole.

All outlet and inlet gate installations were completed, and the trashrack at the inlet of tunnel No. 1 was practically finished. Preparations were being made at the end of the year to install the retractive device that will make possible the supporting of the gates on the beams at its base until the time for lowering. A description of this device will be found in Chapter I - "A" under the heading "Changes in Design". The laying of control lines and the moving of the panel board to elevation 1065 directly above the gate,

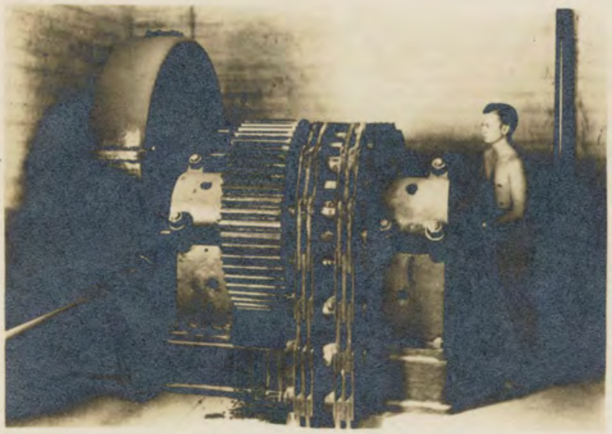
DIVERSION TUNNEL GATES



Operating panel for Bulkhead Gate No. 1

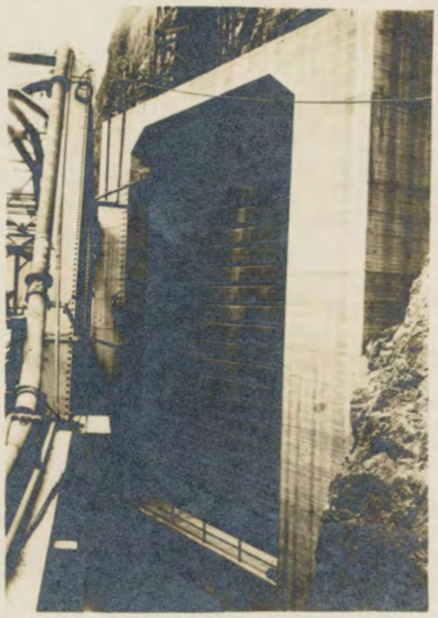


Stoney Gate Tunnel No. 3



One of two hoists for Stoney Gate No. 2

Tunnel side of Stoney Gate No. 2



Bulkhead Gate No. 1

for remote control of lowering operations, were nearing completion at the end of the year. As mentioned previously in this History, the location of the high pressure gates was moved from the Nevada inner tunnel to the Nevada outer tunnel. This relocation will, of course, require the lowering of the bulkhead gate when it is under 300' or more of water.

<u>Plugs and Adits:</u> All excavations were finished in 1934 for the downstream plugs in inner diversion tunnels, and all mass concrete was placed in the two upper plugs of the tunnels excepting that to be poured after the 30' diameter pipes are erected there. The plug in No. 1 tunnel was nearing completion on December 31, and the high pressure gates in the plug were practically installed.

The first concrete was placed in the upper plug of tunnel No. 3 on March 1 and the last pour made on September 25. As shown on drawing No. 45-D-3837, the plug is 306' in length and contains five contraction joints which were established by the pouring of concrete in blocks approximately 50' in length. As in the dam, a 5' lift of concrete was poured at one time, and cooling loops were placed on top of each lift.

Several plans were tried for placing the concrete. First it was hauled direct to the point of placement in agitators. Then a mono-rail was installed along the tunnel arch, extending above the plug, a mono-rail hoist picked up the spout dump buckets or agitators from the truck and carried them to pouring sites. The system finally adopted was to haul the concrete to tunnel No. 3 through the construction adit that was driven in 1931 immediately downstream from the dam for the purpose of excavating diversion tunnels. Concrete was then dumped into a hopper in tunnel No. 3 and thence into a Rex Pumpcrete gun which pushed it through an eight inch pipe to transverse chutes at the plug. A special bottom dump steel car, to run on rails, was built for the haul through the adit. The first Pumpcrete gun could not handle concrete containing aggregates larger than 1½", but another machine was installed later that would operate with 3" maximum aggregate.

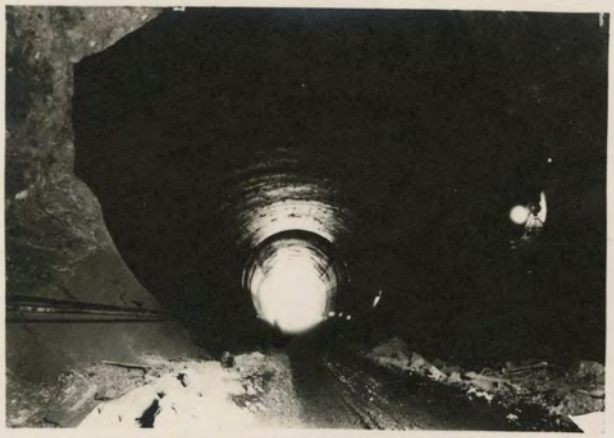
The upper plug in tunnel No. 2 was poured between July 24 and November 27. Its dimensions and the procedure of construction were essentially the same as those for the upper plug in tunnel No. 3, with the exception that the Rex Pumpcrete gun, using 3" maximum aggregate, was used to pour all of the plug.

Concreting of the upper or gate section of tunnel No. 1 plug was started on November 26 and had not been completed at the end of the year. The gates and conduits were practically installed in December. As shown on drawings Nos. 45-D-5744 and 45-D-3202, the upper section of the plug is 214' in length (over all length of plug 393') and contains two sets of four slide gates each that will control the water flow through four 6'0" x 7'6" conduits. The upstream 110' of the conduits are lined with steel. The two sets of gates are placed 56' apart, and the upper set is 37'4" from the upstream face of the plug.

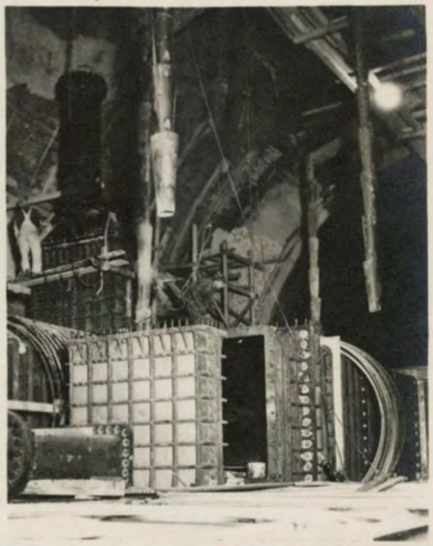
Cooling was started in the upper plug of tunnel No. 3 on October 23 and in the upper plug of tunnel No. 2 on December 30. Precooling water was circulated at first and will be followed by refrigerated water in the plugs, which will be cooled to a temperature of approximately 50°F.

Excavations for the adits to the downstream plugs and to the upstream plug of tunnel No. 2 had been completed before 1934. The adit between the upper plugs of tunnels Nos. 1 and 2 was holed through on September 20. The two adits to the downstream plugs were lined in 1934 with a 12" thickness of concrete from the canyon wall portals nearly to the plugs. The lined adit cross section is horse shoe shaped, and its dimensions, from the outer portal to the short adit that leads to the canyon wall valve house elevator shaft, (a distance of approximately 90') are generally 12'6" in width of 19'5" in height and from this point to the plug 12'6" by 10'4". The floor of the adit was poured first and then the side walls and arch, using wooden forms and placing concrete with a Rex Pumpcrete gun. The side walls and arch forms were built in one movable unit 21' in length. The floors of the adit from the dam to the Nevada upper plugs were being poured at the end of the year, the concrete being supplied from the Pumpcrete gun set up for the plug of tunnel No. 1.

DIVERSION TUNNEL PLUGS AND ADITS



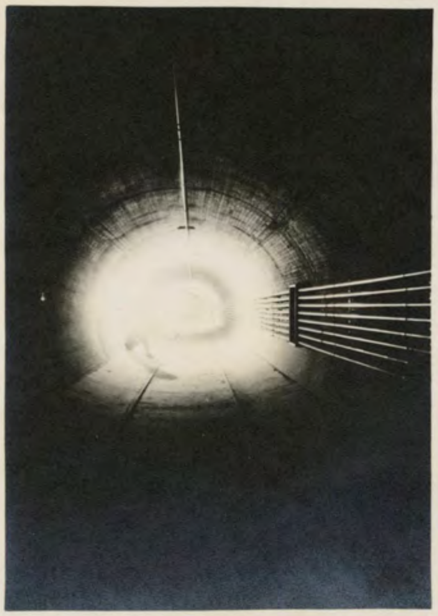
Excavation for D. S. Plug Tunnel No. 3



Placing gates and conduit in No. 1 plug

Construction of U. S. Plug Tunnel No. 3

Placing concrete in U. S. Plug Tunnel No. 2



Access adit to D. S. Plug Tunnel No. 3

Entrance of adit to D. S. Plug Tunnel No. 3

Diversion of the Colorado River

Nevada tunnel No. 1 diverted the flow of the river from January 1 to May 7, when the temporary dam was removed at the inlet of Arizona tunnel No. 4. The river flowed through tunnels Nos. 1 and 4 to July 25, when a rock and earth dam was thrown across the inlet of tunnel No. 1, and No. 4 carried the river for the remainder of the year.

Removal of Lower Cofferdam and Rock Barrier

Removal of the lower cofferdam and rock barrier was started in August on the Arizona side at the downstream face of the rock barrier, and progressed upstream within a hundred feet of the cooling tower. At the end of the year about 60 per cent of the rock barrier and 10 per cent of the lower cofferdam fill had been taken out. The material was excavated by 3½ cubic yard shovel assisted to some extent by a smaller shovel and was hauled downstream to dump grounds by a fleet of 8 and 15 cubic yard trucks.

Dam

General Summary: The preliminary work and construction of the dam in 1933 are described in Chapter II of the preceding volume of the project history and briefly reviewed in the following paragraphs.

The upper cofferdam was completed about March 1, 1933, and the lower cofferdam about May 1, 1933. Excavation of the abutment cuts, and subsequently the river channel, was carried on simultaneously with the cofferdam construction, making possible the first pour of concrete for the dam on June 6, 1933. Pouring continued throughout 1933 without important delays, and by the end of that year the dam was approximately 29 per cent completed.

Concrete: The operations of placing concrete in the dam throughout 1934 were virtually the same as described in the project history for 1933. On December 31, 1933, the highest block on the dam was at elevation 735, and the structure contained 946,203 cubic yards of concrete. At the end of 1934, the high block was at elevation 1185, and the total volume placed amounted to 3,099,000 cubic yards. Concrete was poured on 357 days at an average rate of 6,030 cubic yards per day. The maximum pour of

PROGRESS OF DAM CONSTRUCTION


December 29, 1933


June 3, 1934


June 25, 1934


January 19, 1934


November 20, 1934


December 11, 1934

8,803 cubic yards for a 24-hour period was made on March 20, 1934. The first millionth cubic yard of concrete was poured in the dam on January 7, the second millionth on June 2, and the third millionth on December 5.

Most of the concrete for the dam in 1934 was manufactured by the high level mixing plant; however, the low level plant continued to furnish dam concrete until November 2 when it was shut down.

Cooling: A detailed description of the cooling system may be found in Volume III of this history. Briefly described, the system comprised a series of centrifugal pumps which forced water from an atmospheric cooling tower or from a refrigeration plant through the 14" mains to the headers in the middle slot of the dam, which supplied the coils in the dam.

When the temperature of the concrete had been lowered as much as possible by the cooling tower operations, water, which had been cooled by an ammonia refrigerating process, was circulated by the pumping plant through a separate system of mains and headers and the same coils in the concrete. Refrigerated water entered the dam at about 40°F and was circulated through the coils until the temperature of the concrete

CONCRETE FOR DAM CONSTRUCTION

The two-millionth cubic yard

Transportation from high level concrete plant

Cleaning concrete by jetting

8 cubic yard bucket

Derrick for handling concrete from low level plant

The three-millionth yard-December 5

was lowered to the extent contemplated for that particular location in the dam. This temperature was computed on a straight line variation between the desirable temperatures on the upstream and downstream faces. At the upstream face, these temperatures varied from 40°F at the lowest point to 72°F at the top. The downstream face temperatures varied from 63°F at the lowest point to 72°F at an elevation just above the tail race, and remained at 72°F from there to the top.

The results of cooling operations since cooling was started are summarized in the table appearing on the following two pages.

RESULTS OF COOLING IN BOULDER DAM

Month	Type Cooling	Elevations Where Cooling	Aver. No. of Coils	Approx. Total Length of Coils Ft.	Aver. Temp. in Mains Deg. F Supply	Aver. Temp. in Mains Deg. F Return	Aver. Flow: G.P.M.	Equiv. Tons Refr. at Plant	Cooling Comp. to Aver. El.	Cooling Interrupted Hours
1933										
August	A	530-575	56	26,700	72.5	84.5	240	120		
	B									
Sept.	A	530-600	136	64,600	68.4	74.4	900	225		0
	B									0
October	A	530-640	297	134,700	71.2	78.4	1,360	410		0
	B	530-610	302	143,000	43.5	61.8	1,370	1,045		2
November	A	615-660	548	237,000	58.1	64.8	2,340	650		168
	B	530-620	380	175,500	40.5	53.4	1,510	810		169
December	A	645-670	123	51,900	53.0	57.0	760	125		300
	B	530-650	409	187,000	39.4	47.1	2,030	650	575	19
1934										
January	A	655-680	137	55,400	52.4	56.9	900	170		84
	B	580-670	382	168,000	39.0	45.5	1,940	525	630	55
February	A	675-730	338	132,600	57.0	62.0	2,140	445		77
	B	580-670	383	146,500	38.4	48.8	1,850	800	645	61
March	A	685-775	413	169,000	61.9	67.8	2,300	560		88
	B	625-740	313	128,300	39.3	51.6	1,560	800	660	45
April	A	745-805	560	244,000	66.3	74.2	2,160	710		82
	B	660-740	512	204,800	40.4	52.1	2,040	995	695	88
May	A	745-860	862	407,000	70.8	79.8	2,250	845		14
	B	685-775	525	215,000	40.5	50.4	2,150	895	740	28
June	A	780-890	815	412,000	70.6	81.3	1,620	720		8
	B	715-810	430	187,000	39.7	49.7	1,990	830	770	33
July	A	815-925	712	385,000	77.6	86.8	1,315	505		9
	B	745-840	373	173,000	39.3	51.0	1,810	880	805	16
August	A	850-965	684	397,700	80.9	90.6	1,352	545		10
	B	765-875	360	177,800	39.7	52.4	1,590	840	840	10

RESULTS OF COOLING IN BOULDER DAM (cont.)

Month	Type Cool-ing	Elevations Where Cooling	Aver. No. of Coils	Approx. Total Length of Coils Ft.	Aver. Temp. in Mains Deg. F. Supply	Return	Aver. Flow G.P.M.	Equiv. Tons Refr. at Plant	Cooling Comp. to Aver. El.	Cooling Interrupted Hours	
1934											
September	A	890-995	557	311,420	73.6	88.5	1,560	962		447	*
	B	805-910	377	203,580	39.8	53.1	1,556	866	860	15	
October	A	930-1050	546	361,680	68.1	87.3	1,212	961		106	+
	B	850-965	381	247,700	39.5	53.2	1,494	852	910	$9\frac{1}{2}$	
November	A	970-1065	376	289,520	60.7	76.9	927	625		$23\frac{1}{4}$	
	B	875-1005	327	228,900	39.7	54.1	1,404	842	950	12	x
December	A	1010-1140	201	166,830	56.6	76.7	719	602		34	
	B	940-1085	276	220,800	38.9	53.4	1,328	802	1,055	$21\frac{1}{2}$	x

A - Precooled water only.

B - Refrigerated water only.

* - Precooling shut down while water was pumped to Boulder City, Nevada.

\+ - Approx. 200 G.P.M. of precooling water circulating thru No. 3 plug.

x - Approx. 250 G.P.M. of refrigerated water circulating thru No. 3 plug.

Grouting: A brief description of the plans for grouting contraction joints is given in Volume III of this History.

The contraction joint grouting operations were carried upward in 50' lifts after the concrete was cooled and the cooling slot concreted. The first joints were grouted on May 24, 1934, starting at the foundation rock in the radial joints IJ and KL. Operations were carried on at intervals until all joints had been grouted up to elevation 825 in November. For the lower part of the dam, grout was mixed in a seven-sack mixer set up in the gallery at elevation 705 on the Arizona side of the dam. Grout was discharged from the mixer through a screen into an agitator. The agitator consisted of a vertical open top tank 3' in diameter by 2' deep, equipped with an air driven motor which rotated a vertical shaft that had two blades set close to the bottom of the tank. The grout flowed from the agitator tank by gravity through a 2" pipe line to the lower galleries from where the grouting of the first two 50' lifts was accomplished. Another similar agitator and a 10" x 3" x 10" duplex-piston displacement pump were set up in these lower galleries, and the actual filling of the joints was accomplished by gravity flow from the last agitator. The grout pump, arranged to be quickly connected with the grout line, was used only when the joint was nearly full, in order to drive off surplus water and to consolidate the film of grout in the joint. A pressure of 100 pounds was expected to be sufficient to drive the surplus water into the concrete on either side of the joint and give a grout film of satisfactory density.

The painting of the exposed side of contraction joints was discontinued early in the construction period as it had been determined that the untreated surface accelerated the passage of grout and increased the absorption of excess water into the concrete. From the quantities of cement used, it is estimated that the average joint openings were from .10" to .12" in width.

Drilling and grouting in dam abutments was started in the "A" line holes (from dam galleries) in August and in the "C" line holes (upstream from the dam) in October. Progress at the end of the year in "A" line drilling and grouting was as follows: 60 holes had been drilled for a total length of 8,938; 60 holes had been grouted using 4,497 sacks of cement, the upper holes were at elevation 602 on the Nevada abutment and elevation 615 on the Arizona side, but all drilling and grouting had not been completed to those elevations.

On the "C" line, 68 holes had been drilled for a total length of approximately 6,575; 68 holes had been grouted using 6,944 sacks of cement, grouting was practically completed in all holes up to elevation 748 on the Nevada abutment and to 730 in Arizona.

Technical Installations: Electrical resistance thermometers were placed in the mass concrete of the dam to secure information of the cooling system results during construction and provide readings for a temperature record after the dam is built. Most of the thermometers were located at 25' intervals of elevation and placed around the elevator shafts and in blocks extending radially downstream in sets of from one to three instruments to a block. Cables attached to these instruments were carried through conduit or directly thru the concrete to a nearby gallery where temperature readings were taken at frequent intervals.

Carlson electrical resistance joint meters were installed across contraction joints to secure accurate measurements of the width of openings. One group of these instruments was placed in the GH, HI and IJ radial joints (at 5' intervals) between elevation 650 and 680. Another group was installed at each 5' elevation from 880 to 910 in the MN, NO, and OP joints. It is planned to embed 52 joint meters near the top of the dam for measuring width of joint openings at various points during the cooling operations and to obtain, in future years, data relative to the seasonal temperature effects on the dam arch.

Carlson electrical resistance elastic wire strainmeters were installed in sets of five pairs of instruments placed in different positions, to measure the effect of resultant forces along the line of direction of the meters. Five sets were located between elevation 575 and elevation 620 along the Arizona side of the cooling slot. Nine sets were installed at elevation 800, three along each abutment and three along the Arizona side of the slot. This arrangement was repeated at elevation 900 and elevation 1000, six sets were installed in the same relative positions at elevation 1100, and it is planned to place five strain meters in the "G" blocks at elevation 1200.

Readings were taken from all of these instruments by government forces, and the data sent to the Denver Office for reduction and analysis. Curves were plotted by the local organization of thermometer and joint meter readings for project use.

A summary of instrument installation is given in the following table:

Type	Instruments installed to date	Future installations
Thermometers	404	6
Strain meters	380	5
Joint meters	51	40
Thermometers in Plugs	18	18

FEATURES OF DAM CONSTRUCTION


Cooling pipe installation at contraction joint


Water and grout stops


Monkey Slide on Nevada abutment


Moving forms


Top of dam, February 24


Strain meter installation and form

Spillways

A discussion of the excavation and construction of the Arizona and Nevada spillways may be found in Volumes II and III of this History. Most of the concrete had been placed in the weirs and channel lining by the end of 1933, and, with the exception of the drum gates, the structures were practically completed up to the cross weir. The erection of the drum gates commenced on the Arizona spillway in March 1934 and on the Nevada spillway in the following June. By December 31, 1934, all drum gates were practically installed.

Lining of the Nevada spillway tunnel raise has been completed with the exception of one small section near the portal which will be poured when the tunnel high pressure grouting operations are finished, and there is no further possibility of grout following the lining up the raise and into the spillway drainage system.

Approximately 100' of the upper end of the Arizona spillway raise were lined first to eliminate the danger of working beneath an area of unsafe rock near the portal. Operations were then transferred to the lower end, and on December 31, 1934, the lining had been brought up the raise from the plug section in tunnel No. 4 a distance of approximately 100'.

Pouring concrete in the spillway raises was accomplished by transporting the 4-cubic yard agitators from trains, or trucks, and thence by cableway or dragline to an especially designed car in the portal of the tunnel. This car was lowered to the pouring site down an inclined track by an 175 H.P. hoist and the concrete transferred (from the agitator) to the form by a horizontal conveyor belt and vertical downspouts.

The channel lining on the landward side of the Arizona spillway is supported by buttresses for a distance of 440' from the upstream end, and the area back of this buttress supported lining has been backfilled.

The Arizona section of the Black Canyon Highway crosses the Arizona spillway on a barrel arch bridge that has a span of 129'-9". It is located just upstream from the spillway transition section, and details of its construction will be found on drawings 45-D-1442 and 45-D-3955. The abutments were poured monolithically with the channel lining. The arch will be constructed by three separate pours, the center one of which was made in December 1934.

Approximately 10,500 cubic feet of gunite 4" thick were placed over the rock along the reservoir side of the Nevada spillway during the months of November and December.

The fill of Hemenway Wash material was being placed on the reservoir side of the Arizona weir at the end of the year, and excavations were being made for the concrete apron.

SPILLWAYS

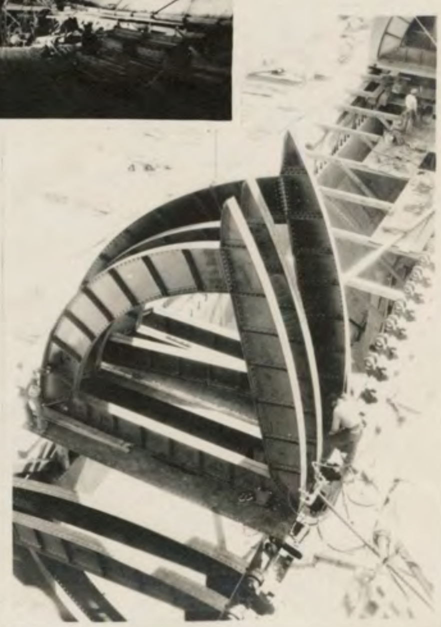
Guniting apron in front of Nevada weir

Nevada Spillway, December 10

Downstream end, Arizona channel

Intersection Nevada incline and Tunnel 1

Arizona Spillway, June 18



Details of gate installation

Intake Towers

The excavation for the foundation of the towers and the method of pouring concrete in the structures have been discussed in Volume III of this History. On December 31, 1933, the installation of the lower gate in the Nevada downstream tower was practically completed and the concrete poured to elevation 895. Concrete had been placed to elevation 890 in the Nevada upstream tower, and preparations were being made to install the throat liners. Concrete in the Arizona downstream tower had been poured to elevation 884. Lining of the inclined tunnel below the Arizona upstream tower had progressed to a point 20' downstream from the upper vertical curve, and the foundation rock was practically ready for the first pour in the tower.

Construction of all four towers progressed steadily through 1934. Installation of the gate at elevation 1040 in the Nevada downstream tower was started in May, and by the end of August the upper gates had been installed in all four towers.

On December 31, 1934, both downstream towers were completed to elevation 1232.83, the level of the operating floor and the bridges connecting the two towers and the dam. One more pour was necessary to bring the Nevada upstream tower to this same elevation. The Arizona upstream tower was poured to elevation

1222.28. Forms and steel were being installed for the operating house on the two higher towers.

INTAKE TOWERS

Pouring Nevada D. S. Tower October 29

Canyon view downstream, October 4

Nevada upstream tower July 20

Reinforcement steel at tower base

Nevada upstream tower, February 23

Canyon view from Arizona side, November 16

Penstock and Outlet System of Tunnels

Penstock and Outlet Headers: A discussion of the excavation and lining of the penstock and outlet headers may be found on page 233 in Volume III of this History. During 1933 the lining of these tunnels had been completed on the Arizona side from the base of the tower to a point 226' downstream from the lower end of the vertical curve and on the Nevada side to a point 239' downstream from the lower end of the curve.

By May 1934 the lining in both tunnels had been completed up to the construction adit. Holes were drilled, and the tunnels were grouted with both high and low pressures. The piers for the 30' steel pipes were poured from transit mixers, hauled on trucks. The thrust block seats were chipped during July. The floors of the construction adits were paved, and the first section of 30' steel pipes was taken into the Nevada penstock header tunnel in September. The section beyond the construction adits is to serve as an anchor and will be filled with concrete around the pipes after they are in place.

Penstocks: A discussion of the excavation and lining of the penstock tunnels may be found starting on page 235 of Volume III of this History. Operations as described were continued. Early in the year all excavation was completed, and in September 1934 lining operations were generally finished except for the anchor section at the powerhouse end on all penstocks. In November 1934 all penstock tunnels had been grouted and drain holes drilled by December 1, and at the end of the year the lining of the penstock passageways was in progress.

Construction Adits: As previously mentioned in the 1933 Project History and in the preceding pages of this article, the construction adits were excavated in 1933, and the floors of the upper adits were paved in June of 1934. The shafts for the oil purification system between the upper and lower construction adits were holed through in April 1934. The floor pavings for the lower construction adits were completed in December 1934.

Valve Houses

A discussion of the excavation of the valve house benches may be found on page 240 of Volume III of this History. The adits to the elevator shafts and the elevator shaft linings were completed in August 1934. In December 1934 the cast iron drain pipe in the foundation of the valve houses had been installed, and a cableway had been erected to handle material and concrete for the buildings.

MISCELLANEOUS FEATURES OF EQUIPMENT AND CONSTRUCTION

Transmission line tower of
Los Angeles Bureau of Power and light

Nevada valve house and adjacent features

Portal of control circuit Tunnel

Grouting machine

Blending, cement screening, and Hi-Mix Concrete Plants

50-ton truck hauling reinforcement steel

Powerhouse

General Description: A discussion of the principal features, materials, and more important installations in the power plant may be found in Volume III of this History, starting on page 64. A description of the plant in greater detail will be given in the following paragraphs.

The powerhouse may be divided for purposes of description into three sections: The central portion, the Nevada wing, and the Arizona wing. The central portion is situated on the downstream toe of the dam between the canyon walls. It will be used to house the plant machine shops, operating rooms, and the offices. The lowest concrete in the powerhouse is in this section at elevation 551, and the lowest rooms--the pump sumps--at elevation 585. The sump pumps are to be located at elevation 639 on the same floor with the Boulder City water supply pumps and the plant air compressors. The plant machine shop floor level will be at elevation 673. Three floors will be available above this shop for offices and the central operating rooms which will be on the top floor. The high point of the superstructure of this section is at elevation 780.

The wings will extend along each canyon wall approximately 610' from the face of the central portion.

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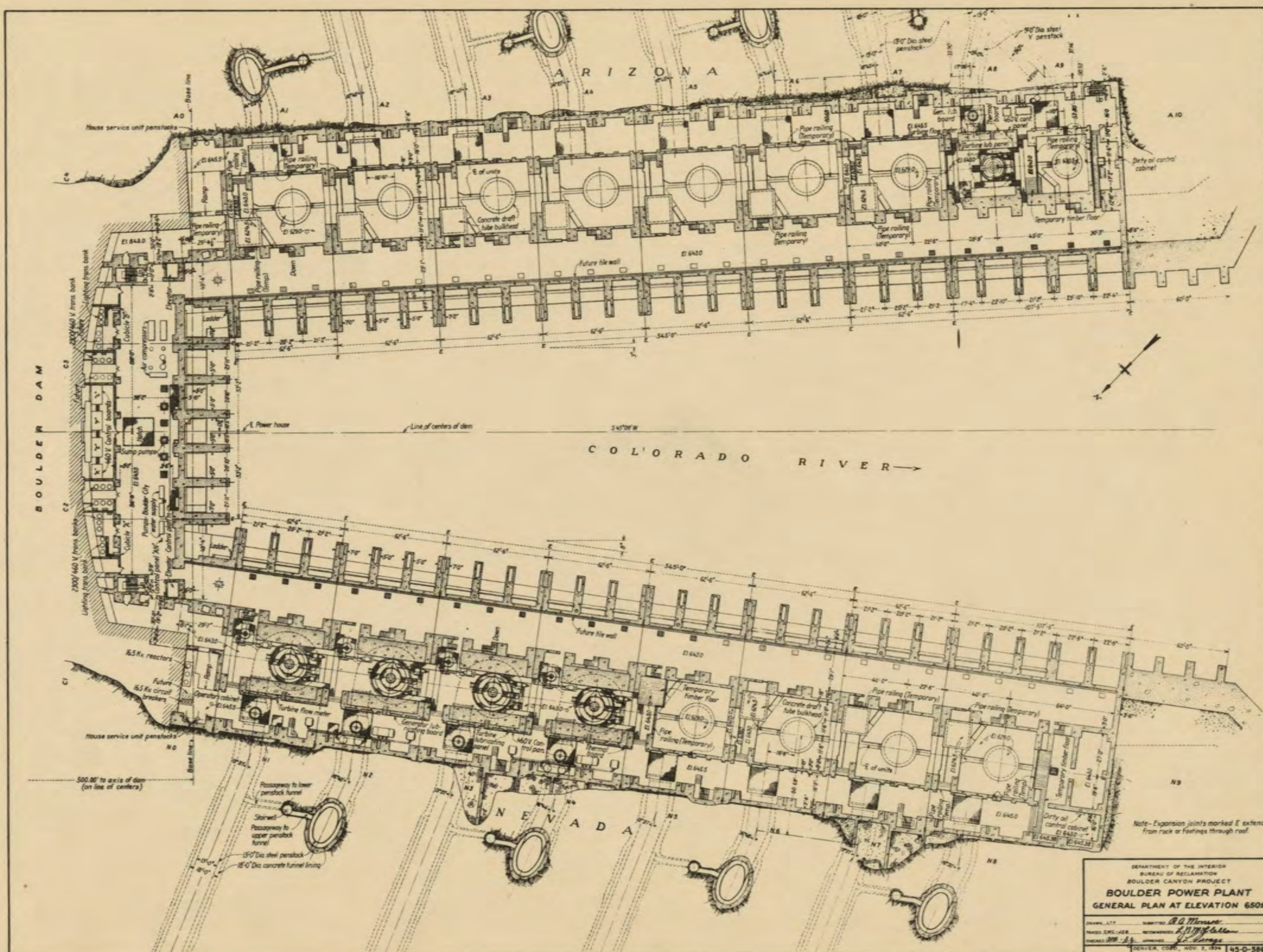
ARIZONA
NEVADA
COLORADO RIVER
BOULDER DAM
House service unit penstocks
Future tile wall
Line of centers of dam
Power house
500.00' to axis of dam (on line of centers)
Passageway to lower penstock tunnel
Stairwell
Passageway to upper penstock tunnel
15'-0" Dia. steel penstock
18'-0" Dia. concrete tunnel lining
16.5 Kv. reactors
Turbine flow meter
Temporary timber floor
Concrete draft tube bulkhead
Pipe railing (Temporary)
Dirty oil control cabinet
Air compressors
Sump pumps
Note- Expansion joints marked E extend from rock or footings through roof.
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT
BOULDER POWER PLANT
GENERAL PLAN AT ELEVATION 650±
DENVER, COLO., NOV. 2, 1934
45-D-5865

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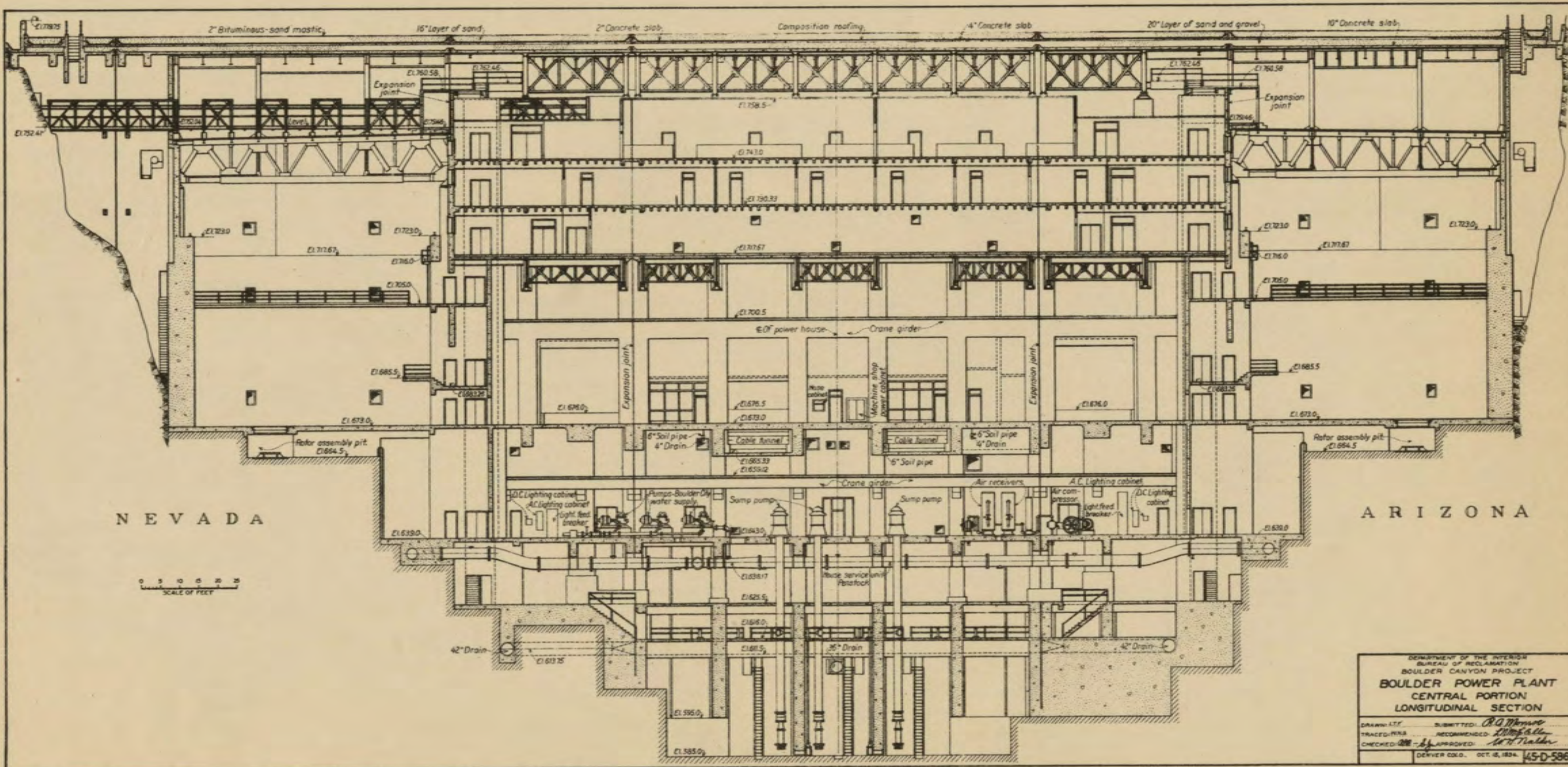


2" Bituminous-sand mastic
16" Layer of sand
2" Concrete slab
Composition roofing
4" Concrete slab
20" Layer of sand and gravel
10" Concrete slab
Expansion joint
Expansion joint
Expansion joint
Expansion joint
℄ Of power house
Crane girder
Machine shop power cabinet
Cable tunnel
Cable tunnel
6" Soil pipe
4" Drain
6" Soil pipe
4" Drain
6" Soil pipe
Rotor assembly pit El. 664.5
Rotor assembly pit El. 664.5
Crane girder
D.C. Lighting cabinet
A.C. Lighting cabinet
Light feed breaker
Pumps-Boulder City water supply
Sump pump
Sump pump
Air receivers
A.C. Lighting cabinet
Air compressor
Light feed breaker
D.C. Lighting cabinet
House service unit Penstock
42" Drain
42" Drain
15" Drain
NEVADA
ARIZONA
SCALE OF FEET
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CANYON PROJECT
BOULDER POWER PLANT
CENTRAL PORTION
LONGITUDINAL SECTION
DRAWN: L.T.F.
SUBMITTED:
TRACED:
RECOMMENDED:
CHECKED:
APPROVED:
DENVER COLO., OCT. 13, 1934.
45-D-5864

227

Image
Coming
Soon

***

Oversized
Material

The Nevada side is designed to house eight units composed of 82,500 KVA generators motivated by 115,000 HP turbines, and on the Arizona side there will be seven similar units and two units of 40,000 KVA generators connected to 55,000 HP turbines. The river wall of each wing, up to the elevation of the generator floor, has been extended 60' downstream beyond the main plant building and then angled to meet the canyon wall at the downstream side of the lower plug adit. The areas between these retaining walls and the canyon wall will be backfilled and paved with concrete at the generator floor level to form landings beneath the 150-ton cableway. Standard gage tracks will lead from the landings to the plug adits, the generator rooms and to the balconies that extend the full length of each wing.

A typical cross section through one of the wings may be best described by considering its construction as divided into the sub-structure below the generator floor, and superstructure above the generator floor.

Two galleries, the butterfly valve gallery at elevation 622.5 and the governor gallery at elevation 645.5, are located in the substructure near the canyon walls. The turbine gallery is situated in the approximate center of the substructure and serves as a passageway between the large turbine wells under each generator in which will be installed the turbines and turbine cranes. The center of the turbine scroll cases will be at elevation 637 and the bottom of the outlet draft tubes at elevation 604. The following galleries are located in a tier along the tail race side of the substructure: The pump gallery at elevation 625.5, the pipe gallery at 643, the cable gallery at 653 and the bus gallery at 663, all elevations being given to the top of the floor.

The superstructure rises generally from the generator floor at elevation 673 to the roof parapet at elevation 758.67. This section, extending along the canyon wall the full length of the wing with an approximate width of 75', houses the generators, the two 300-ton cranes, and accessory features. The superstructure extends 27½' toward the river beyond the generator room where the switch houses and exposed transformers are situated. The switch houses are approximately 33' high and 36' long. Each usually serves two generators, and houses the oil circuit breakers as well as various instrument transformers and the control apparatus. The exposed transformers will be grouped generally in threes between the switch houses. The balconies, containing tracks for the installation of machinery and for miscellaneous work in plant operations, extend along the wings in front of the switch houses and transformers.

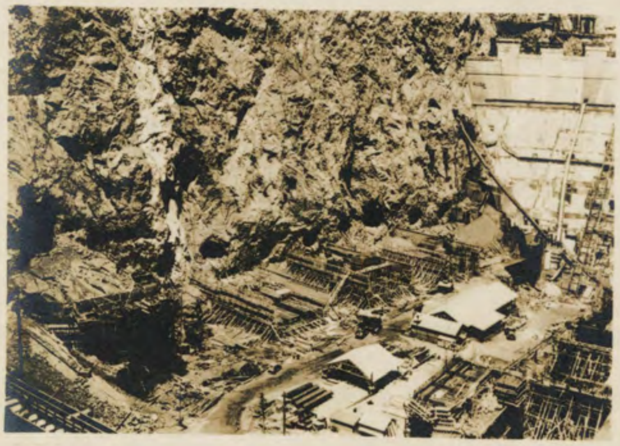
The power plant roof will be supported by trusses, approximately 12' in depth and 71' long, spaced at 20' intervals and resting on the walls of the generator room. The roof of 4½' in thickness is composed of alternate layers of concrete and sand and gravel, with a water proofing layer of bituminous sand mastic on top. The roof has been designed to withstand the heavy impact of rocks which may fall from the high cliffs above.

Hydraulic System: Water, entering the power plant from the penstocks, will first pass through the butterfly valves that will be installed to cut off the water when the generator is idle. A smaller branch, taking off near the intake end of the scroll case, leads to the turbine relief valve and thence to the relief valve draft tube. Water passes from the scroll case, when the generator is running, through wicket gates to the turbine runner. The wicket gates, controlled by a governor, will vary the amount of water flowing through the turbine as the load on the generator fluctuates. In the event that the generator closes the wicket gates, the resulting high pressure in the penstock will be relieved by the opening of the valve, which operates whenever there is a sudden clos-

POWERHOUSE

Nevada wing view downstream July 21

Footings on Dam



Nevada wing view upstream April 26

View of powerhouse from dam December 18

Arches in Pump gallery, Arizona wing

A celebration to mark the beginning of construction of the All-American Canal was held on December 15, 1934.

Tutorow

#76

ing movement of the wicket gates.

<u>Operation:</u> It is planned to place the operation of the plant into a division for states and municipalities and another for public utility corporations. Installations planned for the immediate future include units Nos. 1, 2, 3, and 4 on the Nevada side and one of the smaller units, No. 7, on the Arizona side. The four larger units will be operated by the City of Los Angeles and the smaller unit possibly by the Nevada-California Power Company. Removable concrete bulkheads have been placed in the openings from turbines qnd at the inlets of the relief valve draft tubes, for all units that will be installed after the five mentioned above. The penstocks for these later units will be closed with a steel bulkhead.

Each generator may be operated from its own control cubicle which will be located along the river wall in the generator room. Control of any or all of the generators may be transferred to a minature control board located in the central portion by throwing the switch in one or all of the generator cubicles.

<u>Construction Progress and Methods:</u> Excavation for the power plant foundation was practically completed on December 31, 1933. The first concrete was poured on the Arizona side in Unit No. 5 up to

elevation 575 on January 27. The first few pours were made by dumping the concrete directly into the forms from the bucket on the cableway. Later, as the area became more crowded and the forms more complicated, Rex Pumpcrete guns were used, the greater portion of the concrete in the substructure being placed by these machines. Where practicable a hopper and system of chutes were erected over the pour and the concrete distributed by these direct from the cableway bucket. Most of the concrete was placed in heavily reinforced sections. Columns of reinforcing steel over 60' in height were fabricated on a platform and placed in a vertical position by a cableway. On December 31, 1934, most of the concrete had been placed for the substructure of both wings and the central portion of the power plant.

Control Circuit Tunnel: A general description of the control circuit tunnel is given on page 242 of Volume III of this History. On December 31, 1933, the tunnel had been driven downward for a slope distance of 205' from the upper portal. In February 1934, excavation was started from the lower end and the tunnel holed through on April 27.

Lining operations were started at the powerhouse end, and the lining was generally placed behind a collapsible form. Concrete was transported in agitators from the Hi-Mix plant to the upper end of the tunnel and lowered in a specially built car to the form. Following the lining operations, the conduit benches were poured and the conduit installed. On December 31, 1934, grout hole drilling was in progress.

Image
Coming
Soon

***

Oversized
Material

B

FABRICATION AND ERECTION OF PENSTOCK STEEL PIPE

By

G. L. Yetter, Engineer

Inasmuch as the field fabricating plant of the Babcock & Wilcox Company, contractors for the penstock steel pipe, was designed and equipped principally for the manufacture of large diameter steel pipe, such as the 25 and 30' diameter penstock steel pipe, production of which did not get well under way until early in 1934, it may be well to repeat some of the previous history pertaining to fabrication.

The steel plates and shapes for use in the penstock pipe were furnished by the Illinois Steel Company, Gary, Indiana. The welding electrodes were made of welding wire purchased on the open market and covered with a mineral flux coating at the contractor's Barberton, Ohio works. The plates for the stream line portions of the power penstock branch connections were furnished by the Illinois Steel Company, Gary, Indiana, and hot pressed to shape at the Barberton, Ohio, works of the contractor. The reinforcing tie rods for these sections were furnished by the Midvale Company, Nicetown, Philadelphia, Pennsylvania.

Between time of receipt and start of fabrication, the steel was stored in a storage yard at the west end of the fabricating plant. Approximately 3000 tons of steel were kept in storage in advance of production in order that no delays or interruptions in fabrication might result.

The field fabricating plant was constructed of galvanized steel roofing and siding over a steel column structure approximately 520' long by 85' wide by 55' high. A continuous crane runway has been extended from the plant about 600' beyond the east end of the building and thru the government building intended for storage of the heavy powerhouse machinery. Transfer of the sections from one machine to another and to storage under the crane runway was accomplished by three 75-ton cranes and one light duty crane which was added during the year for handling plates between planer, press and rolls prior to assembly.

The principal items of fabricating equipment in use were one centerless grinder, one 40' planer, one 3000-ton twin cylinder oil hydraulic press, one set of vertical bending rolls 12½' high, three automatic welding machines for circumferential seams, one automatic welding machine for fillet insert stiffeners, one automatic welding machine for buttstraps, one automatic welding machine for miscellaneous purposes, one 300,000 pound capacity testing machine, one stress relieving furnace, two 300,000 volt X-ray sets, one 30' diameter boring mill, one set of drill presses for 25 and 30' diameter pipe. Each welding machine was operated in conjunction with a set of rolls which automatically placed the pipe in proper position for welding.

Shell plates, bars for buttstraps and reinforcing rings and shapes for fillet insert stiffeners were laid out to pattern and size and their edges planed as required to form suitable welding grooves. After being planed, the ends of the plates were given an initial bend in the press and curved to circular shape in the bending rolls. Forming of plates to irregular or unsymmetrical shapes was done in the press. After shaping was completed, plates were placed in an assembly jig and tack welded or clamped to hold them in position while the longitudinal seams were being welded. Not more than three longitudinal seams were made in sections 25 and 30' in diameter. In order to keep the number of longitudinal seams to a minimum, it was necessary to use the largest plates that could be rolled with existing rolling mill equipment.

Buttstraps, reinforcing rings and fillet insert stiffeners were made of two or three pieces welded together in the flat, curved to circular shape in the bending rolls and made into rings by welding the final joint. The fillet insert stiffener was made into a T section by welding on web plates and shrinking and welding a rim to which the support legs were welded.

After longitudinal seam assembly, the cylindrical rings were taken to one of the welding machines and the longitudinal seams welded. Test plates, which were used to determine the properties of the welds, were made as a continuation of one longitudinal seam on each section. After the longitudinal seams were welded, any buttstraps or reinforcing rings were shrunk and welding of the buttstrap completed.

Each layer of deposited weld metal, except the surface beads, was peened. Where practicable peening was done automatically, securing a much better job than if done manually. The dual arc was used for automatic welding. Two beads were laid side by side simultaneously, one arc travelling about seven inches behind the other.

The cylindrical rings and other parts making up a section were next assembled, rounded and centered and moved to another welding machine where the circumferential seams were welded. The reinforcing ring welds were also made during this operation.

After welding was completed, the section was taken to a set of horizontal rolls where it could be revolved conveniently and each seam was X-rayed to detect any flaws. Support legs were than welded to the insert rims.

The radiographic examination formed an excellent means of quality control of the welding, and the physical tests made to represent each section served as a frequent check of the process being used. Defects as small as .02" in thickness were detected, and all injurious defects were chipped out and replaced by new weld metal. Additional special tests were made from time to time to insure satisfactory results from any modifications in the process.

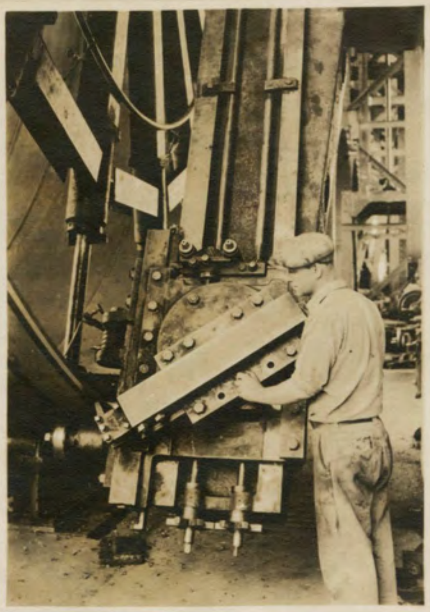
The composition of the steel used and the average physical properties of the plates and welds were as given in the 1933 History.

Welding of the first 30 by 13 branch connection was completed in December. The fabrication of two thirds of the section was fundamentally the same as any other 30' diameter section. The other third was made of hot pressed plates shaped to form a stream line T. The plates were assembled on a jig and welded in position without moving the work. A group of exceptionally highly skilled manual welders was assigned to this work.

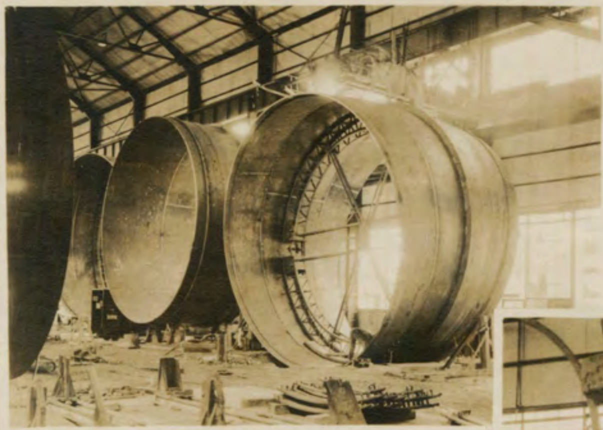
After radiographic examination, repairs, if necessary, inspection and approval, the completed

FABRICATION OF STEEL PIPE

Interior of Fabrication Plant



Facing lathe in operation



Welding 30 foot diameter pipe

Bending 2-3/4 inch Plate for 30 foot diameter Pipe

Y section for outlet pipes

Plant of The Babcock and Wilcox Company

sections were stress relieved by heating thruout to 1100 to 1150 degrees F. The heat was maintained for a sufficiently long time to insure heating the section thoroughly thruout, and heating and cooling were done slowly enough to minimize any tendency towards warping.

The ends of each section were carefully machined on the 30' boring mill to insure a satisfactory fit when assembled. The section was then placed on the 30' drill press and two rows of holes drilled by four drills, operating simultaneously at each end of the section, to mate and join those sections together that would form the field circumferential seams.

The inside surfaces of the sections were then shot blasted and painted and the outside surfaces of sections not to be imbedded in concrete were cleaned and painted.

The pins used in cold pinning the sections in the field were machined to approximate size at the contractor's Barberton, Ohio, works and ground to the required body diameters at the field fabricating plant.

The smaller diameter penstock pipe was transported to the government cableway by railroad car. The 25' and 30' diameter sections were loaded singly on a specially designed trailer and transported by Six Companies Inc. over the highway about one mile to the government cableway. All sections were lowered by the cableway to the adit and loaded on a specially designed "car-on-a-car" which carried the section to the main tunnel and from there to within one foot of position. Transportation from the adit to within one foot of final position was performed by the Richleay Engineering Company, subcontractor.

The sections in the inclined portions of the tunnels were brought to within a foot of final position by means of a set of hoisting equipment consisting of three 75-ton hoists which were set on beams spanning the base of the intake tower. The section was temporarily hung on shackles to the adjacent section. After being rounded and centered, the buttstrap was heated to 600 to 800 degrees F. and shrunk to the mating end. In this operation, a specially designed set of rounding and centering equipment was used on which were mounted eight oil hydraulic pull jacks which furnished the power for pulling the sections together. Dowel pins were then placed in the mating holes.

After several sections were shrunk together, the pin holes at each joint were drilled to the required size by means of a set of rounding and centering equipment on which was installed a broaching machine. This device was then used to broach the holes, countersink the holes on the inside surface and drive the pins. Trepanning and calking was done from the outside with air or electric driven tools. The broaching machine was a special type reamer which produced smooth, round holes with a broaching tool attached or drove the pins cold. The broaching tool was made so that it could increase the diameter of a hole .002" at one cut and burnish the hole after it was broached to size. The pins were ground to a body diameter .003" greater than the pin hole diameter thus insuring a tight fit when driven. The pins were driven under a pressure of 25 to 40 tons.

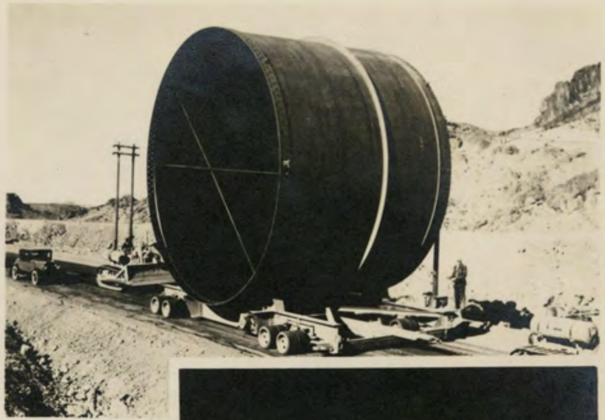
Fabrication was started in April 1933 and production for that year was as follows:

8'6"	diameter	799.5 tons
9'	"	85.5 "
13'	"	2,681.2 "
30'	"	248.9 "
	Total	3,815.1 "

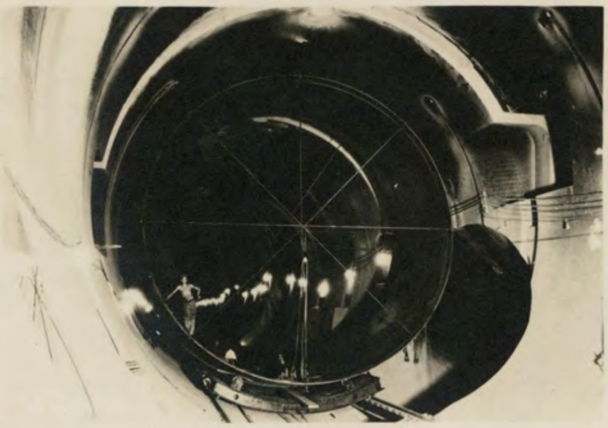
These amounts included three 30' diameter sections, all the 8'6" diameter sections for the upper tunnels, all the 9' diameter sections for the upper tunnels and all the 13' diameter sections for the upper tunnels except the flanged end sections.

TRANSPORTATION AND ERECTION OF STEEL PIPE

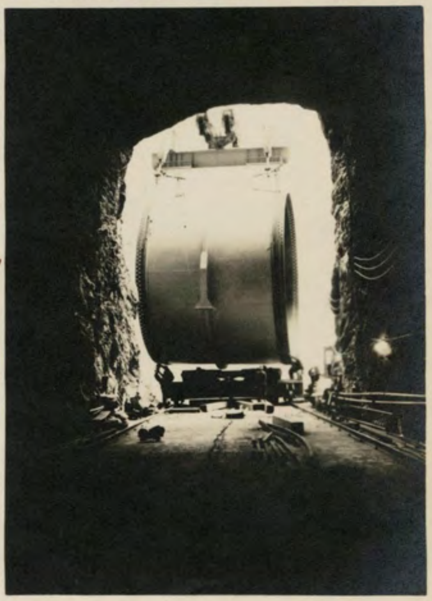
Government cableway handling 30 foot pipe



Transporting 30 foot pipe by trailer



30 foot Pipe in Header No. 5



Pipe at construction adit portal

30 foot Pipe in raise No. 5

30 foot Pipe in No. 3 Tunnel

Fabrication completed during 1934 was as follows:

13' diameter	377.1	tons
25' "	43.4	"
30' "	15,760.0	"
30' x 13' branches	128.2	"
Miscellaneous specials	516.3	"
Total	16,825.0	

These amounts included all the remaining 13' diameter sections for the upper tunnels and all the 30' diameter sections for the upper tunnels except the 30 by 13' branch connections. Total tonnage produced through December 1934 was 20,640.1 tons.

Erection completed during 1934 is as follows:

8'6" diameter	799.5	tons
13' "	204.2	"
30' "	596.0	"
Miscellaneous specials	154.4	"
Total	1,754.1	"

These amounts included all the 8'6" diameter sections for the upper tunnels and the first seven sections in the upper Nevada tunnel. Erection of the 8'6" sections in the upper Arizona was begun in January 1934 and in the upper Nevada in April 1934. Erection of these sections was completed in the upper Arizona in May 1934 and in upper Nevada in July 1934. Erection of the 30' diameter sections was started in upper Nevada in July 1934, and in upper Arizona in September 1934. Erection of the 30' diameter sections in lower Arizona was started in November 1934. Erection of the 30' diameter sections in the lower Nevada tunnel will be started early in January 1935. Erection of the 13' diameter penstocks in the upper Nevada system began in August 1934.

During the year, the 14' x 8'6" branch connections leading to the 102" conduits were tested under 300 pounds hydrostatic pressure and hammer tested without leakage or drop in pressure.

A visitor's gallery was erected during the year at the west end of the field fabricating plant to furnish a good view of the various fabricating operations without danger to spectators.

CHAPTER III

OPERATION & MAINTENANCE

IN

BOULDER CITY

AND

FEDERAL RESERVATION

CHAPTER III

OPERATION AND MAINTENANCE, BOULDER CITY AND FEDERAL RESERVATION

By

Glen G. Walter, Associate Engineer

General

The operation and maintenance of Boulder City and the Federal Reservation was handled, in general, by the four departments of: Buildings and Streets, Water Supply and Sewage Disposal, Electricity and Landscaping. Automotive equipment for the project was maintained by a force of five men at the government garage. A summary of the duties and accomplishments of the various departments, during the year, is briefly given in the following paragraphs.

Buildings & Streets

The maintenance of the more than 100 Government buildings in Boulder City included all general repairs necessary to keep them in first-class condition. The three and four-room brick houses, which were the first to be occupied, were given more attention than other groups. As all rooms, except living rooms, in these houses were finished with white plaster walls, they soon became smoked and dirty, and, therefore, the kitchen, bathroom and bedrooms were painted or textoned when requested by tenant.

In a few cases, living rooms were also refinished, when badly blackened by fireplace smoke. All houses, when vacated for any reason, were thoroughly renovated, woodwork cleaned or repainted, walls retinted when necessary, and floors refinished.

All exterior woodwork on all buildings should soon be painted. Due to the hot sun and drifting sand in this locality, unprotected painted surfaces need a coat of paint now for the protection of the wood.

City streets that were paved with oil mixture are breaking up and considerable time was spent patching holes and resurfacing, using cold mix of sand mixed with one-half Bitumuls (emulsified asphalt) and one-half water. This mixture was spread with street brooms and sanded with dry blow sand. Mixing was done in a concrete mixer when large areas were to be resurfaced, and in a mortar box for smaller areas. Both methods were satisfactory. Several blocks of sidewalk were constructed with the same material, being spread from one to one and one-half inches thick, then rolled with heavy roller and roughly troweled.

The highway from Boulder City to the end of pavement near the Dam was maintained by the city street crew; using the same material as used for street repair. A considerable portion of highway fence was repainted, using white lead and oil. Repairs to fence were made when necessary.

City streets were swept by using hand brooms. Gutters in the business district were cleaned each morning except Sundays and holidays. Due to drifting sand from the desert all streets needed constant cleaning.

Water Supply

The municipal water supply system, described in previous volumes of the history, operated throughout the year under usual conditions and furnished an adequate supply of palatable water to the community.

Water pumped to storage in 1934 amounted to 287,442,500 gallons or an average of 787,300 gallons per day. Based on a population of 6,000, the daily consumption per person in Boulder City amounted to 131 gallons.

The average hardness of the river water in 1934 was 505 parts per million, which was reduced approximately 74 per cent, to an average of 131 p.p.m., by the filtration plant. The coli-eschrischia index of the finished water averaged 0.00135.

Water Distribution

The water distribution system in Boulder City was 100 per cent metered, and a total of 828 water meters was in use at the close of the year, which included 770 5/8", 16 1", 35 1½", 6 2", and 1 6" meter. The 6" meter supplied water to 224 houses owned by Six Companies Inc. Meters were read on the 25th-26th of each month.

A total of 93 fire hydrants was in use. These were inspected and flushed every 60 days.

All plumbing repairs, grease trap cleaning and sewer maintenance in Government buildings and residences were handled by a crew of two men who also maintained and operated the water distribution system.

Sewage Treatment and Disposal

The sewage treatment and disposal plant was in continuous operation throughout the year. The non-odorous settled sewage was discharged as heretofore and used by a real estate lessee for irrigation of a small plot of ground, where he produced pasturage for milk cattle for his own personal use.

The settled solids of the raw sewage contained 96.2% moisture, 3.8% dry solids of which 37.4% were ash, and 62.4 volatile matter. During digestion they produced 3,122,300 cubic feet of gas with a heating value of approximately 750 B.T.U. per cubic feet equivalent to about 84 tons of bituminous coal, after digestion they yielded 13,459 cubic feet of sludge, containing 90% moisture, 10% dry solids of which 63.3% were ash, and 36.7% volatile matter. The digested sludge was air drying and then used by the Landscaping Department for humus and fertilizer for the government lawns and parks.

Electrical

During the year 1934 there was no important construction work carried on by this department. The small electrical force employed was occupied on maintenance and operation work.

The distribution system in some cases required the changing of existing transformers to supply increased load demands. Several secondary lines were extended, and six more street lights were installed.

The telephone and power lines were patrolled once each month by a man on foot, who traveled from Boulder City to the Dam substation, and from substation to No. 1 Pumping Plant. All lines were carefully inspected to determine the condition of poles, cross arms, insulators, pins, guys and bolts. Reports were made on the inspection, after which the line gang made all necessary repairs.

Several times during the year the oil in the transformers at substations and on the distribution system was checked and when necessary was replaced or filtered as required to keep it at the proper dielectric strength.

Due to the extreme climatic conditions, considerable trouble was experienced by poles checking or splitting open. To save the expense of replacing such poles, bands made from 3/16" x 2" strap iron were formed in the government shop and about 75 per cent of all poles were banded by using one to four bands on each pole.

All pole butts were treated with creosote when installed, but during the year considerable dry rot was noted developing below ground surface.

The increase in the number of houses in Boulder City made it necessary to purchase 72 more electric meters, bringing the total of electric meters used by the Government to five hundred and twenty-five (525). This figure does not include meters on any of the Six Companies Inc. houses.

Due to the constant turn-over of labor, meter connections and disconnections were unusually heavy, and one man was required almost constantly for this work and the maintenance of meters.

Monthly inspection was made of all government motors operating in public buildings, and testing laboratories, at which time they were cleaned and oiled and any necessary repairs made.

The heating plants in the Administration Building, Municipal Building and the School Building were given a thorough overhauling and operating repairs made as required.

The maintenance of the telephone system was rather difficult at times due to trouble from electric storms or by telephone lines becoming crossed up with the power lines at the damsite, resulting in injury to parts of the automatic telephone exchange and lightning arresters and interrupting telephonic service for short intervals. On one occasion a bank of transformers was carried into the bottom of the canyon by a land slide, carrying the high tension lines against the telephone lines which were connected into the automatic exchange at the time. Some damage was caused, and the exchange was put out of service for several hours.

Street light replacements were quite heavy due to heavy winds at certain seasons and breakage by boys throwing stones and using air rifles.

Interruptions to electric service during the year have amounted to 5 hours, 41 minutes. This includes the pre-arranged shut-downs, as well as the unavoidable interruptions. Before a pre-arranged shut-down, a careful inspection was made of all the high tension electrical equipment, and arrangements made for repairs during this interval, thus avoiding any unnecessary interruptions of service.

The Nevada-California Power Company delivered a total of 65,130,000 kwh of electrical energy to the project in 1934, of which 52,832,275 kwh were received at the dam substation by the Six Companies Inc., and 12,297,725 kwh by the Government. The Babcock & Wilcox Company required 3,080,400 kwh for use in the fabrication plant and office. Boulder City used 7,168,000 kwh of which the Six Companies Inc. received 2,736,000 kwh from the Boulder City substation over circuit No. 2, which supplies the contractor exclusively. Government public buildings, including all interactivities except street lights, required 229,354 kwh. The street lights consumed 227,660 kwh, private customers, exclusive of Six Companies Inc., used 1,017,005 kwh and Government employees 588,710 kwh.

Landscaping

The small government force employed in landscape gardening in 1934 has been engaged almost entirely on maintenance. This has involved the watering, fertilizing, mowing, and reseeding lawn areas as necessary on approximately ten acres of public grounds, and included supervisory care and maintenance of the lawn area and plant materials which occupy the grounds of 100 government owned residences.

The government employees occupying government owned homes have whole-heartedly and with no little enthusiasm and pride complied with the project requirement that general care of lawns and upkeep around the premises of the individual home be done by the householder. Due to exigencies of the climate, the care of lawns involves daily watering and in generous quantity. While consequent high water bills have increased personal outlay for household expense, yet it is believed the advantage of green lawn and generous growth of plant materials has increased the "joy of living" under desert conditions quite materially.

The largest single activity in maintenance of public grounds is that of irrigation. A metered 53,000,000 gallons of water was distributed through the sprinkler systems to the lawns, and an estimated 4,375,000 gallons of water was distributed to the street shade trees by tank truck. A graphical chart showing water consumption for public ground landscaping in 1934 will be found at the end of this article.

Problems of fertilization have been worked out to include the use of dried and pulverized sludge and the commercial fertilizers less fillers.

Sludge was obtained from the local disposal plant, sun-dried in shallow beds and ground in a ball mill with maximum coarseness of one-half inch diameter. The pulverized material mixed half and half with blow sand was found ideal for use as a complete fertilizer applied directly on grass as a top dressing. Application of the mixture was at the rate of one pound to three square feet. This top dressing holds moisture well. New seeding was remarkably successful when seed was sown on the prepared area and then covered with sludge-sand dressing. Limited quantities of sludge available restricted its use to new work and problem lawns.

The commercial fertilizers, ammonium sulphate, treble super-phosphate, and muriate of potash were used for regular seasonal feeding. Twenty-five pounds of ammonium sulphate and one-fourth pound potash were dissolved in 100 gallons of water. The solution was applied evenly to 1500 square feet of lawn from the mixing tank by force pump through garden hose. Early spring and early fall seasons seemed the best times to apply the solution. Super-phosphate was applied in dry form with a mechanical spreader. Two pounds per 100 square feet were estimated to be sufficient for a two-year period. Heavy irrigation, necessary in this climate, has caused some loss of food by washing.

Plant materials, trees, shrubs, and grass have two periods of growth and two periods of dormancy in this desert location. The normal winter period of dormancy when a plant "rests" is extremely short. The abnormal summer period of dormancy, caused by extremely high air temperatures, is comparatively longer in duration. A heavy growth is put on all plant materials in a long fall season and a normal spring growth is pinched off by early approach of summer heat. This upset of plant metabolism is not conducive to successful growth and limits varieties grown. Shade trees most successfully grown are three in number, namely: Carolina poplar, black locust, and Chinese elm.

The lawn planting and reseeding program was, by experience, narrowed to the use of "short-seeded domestic rye" grass seed, with white Dutch clover as the most satisfactory turf. Seed was sown at the rate of one pound to 100 square feet, being mixed 80 per cent rye and 20 per cent clover. The rye must be mowed carefully and often to prevent it seeding and becoming coarse. In this climate the rye was largely perennial in character. The clover returns nitrogen to the soil and holds up well under temporary drouth conditions, adding to the richness of color in the lawn during the long summer. The clover will not stand traffic, and a 100 per cent clover turf was found undesirable.

As the year closed, plans were being made to transplant the street trees from the contractors' area to the permanent section of the townsite, replacing losses therein and adding to the density of shade tree planting that now exists. This arrangement takes advantage of growth obtained on the plant materials during the past three years and occasions no loss for the reason that abandonment of the contractors' area is contemplated upon completion of the project.

Public use and appreciation of the public areas, in particular the park adjacent to the Administration Building, have increased many fold during the past year. Workmen on the project have been afforded pleasurable recreational areas on the long grassy slopes in which to spend their hours off work. The absence of disagreeable sand storms in the permanent section, where due to landscape development the sand was covered with lawn, has been marked.

Comment by project visitors continues to indicate that Boulder City is truly an oasis, in deep contrast to the numerous miles of desert waste in the adjoining areas, through which one must travel to enter the community.

Maintenance of Automotive Equipment

Forty-five motor vehicles were being maintained at the government garage on December 31, 1934. These comprised two busses, six trucks, twenty station wagons, six pick-ups, ten passenger cars and one motorcycle.

The cars and busses furnished necessary transportation for approximately 240 government employees, and the trucks hauled miscellaneous freight, including water for irrigating street trees.

Gasoline consumed in 1934 amounted to 40,803 gallons, and oil 1,336 gallons. The annual cost of maintenance and operation (including depreciation) amounted to $0.112 per mile for busses and trucks and $0.044 per mile for other vehicles. The total 1934 mileage for all vehicles was 435,607 miles.

Image
Coming
Soon

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Oversized
Material

Image
Coming
Soon

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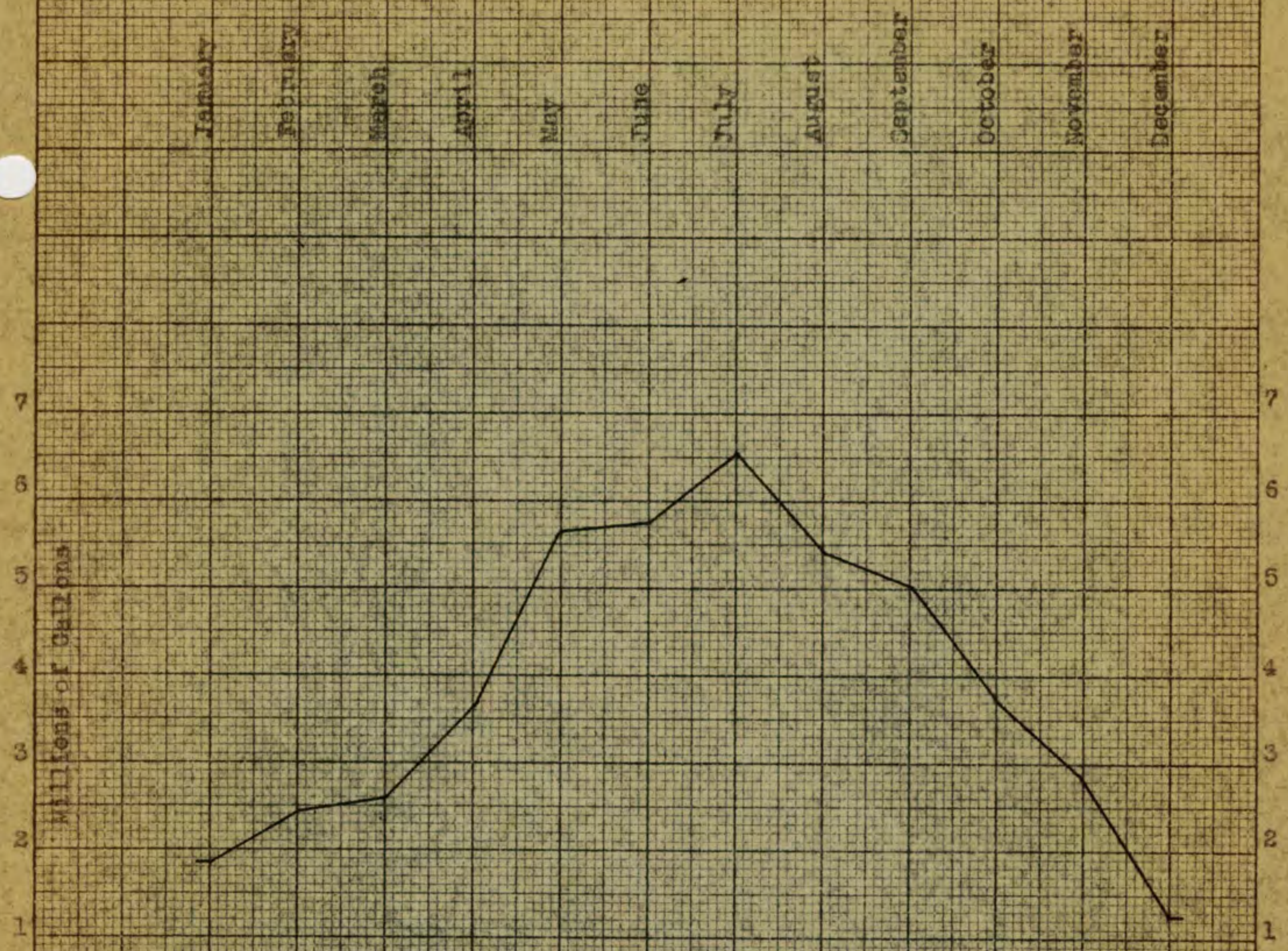
Oversized
Material



WATER CONSUMPTION

PUBLIC GROUNDS LANDSCAPING

1934

High: July, 6,553,000 gallons
Low : December, 1,196,000 gallons

APPENDIX

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INDEX TO APPENDIX

To be prepared June 30 and December 31

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

7-888
March, 1925
SUMMARY OF CONSTRUCTION RESULTS

State of Arizona-Nevada — Boulder Canyon *Project*
Boulder Dam

Results of Reclamation Work from June 30, 1902, to December 31, 1934

Irrigable lands	Acres	Farms*
Estimated total for completed project (see Notes on back).		
Area for which the Bureau can now supply water (see Notes).		
Under water-right applications (public notice), season of 193		
Under rental contracts or other arrangements, season of 193		
Actually Irrigated, season of 193 (see Notes).		

* Estimated where data not available.

Original available reservoir capacity, acre-feet

Canals, miles — With capacities in second-feet:
- More than 800
- From 301 to 800
- From 50 to 300
- Less than 50
- Total canals

Waste water ditches, miles

Land drains, miles (Exclusive structure drains): Open; Closed

Total waste water ditches and drains

Grand total, canals and drains

Tunnels: Number 93; Total length, feet 37,597

Storage dams, volume, cu. yds.: Masonry; ~~Earth~~ Concrete 3,099,260; Rock fill; Total 3,099,260
Number 1 — Under Construction

Diversion dams, volume, cu. yds.: Masonry; Earth; Rock fill; Crib; Total. Number

Dikes or levees: Total length, feet; Volume, cubic yards

Canal structures, number (exclusive of dams and tunnels, but including bridges, culverts, pipes, flumes, etc.):
- Costing over $2,000 each: Concrete; Wood
- Costing from $500 to $2,000 each: Concrete; Wood
- Costing from $100 to $500 each: Concrete; Wood
- Costing less than $100 each: Concrete; Wood
- Total

Bridges	Steel	Combination	Wood	Concrete	Total
No. Length over 50 ft.			2		2
No. Length under 50 ft.			1		1
Total length ft			156		156

Culverts	Number	Length, ft.
Concrete		
Metal	101	6,781
Terra cotta		
Wood		
Total	101	6,781

Pipe, feet laid	Pressure	Culvert	Drain land	Drain structures	Total
Concrete				29,305	29,305
Metal	4,065,532	6,781		78,552	4150,865
Terra cotta	69,430			2,580	72,010
Wood					
Total	4,134,962	6,781		110,437	4252,180

Flumes: Concrete, number ; length, ft. — Metal, number ; length — Wood, number ; length — Total ; length

Canal lined, miles: Concrete; Wood

Buildings, number:
- Offices 2
- Residences & Dormitories 102
- Power plants 0
- Pumping stations 3
- Barns and storehouses, etc. 11
- Total 118

Wells, irrigation and others (number)
aggregate depth (ft.)

Roads, construction and permanent, miles 23.4

Railroad track, miles 10.225

Telephone lines, miles 56.1 Telephones, number 56

Transmission lines, constr'n and perm., miles 19.6

Water power developed at turbine, H. P 0

Material excavated, cubic yards, including canals, tunnels, dams, dikes, structures, etc.:
- Class 1 2,787,086
- Class 2 53,080
- Class 3 4,823,236
- Total 7,663,402

Riprap, cubic yards 231,306

Paving, square yards 9,747

Gunite, square yards 5,810

Stone masonry, cubic yards 12,639

Concrete, cubic yards 4,049,361

Cement used, barrels (including used in manuf'g) 4,576,119

APPROVED:
Walker R. Young
~~Project Superintendent~~ Construction Engineer

(See instructions on other side)

CORRECT (checked against previous report):
John C. Page
Office Engineer.

U. S. GOVERNMENT PRINTING OFFICE: 1930 6—7976

INSTRUCTIONS

TIME FOR RENDERING REPORTS.—Reports on this form should be rendered promptly after June 30 and December 31 of each year, one advance copy to be sent direct to the Washington Office, and other copies to accompany the material for the annual reports. **Promptness in forwarding the advance copy is of importance. In case of doubt as to the meaning of classifications or instructions, data should be transmitted with explanations so that classification can be made in the Washington Office.**

GENERAL.—**No decrease** should be reported in any construction data. This report should include data on **all** systems built or acquired.

ABANDONED FEATURES.—Abandoned canals and features should be included in the total data reported, and a footnote giving features of same separately may be added, if desired.

IRRIGABLE LANDS.—The areas reported should include all lands irrigable from canals constructed or purchased by the Bureau of Reclamation or incorporated into the project by contract. The area of nonirrigable lands should be excluded. Under "Estimated total for completed project," report the area that can probably be irrigated when the project is completed. The "Actual irrigated" data for December 31 should be the same as that in the current O. and M. report and the data for June 30 should be an estimate for that season. The other figures under "Irrigable lands" should be consistent with this data. Under "Area for which the Bureau can supply water," "Area irrigated," etc., report the area for the irrigation season of the calendar year for which the report is rendered. Give the number of **Farms,** estimating where necessary.

RESERVOIR CAPACITY, CANALS, AND STORAGE DAMS.—Quantities reported under "Original **available** reservoir capacity," "Canals," etc., and "Storage dams," etc., should include all such works that have been constructed or purchased by the Bureau of Reclamation or incorporated into the project by contract.

CULVERTS AND PIPE.—The length of pipe under "Culverts" and in closed drains should also be included under "Pipe."

BUILDINGS.—In reporting the number of buildings, minor permanent buildings costing less than $200 each, and temporary camp buildings, should be excluded.

EXCAVATION.—Reports of "Material excavated" should include **all** excavation **of every kind** for canals, tunnels, dams, dikes, levees, roads, structures, etc. Excavation for betterments should be included, but not reexcavation, as in cleaning canals. The classification should be approximately as follows:

Class 1. Material that is loose and can be handled with scrapers and material that can be plowed by a 6-horse team, each animal weighing not less than 1,400 pounds, attached to a suitable plow, all well handled by at least three men; also loose rocks in pieces not exceeding 2 cubic feet in volume occurring in loose material that can be thus plowed.

Class 2. All material not included in classes 1 and 3.

Class 3. Rock in place that can not be removed without the use of powder and detached masses of rock exceeding 10 cubic feet in volume.

RIPRAP AND PAVING.—All work of channel or slope protection by means of loose rock not hand placed should be reported as riprap, and similar protection by means of rock placed by hand should be reported as paving, both grouted and ungrouted paving being included.

CONCRETE.—The quantity reported should include all concrete placed in dams, canal structures, bridges, bridge abutments and piers, buildings, canal and tunnel lining, and structures of every kind.

6—7976

REMARKS

PROJECT MEMORANDUM NO. 120

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOULDER CITY, NEV.

January 12, 1934

From: Construction Engineer

To: All Bureau of Reclamation Employees

Subject: Protection of visitors being taken over the job - Boulder Canyon Project

1. Now that the Hi-Mix concrete plant is operating at capacity, the roadway between the government cableway and the Nevada spillway has become so congested that there is considerable hazard attached to taking visitors along this roadway.

2. Until further notice, Bureau employees will refrain from driving automobiles further than Lookout Point except when necessary in the performance of duty. Women or children are not to be taken past Lookout Point except with special permission which under certain circumstances may be secured at the Administration office. When visiting men are taken along this roadway by guides, they should be divided into parties small enough to insure proper handling and protection. It will be necessary for guides to be strict in "herding" their parties at this point as well as at others where a visitor may be injured or interfere with the contractor's operations.

- - -

Walker R. Young

Walker R. Young

Bulletin Board Ad. Building
" " Municipal "
" Boards Dormitories No. 1 & 2
Copies to: Field Engineer
Office Engineer
Chief Clerk
Mr. Nelson
Bert A. Hall
Paul A. Jones
John Rohrer
G. L. Yetter
Six Companies Inc.
The B & W Co.

PROJECT MEMORANDUM NO. 128

UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

BOULDER CITY, NEV.

August 13, 1934

From Construction Engineer

To All Concerned

Subject: Nomenclature for Construction Features.

1. In order to secure uniformity in all reports, the various features of construction will be designated by the names given below.

Name	Description
Diversion Tunnel No. 1	Nevada Outer Tunnel
" " " 2	" Inner "
" " " 3	Arizona " "
" " " 4	" Outer "
Nevada Spillway Raise No. 1	Nevada Spillway Inclined Tunnel
Arizona Spillway Raise No. 4	Arizona Spillway Inclined Tunnel
Intake Tower No. 2	Nevada Upstream
" " " 5	" Downstream
" " " 3	Arizona Upstream
" " " 6	" Downstream
Penstock Header Tunnel No. 5	Nevada 37' Tunnel
Raise No. 2	Incline Tun. to Tower No. 2
Penstock Header Tunnel No. 6	Arizona 37' Tunnel
Raise No. 3	Incline Tun. to Tower No. 3
Upper Nevada Construction Adit	26' x 43' Adit
Tower " " "	" " "
Upper Arizona " "	" " "
Lower " " "	" " "
Nevada Penstocks	Nevada 18' Tunnels
Nevada Penstock Passageways...	Shafts and adits from power house to penstocks and between penstocks

Name	Description
Nevada Penstock Passageway Stair Wells	Stair wells in Penstock Passageways
Nevada Power House Stair Wells from Power House to Penstock Passageways	
Arizona Penstocks	Arizona 18' Tunnels
Arizona Penstock Passageways.	Shafts and adits from Power House to Penstocks and between Penstocks
Arizona Penstock Passageway Stair Wells	Stair Wells in Penstock Passageways
Arizona Power House Stair Wells from Power House to Penstock Passageways.........	
D.S. Plug Tunnel No. 2	Downstream Plug in Nevada Inner Diversion Tunnel
U.S. " " " 2	Upstream Plug in Nevada Inner Diversion Tunnel
Plug " " 1	Plug in Nevada Outer Diversion Tunnel
D.S. Plug " " 3	Downstream Plug in Ariz. Inner Diversion Tunnel
U.S. " " " 3	Upstream Plug in Ariz. Inner Diversion Tunnel
Plug " " 4	Plug in Ariz. Outer Diversion Tunnel
Nevada Outlet Tunnels	11' Horseshoe Tunnels to Valve House
Arizona " "	11' " " " "
Nevada Valve House	Nevada Canyon Wall Outlet Works
Arizona " "	Arizona " " " "
Power House Substructure	Below Elevation 673
Power House Superstructure ..	Above " 673
Nevada V.H. Elevator Shaft ..	Elev.Shaft to Nevada Valve House
Arizona V.H. " " ..	" " " Arizona " "
Adit to D.S. Plug, Tun.No.2..	Canyon Wall to Plug
" " " " " " 3..	" " " "
Adit " U.S. " " " 2..	" " " "
" " " " " " 3..	" " " "
" from U.S.Plug No. 2 to Plug No. 1	Between Nevada Inner and Outer Tunnels
~~Nevada Stair Wells~~	
~~Arizona " "~~	
Nevada Oil Shaft	Shaft between Nev.Constr.Adits
Arizona " "	Shaft between Ariz. " "
Nevada Cableway Landings	Rim, Valve House, & Power House Landings

Name	Description
Arizona Cableway Landings ...	Valve House and Power House Landings
Control Circuit Tunnel	Power House toward Switch Yard

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Walker R. Young

Walker R. Young

Copies to:
Government Office
Mixing Plant
Government Inspectors
Six Companies Inc.

PROJECT MEMORANDUM NO. 127

Boulder City, Nevada
August 24, 1934

From Construction Engineer

To All Tenants of Government Houses

Subject Plan to be followed in assigning sleeping quarters to project visitors in private homes

1. A new plan has been worked out with reference to the assignment of project visitors who cannot secure accommodation at the Boulder Dam Hotel. It is proposed to put this plan into effect beginning with the influx of tourists this fall.

2. The Boulder Dam Service Bureau, cooperating with this office, will place transients in private homes and will maintain a list of available accommodations for this purpose. The list is to be compi_ed at this office. Providing you will have sleeping quarters available for rent by the night, please advise the Chief Clerk promptly in writing. Character of the available accommodations and number of people you are prepared to quarter must be stated. Your advice must also specify whether cots, single beds or double beds are to be used, and whether the accommodations will consist of bedrooms or spaces on sleeping porches. If no reply is filed at this office by September 15, 1934, it will be understood that you are not prepared to offer accommodations of this character. No further inquiry or follow-up letter will be sent to Bureau employees.

-oOo-

Walker R. Young

Copies to:
All tenants of Govt. houses
Chief Clerk
City Manager

PROJECT MEMORANDUM NO. 132

Boulder City, Nevada
December 17, 1934

From Construction Engineer

To All concerned

Subject Preparation of Project History for 1934 - Boulder Canyon Project

1. The persons listed below are requested to prepare the articles for the 1934 Project History that are placed under their names:

Construction Engineer Walker R. Young
Articles in Chapter I - "Introductory & General"
A. General description of project
B. Summary of important events
C. Summary of reports of Boards of Engineers
D. Orders and Public Notices
F. Future Needs of the Project

Office Engineer John C. Page
Articles in Chapter I - "Introductory & General"
E-2 Office Engineering
E-9 Future Work Proposed

Field Engineer Ralph Lowry
Article in Chapter II - "Construction"
A. Construction of Boulder Dam, Power Plant and appurtenant works.

City Manager Sims Ely
Article in Chapter I - "Introductory & General"
E-3 Administration of Boulder City

District Counsel J. R. Alexander
Article in Chapter I - "Introductory & General"
E-4 Legal Work - Acquisition of Lands

District Counsel Richard J. Coffey
Article in Chapter I - "Introductory & General"
E-4 Legal Work - General

Chief Clerk Earle R. Mills
Article in Chapter I - "Introductory & General"
E-1 Clerical Features

Engineer G. L. Yetter
Article in Chapter II -"Construction"
B. Fabricating and Erection of Steel Penstock and Outlet Pipes

Engineer Grant Bloodgood
Article in Chapter I - "Introductory & General"
E-5 Surveys

Associate Engineer G. G. Walter
Article in Chapter III - "Operation & Maintenance"
A. Operation and Maintenance of Boulder City and Federal Reservation

Associate Engineer W. D. Wood
Article in Chapter I - "Introductory & General"
E-7 Concrete Control

Assistant Engineer D. M. Forester
Article in Chapter I - "Introductory & General"
E-8 Health and Sanitation

Senior Hydrographer Leo E. Dunbar
Article in Chapter I - "Introductory & General"
E-6 Hydrometry and Meteorology

2. Associate Engineer W. R. Nelson is responsible for compilation of the history, and, if desired, may be called upon to assist in the preparation of the articles.

3. As the project history is expected to be completed early in February, your contribution should be submitted by January 15.

-oOo-

Walker R. Young
Walker R. Young

CC Walker R. Young
John C. Page
Ralph Lowry
Sims Ely
J. R. Alexander
R. J. Coffey
Earle R. Mills
G. L. Yetter
G. G. Walter
Grant Bloodgood
W. D. Wood
Don M. Forester
Leo E. Dunbar
W. R. Nelson

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

7—330
(October, 1923)

WEATHER CONDITIONS

PROJECT Boulder Canyon STATION Boulder City YEAR 1934

MONTH	TEMPERATURE—°F.			PRECIPITATION			Evaporation (inches)	Total wind movement (miles)	SKY		
					Greatest 24-hour				Number of Days		
	Max.	Min.	Mean	Total (inches)	Amount (inches)	Date			Clear	Part Cloudy	Cloudy
January,	69	35	49.5	0.30	0.3	1st			28	2	1
February,	70	41	55.6	0.23	0.23	22nd			16	10	2
March,	88	47	66.6						28	3	
April,	93	41	72.7	0.40	0.39	15th			27		3
May,	105	52	79.5						26	3	2
June,	110	50	80.1	0.19	0.17	5th			26	1	3
July,	112	64	90.8	1.18	0.77	23rd			21	6	4
August,	106	68	86.8	0.30	0.13	19th			13	13	5
September,	105	51	81.3						28	1	1
October,	94	51	72.5	0.06	0.05	17th			23	5	2
November,	90	37	60.8	0.01	0.01	17th			22	6	2
December,	64	30	48.1	0.44	0.27	12th			22	7	2
The year,	112	30	70.4	3.11					280	57	27

Date of last killing frost in spring ________, of first killing frost in fall ________

Dates of serious rainfall July 23rd, of hail storms ________, of wind storms ________

Description of evaporation station: ________

Remarks: ________

6—7324

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WEATHER CONDITIONS

INSTRUCTIONS

1. A table of weather conditions shall be filled out for each project and included in the annual operation and maintenance report.

2. In case weather records are kept on the project the data from these records shall be used, but in case no such records are kept the data shall be taken from the weather report of any U. S. Weather Bureau observation station or stations applicable to conditions on the project.

U. S. GOVERNMENT PRINTING OFFICE: 1927 6—7324

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

7—330
(October, 1923)

WEATHER CONDITIONS

PROJECT Boulder Canyon STATION Damsite YEAR 1934

MONTH	TEMPERATURE—°F. Max.	Min.	Mean	PRECIPITATION Total (inches)	Greatest 24-hour Amount (inches)	Date	Evaporation (inches)	Total wind movement (miles)	SKY Number of Days Clear	Part Cloudy	Cloudy
January,	68	32	49.9								
February,	72	42	57.6								
March,	96	48	71.6								
April,	102	52	77.7								
May,	113	60	87.8								
June,	122	65	88.4								
July,	123	70	99.9								
August,	115	71	96.0								
September,	115	58	89.5								
October,	103	55	75.5								
November,	85	40	63.6								
December,	75	37	53.9								
The year,	123	32	76.9								

Date of last killing frost in spring ____, of first killing frost in fall ____

Dates of serious rainfall ____, of hail storms ____, of wind storms ____

Description of evaporation station: ____

Remarks: ____

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WEATHER CONDITIONS

INSTRUCTIONS

1. A table of weather conditions shall be filled out for each project and included in the annual operation and maintenance report.

2. In case weather records are kept on the project the data from these records shall be used, but in case no such records are kept the data shall be taken from the weather report of any U. S. Weather Bureau observation station or stations applicable to conditions on the project.

U. S. GOVERNMENT PRINTING OFFICE: 1937 6—7324

Department of the Interior
Bureau of Reclamation

7—330
(October, 1923)

WEATHER CONDITIONS

Project Boulder Canyon Station Mountain (Sub-Sta.) Year 1934

MONTH	TEMPERATURE—°F.			PRECIPITATION			Evaporation (inches)	Total wind movement (miles)	SKY		
					Greatest 24-hour				Number of Days		
	Max.	Min.	Mean	Total (inches)	Amount (inches)	Date			Clear	Part Cloudy	Cloudy
January,	73	33	51.8								
February,	77	42	59.1								
March,	96	45	72.2								
April,	105	48	78.5								
May,	110	55	86.6								
June,	118	60	86.7								
July,	120	66	98.6								
August,	116	74	94.4								
September,	114	54	87.8								
October,	101	49	74.5								
November,	83	38	62.0								
December,	69	31	50.2								
The year,	120	31	75.2								

Date of last killing frost in spring ________, of first killing frost in fall ________

Dates of serious rainfall ________, of hail storms ________, of wind storms ________

Description of evaporation station: ________

Remarks: ________

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WEATHER CONDITIONS

INSTRUCTIONS

1. A table of weather conditions shall be filled out for each project and included in the annual operation and maintenance report.

2. In case weather records are kept on the project the data from these records shall be used, but in case no such records are kept the data shall be taken from the weather report of any U. S. Weather Bureau observation station or stations applicable to conditions on the project.

U. S. GOVERNMENT PRINTING OFFICE: 1927 6—7324

Image
Coming
Soon

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UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON

June 1, 1934.

BOULDER CANYON PROJECT - QUESTIONS AND ANSWERS

DAM:

Q. Where is the Boulder Dam being built?

A. In upper Black Canyon on the Colorado River about 25 miles in an air line southeast of Las Vegas, Nevada, where the river forms the Arizona-Nevada State boundary.

Q. What does the project include?

A. Construction of a dam and power plant in Black Canyon and of the All-American Canal in southern California.

Q. What are the purposes of this project?

A. Flood control and general river regulation, irrigation, silt control, power development, and domestic water supply.

Q. What will the project cost?

A. The Boulder Canyon Project Act authorizes appropriations not to exceed $165,000,000. This amount is divided as follows: Dam and reservoir, $70,600,000; power development, $38,200,000; All-American Canal, $38,500,000; interest during construction, $17,700,000. Appropriations made to date are as follows: 1930-31, $10,660,000; 1931-32, $15,000,000; 1932-33, $23,000,000; 1933-34, $46,000,000.

Q. How high will the dam be?

A. The maximum difference in elevation between the foundation rock and the roadway on the crest of the dam will be 726 feet. The dam will raise the water surface of the river 584 feet. Towers and parapet ornamentations will extend 40 feet or more above the crest.

Q. How does this height compare with other dams?

A. The Boulder will be by far the highest dam in the world. The Sautet dam in France, now under construction, will be 446 feet in height. Next in height is the 405-foot Owyhee in Oregon, completed in 1932.

Q. What type of dam is under construction?

A. The concrete arch-gravity type, in which the water load is carried by both gravity action and horizontal arch action.

Q. What will be the length along the crest?

A. About 1,180 feet.

Q. What will be the widths up and down stream?

A. About 45 feet at the top and 660 feet at the base.

Q. What is the volume of concrete masonry?

A. About 3,250,000 cubic yards in the dam alone or 4,200,000 cubic yards in the dam, power plant, and appurtenant works. This amount of concrete would build a monument 100 feet x 100 feet and 2-1/8 miles in height or, if placed on the ordinary city block, would rise to a height greater than that of the Empire State Building in New York City (1248 feet). It would build a standard paved highway 16 feet wide extending from Miami, Florida, to Seattle, Washington. For comparison, the Bureau of Reclamation has placed in dams and canal structures a total of 5,116,000 cubic yards of concrete up to June 30, 1932. To date, mass concrete has been placed in the dam at the rate of approximately 160,000 cubic yards per month, with a peak placement of 10,462 cubic yards a day (which includes some concrete placed in intake towers and power house) and slightly over 225,000 cubic yards a month.

Q. What is the weight of the 3,250,000 cubic yards of concrete in the dam?

A. Nearly 6,600,000 tons.

Q. What will be the maximum water pressure at the base of the dam?

A. 45,000 pounds per square foot.

Q. How much cement will be required?

A. About 5,000,000 barrels. The daily demand during construction of the dam is from 25 to 36 cars (7,500 to 10,800 barrels). This Bureau has used 5,862,000 barrels in the 27 years of construction activities preceding June 30, 1932.

Q. How is chemical heat, due to setting of the cement in the mass concrete, being removed?

A. By embedding in the concrete a system of pipes containing 3,000,000 feet (570 miles) of 1 inch steel tubing, through which cooling water is run from a cooling and refrigeration plant. The plant has sufficient capacity to produce 1000 tons of ice from water at 32° F in 24 hours.

Q. What are the unusual features of construction?

A. The dam is being built in numerous vertical columns varying in size from sections approximately 60 feet square at the upstream face of the dam to 25 feet square at the downstream face. Adjacent columns are locked together by a system of vertical keys on the radial joints and horizontal keys on the circumferential joints. Concrete mixed in one or two plants, each of four 4-cubic yard mixers, is transported, generally in 8-cubic yard bottom dump buckets by train and cableway to its final location. Specifications restrict the rate of placement in any one block to a maximum height of 5 feet in 72 hours. After the concrete has been cooled, grout (cement and water) under pressure is forced into spaces opened up between the columns which are formed by the contraction of the concrete as it is cooled. Thus a monolithic structure is formed.

Q. What is the purpose of the 8-foot slot through the center of the dam?

A. To carry supply mains for the cooling system. The slot is filled with concrete as cooling in the adjacent lifts of the dam is completed. Following the filling of the slot, the contraction joints in the dam are grouted in lifts of 50 feet.

Q. What are the principal items of work?

A. Excavation (all classes), diversion tunnels, 1,500,000 cubic yards; excavation (common) for foundation of dam, power plant, and cofferdam, 1,200,000 cubic yards; rock excavation for dam foundation, 400,000 cubic yards; excavation (all classes), spillways and inclined tunnels, 750,000 cubic yards; earth and rock fill for cofferdams, 1,000,000 cubic yards; excavation (all classes), valve houses and intake towers, 410,000 cubic yards; concrete, 4,200,000 cubic yards; drilling grout and drainage holes, 315,000 linear feet; pressure grouting, 422,000 cubic feet; all excavation, more than 5,500,000 cubic yards; total earth and rock fill, more than 1,000,000 cubic yards.

Q. How much reinforcement steel will be used?

A. About 35,000,000 pounds of bars and rails.

Q. What are the estimated quantities of other principal material?

A. Gates and valves, 21,670,000 pounds; plate-steel outlet pipes, 88,000,000 pounds; pipe and fittings, 6,700,000 pounds; structural steel, 18,500,000 pounds; miscellaneous metal work, 5,300,000 pounds; cement, 5,000,000 barrels.

Q. Does the Government purchase these materials?

A. Yes. The purchasing is handled by the Bureau of Reclamation, U. S. Customhouse, Denver, Colorado.

Q. What are the geologic conditions at the dam site?

A. The foundation and abutments are rock of volcanic origin, geologically termed "andesite breccia," hard and very durable.

Q. What is the depth below low-water surface of the river to foundation rock?

A. From 110 feet to 130 feet. The lowest point of excavation in the upstream cutoff trench was at elevation 506, or 139 feet below low water surface (elevation 645).

Q. How is the site of the dam protected from water inflow?

A. By an upstream cofferdam located 600 feet below the diversion tunnel portals. This dam is an earth and rock fill structure 98 feet high, 750 feet thick at the base, 70 feet thick at the top, with steel sheet piling driven 40 to 50 feet to rock at the upper toe. On the upstream face, there is 6 inches of reinforced concrete paving and on the downstream face a layer of dumped rock. This cofferdam contains 568,000 cubic yards of earth and 157,000 cubic yards of rock. A similar cofferdam has been built just below the power plant site, which is 66 feet high, 500 feet thick at the base, and is protected downstream by a rock barrier 55 feet in height and containing 95,000 cubic yards of rock.

Q. What are the canyon widths at the dam site?

A. From 290 to 370 feet at low-water level, and from 850 to 970 feet at elevation 1,232, the crest of the dam.

Q. How long will it take to build the dam, power plant, and appurtenant works?

A. About six years at the present rate of progress. The contractors are allowed seven years from April 20, 1931, under their contract.

Q. How many men are employed by the Government and labor contractors?

A. An average number of 3,500 and a maximum of 5,000. The monthly payroll is approximately $500,000.

Q. Who has the labor contract for construction of the dam, power plant, and appurtenant works?

A. Six Companies, Inc., 510 Financial Center Building, San Francisco, California, has a unit payment basis contract under which payments amounting to approximately $49,000,000 will be made.

Q. Who has the contract for furnishing and installing plate steel penstock and outlet pipes?

A. The Babcock & Wilcox Company of Barberton, Ohio, has a unit payment basis contract under which payments will be made aggregating approximately $11,000,000.

Q. Who is in charge for the Bureau of Reclamation?

A. The Chief Engineer with headquarters at Denver, Colorado, represented by the Construction Engineer in charge of the field office at Boulder City, Nevada.

Q. What is the construction program?

A. Diversion tunnels, start June 1931, complete March 1933; Cofferdam (upstream), start September 1932, complete March 1933; Cofferdam and rock barrier (downstream), start November 1932, complete March 1933; removal complete February 1935; Excavation for dam, start October 1932, complete June 1933; Intake towers, start March 1932, complete June 1935; 37-foot penstock tunnels, start February 1933, complete May 1934; Install 30-foot diameter outlet pipes in upper tunnels, Arizona, start December 1934, complete September 1935; Nevada, start June 1934, complete June 1935; Install 30-foot diameter outlet pipes in lower tunnels, Arizona, start March 1936, complete May 1937; Nevada, start September 1934, complete March 1936; 18-foot penstock tunnels, start December 1932, complete August 1935; Install 13-foot diameter penstock pipes in branch tunnels, start January 1934, complete December 1936; Outlet works (canyon walls) start November 1932, complete September 1934; Outlet works (tunnel plugs), start July 1935, complete April 1936; Stoney gates (tunnel outlets, tunnels Nos. 2 and 3) complete August 1933; Tunnel plugs (tunnels Nos. 2 and 3, penstock tunnels) start July 1934, complete November 1934; Tunnel plugs (tunnels Nos. 1 and 4, spillway tunnels) start January 1935, complete April 1935; Concrete in dam, start June 1933, complete February 1935; Spillways, start January 1932, complete June 1934; Power plant, start December 1932, complete February 1935; Bulkheads closed (tunnels Nos. 1 and 4) January 1935.

Q. What construction work was necessary before operations were started at the dam site?

A. (1) Construction of Boulder City to house both Government and contractors' employees. (2) Seven miles of 22-foot, oil-surfaced highway from Boulder City to dam site. (3) Building 22.7 miles of standard gauge railroad from the Union Pacific main line to Boulder City, and 10 miles from Boulder City to the dam site. (4) A power transmission line 222 miles long, from San Bernardino, California, to the dam site to furnish power for construction purposes.

RESERVOIR:

Q. How much water will the reservoir hold?

A. 30,500,000 acre-feet when full. An acre-foot is the amount of water that will cover 1 acre 1 foot deep. The water in the reservoir would cover the State of New York to a depth of 1 foot. The reservoir will store the entire average flow of the river for two years. Thirty and one-half million acre-feet equal 10,000,000,000,000 gallons, or about 5,000 gallons for every inhabitant on earth, or 80,000 gallons for each person in the United States.

Q. What will be the area of the reservoir?

A. 145,000 acres or 227 square miles. For comparison, Lake Tahoe in California-Nevada has an area of 193 square miles.

Q. What will be the length and width of the reservoir?

A. It is about 115 miles by river from Black Canyon to Bridge Canyon, the limit of the backwater. The reservoir will extend up the Virgin River about 35 miles. The width varies from several hundred feet in the canyons to a maximum of 8 miles.

Q. What will be the elevation of the high-water line?

A. 1,229 feet above sea level. All lands below elevation 1,250 have been retained for reservoir purposes.

Q. How will the reservoir capacity be utilized?

A. 9,500,000 acre-feet for flood control; 5,000,000 to 8,000,000 acre-feet silt pocket; 12,000,000 to 15,000,000 acre-feet active or regulation storage.

Q. Who will operate the dam and reservoir after completion?

A. The Government will operate and maintain the dam, reservoir, pressure tunnels, outlet works, and penstocks to but not including shut-off valves at the inlets to turbine casings.

Q. How much silt will be deposited in the reservoir?

A. The estimated average volume of silt carried by the river into Black Canyon is about 137,000 acre-feet annually under present conditions, and this amount will decrease with upstream development. It is estimated that the total silt deposits in the reservoir will not exceed 3,000,000 acre-feet at the end of 50 years.

Q. Will salt deposits have an injurious effect on the water?

A. While some salt from the extensive deposits in the Virgin River Valley will go into solution, the relatively small amount should not be sufficient to cause any appreciable salinity in the water.

Q. What will be the length of the shore line?

A. About 550 miles.

Q. What is the estimated annual evaporation on the reservoir?

A. 600,000 acre-feet.

Q. Are there any private lands in the reservoir site?

A. There are 12,000 acres of private land in the Virgin and Muddy Valleys and a number of mining claims, but most of the area is Government land. All the Government land is withdrawn from entry for construction purposes. The private land is being purchased.

DIVERSION WORKS, SPILLWAYS AND OUTLET WORKS:

Q. How is river being diverted during dam construction?

A. By a temporary earth and rock fill cofferdam through four 50-foot diameter tunnels, excavated to 56 feet and lined with 3 feet of concrete (300,000 cubic yards), and driven through the rock of the canyon walls, two on each side of the river. These tunnels can carry over 200,000 second-feet of water.

Q. What is the length of these tunnels?

A. The four tunnels have a total length of 15,946 feet, or 3.0 miles.

Q. After their use for river diversion, how will the tunnels be utilized in the project scheme?

A. After being plugged with concrete at locations approximately one-third their length below the inlet ends of the inner tunnels and about midway in the outer tunnels, the two inner tunnels will contain the 30-foot steel pipes connecting intake towers in the reservoir with the penstocks to the power plant and the canyon wall outlet works; and the lower portions of the two outer tunnels will be used for spillway outlets.

Q. What gate installation is proposed for the tunnels?

A. When river diversion through the tunnels is discontinued, the inlet ends of the two outer tunnels will be permanently closed with 50-foot by 50-foot bulkhead gates. Each gate with frame weighs about 3,000,000 pounds and required 42 railroad cars for shipment. At the outlet ends of the two inner tunnels, 50-foot by 35-foot Stoney gates are installed, which may be closed when it is desired to unwater the tunnels for inspection or repairs.

Q. What are the intake towers?

A. There are four reinforced-concrete towers located above the dam, two on each side of the river and about 165 feet apart in a direction parallel with the river. These towers are 75 feet in average diameter, 375 feet in height, and each tower controls one-quarter of the supply of water for the power plant turbines.

Q. How are these towers connected to the power plant and outlet valves?

A. By 30-foot diameter plate-steel pipes installed in 37-foot and 50-foot diameter concrete lined tunnels. Thirty-seven foot inclined tunnels will connect the upstream intake towers to the 50-foot inner diversion tunnels, and 37-foot tunnels will lead from the downstream towers to penstocks and outlet works at elevation 820, 180 feet above the diversion tunnels.

Q. What method of control is used in the intake towers?

A. Two cylindrical gates, each 32 feet in diameter, and 10 feet high, one near the bottom (elevation 900) and the other near mid-height (elevation 1050) of each tower, protected by trashracks located in front of the entrances to the tower.

Q. What pipes are installed in the tunnels for reservoir outlets?

A. 4,700 feet of 30-foot diameter main headers, 1,900 feet of 25-foot diameter pipes below the branch penstock tunnels to the power plant, and 2,000 feet of 8-1/2-foot diameter pipes in 11-foot tunnels leading to the needle valve outlets. The maximum thickness of the largest pipe is almost 3 inches.

Q. How are the 30-foot pipes connected to the power plant turbines?

A. By sixteen 13-foot diameter plate-steel penstock pipes totaling 5,800 feet in length installed in 18-foot diameter concrete-lined tunnels.

Q. What are the principal items in the contract for fabrication and installation of the steel penstock and outlet pipes?

A. Forty-four thousand tons of steel will be formed and welded into 14,000 feet of pipe varying from 8-1/2 feet to 30 feet in diameter. The latter is the largest pipe constructed to date and will have walls up to 2-3/4 inches thick. One length of this pipe, 12 feet long, 30 feet in diameter, and 2-3/4 inches thick, will be made from 3 steel plates, of such weight that only 2 plates can be shipped from the steel mill to the fabrication plant on one railroad car. Two such lengths of pipe welded together comprise one erection section weighing 135 tons and at intersections with the penstocks as much as 186 tons. For comparison, the weight on the drivers of the Consolidation type of steam locomotive on the project is 99 tons. As the larger sizes of pipe cannot be shipped by railroad, the contractor has built a fabricating plant near the damsite.

Q. What is the general procedure of fabrication?

A. Flat plates are rolled to designated shapes; longitudinal and girth joints are electrically welded; butt straps, stiffener rings, supporting brackets, and other features are welded to pipe; welded joints are X-rayed; flaws are replaced by new metal; the pipes are treated in a normalizing furnace, cleaned and painted.

Q. What are the quantities of welding and X-raying film to be used during the contract?

A. Four hundred thousand lineal feet (75 miles) of arc welding and 150,000 lineal feet (28 miles) of X-ray film.

Q. What outlets are proposed?

A. Six 72-inch needle valves in each inner diversion tunnel plug outlet, and six 84-inch needle valves in each canyon wall valve house, there being one house on each side of the river at elevation 820, which is about 180 feet above river level. The valve outlets are pointed downstream at an angle of 15 degrees. Canyon wall valves will not be used except under emergency or flood conditions. Each 72 inch valve is capable of discharging a maximum of 3,670 second-feet at a velocity of about 175 feet per second.

Q. What is the total maximum capacity of these works?

A. 125,000 cubic feet per second, of which 25,000 c.f.s. is for power generation and 100,000 c.f.s. is valve discharge.

Q. What are the plans for the Arizona and Nevada spillways?

A. Each will consist of a concrete-lined open channel, about 650 feet long, 150 feet wide and 120 feet deep, with the side next to the river formed into an ogee-shaped crest. The two spillways required 600,000 cubic yards of rock excavation

Q. How is water discharged from the spillways?

A. Through inclined shafts, 50-feet in diameter and 600 feet long, into the outer diversion tunnels.

Q. What will be the maximum water velocity in the spillway tunnels?

A. About 175 feet per second, (120 miles per hour).

Q. What gate installation is proposed at the spillways?

A. Four 100-foot by 16-foot drum gates on each spillway crest controlled either automatically or manually.

Q. What is the maximum capacity of the spillways, valves and power plants?

A. 525,000 cubic feet per second. Each spillway will have a maximum discharge capacity of 200,000 cubic feet per second. Should a flood occur of sufficient volume to require the full capacity of the spillways, the energy of the falling water would be about 25,000,000 horsepower, the flow over each spillway would be about the same as the flow over Niagara Falls and the total drop would be more than three times as great.

POWER DEVELOPMENT:

Q. What will be the installed capacity of the power plant at Boulder Dam?

A. 1,835,000 horsepower (rated). For comparison, Niagara (United States) is 452,500; Conowingo 378,000 (ultimate 594,000); and Muscle Shoals 250,000 (ultimate 600,000); Dnieprostroy (U.S.S.R.) 750,000.

Q. What is a horsepower in terms of falling water?

A. One second-foot of water falling 8.81 feet equals one horsepower at 100 per cent efficiency. A second-foot of water is 1 cubic foot, or nearly 7½ gallons, passing a given point in one second of time.

Q. What will be the continuous firm power output?

A. About 663,000 horsepower, based on 83 per cent plant efficiency, and 10 per cent maximum shortage.

Q. How much electrical energy will be available yearly?

A. Four billion three-hundred and thirty million kilowatt-hours on completion of the dam (1937) and this amount, it is estimated, will decrease each year thereafter by 8,760,000 kilowatt-hours, as a result of upstream development.

Q. What is a kilowatt-hour?

A. The energy resulting from an activity of 1 kilowatt for one hour. A kilowatt is 1,000 watts. One horsepower equals 0.746 kilowatt. 663,000 (horsepower) x 0.746 x 24 (hours) x 365 (days) = 4,330,000,000 kilowatt-hours.

Q. How will the income from sale of power be used?

A. To pay all expenses of operation and maintenance of works incurred by the United States and the cost of construction of dam and power plant, with interest at 4 percent, within a 50-year period. Excess revenues above amortization requirements will be allocated as follows: 62½ percent to flood control ($25,000,000), repayment and 18-3/4 percent to Arizona and 18-3/4 percent to Nevada. After repayment to the United States of all money advanced, with interest, revenues will be kept in a separate Colorado River Basin fund.

Q. Where will the power plant be located?

A. Just below the dam, one-half on the Nevada side of the river and one-half on the Arizona side, forming a U-shaped structure, built of steel and reinforced concrete. Each wing is 650 feet long, 130 feet high above normal tailrace water surface, and 230 feet (nearly 20 stories) above the lowest concrete in the powerhouse footings.

Q. How will the water reach the turbines?

A. Through four pressure tunnels, two on each side of the river, each provided with shut-off gates and trash racks.

Q. What will be the principal machinery installations?

A. Plans call for fifteen 115,000-horsepower and two 55,000-horsepower vertical hydraulic turbines; fifteen 50-cycle main generating units of 82,500 kv.a. capacity each, and two 60-cycle main generating units of 40,000 kv.a. capacity each. The larger units exceed in size the largest yet manufactured, namely, the 83,000-horsepower turbines and 76,500-kilovolt-ampere generators in the Dnieprostroy plant in Russia.

Q. What facilities are provided for transporting power plant machinery from the canyon rim to the power plant?

A. A permanent cableway of 150 tons normal capacity, electrically operated, with a span of 1,200 feet across the canyon, will be used to lower not only power plant machinery, but also outlet pipes and other machinery, materials and equipment.

Q. What is the maximum load to be carried by the track cables?

A. More than 200 tons, including the weight of the track carriage, fall blocks, and hoisting cables.

Q. What are the prominent features of the government cableway?

A. The cableway track of six 3-1/2-inch diameter cables at 18-inch centers; the track carriage with 48 track wheels and weighing 19 tons; the fall blocks weighing 5 tons; a 90-foot structural steel head tower; anchorages for the track cables in tunnels 50 feet to 80 feet in length, filled with concrete; 2 hoist drums, each 13 feet in diameter and 17 feet long, each carrying a mile of cable in one layer on the drum; power supplied through a motor generator set to 175 and 400 H.P.D.C. motors; operation of the cableway by remote control from any one of 5 stations.

Q. Who furnished and erected the cableway?

A. The Lidgerwood Manufacturing Company of Elizabeth, New Jersey, the contract price being $172,110.00.

Q. Under what heads will the turbines operate:

A. Maximum head, 590 feet; minimum head, 420 feet; average head, 530 feet.

Q. What is the estimated cost of the power development?

A. $38,200,000, not including interest.

Q. What will be the charge for primary or firm power?

A. One and sixty-three one hundredths mills per kilowatt-hour for falling water in terms of energy measured at transmission voltage.

Q. How much secondary or dump power will be available yearly?

A. One billion five hundred and fifty million kilowatt-hours on completion of the dam (1937) and this amount decreasing each year by 8,600,000 kilowatt-hours.

Q. What will be the charge for secondary or dump power?

A. One-half mill per kilowatt-hour for falling water in terms of energy measured at transmission voltage.

Q. Are these rates subject to adjustment?

A. Yes, at the end of 15 years from date of execution of lease and every 10 years thereafter the rates may be readjusted.

Q. How much revenue will be derived from the sale of power?

A. For the first year of operation, the income would be $7,057,900 from the sale of 4,330,000,000 kilowatt-hours of primary energy at $0.00163 and $775,000 from the sale of 1,550,000,000 kilowatt-hours of secondary energy at $0.0005. The amount of income will decrease each year thereafter. The estimated annual income from firm energy will average about $6,550,000 and from secondary energy $650,000 over the 50-year repayment period.

Q. What is the estimated total gross power revenue for the 50-year period?

A. $361,000,000.

Q. How much of this is surplus, after allowing for operation and maintenance, interest, depreciation, and payments for retirement of investment?

A. $166,500,000.

Q. How will this surplus be divided?

A. United States $104,000,000 (62-1/2%); Arizona, $31,200,000 (18-3/4%); Nevada, $31,200,000 (18-3/4%). This will give an average yearly payment of $620,000 to each State.

Q. What disposition will be made of the Government's share?

A. $37,500,000 will be used for payments for retirement of $25,000,000 allocated to flood control with interest at 4 percent. $66,500,000 will go into a fund to be expended within the Colorado River Basin as prescribed by Congress.

Q. Who will operate and maintain the power plant?

A. The City of Los Angeles and the Southern California Edison Company, under the general supervision of a director appointed by the Secretary of the Interior. The city will generate power for the States, municipalities and the Metropolitan Water District. The Southern California Edison Company will generate power for company purchasers.

Q. When will the first units go into operation?

A. In September 1935.

Q. What is the allocation of firm power?

A. State of Arizona, 18 percent; State of Nevada, 18 percent; Metropolitan Water District, 36 percent; smaller municipalities, 6 percent; City of Los Angeles, 13 percent; Southern California Edison Company, 9 percent. All secondary energy is allocated to the District; also so much of the firm energy allocated to the States, the City and the Company as may not be in use by them.

Q. How is the machinery in the plant to be paid for?

A. Machinery and equipment for the generation of power costing about $17,700,000 will be furnished, installed and owned by the Government. This will consist of generating, transforming and high-voltage switching equipment. The contractors will pay in 10 equal annual installments an amount sufficient to amortize this total cost.

Q. How will power be transmitted to market?

A. Contractors for power will provide transmission facilities at their own expense. The Southern Sierras Co. has built such a line to Riverside, California, and the City of Los Angeles has a line under construction.

Q. Who will pay the cost of transmission of power?

A. The contractors who purchase the power.

WATER ALLOCATION:

Q. What is the allocation of water under the Colorado River compact?

A. Based on a mean annual run-off of 16,000,000 acre-feet, the compact allocated 7,500,000 acre-feet to the upper basin States and 7,500,000 acre-feet to the lower basin States, with the right of the latter to increase their beneficial consumptive use of such water by 1,000,000 acre-feet per annum.

Q. How much of the water allocated to the lower basin States does California get?

A. California has agreed that the aggregate annual consumptive use of the river water shall not exceed 4,400,000 acre-feet of the 7,500,000 allocated to the lower basin by Article III (a) of the compact. In addition, California can use one-half of the surplus waters available above the 7,500,000 acre-feet allocated.

Q. How much water is allocated to Nevada and Arizona?

A. The Boulder Canyon Project Act authorizes Arizona, California, and Nevada to enter into an agreement which shall provide that Nevada gets 300,000 acre-feet and Arizona 2,800,000 acre-feet for exclusive beneficial consumptive use; also, that Arizona may annually use one-half of the surplus water unapportioned by the compact and, in addition, shall have the exclusive beneficial consumptive use of the Gila River and its tributaries within the State. Such an agreement has not yet been made.

Q. What agreement as to division of water has been made by the various California interests?

A. (1) 3,850,000 acre-feet of water per annum for beneficial consumptive use to agricultural interests, as follows: First, to Palo Verde Irrigation District, 104,500 acres; Second, to Yuma (Federal) irrigation projects, 25,000 acres in California; remainder to lands in the Imperial and Coachella Valleys served from the All-American Canal and to 16,000 acres on the Lower Palo Verde Mesa; (2) the next 550,000 acre-feet to the Metropolitan Water District; (3) the next 662,000 acre-feet to the Metropolitan Water District (550,000) and San Diego (112,000); (4) the next 300,000 acre-feet to the Imperial and Coachella Valleys and to 16,000 acres on the Lower Palo Verde Mesa; (5) remainder for agricultural use in the Colorado River Basin in California.

RIVER FLOW:

Q. What has been the greatest measured discharge of the Colorado River?

A. Two hundred and forty thousand cubic feet per second, measured at Yuma, Arizona.

Q. Have there been any larger floods?

A. A maximum flood of 300,000 cubic feet per second, it is believed, might have been the flow for a short period in 1884.

Q. What has been the smallest measured discharge?

A. Sixty-six cubic feet per second, measured at Yuma, Arizona.

Q. What is the discharge at the dam site?

A. The average is 22,000 cubic feet per second, with an average annual run-off of 15,700,000 acre-feet.

Q. What will be the maximum flood discharge after completion of the project?

A. The largest flood since 1900 would be held to 48,000 cubic feet per second below the dam and 35,000 cubic feet per second in the delta region. An 1884 flood would be reduced to an outflow of 75,000 cubic feet per second.

IRRIGABLE AREAS:

Q. How much irrigable land is there below the Boulder Canyon reservoir, in the United States?

A. About 2,000,000 acres, according to preliminary estimates.

Q. How is the area divided between the States?

A. Arizona 800,000 acres; California 1,200,000 acres; Nevada 15,000 acres. These areas may be changed materially when more complete surveys are made.

Q. What is the present area under irrigation from the Colorado River below the dam site?

A. About 660,000 acres, divided as follows: California 600,000, Arizona 60,000.

Q. What are some of the possible projects in Arizona?

A. The Gila River Valley with a gross area of about 600,000 acres in the southwestern part of the state, the Colorado River Indian project of about 116,000 acres near Parker, and the Mohave Valley with an irrigable area of 33,000 acres near Needles, California. The Yuma project adjacent to the City of Yuma is an active Federal project, with about 55,000 acres irrigated at the present time, and a total ultimate irrigable area of 112,000 acres, including about 45,000 acres of undeveloped mesa lands.

Q. What are the principal California projects which may be benefited?

A. The Imperial Valley has a present irrigable area of 522,000 acres and about 850,000 acres of valley and adjacent mesa lands can be irrigated under the All-American Canal. The Coachella Valley near Indio has an irrigable area of 150,000 acres, which can be served by a branch of the All-American Canal. In and adjacent to Palo Verde Valley near Blythe about 100,000 acres will be benefited.

Q. Where is the irrigable acreage in Nevada?

A. Areas aggregating about 10,000 acres may be irrigated by pumping along the Colorado River near Searchlight and from the Boulder Canyon Reservoir near Las Vegas.

Q. What is the approximate classification of the irrigable lands?

A. Public, 44 percent; private, 40 percent; State, 1 percent; railroad, 2 percent; Indian, 8 percent; and entered 5 percent.

BOULDER CITY:

Q. Where is the town of Boulder City located?

A. The location is about 6 miles west of the dam site, at the summit and near the terminus of the Union Pacific section of the branch railroad.

Q. What is the source of the domestic water supply?

A. Water is pumped from the Colorado River to the town, a distance of nearly 7 miles, with a total lift of about 2,000 feet. The intake is about 3,500 feet downstream from the dam site on the Nevada side. The water first goes to a presedimentation basin 100 feet above river level, then to a 100,000 gallon receiving tank at Boulder City, from there to a filtration and purification plant, and finally to a 2,000,000-gallon storage tank.

Q. What other improvements were necessary?

A. A sewerage system and electrical distribution system have been installed; sidewalks and curbs have been provided and streets surfaced and paved.

Q. What was the building program?

A. Government employees, principally engineers, inspectors, and clerks required two dormitories, and 100 houses for living quarters. The Government has also erected an office building, municipal building, school, warehouse, and garage.

Q. Do employees of the contractors on the dam and power plant live in the town?

A. Yes. A portion of the town has been set aside for the contractors' use. The contractors arrange for the housing of their workmen, with construction subject to Government approval. They have built mess halls, dormitories, hospital, clubhouse, commissary, machine shop, storehouses, garage, laundry, and 700 employees' cottages. The twelve great dormitories are heated in winter and artificially cooled in summer and are equipped with electric lights, running water and shower baths.

Q. Who owns the lands in the town site?

A. The government owns the land, all of which is under first form of withdrawal.

Q. How can one obtain a town lot for business purposes?

A. The land is leased for a 10-year term to those awarded business permits, the Government to retain ownership and supervisory control. Continuation of the leases is contingent upon compliance with the terms of the contract.

Q. What is the population?

A. About 5,000, which will hold during the construction period, making it the third largest city in the State of Nevada.

Q. Will this town be permanent?

A. It will no doubt be permanent, because the 726-foot dam and 115-mile lake will be a great attraction for tourists. There are also many scenic wonders close by to attract visitors, including three national parks - Grand Canyon, Zion and Bryce Canyon. A sizable force will also be required for operation of the reservoir and power plant.

Q. What construction has been accomplished by the Government?

A. Buildings for employees, waterworks, sewerage system, electric distribution system, street surfacing, sidewalks and curbs have been completed. A highway and railroad from the town to the dam site have also been constructed.

Q. How much money has been expended at Boulder City?

A. It has cost the Government about $1,700,000 to build the town.

Q. What provisions were made for erecting buildings suited to the climatic conditions in that section?

A. A city planner, well acquainted with the type of building construction required, was employed. Government buildings are largely of the Spanish type of architecture, and the main buildings are air-conditioned. The Bureau of Reclamation encountered somewhat similar climatic conditions during construction of the Yuma and Salt River projects in Arizona.

Q. What is the form of town government?

A. The city manager plan is followed and this official is responsible to the construction engineer. An advisory commission of three supplements the city manager. One chief and eight assistant rangers constitute the police force.

Q. What is the range of temperatures in that locality?

A. They vary from 20° to 120°.

Q. How near is Boulder City to Las Vegas, Nevada, and Kingman, Arizona?

A. About 21 miles southeast in an air line, 24 miles by highway, and 32 miles by railroad from Las Vegas, and 95 miles by highway from Kingman.

Q. What is the elevation of the town?

A. About 2,500 feet above sea level.

Q. What is the area of the town site?

A. About 200 acres.

ALL-AMERICAN CANAL:

Q. Is the All-American Canal a part of the Boulder Canyon project?

A. Yes. There are three features included in the project - the Boulder Dam, power plant, and the All-American Canal.

Q. What is the purpose of the canal?

A. To carry water from the Colorado River to the Imperial and Coachella Valleys in the southeastern part of California.

Q. Why the name, "All-American?"

A. Because the canal will be built entirely in the United States. The present Imperial main canal is largely in Mexico.

Q. What part of the $165,000,000 cost of the Boulder Canyon project is allotted to the canal?

A. $38,500,000, not including interest during construction. The Boulder Canyon Project Act of December 21, 1928, authorized the building of a main canal from the Colorado River to the Imperial and Coachella Valleys.

Q. Is this expenditure reimbursable?

A. Yes. Under a repayment contract between the Imperial Irrigation District, and under other repayment contracts now being negotiated between the Coachella Valley County Water District and the City of San Diego, California, and the Bureau, the cost of the canals and appurtenant structures will be returned to the Government as provided in the Reclamation Law.

Q. Will the district have to pay for the water?

A. There will be no charge for the use, storage, or delivery of water for irrigation or water for potable purposes.

Q. Where is the proposed location of the intake?

A. A new diversion dam will be built about 15 miles northeast of Yuma, Arizona, and 5 miles north of Laguna Dam, the diversion point for the main canal of the Yuma (Federal) Irrigation project.

Q. What type of structure will built?

A. Final design studies have not been completed for the (Imperial) dam. Studies will cover the floating or Indian weir type, concrete gravity section type and various reinforced concrete types. Some form of desilting works, the type of which has not yet been determined, will also probably be installed in conjunction with the dam. The water surface of the river will be raised about 22 feet.

Q. How much water will the canal carry?

A. An initial diversion of 15,155 cubic feet per second is planned, which includes 2,000 cubic feet per second diverted at Siphon Drop, for the Yuma project, 3,000 cubic feet per second diverted at Pilot Knob for power development and 155 cubic feet per second diverted near the end of the Canal for the use of the City of San Diego, California. The largest canal so far built by the Bureau of Reclamation has a capacity of 2,695 cubic feet per second.

Q. What will be the dimensions of the canal?

A. The maximum section will be about 232 feet in width at the water surface, 160 feet in width at the bottom, and 20.6 feet in depth. There are only two larger canals in the United States, both ship canals.

Q. What will be the length?

A. The All-American Canal to Imperial Valley will be 80 miles long, and the main canal to the Coachella Valley will be 130 miles long.

Q. Are the sand hills to be crossed by the canal?

A. Yes. The canal for 10 miles will pass through a ridge of shifting sands. Here the deepest cutting is over 100 feet.

Q. What means are being considered to prevent blow sand from drifting into the canal?

A. (1) Growing vegetation in a zone on each side of the canal. (2) Covering the dune sand with coarser excavated material. Spraying the sand with crude oil. (3) Providing 20-foot berms on each side of the canal at the mesa floor level and at ground surface between the edge of the cuts and waste banks.

Q. Will any portion of the canal be lined with concrete?

A. The lining of 47 miles of the Coachella canal may be found necessary.

Q. What structures are proposed?

A. Siphons or culverts will be used to carry the canal under many washes and at other washes the discharge from the wash will be carried over the canal in concrete overshot type structures. Probably 10 wash crossing structures will be required for the All-American Canal and 79 on the Coachella Branch Canal. The All-American Canal will also have to be carried under the Alamo and New Rivers in siphons. Several highway and railroad bridges will also be required.

Q. What is the estimated total of excavation?

A. 65,000,000 to 70,000,000 cubic yards of which but 3 percent will be rock.

Q. Are there opportunities for power development?

A. Yes. At Pilot Knob, about 7 miles west of Yuma, where surplus water will be returned to the Colorado River, and also at four drops on the canal.

Q. How much power can be developed?

A. About 60,000 kilowatts.

Q. Is additional water supply for the City of San Diego tied in to All-American Canal plans?

A. A repayment contract is being negotiated between the City of San Diego and the Bureau for providing capacity in the All-American Canal for carrying water to some point near the end of the canal from which point it will be taken to San Diego.

Q. How much water is San Diego asking for?

A. 155 cubic feet of water per second.

IMPERIAL AND COACHELLA VALLEYS:

Q. What is the irrigable area of the Imperial Irrigation District?

A. 522,000 acres, to water which requires 1,700 miles of canals and laterals.

Q. How much land is now irrigated?

A. From 400,000 to 450,000 acres.

Q. What is the present irrigated area in Mexico (Lower California) from the Imperial Main Canal?

A. About 200,000 acres.

Q. What are the principal crops?

A. Alfalfa, cantaloupes, lettuce, barley, corn, milo maize, and small fruits. About 30,000 carloads of cantaloupes and lettuce are shipped out of the Imperial Valley each season.

Q. What are the average crop yields?

A. Alfalfa 7 to 10 tons per acre, a ton to a cutting; cantaloupes, 96 crates per acre.

Q. What is the growing season?

A. 365 days.

Q. What is the elevation of the Valley?

A. From 250 feet below sea level at the Salton Sea to 50 feet above sea level. The adjoining mesas or high lands vary in elevation from 50 to 250 feet.

Q. What is the Salton Sea?

A. An inland sea in a depression in the northern part of Imperial Valley. Prior to 1905, it was only a small lake, but the Colorado River break of 1905-1907 increased the water surface area of the sea to 515 square miles, or 2-1/2 times the area of the Boulder Canyon reservoir. It then had a length of 42 miles and maximum depth of 80 feet. The present area is 287 square miles and the elevation of the water surface is about stable at 244 feet below sea level.

Q. What is the water surface of the Colorado River which flows to the east and south of the valley?

A. About 100 feet above sea level, or from 50 to 350 feet above the valley floor.

Q. Is the valley protected by levees?

A. Yes. There are 74 miles of protection levees, all in Mexico.

Q. What is the rainfall in this section?

A. About 3 inches a year.

Q. How large is the Coachella Valley?

A. The gross acreage is 187,000 acres. The estimated irrigable area under the proposed canal system is 150,000 acres. There are now about 16,000 acres under cultivation.

Q. What will be the total irrigable area in the Imperial and Coachella Valleys and adjacent East Mesa, West Mesa, Pilot Knob Mesa and Dos Palmas unit, to be served by the All-American Canal and its branches?

A. The estimated area is 1,000,000 acres.

Q. What is the status of these lands as to ownership?

A. Approximately 20 percent public, 70 percent private and 10 percent State, railroad and Indian.

COLORADO RIVER AQUEDUCT:

Q. Is the aqueduct a part of the Boulder Canyon project?

A. No, but one of the purposes of the project is to provide a supplemental domestic water supply for Los Angeles and neighboring cities and towns. The aqueduct will transport water which is stored in the reservoir behind the Boulder Dam.

Q. What is the Metropolitan Water District?

A. A district comprising several cities and towns in southern California that will use this water supply. The district offices are at 306 West Third Street, Los Angeles, California.

Q. What portion of the Colorado River water will the district receive?

A. The district has contracted with the Secretary of the Interior for delivery each year from the reservoir up to but not exceeding 1,050,000 acre-feet. This corresponds to a flow of about 1,500 cubic feet per second, or about a billion gallons daily from the river. The district will pay to the United States 25 cents per acre-foot for the actual amount used, or an average annual payment of about $250,000.

Q. Will the district obtain power from the plant at Boulder Dam?

A. Yes. Its allocation is 36 percent of the firm power produced, with a preferential right to the use of dump or secondary power.

Q. What will be the cost of the aqueduct?

A. A bond issue of $220,000,000 was authorized by the district at a special election held on September 29, 1931. The Reconstruction Finance Corporation has purchased $40,000,000 of district bonds which will finance construction work nearly through 1934.

Q. Where on the Colorado River will the intake for the aqueduct be located?

A. At the Parker dam site in Upper Parker Canyon, about 155 miles below Boulder Dam, and 12 miles above Parker, Arizona.

Q. How will diversion be effected?

A. By means of the Parker dam. A contract has been entered into between the Bureau of Reclamation and the Metropolitan Water District, providing for the design and construction by the Bureau of the Parker dam. This dam will be 320 feet above bedrock and 80 feet above the normal water level of the river. It will be of the concrete arch type superimposed by five 50-foot by 50-foot Stoney gates for river control. Provisions will be made for the ultimate development of a power plant layout.

Q. What is the maximum pumping lift to cross the mountains?

A. About 1,340 feet, from where the water enters the aqueduct. Five pumping stations will be required.

Q. What is the total length of the proposed aqueduct?

A. About 239 miles of main aqueduct and 155 miles of feeder lines.

Q. How many tunnels will be required?

A. There will be 46 tunnels totaling 85 miles in length. The longest is the San Jacinto, 13 miles. The maximum diameter of the tunnels is 16 feet.

Q. How many miles of conduit and open canal will be constructed?

A. There will be 55 miles of buried concrete conduit and 75 miles of concrete-lined open canal.

Q. What amount of siphon construction is involved?

A. About 24 miles.

Q. How many storage and regulating reservoirs must be constructed?

A. There will be nine reservoirs along the route of the aqueduct.

Q. What are the estimated quantities of the major items of construction?

A. There will be 38,000,000 cubic yards of excavation; 6,800,000 cubic yards of embankment; 4,900,000 cubic yards of concrete, involving the use of 6,400,000 barrels of cement; 129,000,000 pounds of reinforcing steel; 34,000,000 board feet of tunnel timbers; 30,000,000 pounds of structural steel for transmission lines; 20,000,000 pounds of steel for penstocks.

Q. How long will the construction take?

A. Provided the district is able to secure funds as needed, water will first be diverted early in 1939.

PARKER AND GILA VALLEYS:

Q. What is the Parker Valley?

A. The river bottom and adjacent low-lying mesa lands on the eastern side of Colorado River from Parker, Arizona, south for about 25 miles, all lying within the Colorado River Indian Reservation.

Q. When will this area be developed?

A. Construction of this project has not been authorized.

Q. What is the Gila Valley?

A. River bottom and adjacent mesa lands along the Gila River from Yuma to Aztec, with a net irrigable area below elevation 600 of about 500,000 acres.

Q. How and when will these lands be irrigated?

A. Water will be diverted from the Colorado River at the Imperial dam and pumped by successive stages to canals serving the lands. Construction of the project has not been authorized and no funds are available for construction. Surveys for a project plan are under way with an allotment of $100,000 for work in the Gila and Parker Valleys.

SETTLEMENT:

Q. Are there any public lands susceptible of irrigation which are now open to homestead entry in the areas below Boulder Dam?

A. No. All of these lands have been withdrawn from entry.

Q. When will these lands be opened to settlement?

A. In its allotment of construction funds for the All-American Canal, the Public Works Board has made the requirement that no new lands shall be brought under irrigation under present conditions. No lands would in any event be opened to entry before completion of the All-American Canal which will probably not be before 1938.

Q. How will the lands be opened?

A. Under the provisions of the reclamation law and similar to openings on the Federal irrigation projects.

Q. Will preference right of entry be given to ex-service men?

A. Yes, for a period of three months after date of opening.

Q. What Federal projects have climatic and crop conditions similar to those prevailing on the Boulder Canyon project?

A. The Salt River in Arizona, Yuma in Arizona-California, and Orland in California.

Q. What will be the principal crops grown?

A. Alfalfa, cotton, grain, melons, vegetables, citrus and other fruits.

Q. Have surveys been made to determine the irrigable areas?

A. No. Surveys are in progress in California, and also in Arizona and Nevada.

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Note: The figures used in the above "Questions and Answers" are in some cases taken from preliminary plans, studies and estimates and may be materially changed when final plans are approved and irrigable area surveys are made.

ELWOOD MEAD,
Commissioner.

ADDRESS ALL COMMUNICATIONS TO
THE COMMISSIONER

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
WASHINGTON

OFFICE OF THE COMMISSIONER

August 15, 1934.

INFORMATION TO APPLICANTS FOR EMPLOYMENT AT BOULDER DAM, BOULDER CANYON PROJECT

The Boulder Dam site is located in upper Black Canyon on the Colorado River about thirty miles southeast of Las Vegas, Nevada, where the river forms the boundary between the States of Arizona and Nevada.

All construction work is being done by contract; hence practically all laborers, helpers, cooks, truck drivers, skilled mechanics, foremen, timekeepers, cost keepers, storehouse men, etc., are being employed directly by the contractors and not by the Government. Employees of the classes listed are usually selected from applicants locally available. The Bureau of Reclamation has nothing to do with the employment of men for the contractors.

Contracts for the construction of Boulder Dam and power plant, and the plate steel outlet pipes for the concrete lined tunnels, which are the principal features of the Boulder Canyon project, were awarded to Six Companies, Incorporated, 510 Financial Center Building, San Francisco, California, and to The Babcock & Wilcox Company, 85 Liberty Street, New York, New York, and 444 17th Street, Denver, Colorado, respectively, (construction offices for both of these contractors being located at Boulder City, Nevada). At the present rate of progress both of these contracts will be completed in 1936. Newspapers and certain technical magazines publish the names and addresses of successful bidders as other principal contract awards are made.

A wage scale of 50 cents per hour for unskilled labor, working eight hours per day, was established by Six Companies, Incorporated, at the beginning of the job, and this rate still prevails; blacksmiths are paid 75 cents; carpenters 70 and 75 cents; cableway and shovel operators $1.00; compressor operators, cement finishers, hook tenders, rigger helpers, shovel and cableway oilers, brakemen, locomotive and stationary firemen, also mixer plant oilers, 62½ cents; mixer operators, riggers, steel sharpeners and electricians 75 cents; welders 62½ to 75 cents; reinforcing steel workers 70 and 75 cents; railroad locomotive engine men and conductors 75 cents per hour, etc.

The Babcock & Wilcox Company also adhere to a scale of 50 cents per hour for unskilled labor on an eight hour per day basis. Welders are paid 60 to 75 cents; chippers 60 to 70 cents; machinists 60 to 75 cents; machine operators 55 to 75 cents; crane operators 60 and 65 cents; electricians 65 to 75 cents; riggers 60 cents to $1.00; handy men 55 to 65 cents per hour, etc.

Six Companies, Incorporated, makes a pay roll deduction of $1.60 per day for board and lodging for single men housed in the dormitories. Each man has his own individual room.

Six Companies, Incorporated, has built and equipped a modern hospital and has employed the physicians, surgeons, nurses, and attendants necessary to provide adequate medical attention for its employees. For this hospital service, a pay roll deduction of $1.50 per month is made.

Over 5,200 people directly engaged in work pertaining to construction activities are now employed on the project, but it is believed that the employment peak has been reached. Within the next eight months and thereafter until completion, the forces will be reduced materially.

Boulder City, Nevada, has been established by the Bureau of Reclamation as the headquarters for the construction of Boulder Dam and appurtenant works. This is a new town, planned and developed by the Government. It is modern in every respect and includes complete water and sewerage systems, street improvements of paving, sidewalks, curbs and gutters, and an electrical distribution and street lighting system. The Bureau of Reclamation has provided office and living quarters for its employees. An area has been set aside for Six Companies, Incorporated, in which it has erected dormitories for single men and over 650 small houses for workmen with families. The contractor operates a well-equipped general store and in addition there are numerous business establishments conducted by private parties.

Employment Opportunities with Contractors:

The contracts of Six Companies, Incorporated, and The Babcock & Wilcox Company contain a provision that the contractor shall so far as practicable give preference at the time of employment first to qualified ex-service men and second to qualified citizens of the United States. Local labor required will as far as practicable be selected from lists maintained by the U. S. Employment Office under the Department of Labor which agency, in cooperation with the State of Nevada, has established a public employment service at Las Vegas, Nevada, with Mr. Leonard T. Blood as Superintendent in Charge. The major contractors, Six Companies, Incorporated, and The Babcock & Wilcox Company, make practically all of their employments through the office of this service which also assists in supplying the country through the newspapers with accurate information regarding the progress of the work and the demand for workmen. Regardless of warnings, large numbers of men, more than the work can accommodate, have proceeded to Las Vegas and the dam site in search of employment with the result that a large number of idle men, without means of livelihood, are at Las Vegas awaiting their turn to be employed. Applications now on file with the Employment Service Office are more than sufficient to supply workmen needed by the contractors; therefore, no one should go to Las Vegas or the dam site unless (1) assured of employment upon arrival or (2) financially able to tide over an uncertain period of unemployment.

Employment Opportunities in Government Service:

Selections have been made for practically all of the engineering positions required at this time in the organization of the Chief Engineer, Bureau of Reclamation, Denver, Colorado, where all designs, plans and specifications for the Boulder Dam and related features are prepared. Whenever practicable to do so, new positions or vacancies are filled from within the service by the transfer or reinstatement and assignment to duty of experienced employees whose services have been made available by the completion of other reclamation projects, or curtailment of work thereon. The opportunities for new appointees in the Government organization for this work will be limited accordingly.

During the construction period the Government organization maintained on the project will be limited to an engineering, inspectional and clerical force--very small when compared with the contractors' forces.

Civil service eligibility is not a requisite for appointment on the rolls of this bureau in connection with employment on construction work provided for from funds allotted under the National Industrial Recovery Act. Work on the project has been under way since early in 1931, and the organization is now complete, but applications for consideration in connection with such vacancies as may exist from time to time should be filed with the Construction Engineer, Bureau of Reclamation, at Boulder City, Nevada.

ELWOOD MEAD
Commissioner.

BIBLIOGRAPHY 1934

Magazines & Newspapers

Boulder Canyon Project

Issue	Article	Magazine or Paper	Author
Oct. 15	Analysis of Boulder Dam Spillways	Engineering News-Record	W. Myer & Peter Henry Favre
Dec. 20	Arizona Rights to Boulder Dam Storage Argued at Hearing (Current News)	"	
Nov. 29	Boulder Canyon-A Fully Planned Project	"	R.F.Blanks
May	Boulder Dam	Harvard Alumni Bulletin	Robert Ridgway
Jan.	Boulder Dam After three Very Intensive Years	Earth Mover	
Nov. 22	Boulder Dam Cement & Concrete Studies	Engineering News-Record	R.F.Blanks
July	Boulder Dam Generators	Mechanical Engineering	L.N. McClellan
Aug.	Bulk Cement Handling at Boulder Dam	Western Construction News & Highway Builder	
April	Construction of Boulder Dam	Compressed Air Magazine	Lawrence P. Sowles
Nov.	Construction of Boulder Dam	"	Wesley R. Nelson
Sept.	Construction of Boulder Dam. Description of Mixing & Blending Plants		Lawrence P. Sowles

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Magazines & Newspapers - Boulder Canyon Project

Issue	Article	Magazine or Paper	Author
July 19	Concrete Placing Details at Boulder Dam	Engineering News-Record	
Jan.	Construction Achievement Without Parallel	Earth Mover	
Oct. 11	Cooling Concrete in Boulder Dam	Engineering News-Record	Byram W. Steele
Dec. 6	Dam Stresses and Strains Studied by Slice Model	"	J. L. Savage
June 28	Derricks Assist Boulder Dam Cableway	"	
Jan.	Eighteen U. S. Bureau of Reclamation Projects to Cost $218,440,000	Western Construction News & Highway Builder	
Jan.	Gigantic Concrete Wedge Called Boulder Dam	Earth Mover	
Oct.	Huge Trailer Hauls Penstock Pipe at Boulder Dam	Compressed Air Magazine	Copeland Lake
July	Hydraulic Valves & Gates for Boulder Dam - Part I	Mechanical Engineering	P. A. Kinzie
Sept.	" Part II	"	"
Oct.	" Part III	"	"
Nov.	" Part IV	"	"
Dec.	" Part V	"	"
Feb.	Los Angeles Prepares to Use Boulder Dam Power	Compressed Air Magazine	Lawrence A. Luther

BIBLIOGRAPHY (Continued)

Magazines & Newspapers - Boulder Canyon Project

Issue	Article	Magazine or Paper	Author
Dec. 20	Miscellaneous Items Page 800	Engineering News-Record	
Aug.	Penstocks for Boulder Dam	Mechanical Engineering	C.M.Day & Peter Bier
Feb.	Refrigeration at Hoover Dam	Ice & Refrigeration	H. N. Royden
June 28	Retrogression of Levels in River Beds Below Dams	Engineering News-Record	E.W.Lane
March	Steel Headers and Penstocks for Hoover Dam Mark Notable Advance in Engineering Construction	Western Construction News & Highway Builder	Robt. G. Skerrett
Oct.	The flow Net and the Electric Analogy	Civil Engineering	E.W.Lane, F.G. Campbell & W.H.Price
Jan.	Three miles were Bored Through Solid Rock	Earth Mover	
July 12	Trailer Moves Pipe Units at Boulder Dam	Engineering News-Record	
Dec. 27	Transporting Bulk Cement at Boulder Dam	"	
July	Turbines for Boulder Dam	Mechanical Engineering	Ireal A. Winter
Nov. 15	Welding and X-Raying the Boulder Dam Penstocks	Engineering News-Record	

FATALITIES (1934)

Industrial

Accidental Falls

Date	Name	Place	Employed by
Feb. 1	Rosyn Grant	Arizona Spillway	Six Cos. Inc.
Mar. 23	Harry Morgan	No. 5 Intake Tower	"
Apr. 14	Allen Jackson	Dam	"
May 25	Fred Deckmann	Babcock & Wilcox Plant	The Babcock & Wilcox Co.
Sept. 26	John W. Rawls	Dam	Six Cos. Inc.
Nov. 1	Paul L. Jordon	Bab. & Wil. Plant	The Babcock & Wilcox Co.

Electrocuted

May 16	G. D. McIsaac	On Arizona side of project	Six Cos. Inc.
Sept. 16	Frank Allen Fritz (Alias James O'Neill, Alias Frank Allen Boden)	Steel Yard in Boulder City	"

Elevator Accident

Mar. 10	George R. Richardson	Elevator at damsite	Six Cos. Inc.

Struck by Machinery or Falling Equipment

Feb. 6	Kenneth, Walden	Dam	Six Cos. Inc.
May 26	Samuel L. Carter	Concrete dinkey on trestle of Nevada keyway	"
June 24	Victor K. Auchard	No. 3 Arizona Penstock Tunnel	"

FATALITIES (cont'd)
(1934)

Struck by Machinery or Falling Equipment

Date	Name	Place	Employed by
Nov. 1	Richard M. Whelan	Tunnel No. 4, Nevada side	The Babcock & Wilcox Co.
Nov. 1	Martin L. Hampel	"	"
Nov. 4	Alfred E. Foreman	"	"
Nov. 14	Kenneth H. Rankin	Dam	Bureau of Reclamation

Struck by Falling Material

Date	Name	Place	Employed by
Jan. 22	George Good	Dam Slot	Six Cos. Inc.
Feb. 26	Eugene Buckner	Diversion Tunnel No.4	"
May 20	Howard Bentley	Lower No. 1 Tunnel	"
Aug. 27	Harris Lange	Babcock & Wilcox Plant	The Babcock & Wilcox Co.

NON-INDUSTRIAL

Automobile Accident

Date	Name	Place	Employed by
July 4	G. B. Rainboth		Six Cos. Inc.

Accidental Fall

Date	Name	Place	Employed by
June 11	Grant Miles		"

Drowning

Date	Name	Place	Employed by
May 17	William Reynolds		Bureau of Reclamation

Deaths from Natural Causes
Pneumonia

Date	Name	Place	Employed by
Jan. 12	Charles King		Six Cos. Inc.
Jan. 15	Sam Rather		Anderson Bros. Supply Co.

FATALITIES (Cont'd) (1934)

Non-Industrial

Deaths from Natural Causes Pneumonia

Date	Name	Employed by
April 3	J. W. Pinckard	Six Cos. Inc.
July 11	Raymond Allen	"
Aug. 11	Henry Fisher	"
Sept. 22	William Sutton	The Babcock & Wilcox Co.
Dec. 10	J. N. Slick	"
Dec. 14	Alton M. King	"
Dec. 25	Roy Drake	"

Deaths from Natural Causes - Miscellaneous

Date	Name	Cause of death	Employee of
Mar.8	Frank Vales	Septecemia Poisoning	Six Cos. Inc.
April 19	N. C. Christoper	" Pneumococcic	"
Aug. 4	C. L. Kesl	Cerebral Vascular Disease	"
Nov. 25	Otis Breeding	Typhoid Fever	"

No records available at this office concerning deaths on the project of persons not employed by Government or by the contractors.

SUMMARY OF FATALITIES

Cause	Industrial Prec. 1934	Industrial During 1934	Non-Industrial Prec. 1934	Non-Industrial During 1934	Total
Heat Prostration	13*	0	3	0	16
Drowning	5	0	1	1	7
Blasting	12	0	0	0	12
Falling Material	16	4	0	0	20
Accidental Falls	13	6	1	1	21
Struck by Equipment or Machinery	17	7	0	0	24
Automobile Accidents	0	0	8	1	9
Misc. Accidents	4	3	0	0	7
Murders & Suicides	0	0	5	0	5
Pneumonia	0	0	29	9	38
Other Natural Causes	0	0	28	4	32
Totals	80	20	75	16	191

*Occurred on job, but not classed as "Industrial Accident".

DISTANCES TO POINTS ON FEDERAL RESERVATION

Point	Distance from Boulder City
By Boulder City - Boulder Dam Highway	
Intersection with Hemenway Wash Road	2 miles
Intersection with road to Pumping Plant #2	5 "
Intersection with road to Observation Point	6 "
Intersection with Construction Road of Six Companies Inc.	6¼ "
Trail to Elks Memorial Flag Pole	7 "
Boulder Damsite	8 "
By Hemenway Wash Road	
Intersection with Boulder City-Boulder Dam Highway	2 "
Intersection with Road to Screening Plant	7 "
Ferry to Kingman, Arizona	9 "
By Road to Screening Plant	
Intersection with road to Screening Plant	7 "
Screening Plant	8 "
Hesse Camp	12 "
Arizona Gravel Deposit	13½ "
By State Highway to Las Vegas	
West entrance to Reservation	1½ "

Distances From Boulder City, Nevada, to Cities and Points of Interest in Southwest

Town	Via	Miles
Anderson, Utah	Glendale, Nev., Hwy. 91	184
Ashfork, Ariz.	Chloride, Arizona	211
Bannock, Calif.	Searchlight, Nev.	78
Barstow, Calif.	Baker, Calif., Hwy. 91	185
Beatty, Nev.	Las Vegas, and Hwy. 5	146
Bright Angel Pt.	Jacob's Lake, Hwy. 89	344
Bryce Canyon	Mt. Carmel & Long Valley, Utah	306
Cameron, Ariz.	Fredonia, Ariz., Hwy. 89	417
Cedar City, Utah	Glendale, Nev., Hwy. 91	218
Chloride, Ariz.	Black Canyon Ferry	75
Darwin, Calif.	Rosewell, Nev., Hwy. 5	282
Death Valley Jct., Calif.	Baker, Calif., Hwy. 91	200
Death Valley Jct., Calif.	Rosewell, Nev., Hwy. 5	179
Flagstaff, Ariz.	Chloride, Nev., Hwy. 66	268
Furnace Creek Inn	Baker, Calif., Hwy. 91	228
Furnace Creek Inn	Rosewell, Nev., Hwy. 5	207
Kingman, Ariz.	Needles, Calif.	149
Kingman, Ariz.	Black Canyon Ferry	95
Las Vegas, Nev.	State Hwy. No. 5	23
Los Angeles, Calif.	San Bernardino, Calif., Hwy. 66	323
Los Angeles, Calif.	Rosewell, Death Valley, Darwin	516
Los Angeles, Calif.	Searchlight, Bannock, Barstow	343
Marble Canyon Bridge, Ariz.	Fredonia, Ariz., Hwy. 89	354
Marble Canyon Bridge, Ariz.	Chloride, Ariz. & Cameron, Ariz.	318
Needles, Calif.	Searchlight, Nev., Hwy. 5	95
Olancha, Calif.	Rosewell, Darwin	312
Parker, Ariz.	Searchlight, Needles	154
Phoenix, Ariz.	Needles, Calif., Prescott, Ariz., Wickenburg, Ariz.	431
Phoenix, Ariz.	Needles, Calif., Parker, Ariz., Wickenburg, Ariz.	337
Phoenix, Ariz.	Chloride, Prescott, Wickenburg	377
Prescott, Ariz.	Choride, Ashfork, Ariz.	264
Provo, Utah	Glendale, Nev., Hwy. 91	442
Reno, Nev.	Beatty, Nev., & Hwy. 40	477

(Cont'd)

Town	Via	Miles
Salt Lake City, Utah	Highway 91	487
San Bernardino, Calif.	Barstow, Calif., Hwy. 66	258
San Francisco, Calif.	Barstow, Bakersfield, San Jose	622
San Francisco, Calif.	Los Angeles, Calif.	764
San Francisco, Calif.	Reno, Nev.	723
Searchlight, Ariz.	State Hwy. No. 5	41
St. George, Utah	Glendale, Nev., Hwy. 91	162
St. Thomas, Nev.	Glendale, Nev., Hwy. 91	91
Stove Pipe Wells, Calif.	Rosewell, Nev.	227
Tonopah, Nev.	Rosewell, Nev., Hwy. 3	236
Williams, Ariz.	Chloride, Ariz., Hwy. 66	231
Zion Canyon, Utah	Anderson, Utah, Hwy. 91	216

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