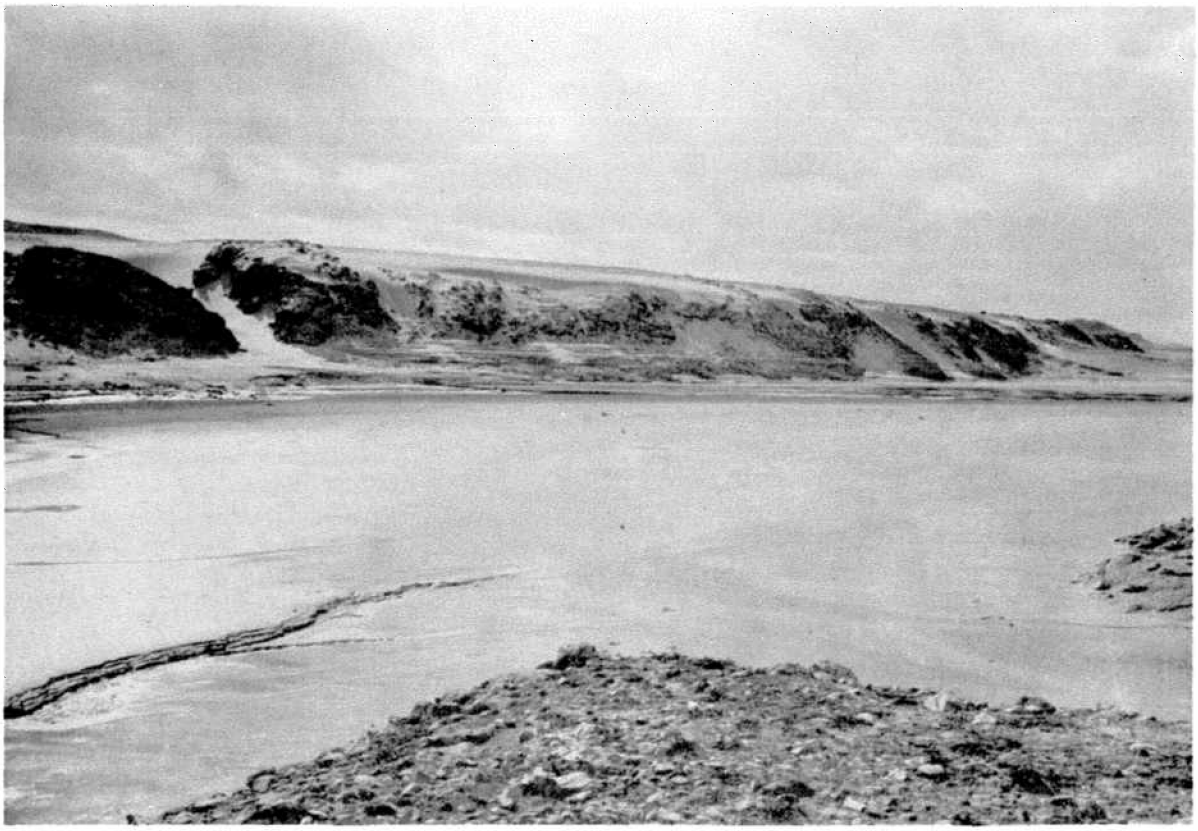
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

# OBSERVATION OF SEDIMENTATION IN PATHFINDER RESERVOIR, WYOMING



SEDIMENTATION SECTION
HYDROLOGY BRANCH
DIVISION OF PROJECT INVESTIGATIONS

DENVER, COLORADO
MAY 1959

# OBSERVATION OF SEDIMENTATION IN PATHFINDER RESERVOIR, WYOMING

## CONTENTS

# INTRODUCTION

## Purpose

This report is a summary of information on reservoir sedimentation obtained from an inspection of Pathfinder Reservoir during October 1958.

To facilitate construction of the power tunnel from Pathfinder Reservoir to the Fremont Canyon Powerplant and sealing of the south outlet work tunnels at Pathfinder Dam, Pathfinder Reservoir was completely evacuated in the fall of 1958. This evacuation provided an opportunity to sample, inspect, and photograph sediment deposits of up to 50 years of age in the reservoir. The information gained from the inspection will be helpful in the study, evaluation, and development of procedures for predicting sediment accumulation and behavior in existing and planned reservoirs.

## Description

Pathfinder Dam is a masonry, arch-gravity type dam situated in a deep, narrow, granite canyon. The dam has a structural height of 214 feet, a hydraulic height of 184 feet, a base width of 96.5 feet, and a crest width of 10.9 feet. The crest of the dam is 432 feet long at an elevation of 5858.1 feet (USGS datum).

Pathfinder Reservoir extends 24 miles up to the North Platte River and 19 miles up the Sweetwater River from Pathfinder Dam. The maximum width of the reservoir is about 3 miles. At the spillway elevation (5850.1 feet) the reservoir had an initial surface area of 22,600 acres and an initial capacity of 1,056,300 acre-feet.

The lake beginning at the dam is confined to a narrow canyon about 120 feet deep and less than 300 feet wide below elevation 5810. Above this elevation the lake widens to 1/2-mile at spillway crest elevation. About one-third mile above the dam, the narrow canyon ends and the whole lake broadens abruptly to a width of one-half mile or more. About 1-1/2 miles west of the dam, the lake is restricted by the base of a mountain and a rock point before opening into a large central basin formed by the confluence of Sand Creek, Canyon Creek, and the Sweetwater River with the North Platte River. This basin is approximately 8 miles long and has a maximum width of 3 miles. The North Platte River arm enters this basin midway along the east side, 7-1/2 miles above the dam, through a relatively narrow rugged valley varying in width from 1/4 to 1/2 mile. About 4-1/2 miles above the North Platte entrance to the basin, the lake narrows into a canyon section approximately 500 feet wide for a distance of about 1-3/4 miles. Continuing upstream, the lake gradually widens to about 1 mile and stays this width to the upper end before narrowing to the back water area 10 miles above the "narrows" or 24 miles above the dam.

The Sweetwater River arm enters the central basin from the north through a rugged canyon about 1/2 mile wide. About 3-1/2 miles above its confluence with the North Platte River, the lake narrows to a width of 800 feet and turns sharply west. Immediately above the "narrows" the lake widens to about 1 mile for a distance of 3 miles and then widens again to its maximum width of 1-1/2 miles where Horse Creek enters the reservoir 13-1/2 miles above the dam. The lake narrows again to a width of 300 feet at a distance of 18 miles from the dam. The lake widens again slightly before tapering off in the back water area 19 miles above the dam.

A general map of the reservoir with established sedimentation ranges is shown on Figure 1.

## History

Approval was given for construction of Pathfinder Dam in 1904 and construction was started in 1905. The dam and associated works were essentially completed in 1909 when closure was made. In 1939 Seminoe Dam was placed in operation 6 miles above the high water line of Pathfinder Reservoir. In September 1950 Kortes Dam, constructed between Pathfinder Reservoir and Seminoe Dam, was closed. Since 1939 little sediment has entered Pathfinder Reservoir from the North Platte River flow.

A resurvey of Pathfinder Reservoir was made in 1950 1/ (1) which resulted in a revision of the original capacity and a correction of the Pathfinder datum to the U. S. Geological Survey datum. The original capacity was revised to 1,056,300 acre-feet at spillway crest elevation 5850.1 instead of 1,070,000 acre-feet at spillway crest elevation 5852. The 1950 resurvey showed a sediment accumulation of 40,400 acre-feet in the reservoir between 1909 and 1950, indicating an annual unit yield rate of 0.117 acre-feet per square mile for 1909-1939 and 0.079 acre-feet per square mile for 1939-1950 for the drainage area above the dam. Sediment deposits were distributed throughout the reservoir in 1950 and have not changed to any great degree since that time.

The original and 1950 thalweg profiles and the area-capacity curve for 1950 are shown in Figures 2 and 3 respectively. Figure 2 may be misleading in some respects since it is a thalweg profile. It indicates no deposition is present in the upper North Platte arm of the reservoir. Actually, a great deal of deposition has taken place but the river has degraded through the deposits back to its original profile as explained later in this report. Figure 2 also gives no information on lateral extent of the sediment deposits.

1/ Numbers in parenthesis refer to articles listed as references at the end of this report.

## SEDIMENT GRAVITY FLOWS

For purposes of clarification, this discussion is added to this report to assist in the description of the existing sedimentation pattern in Pathfinder Reservoir. The mode of sediment distribution within the lower reservoir area is explained to a large degree by the action of sediment gravity flows.

A gravity flow can be described as the flow of any fluid caused by gravitational forces. A density current has been described by Bell [2] as "A gravity flow of a fluid through, under, or over a fluid of approximately equal density." According to Lane [3] one class of density currents called turbidity currents usually involve the deposition of sediment in reservoirs and is a current "with movement due to the suspension of sediment in the flowing water." Lane defines three types of turbidity currents depending on their action when flowing through a reservoir: (1) underflows, (2) interflows, and (3) overflows. In this Pathfinder sedimentation report, the underflowing turbidity current is of main interest. Lane further states:

> "There is reason to believe, however, that in many reservoirs the inflowing water does not dive under the clear water, but pushes it downstream and forms a considerable body of muddy water, in which the sediment is slowly settled to the bottom . . . . When this sediment reaches the bottom, some of it collects in the form of a dense fluid, which flows down the banks to the main channel and then flows down the main channel in an underflowing turbidity current, . . . . This means of formation of a density current is not so easily detected . . . and has not been directly observed but its existence is inferred from the deep deposits of fine material in the streambed near the upper ends of some large reservoirs. These deposits are much deeper compared with the deposits outside the channel, than would occur if there were no movement of the settled sediment after it reached the reservoir bottom."

Lane also states:

> "The velocity of flow in an underflow type of turbidity current depends on the density of the turbid water, the depth of flow, and the steepness of the channel. The force per unit volume causing the flow increases with an increase in the density between the two fluids. It increases with an increase in the bottom slope and with an increase in the thickness of the heavier liquid."

## SEDIMENTATION PATTERN

### Sedimentation at Pathfinder Dam

At the time of observation, sediment deposits extending from the dam through the narrow gorge section were being eroded to some extent as the river cut a new channel through the deposits (Photograph 2817, Figure 4). Construction work had disturbed the sediment deposits near the dam and north outlet trashrack. The river as it approached the north outlet was flowing in its original bed of cobbles and entered the tunnel at sill elevation. Drainage of bank storage in the deposits was causing consolidation of the deposits in the gorge. A triangular area of deposits next to the dam was virtually undisturbed by construction activity or river action and Sample P-1 was secured from this area (Photograph 2835, Figure 4, Table 1, and Figure 15). The elevation of this deposit was determined as 5696.7 feet or 28.6 feet above the north outlet sill. The resurvey of 1950 showed a deposit elevation of 5690.1 at Range 1. The sediment deposited in the gorge section and immediately above is coarse silt to fine sand with about 15 percent clay (Sample P-1, Figure 15).

Above the gorge section where the valley widens abruptly, the old channel and flood plain are covered with a light density sediment deposit of clay, silt, and fine sand. The deposited sediment is level. Some consolidation has taken place within a few feet of the river where some drainage has occurred after reservoir evacuation. This light-density deposit was in the lowest part of the channel and floodplain, but no deposition other than a thin scum was evident above the deposit level in the channel flood plain. From this evidence, it seems logical that particle settlement at this location is not responsible for the deposits but that the deposits are the result of density flow. Photographs PP-2815 and 2816 (Figure 5) show parts of bench slopes with no sediment deposits that run directly into the light density deposits. It can be concluded that even the lightest particles of incoming sediment have settled to the bottom of the reservoir by the time they travel from the reservoir backwater reaches to the area adjacent to the dam. Further conclusions indicate that settlement to the reservoir bottom does not stop the downstream movement of sediment of small particle sizes in this large reservoir but the particles are carried by density flows on down to the dam. In Pathfinder this movement includes particle sizes up to 0.5 mm with dry densities of up to 80 pounds per cubic foot or higher, depending on exposure, drainage, and length of time for compaction.

Small tributaries entering this area had deposited a few feet of sand along their channels in contrast to the light density deposits along the river channel.

## Sedimentation on Sweetwater Arm

### Delta Area

The Sweetwater River does not carry an appreciable sediment load into Pathfinder Reservoir but at the present time is the major contributor of sediment since the North Platte River is controlled by Kortes and Seminoe Reservoirs immediately upstream. Sediment deposits of depths of 6 to 7 feet have occurred on the upper part or the reservoir in what could be called the delta area. The Sweetwater River flows in the shallow channel 25 feet wide in a meandering pattern across the deposits. Deposition has taken place over the flood plain of three-fourth mile in width (Photograph PP-2818, Figure 6).

The river channel follows the original meander pattern except for the reach between Ranges 39A and 40. In this reach the channel has changed from a meander pattern of about 1,500 feet in width to a fairly straight channel with no indication of meander. This change occurred during a period of decreasing slope. This probably is due to a change in channel regime from decreasing load and slope.

A sample secured from the bank near the river is shown in Photographs PP-2820, Figure 7. The top part of the sample, representing recent deposition, was jelly-like clay and silt. The deposited material increased in particle size with depth and changed to fine sands near the sample break in Photograph 2820. Below the fine sands the material graduated to coarse sands and fine gravels of up to 9 mm in size. Sample P-2 shown in PP-2822, Figure 7, was taken from the edge of the river. The top two-thirds of the sample was a jelly-like suspension of silt and clay which at first appeared solid. After a few hours, the suspension broke and the suspended materials settled to a depth of about 3 inches. This suspension had a dry density of 16 pounds per cubic foot (P-2T, Figure 15, and Table 1). The coarse sand and fine gravels had a density of 118 pounds per cubic foot (P-2B, Figure 15, Table 1). The coarse sample was very similar to the bed material of the Sweetwater River above the back water reaches of the reservoir.

### Narrows Area

The thalweg profile shown in the 1950 resurvey (Figure 2) shows approximately 17 feet of deposits at Range 34A above the original river bed. At the present time, the river in the Sweetwater arm of Pathfinder Reservoir near Range 34A appears to be flowing in its original cobble bed after cutting through only 3 to 4 feet of sand deposits (Figure 8). The material deposited near the entrance to the "narrows" section is 6 percent clay, 15 percent silt, 74 percent sand, and 5 percent gravel up to a maximum size of 9 mm (Sample P-3, Figure 15, and Table 1). The "narrows" section appears to be an effective filter to settle out particles of a wide range in size. Silt and clay particles that are carried into the "narrows" section appear to be carried on through it in suspension.

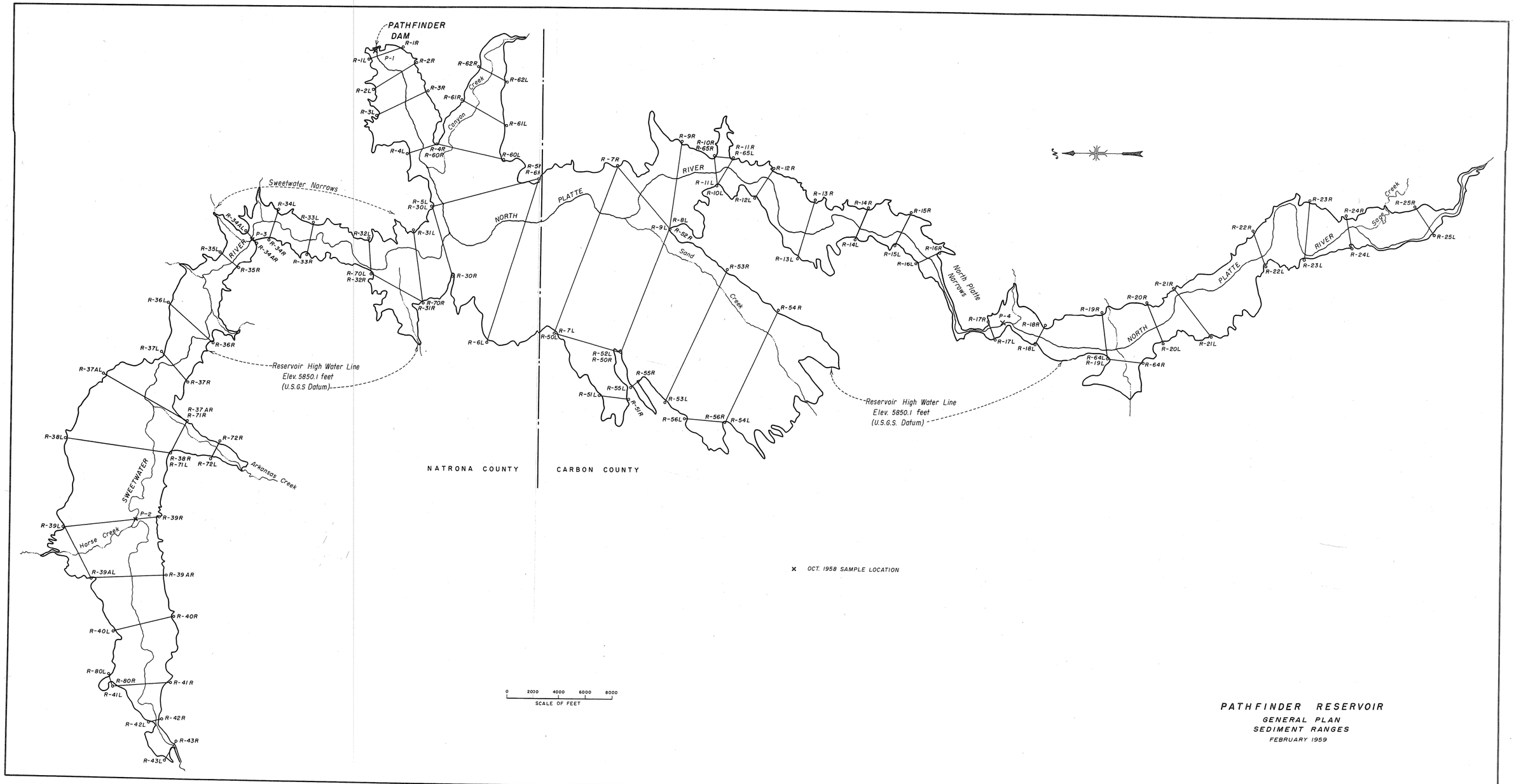
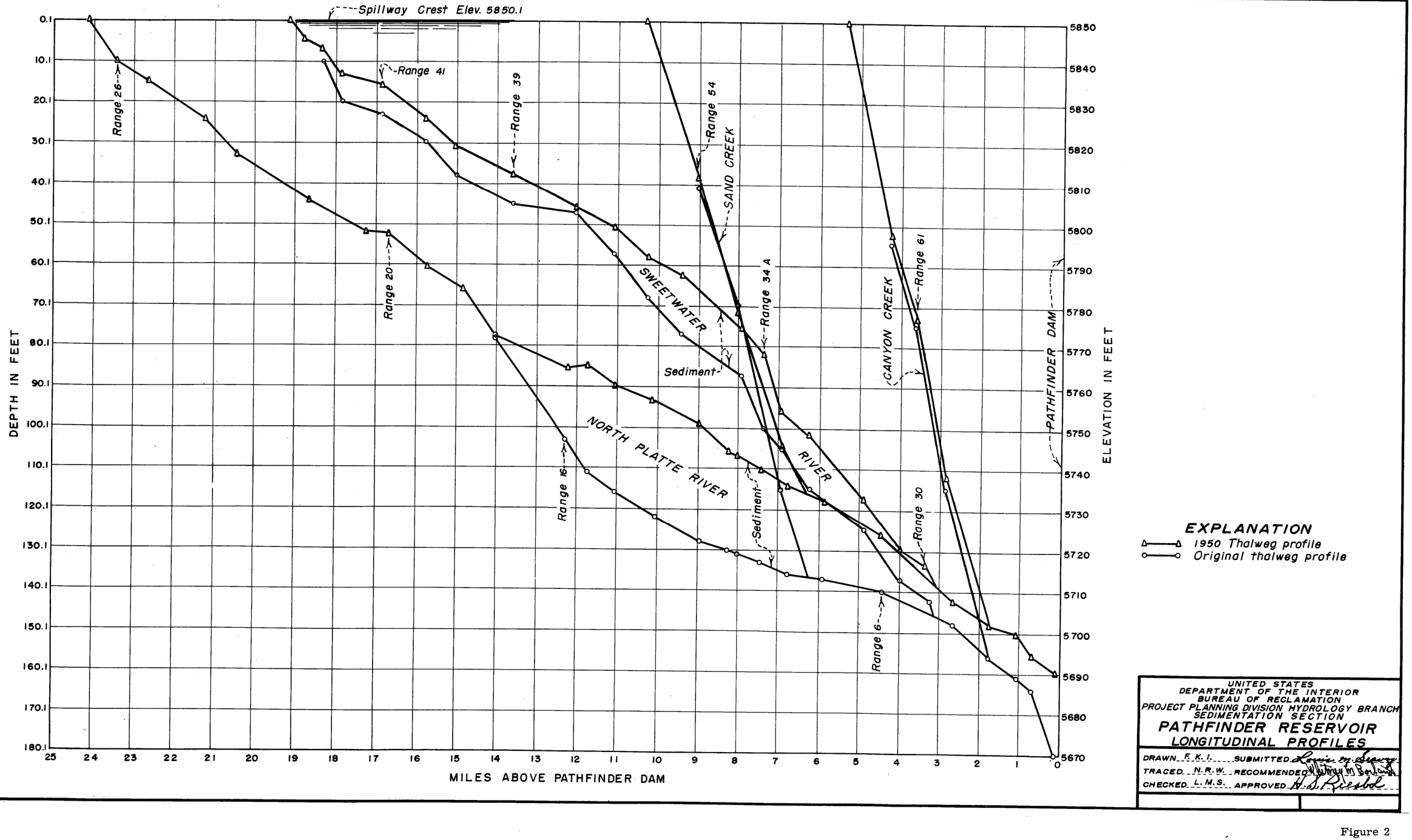

PATHFINDER DAM
R-1R
R-1L
P-1
R-2R
R-2L
R-3R
R-3L
R-62R
R-62L
R-61R
Canyon Creek
R-61L
R-4L
R-4R
R-60R
R-60L
R-5R
R-6R
R-5L
R-30L
R-7R
R-9R
R-10R
R-65R
R-11R
R-65L
R-12R
R-11L
R-10L
R-12L
R-13R
R-14R
R-15R
R-13L
R-14L
R-15L
R-16L
R-16R
North Platte Narrows
R-17R
P-4
R-17L
R-18R
R-18L
R-19R
R-19L
R-64L
R-64R
R-20R
R-20L
R-21R
R-21L
R-22R
R-22L
R-23R
R-23L
R-24R
R-24L
Soda Creek
R-25R
R-25L
NORTH PLATTE RIVER
PLATTE RIVER NORTH
Sweetwater Narrows
R-34AL
R-34L
R-33L
R-32L
R-31L
P-3
R-34R
R-34AR
R-33R
R-35L
R-35R
R-70L
R-32R
R-70R
R-31R
R-30R
R-8L
R-9L
R-8R
Sand Creek
R-53R
R-54R
R-7L
R-6L
R-50L
R-52L
R-50R
R-55R
R-55L
R-51L
R-51R
R-53L
R-56L
R-56R
R-54L
R-36L
R-36R
R-37L
R-37AL
R-37R
R-37AR
R-71R
R-38L
R-72R
R-38R
R-71L
R-72L
Arkansas Creek
SWEETWATER RIVER
P-2
R-39R
R-39L
Horse Creek
R-39AL
R-39AR
R-40R
R-40L
R-80L
R-80R
R-41R
R-41L
R-42L
R-42R
R-43R
R-43L
Reservoir High Water Line
Elev. 5850.1 feet
(U.S.G.S Datum)
Reservoir High Water Line
Elev. 5850.1 feet
(U.S.G.S. Datum)
NATRONA COUNTY
CARBON COUNTY
× OCT. 1958 SAMPLE LOCATION
0 2000 4000 6000 8000
SCALE OF FEET
PATHFINDER RESERVOIR
GENERAL PLAN
SEDIMENT RANGES
FEBRUARY 1959

Figure 1




**EXPLANATION**

1950 Thalweg profile

Original thalweg profile

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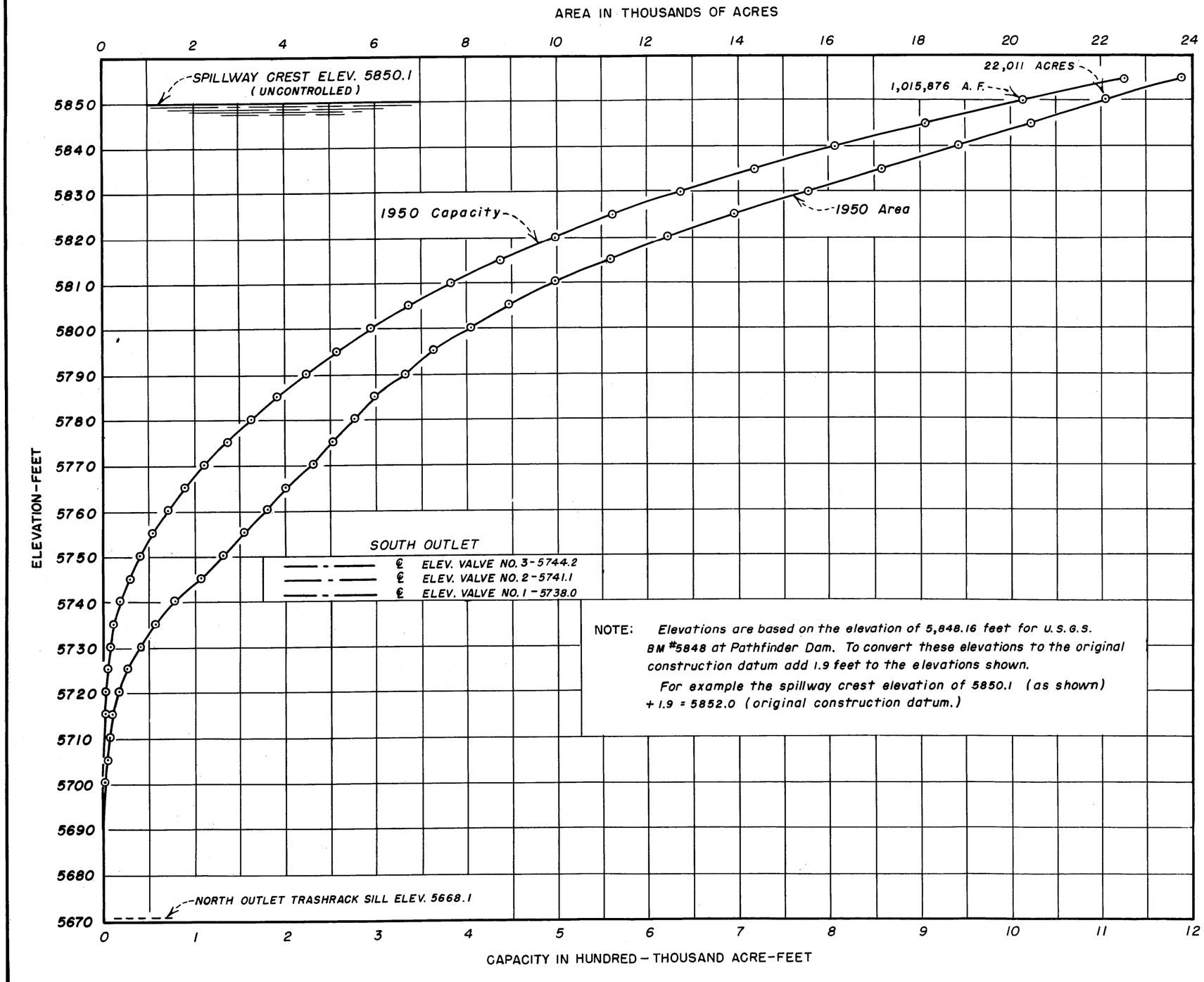
PROJECT PLANNING DIVISION HYDROLOGY BRANCH
SEDIMENTATION SECTION

**PATHFINDER RESERVOIR**
**LONGITUDINAL PROFILES**

DRAWN F.K.I. SUBMITTED Louis M. Laury
TRACED N.R.W. RECOMMENDED William M. Borland
CHECKED L.M.S. APPROVED H.J. Riesbol

Figure 2




1950 SURVEY

| *Elevation Feet | Area Acres | Storage Acre-feet |
|---|---|---|
| 5855 | 23,839 | 1,128,178 |
| 5850.1 | 22,011 | 1,015,876 |
| 5845 | 20,431 | 907,673 |
| 5840 | 18,835 | 809,534 |
| 5835 | 17,153 | 719,598 |
| 5830 | 15,528 | 637,931 |
| 5825 | 13,902 | 564,396 |
| 5820 | 12,465 | 498,512 |
| 5815 | 11,180 | 439,428 |
| 5810 | 9,938 | 386,664 |
| 5805 | 8,932 | 339,513 |
| 5800 | 8,108 | 296,931 |
| 5795 | 7,291 | 258,453 |
| 5790 | 6,680 | 223,538 |
| 5785 | 5,988 | 191,883 |
| 5780 | 5,513 | 163,138 |
| 5775 | 5,040 | 136,765 |
| 5770 | 4,632 | 112,594 |
| 5765 | 4,027 | 90,966 |
| 5760 | 3,599 | 71,912 |
| 5755 | 3,097 | 55,187 |
| 5750 | 2,621 | 40,909 |
| 5745 | 2,139 | 29,030 |
| 5740 | 1,573 | 19,786 |
| 5735 | 1,120 | 13,085 |
| 5730 | 818 | 8,261 |
| 5725 | 497 | 5,008 |
| 5720 | 351 | 2,899 |
| 5715 | 169 | 1,626 |
| 5710 | 123 | 898 |
| 5705 | 79 | 395 |
| 5700 | 37 | 111 |
| 5695 | 7 | 12 |
| 5690 | 0 | ** |
| 5685 | | |
| 5680 | | |
| 5675 | | |
| 5670 | | |

**Area and capacity at and below this elevation is negligible based on 1950 survey

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SEDIMENTATION SECTION
AREA AND CAPACITY CURVES
PATHFINDER RESERVOIR
NORTH PLATTE RIVER

DRAWN F.K.I SUBMITTED
TRACED R.F.S. RECOMMENDED
CHECKED F.K.I APPROVED

DENVER, COLO. 4-25-51

REV. 5-5-53 L.M.S.

Figure 3

## Sedimentation on North Platte Arm

Since construction of Seminoe Dam in 1939 above Pathfinder Reservoir, sediment deposition on the North Platte arm of Pathfinder Reservoir has virtually stopped. Deposits made before 1939 are in place and undisturbed except for a degraded channel which was cut by clear water, fluctuating releases from Seminoe and Kortes Reservoirs. The river is now flowing in its original alluvial gravels and cobbles after cutting through a maximum depth of about 15 feet of sediment deposits and some original alluvial gravels near the "narrows" section (Figures 10, 11, and 12). The deposits vary in depth from 15 feet at the "narrows" to a few feet at the upper end of the reservoir. Since the river is flowing in original alluvial material all the way down to the "narrows" the 1950 thalweg profile shows no difference in elevation between the 1950 profile and the original profile.

Undoubtedly clear water releases from Seminoe and Kortes have caused the degradation of the river back to the original profile by the reduction of spring flood flows with high sediment loads to a higher sustained clear water flow during the summer when the water surface in Pathfinder Reservoir is lowered from releases at Pathfinder Dam. It is apparent that only the deposits over the present channel have been removed with the major deposition over the flood plain still undisturbed by reservoir level or clear water releases upstream (Figure 10).

The deposits that have been removed to form the present channel are not necessarily those that covered the original channel. Near Range 17 just above the "narrows" the original river channel in 1903 followed the western hillside in a semicircle before entering the "narrows." The channel was in this same location in 1931, but between 1931 and 1950, the channel shifted to the east and now runs a fairly straight line across the original semicircle (see Figure 1 and Figure 10).

The material deposited above the "narrows" shows the effect of trapping action similar to the Sweetwater "narrows." The deposits are a sandy loam, with yearly layers topped by vegetation, composed of 7 percent clay, 22 percent silt, and 71 percent sand below a maximum particle size of 1 mm (Sample P-4, Figure 15 and Table 1).

## Sedimentation in the Central Basin

The large central basin of Pathfinder Reservoir was not observed because of inaccessibility. An observation of this area would have been most helpful in completing the pattern of deposition. However, various conclusions can be drawn from information and observations above and below the central basin. The basin, the largest part of the reservoir, acts as a settling basin for sediment moving through the two "narrows" section. A delta area of some type has likely developed below the mouths of both "narrows."

There is a strong possibility that the density flows which carry finer particle sizes to the downstream section of the reservoir may be formed or certainly aided by the two "narrows" sections. The long narrow sections of each arm would effectively aid the collection of finer particles together near the bottom of the thalweg channel into a current or flow which, when reaching the central basin, would continue as a density flow to the reservoir reaches near the dam.

In the lower part of the basin, complete settlement of almost all particles is accomplished and deposits in the lower part and on downstream are made by density flow action. The deposited material should be a combination of sands, silts, and clays with a mean size of about 0.08 mm. Deposition likely is limited to a band along the original river and flood plain whether deposited by particle settlement or density flow action. The two rivers have probably not cut into the deposits any more than is necessary to form a shallow channel since reservoir evacuation.

## Effect of Reservoir Evacuation

Complete evacuation of Pathfinder Reservoir has had some minor effects on sediment deposits. On the North Platte arm no effect is apparent since the river moved into its cut channel and may have cut only some small amount of material from the deposited banks. On the upper Sweetwater arm, the river flows in a shallow channel and is not cutting into the sediment deposits other than as it enters the "narrows" section. Little consolidation is taking place as the upper area deposits are composed mostly of larger sediment particles. In the central basin some deposit cutting is likely taking place, providing some drainage and some consolidation. In the area adjacent to the dam and below the central basin, some drainage is occurring next to the river channel and therefore some consolidation. In the gorge section, deposits have been cut by the river because the slope is increased and a moderate amount of consolidation has occurred. Material that has been cut from the lower reservoir area is carried through the outlet works and is deposited downstream from the dam (Figures 13 and 14). A sample analysis of this material showed 5 percent clay, 15 percent silt, and 80 percent sand below a maximum size of 2 mm (Sample P-5, Figure 15, and Table 1). Silts and clays finer than Sample P-5, cut from the lower reservoir deposits have been carried on downstream to Alcova Reservoir and, therefore, this size analysis is an indication of maximum size material removed from Pathfinder. It was apparent that only a very small amount of sediment has been removed from the reservoir since evacuation.

## SUMMARY

Three types of sediment action influence the pattern of deposition taking place in Pathfinder Reservoir: (1) deposition of bed material

particles, (2) settlement of suspended particles, and (3) particle movement by density flow action. Generally, these three steps account for the deposits in order moving downstream. Overlapping of two actions and deposits from the actions may occur within the reservoir depending on inflow conditions, deposit slopes, channel and valley side slopes, and reservoir level fluctuations. The uniform nature of most Pathfinder deposits at any location and the uniform decrease in size of deposited sediment particles with distance from the head of the reservoir shows an orderly pattern of sediment action and deposition. At the head of both arms the larger bed load material has deposited. From the head on down through the middle of the reservoir, deposition is mostly the result of suspended sediment particle settlement. In the reservoir area upstream from the dam, evidence points to density flow action as the cause of deposition.

The one unusual and nonuniform type of deposition in Pathfinder Reservoir is the layer of fine material overlying the coarse bed load material in the delta area of the Sweetwater River area. According to the evidence and discussion by Lane earlier presented in this report, it is logical that the fine material is the result of an underflowing turbidity current formed by the settlement of suspended particles near the location of Sample P-2. By using the dry unit weight and the wet unit weight of Sample P-2T, the maximum concentration of the suspended fine material would be 225,900 ppm. This concentration is certainly not in excess of any concentrations ever measured in a moving stream and could possibly flow down the river channel to the dam while the reservoir was full, although the concentration is higher than most direct measurements of density currents have been in the past.

Evidence of a possible recent density current or underflowing turbidity current is present in the narrow gorge above the dam and at the dam itself. In photographs PP-2817 and PP-2835 a discoloration of the gorge walls approximately 10 feet above the sediment deposit level is quite evident. This discolored zone could be the zone occupied by a recent density current upon reaching the dam. The two evidences at extreme ends of the reservoir could be indications of an underflowing turbidity current which passed through the entire reservoir. The most plausible explanation of the discolored zone near the dam, however, is the retention of a small pond of about 500 to 800 acre-feet for about 28 days during September 1958 before the reservoir was completely drained. The small storage would allow the river to pick up fine sediment above the storage level and carry it to the dam. The pond would therefor be quite muddy and could easily have discolored the gorge rocks and dam face up to the water surface.

In the small valley immediately above the dam and gorge section, the light density, fluid mixture of fine particles, and water is not an unusual reservoir deposit. The one fact that stands out about this type of deposit is the absence of any sediment deposit above the level in the channel flood plain. This clearly indicates the deposit is the result of a flow of sediment particles rather than a settlement of sediment

particles. The dam has made a "reservoir" of sediment in the lower area with inflow as a density flow of sediment. The two "narrows" areas on both areas could be instrumental in forming the density flows in the lower reservoir by trapping larger sediment particles above and aiding in the collection of the smaller particles into a current or flow. These density flows in the lower reservoir area would appear to have a much higher concentration and density than the usual density currents or underflowing turbidity current.

A summary of the sediment samples is shown in Table 1 and Figure 15 and their location in the reservoir is shown on Figure 1 and Figure 16. Figure 16 shows the sample location with respect to elevation and reservoir fluctuation over the last 10 years. The unit weight computations[4] from particle size analysis (Table 2) are quite accurate for deposited material in the sand, silt, and clay range but do not express an accurate unit weight for deposits containing an appreciable percent of material larger than the sand sizes. (Sample P-2T should be excluded since the laboratory unit weight is based on a suspended condition.) The size analyses of samples obtained during this observation compare favorably with samples obtained by the Corps of Engineers in 1931 [1].

All deposits tend to be level at any cross section but may slope to the channel from river action during drawdown periods as on the Sweetwater arm or may be sharply cut as on the North Platte arm. The two conditions on the reservoir arms make an interesting contrast in deposit formation and river action.

Longitudinal slopes of deposits vary a great deal throughout the reservoir. The deposit slopes upstream from the narrow section on the North Platte arm have decreased from an average of 7 feet per mile to 5 feet per mile in a uniform pattern. The deposit slopes on the Sweetwater arm are nonuniform, some slopes have increased and others have decreased during deposition. A short slope in the Sweetwater delta area was approximately 0.0003 while the general slope in the area was about 0.001. This short flat slope was in the area of deposition of the clay and silt layer over sand and gravel (Sample P-2).

The deposition pattern in Pathfinder Reservoir is generally typical of large reservoirs with an interesting contrast between the pattern in the two arms.

## ACKNOWLEDGMENTS

The cooperation of Regional Director R. J. Walters, Project Manager I. J. Matthews, and M. M. Starr, Chief, Engineering and Project Investigations Division in arranging for the observation survey of Pathfinder Reservoir deposits is gratefully acknowledged. The field work, analysis of data, and preparation of this report were carried out by Mr. John R. Sheppard of the Sedimentation Section, Hydrology Branch, Denver. Messrs. J. B. Marshall and K. A. Grover of the Casper Project Office assisted in the collection of the field data.

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(1) "Sedimentation Surveys of Pathfinder and Seminoe Reservoirs, North Platte River, Wyoming," Project Planning Division, Denver, Colorado, May 1953.

(2) "Density Currents as Agents for Transporting Sediments," H. S. Bell, Journal of Geology, Vol. 50, No. 5 July-August 1942, pp. 512-547.

(3) "Some Hydraulic Engineering Aspects of Density Currents," Hydraulic Laboratory Report No. Hyd.-373, Bureau of Reclamation, August 31, 1954.

(4) "Determination of the Unit Weight of Sediment for Use in Sediment Volume Computations" by Carl R. Miller, U. S. Bureau of Reclamation, February 17, 1953.

Table 1

LABORATORY UNIT WEIGHT DETERMINATIONS
Pathfinder Reservoir
Sediment Deposit Samples
October 1958

| Field sample No. | Volume of sample (cu ft) | Wet unit weight (lb/cu ft) | Dry unit weight (lb/cu ft) |
|---|---|---|---|
| P-1 | .0236 | 108.9 | 78.4 |
| P-2T | .0329 | 72.6 | 16.4 |
| P-2B | .0195 | 135.7 | 118.0 |
| P-3 | .0269 | 106.3 | 86.2 |
| P-4 | .0430 | 113.6 | 90.7 |

P-5 - No unit weight test

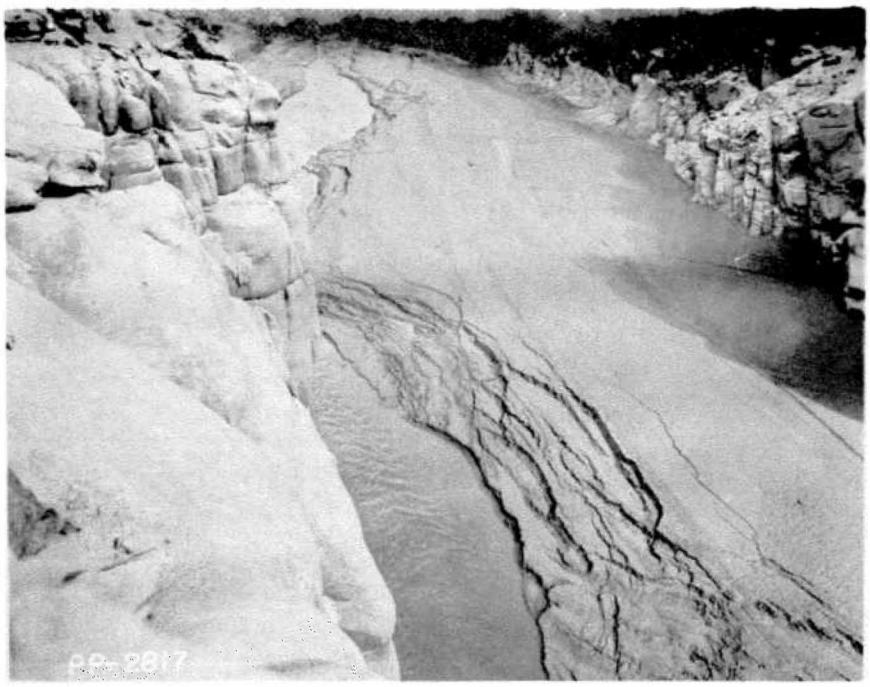
**Table 2**

COMPUTED UNIT WEIGHTS
PATHFINDER RESERVOIR
SEDIMENT DEPOSIT SAMPLES
October 1958

| Field sample No. | Size Analysis (Percent by weight) Clay | Silt | Sand | Estimated* condition of deposits | Estimated age of deposits | Initial** unit weight | Computed unit weight | Laboratory unit weight |
|---|---|---|---|---|---|---|---|---|
| P-1 | 15 | 51 | 34 | b | 2 | 68.3 | 76.7 | 78.4 |
| P-2T | 28 | 40 | 32 | - | 0 | 64.2 | - | 16.4 |
| P-2B | 1 | 2.5 | 96.5 | c | 24 | 92.7 | 93.4 | 118.0 |
| P-3 | 6 | 15 | 79 | a | 19 | 85.0 | 86.7 | 86.2 |
| P-4 | 7 | 23 | 70 | b | 45 | 82.2 | 87.4 | 90.7 |
| P-5 | 5 | 15 | 80 | - | 0 | 85.7 | - | - |

*a. Sediment always submerged or nearly submerged
b. Normally a moderare drawdown
c. Normally considerable drawdown
d. Reservoir normally empty

**Based on Condition a



PP-2817--Exposed sediment deposits between Ranges 1 and 2, Pathfinder Reservoir about one-third mile above the dam. These clay, silt, and fine sand deposits in the narrow gorge section have drained to some extent and are of medium density in comparison to the saturated light density material shown in PP-2816. The river has cut 3 to 4 feet into these deposits since the reservoir was evacuated. 10-28-58

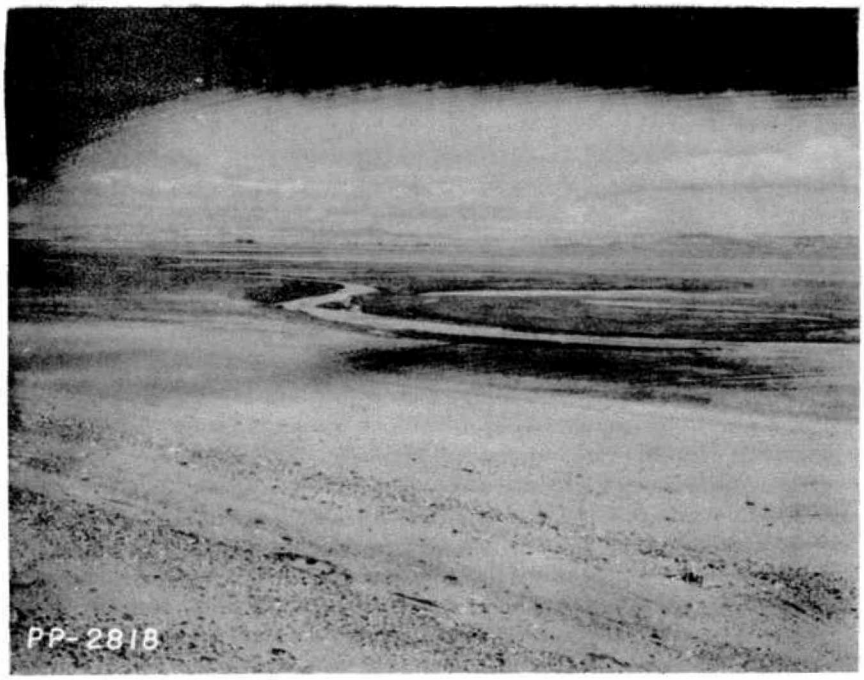
PP-2835--View of upstream face of Pathfinder Dam after reservoir evacuation. River is flowing into lower north outlet tunnel. The triangular shaped lower right deposits of clay, silt, and fine sand have been undisturbed by construction activity and are at elevation 5696.7, approximately up to the top of the north intake vertical trashracks. 10-31-58

**Figure 4**


PP-2815--Exposed sediment deposits at Range 2, Pathfinder Reservoir about one-half mile above the dam. Deposits are mostly clay, silt, and fine sand of light to medium density. 10-28-58


PP-2816--Exposed sediment deposits between Ranges 2 and 3, Pathfinder Reservoir about three-fourths mile above the dam. Deposits are mostly clay, silt, and fine sand of light density that will not support the weight of a rock. Windblown sand is also apparent on the upper bench above the river flood plain. 10-28-58

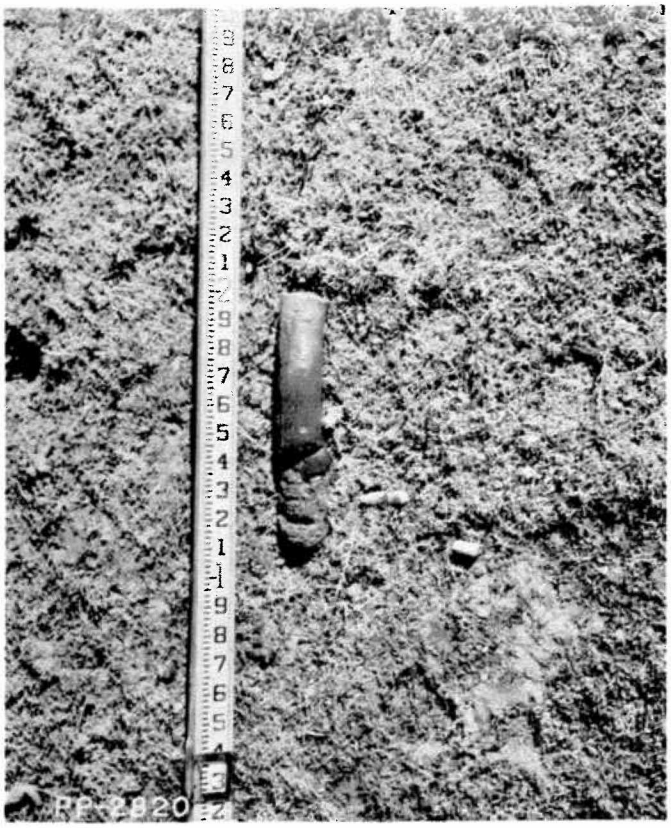
Figure 5



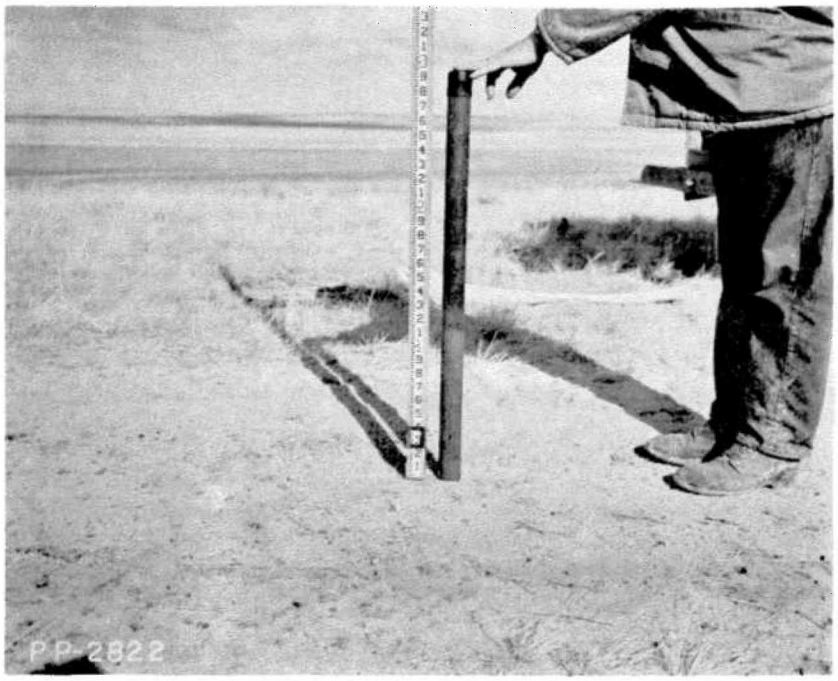

PP-2818--Upper Sweetwater arm of Pathfinder Reservoir between Ranges 38 and 39 looking upstream to the left. 10-29-58


PP-2821--Sweetwater River above Range 38, Pathfinder Reservoir, looking downstream at delta area. Slope of deposits in this area is approximately 0.0003. 10-29-58

**Figure 6**

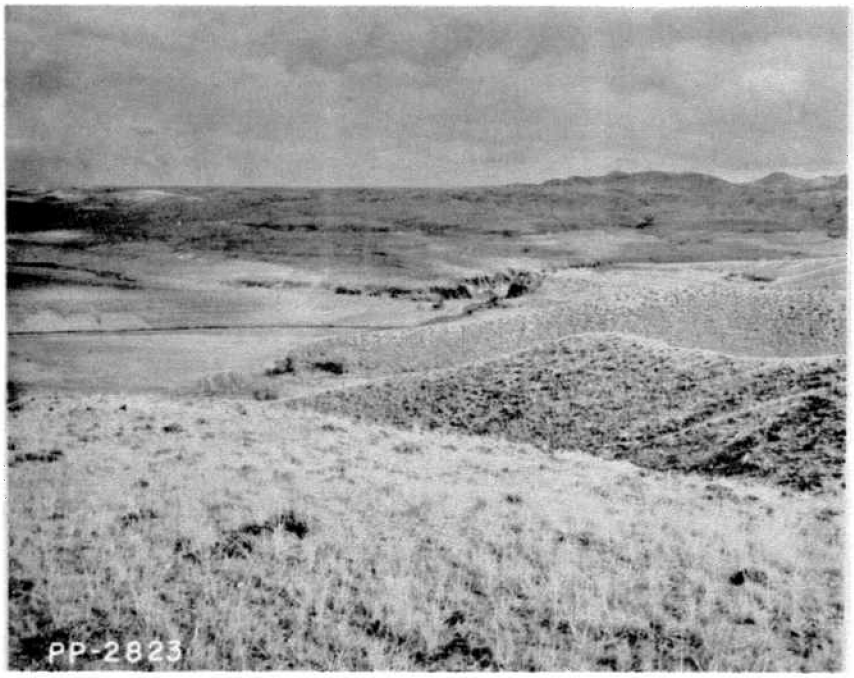



PP-2820--Sample of bed material removed from Sweetwater River between Ranges 38 and 39, Pathfinder Reservoir. Top 6 inches of material is jelly-like clay and silt suspension. Material below 6 inches is a coarse sand to medium gravel deposit. 10-29-58




PP-2822--Sample of deposited material from bed of Sweetwater River between Ranges 38 and 39, Pathfinder Reservoir. The upper two-thirds of this sample is jelly-like clay and silt which is in a thick suspension. The suspension later broke and the sample tube contained approximately 6 inches of clay-silt and the rest of the upper tube was clear water. The lower one-third of the tube is coarse sand to medium gravel. 10-29-58

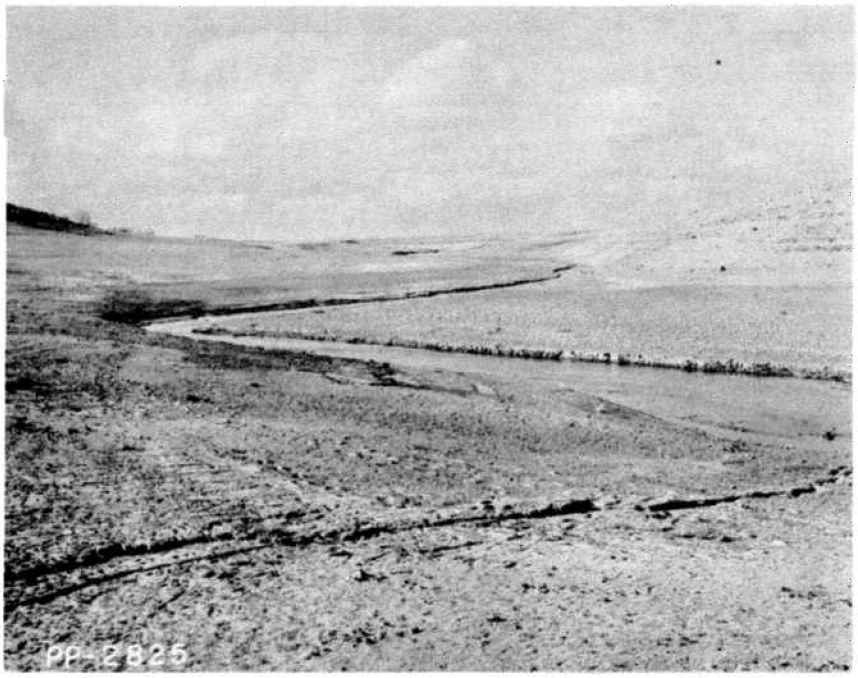
**Figure 7**



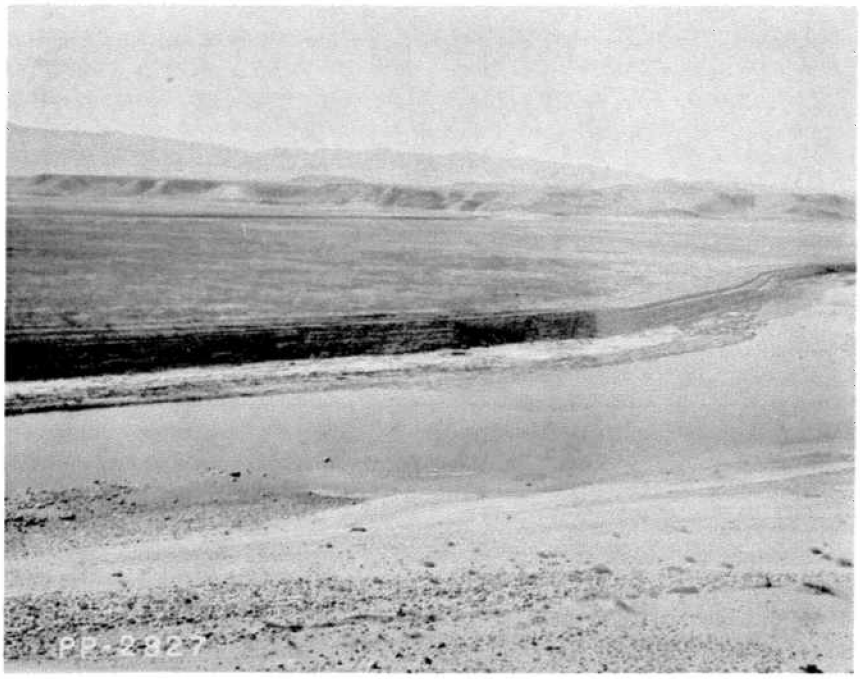

PP-2823--View of "narrows" on Sweetwater arm of Pathfinder Reservoir. 10-28-58


PP-2824--Sweetwater River in "narrows" at Range 34A, Pathfinder Reservoir. River has cut through 3 to 4 feet of coarse sand deposits in this area and is in its original cobble bed. 10-29-58

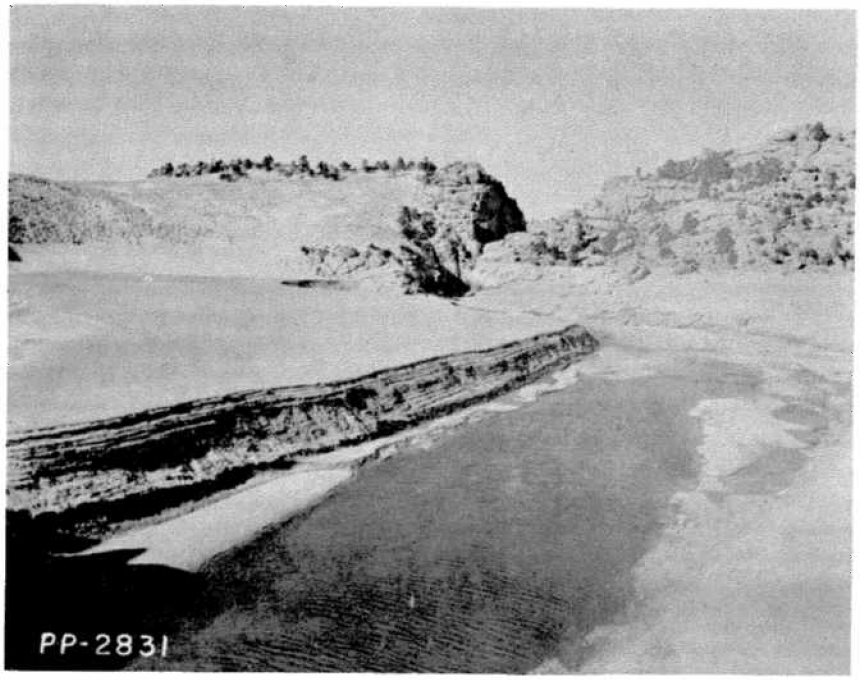
Figure 8



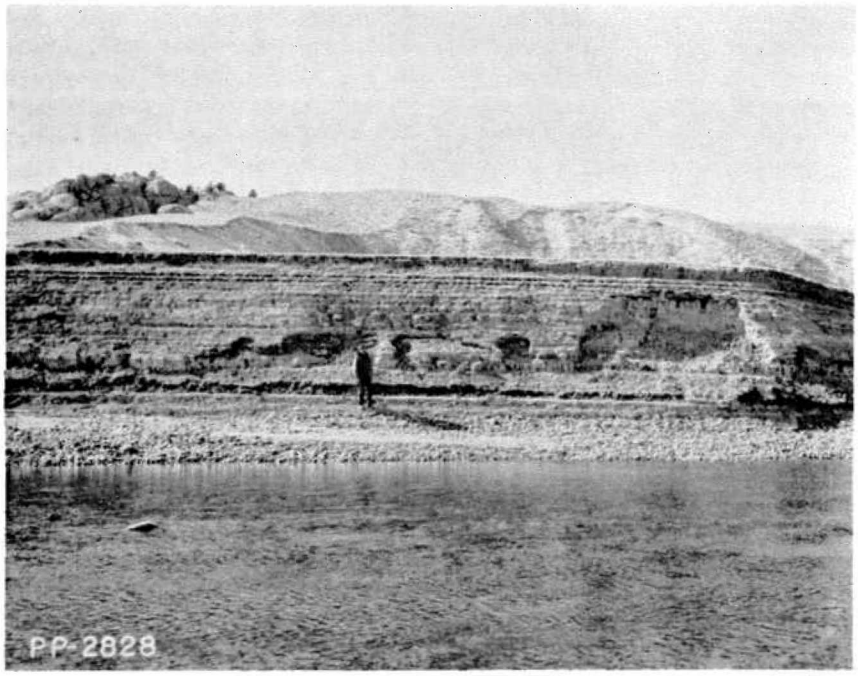

PP-2825--Sweetwater River just above Range 34A looking upstream toward Range 35 before river enters the "narrows", Pathfinder Reservoir. The river has not cut the sediment deposits to any extent and has not reached its original cobble bed as it has after entering the "narrows" section. 10-29-58



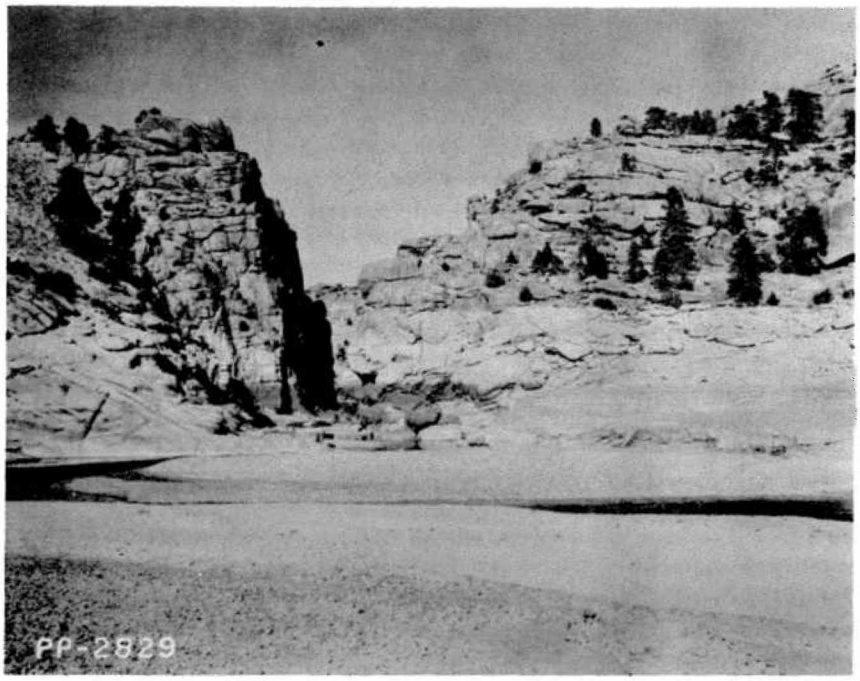
PP-2827--Sediment deposits on North Platte River arm of Pathfinder Reservoir about 1/4 mile upstream from Range 22. Deposits are about 7 feet high and were deposited before construction of Kortes and Seminoe Dams upstream. 10-30-58




PP-2831--Flat deposition of sediment above "narrows" of the North Platte River arm, Pathfinder Reservoir, looking toward Range 17. River has cut through deposits to alluvial sands and gravels. 10-30-58




PP-2828--Sediment deposits on left bank near Range 17 above the North Platte River Narrows, Pathfinder Reservoir. These deposits are approximately 15 feet high and composed of sandy loam material. River has cut through the deposits to its original alluvial sands and gravels. 10-30-58



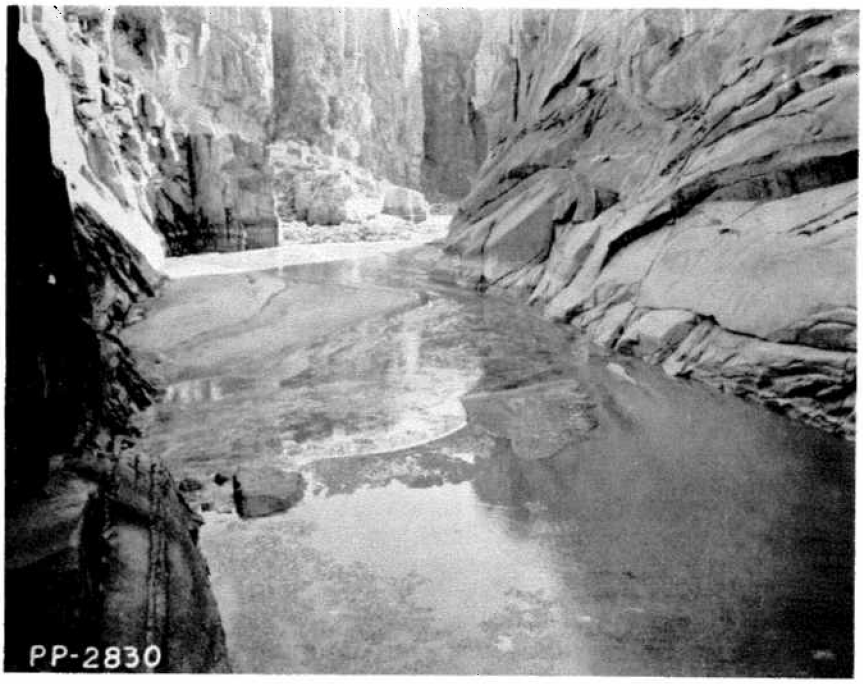

PP-2829--"Narrows" section of North Platte River arm of Pathfinder Reservoir just below Range 17. High water line (white) is apparent. Lower dark line on rocks is the same elevation as cut deposits shown on right side indicating about 20 feet of sediment deposits were cut out of "narrows" section by the river. 10-30-58

Figure 11


PP-2832--Looking upstream from "narrows" section of North Platte arm of Pathfinder Reservoir toward Range 18. Level deposits shown on left. On right side of picture, sediment deposits have been covered by wind-blown sand. 10-30-58


PP-2833--Left bank of cut deposits about 25 feet high near Range 17, North Platte arm of Pathfinder Reservoir. The lower strata is alluvial river gravels with the layered sediment deposits above. Material above is sandy loam. 10-30-58

**Figure 12**




PP-2830--Deposits of material washed from Pathfinder Reservoir and deposited just below Pathfinder Dam. No deposits were present in the river channel before the reservoir was evacuated. 10-31-58


PP-2834--Deposits of material washed from Pathfinder Reservoir and deposited just below Pathfinder Dam. No deposits were present in the river channel before the reservoir was evacuated. 10-31-58

**Figure 13**


PP-2836--Deposits of coarse silt to fine sand in the North Platte River about 1/2 mile below Pathfinder Dam. This material was washed out of the reservoir and deposited in the river channel during and after the reservoir was evacuated. 10-31-58

Figure 14

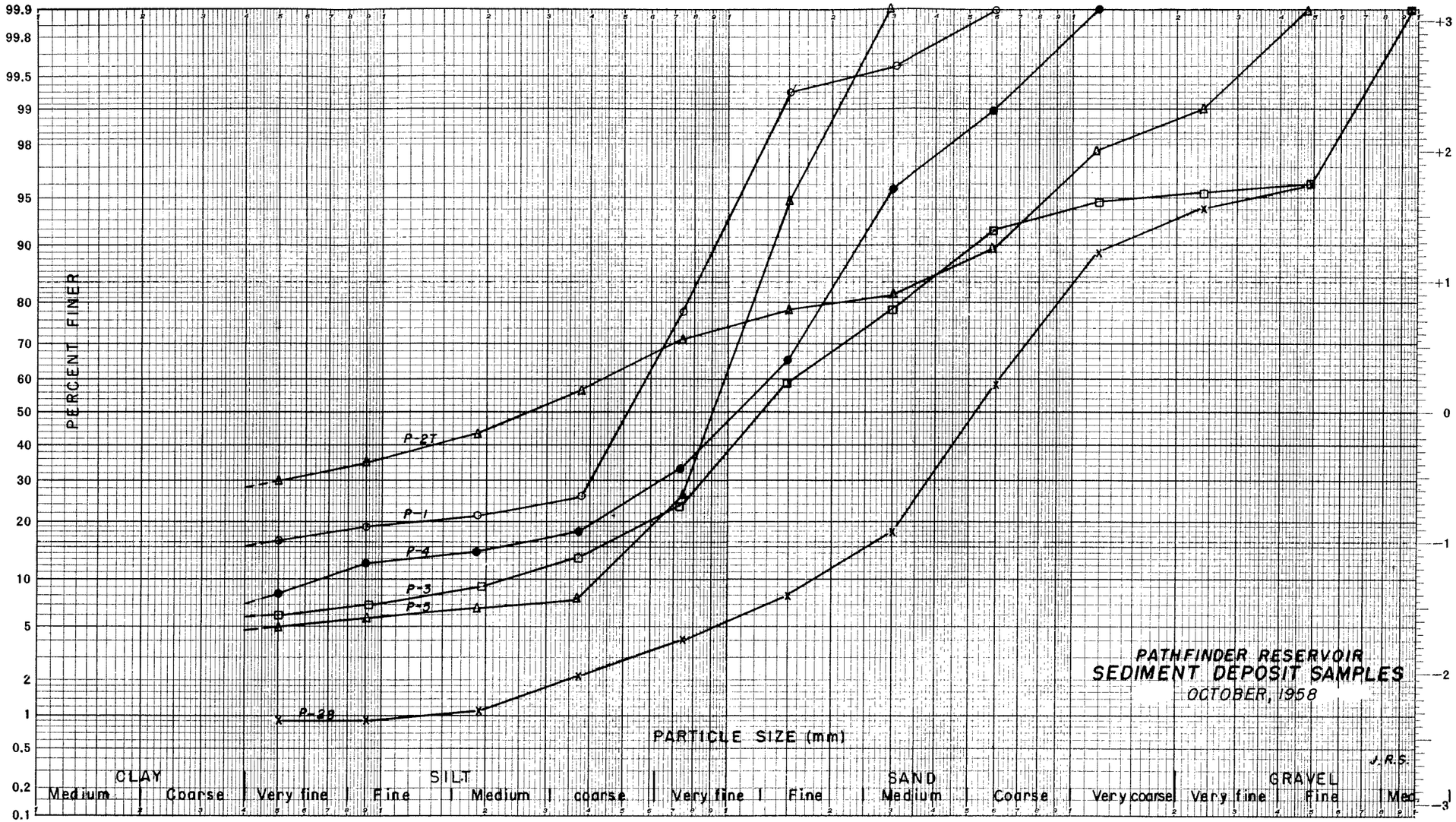

PERCENT FINER
99.9
99.8
99.5
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
+3
+2
+1
0
-1
-2
-3
P-2T
P-1
P-4
P-3
P-5
P-2B
PARTICLE SIZE (mm)
CLAY
Medium
Coarse
Very fine
Fine
SILT
Medium
coarse
Very fine
Fine
SAND
Medium
Coarse
Very coarse
GRAVEL
Very fine
Fine
Med.
PATHFINDER RESERVOIR
SEDIMENT DEPOSIT SAMPLES
OCTOBER, 1958
J.R.S.

FIGURE 15

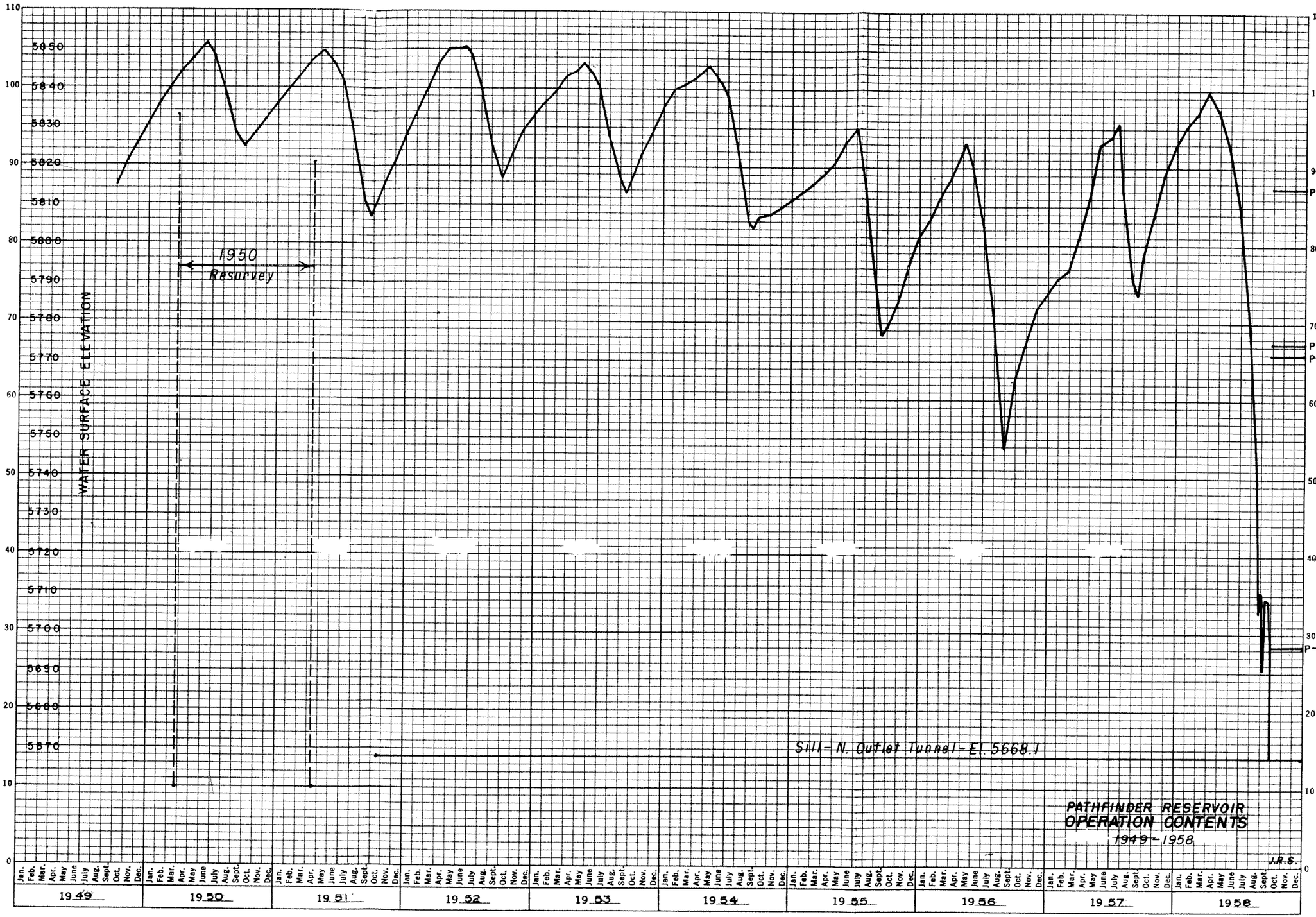



FIGURE 16

GPO 631381