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FORT COLLINS, COLORADO

FINAL REPORT  
TO  
NATIONAL SCIENCE FOUNDATION  
FACILITIES GRANT NO. GU 662

June 25, 1965

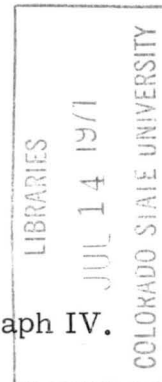
Colorado State University  
Fort Collins, Colorado

Engineering Research Center

D. B. Simons, Associate Dean for Research  
College of Engineering

Amount: \$32,500

Date of Completion: June 25, 1965  
Date of Occupancy: Does not apply  
Date of Final Acceptance: See paragraph IV.



June 1965

CER65DBS34

## PUMPING PLANT FOR ENGINEERING RESEARCH CENTER

### I. Introduction

The pumping plant just completed is a basic facility which provides the opportunity for research associated with graduate student and staff research at Colorado State University. Quoting from the proposal (NSF number UL 1053) which preceded the National Science Foundation Grant (No. GU 662):

"A pumping plant and accessories are proposed to supply water from College Lake to important teaching and research facilities located adjacent to the Northwest end of College Lake in the open-air Hydraulics, Fluid Mechanics and Hydrology Laboratory. . . . ."

It is my pleasure and privilege to report that the pumping plant has been completed (except as noted in paragraph IV) in accordance with the proposal UL 1053, dated August 1963, the supplement dated January 1964 and the letter dated March 19, 1965 which permitted substitution in Item 7 of paragraph C of the proposal and which letter also permitted extension of the termination date to July 1, 1965.

### II. Description of the Facility

The pumps in the pumping plant will supply water to the open-air hydraulics, hydrology, and fluid mechanics laboratory in a large area adjacent to College Lake, marked as the cross-hatched area (1) in the appended Figure 1. A general view of the pumping plant and its relation to the lake can be seen in Figure 2. Two pumps have been installed at the pumping plant. One is a 40 cfs pump at

40 ft head (see Fig. 3), equipped with a variable speed controller (see Fig. 4), and the other is a 6 cfs capacity, multiple stage turbine pump (see Fig. 5) for high head operation to deliver water to those research facilities which will require it and to pump College Lake water back to Horsetooth Reservoir.

The appurtenant facilities to the pumping station are:

1. A roadway to the site (see Fig. 6)
2. A sump at the pumping plant site and a channel from the lake leading to the sump.
3. A steel building sheltering the pumps (see Fig. 7).
4. Power supply to the pumps and to the research area. (see Figs. 8 and 9).
5. Twenty one hundred feet of 24 in. diameter pipe and 250 feet of 12 in. diameter pipe all underground to deliver and distribute water to the research area.
6. Valves to control the flow, installed on the pipe line.

The principal department that will be using this facility and the research area is the Civil Engineering Department. However, since the research programs are classed by functions rather than by departments, it is possible that Mechanical Engineering and Agricultural Engineering Department personnel may also be making ultimate use of the facility.

The staff and statistical data on graduate students in the Civil Engineering Department were reported in the proposal and are appended to this report for sake of convenience. The data on graduate students have been updated. The estimated enrollment has also been updated.

### III. Research to be Conducted Using the New Facilities and Planned Future Research

Several proposals have been prepared and submitted by D. B. Simons, S. Karaki, H.W. Shen, V. M. Yevdjovich and A. H. Barnes which will make immediate use of these facilities. Some of the proposals are imminent, others are only prospective.

D. B. Simons:

1. Study of Earth Channel Stabilization and Methods to Stabilize Channels. Submitted to Office of Research and Development, U.S. Department of Commerce, Bureau of Public Roads. Theoretical and experimental study.
2. Flood Protection of Bridges and Culverts. Submitted to Wyoming Highway Department. Theoretical and experimental study.

S. Karaki:

Investigation of Flow Bifurcation in an Open Channel. Submitted to Northern Colorado Water Conservancy District. Experimental research. Funded - Effective date July 1, 1965.

H. W. Shen:

Transport of Industrial Wastes and Pesticides on the Bed of Alluvial Rivers. Submitted to National Institute of Health. Theoretical and Experimental.

V. M. Yevdjovich:

1. Unsteady Free Surface Flow in a Long Storm Drain. Submitted to Department of Commerce, Bureau of Public Roads. This proposal

V. M. Yevdjovich (cont'd)

is to continue present study underway.

2. Floods from Small Watersheds. Submitted to U. S. Bureau of Reclamation under the Water Resources Research Act. Involves an artificial watershed basin of about 2 acres which will utilize the high head low discharge pump.

A. H. Barnes:

Study of the Hydraulics of Flow Through Solution Cavities. Submitted to Kalium Chemical Ltd. Theoretical and experimental.

For the future it is envisioned that more research proposals will be proposed by the staff who have many research ideas and interests. Particular study areas for future development utilizing the new pumping plant facilities are:

#### A. Hydraulics

1. Alluvial channel mechanics, stable channels and controls.
2. Geomorphological processes of rivers.
3. Hydraulic models and supercritical flow phenomena.
4. Hydro-mechanical and cavitation problems.
5. Unsteady flow phenomena in closed and open channels.

#### B. Hydrology

1. Runoff from small watersheds.
2. Hydrologic process of whole river systems.

#### C. Fluid Mechanics

1. Diffusion of sediments and wastes in alluvial channels.

#### IV. Construction Difficulties

The only unusual construction problem encountered in this project was related to the water surface level of College Lake. Because the lake is basically used to store water for irrigation and because of the peculiarities of water rights and ownership, too complicated and unnecessary to explain herein, the College Lake level is kept at a maximum from mid-September to mid-May. While the high lake level did not stop work on this project, in 1964 it did sufficiently impede progress so that the majority of the work was accomplished in the first 6 months in 1965.

The single major difficulty implied earlier in this report, is that at the time of this writing the final acceptance has not yet been made on the large 40 cfs pump. A test of all pipelines and the high head pump has been made and approved. During the test of the 40 cfs pump on June 15, 1965, a leak in the cooling line in the oil bath of the upper bearing of the pump was detected. The test was being conducted by the suppliers, Fairbanks Morse Inc., and was being witnessed by Mr. S. Karaki who was responsible for the entire project. No damage was done because of the immediate attendance to the leak and restitution will be made by July 15, 1965. Final acceptance will be reported in any event upon completion of the work.

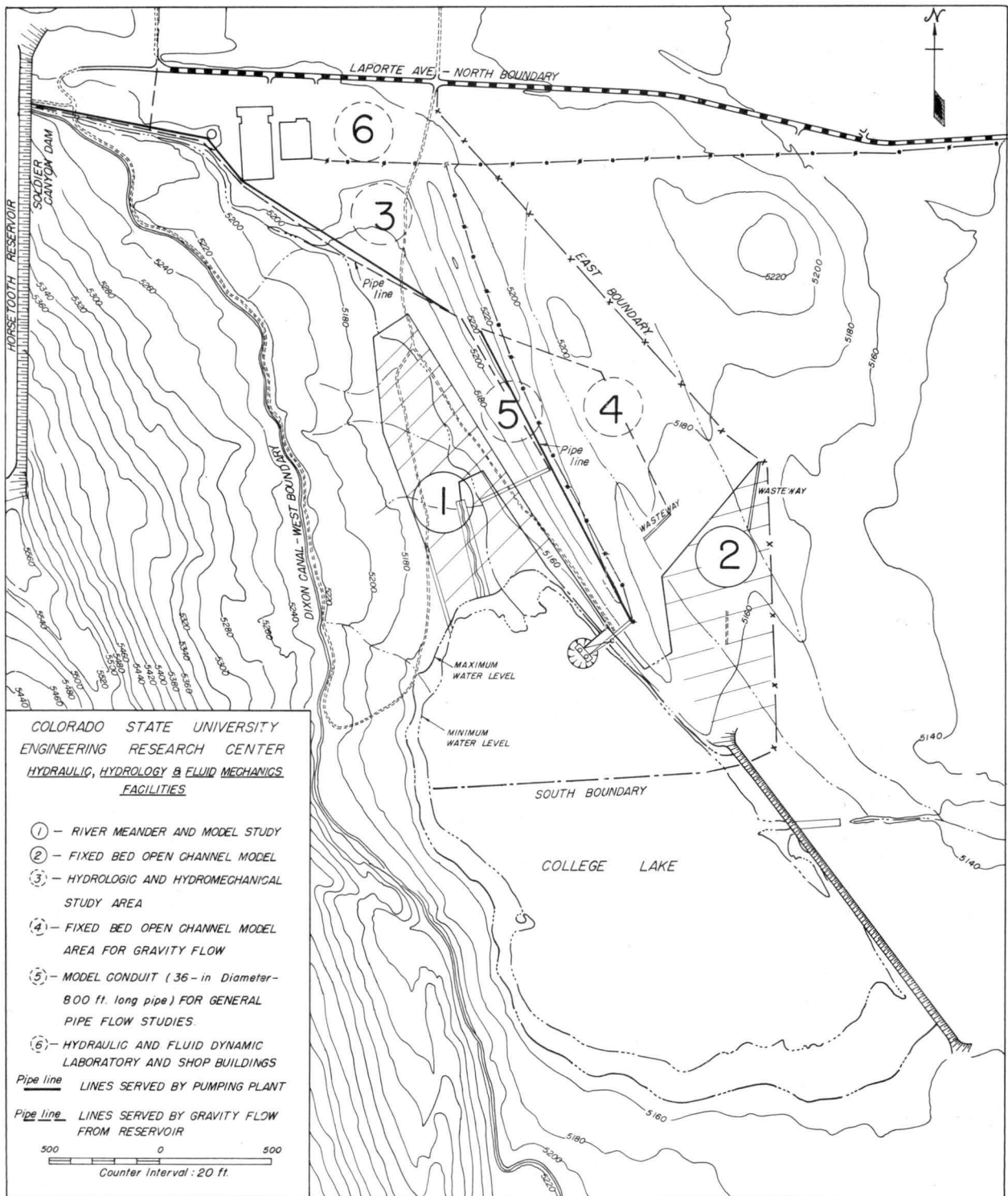
#### V. Comments

On behalf of Colorado State University, I wish to express our gratitude to the National Science Foundation Science Facilities Program whose assistance and funds made this worthwhile project possible. We firmly believe that the

particular program through which this grant was made is extremely valuable to those of us dedicated to education and research in science and engineering.

VI. Appendices

1. Figures 1 through 9.
2. Statistical Data on Graduate Students.





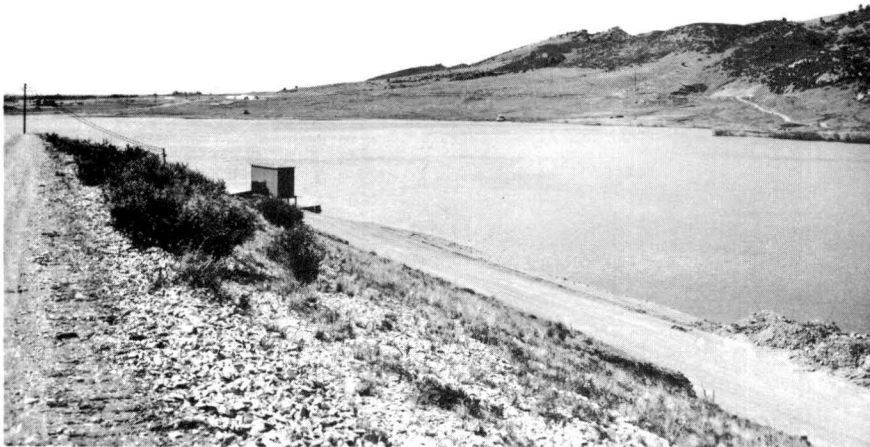


Fig. 2. General view of the pumping plant in relationship to the lake.

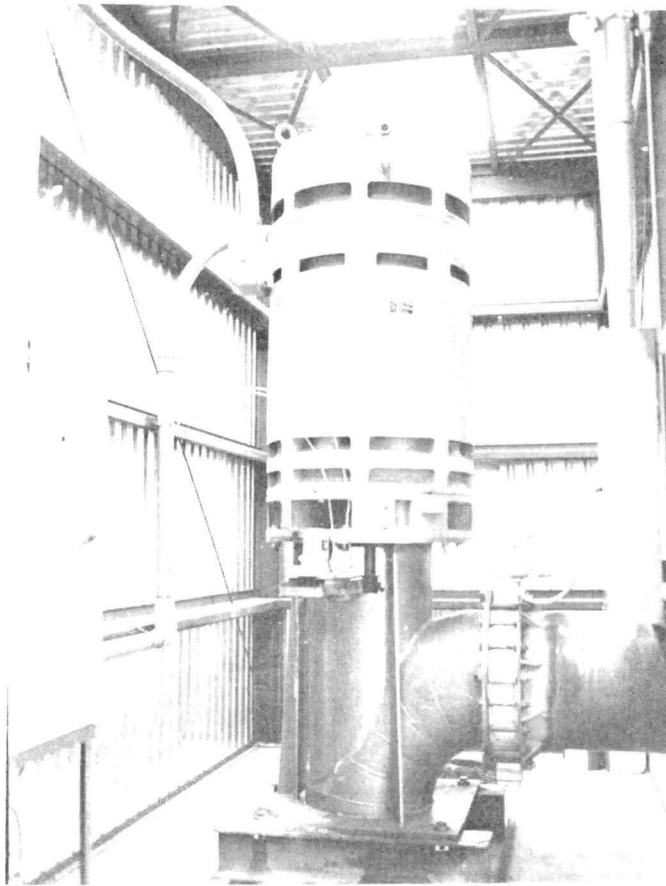


Fig. 3. Pump in pumping plant  
Rating: 40 cfs at 40 ft head.

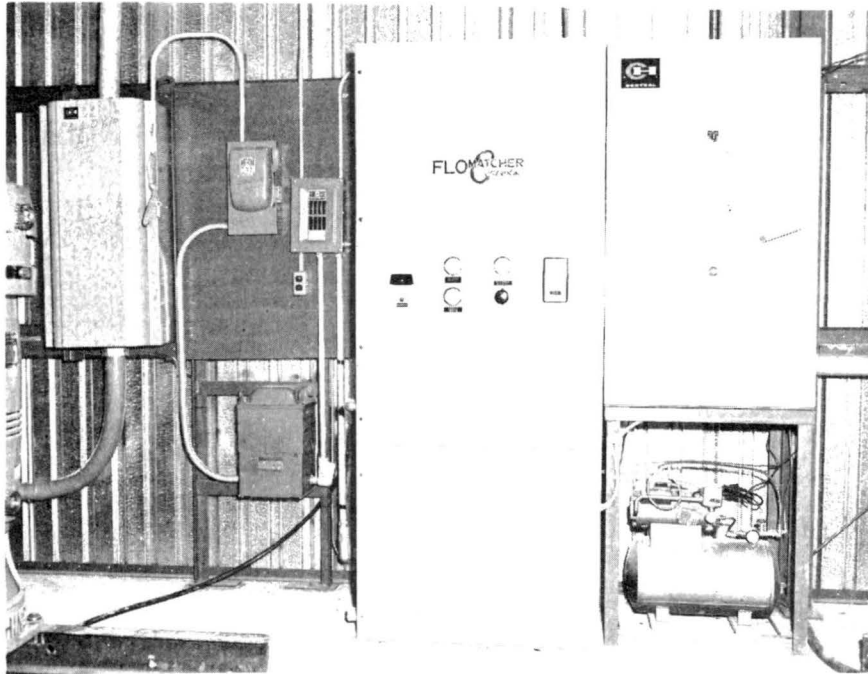


Fig. 4. Variable speed control for pump in Fig. 2.

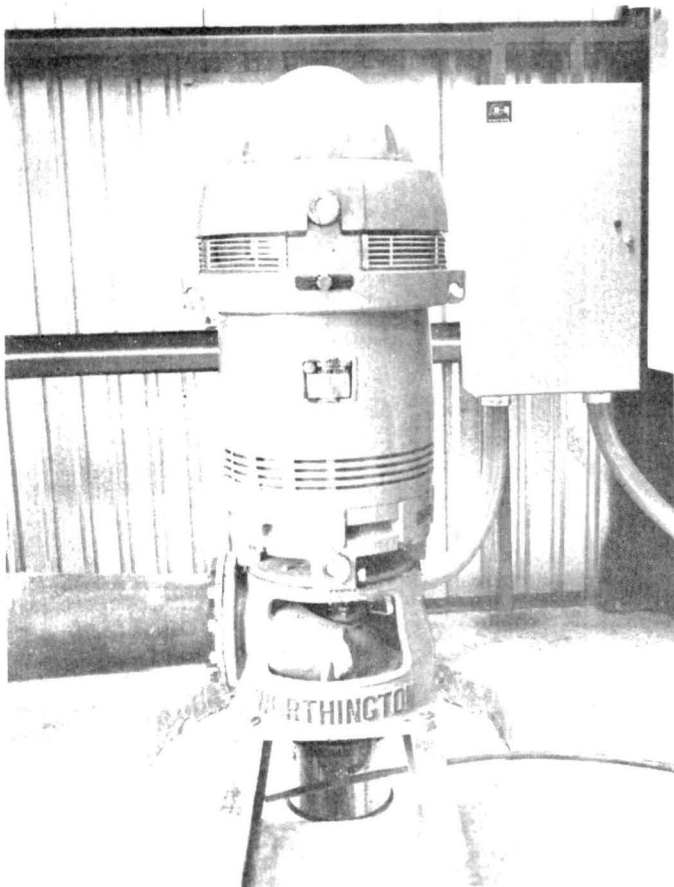


Fig. 5. Multiple stage pump  
Rating: 4 cfs at 280 ft head.



Fig. 6. Roadway to pumping station.

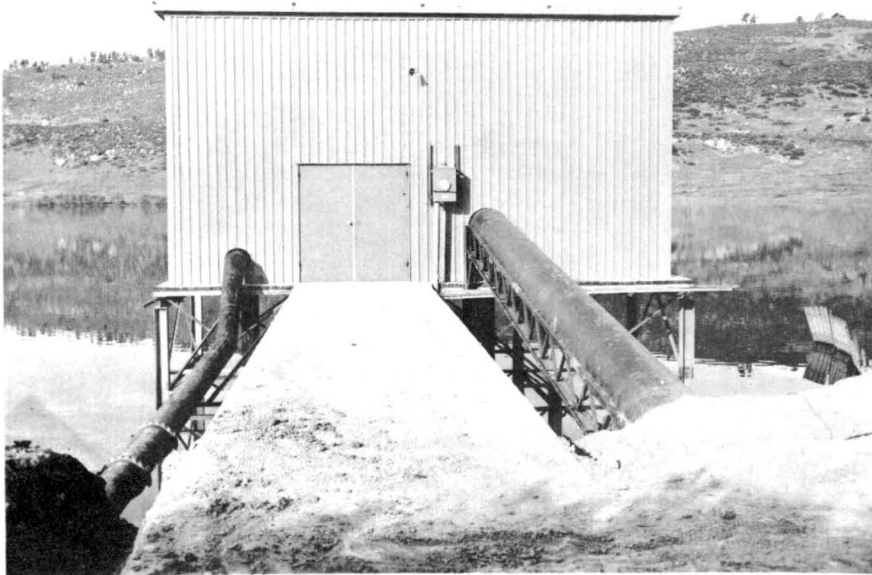


Fig. 7. Steel building which shelters the pumps and controls.



Fig. 8. Power supply to the pumping station.



Fig. 9. Power distribution center for research area outlined in Fig. 1.

## CIVIL ENGINEERING DEPARTMENT

Statistical Data on Graduate Students

| <u>ENROLLMENT</u>    | <u>M. S.</u> | <u>Ph. D</u> |
|----------------------|--------------|--------------|
| Fall Quarter 1958-59 | 17           | 12           |
| Fall Quarter 1959-60 | 19           | 14           |
| Fall Quarter 1960-61 | 11           | 22           |
| Fall Quarter 1961-62 | 21           | 27           |
| Fall Quarter 1962-63 | 39           | 29           |
| Fall Quarter 1963-64 | 48           | 40           |
| Fall Quarter 1964-65 | 66           | 49           |

ESTIMATED ENROLLMENT:

|                      |     |    |
|----------------------|-----|----|
| Fall Quarter 1965-66 | 96  | 68 |
| Fall Quarter 1966-67 | 100 | 75 |
| Fall Quarter 1967-68 | 110 | 80 |
| Fall Quarter 1968-69 | 115 | 85 |

DEGREES GRANTED:

|                           |    |    |
|---------------------------|----|----|
| June and August 1958      | 6  | 3  |
| June and August 1959      | 4  | 2  |
| June and August 1960      | 12 | 0  |
| June and August 1961      | 11 | 4  |
| June and August 1962      | 2  | 10 |
| June and August 1963      | 18 | 6  |
| June and August 1964      | 16 | 6  |
| June 1965                 | 7  | 7  |
| To be granted August 1965 | 6  | 6  |