



Harlem irrigation district
by Charles Sumner Heidel

A THESIS SUBMITTED TO THE GRADUATE STUDIES COMMITTEE MONTANA STATE
COLLEGE THE UNIVERSARY OF MONTANA

Montana State University

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Abstract:

The investigation of an irrigation district requires consideration of several major factors. These may be classified under the three general headings, legal, engineering and economic. It is the purpose of this thesis to give general statements covering these points, show how the Harlem Irrigation District was considered by the Irrigation District Bond Com-mission and present some additional data relating to this district.

FACTORS AFFECTING IRRIGATION DISTRICTS One of the reasons for the organization of most irrigation districts is to provide means to raise funds to pay for construction or purchase of works. This is usually accomplished ty the issuance and sale of bonds. An Irregularity in any of the legal proceedings relating to the creation of the district or in the steps taken leading up to the issuance of bonds would probably cause the bonds to be considered invalid. Consequently it is of utmost importance to a prospective bond purchaser, and therefore to a district, to make sure that all legal proceedings are or have been properly conducted.

HARLEM IRRIGATION DISTRICT

THESIS SUBMITTED TO

THE GRADUATE STUDIES COMMITTEE

MONTANA STATE COLLEGE

THE UNIVERSITY OF MONTANA

Charles Sumner Heidel

June, 1926.

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HARLEM IRRIGATION DISTRICT

SYNOPSIS

The investigation of an irrigation district requires consideration of several major factors. These may be classified under the three general headings, legal, engineering and economic. It is the purpose of this thesis to give general statements covering these points, show how the Harlem Irrigation District was considered by the Irrigation District Bond Commission and present some additional data relating to this district.

FACTORS AFFECTING IRRIGATION DISTRICTS

Legal

One of the reasons for the organization of most irrigation districts is to provide means to raise funds to pay for construction or purchase of works. This is usually accomplished by the issuance and sale of bonds. An irregularity in any of the legal proceedings relating to the creation of the district or in the steps taken leading up to the issuance of bonds would probably cause the bonds to be considered invalid. Consequently it is of utmost importance to a prospective bond purchaser, and therefore to a district, to make sure that all legal proceedings are or have been properly conducted.

In 1887 the California legislature passed the first irrigation district law which was called the "Wright Act". It has been frequently amended, but with its amendments has been the basis of, or afforded the suggestions for the irrigation district laws of most of the western states. Chapter 146 of the Montana Session Laws of 1909 is the basic irrigation district law of Montana. It and many of its amendments have been patterned after those of California.

A similar law allowing for organization under supervision of the State Public Service Commission is contained in sections 3953 to 4025 of the Revised Codes of Montana, 1921. A few districts have been organized under this act, but nearly all of the forty operating districts have organized under the provisions of Chapter 146, Laws of 1909 as amended. This law is contained in sections 7166 to 7264 of the Revised Codes of Montana, 1921 with amendments or additions in Chapters 54, 71, 103, 157 and 161 of the 1923 Session Laws, and in Chapters 89, 100, 125 and 136 of the 1925 Session Laws.

The principal irrigation district matters covered by the law include the organization of the district; the powers, duties and elections of the Boards of Commissioners; the petitioning for and issuance and sale of bonds; the construction of works; and the levying and collection of taxes and assessments. Due care must be

had that all steps are taken in an orderly manner and in accordance with the provisions of the laws previously cited.

An irrigation district is organized by court decree following a duly advertised hearing which is called after the district court receives a proper petition from land owners. Any interested parties may appear at such hearing to give their views, and a report of the State Engineer is required so as to advise the court concerning the engineering features involved and the possibilities of water supplies.

A district is governed by a board of commissioners, three, five or seven in number. Each represents a geographical division of the district and holds office for three years.

Landowners must petition the court to authorize their issuance before any bonds may be sold for construction purposes. But before they may take any steps for this purpose the approval of the Irrigation District Bond Commission is required. This commission is composed of the Attorney General, State Examiner and State Engineer.

The approval of a proposed bond issue by the Irrigation District Bond Commission entitles the bonds to certification by the Secretary of State as legal investments for trust funds, funds of insurance companies,

school funds and other public funds. Since approval by a similar commission and certification are provided for in most of the irrigation states, the bond buying public has become familiar with such bonds. Therefore a bond buying agency usually prefers certified bonds. During the course of construction of works paid for from the proceeds of a bond issue the State Engineer may take such steps as he deems advisable to satisfy himself that the money is being spent for the purposes for which the bonds were authorized. The district officials annually compute the required tax levy for district purposes, and give the county clerk a list of all lands in the district with the amounts of the assessments to be levied against such lands. The district taxes are then collected in the same manner and at the same time as the county and state taxes. The county treasurer is the custodian of district funds.

There are two major advantages possessed by the irrigation district form of organization. In the first place, the irrigation district laws of most of the states are similar. This is a great convenience to bond buyers who operate in several states. Secondly, the collection of district assessments by county tax collection machinery is usually more efficient and satisfactory than if handled by district employees. There is no chance for special favors which are frequently sought by water users under other forms of operation.

Engineering

The engineering features to be considered usually include those common to all irrigation projects. This portion of any report made usually embraces, among other things, a general description of the project and discussions of the lands, climate, crops, water supply, drainage, canals, dams and other structures and costs. Legal questions regarding water rights, rights of way, etc., are commonly referred to in engineering reports. Likewise economic studies are usually given and expected.

Economic

Until within the past five or ten years apparently little thought was given to the subject of proper colonization. At least, events have indicated that former accepted ideas on the subject were erroneous. Many a project was planned and construction started with very few settlers assured. Possible purchasers of land and water were induced to buy regardless of their training, experience or fitness for the job, and regardless of their financial ability to care for necessary preliminary expenses. This led to many mis-fits, and numerous unqualified settlers lost their savings in futile attempts to establish new homes. If a project is not already settled with a substantial class of farmers, a good colonization program must be evolved

before the project may be considered economically sound.

More attention is being given to the classification of soils than formerly. While really an engineering subject, construction engineers have frequently ignored it and built projects without proper knowledge of the soils. Appreciably large areas on some of the federal projects have recently been reclassified as either temporarily or permanently unproductive because of the quality of the soil.

The kinds of crops which can be grown, sufficiency of labor supply and the availability of ample markets must be carefully considered.

When an irrigation district bond issue is considered, all the above mentioned factors must be studied and analyzed in order to answer the question "Will the settlers on the project be able to meet interest and principal payments as due in addition to all other taxes and financial obligations?" If it can not be answered in the affirmative the district should not be approved. An example of how this question has been considered by the Irrigation District Bond Commission is found in paragraphs 18 to 28 of the following report on the Harlem Irrigation District.

HARLEM IRRIGATION DISTRICT

Introductory Statement

Because the writer compiled the report of the Ir-

rigation District Bond Commission on the Harlem district, it is considered proper to include that report in this thesis. Bonds of the Harlem Irrigation District represent an ideal type of irrigation security. The land is all in production; existing farm mortgages are not excessive; there is little or no colonization problem; and there is ample security behind the bonds. As analyzed in the report, the bond issue amounts to less than five per cent of the value of the security. With an irrigation system that has been in satisfactory operation (except at times when dams were washed out) for over thirty years, it is evident that comparatively little engineering study is required. A copy of the report of the Irrigation District Bond Commission follows.

HARLEM IRRIGATION DISTRICT

BLAINE COUNTY, MONTANA

REPORT OF THE
IRRIGATION DISTRICT BOND COMMISSION

HELENA, MONTANA

JANUARY 1926

Feb. 4, 1926.

Honorable C. T. Stewart,
Secretary of State,
Helena, Montana.

Dear Sir:

In accordance with Section 7218 of the Revised Codes of Montana, 1921, as amended in Section 3, Chapter 161, Laws of 1923, we submit herewith our report on the Harlem Irrigation District to be filed in your office. We find the bonds listed in paragraph 32 of this report to be available for certification.

Respectfully,

IRRIGATION DISTRICT BOND COMMISSION

By: (Signed) C. S. HEIDEL

Chairman.

HARLEM IRRIGATION DISTRICT

REPORT OF IRRIGATION DISTRICT BOND COMMISSION.

General Statement

1. The Harlem Irrigation District was created by the District Court of the 18th Judicial District on May 22, 1922. It comprises about 13,000 acres of which 11,572 are classed as irrigable, lying north of Milk River in Township 32 North, Ranges 22, 23 and 24 East. (See map, Plate I). It is irrigated principally by a canal diverting from the Milk River in Section 33, T. 33 N., R. 21 E. The lands served by the canal have been irrigated for about thirty-five years. It was originally built by the Harlem Irrigation Company which was succeeded by the New Harlem Irrigation Company and on June 14, 1919, was succeeded by the Harlem Water User's Association. The district was created for the purpose of entering into an agreement with the United States for securing St. Mary storage water. This will be discussed more fully under the heading, "Water Supply & Water Rights".

2. The lands of the district have been supplied entirely by gravity from Milk River and by flood waters of Thirty-mile Creek from the north. The Milk River follows a winding course, its normal flow being confined between steep banks with a water surface fifteen

feet or more below the level of most of the agricultural land on either side. In order to raise the river water to the canal grade, five dams have been built at different times, but all have been washed out during high water. The last one was destroyed early in 1925. This district would have been without water from Milk River in 1925 if it had not been for the system of the Zurich Irrigation District from which it purchased water at the rate of \$1 per acre-foot.

3. After careful consideration it was considered by the district officials that the best way to insure their water supply would be to install a pumping plant and eliminate the always present danger of having their water supply shut off by a washout early in the spring thus depriving them of irrigation water during that season. The district includes about 8,000 Irrigable acres of land belonging to original owners of stock in the Harlem Water User's Association and also about 3,500 additional irrigable acres largely belonging to persons who have purchased water stock. It was at first thought advisable for the district to purchase the irrigation system at its actual cost, \$110,000 and also construct a pumping plant at an expense of \$30,000 and clean out the canal from the proceeds of a bond issue. Accordingly, on August 31, 1925, the commissioners of the district passed a resolution applying to the Irrigation

District Commission for approval of an issue of \$160,000 worth of bonds.

4. The State Engineer visited the district on August 10 to 12, 1925, and also on October 8 to 9, inspecting the canal and lands on both occasions as well as discussing district affairs with officers at the secretary's office.

5. In a letter dated October 1, 1925, the Attorney General, after due consideration of the legal transcript informed the Irrigation District Bond Commission that it was his opinion that the proceedings had with reference to the formation of the district were sufficient and that the district had been legally created.

6. At several times during the period from September to December 1925, the Irrigation District Bond Commission considered the Harlem Irrigation District. On October 3, the district was discussed in detail and on December 23, the Chairman appeared before the commission and submitted a revised plan of financing. It was realized that a \$160,000 bond issue might be difficult to dispose of at par, and rather than accept a discount the people of the district have decided to arrange for the sale of stock in the Harlem Water User's Association to district land owners who have no stock. Owners of 10,980 acres now hold stock in the association.

It is planned to then deed the canal and other property to the district for a nominal consideration. Cost of repairs and cleaning the ditch had been estimated at not over \$20,000, which it had first been planned to take care of from the annual tax levy, leaving \$30,000, the estimated cost of the pumping plant, to be financed by the sale of bonds. It is believed that these can be sold in the state at par.

7. On December 28, 1925, the Board of Commissioners of the Harlem Irrigation District passed another resolution superseding that of August 31 and requesting approval of a \$30,000 bond issue for the purpose of financing the pumping installation. The Water User's Association has gone ahead with arrangements to install the pumping plant, and when the district acquires title to the property of the association the proceeds of the bonds will be used to pay off the expenses incurred because of the pumping program.

WATER SUPPLY & WATER RIGHTS

8. The subject of water supply and water rights is one on which a voluminous report might be written if all the stream-flow records relating to Milk and St. Mary River discharge and diversions were included. All available discharge records to and including those for 1917 were compiled by B. E. Jones and R. J. Burley and published by the International Joint Commission in

1920 and also by the U. S. Geological Survey as Water Supply Paper 491. Subsequent records have been published in the Water Supply Papers of the U. S. Geological Survey and are on file in the office of the State Engineer.

9. An inspection of the records of the flow of Milk River at Havre will show that it may not be relied upon to supply water from natural flow to other claimants after the 125 second-foot decree of the Fort Belknap Indian Reservation is allowed for. In a few years an ample run-off occurred, but practically always in July usually in June, and sometimes in April and May the supply was inadequate. The lands of the district would have suffered from drouth if the owners had not taken advantage of the early run-off of Thirtymile Creek. This stream has a drainage area of about 176 square miles, above the Harlem Canal but no records of its run-off are available. About three-fourths of the land of the district receives early water from this source which frequently is sufficient to insure crops.

10. In order to insure an adequate water supply for all crops at all times the Harlem Irrigation District was organized for the purpose of entering into a contract with the United States for the delivery of St. Mary storage water. This contract was dated September 1, 1922, and was supplemental to the Vested

Water Rights Contract of November 29, 1911. In the Vested Water Rights Contract the United States recognized the prior rights of about 8,000 acres of the lands under the original canal and also of other lands which have been taken into the district. The duty of water required was stated in the contract as 1 acre-foot per acre per year and that amount was considered as being appurtenant to the lands. On the 28th day of April, 1923, the agreement of September 1, 1922, as well as the taxes levied by its terms and the organization of the district were all confirmed as being legal and valid by the court of the 18th Judicial District.

11. Water rights on Milk River have been filed on by individual owners and also in behalf of the New Harlem Irrigation Company. A filing for 20,000 inches was recorded July 13, 1891, in Book 1, page 244 at Fort Benton by E. M. Kennedy and another for 50,000 inches on page 46 of Book F by Thos. M. Everett on April 30, 1895. However, as the land has been irrigated prior to that time, any rights are considered to be based on the earlier use rather than on these filings. A decree of February 9, 1891, recorded in Book B, page 89 allows the railroad 50,000 gallons which is a negligible quantity. A federal decree dated April 21, 1906, allows the Fort Belknap Indian Reservation 5,000 inches which is considered by the local land owners to be a prior right.

A decree dated February 21, 1896, grants rights to the use of Thirtymile Creek to a number of land owners in the district. It is recorded on pages 222, 223, and 226 of Book B at Fort Benton.

12. In consideration of the early appropriation of the water by actual use, early filings, the recognition of use by the Vested Water Rights Contract, and Supplemental Agreement of September 1, 1922, it is believed that the district has a right to an ample supply of water.

SOIL, DUTY OF WATER AND DRAINAGE

13. The soil is of excellent quality, although quite heavy and may be classed as gumbo. The required duty of water has been fixed as 1 acre-foot per acre, in the Vested Water Rights Contract and this amount appears to be ample, although for more porous soils it would be insufficient. Mr. Winfield Hurst of Zurich, field man for the sugar company, states one irrigation of from four to six inches is frequently ample for sugar beets and two irrigations are always sufficient. There is a remarkable freedom from drainage problems. No seepage was observed on the two visits of the State Engineer and with continued economical use of water it is not expected that seepage will cause trouble.

FEASIBILITY OF PROJECT FOR WHICH BONDS ARE DESIRED

14. The project has been a going concern for over

INVOICE 141 03 14

30 years. The Water User's Association has made arrangements to install a pumping plant which will deliver 110 second-feet at the head of the canal. For this they are incurring an indebtedness of approximately \$30,000. The estimates of cost include \$17,681 for pumps, \$8,100 for house and fittings and \$4,200 for transmission line. After the bond issue has been taken care of and the pumping plant installed, the Harlem Water User's Association will deed its property to the district for a nominal consideration. Before this transfer is effected it is planned to have the owners of land not having water stock, purchase it at par. As there are less than 600 such acres it should not be difficult to arrange. The proceeds of the bond issue will be used to pay off the obligation incurred for the purpose of installing the pumps. All plans and estimates for this proposed improvement have been carefully checked and approved by engineers of the Montana Power Company which will furnish power to the district. The lift will be about 11 feet and the power charge about 20 cents per acre-foot.

15. The pumps to be installed can deliver 220 acre-feet per day or 6600 acre-feet every 30 days. If each of the 11,572 irrigable acres were to receive 6 inches every thirty days, there would be a leeway of 814 acre-feet or more than 12 per cent for seepage

losses. It is not believed, however, that the demand will be as great as this. It is practically agreed that one acre-foot per acre will be the probable maximum annual requirement at the land. So if the maximum capacity of the pumps were utilized, the entire requirement could be delivered in about two months. This will not be the case because of crop requirements and for economic reasons. The power charges are in part based on maximum demand and also at a decreasing rate for each month of service. Consequently it is to the advantage of the district to use as low and as uniform a current for as many months as possible. The use of Thirtymile Creek by a majority of the land will also materially decrease the demand from Milk River.

16. The two following pages are blue prints showing the discharge of the Harlem Canal as measured near its head. The year 1918 was low because of the dam having been washed out. But in 1919, 1920 and 1921 water was supplied to 10, 980 acres. This record is shown graphically in the hydrograph, Plate II. There was more or less water wasted at Thirtymile Creek apillway which was of course included in the record of the diversion. The hydrograph indicates a very uneven use of water. With the pumping facilities available the use should be more uniform. It is probable that the maximum capacity of the pumps will seldom if ever be required.

Monthly Discharge, in acre-feet, of HARTEN CANAL NEAR ZURICH, MONT.[illegible]

IN COOPERATION WITH
UNITED STATES GEOLOGICAL SURVEY—WATER RESOURCES BRANCH
HELENA, MONTANA

Mean Monthly Discharge, in second-feet, of HARLEM CANAL NEAR ZURICH, MONT.

[Drainage areasquare miles]

YEAR	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	YEAR	NORMAL
1904								41.0 ^b	35.0	4.0	1.0 ^b			
1905						25.5 ^c	18.0	16.0	9.0	20.0	10.0 ^d			
1906							18.0 ^e	21.2	54.6 ^f					
1908							49.0 ^g	59.8	32.2	27.6	13.5			
1909							71.4	53.1	31.1	19.5				
1910						61.4 ^h	60.4	59.1	45.5 ⁱ					
1911						54.8 ^j	66.3	63.2	41.9	22.8	4.3 ^k			
1912						29.0 ^l		18.2 ^m	11.4	15.3	5.32	0.64		
1913							24.6 ⁿ	39.4	31.9	10.5				
1914							45.0	47.9	24.8	7.39				
1915							52.7 ^o	40.2	21.6	11.2	4.62 ^p			
1916							38.7	48.1	21.0	3.62 ^q				
1917							7.53 ^r	42.3	38.2	63.6	28.9	29.7		
1918									12.1 ^s	28.3	33.5 ^t			
1919							23.2	36.7	46.8	35.0	23.1	0.57		
1920								43.4 ^u	48.3	36.2	30.6	5.49		
1921							65.2 ^v	63.5	48.1	34.6	19.2	11.7		

a-May 11-31: b-Aug 1-13: c-Mar 5-31: d-Aug 1-19: e-Apr 9-30: f-June 1-7: g-Apr 7-30:
h-Mar 10-31: i-June 1-10: j-Mar 19-31: k-Aug 1-22: l-Mar 26-31: m-May 8-31: n-Apr 20-30:
o-Apr 8-30: p-Aug 1-5: q-July 1-8: r-Apr 19-30: s-June 11-30: t-Aug 1-23: u-May 14-31:
v-Apr 8-30:

17. In 1921 the Association purchased an Austin one-half yard dragline and cleaned the north bank of the canal from Thirtymile Creek up to the headgate and back down the south side for a distance of four miles. It is planned to continue the cleaning where necessary. Mr. A. G. Middleton, Civil Engineer of Chinook, made a survey of the canal in December, 1925, and estimated the cost of finishing the cleaning of the main canal and of 5.4 miles of laterals to be \$14,930. This cleaning will be paid for by the annual assessments.

18. The feasibility of the project is assured only if it is known that the land will pay the charges against it. The annual assessments will include bond interest and sinking fund, operation and maintenance, power charge, storage water charge to be paid to the United States by the terms of the agreement dated September 1, 1922, and county and state taxes.

19. The bond interest for the first year will be \$1,800, (\$900 due July 10, 1926, and \$900 due January 10, 1927). On January 10, 1927, \$5,000 worth of bonds will be retired and an additional amount of \$5,000 on July 10, 1927. The 1925 assessment should take care of the interest due July 10, 1926. The 1926 assessment should pay the \$900 interest due on January 10, 1927 and the \$750 interest due July 10, 1927. This makes a total tax for bond interest and principal of \$11,650 to be assessed for 1926 or approximately \$1.01 per acre.

In 1927 the interest charge will be \$1050 or a reduction of 5 cents per acre and in 1928 the tax for bond interest and principal should be \$10,450 or about 90 cents per acre.

20. A study of the operation and maintenance costs for over twenty years indicates that about 20 cents per acre has been a fair average except when paying for new dams or in 1923 when \$3,500 was spent on a new headgate and concrete work at Thirtymile Creek. After the pumping plant is installed this charge can be kept this low except for occasional unforeseen contingencies which should not cost a great deal.

21. The power charge has been carefully figured out and will be about 20 cents per acre per year.

22. The operation charge to be paid to the United States for delivery of stored water will probably remain about 25 cents per acre as it has been in the past.

23. The county and state tax is about 27 mills based on 30 percent of the assessed valuation. The assessed valuation is about \$40 per acre so the average tax is about 32 cents.

24. Thus we have a total tax for 1926 for all the above items of about \$1.98 or practically \$2 per acre. If the cleaning and repair of the canal is all

added to the 1926 tax, there will be an additional levy of about \$1.30 per acre, or a total per acre tax of \$3.30. In 1927 it should be about \$1.95 per acre; in 1928 from \$1.85 to \$1.90. After 1928 it would run according to the above assumptions 97 cents or practically \$1 per acre including the state and county taxes or 65 cents per acre for only the irrigation tax. There will be a refund of 20 per cent of the power receipts each year until the cost of the transmission line has been refunded to the district. This will amount to about 4 cents per acre and will help a little to reduce the total charge.

25. A consideration of the highly improved state of development in this district leads one to believe that the above taxes can be met without trouble. It may be seen by the map, Plate I, that no part of the district is over $3\frac{1}{2}$ miles from a shipping point, which permits raising high priced crops. It may prove wise to borrow from the local sources, funds to finance the repair of the ditch and spread the payments over several years or the work may be spread over several years which would lighten the payment for the first year. An approximate crop estimate of the district for 1925 follows:

Crop	Acres	Yield	Value per unit	Value per acre	Total Value
Alfalfa	2,000	2½ tons	\$ 6	15	\$30,000
Blue Joint hay	3,000	1 "	12	12	36,000
Wheat	3,000	25 bu.	1	25	75,000

Crop	Acres	Yield	Value per unit per acre	total Value
Sugar beets	1,000		80	\$80,000
Potatoes, corn beans, etc.	2,000		30	60,000
Pasture	500		12	6,000
Total	11,500		25	\$287,000

While the above estimate may appear a little high for the pasture or blue joint hay, it is low for wheat at the present price and may be considered reasonable. It seems probable that the taxes will be met without difficulty. There are 54 land owners of which 6 are non-residents. A number rent portions of their farms, so that there are about 100 farmers on the land.

26. The total amount of mortgages against the district has been estimated at \$116,000 of which \$70,900 are Federal Fram Loans. A number of mortgages had been paid and the county records did not show them satisfied when the estimate was made. Some payments have been made on others and not recorded. So it is probable that the mortgages outstanding are less than \$10 per irrigable acre. This should be retired without great difficulty in addition to paying other taxes.

27. The only obligation against the district lands which has not been mentioned is the construction charge for the St. Mary storage water. The district lands are liable for their share of the cost of the storage works which it was supposed would be \$12.50 per acre. It is

probable that no payments will be requested until after the present bond issue is paid up, and the terms of repayment will probably be on the basis of the low rate of repayment without interest. This should not prove burdensome, even when added to the payments for taxes outlined in paragraph 24.

28. The figures given thus far in this report are based on an irrigable area of 11,572 acres. Included in this are three tracts north of the canal with a total of 200 irrigable acres which are now being irrigated, but have not been legally included in the district. Steps are being taken to have the inclusions made at an early date.

MARKET VALUE OF IRRIGATION SYSTEM

29. The market value of the irrigation system may be considered as the present cost plus the cost of the pumping installation or \$140,000.

MARKET VALUE OF LANDS IN THE DISTRICT

30. The assessed value of the district lands is about \$40 per acre. The land has sold as high as \$40 without a water right and it is considered by district officials that \$55 is a fair value to place on irrigated lands without improvements. We have no reliable estimate of the value of improvements but they are substantial. It is, however, conservative to place a market value of \$40 per acre or the assessed valuation on the land. This would amount to \$462,880 for 11,572 irrigable acres.

RELATION OF PROPOSED BONDS TO MARKET VALUE

31. The sum of the values listed in paragraphs 29 and 30 is \$602,880. Sixty per cent of this total is \$361,728, which according to law is the maximum amount for which bonds may be issued. As the proposed issue amounts to only \$30,000, it is evident that there is ample security behind the bonds.

BONDS AVAILABLE FOR CERTIFICATION

32. We find that the following thirty bonds of denomination of one thousand dollars (\$1,000) each, dated January 10, 1926, and bearing interest at the rate of 6 per cent (6%) per annum, are available for certification.

Number of Bonds	Date of Maturity
1 to 5	January 10, 1927
6 to 10	July 10, 1927
11 to 15	January 10, 1928
16 to 20	July 10, 1928
21 to 25	January 10, 1929
26 to 30	July 10, 1929

IRRIGATION DISTRICT BOND COMMISSION:

(Signed) C. S. HEIDEL State Engineer

(Signed) L. A. Foot Attorney General

(Signed) Jay G. Larson State Examiner

SUPPLEMENTAL INFORMATION

Individual Acreage Agreements

A frequent source of dispute on irrigation projects is the amount of land actually irrigable in any individual holding. In the case of the Harlem district this matter was settled by the land owners signing agreements. A sample is shown as Exhibit 11 in pocket. Owners of approximately 9000 acres have signed these agreements, and there has never been any controversy over acreage figures.

Condition of Canal

As may be seen by the hydrograph, exhibit 2, the canal has diverted as much as 98 second-feet. This has been equalled in recent years as shown by incomplete records of the Milk River Project. Since the district plans on continuing the use of its drag line for cleaning the canal, there is no doubt that it will have sufficient capacity to supply district lands. The upper portion, which has been recently cleaned, has considerable excess capacity, while certain sections lower down require some cleaning.

The canal has a rather low grade, it being .0002 for the greater part of its length, and about .0003 in some places. This causes a low velocity, which probably is conducive to the growth of willows and heavy deposition of silt. Local engineering studies have used the

coefficient "n" in Kutter's formula as .025 and .030. This may be due to the retarding effect of the willows because I have found canals in similar soil, but with steeper grades to require coefficients of from .020 to .025

Pumping Installation

Pump House.-- The Water User's Association employed Bird and Van Teylingen, Architects, of Great Falls to design the pump house. See drawings, exhibits 3 and 4 in pocket for details of design. It rests on 42-10 inch piles, contains about 140 cubic yards of concrete 15460 pounds of steel and 2500 board feet of lumber. The 2 foot concrete floor was designed to withstand a hydrostatic pressure of 900 pounds per square foot. It will be noted on Exhibit 3, section A-A, that a sump is provided with float to automatically start a 2½ inch centrifugal pump when necessary to remove seepage or other water. The building was erected by a local contractor and cost \$5250. The architects were paid \$400 for their designs. Construction started February 27, and the concrete of the building was all poured by April 10. See photos for views of the building.

Power Line and Power Rates.--The Montana Power Company has constructed the power line to the pump house from its recently constructed 50000 volt line between Chinook and Malta. The cost of the 5/8 mile branch line and substation including transformer was \$45000

This was advanced by the water users, but will be re-funded by the power company at a rate of 20 percent of the gross income from the line each year until paid back, if present proposals are carried out. The power rates charged are in accordance with an agreement embodying the following schedule.

NO MINIMUM CHARGE

Power Charge

The monthly power charge shall be the product of the connected load in horsepower and the rate per horsepower month as shown by the following schedule:

1st	month's service	....	\$2.50	per horsepower		
2nd	"	"	....	2.00	"	"
3rd	"	"	....	1.50	"	"
4th	"	"	....	1.25	"	"
5th	"	"	....	1.00	"	"
6th	"	"	....	.75	"	"
7th	"	"	....	.60	"	"
8th	"	"	....	.55	"	"
9th	"	"	....	.50	"	"
10th	"	"	....	.45	"	"
11th	"	"	....	.45	"	"
12th	"	"	....	.45	"	"

Energy Charge

The monthly energy charge shall be the number of kilowatt-hours used multiplied by the rate per kilowatt hour for the power charge applying during that month in accordance with the following schedule:

HP Rate per
 KW Hr

1.....\$.028

2..... .027

3..... .026

5..... .025

7½..... .023

10..... .021

15..... .019

20..... .017

25..... .016

HP Rate per
 KW Hr

35.....\$.014

50..... .0116

75..... .0098

100..... .0087

125..... .0080

150..... .0074

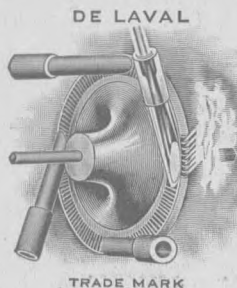
175..... .0071

200..... .0068

300..... .0061

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Pumps and Motors.-- The principal pumps are two single stage double suction De Laval pumps as described in the following proposal-contract and specifications.



PROPOSAL-CONTRACT

DE LAVAL STEAM TURBINE COMPANY

TRENTON, N. J.

Proposal No. _____ Date **12, 21** 1925

To **Harlem Water Users Assn**
(Hereinafter called the Purchaser)

Harlem, Mont.

The De Laval Steam Turbine Company (hereinafter called the Company) proposes to furnish the Purchaser, f. o. b. cars as specified, the following apparatus, machinery or materials (hereinafter termed machinery), which is further described in the specifications hereto attached and made a part hereof, subject to the stated conditions:

- 2-Single Stage, Double Suction, 36" suction 30" discharge designed to deliver 25,000 G.P.M. at 12' head**
- 2- Frame F worm gears $7\frac{1}{2}$ to 1 ratio for 100 H.P.**
- 2- 100 H.P., 3 phase, 60 cycle, 2200 volt, 1750 rpm GE motors.**
- 2- 100 H.P. hand compensators for starting motors.**
- 2- Bedplates complete**
- 4- Flexible couplings**
- 1- 1" direct connected motor driven pump, gland seal.**
- 1- $2\frac{1}{2}$ " double suction pump arranged for motor drive**
- 1- $7\frac{1}{2}$ H.P. 1750 rpm GE motor**
- 1- Vacuum priming pump and motor.**
- Engineering service of design as specified.**
- Services necessary to erect machinery including wages and all necessary travel of erecting engineer.**
- Freight to Zurich, Montana.**

Unless otherwise specified the machinery covered by this proposal is to be furnished f. o. b. cars Trenton, N. J. Delivery to the transporting carrier shall constitute delivery to the Purchaser, and if the delivery specified and covered by the purchase price is other than the point of shipment the Purchaser is to pay the freight and charge same to the Company.

The machinery shall be installed by and at the expense of the Purchaser, unless otherwise expressly stipulated. If the Company furnishes an engineer to superintend the erection and starting of any machinery for the Purchaser payment for his services is to be made by the Purchaser at the rate of \$ **contract** day, including the traveling time and plus all proper expenses of said man. Any man supplied by the Company, in any circumstances, shall be understood to be employed by the Purchaser.

It is intended that the machinery is to be free from latent defects in material and workmanship, and should any part of it be found within ninety days from the time of starting to have been defective at the time furnished the Company will repair or replace said part f.o.b. its Works, provided the original part is returned to the Company's Works freight prepaid and its inspection may establish the claim. No allowance will be made for repairs or alterations unless made with the Company's written consent or approval.

Without relieving the Purchaser from the obligation to make payment as provided for and without reference to the form of invoice that may be used by the Company, it is agreed that the title to the machinery furnished shall remain in the Company until the purchase price (including any extensions of payment, whether evidenced by note or otherwise) shall have been fully paid in cash, and the machinery shall remain the personal property of the Company, whatever may be the mode of its attachment to realty or other property, until fully paid for in cash; and the Purchaser agrees to perform all acts which may be necessary to perfect and assure retention of title in the Company. In case of failure by the Purchaser to make any payment when due it is expressly understood that it shall be optional with the Company to take exclusive possession of the machinery wherever found and remove same without legal process, and that any payments which may have been made on account of same shall be retained by the Company as liquidated damages, without prejudice to its right of recovery of further or other damage it may suffer from any cause.

Fire insurance in an amount sufficient to protect the Company's interest in the machinery is to be taken out and maintained by the Purchaser until same may have been fully paid for in cash, and such policies of insurance are to be made payable to the Company as its interest may appear at the time of loss, the Purchaser to assume all loss resulting from fire that the Company may not recover through such insurance.

If part of the machinery is to be shipped in advance of all of it, or may be so shipped by direction of the Purchaser or with the Purchaser's approval, proportionate settlement shall be made therefor in accordance with the specified terms; and if shipment or any other act or condition affecting payment for the machinery or any part thereof shall be delayed on account of the Purchaser, payment therefor shall become due as if shipment had been made. In case of delay in shipment at the instance of the Purchaser a reasonable storage charge will be made by the Company, and such storage shall be at the risk of the Purchaser.

It is understood that the specifications hereto attached are a standard form covering the Company's machinery of substantially identical type and character and that there may be immaterial variations therefrom in the details of design and construction of any particular machine. Also that the Company reserves the right to make such changes in details of design, construction, arrangement or equipment of its machinery to be furnished hereunder as shall, in its judgement, constitute an improvement over such former practice as may be shown or described in the attached specifications.

The specified shipment, or erection if specified, is subject to any delay on the part of the Purchaser in supplying the Company with necessary data or any changes therein at the Purchaser's instance, and to delays caused by fires, floods, strikes, accidents, civil or military authority, or any other cause beyond the Company's reasonable control. In no circumstances shall the Company be liable for special or consequential damages. The taking of any machinery by the Purchaser from the transporting carrier shall constitute a waiver of any claim in respect to delay.

Price: The price of the said machinery is **Seventeen thousand six hundred eight one and no/100** Dollars, (\$ **17681.00**)

Payable as follows in New York par funds, 50% upon delivery sight draft attached to bill of lading, 40% in 30 days from date of bill of lading and remaining 10% less freight bills paid in 60 days after date of bill of lading.

Shipment: The machinery covered hereby is to be shipped within about **12 weeks.**
from the date of the Company's approval of this contract after acceptance by the Purchaser.

In case of delay by the Purchaser in furnishing any required information, or later change in any of the specifications at the instance of the Purchaser, shipment will be extended a reasonable time, according to such delay or change and conditions in the Company's Works.

This proposal is made in duplicate and shall become a contract when accepted by the Purchaser in writing and thereafter approved by an executive officer of the Company at its Home office. The person signing the acceptance of this proposal for the Purchaser hereby represents that he is legally authorized to enter into this contract for the Purchaser. If accepted and approved this contract shall be understood to embody all of the understandings between the parties as to its subject matter, and shall not be modified or amended except in writing authoritatively signed by the parties.

This proposal is made for prompt acceptance, conditional upon executive approval as provided for, and the price or prices named are subject to change without notice.

DE LAVAL STEAM TURBINE COMPANY

ACCEPTED **12/21** 192 **5** By _____
(Purchaser sign here) _____

Trenton, N. J., _____ 192

APPROVED _____
Vice President

SHIPPING INSTRUCTIONS — Mark and ship: _____

To be Filled in by the Purchaser

Accompanying Proposal of C. F. Farmer

To Harlem Water Users Association

Proposal No. Specification No. Date 10/9/25

Special Data:

The company under this contract will furnish skilled mechanical engineer from their factory to make the installation and they will furnish all necessary labor in addition that may be necessary. The work that is to be done shall consist of the erecting of the two large units complete with the exception of making the piping connections. The district through its building contractor is to unload all equipment from the cars and deliver it upon the floor of the pump house and it is further understood that a bridge crane is to be available for the erecting work.

The engineering supervision of design which the company is to furnish is to consist of the design of all piping and electrical connections and general layout of the plant as to mechanical and electrical equipment. The district is to employ Bird and Van Teylingen of Gt. Falls to design the details of the pumping house and to present complete drawings. The cost of this service is to be based upon and shall be 5% of the contract price of the house and intake exclusive of machinery covered by this contract.

Specifications

FOR

DE LAVAL CENTRIFUGAL PUMP

Accompanying Proposal of C. F. Farmer

To Harlem Water Users Association.

Proposal No. _____ Specification No. _____ Date 10/9/25

Pump: The suction inlet of the pump will be 36 inches in diameter.

The discharge outlet of the pump will be 30 inches in diameter.

The pump will be a double suction single stage pump.

The pump will be arranged to be driven by worm gear and motor which will be connected to the pump by means of flexible couplings

Suitable cast iron bed-plate will be furnished for mounting of pump and motor

Operating Conditions: When operating at a speed of 226 revolutions per minute, the pump will deliver 25,000 U. S. gallons of water per minute, against a total gage-head, including suction-lift, of 12 feet, with an efficiency of not less than 84 per cent., requiring 90.8 brake horse power to drive it. The gages are to be located at the pump, and correction is to be made for any difference in elevation of gages or other measuring instruments. The suction-lift, corrected to center of impeller and including friction, is not to exceed 8 feet. The capacity, head and efficiency under conditions as specified herein are based on the performance of the pump when discharging clear, fresh water at a temperature not exceeding 85° F., and at an atmospheric pressure of 30 inches of mercury.

Material of Parts: The pump will consist of the following principal parts, composed of materials as specified :

Pump Case and Cover	<u>cast iron</u>	Impeller	<u>bronze</u>
Bearings	<u>babbitt</u>	Impeller Protecting Rings	<u>bronze</u>
Shaft	<u>steel</u>	Case Protecting Rings	<u>bronze</u>
Glands	<u>brass</u>	Shaft Protecting Sleeves	<u>bronze</u>

Special Data: This unit is fully guaranteed as to head, capacity and efficiency as well as workmanship and materials. After assembling the complete unit will be tested at the factory to determine if all guarantees have been met and a certified copy of the test record will be furnished the customer.

Specifications

FOR

DE LAVAL WORM REDUCTION GEAR

Accompanying Proposal of C. F. Farmer

To Harlem Water Users Association

Proposal No. _____ Specification No. _____ Date 10/9/25

Operating Conditions: Type of Driven Machine Centrifugal pump
Method of Drive Motor thru gear to pump by flexible couplings
Type of Motor KT form E General Electric Current alt.
H. P. (low speed) _____ R. P. M. _____
H. P. (high speed) 1750 R. P. M. _____
Frame Size—Worm Reduction Gear Frame F.
Normal Rated Capacity of Worm Reduction Gear _____ H. P.
Continuous Rated Capacity of Worm Reduction Gear 100 H. P.
at a temperature rise of 56 degrees C. based on an ambient temperature of 25 degrees C.
normal conditions of ventilation and an altitude not greater than 3300 feet.
Speed of Worm Shaft 1750 R. P. M.
Speed of Wheel Shaft 226 R. P. M.
Ratio of Speed Reduction 7 $\frac{1}{2}$ to 1
Flexible Couplings will have to be furnished.
Bed Plate will have to be furnished.

General Description: The De Laval worm reduction gear represents the highest development in the art of worm gear design and manufacture. The tooth parts, shafts, bearings and casing are of unusually generous proportions. The design throughout is rugged and capable of withstanding heavy duty service over a long period of time with a minimum of expense for repairs. In the construction of the gear particular attention has been given to making the working parts readily accessible to facilitate inspection in the field. The cover and wheel shaft bearings may be removed without disturbing the wheel shaft or coupling. To render correct assembly easy for unskilled attendants the gear is furnished throughout with tapered dowels.

All parts are made from the best quality of materials especially selected for the particular duty they perform. Interchangeability is secured by machining the parts to limit gages. The foundation bolt holes are jig drilled. Each piece is stamped with a symbol number for convenience in ordering or identification.

Worm: The worm is made from a low carbon alloy steel forging. The threads are accurately cut on the worm shaft after which the piece is carburized and heat treated obtaining a hard surface on the worm threads to resist wear, and a soft ductile core to withstand shock loads. De Laval worms are treated in electrical furnaces with temperatures maintained both electrically and mechanically to within close limits insuring the correct conditions to realize the maximum physical properties of the steel. The ends of the worm

shafts are drawn to remove brittleness and insure a uniform decrease in hardness from the worm threads to the shaft ends. The worm being the controlling member in a gear set must be made with the utmost precision to obtain the maximum efficiency and life. De Laval worms are ground all over, especial attention being given to correcting any distortion caused by the heat treating process to insure the correct lead. The worm threads are accurately ground and highly polished, both operations being performed to the true lead on machines especially developed for the purpose. An accurately ground worm incorrectly polished will not produce precision gearing or give the best results in service.

Wheel: The wheel is made from a phosphor bronze casting as this material gives a low coefficient of friction and possesses toughness, elasticity and tensile strength. De Laval wheels are made from Virgin Lake Copper and Virgin Straits Tin Phosphorized. The rims are chill cast in a dry sand mould to obtain the maximum hardness and prevent the formation of eutectoids. The pouring temperatures are carefully watched by means of electrical pyrometers, an important feature in obtaining castings that will give the best results. In the larger sizes of the reduction gears the rims only are of bronze. These rims are shrunk on solid cast iron centers further secured by a number of threaded keys riveted in place.

To insure a true pitch line the gear wheel is mounted on the shaft and hobbled on its own bearings which eliminates the inaccuracies present in gearing pressed on the shafts after generation.

All De Laval worm gears are generated with especially relieved hobs fed in an axial plane tangential to the gear. The hobs are designed to produce a tooth formation giving the maximum of rolling and the minimum of sliding action with the greatest possible tooth contact resulting in high load capacity.

Case: The case consists of two parts separated horizontally in the plane of the center line of the wheel shaft by a flat joint, both pieces being made of cast iron, machine tool quality, of heavy mill type construction. The castings are thoroughly sand blasted and all surfaces exposed to the lubricant coated with an oil and heat resisting compound. Ribs are carried between the base and wheel shaft bearings relieving the side walls of the case from the bearing loads. The frame is supported by four substantial feet designed to obtain air circulation under the case thus gaining additional radiating surface. A large oil reservoir is provided in the case with baffles mounted on the bottom to catch and prevent the circulation of foreign matter in the lubricant. The wheel shaft bearing seats are carefully scraped to alignment and standard size to permit interchangeability of bearings. Large passages are provided for the return of the lubricant to the oil well. A slinger is mounted on the wheel shaft to prevent oil escaping. An air vent is provided in the filler hole plug.

In the design of the De Laval case an endeavor has been made to keep the machine as compact as practical without too great a sacrifice of radiating surface as this directly affects the continuous horse power capacity of a worm reduction gear.

Worm Shaft Gland: The gland is made from brass, split in a horizontal plane and can be readily removed for packing the stuffing box without disturbing the worm shaft coupling. The stuffing box is packed with a soft packing.

Wheel Shaft Bearing: The wheel shaft is carried on plain bronze bearings cast of a high grade bearing metal giving a low coefficient of friction. The bearings are split so as to be easily accessible and can be removed without disturbing the wheel shaft or its coupl-

ing. The side thrust of the wheel is carried upon a hardened, ground and polished steel plate bearing against the bronze face of the wheel shaft bearing.

Worm Shaft Bearing: The worm shaft is mounted on ball bearings selected with a large factor of safety. The bearing at the rear of the worm is of the double type particularly designed to carry the combined radial and thrust loads encountered in worm gearing. This bearing is pressed on the shaft and further held by means of a nut and lock pin. The outer races of the bearings are clamped both radially and axially definitely securing the worm in the case at this point. As this bearing is constructed to carry both thrust and radial loads in either direction, the worm may be rotated clockwise or counter clockwise without making bearing adjustments. At the forward end of the worm the load is carried by a radial ball bearing. This bearing is pressed on the shaft and held in place by a lock wire. The outer race is provided with axial clearance in the housing permitting the bearing to adjust itself to expansion of the worm eliminating cramping action in the bearings. Guards are mounted between the bearings and the worm shoulders to protect the bearings from foreign matter. The ball bearings are carried in separate housings which protect the case bores from wear. The outer races of the bearings are allowed to creep slowly to distribute any wear over the race ways.

Oiling System: The worm, wheel and bearings are lubricated by a splash oil system. The oil thrown from the gearing is caught in troughs, cast on the case walls, which feed it to the bearings providing ample lubrication. The oil returns to the reservoir through large passages provided for this purpose in the castings. The oil reservoir contained in the lower half of the case is of unusually large proportions designed to prevent the circulation of sediment and foreign matter with the lubricant. Two oil cocks at the side of the case indicate the high and low limits within which the oil level must be carried. The oil filling hole provided in the top of the case is closed by a threaded plug. The lubricant may be removed when necessary through drains at the side of the case. A plate giving lubrication instructions is mounted on each case.

Flexible Couplings: Unless otherwise stated in this proposal the worm reduction gear will be furnished with De Laval flexible couplings connecting the worm shaft to the motor and the gear shaft to the driven machine. The couplings may be quickly disconnected permitting the removal of either machine without disturbing the other. All surfaces of the coupling are flush, thus eliminating the danger of catching an operator's clothing.

Bed Plate: Unless otherwise stated in this proposal the reduction gear will be furnished with a heavy cast iron bed plate of the box type extended to accommodate the driving motor. Both, reduction gear and motor will be located on this bed plate by means of tapered dowels to insure proper realignment if for any reason the machine should be disassembled.

Painting, etc.: All exterior surfaces of the case will be coated with an oil proof enamel before shipment. A name plate will be mounted on the case giving the shop number, frame size, reduction ratio, horse power capacity and revolutions of the worm shaft to assist our customers to identify the machine.

DE LAVAL SINGLE-STAGE PUMP

Type: The De Laval centrifugal pump is rugged in construction, and of such design that it can be disassembled and all parts inspected without disturbing the suction or discharge pipe connections. Long life and maintenance of the maximum efficiency with minimum expense for repairs are insured by providing such parts as are subject to wear with easily replaceable protecting pieces.

High efficiency is obtained by the proper proportioning of the impeller and water passages, and not by the use of diffusion vanes or similar devices, which are subject to rapid deterioration by corrosion and cavitation, or are liable to damage by foreign material that may find its way into the pump.

The pump case and cover, as well as all interior parts, are so designed that there is but one joint in the casing, and there are no joints within the pump case subject to leakage or corrosion by the liquid.

The materials used for the component parts are those best suited to resist corrosion and wear. Interchangeability is secured by machining all parts to limit gages. Each piece is stamped with a symbol number for convenience in ordering or identification, and the machine is furnished throughout with taper dowels to render correct assembling easy for unskilled attendants.

Pump Casing: The pump casing consists of two parts, separated horizontally in the plane of the center line of the shaft by a flat joint and maintained air and water tight by a thin paper gasket. The lower half of the casing contains both the suction and discharge openings. The top half, or pump case cover, may be raised readily, rendering the impeller and all interior parts accessible at once, and by removing the bearing caps, the shaft and attached parts may be lifted out without disturbing the suction or discharge connections or other parts of the machine.

High efficiency demands water passages true to design and of very smooth surface, and this perfect form and smoothness of surface is obtained by casting the casing in dry sand molds.

Impellers: Each individual impeller is designed to meet the specified conditions of capacity, head, speed and performance, in order that the maximum efficiency may be attained and successful operation of the pump secured. The impeller is of the enclosed double-suction type, and hydraulic balance is maintained under all conditions of head and capacity. The impeller is finished on all surfaces in order to diminish friction, and all vanes are filed and scraped to templates to secure the proper shape required for correct design.

Impellers are made of bronze, unless otherwise specified, as this metal has proved to be the one best adapted to withstand the corrosive action of water and to retain its original shape and finish. When the liquid to be pumped exerts a corrosive action on bronze, other more suitable metals are used.

Labyrinth Protecting Rings: The joints between the suction and discharge chambers of the pump case, surrounding the inlet opening of the impeller, are protected by removable De Laval labyrinth protecting rings. These protecting rings are made to limit gages and can be replaced quickly without fitting, thus providing a ready means for controlling the internal leakage of the pump. The inter-meshing grooves of the De Laval labyrinth rings greatly reduce leakage with correspondingly increased efficiency. This type of packing permits of large running clearances without excessive leakage.

Bearing Brackets: The bearing brackets are supported directly upon the pump case casting, thus making the pump entirely self-contained and preventing distortion or loss of alignment from piping strains. The brackets are separate and distinct from the stuffing boxes, so that there is no possibility of water finding its way from the pump into the bearings or oil reservoirs. The oil reservoirs are of ample size to retain a body of oil of sufficient volume to insure freedom from agitation and to allow any impurities in the oil to settle to the bottom. The oil reservoirs are fitted with suitable sight gages, and with openings for filling and drainage.

Bearings: The bearing brackets are scraped to standard gages, insuring interchangeability of bearing shells, and are so arranged that the bearings can be removed without disturbing any parts of the pump other than the bearing caps. The bearings, which are of the vertically split, ring oiled type, are of ample size, lined with high grade babbitt metal, and provided with oil rings to insure perfect lubrication. The bearing shells are ground on the outside to standard dimensions and the bearing supports scraped to gages to insure correct seating. The babbitt surfaces are carefully machined and reamed to the standard gages to insure proper bearing for the shaft and interchangeability.

Shaft: The shaft is of hammer forged, open hearth steel, ground and polished over its entire surface on a dead center grinder, thus insuring perfect alignment, accurate dimensions and a high finish. The shaft is protected from wear and contact with the liquid by removable protecting sleeves, extending from the impeller to the outer ends of the stuffing-boxes, completely covering the shaft and providing a bearing surface for the packing. The shaft is provided with oil slingers to prevent the escape of oil from the bearings.

Glands: The stuffing boxes are arranged for soft packing, and are provided with water seals and all necessary drip boxes and drainage openings. The glands are of the split type, and can be removed without disturbing other parts, thus facilitating the examination or replacement of the packing.

Flexible Coupling: Unless otherwise stated in the proposal, the pump will be furnished with a De Laval flexible coupling for connecting the pump to the driving motor, the flexibility of which will prevent damage to the motor or pump bearings by small inequalities of alignment.

Bed Plate: Unless otherwise stated in the proposal, the pump will be furnished with a heavy cast iron sub-base of the box type, extended to accommodate the driving motor. Both pump and motor will be located on this bedplate by means of taper dowels to insure proper realignment if for any reason the machine should be disassembled.

Priming: All necessary priming and drainage openings will be provided, but no priming devices will be furnished unless specifically provided for in this proposal.

Equipment, Painting, etc.: All necessary special wrenches and eye bolts for handling the different parts will be furnished with the pump.

The exterior surface of the pump and bedplate will be given two coats of filler, rubbed smooth, and one coat of flat paint, before shipment. All subsequent paintings is to be done by and at the expense of the purchaser.

No companion flanges or foundation bolts will be furnished with the pump unless specifically provided for in this proposal.

They are installed as indicated in the plan showing equipment, exhibit 3. Between the pumps and outlets are Walker 30 inch low pressure gate valves. The pumps are each guaranteed to deliver 25,000 gallons per minute, (about 55 second-feet), against a head of 12 feet. Blue prints, exhibits 5, 6, 7, 8, 9 and 10 show manufacturer's drawing, factory record of test and characteristic curve for each of the two large pumps.

The auxiliary equipment consists of one 2½ inch single stage double suction centrifugal pump, one 1 inch single suction gland seal pump and one #12 Connelsville rotary blower. These are driven by 7½, 1, and ½ horsepower motors. They are placed as shown on the architects drawings except that the blower is placed on a concrete base on the floor instead of on a wall bracket. It is designed to prime the pumps in 30 minutes. As tried out on May 25, it primed one of the large pumps in 10 minutes. Instead of one settling tank as indicated on exhibit 4, two iron barrels have been connected to supply clear water to the gland seals. The natural river water is too muddy to use before allowing it to settle.

The pumps and motors were shipped from Trenton April 26, 1926 and arrived at Zurich May 8. They were unloaded and all delivered at the pump house by May 18. Placing of machinery was started May 17, and was practically all set in place by May 22. The total shipment weighed 50,000 pounds. Freight from Trenton to Zurich was \$3.75 per hundred.

Each large pumping unit was shipped in two parts. The pump with bedplate was one, and the reduction gear with motor was the other. All were disassembled for moving. See photos for some of the details of moving from car to pump house. An opening was left in the concrete wall just above the floor to permit the passage of machinery, after which it was sealed with concrete.

Two 36 inch steel suction pipes, one for each pump, extend into the river 36 feet from the house. From the house they drop 10 feet by 90 degree elbows so that their tops are on level of the bed of the river. At the ends are iron grizzlies consisting of $\frac{1}{4}$ inch bars spaced 3 inches apart. Because of the enormous amount of silt in the river considerable thought was given to this part of the plant.

To facilitate handling and placing the machinery a 10 ton bridge crane is provided. It travels on two 12 inch I beams 10 feet apart and extending the length of the house.

Cost.-- The cost of the pumping plant prior to the first trial of the pumps was about as follows:

Pumps and motors f.o.b. Zurich including erecting	\$17,681.
Hauling 50,000 lbs. to pump house (about 3 miles)	400
42 piles.....	127
Pile driving.....	730
Contract for construction of pump house including labor for placing machinery.....	5,240
Pipes, valves and fittings.....	3,400
Additional fittings for small pumps.....	200
10 ton crane.....	1,000
Electrical wiring and installation.....	200
Power line (to be refunded).....	4,500
Additional force account labor.....	200
Architects' fee.....	400
	<u>\$34,088</u>

Additional Construction.--Original tentative plans of C. F. Farmer, C.E., contemplated wing walls from the corners of the building extending as cut-off walls into the banks on each end. The district and water users association officials did not retain an engineer, and omitted the wing walls from the contract with the idea of building them later by force account.

One of the commissioners was delegated to inspect the construction of the building, but his ranch interests prevented his careful attention. The contractor left most of the supervision to his foreman, and there was no engineer inspecting the pouring of concrete. It is porous in places, apparently due to insufficient fine material altho the the proportion of 1:2:4 is said to have been used.

The backfilling was supposed to have been of good material and puddled. It did not appear to have been very well done, and before testing it several of those present expressed doubts as to its ability to hold water. It was intended that the water should rise about four feet above the discharge pipes and flow down the canal.

On the afternoon of May 25 the pump on the north side of the plant was started and it ran a few minutes with the gate valve open a few inches. Water started flowing down the canal as intended, but it also started seeping through the backfill around both ends of the building. The volume of water seeping through increased rapidly

so that it was necessary to shut down the pump to prevent the backfills washing away. This proved that our fears regarding the safety of the backfill were justified.

It was then decided to build a concrete flume from the discharge pipes out a distance of about 25 feet down the canal. At this point there are excellent puddled banks into which a concrete cut-off wall will be built. This should permit the passage of water from the pumps without allowing it to back up against the wall of the house. A concrete headgate across the canal about 100 feet below the pump house is in excellent condition after several years' use. Therefore it is believed that the proposed flume will not be damaged by frost or alkali. Excavation for the flume or lined channel was started on the morning of May 26, and when the writer left that noon it was expected that they would be ready to pour the floor in a few hours.

The lesson to be learned from the results of poor construction is that a competent engineer should be retained to supervise engineering work. It is poor economy to try to save money by proceeding without adequate inspection. The pumping installation is an excellent one and it is hoped that no more difficulties will be encountered.



- Diversion Dam from Left Bank



Near Harlem

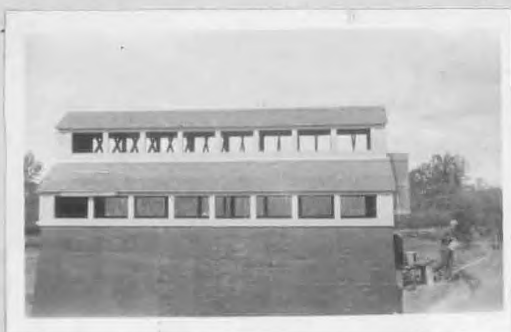
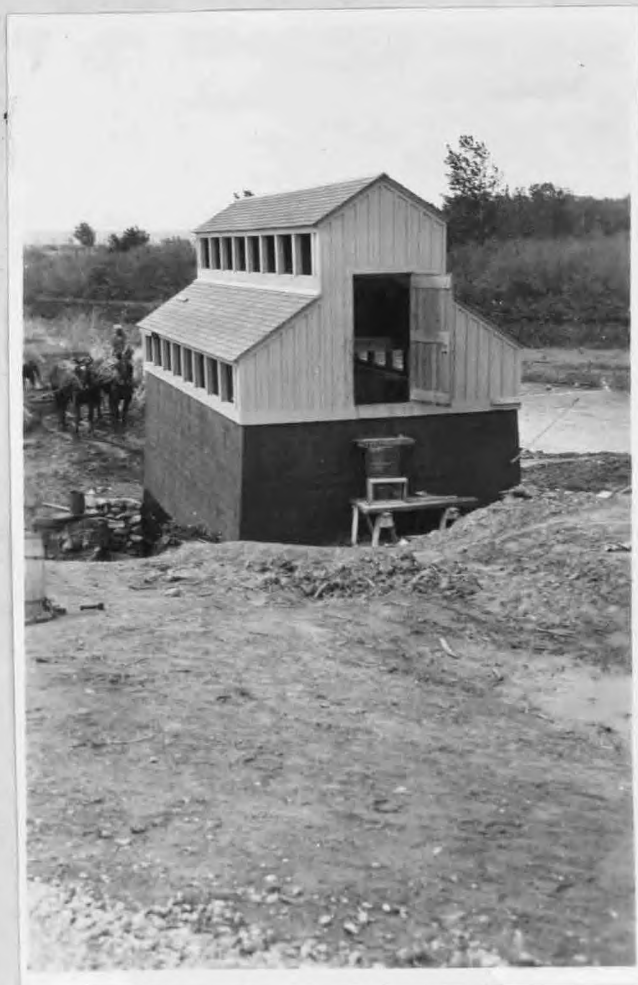


Near Headworks

Views of Canal



- Moving Machinery from Zurich to Pump House



- Views of Pump House



Discharge Side



Intake Side

Showing Settlement Around South End of House After
First Trial



OFFICE OF THE STATE ENGINEER
HARLEM IRRIGATION DISTRICT

Drawn from blueprint dated 3-1-22
 Traced & Revised F.A.L.

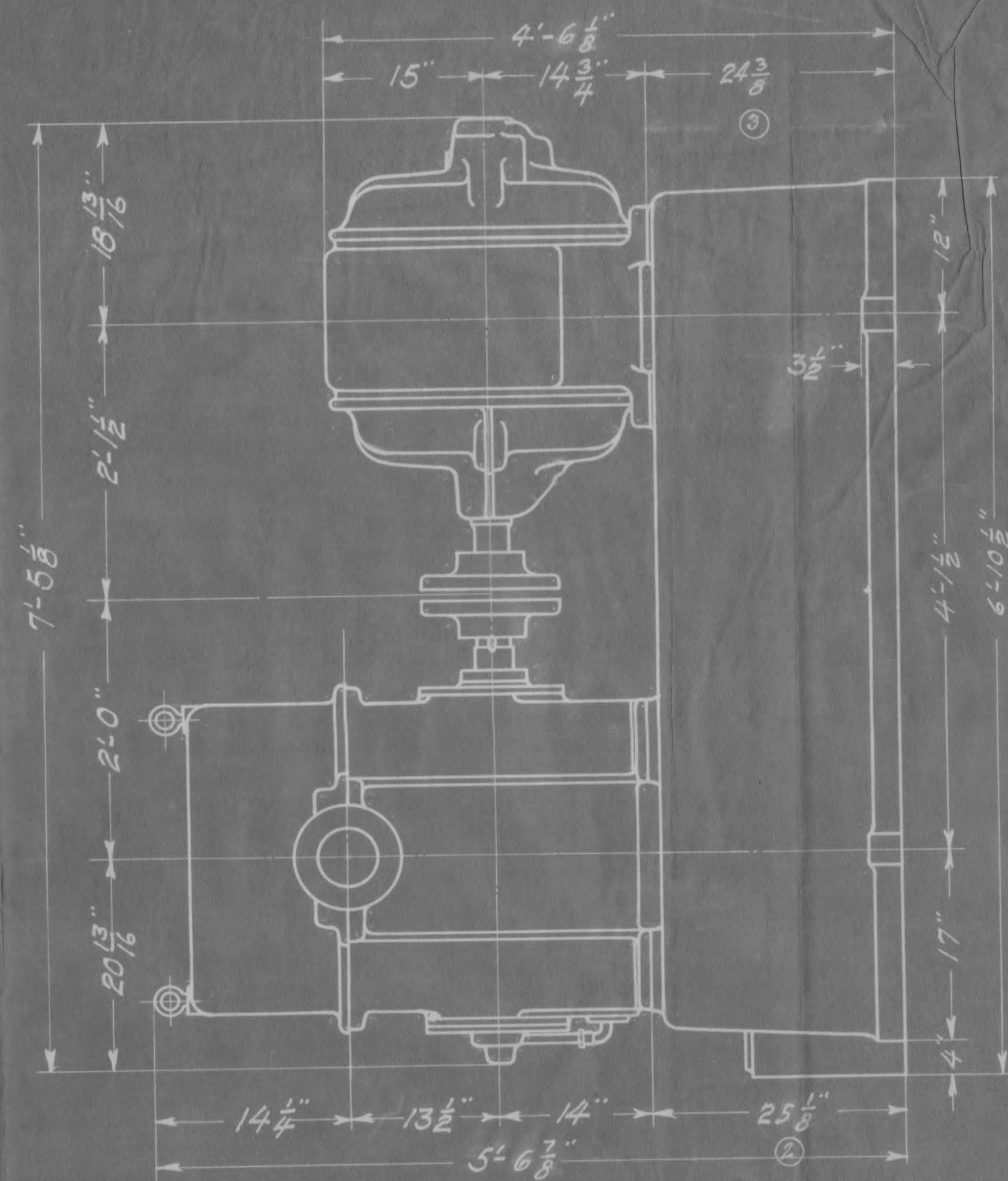
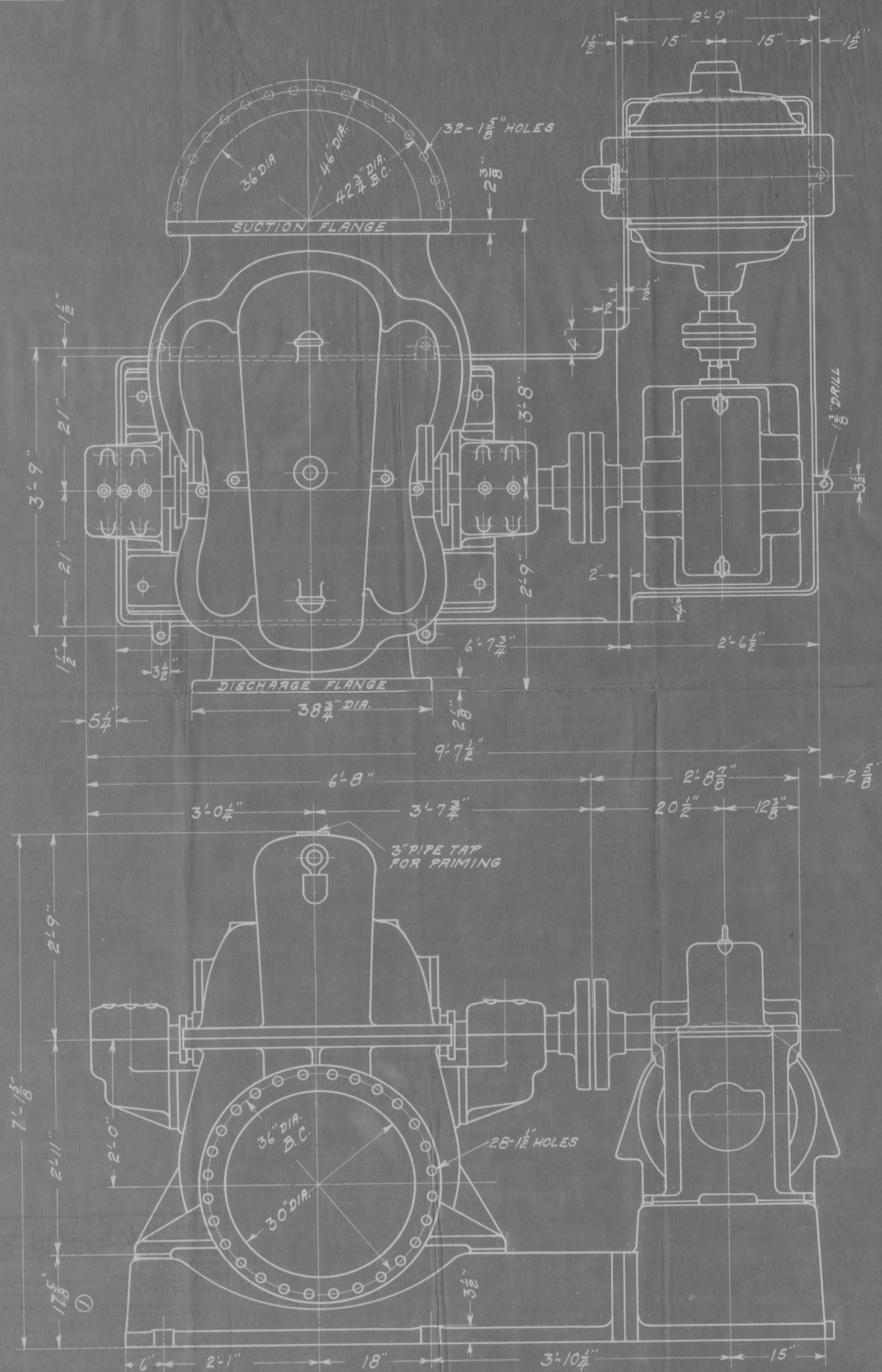
B.C. Helena, Montana, Jan. 1923, Plate 1

SCALE $\frac{1}{2} = 1.0$

Diederik van Teulingen Architects
814 1st Nat Bank Bldg
Great Falls Mont.

E-7125

WHOLE OR FRACTIONAL FINISHED DIMENSIONS ALLOW 1 OR 1/2" ALLOWANCES FOR ALL OTHER FINISHED DIMENSIONS ARE GIVEN ON DRAWING.



This print supersedes print from drawing E-7125 previously issued for this order.
For description of change see lower left hand corner.
Date 4/2/24
DE LAVAL STEAM TURBINE COMPANY
TRENTON, NEW JERSEY

4-2-26	③ WAS 21 3/4"			
	① WAS 15" ② WAS 22 1/2"			
DATE	ALTERATIONS	CHG.	CK.	WHY

MATERIAL	TYPE 100M-WG-734/30 100 H.P. MOTOR DRIVEN PUMP SPEED 224 R.P.M. DE LAVAL STEAM TURBINE CO. TRENTON, N. J.		
DRAWN BY	S. H. H.	SCALE	1"=1'-0"
TRACED BY	S. H. H.	DATE	2-6-26
CHECKED BY	W. H. H.		
APPROVED			

66958

USED ON

E-7125

EXHIBIT 5

SENT TO
SUBJECT State Engineer of Montana
OUR ORDER NO. 66958
YOUR ORDER NO. _____
OUR LETTER DATED _____
YOUR LETTER DATED _____

PRINT IS LOANED SUBJECT TO RETURN UPON
DEMAND UPON THE EXPRESS CONDITION THAT
IT IS NOT TO BE USED DIRECTLY OR INDIRECTLY
IN ANY WAY DETRIMENTAL TO OUR INTERESTS:

DE LAVAL STEAM TURBINE CO.
TRENTON, N. J.

**Dimensions APPROXIMATE. NOT
CORRECT FOR CONSTRUCTION
UNLESS ENDORSED**

BY _____

CHIEF ENGINEER

E-7126

This print supersedes print from drawing E-7126
previously issued for this order.

For description of change see lower left hand corner.
Date 4/2/76

Date 4/2/20

DE LAVAL STEAM TURBINE COMPANY
TRENTON, NEW JERSEY

ED 924

MATERIAL	TYPE 100M-WG-P36/30 100HP. MOTOR DRIVEN PUMP SPEED 224 R.P.M. DE LAVAL STEAM TURBINE CO. TRENTON, N. J.
----------	---

DRAWN BY *S. C. N.*

66959

LAWTON TRACING CLOTH
GENE DIETZGEN CO., INC. N. Y.

EXHIBIT 6

Distances reckoned from bottoms of
bedplates are subject to slight variation
from those indicated on this print.

SENT TO _____
SUBJECT State Engineers of Montana
OUR ORDER NO. 66959
YOUR ORDER NO. _____
OUR LETTER DATED _____
YOUR LETTER DATED _____

PRINT IS LOANED SUBJECT TO RETURN UPON
DEMAND UPON THE EXPRESS CONDITION THAT
IT IS NOT TO BE USED DIRECTLY OR INDIRECTLY
IN ANY WAY DETRIMENTAL TO OUR INTERESTS:

DE LAVAL STEAM TURBINE CO.

TRUSTEES, N. Y.

REMARKS: ONE ADDRESS NOT
CORRECT FOR INFORMATION
UNLESS ENCLOSED

BY _____

CHARACTERISTIC CURVE

C. C. 18116

FOR HARLEM WATER USERS

SHOWING PERFORMANCE OF

AVERAGE SPEED 226 R. P. M.

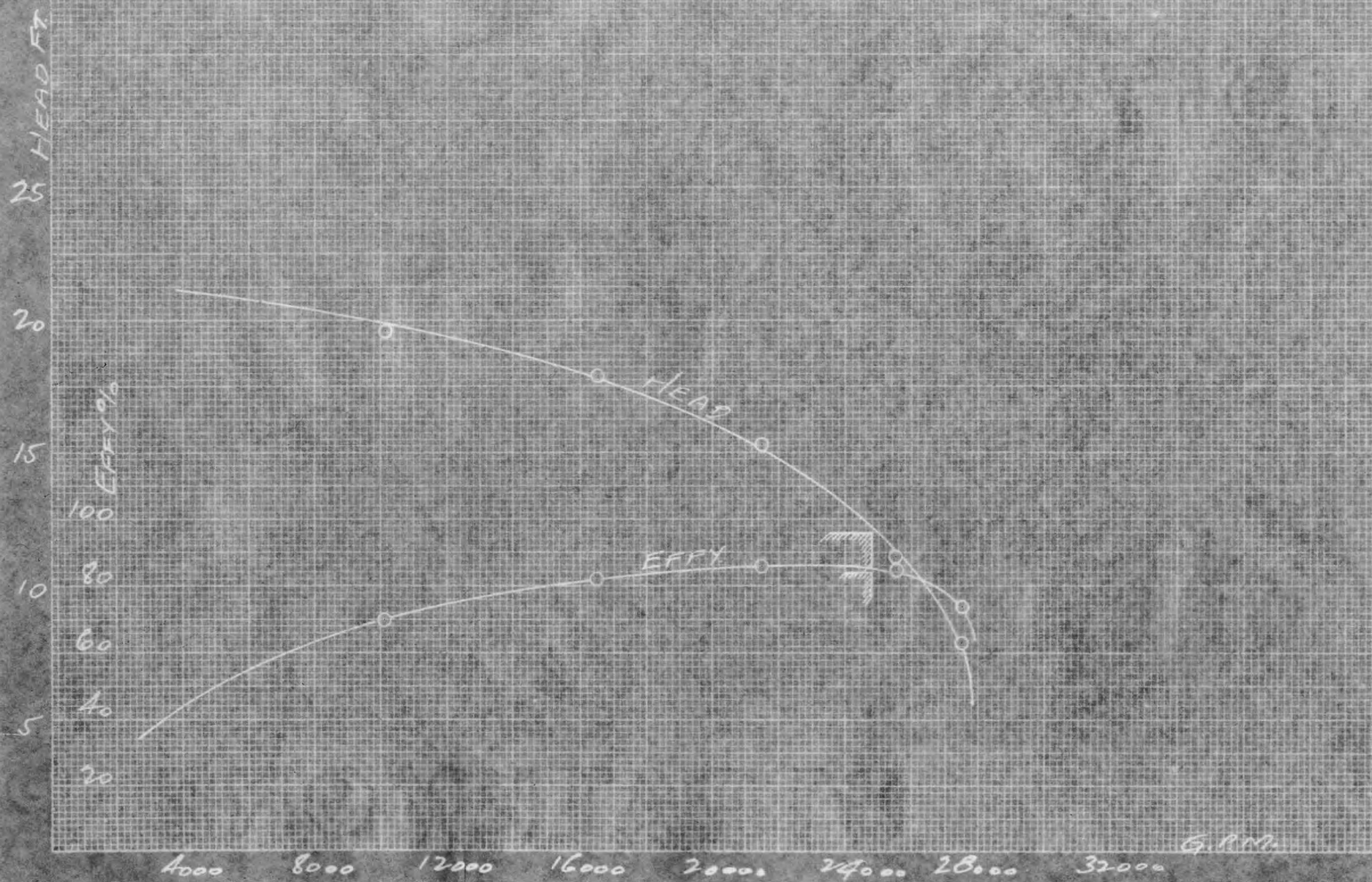
CENTRIFUGAL PUMP

SUCTION LIFT 6.7 FT.

NO. 66959 TYPE 100M-W6-P36

DATE OF TEST 4-16-26

DE LAVAL STEAM TURBINE CO.
TRENTON, N. J.



THE HARLEM IRRIGATION
DISTRICT.

.....J. M. Everett.....
Owner

Sec...22.Twp.32.N..Rge.22.E

22

Description	Sec.	Total Area	Less Road	Less Canal	Excluded Area	Assessable Area
1..NE $\frac{1}{4}$.NE $\frac{1}{4}$	22	40	1			39
2..SE $\frac{1}{4}$.NE $\frac{1}{4}$	22	40	1			39
3..SW $\frac{1}{4}$.NE $\frac{1}{4}$ (lot4)	22	30.81			7.81	23
4..NW $\frac{1}{4}$.NE $\frac{1}{4}$ (lot5)	22	20.40			4.40	16
5..NE $\frac{1}{4}$.SW $\frac{1}{4}$ (lot 3)	22	21.78			8.78	13
6.....						
7.....						
8.....						
9.....						
10.....						
11.....						
12.....						
13.....						
14.....						
15.....						
16.....						
Total						130

I hereby approve the above area as being correct for the
irrigable lands of which I am the owner.

Dated.....Aug..1st.....1925

(signed)....J. M. Everett.....

0471-233-3

100

[illegible][illegible]

CHARACTERISTIC CURVE

C.C. 18/25

FOR HARLEM WATER USERS

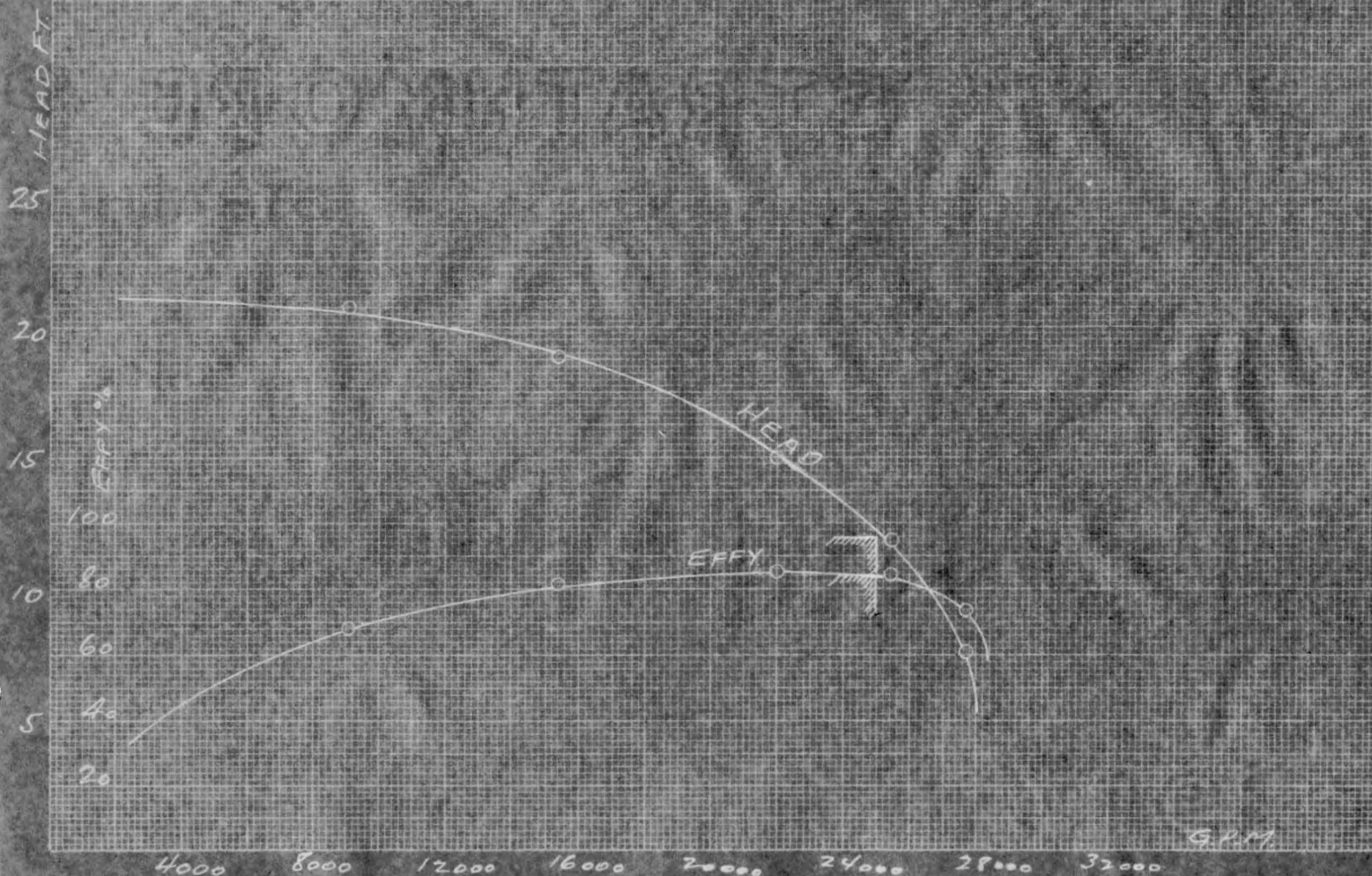
SHOWING PERFORMANCE OF

AVERAGE SPEED 226 R. P. M.

CENTRIFUGAL PUMP

SUCTION LIFT 6.8 FT.NO. 66958 TYPE 100M-WG-36"DATE OF TEST 4-7-26

CP
 DE LAVAL STEAM TURBINE CO.
 TRENTON, N. J.





DE LAVAL STEAM TURBINE COMPANY

TRENTON, NEW JERSEY

RECORD OF TEST FOR

HARLEM WATER USERS ASSOCIATION

100 BRAKE H. P. STEAM TURBINE DRIVEN } TYPE 100M-WG-P36"
 STEAM PRESS. _____ LBS. ELECTRIC MOTOR DRIVEN } CENTRIFUGAL PUMP
 COND. _____ IN. VAC. TOTAL HEAD 12 FEET NUMBER OF STAGES 1
 BACK PRESS. _____ LBS. SUCTION 8 FEET DIAM. DISCH. OPENING 30 IN.
 MAKE _____ CAPACITY 25000 G. P. M. DIAM. SUCT. OPENING 36 IN.
 MOTOR TYPE _____ CHAR. CURVE NO. 18115 WORKING SPEED 1750/226 R. P. M.
 COPY FROM TEST MADE 4-7-26 STROKE OF GOV. LEVER _____ IN.

PER CENT LOAD	STEAM PRESS. LBS.		TEMP. OF STEAM CENTIG.	COND. IN VAC. BACK PRESS. LBS.	REVOL. PER MIN.	NOZZLES OPEN	SUCTION HEAD FEET	DISCH. HEAD FEET	TOT'L HEAD FEET	WATER GALS. PER MIN.	Water Horse Power	Brake Horse Power	LBS. OF STEAM PER HOUR		DUTY MILL. FOOT LBS. PER 1000 LBS. OF STEAM	EFFIC. OF PUMP
	ABOVE VALVE	BELOW VALVE											W.H.P.	B.H.P.		
					226		7.0	0.7	7.7	27700	539	729				73.9
					226		6.8	5.0	11.8	25450	759	898				84.5
					226		6.2	8.8	15.0	22000	833	978				85.2
					226		5.9	13.0	18.9	15410	736	908				81.2
					226		5.5	15.2	20.7	9040	472	696				68.0

STEAM NOZZLES

NOZZLE NO.	SIZE NO.	SMALL DIAM. M. M.	CONDEN.	NON CONDEN.	SHUT- OFF VALVES

DE LAVAL STEAM TURBINE CO.

April 19 - 1926

A. Peterson

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N378
H36h

46225

Heidel, O.S.

Harlem irrigation district

DATE

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MAR 2 1952

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46235

H36h

cop. 2