A DETERMINATION OF THE COST OF DELIVERING LAKE MICHIGAN WATER TO THE CITY OF GRAND RAPIDS, MICHIGAN, THROUGH EXISTING SUPPLY SYSTEM

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE

Thomas B. Newberg

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A Determination of the Cost of Delivering Lake Michigan Water to the City of Grand Rapids, Michigan, Through Existing Supply System

A Thesis Submitted to

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by

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Purpose;

To determine the average total cost per gallon of supplying the city water filtration plant at Grand Rapids, Michigan with water from Lake Michigan through the supply system which has been in operation since August of 1940. The fiscal year 1947 (June 30, 1947 to July 1, 1948) will be used as the basis for calculations.

Description;

The accompanying Plan and Profile map of the portion of the Water Supply System under consideration shows the main intake located at a point 6200 feet out from the lake shore. This intake consists of a 54 inch steel pipe elbow turned up and protected by a 36 foot square heavy timber crib. The top of the intake is approximately 42 feet below the mean surface of the lake. Water admitted by the intake flows through the 54 inch intake pipe to a wet well surrounding the lakeshore pumping station, entering the wet well at an elevation of 560.00 feet above M.S.L., which is 18 feet below the Lake Michigan surface elevation of 578.00 feet, M.S.L.. Two emergency intakes are located on the intake line between the main intake and the shoreline. The intake line is constructed of 54 inch steel and concrete pipe, anchored and supported by concrete saddles at 120 foot intervals, and connected at the joints by rubber gaskets and steel rings.

The wet well consists of a cylindrical shell 6.5 feet wide, 70 feet in diameter and 42 feet in depth, the bottom elevation being 552.00 feet above M.S.L.. The 45 foot (inside diameter) cylinder which forms the inner wall of the wet well houses the lakeshore pumping station, the pump intake level being at 556.00 feet elevation. Normal depth of water in the wet well with no pumps operating is 26.00 feet, with a drawdown of approximately 11 feet during maximum pumping operation.

In the lakeshore pumping station there are five vertical pumps, the pump floor being at elevation 560.00 feet M.S.L., and the motor floor being at the high water elevation of 584.00 feet M.S.L., 5 inch pump shafts are suspended from bearings on the motor floor. The pumps are of the following ratings and operating heads;

#1— 14 M.G.D.	220 Foot Head
#2— 17 M.G.D.	235 Foot Head
#3— 21 M.G.D.	255 Foot Head
#4— 25 M.G.D.	280 Foot Head
#5— 31 M.G.D.	325 Foot Head

Maximum capacity is obtained by operating #4 and #5 pumps simultaneously. This combination supplies 52.7 M.G.D. to the filter plant at Grand Rapids, provided the booster station at Allendale is in operation. A supply of 33 M.G.D. is provided by operating the #5 pump only, with no boost required.

Automatically operated cone valves are set between the pumps and the header pipe, which header feeds into the main transmission line. Valves open or close in approximately thirteen

minutes to prevent water hammer. Surge valves are located at the junction of the header and the main transmission line. A venturi is located in the first fifty feet of the transmission line from which lines run to a control board inside the pumping station, indicating pressures and volumes of water being transmitted. Hourly readings are tabulated.

From the lakeshore pumping station the water is transmitted through a 46 inch Lock Joint steel and reinforced concrete pipe along highway M-50 right-of-way to a booster station located one-half mile west of Allendale, Michigan. During periods when more than 33 M.G.D. are being transmitted to the filter plant, the booster station is operated, the water being by-passed from the transmission line, through the booster pumps, and back to the transmission line at increased pressure. The booster station pumps are of the following ratings and operating heads;

#1 -- 14 M.G.D. 200 Foot Head

#2 -- 21 M.G.D. 210 Foot Head

#3 -- 25 M.G.D. 225 Foot Head

#4 -- 31 M.G.D. 235 Foot Head

From the booster station the water flows under pressure through the transmission line Easterly along M-50 to highway M-114, thence North along M-114 to the highest point on the line, as indicated on the Profile map..This highest point is 168 feet above the lakeshore station pump level. Gravity flow then carries the water by the circuitous route shown on the

accompanying map, around the Northwest section of the city of Grand Rapids, into the city at Richmond Park, and across Grand River to the city filtration plant located on Monroe Avenue and Sweet Street.

Man holes and valves therein are located as shown on the accompanying Profile map.

History;

On May 12, 1938, the city commission of Grand Rapids, Michigan initiated a survey to determine the feasability of obtaining water from Lake Michigan for city use in place of the then present Grand River source of supply. The main reason stated for the move was that during periods of high consumer use, the fire demand supply was dangerously low, and it was feared that with the inevitable growth of the city, the Grand River source would be insufficient within a period of a very few years.

In June of 1938 the city commission entered into an agreement with the Federal Government, whereby a water supply system improvement including the procurement of water from Lake Michigan would be financed fifty-five percent by the City of Grand Rapids and forty-five percent by the Public Works Administration of the United States.

The city commission then floated a bond issue of $2,255,000.00 in $1,000.00 bonds at 2.82% interest, maturing as per the following schedule;

Principal	Maturity Date
$70,000.00	8-'43
70,000.00	8-'44
70,000.00	8-'45
80,000.00	8-'46
80,000.00	8-'47
85,000.00	8-'48
90,000.00	8-'49
90,000.00	8-'50
90,000.00	8-'51
90,000.00	8-'52
90,000.00	8-'53
90,000.00	8-'54
90,000.00	8-'55
90,000.00	8-'56
90,000.00	8-'57
90,000.00	8-'58
90,000.00	8-'59
90,000.00	8-'60
90,000.00	8-'61
90,000.00	8-'62
90,000.00	8-'63
90,000.00	8-'64
90,000.00	8-'65
90,000.00	8-'66
90,000.00	8-'67
90,000.00	8-'68

P.W.A. Project #1587-F included the construction of additional reservoirs and pipelines within the city of Grand Rapids which do not enter into the cost of delivering water from Lake Michigan to the Grand Rapids filter plant.

Work on the Lake Michigan to Grand Rapids pipeline was begun in May of 1938 and completed in August of 1940.

Determination of Costs;

Plant Costs

Water transmission line, 30.6 miles in length, 46 inches in diameter. Steel tube with reinforced concrete on inside and outside; Lock Joint type.

Materials ----	$1,292,893.00	
Laying ----	750,911.49	$2,043,804.49

Contractors -

Lock Joint Pipe Co., East Orange, New Jersey

Dowding Trucking Co., Flint, Michigan

Price Brothers, Dayton, Ohio

Fry and Kain, Lansing, Michigan

Intake pipe, 6200 feet in length, 54 inches in diameter. Steel.

Materials and Laying -- 234,612.00

Contractor -

Lyon Construction Co., Whitehall, Michigan

Valves.

7 - 24 inch cone valves (manual oper.)	$29,925.00	
3 - 24 inch cone valves (manual & auto)	16,845.00	
3 - 24 inch cone valves (manual and automatic with water level control)	16,680.00	
18 - 4 inch needle relief valves	4,500.00	$67,950.00

Contractor -

Chapman Valve Mfg. Co., Indian Orchard, Massachusetts.

Pumps, including motors.

5 vertical pumps at Lake station.

1 - 14 M.G.D. 220 Foot Head	$15,700.00	
1 - 17 M.G.D. 235 Foot Head	16,500.00	
1 - 21 M.G.D. 255 Foot Head	22,093.00	
1 - 25 M.G.D. 280 Foot Head	22,800.00	
1 - 31 M.G.D. 325 Foot Head	26,359.00	
	103,452.00	

4 horizontal pumps at Allendale station.

1 - 14 M.G.D. 200 Foot Head	$ 7,135.00	
1 - 21 M.G.D. 210 Foot Head	9,000.00	
1 - 25 M.G.D. 225 Foot Head	13,000.00	
1 - 31 M.G.D. 235 Foot Head	14,093.00	
	43,228.00	
Less 10%	-14,668.00	$132,012.00

Pumps - Worthington Pump Co., Harrison, New Jersey

Motors - Westinghouse Electric Co.

Lakeshore pumping station.

Substructure ---	$ 95,300.00	
Superstructure -	68,450.00	
Piping, valves, installing equipment, setting pumps.	116,200.00	
Less 6%	16,797.00	$263,153.00

Contractor -

Owen, Ames, Kimball Co., Grand Rapids, Michigan

Allendale booster pumping station.

Building ---	$55,200.00	
Piping, valves, installing equipment, setting pumps. --	76,600.00	
Less 5½%	7,249.00	124,551.00

Contractor -

Owen, Ames, Kimball Co., Grand Rapids, Michigan

Electrical starting equipment, switchboards, etc.

Lakeshore station ---	$59,329.00	
Allendale station ---	43,159.00	102,488.00

Contractor -

Clement Industrial Electrical Co., Grand Rapids, Michigan

Engineering costs.		
Consulting Engineers ---	$115,766.34	
Plans and Specifications(extra)	20.16	
Survey, Test borings, etc. -	2,878.95	
Supervision and inspection -	37,113.60	
Supplies and misc. -	2,173.62	157,952.67
Consulting Engineers -		
Consoer, Townsend, & Quinlan, Chicago, Illinois.		
Legal and Administrative costs.		13,384.80
Lands, Right-of-way, and Easements.		
Lakeshore station site ---	$11,500.00	
Booster station site ---	250.00	
Right-of-way and Easements ---	30,091.40	41,841.40
Interest during construction.		104,094.99
Total Plant Cost -		$3,285,844.35
Less 45% paid by P.W.A.		1,478,629.96
Total Plant Cost to City ---		1,807,214.39
Useful life of Plant -- 50 years --		
Depreciation -- 2%.		
Total Plant Cost to City per year --		$36,144.29

Maintenance Costs		
Pipeline maintenance ---	$1,380.37	
Labor (12 Operators, 1 Supt.) --	35,910.40	$37,290.77
Operating Overhead		
Pension (4% of Labor) --	$1,436.42	
Office (5% of Labor) --	1,795.52	
Transportation (1 vehicle) --	1,720.43	
Fuel, Grounds, Telephone, etc. --	6,354.56	11,306.93
Bonds		
Bonds maturing in 1947, applicable to this project ---	$60,000.00	
Interest on outstanding bonds --	58,092.00	118,092.00
Power Costs		
13,421,600 KWH electricity --- (See chart)	$120,518.83	120,518.83
Insurance		
Property insurance cost --	$1,116.30	1,116.30
Taxes		
State taxes ---	$256.75	
City taxes (to General Fund) --	23,343.04	23,599.79

Summary of Costs

Total cost of water delivered to Grand Rapids Filter Plant during fiscal year 1947 ---- $348,068.91

Total quantity delivered --- 10,636,160,000 Gallons

Total Cost per gallon ---------- $00.000032725

Bibliography:

Grand Rapids Water Works personnel -- Mr. L.J. Troske
Mr. J.P. DeKorn (Supt.)

Grand Rapids City Commission Proceedings (1938 to 1947)

Office of Grand Rapids City Engineer

Office of Grand Rapids City Comptroller and Auditor

Office of Grand Rapids City Clerk

Office of Grand Rapids City Treasurer

Consoer, Townsend, and Associates, Consulting Engineers, Chicago.

Grand Rapids Press - Issue of January 1, 1940.

Lake Michigan Water Supply Current and Pumpage Costs

June 30,1947 to July 1,1948

Lakeshore pumping station and Allendale booster station totals.

Period of Bill	Kilowatt-hours	Power Cost	Pumpage (M.G.)
6-30-1947 7-30-1947	1,367,200	$12,243.90	947.790
7-30-1947 8-29-1947	2,460,800	21,894.69	1,313.735
8-29-1947 9-30-1947	1,167,200	10,474.60	952.150
9-30-1947 10-30-1947	908,000	8,186.53	816.105
10-30-1947 11-28-1947	816,000	7,374.96	746.870
11-28-1947 12-30-1947	822,400	7,427.71	811.840
12-30-1947 1-30-1948	825,600	7,456.18	794.195
1-30-1948 2-27-1948	793,600	7,178.72	735.760
2-27-1948 3-30-1948	843,200	7,600.74	809.655
3-30-1948 4-29-1948	838,400	7,570.52	792.780
4-29-1948 5-28-1948	944,000	8,500.95	801.405
5-28-1948 6-30-1948	1,635,200	14,609.43	1,113.875
	13,421,600	$120,518.83	10,636.160

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