Milwaukee's North Point Pumping Station

The Old and The New

This is the story of the development of water pumping operations at the North Point Pumping Station in Milwaukee, Wisconsin.

The city began the development of this pumping station by the appointment of Moses Lane as Chief Engineer August 31, 1871. The preparation of plans and estimates started in October 1871, and the contract for building the pumping engines was awarded to Messrs. Edw. Allis & Company of Milwaukee, May 10, 1872. The two original pumps were started September 14, 1874.

The following description of the pumps was obtained from Lane's report to the Board of Water Commissioners in 1874.

"The Pumping Engines are condensing beam and fly-wheel Engines, both coupled to one fly-wheel, and so arranged that they can be run together or separately. The Engines are of the compound or double-cylinder style. Each Engine can pump into the Reservoir eight million gallons of water in twenty-four hours, with a consumption of eight tons of coal."

"Each Engine has two steam cylinders. The high pressure cylinder is thirty-six inches diameter and sixty-two inches stroke; the low pressure cylinder is fifty-eight inches diameter, and eight feet stroke."

"The beams are of wrought iron, consisting of two plates each thirty feet long, six feet four inches deep at the center, and one and three-fourths inches thick. The plates are two feet apart, and properly stiffened by cast-iron hubs and braces. The weight of each beam is twelve tons. The beams are supported by a frame-work of cast iron twenty-two and one-half feet high above the bedplates."

"The fly-wheel is twenty-four feet diameter, and weighs thirty tons. The crank shaft is sixteen feet long, and eighteen inches diameter. The Pumps are bucket and plunger, and at the opposite end of the beam from the steam cylinders. They are forty inches diameter, and seven feet stroke. The plunger is twenty-eight inches diameter. The delivery of each pump is four hundred and fifty gallons per stroke. The air chambers are five feet diameter, and forty-seven and one-half feet high."

"There are four drop return flue Boilers, each seven feet diameter, and twenty-four feet long."

"The total weight of metal in the two Engines and four Boilers is over five hundred tons."

The original Engine House was 84 by 70 ft, the Boiler House 42 by 40 ft and the coal shed 40 by 100 ft. The chimney was 150 ft high. The first intake was two 36-in. cast-iron pipes extending from the Engine House for a distance of 2,100 ft to a crib in Lake Michigan. The pumps discharged into mains leading to the distribution system and to a reservoir, known as Kilbourn Park Reservoir having a capacity of 21.5 mil gal, from which the water flowed by gravity into the distribution system.

In all, eleven pumping engines were purchased between 1874 and 1920. In 1913 the old Engines No. 1 and 2 were dismantled and in 1919 the original No. 3 Engine was removed. Of the eight original engines left at the beginning of the recent improvement program, four engines pumped into the low pressure service area at a head of about 160 ft and four pumped into the high pressure district at a head of 275 ft. The date of installation and capacity for the engines are given in Table 1.

The early pumps operated on steam pressures of 80-85 psig and as new pumps and boilers were added, the pressures were increased until pressures of 135 psig were reached. Along with the increased steam pressures and improvements to the equipment, the duty increased from 85,000,000 to 142,000,000 ft/lb per 100 lb of anthracite coal.

The original 36-in. intake soon became inadequate and large amounts of sand were pulled into the
pump to cause scouring of pump cylinders and sand accumulations in the mains. Accordingly work started in 1890 and completed in 1895 on a new intake consisting of a brick lined tunnel 7.5 ft in diameter, extending from the shore shaft for a distance of 3,146 ft to a crib in Lake Michigan. From this crib, two 60-in. cast iron pipes extended 5,000 ft further out into the lake terminating at two submerged cribs. By 1913, this intake was outgrown and a contract was let for the intake now in use. This is a tunnel 12 ft in diameter extending from the shore shaft to a submerged timber crib 6,565 ft from the shore in 67 ft of water. This tunnel was completed in 1918. The shore shaft of this tunnel is 5,700 ft north of North Point Pumping Station. A tunnel nine ft in diameter connects the shaft to the station.

Until 1939 raw water, chlorinated after September 29, 1913, was pumped directly from the lake to the distribution system. In 1939, a water purification plant of approximately 300 mgd was completed and since that time completely treated water has been pumped into the system.

New Station

In 1956, after a comprehensive study of the Milwaukee water works system, Black & Veatch recommended the abandonment of the existing North Point Pumping Station and the construction of a new station at the same location having electric motor driven centrifugal pumps. The new pumping station has been in operation since September 1963. The pumps consist of three high service pumps each having a capacity of 20,800 gpm at a head of 335 ft and three low service pumps each having a capacity of 17,500 gpm at a head of 193 ft. All pumps are vertical, diffusion vane units driven by electric motors. The pumping station has an additional space available for another pump which can serve either the high or low service area.

Audiotone Telemetering

Normal starting and stopping of the pumping units and supervision of their performance is done over leased telephone lines from the Linwood Purification Plant by means of audio tone type supervisory control equipment. Automatic protective features insure proper sequence of starting each synchronous motor and the opening of the respective discharge valve. Monitoring devices and protective relays inform the dispatcher of abnormalities and automatically shut down the pumping units whenever condi-

<table>
<thead>
<tr>
<th>Date of Installation</th>
<th>Engine Number</th>
<th>Type of Engine</th>
<th>Manufacturer</th>
<th>Capacity mgd</th>
<th>Head Feet</th>
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<tbody>
<tr>
<td>1874</td>
<td>1</td>
<td>Condensing-Beam &amp; Fly-Wheel Engines</td>
<td>Edw. P. Allis &amp; Company</td>
<td>8</td>
<td>168</td>
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<tr>
<td>1874</td>
<td>2</td>
<td>Fly-Wheel Engines</td>
<td>Edw. P. Allis &amp; Company</td>
<td>12</td>
<td>168</td>
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<td>1882</td>
<td>3</td>
<td>Compound Engine</td>
<td>Edw. P. Allis &amp; Company</td>
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<td>1891</td>
<td>4</td>
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<td>Wisconsin Engine Company</td>
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<td>6</td>
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<td>1914</td>
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<td>1920</td>
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<td>160</td>
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</table>
North Point Pumping Station, 1874 to 1884, showing water tower in background.

Views showing development of the North Point Pumping Station.

Aerial view of the old station showing the base of the water tower in background and extent of filled ground in foreground.
Exterior view of the new pumping station. The new station is located just in front of the old, as indicated by the water tower in background.

Ground floor of the new pumping station showing the motor for the service pumps and the operating console.

tions warrant such action. Control and indication is made positive by the use of coded signaling composed of tones employed in multiple and various sequences which must be decoded and found to be of predetermined combinations and order.

The new pumping station is located near the old station in a wooded park. It is a brick veneered reinforced concrete structure designed to resist a nuclear bomb blast overpressure of 5 psi and momentary reflected pressures on the vertical faces of 13 psi. The existing tunnel supplying the old station has been utilized to serve the new station.

Operating Comparisons

The Btu value of Pocahontas coal, which has been used by the City as a standard, is 14,000-14,500 Btu
per pound. The total energy in 100 lb of coal is 14,
000 x 100 x 777.5 = 1,085,000,000 ft-lb.

The efficiencies of the pumping engines have in-
creased as new pumps were added, steam pressures
increased and other improvements embodied in the
plant according to the estimates as given in Table 2.

<table>
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<tr>
<th>Engine Number</th>
<th>Test Duty Foot Pounds Per 100 lb. Coal</th>
<th>Percent Efficiency</th>
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<tr>
<td>1 and 2</td>
<td>85,000,000</td>
<td>7.8</td>
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<tr>
<td>3</td>
<td>104,820,400</td>
<td>9.6</td>
</tr>
<tr>
<td>4, 5 and 6</td>
<td>135,770,000</td>
<td>12.5</td>
</tr>
<tr>
<td>7 and 8</td>
<td>142,000,000</td>
<td>13.1</td>
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An estimate of the efficiency of operating elec-
tric motor driven pumps based on a net plant Btu heat
rate of 10,000 per kw hr, line loss of 7.5 percent,
and weighted wire to water efficiency of the pumps
of 81.5 percent is obtained by the following calcu-
lation:

$$3415 \times .925 \times .815 \div 10,000 = 25.7 \text{ percent}$$

This calculation indicates that the new electric
motor driven pumps can be expected to operate at al-
most twice the efficiency of the newest of the steam
pumping engines.

The monthly cost of labor for the original instal-
lation as given in the 1874 Annual Report of the
Board of Public Works was as follows:

| One Engineer at $125 per month | $125.00 |
| One Assistant Engineer at $75 per month | 75.00 |
| Two Oilers at $60 per month | 120.00 |
| Two Firemen at $50 per month | 100.00 |
| Two Coal-Passers at $40 per month | 80.00 |
| Total Monthly Payroll | $500.00 |

No information is available on the monthly pump-
age in 1874. In 1875 the City pumped 953.7 mil gal
at a labor cost of $6.30 per mil gal.

In 1961, the last full year of operation of the
steam station, the labor cost of pumping was $20.80
per mil gal.

Since the new station is operated from the Linn-
wood Purification Plant the labor for operation
will consist only of general maintenance work and
should not exceed $5.63 per mil gal of water pumped.

One year of operating experience has shown that
the new station operates exceptionally well on re-
 mote control from the Linnwood Avenue Purification
Plant. Little or no trouble has been experienced with
the operating equipment.

The station is visited once during each eight hour
shift by one man from the Linnwood Avenue Purifi-
cation Plant for a visual operational check. An
 electrical mechanic is present in this station 24 to 40
hours per week to provide preventive maintenance
and insure proper operation of electrical switchgear,
electric motors and electric auxiliary equipment. Two
instrument technicians work in this station approxi-
mately six hours per week performing preventive
maintenance on instruments, telemetering and super-
visory equipment.

References

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