COMPARISON OF HIGH PRESSURE WATER SYSTEMS FOR FIRE PROTECTION.

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1923.

Massachusetts Institute of Technology.

May 1923.

May 1923.

To Mass. Inst. of Tech.

We herewith submit the following thesis on "Comparison of High Pressure Water Systems for Fire Protection".

ACKNOWLEDGEMENT.

We wish to acknowledge the valuable advice and assistance of Prof. George B. Haven thruout the work of the thesis.

We also wish to acknowledge the assistance of P. W. Wilkinson, Secretary and Clerk of the Baltimore Fire Dept., Mr. Donnelly and Mr. Smith, Superintendents of High Pressure Water Service, Philadelphia, H. B. Machen, Borough Engineer, Manhattan, New York, and Superintendent Byington of the Boston Fire Dept.

For data concerning the systems, we are indebted to the above and to the city engineers of the cities supplying data in answer to our questionaire.

For the piping diagrams, we are indebted to the Insurance Library of Boston.

For information concerning the insurance rates we are indebted to Mr. Booth of the National Board of Fire Underwriters of New York.

Table of Contents.

SUMMARY.

The comparison of the High Pressure Systems was undertaken by investigating the present state of development of the systems.

The investigation was made in part by personal visits to several systems and in part by means of questionaires sent to city engineers.

The description of original installations were secured from engineering periodicals.

This thesis will be confined to the mechanical aspects alone with some few figures on maintenance expenses where they are available. Special attention will be given to differences in design and operation of the different systems.

A brief tabulation of the results is to be found in Appendix "D".

INTRODUCTION.

High Pressure Systems are misnamed in that it is not primarily the pressure but the fact that the system is used only for fire protection that is important. Pressures are usually higher than the domestic supply but as a general rule the pressure at a hose nozzle is no higher than that obtained by portable pumpers. High Pressure Systems are those in which water used only for fire protection is drawn from special hydrants at a pressure sufficient to supply effectual hose streams. Monitor nozzles are coming into use in which there is no upper limit to the pressure that can be used, and for these high pressure is especially effective. High Pressure Systems originally consisted of higher pressure built up in the domestic system during a fire. Various difficulties were attendent on this method. Next came the loops from the water fronts supplied by fireboats. Finally an independent pipe system with a separate pumping station became the usual design. The finest system now in existence in San Francisco makes use of gravity tanks, an auxiliary station, and fireboats as a second alternative.

Development is as a general rule slow but steady. Extensions are expensive, and but a small amount of

new pipe can be laid at any one time. However conditions are always changing and a comparison of various systems is only good for a short time.

Comparisons may be made from three standpoints; 1. Firefighting efficiency; 2. Financial gains due to the use of the system; and 3. a comparison of the types of mechanical equipment which go to make up the various systems. The first two are rather vague and unsatisfactory due to the fact that it is almost impossible to obtain numerical results for comparisons.

IV.

REPORT.

REPORT.

There are a large number of points that are necessary to consider in the comparison of High Pressure Systems. The important ones are the type of installation and the method of operation.

There are four general types of installation, those with steam, gas, electricity, and gravity as the sources of power. Typical installations are Baltimore, Philadelphia, New York, and San Francisco, respectively.

Various factors influence the type of installation for the different cities. The initial cost, cost of maintenance, and availability of the different types of power.

The chief requirement that all seek to obtain is the absolute reliability of the plant. This requirement includes the fact that all stations are as self contained as possible.

In general, steam is the most expensive power to use as the value of equipment necessary for the station is high, and the upkeep is also high as steam pressure must be kept up at all times, even tho the station may be used only a small number of hour in a year. Labor charges are much higher with this type of system. However, in the case of Baltimore the actual

cost of maintenance for the H.P. alone is cut down by the use of surplus steam for heating, lighting, and elevator service in municipal buildings.

Here has been more or less controversy regarding the relative costs of electricity and gas. Electric installations are much more frequently installed due to the ease with which power from several sources can be obtained. The installation charge is much less as the space occupied is smaller and a less expensive building can be used. The cost of maintenance is about the same, except where excessive charges are made to insure the reliability of the electric power as in the case of Manhattan and Brooklyn. Producer gas systems, as installed in Winnipeg, are more expensive than illuminating gas because of the large amount of equipment necessary and also because of the large amount of labor necessary to run the plant. Some cities, as Boston, used both steam and electric power.

The gravity system is the cheapest where a reservoir is availabie, as a high duty pump can be used for filling the reservoir.

The pumping equipment most favored is the stage-centrifugal pump, which may be either steam or electric driven. When gas is used the triplex plunger pump is generally used on it providing a much more even load

on the gas engine than would be true of other pumps. Baltimore is unique, in its use of steam plunger pumps.

The most generally used distribution system is one made up of cast iron mains having a bell and spigot joint with lead grooves. Flanged joints as used in Philadelphia proved very unsatisfactory owing to the many breaks in the system, and a universal machined joint is now being installed. Special universal joints are used in Baltimore where the piping is of soft O.H. Steel.

Many types of hydrants have been designed for high pressure work. The old type of gate valve hydrant has now become obsolete and the most modern hydrants are of the post compression type, that is they open against the pressure. These hydrants are usually equipped with pilot valves for easy opening and have independent valves on each outlet. A special hydrant of this type was designed for Boston by Commissioner Rourke. Cincinnati uses the flush type of hydrant with portable head which has been used in Baltimore since the installation of the H.P. System.

The control of the High Pressure System varies with the conditions in the varicus cities. The system generally is divided into stations and equipment, and

the distribution system. The stations are under the fire department control, and the mains and hydrants are under the water department. There are three exceptions to this general rule. Baltimore's entire system is under the direct control of the fire department; New York and Philadelphia have their entire systems under the water department. In Philadelphia they go so far as to have special water department men to open the hydrants at a fire.

The methods of operation vary with the type of system. In Baltimore the maximum pressure is always put on the line as soon as an alarm of fire comes in. This is possible because each hydrant outlet has a regulating valve and any pressure in any outlet can be secured. In most of the other systems the pressure is raised to a definite amount and held there until further orders are received. In the gravity systems the maximum pressure is always on the line and it is only necessary to open the hydrant. In Brooklyn the system is kept full by gravity supply at 100 lb. and the pumps are only started when orders for higher pressures are received.

In trying to secure information concerning the reduction of rates in high pressure districts it was discovered that no standard method of rating high

pressure in figuring insurance rates has been adopted nationally.

The only reduction that has been made anywhere is in figuring the points reduction of the basic rate some consideration is given to the fact that there is a high pressure. But in any case the reduction is not very large.

APPENDIX "A".

SPECIFICATIONS.

BALTIMORE.

Date of installation:-

1912.

Type and description of plant:-

Steam. Fire proof building. (Municipal Power Plant.)

Source of power:-

4 Edgemoor water tube boilers.

Type of prime mover:-

(a) 3 Allis Chalmers horizontal Corliss crank and flywheel.
(b) 1 Epping Carpenter horizontal Duplex.

Type of pump:-

(a) 3 Allis Chalmers horizontal Corliss crank and flywheel.
(b) 1 Epping Carpenter horizontal Duplex.

Number of units:-

Four.

Pumping capacity - gals/min. at max. pressure:-

Allis Chalmers pumps	4500 gal/min. each.
Epping-Carpenter	1000 " "

Maximum pressure:-

(a) Allis-Chalmers	200 lbs.
(b) Epping-Carpenter	150 "

Suction supply:-

(a) Domestic system.
(b) Auxiliary connection to harbor.

Distribution system:-

Gridiron.

Length of mains:-

8.9 miles.

Depth of mains below street level:-

3 ft.10 in.

Type of joint:-

Special universal.

Pipe sizes:-

8" - 24"

Kind of pipe:-

Soft steel.

Number of hydrants:-

226

Size and type of hydrants:-

Ross portable hydrant head.

Spacing of hydrants:-

170 feet.

Acres of protected area:-

170

Remarks:

The municipal power plant, located in the High Pressure Station, furnishes the power for the station.

The complete system is under the control of the fire department, including the power plant.

The station is entirely fire proof being protected by wire glass windows in metal frames and rolling

shutters inside. There are 8" risers to monitor nozzles and hose connections on roof.

There is an auxiliary 42" suction supply to harbor with a well under the station.

The hydrants are of the Ross Portable type. All of the connections are just inside the outer edge of the sidewalks being protected by manhole covers.

BOSTON.

Date of installation:-

1922.

Type and description of station:-

(a) Station No. 1, steam.
(b) Station No. 2, electric.

Source of power:-

(a) Station No. 1, steam from B.E.Co. Power House at Commercial St.
(b) Station No. 2, electricity from Edison Third Station.

Type of prime mover:-

(a) No. 1, Westinghouse Impulse Steam Turbine, 750 H.P.
(b) No. 2, Westinghouse Shunt Motors, 750 H.P.

Type of pump:-

(a) No. 1, 3 Stage Double Suction Worthington Centrifugal.
(b) No. 2, 4 Stage Single Suction Worthington Centrifugal.

Number of units:-

(a) No. 1, 2 units.
(b) No. 2, 2 units.

Pumping capacity, gals/min. at maximum pressure:-

(a) No. 1)
(b) No. 2) Total = 12000 gal/min. @ 300

Maximum pressure:-

300 lbs/sq.in.

Suction supply:-

Domestic service. Auxiliary from harbor.

Distribution system:-

Gridiron.

Length of mains:-

11.75 miles.

Depth of mains below street level:-

5-1/2 ft.

Type of joint:-

Bell and spigot with 2 lead grooves.

Pipe sizes:-

12" - 20"

Kind of pipe:-

Cast iron. Semi-steel above 12".

Number of hydrants:-

313.

Size and type of hydrants:-

Rourke Special. Post compression. 4 - 2-1/2" outlets.

Acres of protected area:-

.92 sq. miles.

Remarks:

Domestic pressure is maintained in pipes at app. 55 lbs/sq.in. pressure. Also there is a connection with the high pressure domestic pressure at 85 lb. pressure.

The valves in the stations are all electrically operated. Those on the pumps are Ross and the remainder Deane controlled.

Turbines are regulated by hand throttle in Station No. 1.

Station No. 2 is in a special fire proof building in the boiler room of the Edison Third Station.

One hydrant protects 40,000 Sq.ft. of surface.

The special alloy of the joints consists of 95% lead and 5% tin.

Each hydrant will discharge 2000 gal/min with a loss of 8 lbs. pressure.

There is a three way pilot valve automatically opening with removal of bonnet and automatic drain to sewer with replacement of bonnet.

BROOKLYN.

Date of installation:-

1908.

Type and description of station:-

Electric, 2 stations.

Source of power:-

Brooklyn Edison Co.

Type of prime mover:-

800 H.P., G.E. Induction Motor.

Type of pump:-

Worthington 6 stage centrifugal pump.

Number of units:-

(a) Joralemon St. Five.
(b) St. Edwards St. Three.

Pumping capacity, gals/min at maximum pressure.

Total 6400 gal/min @ 300 lbs. pressure.

Maximum pressure:-

300 lbs.

Suction supply:-

Ashokan Reservoir Supply @ 100 lbs. pressure.

Distribution system:-

Gridiron.

Length of mains:-

44.5 miles.

Depth of mains below street level:-

5 ft.

Type of joint:-

Bell and Spigot.

Pipe sizes:-

8" - 20"

Kind of pipe:-

Cast iron.

Number of hydrants:-

1367.

Size and type of hydrants:-

Post compression. Independent gates.

Spacing of hydrants:-

300 ft.

Acres of protected area:-

1420.

Total cost of installation:-

$1,384,500.

Cost per acre:-

$975.

Cost of maintenance:-

Current cost - $25,992.

Remarks:

The water in the mains is kept at the full pressure from the Catskill Water Supply, which is about 100 lbs. For the greater number of fires, it is not necessary to start the pumps as 100 lbs. is sufficient pressure for ordinary conditions.

BUFFALO.

Date of installation:-

1922.

Type and description of station:-

Steam. Fire proof building (brick, concrete, and tile roof.)

Source of power:-

Water tube boilers.

Type of prime mover:-

3 Terry Turbines, 750 H.P. each.

Type of pump:-

Manistee Iron Works. (4 stage solid bronze rotors 1500 R.P.M. centrifugal pumps)

Number of units:-

Three.

Pumping capacity gals/min. at maximum pressure:-

9000 gal/min. @ 300 lbs.

Maximum pressure:-

300 lbs.

Suction supply:-

Buffalo River.

Type of joint:-

Universal machine bolted joints.

Pipe sizes:-

16" - 20"

Kind of pipe:-

Cast Iron.

Size and type of hydrants:-

Post compression with independent gates.

Remarks.

Steam is supplied from the boilers supplying the domestic system.

Fire boat connections at two points with maximum pressure of140 lbs/sq.in.

Full capacity is obtained 90 seconds after alarm is sounded.

Steam is supplied to turbines at 225 lbs. and 60° superheat.

Turbines are run non-condensing at 3170 R.P.M.

Reducing gears are herring-bone spur gears running in oil bath.

Pumps supply 8 gallons @ 300 lbs. pressure per pound of steam used.

System is kept full at 40 lbs/sq.in. pressure.

CINCINNATI.

Date of installation:-

Not completed.

Type and description of station:-

Gravity system.

Pumping capacity gals/min. at maximum pressure.

10,000 gals.

Maximum pressure:-

175 lbs.

Suction supply:-

City supply to Eastern Hills.

Length of mains:-

9-1/2 miles.

Depth of mains below street level:-

5 ft.

Type of joint:-

Hub and Spigot.

Pipe sizes:-

12" to 24"

Kind of pipe:-

Cast iron.

Number of hydrants:-

182.

Size and type of hydrants:-

8" flush.

Spacing of hydrants:-

2 at all intersections, and 2 between streets.

Acres of protected area:-

2/3 sq.mi.

Total cost of installation:-

Uncompleted.

Remarks.

Hydrants are of the flush type, placed in the centre of the street.

CLEVELAND.

Date of installation:-

1913.

Type and description of station:-

Brick and steel.

Source of power:-

Private illuminating company and Municipal Elec. Plant.

Type of prime mover:-

3 Phase, A.C., 440 V., enclosed type induction motor.

Type of pump:-

5 Stage horizontal centrifugal pumps (Allis-Chalmers)

Number of units:-

Four.

Pumping capacity gals/min. at maximum pressure.

11,200 gals.

Maximum pressure:-

270 lbs./sq.in.

Suction supply:-

42" domestic supply main to E.49th St.Station.

Length of mains:-

11 miles.

Depth of mains below street level:-

6 ft. to 8 ft.

Type of joint:-

Lead.

Pipe sizes:-

6" - 30"

Kind of pipe:-

Cast iron, class G-H

Number of hydrants:-

182.

Size and type of hydrants:-

8" R.D.Wood.

Spacing of hydrants:-

200 ft. - 250 ft.

Total cost of installation:-

Station - $210,000.

Cost per foot of mains:-

30" - $8.00; 24" - $7.00; 20" - $6.75; 16" - $6.50;
12" - $6.00; 10" - $5.50; 8" - $5.00;
6" - $4.50.

Cost of maintenance:-

$20,000 year.

Remarks.

The building is entirely fire proof with a water curtain on three sides.

The fire boats and pumping engines were removed from the high pressure district.

Each hydrant has private telephone line to station.

CONEY ISLAND.

Date of installation:-

1906.

Type and description of station:-

Gas.

Source of power:-

Gas company.

Type of prime mover:-

Nash gas engines.

Type of pump:-

Triplex Plunger (Gould).

Number of units:-

Two.

Pumping capacity, gals/min. at maximum pressure.

4500 gals.

Maximum pressure:-

150 lbs.

Suction supply:-

Domestic. Auxiliary from creek.

Distribution system:-

Loop.

Length of mains:-

6 miles.

Pipe sizes:-

8" - 16"

Number of hydrants:-

150.

Acres of protected area:-

250.

Total cost of installation:-

$160,000.

Cost of maintenance:-

$17,500.

JACKSONVILLE, FLA.

Date of installation:-

Jan. 1, 1911.

Type and description of station:-

Electric. 1 room, reinforced concrete.

Source of power:-

Electricity. (Municipal plant).

Type of prime mover:-

2 375 H.P., 3 phase, 2200 volts, Bullock motors.

Type of pump:-

2 10", 4 stage centrifugal pumps (Allis-Chalmers).

Number of units:-

Two.

Pumping capacity, gals/min. at maximum pressure.

2500 gals. each.

Maximum pressure:-

175 lbs.

Suction supply:-

St. Johns River.

Distribution system:-

Gridiron.

Length of mains:-

22,688 ft.

Depth of mains below street level:-

3 inches.

Type of joint:-

Lead.

Pipe sizes:-

8" to 20"

Kind of pipe:-

Cast iron.

Spacing of hydrants:-

103 ft.

Total cost of installation:-

$75,000

Cost of maintenance:-

$5,000.00

Remarks:

Electric station St. Johns River, power from municipal electric light and power station thru a sub station. Pumps take water from independent mains and discharge into gridiron system.

One room concrete building tile covering on roof. Wire glass windows in metal frames. Standpipe with 50 ft. of hose and nozzle in station. 150 ft. from station on street there are 1 H.P. hydrant and 1 domestic hydrant.

2 10" 4-stage centrifugal pumps each direct connected to a 375 H.P. 3 phase, 2200 volt motor. 2,500 gal/min at 175 lbs. Each pump has a separate 14" suction pipe. 10" discharge pipe with automatic relief valve, then to 12" pipe under floor, then both join into 1 20" main. 4" priming pipe from domestic system. Continuous watch is kept, one man always on duty in station. All alarms are received in station. When an alarm comes in pressure is raised to 100 lbs. The motor can be brought up to speed in less than one minute. There are special signals from the boxes to the station. Pumps are tested twice each week for 15 minutes at 175 lbs.

LAWRENCE.

Date of installation:-

1906.

Type and description of station:-

Standpipe.

Source of power:-

Steam.

Type of prime mover:-

Barr and steam turbine.

Type of pump:-

Barr and steam turbine.

Number of units:-

Two.

Pumping capacity, gals/min. at maximum pressure.

(a) 1300 gals/min. (Barr)
(b) 2000 " " (Steam turbine)

Maximum pressure:-

130 lbs.

Suction supply:-

Pump well at Pumping Station.

Distribution system:-

Loop.

Length of mains:-

11,674.4 ft.

Depth of mains below street level:-

6.2 ft.

Type of joint:-

Lead.

Pipe sizes:-

8", 10", & 12".

Kind of pipe:-

Cast iron.

Number of hydrants:

42.

Size and type of hydrants:-

Matthews.

Spacing of hydrants:-

300 ft.

Acres of protected area:-

120 acres.

Total cost of installation:-

$30,000.

Cost per acre:-

$250.

Cost per foot of mains:-

$2.57

Remarks:

The supply for this system is from a Standpipe containing 532,000 gallons. Two pumps one a Barr Pump, of 1,800,000 gallons; and one Steam Turbine of a rated capacity of 3,000,000 gallons a day are at the pumping station. The following will give you the size pipe and the number of feet laid.

A twelve inch pipe has been laid extending from the distributing main on Haverhill St. down Lawrence St. to the south side of Essex St. From this point a 10 inch main extends up Essex St. to Broadway, Broadway to Common, Common to Union, Union to Essex and thence up Essex to Lawrence St. completing the circuit. The

whole system is laid out so that in case of accident there will be but a small unit out of service at one time. Two crosses have been put in, one at the corner of Essex St. and Broadway, for an extension on Broadway south of Essex St. and for an extension of the service on Essex St. west of Broadway. The other has been placed on Jackson St. at the corner of Common St. for extensions to Haverhill St. and Essex St. respectively.

The material used is of the very best, all the pipe is extra heavy, as it requires a working pressure of 173 lbs. to the square inch.

The total number of gates is 58 - 12 inch gates 2; 10 inch gates 14; and 8 inch gates 42.

MANHATTAN, N.Y.

Date of installation:-

1908.

Type and description of station:-

Electric. 2 stations.

Source of power:-

N. Y. Edison and Brooklyn Edison.

Type of prime mover:-

800 H.P. Allis-Chalmers 6600 Volt,3 phase, 25 cycle Induction Motors.

Type of pump:-

Allis-Chalmers 5 state centrifugal pumps.

Number of units:-

6 units in each station.

Pumping capacity, gals/min at maximum pressure:-

36,000 gal/min. @ 300 lbs. pressure.
60,000 " " @ 200 " "

Maximum pressure:-

300 lbs.

Suction supply:-

Domestic system.

Distribution system:-

Gridiron.

Length of mains:-

128 miles.

Depth of mains below street level:-

5 ft.

Type of joint:-

Bell and Spigot. Double lead groove.

Pipe sizes:-

8" - 24"

Kind of pipe:-

Cast iron.

Number of hydrants:-

2751.

Acres of protected area:-

2220 acres.

Total cost of installation:-

$5,550,000.

Cost per acre:-

$2000.

Cost of maintenance:-

Current cost, $49900.00

Remarks.

There is a duplex system from the Oliver St. Station.

Both stations pump into the same system, but there are gates between which can separate the system into two separate units.

There is a very large amount of leakage in the system.

The system is under the control of the department of Water, Gas, and Electricity.

MIAMI, FLA.

Date of installation:-

Nov. 1921

Type and description of plant:-

Fire proof building. Electric.

Source of power:-

Miami Electric and Power Co.

Type of prime mover:-

G.E. Co. 300 H.P. motors (2300 V. 969 Amps.) at full load.

Type of pump:-

Three stage centrifugal pumps (Morris Man'f.Co.)

Number of units:-

Two.

Pumping capacity:-

4300 gals./min. at 215 lbs.

Maximum pressure:-

215 lbs.

Suction supply:-

Battery of 8" wells.

Distribution system:-

Length of mains:-

9500 ft.(app.)

Type of joint:-

Bell and Spigot.

Pipe sizes:-

8" - 16"

Kind of pipe:-

Cast iron. Class D.

No. of hydrants:-

37.

Size and type of hydrants:-

Matthew type: one 3", and two 2-1/2" openings.

Spacing of hydrants:-

250 ft.

Total cost of installation:-

$55000.

Cost of maintenance and operation:-

$500. per year (app.)

Remarks:

Pumps are housed in fire proof buildings located on same lot with fire Headquarters building, current is supplied by the Miami Electric Light and Power Company, through a special underground service.

On official test, pumps supplied 4,300 gals/min. at a pump pressure of 215 lbs.; flowing pressure at outlet 185 lbs.

Suction supply, is secured from a battery of eight, eight inch wells in which the water level stands at 8.6 feet below mean low tide level and when pumps are working at maximum capacity gauge shows 15-1/2 inch vacuum.

Distribution system, covers the entire mercantile district and range from 8 to 16 inches in size. There are 37 hydrants spaced 250 feet apart. They have six inch valve openings and one three inch, and two 2-1/2 inch nozzles with individual control valves on the 2-1/2 inch openings, hydrants are furnished by R. D. Wood Company, of Philadelphia; Matthews Type. Pipe is regular Class D, Bell and Spigot, furnished by the

American Cast Iron Pipe Company.

Total cost of installation amounted to approximately $55,000.00 including building, wells, pumping machinery and mains. The cost of laying pipe averaged $1.40 per foot, not including cost of re-paving.

Maintenance costs amount to approximately $1,500.00 per year, not including salaries of two engineers, which amount to $3,360.00 per year.

MILWAUKEE.

Date of installation:-

1889.

Type and description of station:-

Steam fire boats.

Source of power:-

Steam. Tubular & Scotch Boilers.

Number of units:-

Four.

Pumping capacity, gals/min. at maximum pressure:-

24,000 gal/min.

Maximum pressure:-

250 lbs.

Suction supply:-

Milwaukee River.

Distribution system:-

27 mains, 550 ft. to 5623 ft., no branches.

Length of mains:-

12.7 miles.

Depth of mains below street level:-

3 to 4 ft.

Pipe sizes:-

8" - 12"

Kind of pipe:-

Cast iron.

Number of hydrants:-

260.

Size and type of hydrants:-

Special. Independent valves.

Remarks:

There are 27 separate mains under the control of the fire department. They vary in length from 550 to 5623 ft. with a total of 12.7 miles. These lines are mostly 8 to 12" in size with a few 6". The lines are kept full except in the fall when they are drained for the winter.

The hydrants are of a special design with an independent gate valve for each outlet.

There are no gates in the branches.

Signal boxes connect with the fire boats.

Each fire boat is capable of supplying only two branches at a time.

PHILADELPHIA.

Date of installation:-

(a) No. 1 Race St., 1903.
(b) No. 2 Fairhills, 1910.

Type and description of station:-

Both gas.

Type of prime mover:-

Westinghouse gas engines, 3 cylinder, single acting.

Type of pump:-

Vertical, double acting, triplex Deane Pumps.

Number of units:-

Race St., 7 large, 2 small.
Fairhills, 10.

Pumping capacity, gals/min. at maximum pressure:-

Small, 350 gal/min. Race St. -
Large, 1200 gal/min.

Maximum pressure:-

300 lbs.

Suction supply:-

Race St. - Delaware River.
Fairhills - Reservoir supplied from domestic system.

Distribution system:-

Gridiron.

Length of mains:-

52 miles.

Depth of mains below street level:-

4 ft.

Type of joint:-

Flanged on old (16-1/2 miles)
Universal on new (35-1/2 miles)

Pipe sizes:-

8" - 20"

Kind of pipe:-

Cast iron.

Number of hydrants:-

Race St. - 298.
Fairhills - 609.

Size and type of hydrants:-

Old - Gate valves (30% of total)
New - Post Compression with pilot valve.

Spacing of hydrants : -

350 ft.

Total cost of installation:-

Race St. - $750,000
Fairhills - $2,150,000

Remarks:

System is filled with domestic water @ 35 lbs.

Pressure is built up to 175 lbs. on receiving alarm.

Relief valve on pumps opens at 300 lbs.

The system is under the contaol of the water department. A truck with 3 men is sent out from the

station to every fire to open the hydrant. There is a fireman on duty continuously at each pumping station.

The gas company supplying the stations has six containers with a capacity of 1,000,000 cu.ft.

There are three sources of ignition current.

1. Duplicate set 71/2 K.W. 220 V. D.C. generators.

2. 220 V. Edison current.

3. 8 Primary cells.

The compressed air for starting is furnished by duplicate 2 stage air compressors and stored in 8 tanks at 200 lbs. pressure.

The time required to maximum pressure of 300 lbs. is 45 seconds.

Each engine has its own gas meter.

There are 4 high pressure pipe line companies, one of which attends every fire.

There are connections for fire boats.

ROCHESTER, N.Y.

Date of installation:-

(a) Brown's Race Station - 1873.
(b) South Water St. Station - 1906.

Type and description of plant:-

(a) Steam and water plant.
(b) Electric plant.

Source of power:-

(a) Two 250 H.P. Scotch Marine Boilers.
Genesee River.
(b) Rochester Gas and Electric Corporation.

Type of prime mover:-

(a) One Holly steam engine set.
One DeLaval condensing steam turbine.
Two 256 H.P. water turbines - with auxiliary belt drive from 100 H.P. Simplex engine.
(b) One 275 H.P., G.E. induction motor.

Type of pump:-

(a) One Holly steam driven quadruplex pump.
One d'Olier 2-stage centrifugal pump.
Two Holly inclined, quadruplex, double-acting pumps.
(b) One Worthington, 10-inch, 3-stage centrifugal pump.

Number of units:-

(a) One steam quadruplex.
One steam turbine.
Two water sets.
(b) One electric driven set.

Pumping capacity, gals/min. at maximum pressure:-

Rated capacities-

(a) Holly steam driven quadruplex,	2000	gal/min.		
d'Olier centrifugal pump,	2000	"	"	
Two Holly inclined quadruplex,	1400	"	"	each
(b) Worthington pump,	2000	"	"	

Maximum pressure:-

140 lbs.

Suction supply:-

(a) and (b) Race from Genesee River.
Auxiliary supply from domestic system.

Distribution system:-

Mains extend through the heart of the congested value district and supply the distribution system, gridironed in the central portions.

Length of mains:-

25.21 miles.

Depth of mains below street level:-

4-1/2 ft.

Type of joint:-

Lead joint.

Pipe sizes:-

4", 6", 8", 10", 12", 16", 20".

Kind of pipe:-

Classes B and C and some heavier pipe (American Water Works Association specifications).

Number of hydrants:-

458.

Size and type of hydrants:-

421 Matthews, 34 Corey, 2 Ludlow and 1 Cayuta.
10 with one 4-1/2" and two 2-1/2" outlets.
88 with three 2-1/2" outlets.
347 with two 2-1/2" outlets.
13 with four 2-1/2" outlets.

Spacing of hydrants:-

220 feet in the congested value district.
260 feet elsewhere.

Acres of protected area:-

1686.

Total cost of installation:-

$494,000

Cost per acre:-

$293.

Cost per foot of mains:-

$3.71

Cost of maintenance and operation:-

$12,000 per year (1908).

SAN FRANCISCO.

Date of installation:-

1913.

Type and description of station:-

Steam plant. Fire boats.

Source of power:-

Station No. 1 - 8 350 H.P. B & W Boilers (Oil Fuel)
Station No. 2 - 8 350 H.P. Sterling Boilers (Oil Fuel).

Type of prime mover:-

Station No. 1 - 4 750 H.P. horizontal non-condensing steam turbines of the Curtis type.
Station No. 2 - Same as No. 1 and Fire boats - 2 Steam Turbines of the Curtis type.

Type of pump:-

Station No. 1 and No. 2
4 sets multi-stage turbine pumps.
Fire Boats
2 stage Turbine pumps.

Number of units:-

Station No. 1 & No. 2 - four sets.
Fire boats - two sets.

Pumping capacity, gals/min. at maximum pressure:-

Station No. 1 and No. 2		
Each set	3000	gal/min.
Fire boats	9000	" "

Maximum pressure:-

Station No. 1 and No. 2 - 300 lbs.
Fire boats - 150 lbs.

Suction supply:-

Station No. 1 - Salt water from bay.
Station No. 2 - Domestic supply from reservoir.

Distribution system:-

Two zones.

Length of mains:-

75 miles.

Type of joint:-

Bell and Spigot.

Pipe sizes:-

8" - 20" 14" average.

Kind of pipe:-

Heavy cast iron.

Number of hydrants:-

907.

Size and type of hydrants:-

Three 3-1/2" outlets.

Acres of protected area:-

9-1/2 sq.miles.

Total cost of installation:-

$5,756,000.

Cost of maintenance:-

Pumping stations	51,635.20	
High pres. fire lines	65,091.72	Fiscal year
Fire boats	120,000.00	1921-1922.
Total	$236,726.92	

Remarks:

There are two zones, upper and lower. Both are supplied by independent reservoirs which are connected to a third. The lower zone includes all pipes below the 150 ft. level and the upper all above 150 ft.

There is a telephone system for the exclusive use of the Fire Department. Communication can be maintained with the gate men at the various reservoirs from the fire.

The pipes are kept filled with fresh water supplied from the reservoirs.

The hydrants connected with the domestic water supply from the Spring Valley Water Co. are used first in all fires.

The maximum pressure from the largest reservoir which can be maintained in the lower zone is 328 lbs. per sq.in.

Pumps are not used except as an auxiliary in case of failure of reservoir supply.

Station entirely self sustaining for 96 hours, without communication to outside.

TOLEDO.

Date of installation:-

January 18, 1917.

Source of power:-

Three power lines from The Toledo Edison Co.

Type of prime mover:-

550 H.P., 3 phase, 25 cycle, 4000 volt motors.

Type of pump:-

10 inch, 5 stage, horizontal, centrifugal pumps, manufactured by the Allis-Chalmers Co., Milwaukee, Wis.

Number of units:-

Four.

Pumping capacity, gals/min. at maximum pressure:-

8000 G.P.M. 700 foot head or 3000 lbs. pressure.

Maximum pressure:-

300 lbs.

Suction supply:-

From Maumee River - raw water supply.

Length of mains:-

4825 ft. 16", 2250 ft. 12", 15550 ft. 10".

Depth of mains below street level:-

Averages about 5 feet.

Type of joint:-

Standard for Class "G" pipe.

Pipe sizes:-

10", 12", and 16". Hydrant branches 8"

Kind of pipe:-

Cast iron pipe - Class "G", A.W.W.A. specifications

Number of hydrants:-

66

Size and type of hydrants:-

8" Matthews Post-Compression type, Mfd. by R.D. Wood and Co., Philadelphia.

Spacing of hydrants:-

Street corners and between blocks.

Acres of protected area:-

140 acres.

Total cost of installation:-

Lands $20,000.00. Sub-structure $450,548.61. Superstructure $57,541.70. Machinery and equipment $62,423.17. Electrical equipment $410.67. Distribution system $110,000.00

Cost per acre:-

$2,140.00

Cost per foot of mains:-

$13.30

Cost of maintenance:-

Year 1922 $19,085.57

Remarks:

The system is kept full at all times.

The pipes are tested for 600 lbs. pressure.

TORONTO.

Date of installation:-

From 1905 to 1908.

Type and description of station:-

Brick building, 49x50x50' high. Steam is furnished by sixteen boilers, aggregating 4800 boiler horse power (normal rating) at 160 lbs. pressure. These boilers are also used for domestic pump service and full working pressure is kept up continuously. The operating staff is on duty 24 hours per day (3 watches of 8 hours). The pumping equipment consists of two Westinghouse Parsons steam turbines, direct connected to two 5,000,000 Imperial gallons, 2 stage John McDougall pumps. Maximum speed 1500 revolutions per minute.

Source of power:-

Steam.

Type of prime mover:-

Westinghouse Parsons turbine, 1500 R.P.M. with barometric condenser.

Type of pump:-

Two stage centrifugal, built by John McDougall Company, Montreal. (Cast steel casings).

Number of units:-

Two.

Pumping capacity, gals/min. at maximum pressure:-

4166 U.S. gallons per pump per minute at maximum.

Maximum pressure:-

The maximum pressure carried at the pumps has been 350 lbs/sq.in.

Suction supply:-

Toronto harbor, by duplicate conduits.

Distribution system:-

Length of mains:-

45,241 ft.

Depth of mains below street level:-

8 ft.

Type of joint:-

Double grooves on spigot and faucet.

Pipe sizes:-

8", 12", and 20"

Kind of pipe.

Cast iron tested to 700 lbs.pressure per sq.in.

Number of hydrants:-

147.

Size and type of hydrants:-

Three nozzle, made by A.P.Smith & Co.,Newark,N.J.

Spacing of hydrants:-

About 300 ft. apart.

Acres of protected area:-

300 acres.

Total cost of installation:-

$780,000 including mains, pumping plant, fire department equipment and debenture discount.

Cost per foot of mains:-

$11.50 per foot of main only.

Cost of maintenance:-

The cost for 1923 was $27,650.84 exclusive of interest on investment.

Remarks:

When an alarm from the High Pressure District is rung in, one pump is started immediately whether the Fire Department request it or not, by the High Pressure Fire signal system, and the pressure held at 150 pounds. By the signal system the pressure is raised by steps of 50 pounds, until the maximum pressure is reached. Each step takes about 30 seconds. From a standstill a pressure of 300 pounds can be reached in about one minute. The highest pressure recorded at the pump is 350 pounds per square inch.

During a fire if it is found that 300 pounds pressure cannot be maintained by one pump the second one is started up. The High Pressure System is entirely divorced from the Domestic Service there being no physical connection whatever. When the high pressure pumps are not in operation the mains are kept fully charged by means of a small duplex pump, which maintains the pressure from 80 to 100 pounds. A second duplex pump is held in reserve. A private telephone line is used in case the signal system becomes

inoperative.

Recording pressure charts with complete tape records of all alarms are kept. The tape records give the number of the box, also date, hour and minute when alarms are rung in. Similar records for the signal system are kept.

WINNEPEG.

Date of installation:-

1907.

Type and description of station:-

Fire proof construction.

Source of power:-

Producer Gas Plant adjoining station, and Winnepeg Hydro Electric.

Type of prime mover:-

Gas engines.

Type of pump:-

6 Glenfield & Kennedy Reciprocating double acting pumps driven by Crossley gas engines, and 2 Canadian Allis Chalmers motors each 315 H.P. with Mather & Platt Turbines.

Number of units:-

Eight.

Pumping capacity, gals/min. at maximum pressure:-

900 gals/min.

Maximum pressure:-

300 lbs.

Suction supply:-

Direct connection to G.W.D. Aqueduct 36" and standby 36" suction to Red River.

Length of mains:-

12.153 miles.

Depth of mains below street level:-

8 feet.

Type of joint:-

Lead hydrant connections flanged.

Pipe sizes:-

10", 12", 18", 20"

Kind of pipe:-

Cast iron.

Number of hydrants:-

160

Size and type of hydrants:-

R.D.Wood Co. High Pressure 8" with 4, 4-1/2" hose nozzle with independent gates.

Spacing of hydrants:-

Approx. 260 ft.

Acres of protected area:-

207,289.70 ft. frontage assessed

Total cost of installation:-

$1,289,442.09.

Cost of maintenance:-

1922 - $76,251.82

Remarks:

All engines can be working under load within 3-1/2 minutes after the alarm has sounded.

All auxiliaries are in duplicate.

The producers are able to be cleaned while in operation. There are air superheating hot gas boilers, wet scrubbers, tar extractors, and tar extractors attached to the producers.

The gas holder and pumping station are connected with the city gas system.

WORCESTER.

Date of installation:-

1863.

Source of power:-

Gravity system.

Pumping capacity gals/min at maximum pressure.

5000 gals.

Maximum pressure:-

160 lbs.

Length of mains:-

19 miles.

Depth of mains below street level:-

4-1/2 ft. to center of pipe.

Type of joint:-

Bell and Spigot.

Pipe sizes:-

6" - 36"

Kind of pipe:-

Cast iron.

Number of hydrants:-

About 2500.

Size and type of hydrants:-

Principally Matthews.

Spacing of hydrants:-

At each street corner (not over 300 ft. apart).

Remarks:

Our high pressure system was not designed for fire protection only. It is the first supply of consequence built for Worcester and when a new supply was found necessary, another source was found, reservoirs were constructed at a lower level than the high pressure and all sections which could be supplied from the low source were taken off the high, merely leaving the high pressure to furnish fire protection in the closely settled parts of the city and a domestic supply on the hills which the low service would not reach.

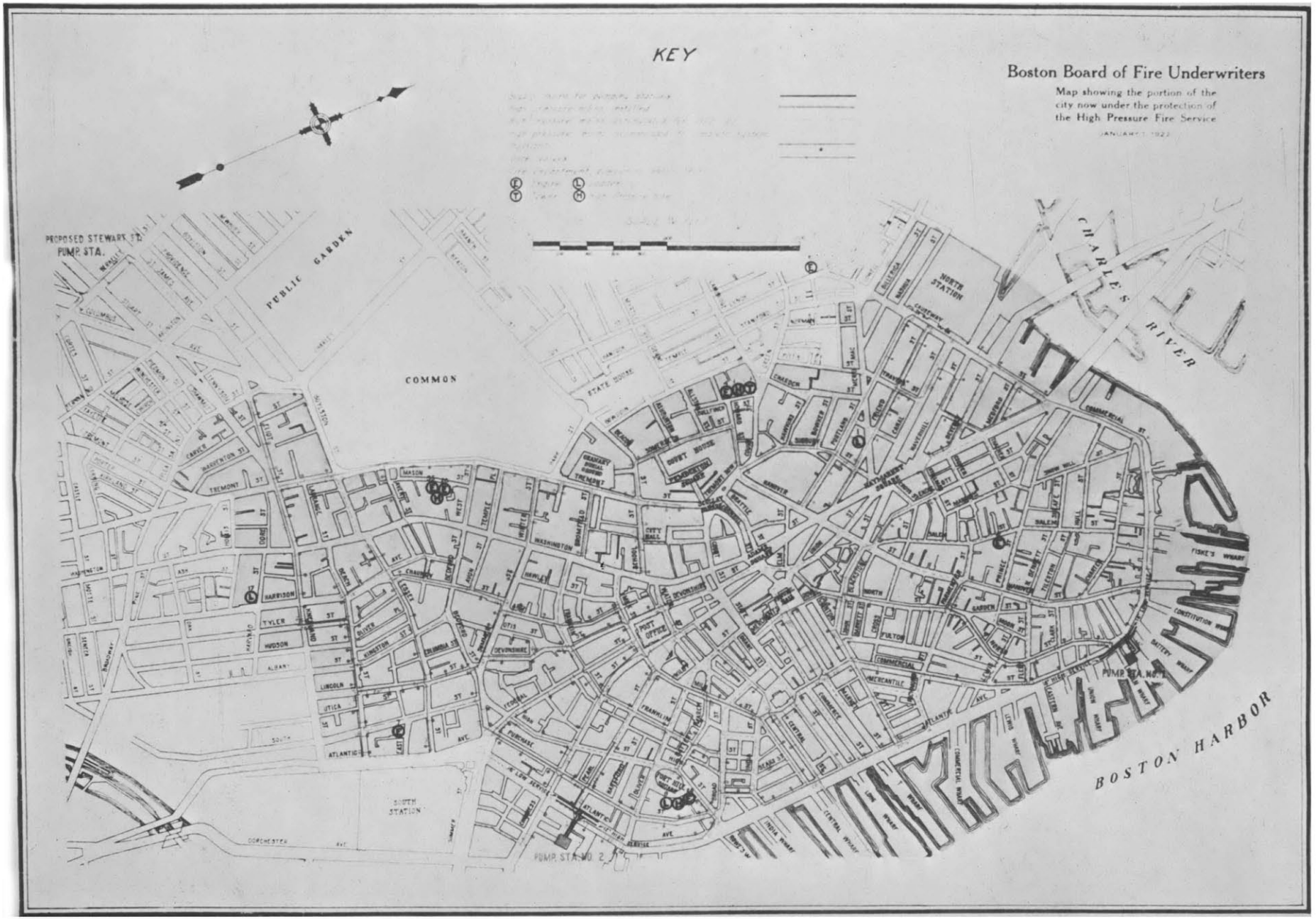
APPENDIX "B".

PIPING DIAGRAMS.

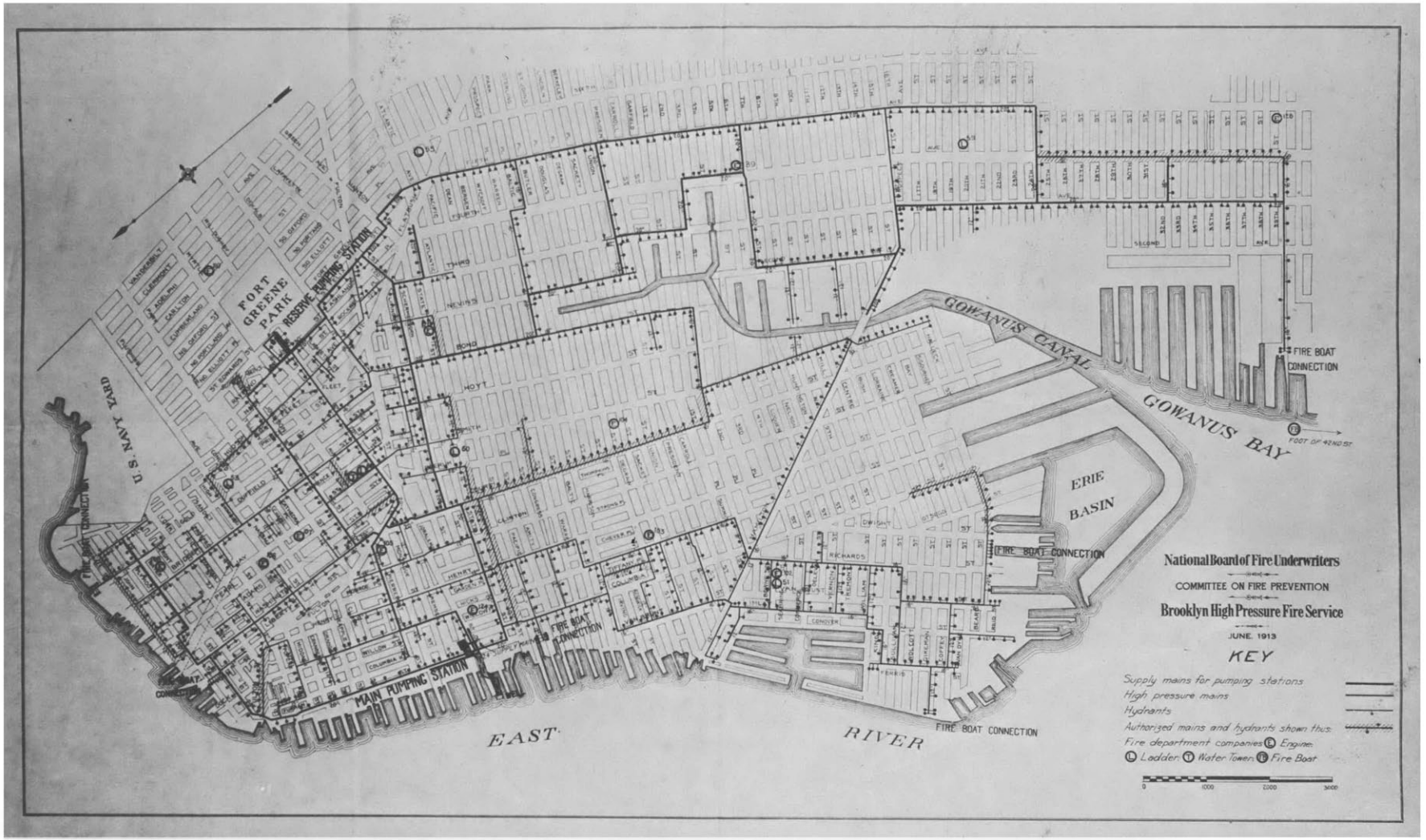
BALTIMORE.


National Board of Fire Underwriters
COMMITTEE ON FIRE PREVENTION
BALTIMORE, MD.
Congested Value District
AND
High Pressure Fire Service
MAY. 1916.
KEY
Congested Value District
Mains of the domestic system shown thus;
High Pressure fire mains shown thus;
Hydrants and Valves shown thus;
Fire Department companies designated by symbols thus. (E) Engine; (Z) Engine (Tractor engine and automobile hose wagon); (L) Ladder; (T) Water Tower; (H) High Pressure Hose company; (O) Automobile apparatus; (C) Chemical Tanks on above.
10" 40"
SCALE OF FEET
0 1 2 3 4 500 1000 1500 2000
COURT HOUSE
U.S. POST OFFICE
CITY HALL
HIGH PRESSURE FIRE SYSTEM PUMPING STATION
BASIN
MIDDLE SERVICE MAINS
MONUMENT
CENTER
FRANKLIN
MULBERRY
SARATOGA
CLAY
LEXINGTON
BALTIMORE
GERMAN
LOMBARD
PRATT
PORTLAND
COLUMBIA
CAMDEN
PERRY
CONWAY
BARRE
WELCOME
LEE
HILL
PLEASANT
COURT
CALVERT
WATER
COMMERCE
FALLSWAY
GRANBY
STILES
FAWN
FLEET
ALICE ANNA ST
FRONT
PATAPSCO
1
2
3
4

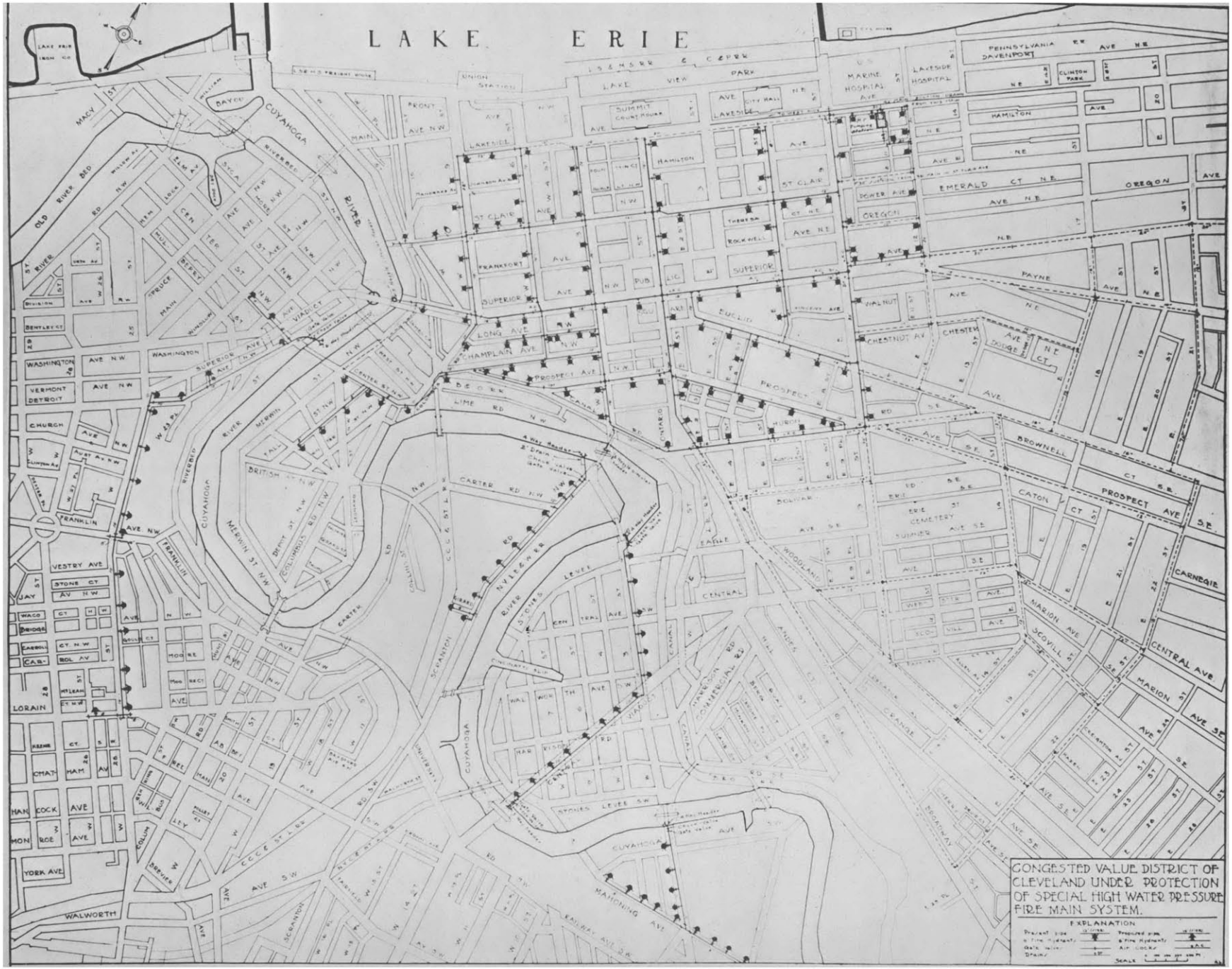
BOSTON.


KEY
Boston Board of Fire Underwriters
Map showing the portion of the city now under the protection of the High Pressure Fire Service
JANUARY 1922
PROPOSED STEWART ST. PUMP STA.
PUBLIC GARDEN
COMMON
STATE HOUSE
NORTH STATION
CHARLES RIVER
SOUTH STATION
POST OFFICE
CITY HALL
PUMP STA. NO 2
PUMP STA. NO 1
BOSTON HARBOR
FISKE'S WHARF
CONSTITUTION WHARF
BATTERY WHARF
COMMERCIAL WHARF
LONG WHARF
CENTRAL WHARF
INDIA WHARF
TREMONT ST
BOYLSTON ST
ARLINGTON ST
BERKELEY ST
CLARENDON ST
DARTMOUTH ST
HUNTINGTON AVE
MASSACHUSETTS AVE
COLUMBUS AVE
WASHINGTON ST
TREMONT ST
SHAWMUT AVE
HARRISON AVE
ALBANY ST
SOUTH ST
KNEELAND ST
BEACH ST
ESSEX ST
LINCOLN ST
UTICA ST
HUDSON ST
TYLER ST
ATLANTIC AVE
DORCHESTER AVE
SUMMER ST
CONGRESS ST
DEVONSHIRE ST
FRANKLIN ST
MILK ST
PURCHASE ST
OLIVER ST
FEDERAL ST
HIGH ST
CENTRAL ST
SUDBURY ST
HANOVER ST
NORTH ST
SALEM ST
PRINCE ST
GARDEN CT
FULTON ST
COMMERCIAL ST
MERCANTILE WHARF
COMMERCIAL ST
ATLANTIC AVE
NORTHERN AVE
CHARLESTOWN BRIDGE
CRAWFORD ST
CAMBRIDGE ST
BOWDOIN SQUARE
GRANARY BURIAL GROUND
TREMONT TEMPLE
OLD SOUTH CHURCH
OLD SOUTH MEETING HOUSE
OLD STATE HOUSE
FANEUIL HALL
OLD CORNER BOOK STORE
OLD SOUTH WORK

BROOKLYN.


FORT GREENE PARK
RESERVE PUMPING STATION
U.S. NAVY YARD
GOWANUS CANAL
GOWANUS BAY
FIRE BOAT CONNECTION
FOOT OF 42ND ST
ERIE BASIN
FIRE BOAT CONNECTION
MAIN PUMPING STATION
FIRE BOAT CONNECTION
FIRE BOAT CONNECTION
EAST RIVER
National Board of Fire Underwriters
COMMITTEE ON FIRE PREVENTION
Brooklyn High Pressure Fire Service
JUNE, 1913
KEY
Supply mains for pumping stations
High pressure mains
Hydrants
Authorized mains and hydrants shown thus:
Fire department companies E Engine
L Ladder T Water Tower FB Fire Boat
0
1000
2000
3000

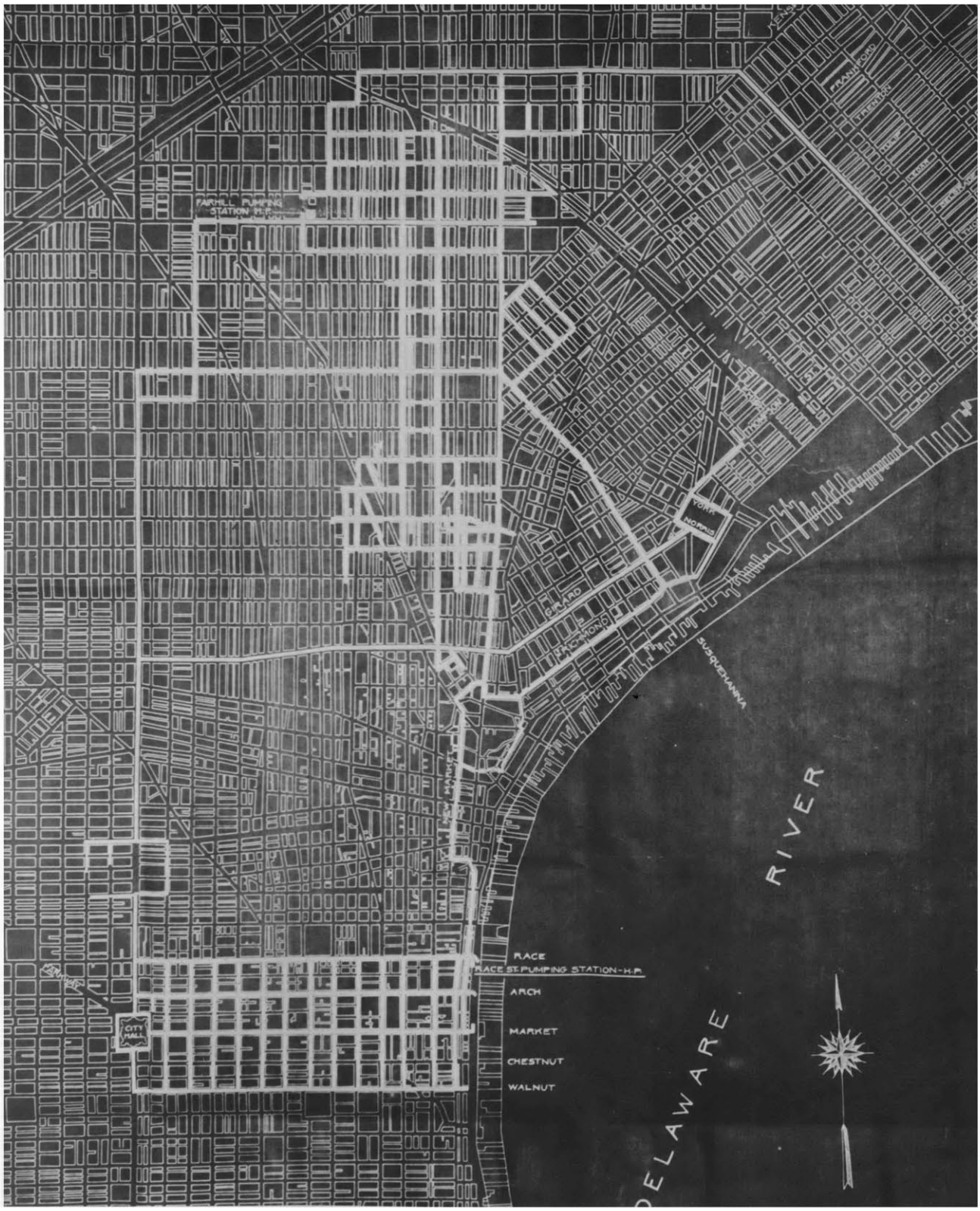
CLEVELAND.


LAKE ERIE
CONGESTED VALUE DISTRICT OF CLEVELAND UNDER PROTECTION OF SPECIAL HIGH WATER PRESSURE FIRE MAIN SYSTEM.
EXPLANATION

MANHATTAN.


National Board of Fire Underwriters
COMMITTEE ON FIRE PREVENTION
NEW YORK HIGH PRESSURE FIRE SERVICE
JANUARY 1914
CANSEVOORT ST. PUMP STA
HUDSON RIVER
OLIVER ST. PUMP STA
EAST RIVER
KEY
(Mains not otherwise marked are 12 inch)
East of the Bowery and east of Nassau street mains and hydrants in alternate streets are separate systems interconnected through by-passes with valves closed. The closing of electrically operated valves from the Oliver Street station permits the use of either system independently of the other.
Section in which extension of high pressure service is authorized shown thus
(Date of completion early in 1915)
Fire Department companies designated thus
Engine company equipped with engine and hose wagon
Hose company equipped only with hose wagon
Ladder company
Water Tower
Fire-boat
Search Light engine
Boat-tender
SCALE OF FEET

PHILADELPHIA.

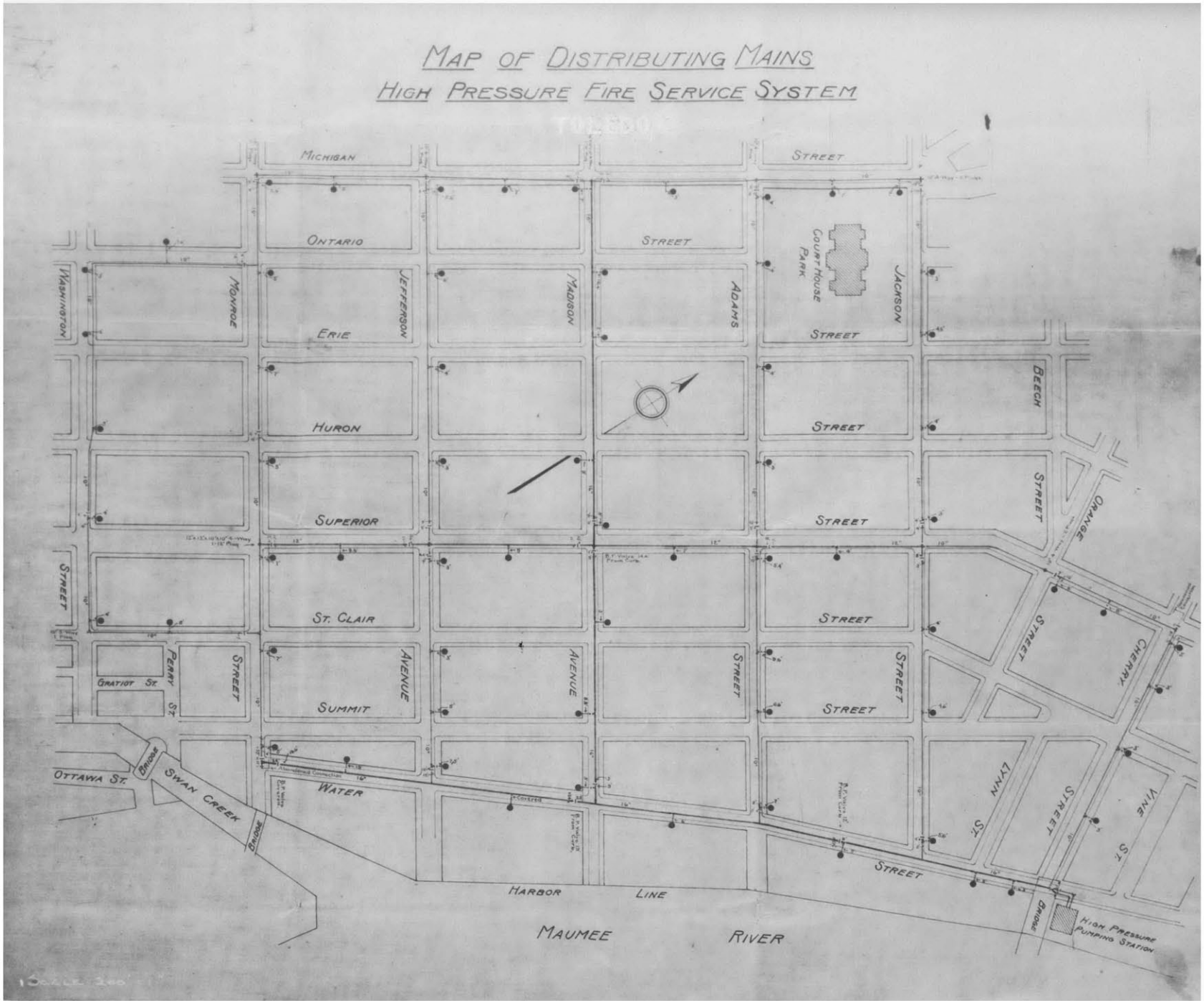

FAIRMOUNT PUMPING STATION H.P.
FRANKFORD
YORK
NORRIS
GIRARD
RICHMOND
SUSQUEHANNA
RIVER
RACE
RACE ST. PUMPING STATION-H.P.
ARCH
MARKET
CHESTNUT
WALNUT
CITY HALL
DELAWARE

SAN FRANCISCO.

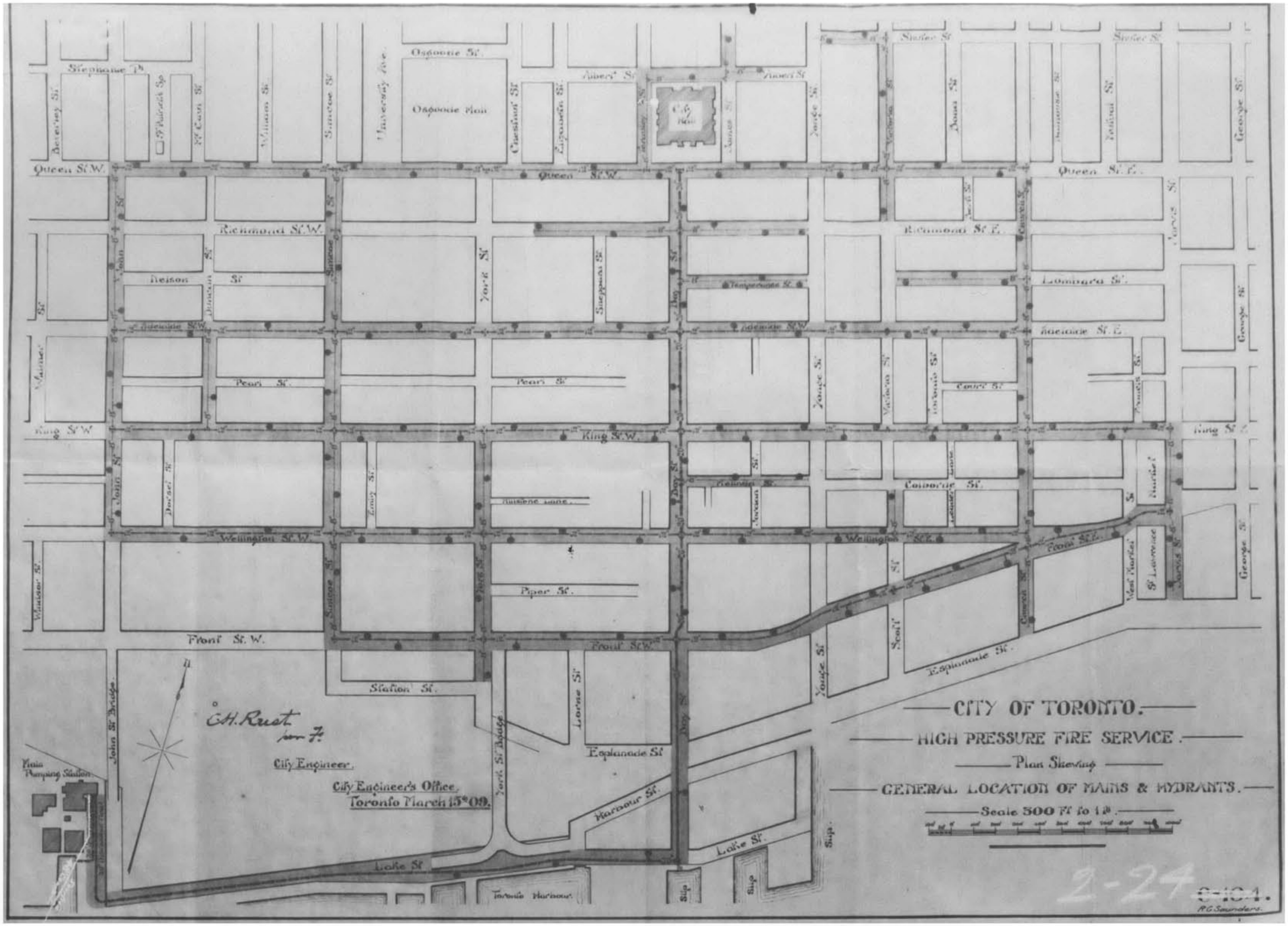

BAY OF SAN FRANCISCO
PRESIDIO
FORT MASON
U.S. MILITARY RESERVE
LABOR SQUARE
ALTA PLAZA
LAFAYETTE SQUARE
ALAMO SQUARE
BUENA VISTA PARK
LAUREL HILL CEMETERY
ODD FELLOWS CEMETERY
CALVARY CEMETERY
MASONIC CEMETERY
GOLDEN GATE PARK
TWIN PEAKS RESERVOIR
Area covered by AWSS 9.5 sq miles
34.5 miles of pipe lines - 312 hydrants
38 cisterns of various sizes.
65 new concrete cisterns of 75,000 gals. each
Average pressure at hydrant is
Lower Zone 130 lbs.
Upper Zone 143 lbs.
The lower Zone is the district below the 100 foot level.
Cost of AWSS $3,576,000.00
Saving in insurance due to AWSS is $ 1,440,000 per year.
Each Pumping Station is equipped with 4 - 2500 gallon, main turbine pumps direct connected to 150 H.P. Curtiss turbines.
Area of Burnt District
3.12 Square Miles.
Cisterns built before 1908
Concrete Cisterns 75000 Gallons.
1908 Bond Issue.
AUXILIARY WATER SUPPLY SYSTEM FOR FIRE PROTECTION AND FIRE DEPARTMENT HOUSES.
-LEGEND-
12" PIPE
8" "
6" "
4" "
HYDRANT
VALVE
PIPE LINES NOT YET CONSTRUCTED BUT UNDER CONTRACT
C.E. CHIEF ENGINEER
1ST'CE. FIRST ASST ENGINEER
2ND'CE. SECOND "
B.C. BATTALION CHIEF
E. ENGINE
C. CHEMICAL
T. TRUCK
W.T. WATER TOWER
M. MONITOR BATTERY
F.P. FIRE PATROL
C.F.D. COMMERCIAL FIRE DISPATCH
BURNT DIST. SHOWN THUS
SCALE
SAN FRANCISCO
AUXILIARY WATER SUPPLY SYSTEM
FOR
FIRE PROTECTION
PREPARED BY
M.M. O'SHAUGHNESSY, CITY ENGINEER.
APRIL 1921.
84673

TOLEDO.

MAP OF DISTRIBUTING MAINS
HIGH PRESSURE FIRE SERVICE SYSTEM



TORONTO.



CITY OF TORONTO.
HIGH PRESSURE FIRE SERVICE.
Plan Showing
GENERAL LOCATION OF MAINS & HYDRANTS.
Scale 500 Ft to 1 In.
City Engineer
City Engineer's Office,
Toronto March 15th 09.
Main Pumping Station
Queen St. W.
Queen St. E.
Richmond St. W.
Richmond St. E.
Adelaide St. E.
King St. W.
Wellington St. W.
Front St. W.
Esplanade St.
Harbour St.
Lake St.
Station St.
Piper St.
Pearl St.
Colborne St.
Lombard St.
Osgoode St.
Osgoode Hall
Albert St.
City Hall
Shuter St.
John St.
York St.
Bay St.
Yonge St.
Scott St.
Church St.
George St.
Toronto Harbour
Slip
2-24
R.G. Saunders.

WINNIPEG.

CITY OF WINNIPEG

PLAN SHOWING FIRE SERVICE WATER MAINS.

CITY ENGINEERS OFFICE
WINNIPEG MAN. MAY 22-14

SCALE 200 FEET = 1 INCH

H.N. RUTTAN
CITY ENGINEER.

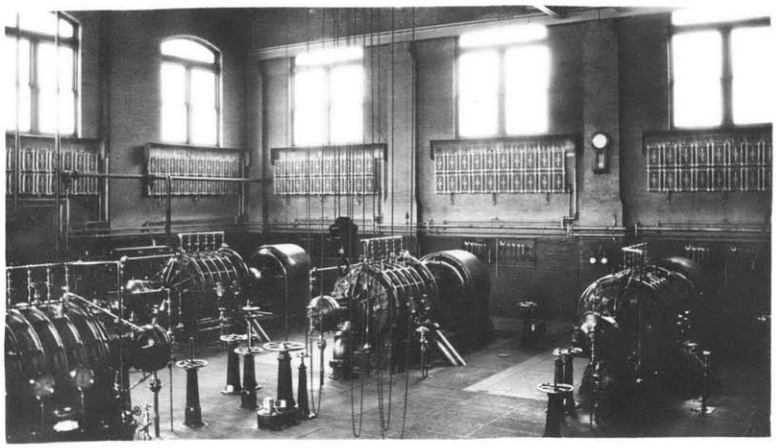
APPENDIX "C"

PHOTOGRAPHS

JORALEMON ST. STATION,

BROOKLYN.

Interior.



JORALEMON ST. STATION,

BROOKLYN.

Exterior.

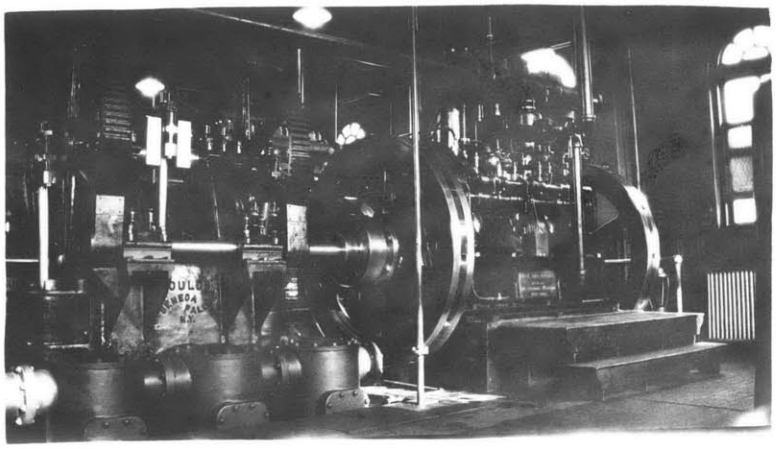
ST. EDWARDS ST. STATION,

BROOKLYN.


CRANE
FITTINGS
VALVES
AND
PIPE

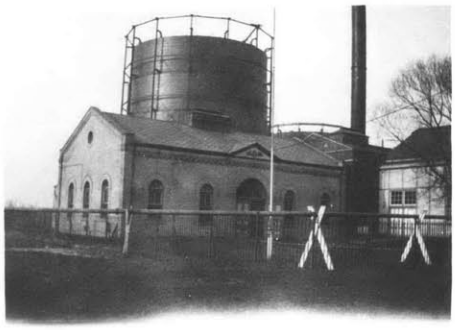
CONEY ISLAND.

Interior.



CONEY ISLAND.

Exterior.



APPENDIX "D".

TABLE.

City	Date	Type of Station	Source of Power	Prime Mover	Type of Pump	No. Units	Capacity G.P.M	Max. Press.	Suction Supply	Distribution System	Mains Length Mis.	Mains Depth Ft.	Type of Joint	Pipe Size	Pipe Kind	Hydrant No.	Hydrant Size Type	Hydrant Space ft.	Total Area Acres	Cost Total - $	Cost per Acre	Cost per Ft. Main	Cost Maintenance
Baltimore	1912	Steam	Municipal Plant	3 Allis-Chalmers Horiz. Crank & Fly. / Epping-Carpenter-Horiz. Duplex		4	14,000	250	Domestic Aux.-Harbor	Gridiron	8.9	3.10	Special Universal	8" - 24"	Soft Steel	226	Ross Portable 4-2½" Outlets	170	230				
Boston	1921 1922	Steam Electric	Boston "L" Edison	Westinghouse Impulse Turbine Westinghouse Interpole Motor	3 Stage Double Suction Worthington Centrifugal 4 Stage Single Suction Worthington Centrifugal	2 2	12,000	300	Domestic Aux. from Harbor	Gridiron	11.73	7	Bell and Spigot with 2 lead grooves	12" - 20"	C.I. Semi-Steel	313	Rourke Posi. Compression 4-2½" Outlets	300	590	1,370,000.	2859.		
Brooklyn	1908	Electric	Edison	800 H.P. General Electric Induction Motors	Worthington 6-stage Centrifugal	5 3	64,000	300	Ashokan Reservoir at 100 # pressure	Gridiron	44.5	5	Bell and Spigot	8" - 20"	C.I.	1367	Post Compression Independent Gate	300	1420	1,387,500	975.		Current 25,992.
Buffalo	1922	Steam		3-750 H.P. Terry Turbines	4 Stage Centrifugal "Manister Iron Works"	3	9,000	300	Buffalo River	Loop			Universal Machine Bolted	10" - 20"	C.I.		Post Compression Independent Gate						
Cincinnati		Gravity					10,000	175			9.5	5	Hub and Spigot	12" - 24"	C.I.	182	Ross Portable 4-2½" Outlets		406				
Cleveland	1913	Electric	Municipal Plant	3 ϕ Induction Motor	5 Stage Allis-Chalmers Centrifugal	4	11,200	270			11.	6-8	Lead	6" - 30"	C.I. "H"	182	R.D. Wood	200 250		210,000.			20,000
Coney Island	1906	Gas	Gas Co.	Nash Gas Engines	Gould Triplex Plunger Pump	3	4500	150	Domestic	Loop	6			8" - 16"		150			250	160,000.			17,500
Jacksonville	1911	Electric	Municipal Plant	375 H.P. Bullock Motor	4 Stage Allis-Chalmers Centrifugal	2	5000	175	St. Jonn's River	Gridiron	4.3	3	Lead	8" - 20"	C.I.			103		75,000.			5,000
Lawrence	1906	Gravity					2300						Lead	8" - 12"	C.I.	42	Matthews	300		30,000.			
Manhattan	1908	Electric	New York & Brooklyn Edison	800 H.P. Allis-Chalmers Induction Motor	5 Stage Allis-Chalmers Centrifugal	6 6	60,000	300	Domestic	Gridiron	128	5	Bell & Spigot Double Lead Groove	8" - 24"	C.I.	2751			2220	5,550,000			Current 49,900.
Miami	1921	Electric		300 H.P. General-Electric Motors	3 Stage Morris Centrifugal	2	4300	215	Wells		950ft		Bell & Spigot	8" - 16"	C.I. "D"	37	Matthews 1-3" 3-2½"	250		55,000.			5000.
Milwaukee	1889	Fire Boat (Steam)				4	24000	250	Milwaukee River	27 Short Mains	12.7	3-4		8" - 12"	C.I.	260	Special Independent Gate						
Philadelphia	1903 1910	Gas	Gas Co.	Westinghouse Gas Engine 3 cyl. - single acting	Vertical double acting triplex Deane pumps	9 10	9100 12,000	300	Delaware R. Domestic	Gridiron	52	4	Flanged on Old Universal on New	8" - 20"	C.I.	298 609	Gate Valve & Post Compression with Pilot Valve	350		150,000. 2,150,000			
Rochester	1873 1906	Steam & Water Electric	2-250 BHP Boilers Rochester G. & E. Co.	1 Hall. Engine 1 De Laval Turbine 2 256 HP Water Turbines 1 275 HP GE Induct Motor	3 Holly Quadruplex 1 Olier 2 Stage Centrif. Worth. 3 Stage Centrif.	4 1	7400 2000	140	Genesee R. with Domestic Auxiliary	Gridiron	25.2	4.5	Lead	4" - 20"	C.I. "B" & "E"	458	Matthews - 2½"	220 & 260	1686	444,000	293.	3.71	12,000. (1908)
San Francisco	1913	Steam	Individual Steam Plants	750 HP Horiz. Non-Cond. Curtis Turbines	Multi-Stage Centrif.	4 4	12,000 12,000	300 300	Bay-Salt Water Domestic System		75		Bell & Spigot	8" - 20" 10" ave.	Heavy C.I.	907	3½" Outlets		6080	5,756,000			236,726. (1922)
Toledo	1917	Electric	Toledo Ry. & L.I. Co.	1-275 HP GE Induct. Motor 1-350 HP 3 ϕ Induct. Motor	5 Stage Allis-Chalmers	4	8000	300	Maumee R.		4.25	5	Std. for Class G	8" - 16"	C.I.	66			140	700,000	2140.	13.30	190.85 (1922)
Toronto	19058	Steam	16-480 HP Boilers	Westinghouse Parsons Turbine	2 Stage Centrifugal	2	8330	350	Toronto Harbor		8.5	8	Spigot & Faucet Double Groove	8" - 20"	C.I.	147	Smith - 3 Nozzle	300	300	780,000	2600	11.50	27,650 (1922)
Winnipeg	1907	Producer Gas	Gas Plant with Hydro ϕ	Crossley Gas Engines	Double Acting Vertical Pumps	6	9000	300	Domestic		12.2	8	Lead	10" - 20"	C.I.	160	R.D. Wood Co. 4½" Ind. Gate	260					76,251 (1922)
Worcester	1863	Gravity					5000	160			19	4.5	Bell & Spigot	6" - 30"	C.I.	2500	Matthews	300					

HIGH PRESSURE WATER SYSTEMS FOR FIRE PROTECTION

MIT THESIS
MAY 1923

C.O. AVERY L.E BARSTOW

APPENDIX "E".

BIBLIOGRAPHY.

BIBLIOGRAPHY.

A more complete description of the system may be found in the following articles which were consulted.

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APPENDIX "E".

SPECIMEN LETTERS.

SPECIMEN LETTER SENT TO CITY ENGINEERS.

R 405 M.I.T. Dorms.
Cambridge 39 Mass.
March 28, 1923.

City Engineer
New York N.Y.

Dear Sir:

As we are engaged in compiling data information concerning the high pressure systems for fire protection in the various cities, we are asking you for accurate information about your installation which is not obtainable elsewhere.

This work is being done as thesis work under the direction of Prof. Edward F. Miller of Mass. Institute of Technology and any aid that you can give us will be appreciated.

For your convenience, we have enclosed a list of specifications in which the important points are covered.

Respectfully,

QUESTIONAIRE.

HIGH PRESSURE SPECIFICATIONS.

1. Date of installation.
2. Type and description of station.
3. Source of power.
4. Type of prime mover.
5. Type of pump.
6. Number of units.
7. Efficiency of station.
8. Pumping capacity gals/min. at max. pressure.
9. Maximum pressure.
10. Suction supply.
11. Distribution system.
12. Length of mains.
13. Depth of mains below street level.
14. Type of joint.
15. Pipe sizes.
16. Kind of pipe,
17. Number of hydrants.
18. Size and type of hydrants.
19. Spacing of hydrants.
20. Acres of protected area.
21. Total cost of installation.
22. Cost per acre.
23. Cost per foot of mains.
24. Effect on insurance rates.
25. Saving per year due to H.P. system (net).
26. Cost of maintenance.
27. National board rating.
28. Diagram of piping system.

SAMPLE REPLY.

R.C. HARRIS
COMMISSIONER OF WORKS
CORRESPONDENCE TO BE ADDRESSED TO
THE COMMISSIONER OF WORKS.

DEPARTMENT OF WORKS

TORONTO. April 26th., 1923.

IN REPLY PLEASE REFER TO

SUBJECT Data Concerning High Pressure Fire System.

ATTENTION OF Mr. Milne.

Massachusetts Institute of Technology,
Dep't of Mechanical Engineering,
Cambridge,
Mass.

Gentlemen:- Attention of Mr. Lawrence E. Barstow.

In reply to yours of the 11th. inst., I answer below your questions seriatim, and trust that the information given is what you desire, viz.:-

1. Date of installation.
From 1905 to 1908.

2. Type and description of Station.
Brick Building, 49'x50'x50' high. Steam is furnished by sixteen boilers, aggregating 4800 boiler horse power (normal rating) at 160 pounds pressure. These boilers are also used for domestic pump service and full working pressure is kept up continuously. The operating staff is on duty 24 hours per day (3 watches of 8 hours). The pumping equipment consists of two Westinghouse Parsons steam turbines, direct connected to two 5,000,000 Imperial gallons, 2 stage John McDougall pumps. Maximum speed 1500 revolutions per minute.

April 26th., 1923.

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Remarks

When an alarm from the High Pressure District is rung in, one pump is started immediately whether the Fire Department request it or not by the High Pressure Fire signal system, and the pressure held at 150 pounds. By the signal system the pressure is raised by steps of 50 pounds, until the maximum pressure is reached. Each step takes about 30 seconds. From a standstill a pressure of 300 pounds can be reached in about one minute. The highest pressure recorded at the pump is 350 pounds per square inch.

During a fire if it is found that 300 pounds pressure cannot be maintained by one pump the second one is started up. The High Pressure System is entirely divorced from the Domestic Service, there being no physical connection whatever. When the high pressure pumps are not in operation the mains are kept fully charged by means of a small duplex pump, which maintains the pressure from 80 to 100 pounds. A second duplex pump is held in reserve. A private telephone line is used in case the signal system becomes inoperative.

Recording pressure charts with complete tape records of all alarms are kept. The tape records give the number of the box, also date, hour and minute when alarms are rung in. Similar records for the signal system are kept.

3. Source of Power.

Steam.

4. Type of prime mover.

Westinghouse Parsons turbine, 1500 revolutions per

minute with barometric condenser.

5. Type of pump.

Two stage Centrifugal, built by John McDougall Company, Montreal. (Cast steel casings).

6. Number of units.

Two.

7. Efficiency of Station.

This question is not very explicit. From the standpoint of the Fire Department the efficiency is high, as the pressure is always on the mains when required.

8. Pumping capacity.

4166 U.S. gallons per pump per minute at maximum pressure.

9. Maximum pressure.

The maximum pressure carried at the pumps has been 350 pounds per square inch.

10. Suction supply.

Toronto Harbor, by duplicate conduits.

11. Distributing system.

~~20", 12" and 8" pipe.~~

April 26th., 1923.

Massachusetts Institute of Technology - 4.

12. Length of Mains.

The length is 45,241 feet.

13. Depth of main below street level.

Eight feet.

14. Type of joint.

Double grooves on spigot and faucet.

15. Sizes of Pipe.

20", 12" and 8".

16. Kind of pipe.

Cast iron tested to 700 pounds pressure per square inch.

17. Number of hydrants.

There are 147.

18. Size and type of hydrants.

Three nozzle, made by A. P. Smith & Co., Newark, N.J.

19. Spacing of hydrants.

About 300 feet apart.

20. Acres of protected area.

300 acres.

21. Total cost of installation.

$780,000. imcluding mains, pumping plant, Fire Department

equipment and debenture discount.

22. Cost per acre.

$2600.

23. Cost per foot of main.

$11.50 per foot of main only.

24. Effect on insurance rates.

This question, along with No.25, was submitted to the Secretary of the Canadian Fire Underwriters' Association, which we quote in full as follows:-

> "With regard to Question No.24, after completion of the High Pressure System in Toronto, a reduction was made in the Key Rate in the area protected by the system of .25¢ on buildings and contents, with a further reduction of .25¢ on buildings only. This statement it may be observed should be qualified by remarking that in practically all cities of the United States pressures at hydrants connected to the ordinary domestic system are comparatively low, so that fire engines have to be used almost entirely in the event of a fire. In Toronto, on the other hand, pressures on the ordinary system are generally fair and in some areas good, and require the assistance of fire engines only to a limited extent. On this account it will easily be seen that a High Pressure System is of relatively greater value in cities of the United States than in a City such as Toronto.
>
> As for Question No.25, on the nett saving per year due to the High Pressure System, I regret that it is one which I have no means whatever of answering".

25. Saving per year due to H.P. system (net).

See above.

April 26th., 1923.

Massachusetts Institute of Technology - 6.

26. Cost of maintenance.

The cost for 1922 was $27,650.84 exclusive of interest on investment.

27. National Board rating.

The secretary of the Canadian Fire Underwriters' Association states, in reply to this question, "I regret that we have nothing of this kind in our records".

28. Diagram of piping system.

The same is enclosed herewith.

Yours truly,

EM

Commissioner of Works.

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