WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIRS.

CALIFORNIA.

MARYSVILLE:
Name of corporation: Marysville Water Company (private).
Water obtained from: Two artesian wells. Well No. 1, 80 feet deep, 12-inch bore; well No. 2, 150 feet deep, 12 inch bore.
Water first introduced: September, 1850.
Sizes of distributing mains: 12 to 2 inches.
Total length of distributing mains: 8 miles.
Number of water-takers: 700.
Consumption of water: 800,000 gallons per day in summer, 200,000 gallons per day in winter (estimated).
First cost of water-works: $200,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 12.
Design and dimensions of pumps and water-plungers: Lowell, Marysville, pump, plunger 7 inches diameter, 95 strokes per minute; 1 Worthington No. 4 New York pump, plunger 14 inches diameter, 60 strokes per minute.
Time pumps are run: 6 to 12 hours per day.
Description of force-main: Head on pumps, 50 feet.
Description of water-valves: Solid rubber.
Kind of power used: Steam.
Description of boilers: 54 inches diameter, 10 feet long; 6-inch wood.
Description of engine: Condensing low-pressure; 10-inch diameter, 14 inch stroke; globe valves.
Cost of engine and pumps: $4,000.

SAN DIEGO:
Population: 2,337 inhabitants.
Name of corporation: San Diego Water Company (private).
Water obtained from: San Diego river.
Water first introduced: In 1853.
Description of reservoirs: Settlement reservoir, capacity 80,000 gallons; storage reservoir, capacity 800,000 gallons; distributing reservoir, capacity 44,000 gallons; all walled with rock and cement.
Size of distributing mains: 5 inches.
Available head: 200 feet (average).
Total length of distributing mains: 8 miles.
Number of water-takers: 225.
Consumption of water: 85,000 gallons per day in summer, 40,000 gallons per day in winter (estimated).
First cost of water-works: $76,357 62.
Average annual cost of maintenance and repairs: $6,000.
Number of fire-plugs: 4.
Design and dimensions of pump and water-plunger: Hooker pump, by Garrett & Co., San Francisco, California; plain plunger, 30 inches stroke, 8 inch diameter, 98 strokes per minute.
Time pump is run: 11 hours per day.
Description of force-main: 1 mile long; 200 feet head on pumps.
Description of water-valves: Vulcanized spring, 8- and 4-inch. Kind of power used: Steam.

SAN DIEGO—Continued.
Description of boilers: Tubular, 4 by 15 feet; 40 tubes; 40 pounds pressure; fuel, coal.
Description of engine: Simple, 14 inches diameter, 28 inches stroke; 42 single strokes per minute; slide-valves.
Cost of engine: $3,000.
Duty of engine: 1,315,000 pounds daily.

COLORADO.

CAHON CITY.
Population: 1,051 inhabitants.
Name of corporation: Canion City Water Company (private).
Water obtained from: Arkansas river.
Capacity of receiving reservoir: 1,000,000 gallons.
Cost of dam: $3,500.
Water first introduced: January, 1881.
Description of distributing reservoir: Capacity, 1,000,000 gallons; on an elevation of 140 feet above town.
Sizes of distributing mains: 10, 8, and 6 inches.
Available head: 100 feet (average).
Total length of distributing mains: Over 3 miles.
Number of water-takers: 120.
First cost of water-works: $41,000.
Filtering system: Well, 30 by 100 feet, 12 feet deep; natural gravel formation.
Number of fire-plugs: 15.
Design of pump: Knowles pump, Boston, Angual, 1880; 20 strokes per minute.
Time pump is run: 4 hours per day.
Kind of power used: Water.
Character and dimensions of water-wheels: Two 48-inch turbines, Whitney's, Leominster, Massachusetts; 11 feet head.

TRINIDAD:
Population: 2,296 inhabitants.
Name of corporation: The Trinidad Water-Works Company (private).
Water obtained from: Well.
Cost of dam: $8,000.
Water first introduced: October, 1876.
Description of main conduit: 300 feet long, 2 feet wide, 3 feet high; laid in stone and covered with cap-stones.
Discharging capacity: 2,600,000 gallons per 24 hours, under 6 feet head.
Description of distributing reservoir: Rectangular; 150 by 250 feet, 16 feet deep; bottom paved with round stones and grouted with cement and concrete; sides paved with flat stones in regular course 8 inches thick; joints filled with cement.
Sizes of distributing mains: 10, 8, 6, and 4 inches.
Available head: 120 feet (average).
Total length of distributing mains: 20,800 feet.
Number of water-takers: 250.
Consumption of water: 90,000 gallons per day (exact).
First cost of water-works: $70,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 30.
TRINIDAD.—Continued.

Design and dimensions of pumps and water-plungers: Pump made by Cope and Maxwell Manufacturing Company, Hamilton, Ohio; two plain plungers, 30 inches stroke, 10 inches diameter, 40 strokes per minute; pump-barrel, 11 inches diameter.

Time pump is run: 10 hours per day.

Description of force-main: Length 5,600 feet, diameter 12 inches; head, 310 feet on pump.

Description of water-valves: Rubber; 8 inches diameter, 1 inch lift.

Kind of power used: Steam.

Description of boilers: Steel; 8 by 4 feet; four 8- and two 10-inch flues; fuel, gas or ealking-coal.

Description of engines: Compound non-condensing; 16 inches diameter, 28 inches stroke, 40 strokes per minute; slide-valves.

Cost of engine: $8,000.

DELWARE.

NEW CASTLE:

Population: 3,700 inhabitants.

Name of corporation: New Castle Water-Works (private).

Character and dimensions of dam: 200 feet long, 8 feet high; made of stone and earth.

Water first introduced: In 1870.

Description of main conduit: 4 miles long, 10 inches diameter; cast iron.

Capacity of distributing reservoir: 1,000,000 gallons.

Sizes of distributing mains: 10, 8, 6, and 4 inches.

Available head: About 40 pounds (average).

Total length of distributing mains: About 6 miles.

Number of water-takers: About 300.

Consumption of water: 100 gallons per capita daily (estimated).

First cost of water-works: About $100,000.

Average annual cost of maintenance and repairs: About $500.

Number of fire-plugs: 35.

Design of pump: Blake pump, 25 strokes per minute.

Time pump is run: 80 hours per week.

Time spent in repairs: About 40 hours per year.

Description of force-main: 14 miles long; 40 pounds head on pump.

Description of water-valves: Made of gum.

Kind of power used: Steam.

Description of engines: Non-condensing; 35 strokes per minute.

Cost of engine: About $4,000.

Remarks: Water has some sediment, but pronounced by chemists not to be detrimental to health.

WILMINGTON:

Population: 42,478 inhabitants.

Name of corporation: Wilmington Water-Works (municipal).

Water obtained from: Brandywine before it reaches tide-water.

Water first introduced: November, 1827.

Description of distributing reservoirs: Low-service, capacity 3,500,000 gallons; high-service, capacity 2,000,000 gallons.

Sizes of distributing mains: 20, 10, 10, 10, 10, 10, 10, 8, 6, and 4 inches.

Available head: 140 to 240 feet.

Total length of distributing mains: 275,604 feet.

Number of water-takers: 4,344.

Consumption of water: 81 gallons per head daily.

First cost of water-works: $274,565 50.

Average annual cost of maintenance and repairs: $25,593 36.

Number of fire-plugs: 476.

Design and dimensions of pumps and plungers: Worthington 1872 pump, 12 strokes per minute; Knowles 1880 pump, 60 strokes per minute; Jouval turbino bucket-plunger, 11¾ inches diameter.

Time spent in repairs: 100 hours per year.

Description of force-main: 1,000 feet long, 10 inches diameter; 57 pounds pressure; Knowles pump, 55 pounds pressure; 19-inch main.

WILMINGTON.—Continued.

Kind of power used: Steam and water.

Character and dimensions of water-wheel: One Geyolla-Jouval turbine, 4 feet head and fall, 15 revolutions per minute; 3 gallons of water used to lift 1 to reservoir.

Fuel used: Cumberland coal used for fuel, from George’s creek.

Description of engines: Worthington duplex, 11 strokes per minute; Knowles’ single.

Cost of engines: Worthington, $27,000; high service, $4,500; water-power, $8,000.

Duty of engines: 7,000,000 pounds daily.

GEORGIA.

ROMA:

Population: 3,877 inhabitants.

Name of corporation: Roma Water-Works (municipal).

Water obtained from: Well.

Water first introduced: In 1871.

Description of distributing reservoir: Built on a hill 100 feet above city level; 25 feet diameter, 53 feet high; made of boiler-iron.

Sizes of distributing mains: 10 to 4 inches.

Available head: 150 feet (average).

Total length of distributing mains: 5 miles.

Number of water-takers: 350.

Consumption of water: 100,000 gallons per day (estimated).

First cost of water-works: $100,000.

Average annual cost of maintenance and repairs: $2,500.

Number of fire-plugs: 55.

Design and dimensions of pump and water-plungers: Pump, Noble Brothers & Co., Rome, Georgia; bucket-plungers, 42 inches stroke, 14 inches diameter; 15 strokes per minute; diameter of pump-barrel, 14 by 12 inches.

Time pump is run: 8 hours per day.

Time spent in repairs: 900 hours per year.

Description of force-main: 200 feet head on pump.

Description of water-valves: Brass and leather.

Kind of power used: Steam.

Description of boilers: 4 feet, 20 inches; 2 flues; fuel, bituminous coal, 1 pound to 100 gallons water.

Description of engine: Simple; 20 inches diameter, 42 inches stroke, 14 strokes per minute; slide-valves, by eccentric.

Cost of engine: $12,000.

ILLINOIS.

DE Kalb:

Population: 1,598 inhabitants.

Style of corporation: Municipal.

Water obtained from: Well.

Capacity of receiving reservoir: 60,000 gallons.

Water first introduced: In 1877.

Available head in main conduit: 55 feet (average).

Sizes of distributing mains: 6 and 4 inches.

Available head in the town: 50 to 75 feet.

Total length of distributing mains: 7,000 feet.

Number of water-takers: 92.

Consumption of water: 15,000 gallons per day (estimated).

First cost of water-works: $32,000.

Average annual cost of maintenance and repairs: $1,500.

Number of fire-plugs: 13.

Design and dimensions of water-plungers: Two plain plungers, 10 inches diameter, 10 inches stroke, 40 strokes per minute; size of pump-barrel, 10 inches diameter.

Time spent in repairs: 60 hours per year.

Description of force-main: 4,000 feet long; 60 feet head on pump.

Kind of power used: Wind and steam.

Description of boilers: 42 inches diameter; 80 pounds pressure; made by Chicago Boiler Works.

Description of engine: Non-condensing, simple; 10 inches diameter, 12 inches stroke, 140 strokes per minute.

Cost of engine: $2,500.
LOCKPORT:
Population: 1,679 inhabitants.
Name of corporation: Lockport Artesian Well Company (private).
Water obtained from: Artesian well.
Cost of dam: $6,600.
Water first introduced: In 1870.
Size of distributing mains: 4 inches.
Available head: 100 feet (average).
Total length of distributing mains: 1 mile.
Number of water-takers: 40.
First cost of water-works: $6,000.
Average annual cost of maintenance and repairs: $200.
Number of fire-plugs: 10.
Design and dimensions of pump and water-plunger: Pump made by Hart, Ball & Hart, Buffalo; New York; Plunger, 3 inches diameter, 5 feet stroke, 50 strokes per minute.
Time pump is run: 10 hours per day.
Kind of power used: Water.

QINCY:
Population: 27,265 inhabitants.
Name of corporation: Quincy Water-Works Company (private).
Water obtained from: Mississippi river.
Water first introduced: August, 1873.
Description of distributing reservoirs: Two tanks; aggregate capacity, 155,000 gallons; one has fire-proof jacket, but during winter of 1880-81, with thermometer at 20° below zero no ice formed in either.
Sizes of distributing mains: 10 to 6 inches.
Available head in the town: 50 feet (average).
Total length of distributing mains: About 7 miles.
Number of water-takers: 256.
Consumption of water: 400,000 gallons per day (estimated).
First cost of water-works: $115,000.
Average annual cost of maintenance and repairs: $4,500.
Number of fire-plugs: 77.
Design and dimensions of pump: McGowan Pump Company, Cincinnati, Ohio; plunger-pump; 60 strokes per minute; pump-barrel, 24 by 10 inches.
Time pump is run: 94 hours per day.
Description of force-main: 1 mile long, 16 inches diameter; 60 pounds pressure.
Description of water-valves: 4 vulcanized-rubber disks, 12 inches diameter, 4 inch lift.
Kind of power used: Steam.
Description of boilers: Tubular; 6 feet long, 5 feet diameter; 48 fluxes, 4 inches diameter each; 60 pounds pressure; fuel, bituminous coal.
Description of engine: Non-condensing; cutting off 3 stroke; cylinder, 16 inches diameter; 60 strokes per minute; globe valves.
Cost of engine: $1,500.
Duty of engine: 20,000,000 pounds daily (average).
Remarks: Water impuren only during floods, than only from earth and sand sediments.

INDIANA:
Population: 2,150 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Springs.
Total area of water-shed available: 14 acres.
Water first introduced: In 1868.
Description of distributing reservoir: Built of sandstone, laid in cement; roofed over; capacity, 55,000 gallons.
Sizes of distributing mains: 8 to 5 inches.
Available head: 150 feet (average); water-supply sometimes deficient.
Total length of distributing mains: 5 miles.
Number of water-takers: 250.

ATTICA—Continued.
Consumption of water: About 55,000 gallons per day (estimated).
First cost of water-works: $40,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 219.
Design and dimensions of pump and water-plungers: Pump made by Dear Bros., Indianapolis, Indiana; 2 plain plungers, 5 inches diameter, 9 inches stroke, 70 strokes per minute.
Time pump is run: 7 hours per day.
Description of force-main: 150 feet long, 4 inches diameter; 35 pounds pressure on pump.
Description of water-valves: Rubber; sizes 5 inches, 4 inch lift.
Kind of power used: Steam.
Description of boilers: Nos. 1, 2, 42 inches diameter, 10 feet long, 38 2-inch tubes; No. 3, 44 inches diameter, 12 feet long, 9 6-inch tubes.
Description of engine: Ordinary slide-valves; 70 strokes per minute.
Cost of engines: $4,100.

FORT WAYNE:
Population: 20,550 inhabitants.
Name of corporation: Fort Wayne Water-Works (municipal).
Water obtained from: Creek.
Total area of water-shed available: 8 square miles.
Dimensions of dam: 50 feet long.
Cost of dam and reservoir: Reservoir, etc., about $40,000; dam, $1,500.
Water first introduced: December, 1889.
Description of distributing reservoir: Oval; 149 by 203 feet at top, 62 by 112 feet at bottom, 34 feet deep; capacity, 3,911,310 gallons; embankment, 12 feet wide at top; inner slope, 1 to 1; faced with brick, 8 inches thick, laid in cement; exterior slope, 14 to 1; built of clay.
Sizes of distributing mains: 4,001 feet, 24 inches, 1,981 feet, 20 inches, 5,166 feet, 16 inches; 2,276 feet, 12 inches; 3,140 feet, 8 inches; 60,141 feet, 6 inches; 9,092 feet, 4 inches.
Total length of distributing mains: 25,998 feet.
Number of water-takers: 1,000.
Consumption of water: 700,000 gallons per day (estimated).
First cost of water-works: $275,000.
Average annual cost of maintenance and repairs: $7,000.
Filtering apparatus: Basin made by widening the channel of creek, so as to form a settling basin; area, 1 acre, with banks protected by levees.
Number of fire-plugs: 219.
Design and dimensions of pump and water-plungers: Pump made by Holly Manufacturing Company; plain plungers, four 11 inches diameter, 27 inches stroke; two 10 inches diameter, 24 inches stroke; 24 strokes per minutes; pump-barrel, 11 by 27 inches.
Time pump is run: 24 hours per day.
Description of force-main: 4,200 feet, 24 inches diameter; 3,000 feet, 20 inches diameter; 2,000 feet, 16 inches diameter; 160 feet head, or 65 pounds pressure on pumps.
Description of water-valves: Rubber; 6 inches diameter, 4 inch lift.
Kind of power used: Steam.
Description of boilers: Four tubular; 41 by 10 feet, with 64 4-inch flues; fuel used, Blowing Valley coal.
Description of engine: Non-condensing, condensing, or compound at will; 10 inches diameter, 57 inches stroke, 24 strokes per minute; slide-and-pump-valves; injection-condenser; single-acting vertical air-pumps.
Cost of engine: $30,000.
Duty of engine: 60,000,000 pounds, daily average; 70,000,000 foot-pounds guaranteed.
Remarks: The disadvantages of direct pumping to mains principally are unequal motion of engines, constant attention necessary, and comparative expensiveness.

LA FAYETTE:
Population: 14,450 inhabitants.
NEW ALBANY—Continued.

Description of boiler: Two 48 inches diameter, 26 feet long; two 17-inch flues, 80 pounds pressure; 3 pounds of water to 1 pound of coal; fuel, Pittsburgh coal.

Description of engine: High-pressure, non-condensing; 20 inches diameter, 6 feet stroke, 12 to 14 strokes per minute; pump-valves worked by eccentric.

Cost of engine: $15,000.

Duty of engine: 4,187,000 gallons per 100 pounds coal daily; 2,000,000 gallons per day guaranteed.

KENTUCKY.

MAYSVILLE.

Population: 5,920 inhabitants.

Name of corporation: Maysville Water Company (private).

Water obtained from: Ohio river.

Capacity of receiving reservoir: 2,500,000 gallons.

Cost of dam: $50,000.

Water first introduced: In 1890.

Description of main conduit: Iron.

Description of distributing reservoir: Built on hill-side; half excavation and half embankment; base embankment, 18 inches puddle; core, 4-inch brick wall.

Sizes of distributing mains: 14, 12, 10, 8, 6, and 4 inches.

Available head: 340 feet (average).

Total length of distributing mains: 7 miles.

Number of water-takers: 294.

First cost of water-works: $100,000.

Number of fire-plugs: 70.

Design of pump: Pump made by Blake Manufacturing Company, Boston, Massachusetts, 1880.

Description of force-main: 5,600 feet long, 12 inches diameter; 250 pounds pressure on pump.

Kind of power used: Steam.

Description of boilers: Four boilers; two batteries, 26 feet long, 48 inches diameter.

Cost of engine: $30,000.

NEWPORT.

Population: 50,433 inhabitants.

Name of corporation: Newport Water Works (municipal).

Water obtained from: Ohio river.

Capacity of receiving reservoir: 45,000,000 gallons.

Character and dimensions of dam: 36 feet high, 20 feet wide on top; slopes: 1 to 1 and 3 to 1.

Cost of dam: $141,000.

Water first introduced: In 1870.

Description of main conduit: 13,450 feet long, 20 inches diameter; cast iron; head, 174 feet (average).

Description of distributing reservoir: Constructed by dam across two ravines.

Sizes of distributing mains: 16, 10, 8, 6, and 4 inches.

Available head: 132 to 267 feet.

Total length of distributing mains: 16½ miles.

Number of water-takers: 1,583.

Consumption of water: About 30½ gallons per head daily (estimated).

First cost of water-works: $615,000.

Average annual cost of maintenance and repairs: $650.

Number of fire-plugs: 107.

Design and dimensions of pump and water-plungers: Pump made by Cope & Maxwell Manufacturing Company, Hamilton, Ohio, 1873; plain plunger, double-acting, 18 inches diameter, 4 feet stroke, 14 strokes per minute; pump-barrel 18 inches by 5 feet.

Time pump is run: 14 hours per day.

Description of force-main: 1,000 feet long, 24 inches diameter; 350 feet head on pump.

Description of water-valves: Rubber; 14 inches diameter, 14 inch lift.

Kind of power used: Steam.

Description of boilers: Two; 24 feet long, 40 inches diameter; 80 pounds pressure; fuel, bituminous coal.
NEWROX—Continued.
Description of engine: Non-condensing, direct-acting; 26 inches diameter, 4 feet stroke, 14 strokes per minute; slide-valves.
Cost of engine: $12,500.

PLEASANT HILL:
Population: 263 inhabitants.
Style of corporation: Municipal.
Water obtained from: Springs.
Capacity of receiving reservoir: 5,000 gallons.
Description of distributing reservoir: Built of cedar, black locust, and mulberry slabs, fixed with iron; capacity, 5,000 gallons.
Sizes of distributing mains: 2, 1, 1, and 4 inches.
Total length of distributing mains: 1 mile.
Number of water-takers: 200.
Consumption of water: 200 gallons per day (estimated).
First cost of water-works: $0,000.
Average annual cost of maintenance and repairs: $0.

Design and dimensions of pump and water-plungers: Pump made by Burnett, Cincinnati, Ohio, 1892; two plain plungers, 4 inches diameter, 4 strokes per minute; pump-barrel, 4 inches diameter.
Time pump is run: 8 hours per day.
Description of force-main: 1 mile long, 3 inches diameter; cast iron; 120 feet head on pump.
Description of water-valves: 2 1/2 inches diameter.
Kind of power used: Horse.

MAINE.

BIDDEFORD:
Population: 12,451 inhabitants.
Name of corporation: Saco Water-Power Company (private).
Water obtained from: Saco river.
Capacity of receiving reservoir: 250,000 gallons.
Character and dimensions of dam: Of granite, where water is taken.
Cost of dam: $20,000.
Description of main conduit: Cast iron; diameter, 12 inches; head, 55 feet (average).
Description of distributing reservoir: Built on eminence, 35 feet above pump; granite lined with brick and cement; roofed over.
Sizes of distributing mains: 12, 8, and 6 inches.
Available head: 90 feet (average); water-supply seldom deficient.
Fire-plugs: Made by Saco Water-Power machine-shops.
Design of pumps: Pelso and Jenk rotaries; W. P. Crocker's twin rotary.
Time pumps are run: Constantly.
Kind of power used: Water.

LEWISTON—Continued.
Average annual cost of maintenance and repairs: About $5,000.
Filtering apparatus: Built in arch leading from head-gates to screening-well; area (superficial), 400 feet; see-gravel and sand 30 inches deep; cleaned once a week.
Number of fire-plugs: 141.
Design and dimensions of pump and water-plungers: Pump made by H. H. Worthington, Brooklyn, New York; 4 plain plungers, 174 inches diameter, 38 inches stroke, 3 strokes per minute; pump-barrel, 20 inches diameter.
Time pump is run: 222 days in 1890.
Description of force-main: 24 inches diameter; 92 pounds head on pump.
Description of water-valves: Hard rubber; 7 inches diameter, 4 to 6 inch lift.
Kind of power used: Water.
Description of water-wheels: Two Francis turbines; 54 inches; 25 feet head; 80 revolutions per minute.

MASSACHUSETTS.

DANVERS:
Population: 6,590 inhabitants.
Name of corporation: Danvers Water-Works (municipal).
Water obtained from: Middleton and Swan ponds.
Total area of water-ash available: 2,080 acres.
Area of receiving reservoirs: Middleton pond, 106 acres; Swan pond, 69 acres.
Water first introduced: In 1876.
Description of distributing reservoir: Oval, 21 feet deep, nearly vertical walls; owned by state of Massachusetts; capacity, 5,000,000 gallons.
Sizes of distributing mains: 12, 8, 6, and 4 inches.
Available head: 220 feet (average).
Total length of distributing mains: 244 miles.
Number of water-takers: 1,000.
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $4,000.
Number of fire-plugs: 164.
Design and dimensions of pump and water-plungers: Pump made by H. H. Worthington, New York; 2 plain plungers, 16 inches diameter, 26 inches stroke, 52 strokes per minute.
Time pump is run: 1,600 hours per year.
Description of force-main: 15,700 feet long, 12 inches diameter; 50 to 80 pounds pressure on pump.
Description of water-valves: Worthington's patent.
Kind of power used: Steam.
Description of boilers: Tubular; 18 feet long, 5 feet 4 inches diameter, 25 pounds pressure; fuel used, anthracite furnace coal.
Description of engines: Duplex compound condensing; high-pressure cylinder 21 inches diameter, low-pressure cylinder 43 inches diameter, 30 inches stroke, 52 strokes per minute; balanced slide-valves, each operated by piston of other engine; Worthington's air-pump.
Duty of engines: 50,000,000 to 60,000,000 foot-pounds daily, (average) 50,000,000 foot-pounds guaranteed.
Remarks: Only in one instance has any impurity of water been noticed.

KINGSTON:
Population: 1,524 inhabitants.
Name of corporation: Kingston Aqueduct Association (private).
Water obtained from: Spring, will privilege.
Water first introduced: In 1894.
Description of main conduit: 2,556 feet long, 21 inches diameter; cast iron.
Description of distributing reservoir: Situated about 2 miles from pumping-station; 200 feet elevation; core of embankment, brick and cement; capacity, 15,000,000 gallons.
Sizes of distributing mains: 24 to 4 inches.
Available head: 34 to 37 pounds.
Total length of distributing mains: About 52 miles.
Number of water-takers: 1,256.
Consumption of water: About 1,000,000 gallons per day; 32 gallons per head.
First cost of water-works: $60,000.
WATER-SUPPLY OF CITIES.

LYNN.—Continued.
Number of fire-plugs: 411.
Design and dimensions of pump and water-plunger: Pump designed by E. D. Lavitt, jr., built by J. P. Morris & Co., Philadelphia; one bucket-plunger, 18 inches diameter, 7 feet stroke; piston-valve, 22 and 104 inches diameter, 184 strokes per minute; pump-barrel, 36 inches diameter, 7 feet stroke.
Time pump is run: 2,105 hours per year.
Description of force-main: 1,304 feet long; 166 feet head on pump.
Description of water-valves: Cornish, double-boat; 154 inches diameter of lower seat outside, 10 inches diameter upper seat inside; 24 inches lift.
Kind of power used: Steam.
Description of boilers: Horizontal tubular, 16 feet long, 5 feet diameter; 72 3-inch tubes; drum, 6 feet high, 3 feet diameter; 6,538 pounds to 1 pound coal; fuel, anthracite coal.
Description of engine: Compound condensing; high-pressure cylinder 17 inches diameter, low-pressure cylinder 20 inches diameter, 7 feet stroke, 195 strokes per minute; griddle-elm-valves, worked by cams; jet-condenser; air-pump, double-acting, 112 inches diameter, 494 inches stroke.
Cost of engine and pump: $50,000.
Duty of engine: 92,815,506 foot-pounds daily (average); 70,000,000 foot-pounds guaranteed.
Remarks: One pond in summer is tainted by a smell of animal matter, rendering it unfit for domestic use.

SOMERVILLE: Population: 24,933 inhabitants.
Style of corporation: Municipal.
Water obtained from: Boston water-works.
Water first introduced: In 1876.
Available head: 6 to 130 feet; water-supply sometimes deficient.
Total length of distributing mains: 45 miles.
Number of water-takers: 4,683.
First cost of water-works: $349,698 76 (cost of distribution).
Average annual cost of maintenance and repairs: $4,000.
Number of fire-plugs: 276 (see accompanying report on Boston, p. 17-31).

WALTHAM: Population: 11,712 inhabitants.
Name of corporation: Waltham Water-Works (municipal).
Water obtained from: Charles river.
Water first introduced: In 1873.
Description of main conduit: 2,029 feet long, 16 inches diameter; wrought iron and cement.
Description of distributing reservoir: Built in natural gorge; pumped from at ends, oval in shape; ends semicircles, 105 feet radius, joined by straight walls 50 feet long; slopes 14 to 1; inner slope lined with granite 12 inches through.
Sizes of distributing mains: 16, 12, 10, 8, 6, 4, and 2 inches.
Available head: About 135 feet (average).
Total length of distributing mains: 23.33 miles.
Number of water-takers: 1,557.
Consumption of water: 411,000 gallons per day (average).
First cost of water-works: $253,000.
Filtering apparatus: Basin, 4 acres, 8 feet deep, 30 feet from bank of Charles river; gravel, no cleaning.
Number of fire-plugs: 139.
Design and dimensions of pumps and water-plungers: Two pumps, made by H. R. Worthington, New York, in 1875 and 1880; two plain double-acting plungers, 14 inches diameter, 15 inches stroke, 45 strokes per minute.
Time pumps are run: 12 hours per day, 5 days per week.
Time spent in repairs: 12 hours per year (average).
Description of force-main: 2,029 feet long, 10 inches diameter. 104 feet head on pumps.
PUMPING TO DISTRIBUTING RESERVOIRS.

Continued.

Description of water-valves: Rubber; weighted on grist mill seats; 62 inches diameter, 4-inch lift.

Kind of power used: Steam.

Description of boilers: Horizontal return-tubular; 16 feet long, 5 feet diameter; 55 pounds pressure (average); fuel used, hard coal.

Description of engine: Compound condensing; high-pressure cylinder 14 inches diameter, low-pressure cylinder 84 inches diameter, 18 inches stroke, 90 strokes per minute; globe-valves, operated by wheel and spindle; 4 air-pumps, 0 by 13 inches; jet-condenser, 16 by 22 inches.

Cost of engine and pumps: $17,175.

Duty of engine: 45,000,000 foot-pounds guaranteed.

MISSOURI.

Saint Joseph:


Name of corporation: Saint Joseph Water Company (private).

Water obtained from: Missouri river.

Water first introduced: December, 1860.

Description of distributing reservoir: Three basins; middle basin used as a subsiding reservoir; water from main received in well, whence it passes into middle or either basin or into mains direct; capacities, subsiding basin, 2,000,000 gallons; south district basin, 4,000,000 gallons; north district basin, 6,000,000 gallons.

Sizes of distributing mains: 20, 10, 12, 10, 8, 6, and 4 inches.

Available head: 116 to 314 feet.

Total length of distributing mains: 24 miles.

Number of water-takers: 134.

Consumption of water: 600,000 gallons per day (estimated).

First cost of water-works: $70,000.

Filtering system: Use subsiding basin.

Number of fire-plugs: 184.

Design and dimensions of pumps and water-plungers: Two pumps, made by H. E. Warringhnn, Brooklyn, New York, in 1890-91; main engine, two plungers, 174 inches diameter, 36 inches stroke, 58 strokes per minute; diameter of pump-barrel, 174 inches; auxiliary engine, two plungers, 10 inches diameter, 15 inches stroke, 120 strokes per minute; diameter of pump-barrel, 10 inches.

Duty of force-main: 1,100 feet long, 16 inches diameter.

237 pounds pressure on pumps.

Description of water-valves: 64 rubber; 4-inch opening, 4 inch lift.

Kind of power used: Steam.

Description of boilers: 3 tubular; 59 4-inch tubes; shell, 54 inches diameter, 16 feet long; fuel used, semi-bituminous coal.

Description of engine: Compound condensing; cylinders 25 and 13.3 inches diameter, 36 and 38 inches stroke, 55 strokes per minute; balanced slide-valves, worked from rock-shaft; four air-pumps, 15 inches diameter, 15 inches stroke.

Cost of engine and pumps: $30,000.

NEW HAMPSHIRE.

Nashua:

Population: 13,397 inhabitants.

Name of corporation: Pennichucks Water-Works (private).

Water obtained from: Small stream.

Total area of water-shed available: About 30 square miles.

Character and dimensions of dam: One wood and stone, 15 feet fall; one stone, 17 feet fall; use water for power twice (two pumping-houses).

Water first introduced: In 1855.

Description of distributing reservoir: Capacity, 1,500,000 gallons.

Sizes of distributing mains: 10 to 4 inches.

Available head: 100 feet (average).

Total length of distributing mains: About 20 miles.

Nashua—Continued.

Number of water-takers: 1,021.

Consumption of water: 1,000,000 gallons per day (estimated).

First cost of water-works: $60,000.

Average annual cost of maintenance and repairs: About $10,000.

Number of fire-plugs: 55.

Design and dimensions of pump and water-plunger: Old pump removed in 1881, and Lang's substituted; made at Burlington, Vermont; plain plunger, 12 inches diameter, 22 inches stroke, 35 strokes per minute; pump-barrel, 13 inches diameter.

Time pump is run: Constantly.

Description of force-main: 5,200 feet long; head on pump, 132 feet.

Description of water-valves: Lang's patent.

Kind of power used: Water; steam in case of drought.

Description of water-wheels: 1 Jennal turbine, 15 feet head, 94 revolutions per minute; 10 gallons of water used to lift 1 gallon to reservoir; 2 Swain wheels to Lang pump, 24 feet head, 900 revolutions per minute, 8 gallons used to lift 1 gallon to reservoir.

Description of boiler: Hinckley's patent locomotive boiler; 65 pounds pressure; fuel, hard coal.

Description of engine: Cylinder, 14 by 30 inches; 60 strokes per minute; pump-valve, worked by bevel-gear.

Cost of engine and pumps: $14,000.

Duty of engines: 1,000,000 gallons in 24 hours; 3,000,000 gallons in 24 hours guaranteed.

NEW JERSEY.

Bridgeton:

Population: 8,728 inhabitants.

Style of corporation: Municipal.

Water obtained from: East Lake pond (Cedar Swamp-water).

Water first introduced: December, 1877.

Description of distributing reservoir: Area, 125 feet square; clay banks lined with brick; slope, 15 to 1; capacity, 1,500,000 gallons.

Sizes of distributing mains: 10 and 2 inches.

Available head: 15 to 40 pounds.

Total length of distributing mains: 114 miles.

Number of water-takers: 540.

Consumption of water: 108,000 gallons per day (average).

First cost of water-works: $60,000.

Average annual cost of maintenance and repairs: $1,445.

Number of fire-plugs: 77.

Design and dimensions of pump and water-plungers: Wurthington, 1877, Brooklyn, New York; two plain plungers, 15 inches diameter, 16 inches stroke, 55 strokes per minute; pump-barrel, 13 inches diameter.

Time pump is run: 267 hours per year in 1880.

Description of force-main: 2,300 feet long, 16 inches diameter; 87 feet head on pump (average).

Description of water-valves: Rubber, 6 inches diameter, 4 inch lift.

Kind of power used: Steam.

Description of boilers: Tubular, 12 feet long, 42 inches, diameter; 45 pounds pressure; fuel used, hard coal.

Description of engine: Compound duplex; high-pressure cylinder 14 inches diameter, low-pressure cylinder 30 inches diameter, 18 inches stroke, 55 strokes per minute; D slide-valve with out-off at 4 inch stroke; two air-pumps, 10 inches bore, 12 inches stroke; jet condenser.

Cost of engine and pump: $10,000.

Cape May:

Population: 1,869 inhabitants.

Style of corporation: Municipal.

Water obtained from: Wells.

Capacity of receiving reservoir: 40,000 to 60,000 gallons.
Cape May—Continued.

Water first introduced: In 1876.
Description of main conduit: Diameters, 12, 10, and 8 inches; cast iron; 20 pounds pressure.
Sizes of distributing mains: 12, 10, and 8 inches.
Total length of distributing mains: 3 miles.
Number of water-takers: 300.
Consumption of water: 100,000 gallons per day (estimated).
First cost of water-works: $5,000.
Number of fire-plugs: 65.
Design and dimensions of pump and water-plunger: R. D. Wood & Co., Millville, New Jersey; plain plunger 10 inches diameter, 65 inches stroke, 65 strokes per minute; pump-barrel, 24 by 16 inches.
Time pumps are run: 24 hours four months; 7 hours eight months.
Description of force-main: 20 pounds pressure on pump.
Kind of power used: Steam.
Description of boilers: Upright; 60 inches diameter, 6 feet flues; fuel, pen-coal.
Description of engine: Simple; 65 strokes per minute; common globe-valves.
Cost of engine and pump: $1,900.
Duty of engine: 400 gallons per minute daily guaranteed.

Jersey City:
Population: 120,729 inhabitants.
Name of corporation: Jersey City Water-Works (municipal).
Water obtained from: Passaic river.
Total area of water-shed available: 981 square miles.
Water first introduced: In 1853.
Description of main conduit: 64 miles long; 36 and 24 inches diameter; cast iron and cement.
Sizes of distributing mains: 30 and 26 inches.
Available head: 30 to 90 feet.
Total length of distributing mains: About 13.5 miles.
Consumption of water: 60 gallons per head (estimated).
Design of pumps and water-plungers: 3 Cornish and 3 Worthington.
Kind of power used: Steam.

Mount Holly:
Population: 4,621 inhabitants.
Name of corporation: Mount Holly Water Company (private).
Water obtained from: Rancocass river.
Capacity of reservoirs: 2 basins, 250,000 gallons each.
Cost of dam: $20,000.
Water first introduced: In 1851.
Description of main conduit: Diameter, 6 inches; iron.
Description of distributing reservoir: 2 basins; about 161 feet above tide-water; puddled clay and brick walls.
Size of distributing mains: 6 inches.
Available head: 40 to 90 feet.
Total length of distributing mains: 1,800 feet.
Number of water-takers: About 310.
Consumption of water: 108,000 gallons per day (estimated).
First cost of water-works: $84,000.
Average annual cost of maintenance and repairs: About $3,000.
Number of fire-plugs: 92.
Design and dimensions of pumps and water-plungers: One plain horizontal pump, plunger 6 inches diameter, 3 feet stroke, 30 strokes per minute; one Worthington duplex pump, plunger 10 inches diameter, 12 inches stroke, 66 strokes per minute.
Time pumps are run: 4 hours per week.
Time spent in repairs: None; apparatus duplicato.
Description of force-main: 1,800 feet long; 41 pounds pressure (standing) and 60 pounds pressure (running) on pumps.
Description of water-valves: Rubber (small spring).
Kind of power used: Steam.
Description of boilers: 1 Harrison, 20 horse-power; 1 tubular, 14 feet long, 40 inches diameter.

Mount Holly—Continued.

Description of engines: 1 condensing; 1 non-condensing; high-pressure 12 inches diameter, 18 inches stroke, low pressure 94 inches diameter; 63 strokes per minute on condensing engine; plain slide-valves; air-pump, 8-inch bore, 18 inches stroke; jet-condenser, 12 inches diameter, 36 inches long.
Cost of engines and pumps: $14,000.
Duty of engines: 200,000 gallons against 60 pounds pressure, with 900 pounds coal daily.

Passaic:
Population: 6,533 inhabitants.
Name of corporation: Aequanocuawoc Water Company (private).
Water obtained from: Passaic river.
Capacity of reservoir: About 1,380,000 gallons.
Water first introduced: In 1873.
Description of distributing reservoir: Area 10 feet diameter, 7 1/2 feet deep.
Sizes of distributing mains: 8 and 6 inches.
Total length of distributing mains: About 9 miles.
Number of water-takers: 550.
Consumption of water: 230,000 gallons per day (estimated).
Average annual cost of maintenance and repairs: $8,468.17.
Number of fire-plugs: 83.
Design and dimensions of pump and water-plunger: Pump made by C. Carr, Trenton, New Jersey; one plain plunger, 12 inches diameter, 5 feet stroke, 14 strokes per minute; pump-barrel, 3 inches diameter.
Time pump is run: 10 or 12 hours per day.
Description of force-main: 5,831 feet long, 12 inches diameter; 45 pounds head on pump.
Description of water-valves: 4 side-buckets, 12 by 18 inches diameter, 8 inches lift.
Kind of power used: Steam.
Description of boilers: Tubular; 16 feet long, 80 pounds pressure; fuel, stove and nut coal.
Description of engine: Simple; cylinder 11 inches diameter, 3 feet stroke, 60 strokes per minute; slide-valves.
Cost of engine and pump: About $8,900.

Paterson:
Name of corporation: Passaic Water Company (private).
Water obtained from: Passaic river.
Capacity of reservoir: 18,000,000 gallons.
Character and dimensions of dam: Stone and timber, 4 feet high; total head and fall on turbine wheel, 25 feet.
Water first introduced: In 1857.
Description of distributing reservoirs: One with stone wall inside, earth outside; two built with clay puddle-wall and clay bottom, paved on inside.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, and 4 inches.
Available head: 26 pounds (average); water-supply sometimes deficient.
Total length of distributing mains: About 40 miles.
Number of water-takers: 3,635.
Consumption of water: 110 gallons per head per day.
First cost of water-works: $506,000.
Average annual cost of maintenance and repairs: $12,000.
Number of fire-plugs: 430.
Design and dimensions of pumps and plungers: Paterson Steam Engine Company, three plain single pumps, double-acting, 6 feet stroke; H. R. Worthington, New York, one duplex, 18 inches stroke; all cylinders 18 inches diameter, 12 to 15 strokes per minute.
Time pumps are run: 23 hours per day.
Time spent in repairs: 1 hour per day (average).
Description of force-main: 700 feet long, 10 inches diameter; 600 feet long, 16 inches diameter, 68 feet head on pumps; 110 feet long, 12 inches diameter, 20 pounds pressure on pumps.
Description of water-valves: Rubber: 1st, 14 inches diameter, 1 1/2 inch lift; 2d, 8 inches diameter, 1 1/2 inch lift.
PUMPING TO DISTRIBUTING RESERVOIRS.

Cohoes—Continued.

Description of distributing reservoirs: On elevation; one built in clay soil and the other in clay and gravel; capacity, 4,000,000 and 8,000,000 gallons. Sizes of distributing mains: 10 to 4 inches. Available head: 320 to 240 feet. Total length of distributing mains: About 13 miles. Consumption of water: 31 gallons per head per day (estimated). First cost of water-wells: $169,000. Average annual cost of maintenance and repairs: $13,000 to $15,000. Number of fire-plugs: 125. Design and dimensions of pumps and water-plungers: Goyelin, Philadelphia; built at Cohoes in 1858-59 and 1868-69; two plain plungers, 10 and 10 inches diameter, 6 and 6 feet stroke, 12 to 10 strokes per minute; pump-barrels, 10 inches by 5 feet, 10 inches by 6 feet. Time pumps are run: Almost constantly. Time spent in repairs: About five days per year. Description of force-main: 1,250 feet long, 10 inches diameter; 3,400 feet long, 16 inches diameter; 20 to 30 pounds pressure on pumps. Description of water-valves: Check-valves. Kind of power used: Water. Description of water-wheels: 2 Jourval turbines, one 4 feet diameter, one 3 feet 6 inches diameter, 30 and 40 horse-power; 14 feet head; 70 revolutions per minute; 122 gallons required to lift 1 gallon to reservoir. Remarks: Water supply only after freshets.

Hudson:

Population: 8,267 inhabitants. Name of corporation: Hudson Water-Works (municipal). Water obtained from: Hudson river. Capacity of receiving reservoir: 4,000,000 gallons. Water first introduced: In 1854. Description of conduit: 7,215 feet long, 12 inches diameter; iron; head, 130 feet (average). Description of distributing reservoir: Area at crestline, 32,000 square feet; 20 feet deep; capacity, 3,000,000 gallons. Sizes of distributing mains: 12, 14, 16, and 18 inches. Available head: 80 pounds (average). Total length of distributing mains: 121/2 miles. Number of water-takers: 882. Consumption of water: 820,000 gallons per day (average). First cost of water-wells: $360,000. Average annual cost of maintenance and repairs: $10,000. Filtering system: 123 feet deep; area at crest, 15,000 square feet; surface of sand, 0.9 feet; stone gravel; cleaned every six weeks (average). Number of fire-plugs: 157. Design and dimensions of pump and water-plungers: Clapp & Jones, Hudson, New York, 1874; 2 plain plungers, 8 inches diameter, 30 inches stroke, 34 strokes per minute; pump barrel, 36 by 8 inches. Time pump is run: 12 hours per day (average). Time spent in repairs: 1 hour per day (average). Description of force-main: 7,215 feet long; 311.9 feet head on pump. Description of water-valves: Rubber; made by Clapp & Jones. Kind of power used: Steam. Description of boilers: Tubular; 10 by 51 feet; 40 pounds pressure, 8 pounds by 1 pound coal; fuel, Pittston coal. Description of engine: Condensing; 36 by 26 inches, 34 strokes per minute; slide-valves; jet-condenser, 15 by 20 inches; lifting-pump. Cost of engine and pump: $34,000. Duty of engine: 77,000,000 foot-pounds daily; 50,000,000 foot-pounds guaranteed.

Lyons:

WATER-SUPPLY OF CITIES.

LYONS—Continued.

Description of reservoir: Large cistern, 40 by 60 feet, 12 feet deep.
Cost of dam: $3,600.
Water first introduced: September, 1878.
Description of main conduit: 1,200 feet long; head, 70 feet (average).
Sizes of distributing mains: 4, 2, and 1½ inches.
Available head: 70 feet (average).
Total length of distributing mains: About 7,000 feet.
Number of water-takers: 35.
Consumption of water: 3,200 barrels per day.
First cost of works: About $3,600.
Average annual cost of maintenance and repairs: $500.
Design and dimensions of pump and water-plungers: Made by M. Y. B. Rowly, double-acting 2-cylinder, 40 to 60 strokes per minute; pump-barrel, 2 and 4 by 7 inches.
Kind of power used: Wind-mill.

OSWEGO:

Population: 21,110 inhabitants.
Name of corporation: Oswego Water Company (private).
Water obtained from: Oswego river.
Water first introduced: In 1849.
Description of distributing reservoirs: Two in embankment; no puddling, faced with rippin; eastern, 325 by 600 feet, 15 feet deep; slope 1 to 1; western, nearly rectangular, 500 by 700 by 225 by 275 feet; area, 4,922 acres; depth, 15 feet; cobblestone and sand division-wall in reservoirs for filtration.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Total length of distributing mains: 10 miles.
Number of water-takers: 600.
Consumption of water: 3,000,000 gallons per day.
First cost of works: $40,500.
Average annual cost of maintenance and repairs: $27,000.
Number of fire-plugs: 167.
Design and dimensions of pumps and water-plungers: Two made by H. Storey, New York, in 1859; two plain piston plungers to each, 104 inches diameter, 3 feet stroke, 50 strokes per minute.
Time pumps are run: Constantly.
Description of force-mains: Western reservoir, two cast-iron pipes, one 8 inches and the other 10 inches diameter, each 1,450 feet long; eastern reservoir, one 4,100 feet long, 10 inches diameter, and one 3,800 feet long, 8 inches diameter; 200 feet head on pumps, each.
Description of water-valves: Two square rubber flap, 63 by 7 inches, at each end of the pump-cylinders, each ½ inch thick; free lift.
Kind of power used: Water.
Description of water-wheels: Two Storer patent, 5 feet diameter, 3 feet high, 1½ feet head, 50 revolutions per minute.

PEEKSKILL—Continued.

Average annual cost of maintenance and repairs: About $1,600.
Number of fire-plugs: 76.
Design and dimensions of pump and water-plunger: Flander's patent, made by Vergennes Machine Company, Vermont, 1873–74; one plain plunger, 11½ inches diameter, 16 feet strokes, 24 strokes per minute.
Time pump is run: 10 hours per day.
Time spent in repairs: 5 days per year.
Description of force-main: ½ mile long, 12 inches diameter; 150 pounds pressure on pump.
Kind of power used: Water.
Description of water-wheels: Two American turbines, made by Stout, Mills, & Temple; 48 inches and 30 inches diameter; 24 gallons of water required to lift 1 gallon to reservoir.

WEST TROY:

Population: 8,920 inhabitants.
Name of corporation: West Troy Water-Works Company (private).
Water obtained from: Mohawk river and surface-water.
Total area of water-shed available: 700 acres.
Area and capacity of reservoir: 10 to 12 acres; 70,000,000 gallons.
Character and dimensions of dam: 1,200 feet long, made of stone, riprapped, with timber frame and plank sheathing; head, 7 feet; reservoir dam; 250 feet breadth at base, 50 feet high; earth.
Available head: 110 to 120 pounds.
Cost of dam: $250,000.
Water first introduced: In 1857.
Description of main conduit: 16 inches diameter; wrought iron, cement-lined inside and out; head, 180 feet (average).
Description of distributing reservoir: It is a natural ravine.
Sizes of distributing mains: 16 and 4 inches.
Available head: About 100 feet (average).
Total length of distributing mains: 14 miles.
Number of water-takers: About 270.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of works: $250,000.
Number of fire-plugs: 100.
Design and dimensions of pumps and water-plunger: Flander's pump, made at Vergennes, Vermont; 2 cylinders, double-acting; 16 strokes per minute (average); pump-barrel, 14 inches diameter.
Time pump is run: 11 months per year.
Description of main conduit: ½ mile long; 50 pounds pressure on pump.
Kind of power used: Water.
Description of water-wheels: American turbine, 72 inches diameter, made by Stout, Mills, & Temple, Dayton, Ohio; 6 feet head, 17 revolutions per minute.
Remarks: Water a little hard, on account of rocky bed over which it flows.

OHIO.

BELLAIRE:

Population: 8,095 inhabitants.
Name of corporation: Bellaire Water-Works (municipal).
Water obtained from: Ohio river.
Capacity of receiving reservoir: 31,000,000 gallons.
Character and dimensions of dam: One across front of reservoir; stone wall filled and puddled, 24 feet from river bed.
Water first introduced: In 1872.
Description of distributing reservoir: Semi-circular, with dam across front; excavated in hillside; capacity, 3,000,000 gallons.
Sizes of distributing mains: 12 to 3 inches.
Available head: 46 pounds (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 1,200.
Consumption of water: 1,586,855 gallons per day (estimated).
First cost of works: $100,000.
Average annual cost of maintenance and repairs: About $4,000.
Number of fire-plugs: 75.
PUMPING TO DISTRIBUTING RESERVOIRS.

ALLEGHENY—Continued.

Design and dimensions of pumps and water-plungers: One Lowry’s, designed by Harney, Pittsburgh, Pennsylvania; two plain plungers, 30 inches diameter, 8 feet stroke, 8 strokes per minute; pump-barrel, 30 inches diameter; four Knapp & Tuttun pumps, Pittsburgh, Pennsylvania; four double-acting piston-plungers, 32 inches diameter, 8 feet stroke, 16 strokes per minute; pump-barrel, 32 inches diameter.

Time pumps are run: Constantly.

Time spent in repairs: 600 hours per year.

Description of force-main: 666 feet long, 30 inches diameter; 216 feet head on pump.

Description of water-valves: Lowry’s disk, 15 inches diameter, 1½ inches lift; Knapp & Tuttun hinge.

Kind of power used: Steam.

Description of boilers: Four 2½ feet long, 48 inches diameter; two 16-inch flues; 8 pounds of water to 1 pound of coal; fuel, bituminous coal.

Description of engines: Simple; Lowry’s 44 inches diameter, 11 feet stroke, 8 strokes per minute; balance disk-valve by ordinary gear. Knapp & Tuttun’s, 30 inches diameter, 8 feet stroke, 16 strokes per minute.

Duty of engines: Lowry’s, 30,000,000 foot-pounds daily.

Remarks: Water sometimes impregnated with oil.

BUTLER:

Population: 3,103 inhabitants.

Name of corporation: Butler Water-Works Company (private).

Water obtained from: Connoquenessing creek.

Water first introduced: November, 1878.

Description of distributing reservoir: Area, 191 by 121 feet, 110 by 100 feet, 18 feet high to flow-line; capacity, 5,000,000 gallons.

Sizes of distributing mains: 10, 8, 6, and 4 inches.

Available head: 100 to 600 feet; water-supply sometimes deficient.

Total length of distributing mains: About 5 miles.

Number of water-takers: 40.

Average annual cost of maintenance and repairs: $5,000.

Number of fire-plugs: 2.

Design and dimensions of pumps and water-plungers: Made by Maxwell Manufacturing Company, Hamilton, Ohio, 1879; two plain plungers, 10 inches diameter, 3 feet stroke, 20 strokes per minute; pump-barrel 10 inches diameter.

Time pump is run: 8 hours per day, 4 days per week.

Description of force-main: 900 feet long.

Description of water-valves: Gate, 4 inches diameter, 3 inches lift.

Kind of power used: Steam.

Description of boilers: Two flue; 6 flues to each.

Description of engine: Compound; 14 by 22 inches diameter, 9 feet stroke, 20 strokes per minute.

Cost of engine and pump: $6,000.

Duty of engine: 3,000,000 foot-pounds in 24 hours.

PENNSYLVANIA.

ALLEGHENY:

Population: 78,652 inhabitants.

Name of corporation: City Water-Works (municipal).

Water obtained from: Allegheny river.

Capacity of reservoirs: 10,000,000 gallons.

Water first introduced: 1848.

Description of distributing reservoir: Parallelogram in shape, with cross-section stone wall dividing it into two compartments, each containing about 5,000,000 gallons, with one in-fine-tent; effluent chamber constructed at ends of division-wall.

Size of distributing mains: 20 inches.

Available head: 92 feet (average); water-supply sometimes deficient.

Total length of distributing mains: 50 miles.

Number of water-takers: 13,000.

Consumption of water: 5,000,000 gallons per day (estimated).

Average annual cost of maintenance and repairs: $90,000.

VOL. 17—46

CARRIAGE.

Population: 6,000 inhabitants.

Name of corporation: Canfield Gas and Water Company (private).

Water obtained from: Conesville and cranberry.

Character and dimensions of cistern: Woodo; 200 feet long between abutments; meadow dam, 150 feet long.

Water first introduced: 1854.

Description of main conduit: 1½ mile long, 6 inches diameter; head, 80 feet (average).

Description of distributing reservoirs: Two, 190 feet square each, 11 feet deep.

Sizes of distributing mains: 8, 6, and 4 inches.

Available head: 80 feet (average).

Total length of distributing mains: 8 miles.

Number of water-takers: 60.
CARLISLE—Continued.
Consumption of water: 20 gallons per head (estimated).
First cost of water-works: About $90,000.
Average annual cost of maintenance and repairs: $300.
Number of fire-plugs: 61.
Design and dimensions of pump and water-plungers: Made by A. P. Smith, Chambersburg, Pennsylvania, 1854; two bucket-plungers, 14 inches diameter, 18 inches stroke, 26 strokes per minute; pump-barrel 8 feet high, 24 inches diameter.
Time pump is run: Constantly.
Description of force-main: 14 mile long, 6 inches diameter; 40 pounds pressure on pump.
Description of water-valves: Ordinary check; 8 inches diameter, 12 inch lift.
Kind of power used: Water.
Description of water-wheel: One turbine; 26 inches diameter (Leffel turbine), 4 feet head, 20 revolutions per minute.
Remarks: Sometimes, after heavy rains and sudden thaws, the water is muddy.

CHESTER:
Population: 14,997 inhabitants.
Name of corporation: South Ward Water-Works of Chester (municipal).
Water obtained from: Delaware river.
Capacity of reservoir: 1,600,000 gallons.
Water first introduced: In 1868.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 15 miles.
Number of water-takers: 1,000.
Consumption of water: 500,000 gallons per day (estimated), or 20 gallons per head.
First cost of water-works: $84,000.
Average annual cost of maintenance and repairs: $8,000.
Number of fire-plugs: 64.
Design and dimensions of pump and water-plungers: Made by Robert Wetherill & Co., Chester, Pennsylvania, in 1879; 2 plain plungers, 4 inches diameter, 30 inches stroke, 47 strokes per minute.
Time pump is run: 70 hours per week.
Description of force-main: 1 mile long, 12 inches diameter; 35 to 40 pounds pressure on pump.
Description of water-valves: Rubber, 3½ inches diameter, 4 inch lift.
Kind of power used: Steam.
Description of boilers: 2 sets, double deck; 10 feet 14 inch long, 42 inches diameter; about 90 horse-power; fuel used, pen coal.
Description of engine: Compound condensing, 20 and 9 inches diameter, 30 inches stroke, 47 strokes per minute; Corliss valves; air-pump, jet-condenser.
Cost of engine and pump: $10,000.
Duty of engine: 650,000 gallons daily; 2,500,000 gallons in 24 hours guaranteed.

CLARION—Continued.
Filtering apparatus: Made of broken stone; cleaned once a year.
Number of fire-plugs: 11.
Design and dimensions of pump and water-plunger: Eclipse pump, made by H. D. McKnight, Pittsburgh, Pennsylvania; plunger, 4 inches diameter, 3 strokes per minute; pump-barrel, 4 by 14 inches.
Time pumps are run: 3 days per week.
Description of force-main: 3,300 feet long; 210 pounds pressure perpendicularly on pump; height, 325 feet.
Description of water-valves: Brass; 3 inches lift.
Kind of power used: Steam.
Description of boilers: Tubular; 100 pounds pressure; fuel, Erie City coal.
Description of engine: Simple; 0 inches diameter, 14 inches stroke, 30 strokes per minute; expansion valves.
Cost of engine and pump: $1,000.
Duty of engine: 2,700 gallons daily.

HARRISBURG:
Population: 30,762 inhabitants.
Name of corporation: Harrisburg Water-Works (municipal).
Water obtained from: Susquehanna river.
Water first introduced: In 1840.
Discharging capacity: 65 pounds pressure (average).
Description of distributing reservoir: Rectangular embankment, 525 by 276 feet at top, 22 feet deep; slope 1½ to 1; two divisions separated by masonry, dividing wall 14 feet high; slope, 1½ to 1; slopes puddled with concrete, stone, rip-rap; capacity, 30,000,000 gallons; stand-pipe wrought iron, 6 by 207 feet, brick tower, stone base; situated at pump-sta-
tion on river.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 19,908 feet, 6 miles.
Number of water-takers: 5,000.
First cost of water-works: $600,000.
Average annual cost of maintenance and repairs: $80,000.
Number of fire-plugs: 200.
Design and dimensions of pumps and water-plungers: Two made by Harrisburg Foundry Company, 1874; plain, solid plungers, 224 inches diameter, 5 feet stroke, 40 strokes per minute.
Time pumps are run: 14 hours per day.
Description of force-main: 15,220 feet long, 30 inches diameter; cast iron; 90 pounds pressure on pumps.
Description of water-valves: Lifting disk, 2½ inches diameter, 1 inch lift; 28 inches each pump.
Kind of power used: Steam.
Description of boilers: 18 multitubular, 10 feet long, 4 feet diameter; 20 4-inch tubes in each; 100 to 150 pounds pressure; fuel, anthracite coal.
Description of engines: Condensing, 54 inches diameter, 6 feet stroke; non-condensing, 30 inches diameter, 5 feet stroke; 40 strokes per minute; double-valves, by cams; jet-condenser, 4 feet long, 24 inches diameter; two air-pumps, 25 inches diameter, 2 feet stroke.
Cost of engines and pumps: $126,000.
Duty of engines: 51,000,000 foot-pounds daily (average).

KENNEDY SQUARE:
Population: 1,021 inhabitants.
Style of corporation: Municipal.
Water obtained from: Springs.
Total area of water-10ed: About 6 square miles.
Capacity of reservoirs: 100,000 gallons.
Character and dimensions of dam: Covers 2 acres; fed by a race 1 mile long; used to supply pump in case spring should fail.
Cost of dam: $30,000.
Water first introduced: In 1843.
Description of main conduit: ½ mile long, 6 inches diameter, terra cotta; ¼ mile long, 6 inches diameter, iron.
PUMPING TO DISTRIBUTING RESERVOIRS.

KENTUCKY—Continued.
Description of distributing reservoirs: No. 1, 20 feet square, 10 feet deep; capacity, 55,000 gallons. No. 2, 10 feet square, 12 feet deep; capacity, 34,000 gallons.
Sizes of distributing mains: 6, 4, 3, and 2 inches.
Available head: 10 to 100 feet; water-supply deficient only in extremely dry weather.
Total length of distributing mains: About 14 miles.
Number of water-takers: About 250.
Consumption of water: 20,000 to 40,000 gallons per day (estimated).
First cost of water-works: $30,000.
Average annual cost of maintenance and repairs: $800 to $200.
Number of fire-plugs: 15.
Design and dimensions of pump and water-plunger: 12-inch cast-iron, single-head, single-stage, 30 strokes per minute; pump-barrel, 9 inches diameter.

KITTANNING:
Population: 2,564 inhabitants.
Name of corporation: Kittanning Water Company (private).
Water obtained from: Allegheny river.
Water first introduced: January, 1773.
Description of distributing reservoir: Stone cistern, 100,000 gallons capacity.
Sizes of distributing mains: 6, 8, and 4 inches.
Available head: 216 feet; 89 pounds (average).
Total length of distributing mains: 64 miles.
Number of water-takers: 400.
Consumption of water: 40 gallons per head per day (estimated).
Number of fire-plugs: 26.
Design and dimensions of pump and water-plunger: Made by Neale & Company, Pittsburgh, in 1876; single-head, single-stage, 30 strokes per minute; pump-barrel, 10 inches diameter.
Time pump is run: 10 hours per day.
Description of force-main: 2,900 feet long; 120 pounds pressure on pump.
Description of water-valves: 2½ by 12 inches diameter, 2½ inches lift.
Kind of power used: Steam.
Description of boilers: Single, 20 feet long, 38 inches diameter; fire, 100 pounds pressure; fuel, bituminous coal.
Description of engine: Single, 100 horse-power, 10 inches diameter; single-head, 30 strokes per minute; slide-valves, operated with steam.
Cost of engine and pump: $3,500.

LANCASTER—Continued.
Available head: 1 to 40 feet; water-supply sometimes deficient.
Total length of distributing mains: About 33 miles.
Number of water-takers: About 3,500.
Consumption of water: 112 gallons per head per day (estimated).
First cost of water-works: $64,000.
Average annual cost of maintenance and repairs: $10,000.
Filtration system: Gallery required, as it is necessary to distribute the muddy water as soon as pumped into the reservoir. Number of fire-plugs: 250.
Design and dimensions of pumps and water-plungers: Steam, made by Worthington, New York, 1858; 2 water-power, by Berkley, and one by Geyelin, in 1829; 2 plain Berkley plungers, 10 inches diameter, 44 inches stroke, 23 strokes per minute; one Geyelin plunger, 10 inches diameter, 48 inches stroke, 23 strokes per minute; pump-barrels same size as plungers.
Time pumps are run: Steam, almost constantly; water, very seldom.
Description of force-main: 34, 32, 8, and 3 inches diameter.
Description of water-valves: Gosen; 6 inches diameter, 3-inch lift.
Kind of power used: Steam and water.
Description of water-wheels: Three 6-foot turbines; Berkley, 7 feet head, 23 revolutions per minute; Geyelin, 13 revolutions per minute.
Description of boilers: Four horse-power, tubular; 65 pounds pressure; fuel used, coal No. 1, hard pen.
Description of engine: Compound condensing; 50 strokes per minute; Worthington patent valves and condenser.
Cost of engine and pumps: Worthington, $28,000.

MEADVILLE:
Population: 5,000 inhabitants.
Name of corporation: Meadville Water Company (private).
Water obtained from: French creek.
Capacity of reservoir: 5,000,000 gallons.
Cost of dam: $22,000.
Water first introduced: September, 1875.
Description of man conduit: 100 feet long, 40 inches diameter; 4,700 feet long, 12 inches diameter; cast iron; head, 200 feet (average).
Description of distributing reservoir: 145 by 30 feet; 24 feet deep; division-wall, 10 feet high; walls, puddled clay bricked in cement.
Sizes of distributing mains: 12, 6, and 4 inches.
Available head: 200 feet (average).
Total length of distributing mains: 12½ miles.
Number of water-takers: 700.
Consumption of water: 20,000 gallons per day.
First cost of water-works: $137,735.
Average annual cost of maintenance and repairs: $4,000.
Filtering system: 24 by 30 feet; filled with gravel; cleaned every 3 years.
Number of fire-plugs: 26.
Design and dimensions of pumps and water-plungers: One Flander's improved; one W. H. Lang; one Flander's; two plain Flander's plungers, 10 inches diameter, 20 inches stroke; Flander's improved plunger, 13 inches diameter, 30 inches stroke, 14 to 20 strokes per minute; pump-barrels, 24 inches diameter.
Time pumps are run: Flander's, 10 hours per day.
Description of force-main: 4,000 feet long; 120 pounds pressure on pumps.
Description of water-valves: Lang's and Flander's.
Kind of power used: Water.
Description of water-wheel: Two, 64 inches diameter, 15 feet head.

MOUNT JOY:
Population: 2,568 inhabitants.
Style of corporation: Municipal.
Water obtained from: Chiques Salunga creek.

723
Mount Joy—Continued.
Total area of water-shed available: 48 square miles.
Character and dimensions of dam: 80 feet wide, 5 feet fall; backing up about 1,800 feet; walled up with stone.
Cost of dam: $40,000.
Water first introduced: In 1874.
Description of main conduit: 8 inches diameter; cast iron.
Description of distributing reservoir: Capacity, 750,000 gallons; 120 feet above creek; water pumped up 80 feet above main level of town; made by excetration and embankment, lined with puddled clay and brick, 13 feet deep.
Sizes of distributing mains: 8, 6, and 4 inches.
Total length of distributing mains: 17,544 feet.
Number of water-takers: 155.
First cost of water-works: $40,000.
Average annual cost of maintenance and repairs: $500.
Number of fire-plugs: 25.
Design and dimensions of pump and water-plunger: Made by Werner & Berkenbine, Lebanon, Pennsylvania; plain plunger, with patent water-cushions; 8 inches diameter, 2 feet strokes 40 strokes per minute.
Time pump is run: 3 to 4 days per week.
Description of force-main: 1,000 feet long; 50 pounds pressure on pump.
Description of water-valves: Brass; 8 inches diameter, 4 inch lift.
Kind of power used: Steam and water.
Description of water-wheel: Riston turbine; 6 feet head.
Description of boiler: 13 feet long, 34 feet diameter; 50 to 70 pounds pressure; fuel used, soft bit coal.
Description of engine: Simple; 10 inches diameter, 18 inches stroke, 110 strokes per minute; four air-chambers, 12 inches diameter, 2 feet high.
Remarks: No impurities, except in rainy weather, when water is muddy.

Newstown:
Population: 13,003 inhabitants.
Name of corporation: The Norristown Insurance and Water Company (private).
Water obtained from: Schuylkill river.
Water first introduced: December, 1847.
Description of distributing reservoirs: One, capacity about 1,000,000 gallons; one, capacity about 10,000,000 gallons; partly excavated and partly embankment; puddled with clay and paved with bricks.
Sizes of distributing mains: 16, 12, 10, 8, 6, 4, and 3 inches.
Available head: 1st reservoir, 100 feet (average); 2nd reservoir, 104 feet (average); water supply seldom deficient.
Total length of distributing mains: 16 to 18 miles.
Number of water-takers: 2,500 to 3,000.
Consumption of water: 750,000 gallons per day (estimated).
Number of fire-plugs: 150.
Design and dimensions of pumps and water-plungers: No. 1, made by H. B. Worthington, New York; plunger, two 14-inch pistons, brass packing, 20 strokes per minute; pump-barrel, 14 by 18 inches; No. 2, made by H. S. Newbold, Norristown, Pennsylvania; one 16-inch plunger, 13 strokes per minute; pump-barrel, 16 by 20 inches; both plungers double.
Description of water-valves: 1½ mile long, 24 inches diameter; 1st reservoir, 57 pounds pressure on pumps; 2d reservoir, 80 pounds pressure.
Description of water-valves: No. 1, rubber; No. 2, metal, leather faced.
Kind of power used: Steam.
Description of boilers: Six, 30 inches by 33 feet, plain cylinder or tubular boiler, equal to 3 of the above.
Description of engines: No. 1, compound, high-pressure cylinder 16 inches diameter, low-pressure cylinder 24 inches diameter, 18 inches stroke, 80 strokes per minute; No. 2, non-condensing, 22 inches high, 5 feet stroke, 20 strokes per minute; ordinary globe valves, by hand; 4 single 8 by 18 inches cylinder condenser.

Oil City.
Population: 7,515 inhabitants.
Name of corporation: Oil City Water Company (municipal).
Water obtained from: Allegheny river.
Capacity of reservoir: 3,000,000 gallons.
Cost of dam: About $160,000.
Water first introduced: In 1872.
Description of main conduit: 12 inches diameter; iron; head, 310 feet.
Description of distributing reservoir: Excavated; two compartments, 60 by 80 feet, with berms 10 feet high; slope, 1:4 to 1; total depth, 20 feet; puddled with clay and lined with brick.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 50 to 120 pounds.
Total length of distributing mains: 10 miles.
Number of water-takers: About 1,000.
Consumption of water: 560,000 gallons per day or 70 gallons per head (estimated).
First cost of water-works: $160,000.
Average annual cost of maintenance and repairs: About $8,000.
Number of fire-plugs: 75.
Design and dimensions of pump and water-plunger: Made by Eclipse Pump Works, Pittsburgh, Pennsylvania, in 1872; plain plunger, 20 by 30 inches cylinder, 14 to 20 strokes per minute; pump-barrel, 12 inches diameter.
Time pump is run: 24 hours; one at a time.
Description of force-main: 1,200 feet long and 310 feet long; 130 pounds pressure on pumps.
Description of water-valves: Metal, lined with leather; 46 by 9 inches diameter.
Kind of power used: Steam.
Description of boilers: Two; 5 by 12 feet; 62 3-inch flues; fuel, bituminous coal.
Description of engine: Simple cylinder, 9 inches diameter, 2 feet 6 inches stroke, 14 to 20 strokes per minute; rod valves worked by cam-brake from cylinder.
Cost of engine and pump: $4,000.
Duty of engine: 650,000 gallons daily.
Remarks: Water is impure only in June from vegetable matter.

Oxford:
Population: 1,603 inhabitants.
Style of corporation: Municipal.
Water obtained from: Wells.
Capacity of reservoir: 48,000 cubic feet.
Water first introduced: In 1870.
Description of main conduit: 7,250 feet long, 6 inches diameter; 4,546 feet long, 4 inches diameter; 4,820 feet long; 3 inches diameter; cast iron.
Description of distributing reservoir: 89 by 80 feet, top; 24 by 24 feet, bottom; 18 feet deep; basin lined with puddle clay and paved with bricks.
Sizes of distributing mains: 6 and 4 inches.
Available head: About 20 feet (average); water-supply sometimes deficient.
Total length of distributing mains: About 13,715 feet.
Number of water-takers: About 110.
First cost of water-works: About $40,000.
Average annual cost of maintenance and repairs: About $800.
Number of fire-plugs: 13.
Design and dimensions of pumps and water-plungers: Two; 4 plain plungers, 4 inches diameter, 2 feet stroke, 8 or 10 strokes per minute; diameter of pump-barrel, 4 inches.
Description of force-main: 4,080 feet long, 3 inches diameter.
Description of water-valves: Brass.
Kind of power used: Steam and water.
Description of water-wheel: Overshot; 11 feet diameter, 3 feet lift, 11 feet head, 8 to 10 revolutions per minute.
Description of boilers: About 4 horse-power; fuel used, anthracite coal.
Description of engine: Simple.
Duty of engine: About 30,000 gallons daily.
PUMPING TO DISTRIBUTING RESERVOIRS.

PARKER'S LANDING:
Population: 1,855 inhabitants.
Name of corporation: Parker's and Lawrenceburg Water Company (private).
Water obtained from: Allegheny river.
Area and capacity of reservoirs: 45,000 gallons each at three points.
Water first introduced: In 1875.
Description of main conduit: 4 inches diameter; head, 50 to 150 feet.
Description of distributing mains: Wooden tankage at three points.
Size of distributing mains: 4 inches.
Available head: 40 to 60 pounds.
Total length of distributing mains: About 2 miles.
Number of water-takers: 200.
Consumption of water: 8,000 gallons per day (estimated).
First cost of water-works: $14,600.
Average annual cost of maintenance and repairs: $300.
Filtering apparatus: Tank, 8 by 12 by 5 feet, sunk in bottom of river, filled with sand and gravel.
Number of fire-plugs: 37.
Design and dimensions of pumps and water-plungers: Cameron pump; made in 1881; 2 plain plungers; 6 inches diameter; 12 inches stroke; 36 strokes per minute; pump-barrel, 6 by 12 inches.
Time pumps are run: About 20 hours per day.
Description of force-main: 1 mile long; 200 pounds pressure on pumps.
Description of water-valves: Flat composition.
Kind of power used: Steam.
Description of boiler: Tubular; 40 horse-power; 75 pounds pressure; fuel, bituminous coal.
Description of engine: Non-condensing; 14 inches diameter, 36 inches stroke, 40 strokes per minute; simple globe-valves.
Cost of engine and pump: $600 each.

PHOENIXVILLE:
Population: 6,882 inhabitants.
Style of corporation: Municipal.
Water obtained from: Schuylkill river.
Total area of water-shed available: 80 square miles.
Capacity of reservoir: 2,250,000 gallons.
Character and dimensions of dams: Receives water from Black Rock dam; 2 miles long; 4 mile wide.
Cost of dam: $92,000.
Water first introduced: In 1875.
Description of main conduits: 1 mile long, 16 inches diameter; cast iron; 60 to 72 pounds pressure.
Description of distributing reservoirs: 130 feet above level of river; lined inside, 18 inches clay; covered with brick and cement; division-wall, 6 feet high; depth of water, 11 feet.
Size of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Available head: 65 pounds (average).
Total length of distributing mains: About 12 miles.
Number of water-takers: 453.
Consumption of water: 450,000 gallons per day, or 64 gallons per head (exact).
First cost of water-works: $125,000.
Average annual cost of maintenance and repairs: $3,000; $14,000 bonded debt.
Number of fire-plugs: 128.
Design and dimensions of pump and water-plungers: Compound duplex, made by Worthington, New York; two plain plungers, 12 and 14 inches diameter, 24 inches stroke each, 24 strokes per minute; one 12- and one 14-inch pump-barrel.
Time pumps are run: 10 hours per day (average).
Time spent in repairs: 10 days in a year (average).
Description of force-main: 900 feet long.
Description of water-valves: Rubber; 6 inches diameter, 1 inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 5 by 14 feet; fuel, coal.

PHOENIXVILLE—Continued.
Description of engines: Compound duplex condensing; high-pressure cylinder 23 inches diameter, low-pressure cylinder 36 inches diameter, 24 inches stroke, 15 strokes per minute; common globe-valves; double 16-inch bore-air-pump, 12 inches stroke.
Duty of engine: 37,000,000 feet pounds.
Remarks: The American Wood Paper Company's works are 24 miles above water-works on river, and refuse and chemicals used in dying contaminate the water.

PITTSBURG:
Population: 7,477 inhabitants.
Name of corporation: Pittsburg Water Company (private).
Water obtained from: Stagshawanna river.
Water first introduced: In 1855.
Description of distributing reservoir: Area, top, 129 feet long, 106 feet wide; bottom, 65 feet long, 46 feet wide; depth of water, 15 feet; capacity, 1,000,000 gallons.
Size of distributing mains: 15, 8, 6, 4, 3, and 2 inches.
Available head: 40 to 50 pounds.
Number of water-takers: 1,000.
Consumption of water: 60,000 gallons per day, or 70 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $7,839.
Number of fire-plugs: 38.
Design and dimensions of pump and water-plungers: Made by H. R. Worthington, New York, in 1877; 4 plungers, 16 inches diameter, 234 inches stroke, 15 strokes per minute; pump-barrel, 28 by 24 inches.
Time pumps are run: 10 hours per day (average).
Time spent in repairs: About 30 hours per year.
Description of force-main: 50 pounds pressure on pump.
Description of water-valves: Rubber; 6 inches diameter.
Kind of power used: Steam.
Description of boilers: Six plain cylinder; 36 feet long, 30 inches diameter; 75 pounds pressure; fuel used, coal.
Description of engines: Compound condensing; high-pressure cylinder 214 inches diameter, low-pressure cylinder 244 inches diameter, 20 inches stroke, 15 strokes per minute; Worthington, duplex valves.
Cost of engine and pump: $7,500.
Duty of engine: 750,000 gallons daily; 2,000,000 gallons per day guaranteed.

SAINT PETERSBURG:
Population: 1,644 inhabitants.
Name of corporation: Saint Petersburg Water-Works (municipal).
Water obtained from: Spring.
Water first introduced: April, 1873.
Description of distributing reservoirs: Two wooden tanks; capacity, 30,000 gallons each.
Sizes of distributing mains: 4, 3, and 2 inches.
Available head: About 40 pounds (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 125.
Consumption of water: 15,260 gallons per day (estimated).
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: $1,000.
Number of fire-plugs: 20.
Design and dimensions of pump and water-plunger: One Cameron pump, plain plunger; diameter of pump-barrel, 4 inches.
Time pumps are run: 8 to 10 hours per day.
Description of force-main: 700 feet long, 2.2 inches diameter.
Kind of power used: Steam.
Description of boiler: One 15 horse-power (Tift); 40 pounds pressure; fuel, bituminous coal.
Cost of engine: $400.

SUMMIT HILL:
Population: 288 inhabitants.
Name of corporation: Summit Hill Water Company (private).
Water obtained from: Mountain streams.

725
WATER-SUPPLY OF CITIES.

SUMMIT HILL—Continued.
Total area of water-shed available: 2 square miles.
Capacity of reservoir: 24,000 cubic feet.
Cost of dam: $8,400.
Water first introduced: January, 1877.
Discharging capacity: 40 to 75 feet head.
Description of distributing reservoir: 100 feet long, 30 feet wide, 8 feet overflow.
Sizes of distributing mains: 6, 5, 4, and 3 inches.
Available head: 40 to 75 feet.
Total length of distributing mains: 7,000 feet.
Number of water-takers: 300.
Consumption of water: 15,000 gallons per day (estimated).
First cost of water-works: $15,000.
Average annual cost of maintenance and repairs: $750.
Number of fire-plugs: 33.

Design and dimensions of pump and water-plungers: Made by Carter & Allen, Tamaqua, Pennsylvania, in 1876; two plain plungers, 4 inches diameter, 18 inches stroke, 36 strokes per minute; pump-barrel, 4 inches diameter.
Time pump is run: About 6 hours per day.
Description of force-main: 5,700 feet long, 12 inches diameter; 130 pounds pressure on pumps.
Description of water-velvases: Steam-velvases.
Kind of power used: Steam.
Description of boilers: Upright tubular, 9 feet high, 48 inches diameter, 46 pounds pressure; fuel, anthracite coal.
Description of engine: Non-condensing, double; 12 inches diameter; 18 inches stroke, 36 strokes per minute; ordinary cast-iron valves.
Cost of engine and pump: $3,300.
Duty of engine: 2,300,000 foot-pounds daily.

WESTCHESTER:
Population: 7,040 inhabitants.
Style of corporation: Municipal.
Water obtained from: Small creek.
Area and capacity of reservoir: 25,000 square feet; nearly 2,000,000 gallons.
Character and dimensions of dam: Very small one; pool, 200 by 100 feet, used for collecting and holding water; depth, 6 feet (average).
Cost of dam: Reservoir (proposed), $12,000.
Water first introduced: In 1840.
Description of main conduit: 1½ mile long, 32 inches diameter; iron; head, 40 feet.
Description of distributing reservoir: 160 by 140 feet; has a division about 6 feet from bottom, making two sections; side sluiced 30 feet; embankments rise 7 feet above ground, bottom 7 feet below ground; lined with clay and paved with brick.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 40 to 100 feet.
Total length of distributing mains: 8 to 10 miles.
Number of water-takers: About 1,400.
Consumption of water: 250,000 gallons per day.
Average annual cost of maintenance and repairs: About $4,000.
Number of fire-plugs: 130.
Design and dimensions of pump and water-plungers: Pump-barrel, 7 inches diameter.
Time pump is run: 10 to 15 hours per day.
Kind of power used: Steam.

YORK—Continued.
Filtering apparatus: Cleaned every 5 years.
Design and dimensions of pump and water-plungers: Made by Berkhehrs, Philadelphia, Pennsylvania, in 1850; round brass-ring plunger, 10 inches diameter, 30 inches stroke, 10 strokes per minute; pump-barrel, 10 inches diameter, 36 inches stroke.
Time pump is run: Constantly.
Description of force-main: 4,300 feet long, 90 feet rise, 10 inches diameter.
Description of water-velvases: 8½ to 10½ inches.
Kind of power used: Steam.
Description of boilers: Return tubular; 60 pounds pressure; evaporated 3,000 gallons in 12 hours; fuel, anthracite coal.
Description of engines: Condensers, 10 inches diameter, 3 feet stroke, 50 strokes per minute; common valves.
Cost of engine and pump: $3,500.

CHATTANOOGA:
Population: 12,892 inhabitants.
Name of corporation: Lookout Water Company (private).
Water obtained from: Tennessee river.
Cost of dams: $18,000.
Water first introduced: In 1813.
Description of main conduit: 12 inches diameter; iron.
Description of distributing reservoir: In two divisions; can discharge into either from pump, or supply city with either.
Sizes of distributing mains: 12 to 1½ inches.
Available head: 125 feet (average).
Total length of distributing mains: About 12 miles.
Number of water-takers: About 700.
Consumption of water: 1,350,000 gallons per day (estimated).
First cost of water-works: $115,000.
Average annual cost of maintenance and repairs: $10,050.
Number of fire-plugs: 56.
Design and dimensions of pump and water-plungers: Made by G. M. Woodward, New York, in 1830; plain double-acting plungers; two, 30 by 8 inches; two, 16 by 8 inches; one, 16 by 9 inches; 30 strokes per minute; pump-barrels, 12½ and 9 inches diameter.
Time pump is run: 20 hours per day.
Description of force-main: 800 feet long; 1½ feet head on pump.
Description of water-velvases: Metal.
Kind of power used: Steam.
Description of boilers: 22 feet long, 44 inches diameter; 4 flues, two 13 inches and two 19 inches diameter; 50 pounds pressure; fuel, soft coal.
Description of engines: Simple, high pressure; 10 and 20 inches diameter, 9 inches stroke, 30 and 50 strokes per minute; slide and eccentric valves.
Cost of engines and pump: $6,000.
Duty of engine: 2,520,000 foot-pounds daily.

TEXAS.

AUSTIN:
Population: 11,013 inhabitants.
Name of corporation: City Water Company (private).
Water obtained from: Colorado river.
Cost of dams: $10,000.
Water first introduced: February, 1876.
Description of distributing reservoir: 14,920 feet from pumps; covers 1 acre; capacity, 2,600,000 gallons; slopes are lined with concrete, 6 inches thick; elevation, 170 feet above pumps.
Sizes of distributing mains: 10, 8, and 6 inches.
Available head: 60 pounds (average).
Total length of distributing mains: About 10 miles.
Number of water-takers: 325.
Consumption of water: 227,000 gallons per day (exact).
PUMPING TO DISTRIBUTING RESERVOIRS.

AUSTIN—Continued.
First cost of water-works: $80,000.
Average annual cost of maintenance and repairs: $13,000.
Number of fire-plugs: 75.
Design and dimensions of pumps and water-plungers: Two, made by Blink & Co., Boston, Massachusetts, in 1875; bucket-plungers, 65 strokes per minute; pump-cylinder, 14 by 24 inches.
Time pumps are run: 2,220 hours per year.
Description of force-main: 14,340 feet long; 80 pounds pressure on pumps.
Description of water-valves: Rubber; 5 inches diameter.
Kind of power used: Steam.
Description of boilers: Two; fire; 14 feet long, 48 inches diameter, 55 pounds pressure.
Description of engine: Cylinder, 20 inches diameter, 24 inches stroke, 65 strokes per minute; Laidlow valves.
Duty of engine: 2,457,500 foot-pounds daily.

VERMONT.

BURLINGTON.
Population: 11,393 inhabitants.
Name of corporation: Burlington Water-Works (municipal).
Water obtained from: Lake Champlain.
Water first introduced: In 1865.
Discharging capacity: Head, 284 feet (average).
Description of distributing reservoir: Embankment; capacity, 3,000,000 to 4,000,000 gallons.
Sizes of distributing mains: 10, 6, 4, and 3 inches.
Total length of distributing mains: 25 miles.
Number of water-takers: 2,200.
Consumption of water: 90,000 gallons per day.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $6,450.
Number of fire-plugs: 128.
Design and dimensions of pumps and water-plungers: Two; made by H. R. Worthington, New York, in 1869; plain plungers, 10 inches diameter, 17 inches stroke, 21½ strokes per minute.
Time pumps are run: 10 hours per day.
Description of force-main: 14 mile long, 10 inches diameter.
Description of water-valves: 9 inlet and 0 discharge each cylinder; 3 inches diameter, 4 inch lift.
Kind of power used: Steam.

BURLINGTON—Continued.
Description of boilers: Two multitubular, 14 feet long, 3½ feet diameter; 44 inches, 3 inches diameter each; 40 pounds pressure; fuel, anthracite coal.
Description of engine: Compound; high-pressure cylinder 14 inches diameter, low-pressure cylinder 24½ inches diameter, 17 inches stroke, 21½ strokes per minute each; slide-valves; condenser, 14 by 48 inches; air-pump, 9 by 17 inches.
Cost of pumps and engine: $16,000.
Remarks: Whole pumping plants in good condition.

VIRGINIA.

DANVILLE.
Population: 7,500 inhabitants.
Name of corporation: Danville Water and Gas Works (municipal).
Water obtained from: Dan river.
Capacity of reservoir: 1,500,000 gallons.
Water first introduced: In 1875.
Description of distributing reservoir: 105 by 155 feet top, 15 feet deep; slope 2 to 1; made of loose earth, embankments lined with brick.
Sizes of distributing mains: 10, 8, 6, 4, and 3 inches.
Available head: 19 to 200 feet.
Total length of distributing mains: 8.2 miles.
Number of water-takers: 600.
First cost of water-works: $141,500.
Average annual cost of maintenance and repairs: $6,475 69 in 1880.
Number of fire-plugs: 66.
Design and dimensions of pump and water-plungers: Made by H. R. Worthington, New York, in 1875; two plain plungers, 18 inches diameter, 12 inches stroke, 100 to 200 strokes per minute.
Description of force-main: 3,600 feet long; 80 pounds pressure on pump.
Description of water-valves: Gum; 2 inches diameter.
Kind of power used: Steam.
Description of boilers: Tubular; 15 feet long, 5 feet diameter; 62 square; 65 pounds pressure; fuel, wood.
Description of engine: Non-condensing; 20 inches diameter, 12 inches stroke, 100 to 200 strokes per minute.
Duty of engine: 3,200,000 foot-pounds daily.
WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO STAND-PIPE.

ARKANSAS.

LITTLE ROCK:
Name of corporation: Little Rock Water Company (private).
Water obtained from: Arkansas River; about to use well in soil, near river, 4 mile above court-house; rest, drive-wells.
Water first introduced: In 1879.
Description of stand-pipe: 100 feet high, 20 feet diameter; wrought iron; one outlet and one inlet; used as surplus over direct pumping; filled at night.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 5 miles.
Number of water-takers: 300.
Consumption of water: About 200,000 gallons per day.
First cost of water-works: Contract was for $100,000.
Average annual cost of maintenance and repairs: $20,000.
Number of fire-plugs: 103.
Design and dimensions of pumps and water-plungers: Two, double-acting, made by George F. Blair, New York, in 1878; piston-plunger, 14 inches diameter, 24 inches stroke; varies up to 45 double strokes per minute; pressure on pumps, about 32 pounds.
Time pumps are run: One or the other 8 to 10 hours per day.
Description of force-main: About 300 feet long, 12 inches diameter.
Description of water-valves: Brass disks; 24 inlet and 24 discharge; 3 inches diameter; maximum lift, 3 inch.
Kind of power used: Steam.
Description of boilers: Two, cylindrical; 20 feet long, 43 inches diameter; 12 tubes, $\frac{1}{2}$ inches diameter, in each; 80 to 130 pounds pressure.
Fuel: Pittsburgh coal.
Description of engine: High-pressure condensing; cylinder, 30 inches diameter, 24 inches stroke, up to 45 double strokes per minute; slide-valves by piston-valve rod; Berkeley condenser.
Duty of engine: 1,000,000 gallons daily.

GEORGIA.

AUGUSTA:
Name of corporation: Augusta Water-Works (municipal).
Water obtained from: Savannah river by Augusta canal.
Character and dimensions of dam: 1,700 feet long, 9 feet deep (average), 6 feet wide, top; upstream fall 15 inches lower than downstream; rubble masonry.
Cost of dam: $30,000.
Water first introduced: In 1851.
Description of main conduit: 345.5 feet long, 20 inches diameter; cast iron.
Discharging capacity: 9.33 cubic feet per second; head, 17 feet (average).
Description of stand-pipe: Two concentric brick towers 65 feet high, supporting a boiler-iron tank 37 feet diameter and 30 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: 25 to 32 pounds; water-supply deficient.
Total length of distributing mains: 21.61 miles.

AUGUSTA—Continued.
Number of water-takers: 1,644.
Consumption of water: 81.5 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $7,548.78.
Filtering apparatus: Three settling basins; bricks set on edge; capacity, 10,000,000 gallons.
Number of fire-plugs: 103.
Design and dimensions of pump and water-plungers: Made by I. P. Morris & Co., Philadelphia, Pennsylvania, in 1869; two bucket-plungers, 18\frac{1}{4} inches diameter, 3 feet stroke, 20 strokes per minute; pump-barrel, 3 feet by 18\frac{1}{4} inches.
Time pump is run: Constantly.
Time spent in repairs: 24 hours per year.
Description of force-main: 2,000 feet long, 16 inches diameter, 35.12 pounds pressure; 88 feet head on pump.
Kind of power used: Water and steam.
Description of water-wheel: Journal turbine, 45 horse-power, 11 feet head, 68 revolutions per minute.
Description of boiler: 15 feet long, 4 feet diameter; 23 lines, 3 inches diameter.
Description of engines: Steam, simple, 20 inches stroke, 24 inches diameter, 24 inches stroke, 65 strokes per minute.

SAVANNAH:
Population: 30,709 inhabitants.
Name of corporation: Savannah Water-Works (municipal).
Water obtained from: Savannah River.
Water first introduced: In 1854.
Description of stand-pipe: Brick tower, 60 feet high, 18-inch iron beams on top support a tank of boiler-iron 30 feet diameter and 57 feet high.
Sizes of distributing mains: 12, 6, and 4 inches.
Available head: About 40 pounds (average); water-supply deficient, because mains are too small.
Total length of distributing mains: 22 miles.
Number of water-takers: 2,013.
Consumption of water: 70 gallons per head per day.
First cost of water-works: $225,000.
Average annual cost of maintenance and repairs: $11,000.
Number of fire-plugs: 257.
Design and dimensions of pumps and water-plungers: Made by Worthington, one in 1854, and one duplex in 1874; plain plungers, 17\frac{1}{8} inches diameter, 3 feet stroke, about 40 strokes per minute.
Time pumps are run: Constantly.
Description of force-main: Two, each 3,000 feet long, 16 and 12 inches diameter; 50 pounds pressure on pumps.
Description of water-valves: Indin-rubber; 7 inches diameter, $\frac{1}{8}$ inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 14 feet long, 48 inches diameter; 40 pounds pressure; fuel, wood.
Description of engine: Compound condensing; high-pressure cylinder, 21 inches diameter, 3 feet stroke; expansion cylinder, 36 inches diameter, 3 feet stroke, 40 strokes per minute; common D valve.
Cost of pumps and engine: $85,000.
Duty of engine: 46,000,000 foot-pounds daily.
Remarks: Water discolored during freshet by red clay.
INDIANA.

**SOUTH BEND:**
- Population: 13,320 inhabitants.
- Style of corporation: Municipal.
- Water obtained from: Saint Joseph river.
- Character and dimensions of dam: 600 feet long, 9 feet fall; made of wood.
- Cost of dam: $100,000.
- Water first introduced: In 1873.
- Description of stand-pipe: 204 feet high, 5 feet diameter.
- Sizes of distributing mains: 30, 10, 15, 10, 8, and 6 inches.
- Available head: 156 feet.
- Total length of distributing mains: 10 miles.
- Number of water-takers: 500.
- First cost of water-works: $170,000.
- Average annual cost of maintenance and repairs: About $3,000.
- Number of fire-plugs: 200.
- Design and dimensions of pump and water-plungers: Made by Flanders & Co., Vergennes, Vermont; plain plungers, 14 by 30 inches, 6 double-acting, taking and discharging water at each end of cylinder; 25 strokes per minute; pump-barrel, 14 inches diameter.
- Time pump is run: Constantly.
- Time spent in repairs: 48 hours per year.
- Description of force-main: 300 feet long, 100 feet head on pump.
- Description of water-valves: Iron, with rubber and brass; rubber removable, and brass on seats; 10 inches diameter, 1 foot lift.
- Kind of power used: Water.
- Description of water-wheels: Two 10-inch American turbines, made by Stout, Mills, & Temple, Dayton, Ohio; 7 to 9 feet head; 16 revolutions per minute.
- Cost of engine and pump: $4,000.

**FEEDHAUSEN:**
- Population: 26,042 inhabitants.
- Name of corporation: Torre Haute Water-Works Company (private).
- Water obtained from: Wabash river.
- Description of stand-pipe: Each pump has a close stand-pipe 98 feet high, 24 inches diameter, into which all the water is pumped; from thence, by compressed air, it is forced into the mains.
- Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
- Available head: 40 pounds (average).
- Total length of distributing mains: 17 1/4 miles.
- Number of water-takers: 453.
- Consumption of water: 500,000 gallons per day (estimated).
- First cost of water-works: $300,000.
- Average annual cost of maintenance and repairs: $3,000.
- Filtration apparatus: Course gravel in gallery; cleaned twice per year.
- Number of fire-plugs: 374.
- Design and dimensions of pump and water-plungers: Made by Clapp & Jones, Hudson, New York, in 1873; 4 grooved plungers, 9 inches diameter, 30 inches stroke, 6 to 60 strokes per minute; pump-barrel, 9 by 36 inches.
- Time pump is run: Constantly.
- Description of force-main: 10 inches diameter; 40 pounds pressure on pump.
- Description of water-valves: Clapp's, patent rubber; 1 inch thick, 4 inches wide.
- Kind of power used: Steam.
- Description of boilers: Two; 16 feet long, 44 inches diameter; two 16-inch tubes each; 1 Linbock & Wilcox, 75 horsepower; fuel, slack coal.
- Description of engines: Four condensing beam, 30 inches diameter, 30 inches stroke, 6 to 60 double strokes per minute; common slide cut-off; air-pump, 10 by 15 inches; jet-condenser.
- Cost of engines and pump: $45,000.
- Duty of engines: 45,000,000 foot-pounds daily (average).

PUMPING TO STAND-PIPE.

MASSACHUSETTS.

**FALL RIVER:**
- Population: 48,301 inhabitants.
- Name of corporation: Fall River Water-Works (municipal).
- Water obtained from: Watuppa lakes.
- Total area of water-land available: 34 square miles.
- Water first introduced: In 1874.
- Description of main conduit: 87 feet long; cross-section, 6 feet wide; to crown of each inside radius, 3 feet; brick.
- Description of stand-pipes: One 30 feet high, the other 40 feet high; each 3 feet 6 inches diameter; built of boiler-iron.
- Sizes of distributing mains: 24 to 6 inches.
- Total length of distributing mains: 16.25 miles.
- Number of water-takers: 2,500.
- Consumption of water: 27 gallons per head per day (estimated).
- First cost of water-works: $4,563,561.52.
- Average annual cost of maintenance and repairs: $20,000.
- Number of fire-plugs: 337.
- Design and dimensions of pumps and water-plungers: One, made by Boston Machinery Company, in 1874, two plungers, 10 inches diameter, 48 inches stroke; one, duplex Worthington, 1875, plain plunger, 294 inches diameter, 48 inches stroke; one, 22 inches diameter, 48 inches stroke, 4 strokes per minute.
- Time pumps are run: Constantly.
- Time spent in repairs: 10 days in 1880.
- Description of force-main: 4,150 feet long; head on low-pressure 1st feet, high-pressure 156 feet (average).
- Description of water-valves: Rubber; 6 inches diameter, 2 inch lift.
- Kind of power used: Steam.
- Description of boilers: Two, return-tubular, 6 feet 6 inches by 10 feet long, with 96 tubes, 4 inches diameter each; fuel, Cumberland coal.
- Description of engines: Boston, condensing; sump-valves operated by cams; air-pump, 27 by 23 inches; 23 inches stroke; 6 feet 6 inches rubber-top valve; condenser, 6 by 3 feet. Worthington compound, 11.0 strokes per minute; balance slide-valves.
- Cost of engines and pumps: Boston, $30,700 18; Worthington, $20,371 24.
- Duty of engines: Boston, 23,414,236 foot-pounds daily; 60,000,000 foot-pounds guaranteed. Worthington, 49,914,928 foot-pounds daily; 65,000,000 foot-pounds guaranteed.

**NANTUCKET:**
- Population: 3,727 inhabitants.
- Name of corporation: Waanacomet Water Company (private).
- Water obtained from: Waanacomet lake.
- Total area of water-land available: 23 acres.
- Capacity of reservoir: 30,000 gallons.
- Cost of dam: $3,500.
- Water first introduced: In 1870.
- Description of main conduit: 2 miles long, 8 inches diameter; cast iron; 104 feet head (average).
- Description of stand-pipe: 4-inch boiler-iron circular tank, 24 feet diameter, 15 feet deep, 42 feet above ground, on iron trestle-work.
- Sizes of distributing mains: 6, 4, and 2 inches.
- Available head: About 80 feet (average).
- Total length of distributing mains: About 5 miles.
- Number of water-takers: 150.
- Consumption of water: 60,000 gallons per day (estimated).
- First cost of water-works: $40,000.
- Average annual cost of maintenance and repairs: About $600.
- Number of fire-plugs: 4.
- Description of pumps and water-plungers: One, made by H. R. Worthington, New York, in 1880; two plain plungers, 14 inches diameter, 10 inches stroke; one made by G. R. Blake & Co., Boston, in 1878; two plain plungers, 6 inches diameter, 12 inches stroke, 230 strokes per minute.
- Time pumps are run: One pump 6 hours per day.
- Description of force-main: 400 feet long, 8 inches diameter; 20 pounds pressure on pumps.
NANTUCKET—Continued.

Description of water-valves: Rubber disks.

Kind of power used: Steam.

Description of boilers: One upright tubular, 15 horse-power; 77 tubes, 2 inches diameter, 5 feet long; 50 pounds pressure; one locomotive, 45 horse-power; 83 tubes, 3 inches diameter, 12 feet long; 90 pounds pressure; fuel, hard coal.

Cost of pump and engine: $1,520.

NEW JERSEY.

BELVIDERE.

Population: 1,773 inhabitants.

Name of corporation: Belvidere Water-Works (private).

Water obtained from: Delaware river.

Water first introduced: In 1878.

Description of main conduit: 225 feet long, 10 inches diameter; cast iron; head, 160 feet (average).

Description of stand-pipes: 100 feet high; made of heavy boiler-iron, on stone foundation.

Sizes of distributing mains: 8, 6, and 4 inches.

Available head: About 100 feet (average).

Total length of distributing mains: About 15,000 feet.

Number of water-takers: 106.

Consumption of water: 35,000 gallons per day (estimated).

First cost of water-works: About $40,000.

Number of fire-plugs: 15.

Design and dimensions of pump and water-plunger: Blake’s duplex pump, made by Blake Manufacturing Company, Boston and New York, in 1875; two plunger, bucket or suction, 8 inches diameter, 12 inches stroke, 100 strokes per minute (average); pump-barrel, 8 inches diameter.

Time pump is run: About 2 hours per day.

Description of force-main: 104 feet long; 30 pounds pressure on pumps.

Description of water-valves: Rubber; 3 inches diameter, inch lift.

Kind of power used: Steam.

Description of boilers: Tubular; 50 pounds pressure (average); fuel, No. 2 chestnut coal.

Description of engine: Simple; 14 inches diameter, 22 inches stroke, 100 strokes per minute (average); Blake’s patent valves.

Cost of engine and pumps: About $4,700.

Remarks: Water very pure.

MILLVILLE.

Population: 7,000 inhabitants.

Name of corporation: Millville Water Company (private).

Water obtained from: Well.

Water first introduced: In 1870.

Description of stand-pipes: 108 feet high, 12 feet diameter.

Sizes of distributing mains: 12, 10, 8, and 4 inches.

Available head: 90 pounds (average).

Total length of distributing mains: 41,064 feet.

Number of water-takers: 220.

Consumption of water: 150,000 gallons per day (estimated).

First cost of water-works: $63,620 $5.

Average annual cost of maintenance and repairs: About $60.

Design and dimensions of pumps and water-plungers: Two direct-acting duplex, made by Worthington, New York, in 1876; 4 plain plungers, 182 inches diameter, 10 inches stroke, 23 strokes per minute (average).

Time pumps are run: About 10 hours per day.

Description of force-main: 20 feet long, 8 inches diameter, 45 pounds pressure on pumps.

Description of water-valves: Rubber, 3 inches diameter, 1 inch lift.

Kind of power used: Steam.

Description of boilers: Return tubular, 9 feet long, 44 inches diameter, 40 pounds pressure; fuel, pea coal.

Description of engine: Non-condensing, 16 by 10 inches, 132 strokes per minute; slide-valve operated by opposite piston.

Cost of engine and pumps: $5,500.

Duty of engine: 1,500,000 feet-pounds daily.

OHIO.

LANCASTER.


Name of corporation: Lancaster Water-Works (municipal).

Water obtained from: Hoeking canal.

Water first introduced: In 1877.

Description of stand-pipes: 70 feet high.

Sizes of distributing mains: 6 inches.

Available head: 55 pounds (average).

Number of water-takers: 30.

First cost of water-works: $11,500.

Number of fire-plugs: 10.

Design of pump and water-plunger: Made by Smith, Vail, & Co., Dayton, Ohio.

Time pump is run: 1 hour per day.

Description of force-main: 110 feet; 55 pounds pressure on pumps.

Kind of power used: Steam.

Description of boiler: Upright, 20 horse-power, 70 pounds pressure; fuel, soft coal.

Cost of engine and pumps: $1,000.

Remarks: Canal water is unfit for use, but new works are in preparation and will be built in 1881.

PENNSYLVANIA.

BRISTOL.

Population: 5,273 inhabitants.

Name of corporation: The Bristol Water Company (private).

Water obtained from: Delaware river.

Water first introduced: February, 1876.

Description of stand-pipe: 140 feet high above stone foundation; 6 feet diameter.

Sizes of distributing mains: 12, 10, 8, and 4 inches.

Available head: 45 pounds (average).

Total length of distributing mains: 33 miles.

Number of water-takers: 225.

Consumption of water: Average pumping, 130,000 gallons; 110,000 gallons are estimated to go to railroad company.

First cost of water-works: $89,450.

Average annual cost of maintenance and repairs: About $60.

Design and dimensions of pumps and water-plungers: Two direct-acting duplex, made by Worthington, New York, 1876; 4 plain plungers, 182 inches diameter, 10 inches stroke, 22 strokes per minute (average).

Time pumps are run: About 10 hours per day.

Description of force-main: 20 feet long, 8 inches diameter, 45 pounds pressure on pumps.

Description of water-valves: Rubber, 3 inches diameter, 1 inch lift.

Kind of power used: Steam.

Description of boilers: Return tubular, 9 feet long, 44 inches diameter, 40 pounds pressure; fuel, pea coal.

Description of engine: Non-condensing, 16 by 10 inches, 132 strokes per minute; slide-valve operated by opposite piston.

Cost of engine and pumps: $5,500.

Duty of engine: 1,500,000 feet-pounds daily.

SOUTH CAROLINA.

CHARLESTON.

Population: 40,084 inhabitants.

Name of corporation: City Water-Works (private).

Water obtained from: Artesian well, 1,084 feet deep.

Area and capacity of reservoirs: 3,500,000 gallons.

Water first introduced: In 1888.

Description of main conduit: 4 mile long, 4 feet diameter; cast iron.

Description of stand-pipes: 76 feet high, 18 feet diameter, 50 feet above pump.

Sizes of distributing mains: 16, 12, 10, 8, and 6 inches.

Available head: 60 to 90 feet; water-supply deficient during very dry weather for a few hours daily.

Total length of distributing mains: 10 miles.

Number of water-takers: 500.
PUMPING TO STAND-PIPE.

CHARLESTON—Continued.
Consumption of water: 910,000 gallons per day.
First cost of water-works: $400,000.
Average annual cost of maintenance and repairs: $7,000.
Number of fire-plugs: 208.
Design and dimensions of pump and water-plungers: Made
by Knowles Manufacturing Company, New York, in 1880;
plain plungers, 20 strokes per minute; pump-barrel, 20 by
36 inches.
Time pump is run: 3 to 4 hours per day.
Description of force-main: 80 feet long, 20 inches diameter;
head, 90 feet; 85.58 pounds pressure on pump.
Description of water-valves: Indin-rubber, 4 to 1 inch.
Kind of power used: Steam.
Description of boilers: 60 pounds pressure; fuel, anthracite coal.
Description of engine: Compound; high-pressure cylinder 20
inches diameter, 36 inch stroke; low-pressure cylinder, 36
inches diameter, 36 inches stroke; 32 to 44 strokes per minute;
Knowles' valves and condenser.
Cost of engine and pump: $32,000.

TEXAS.

DALLAS.
Population: 10,308 inhabitants.
Name of corporation: Dallas Water-Supply Company (pri-
vate).
Water obtained from: Wells, springs, and Trinity river.
Available head: 40 to 50 feet.
Consumption of water: 114,000 gallons daily.
Filtering apparatus: Gallery; gravel, not yet tested.
Design and dimensions of pump and water-plungers: Made
by G. F. Blake Manufacturing Company, Chicago and Bos-
ton; one Blake plunger 24 inches; 100 steam-cylinder, 140
water-cylinder; one Knowles plunger, 10 inches, horizontal,
21-inch valve; 21-inch steam-cylinder; pump-barrels, 6 and
10 inches diameter.
Time pump is run: 16 hours per day.
Description of water-valves: Rubber, 50 inches diameter, 3
inches lift.
Kind of power used: Steam.
Description of engine: Simple, non-condensing.
WATER-WORKS EMPLOYING SYSTEM OF PUMPING DIRECT INTO DISTRIBUTING MAINS.

CALIFORNIA.

CHICO:
Population: 3,300 inhabitants.
Name of corporation: Chico Water Company (private).
Water obtained from: Well.
Water first introduced: In 1875.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Available head: 50 feet (average).
Total length of distributing mains: 5 miles.
Number of water-takers: 920.
Consumption of water: 300,000 gallons per day (estimated).
First cost of water-works: $90,000.
Average annual cost of maintenance and repairs: $4,500.
Number of fire-plugs: 30.
Design and dimensions of pump: Hooker pump, made by Garrett & Co., San Francisco, in 1875-78; plain plunger, with metallic packing, 150 strokes per minute; pump-barrels, 2 and 8 inches diameter.
Time pump is run: 12 hours per day.
Time spent in repairs: 150 hours per year.
Description of force-main: 3,000 feet long, 8 inches diameter; 224 to 260 pounds pressure on pump.
Description of water-valves: Rubber, 6 inches diameter, 1¼ inch lift.
Kind of power used: Steam.
Description of boilers: Two, 18 feet long, 42 inches diameter, 60 to 80 pounds pressure; fuel, wood.
Description of engines: 10 inches diameter, 18 inches stroke; 30 inches diameter, 24 inches stroke.
Cost of engines and pumps: $4,500.

SACRAMENTO:
Population: 21,420 inhabitants.
Name of corporation: Sacramento City Water Works (municipal).
Water obtained from: Sacramento river.
Total area of water-ethyl available: 15,000 square miles.
Water first introduced: April, 1854.
Sizes of distributing mains: 20 to 3 inches.
Available head: 40 pounds (average).
Total length of distributing mains: About 55 miles.
Number of water-takers: 3,000.
First cost of water-works: $300,000.
Average annual cost of maintenance and repairs: $25,000.
Number of fire-plugs: 300.
Design and dimensions of pumps: One set, made by Holly Manufacturing Company, Lockport, New York; piston type water-plunger, double-acting, 10 inches diameter, 27½ inches stroke, 75 to 80 strokes per minute; one Stevens, built by Central Pacific Railroad Company, Sacramento, California; plunger, 8 inches stroke, 24 inches diameter, 80 to 90 strokes per minute; pump-barrels: Holly, 10 by 36 inches; Stevens, 24 by 90 inches; head on pumps, 92½ feet.
Time pumps are run: Constantly.
Description of water-valves: Stevens, rubber, 2 inch thick, 7 by 14 inches; Holly, iron plates, shod with rubber, 5 by 11 inches, 1 inch lift.
Kind of power used: Steam.

SACRAMENTO—Continued.
Description of boilers: Three tubular, 16 feet long, 30 inches diameter; 58 tubes, 4 inches diameter; 75 pounds pressure; fuel, gas-coke.
Description of engines: Holly, non-condensing, condensing, and compound; 16 inches diameter, 27½ inches stroke, 75 to 80 strokes per minute; plain valves, with pump cut-off; Stevens, condensing, 30 inches diameter, 30 inches stroke, 30 to 30 strokes per minute; balanced triple-valves; 2 air-pumps, 15 by 26 inches and 20 by 24 inches; condensers for both.
Cost of pumps and engines: Holly, $50,000; Stevens, $30,000.
Duty of engines: 1,000,000 foot-pounds per bushel of coal daily.
Remarks: The advantages of direct pumping are that pressure can be controlled, but when pumps stop working, the supply is also stopped.

COLORADO.

DENVER:
Population: 35,000 inhabitants.
Name of corporation: City Water Company (private).
Water obtained from: South Platte river.
Character and dimensions of dam: Dam across river, 3 miles south of Denver.
Cost of dam: $600,000.
Water first introduced: In 1870.
Description of main conduit: Canal, 24 miles long, 25 feet fall.
Sizes of distributing mains: 20 to 3 inches.
Total length of distributing mains: 55 miles.
Number of water-takers: 2,500.
Consumption of water: 75 gallons per head per day (exact).
First cost of water-works: $600,000.
Average annual cost of maintenance and repairs: $35,000.
Filtering apparatus: Gallery, 30 by 10 feet; sides and ends, 8 feet through; filled with sand and gravel; cleaned once a year.
Number of fire-plugs: 300.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, 1874; six bucket-plungers, 16 inches diameter, 16 inches stroke, 30 strokes per minute.
Time pumps are run: Constantly.
Description of force-main: 60 pounds pressure on pumps; domestic, 135 pounds pressure on pumps.
Description of water-valves: Old works, oak; new works, rubber disks.
Kind of power used: Steam and water.
Description of water-wheels: Two American turbines, made by Stout, Miller, & Temple, Dayton, Ohio; 54 inches diameter, 30 feet head, 115 revolutions per minute.
Description of boilers: Tubular, 54 inches diameter, 18 feet long; 16 lives, 6 inches diameter each; 7 pounds of water to 1 pound of coal; fuel, slack coal.
Description of engines: Compound; two 10 inches diameter, 27 inches stroke; one, 18 inches diameter, 27 inches stroke; one 25 inches diameter, 30 inches stroke; 15 to 115 strokes per minute (double); old works, slide- and puppet-valves; new works, puppet, operated by French cams; jet-condenser.
Cost of engines and pumps: $140,000.
PUEBLO:
Population: 3,217 inhabitants.
Name of corporation: Pueblo City Water-Works (municipal).
Water obtained from: Arkansas river.
Water first introduced: November, 1874.
Sizes of distributing mains: 12, 8, 6, and 4 inches.
Total length of distributing mains: 61 miles.
Number of water-takers: 350.
Consumption of water: 375,000 gallons per day (estimated).
First cost of water-works: $420,000.
Average annual cost of maintenance and repairs: $8,500.
Filtering apparatus: Wells, 50 feet diameter; gravel; cleaned once a year; settling reservoir being constructed, 100 by 500 feet.
Number of fire-plugs: 60.
Sizes of plungers: Two double-acting piston-plungers, 6 inches diameter, 31 inches stroke, 10 strokes per minute; pump-barrel, 63 by 21 inches.
Time pump is run: Constantly.
Description of force-main: 6 1/2 miles long; 1 head, 100 feet on pump.
Description of water-valves: Rubber, 8 inches long; 2 inches diameter, 1/4 inch lift.
Kind of power used: Steam.
Description of boilers: Two return-flue, 12 feet long, 56 inches diameter; 41 tubes, 4 inches diameter each, 7 pounds pressure; fuel, screenings from lignite coal.
Description of engine: Usually compound, four cylinders, 10 inches diameter, 21 inches stroke, 20 strokes per minute; slide, also a variable cut-off valve; two air-pumps, 10 inches diameter, 12 inches stroke; jet-condenser.
Cost of engine and pump: $25,000.
Duty of engine: 3,000,000 feet-pounds to 100 pounds coal daily.
Remarks: The advantage of direct pumping into main is the control of pressure.

ATLANTA—Continued.
Cost of engines and pumps: $50,000.
Duty of engines: About 66,000,000 feet-pounds daily.
Remarks: The advantage of pumping direct into distributing mains is (1) less first cost; (2) no greater cost to operate.

ILLINOIS.
Population: 8,647 inhabitants.
Style of corporation: Municipal.
Water obtained from: Sangamon river.
Water first introduced: In 1871.
Description of main conduit: 300 feet long, 24 inches diameter; cast iron.
Discharging capacity: 17,000,000 gallons per 24 hours; 6 feet head (average).
Sizes of distributing mains: 12, 8, 6, 4, 2, and 1 1/2 inches.
Available head: 350 feet (average).
Total length of distributing mains: 50,554 feet.
Number of water-takers: 275.
First cost of water-works: $75,000.
Average annual cost of maintenance and repairs: About $5,000.
Filtering apparatus: Gallery, 600 feet long, 4 feet below bed of river; 10 feet wide; 6 feet galley, with brick arch; filled with gravel.
Number of fire-plugs: 60.
Design and dimensions of pumps and water-plungers: Made by Cameron, New York; plain plungers, 18 inches diameter, 2 feet stroke, 15 to 30 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: Constantly.
Description of force-main: 5,980 feet long, 18 inches diameter; 70 pounds pressure on pumps.
Description of water-valves: Plain; 12, 6, and 4 inches.
Kind of power used: Steam.
Description of boilers: One tubular, 14 feet long; one flue, 20 feet long; 5 flues; 70 pounds pressure.
Description of engine: Non-condensing, simple; 18 inches diameter, 3 feet stroke, 15 to 20 strokes per minute; globe-valves; common air-chamber.
Cost of engines and pumps: Two Cameron, $3,000.
Duty of engines: 439,000 gallons in 24 hours, each pump, daily; 664,000 gallons in 24 hours, each pump, guaranteed.
Remarks: The advantage of pumping direct to mains consists in great pressure in case of fire.

GEORGIA.
Population: 37,400 inhabitants.
Name of corporation: Atlanta Water-Works (municipal).
Water obtained from: Two small streams.
Capacity of reservoir: 265,000,000 gallons.
Character and dimensions of dam: 40 feet high, 300 feet wide at base, 12 feet wide at top; earth, with puddle wall in center.
Cost of dam: $46,009.60.
Water first introduced: In 1875.
Sizes of distributing mains: 12 to 4 inches.
Available head: 30 to 100 feet; water-supply deficient.
Total length of distributing mains: 14 miles.
Number of water-takers: 1,470.
Consumption of water: 2,350,000 gallons per day (average exact).
First cost of water-works: $350,000.
Average annual cost of maintenance and repairs: About $3,500.
Number of fire-plugs: 291.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plungers, 72 inches diameter, 37 inches stroke; strokes per minute vary; pump-barrel, 72 to 27 inches.
Time pump is run: Constantly.
Description of force-main: 234 miles long, 10 inches diameter; 110 pounds pressure on pump.
Description of water-valves: Clock; 2 by 6 inches, 1/4 inch lift.
Kind of power used: Steam.
Description of boilers: Three tubular, 8 pounds pressure; fuel, bituminous coal.
Description of engine: Compound; 20 to 20 strokes per minute; slide-valves, with balance cut-off; jet-condenser.

ATLANTA—Continued.
Cost of engines and pumps: $50,000.
Duty of engines: About 66,000,000 feet-pounds daily.
Remarks: The advantage of pumping direct into distributing mains is (1) less first cost; (2) no greater cost to operate.

ILLINOIS.
Population: 8,647 inhabitants.
Style of corporation: Municipal.
Water obtained from: Sangamon river.
Water first introduced: In 1871.
Description of main conduit: 300 feet long, 24 inches diameter; cast iron.
Discharging capacity: 17,000,000 gallons per 24 hours; 6 feet head (average).
Sizes of distributing mains: 12, 8, 6, 4, 2, and 1 1/2 inches.
Available head: 350 feet (average).
Total length of distributing mains: 50,554 feet.
Number of water-takers: 275.
First cost of water-works: $75,000.
Average annual cost of maintenance and repairs: About $5,000.
Filtering apparatus: Gallery, 600 feet long, 4 feet below bed of river; 10 feet wide; 6 feet galley, with brick arch; filled with gravel.
Number of fire-plugs: 60.
Design and dimensions of pumps and water-plungers: Made by Cameron, New York; plain plungers, 18 inches diameter, 2 feet stroke, 15 to 30 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: Constantly.
Description of force-main: 5,980 feet long, 18 inches diameter; 70 pounds pressure on pumps.
Description of water-valves: Plain; 12, 6, and 4 inches.
Kind of power used: Steam.
Description of boilers: One tubular, 14 feet long; one flue, 20 feet long; 5 flues; 70 pounds pressure.
Description of engine: Non-condensing, simple; 18 inches diameter, 3 feet stroke, 15 to 20 strokes per minute; globe-valves; common air-chamber.
Cost of engines and pumps: Two Cameron, $3,000.
Duty of engines: 439,000 gallons in 24 hours, each pump, daily; 664,000 gallons in 24 hours, each pump, guaranteed.
Remarks: The advantage of pumping direct to mains consists in great pressure in case of fire.

GEORGIA.
Population: 37,400 inhabitants.
Name of corporation: Atlanta Water-Works (municipal).
Water obtained from: Two small streams.
Capacity of reservoir: 265,000,000 gallons.
Character and dimensions of dam: 40 feet high, 300 feet wide at base, 12 feet wide at top; earth, with puddle wall in center.
Cost of dam: $46,009.60.
Water first introduced: In 1875.
Sizes of distributing mains: 12 to 4 inches.
Available head: 30 to 100 feet; water-supply deficient.
Total length of distributing mains: 14 miles.
Number of water-takers: 1,470.
Consumption of water: 2,350,000 gallons per day (average exact).
First cost of water-works: $350,000.
Average annual cost of maintenance and repairs: About $3,500.
Number of fire-plugs: 291.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plungers, 72 inches diameter, 37 inches stroke; strokes per minute vary; pump-barrel, 72 to 27 inches.
Time pump is run: Constantly.
Description of force-main: 234 miles long, 10 inches diameter; 110 pounds pressure on pump.
Description of water-valves: Clock; 2 by 6 inches, 1/4 inch lift.
Kind of power used: Steam.
Description of boilers: Three tubular, 8 pounds pressure; fuel, bituminous coal.
Description of engine: Compound; 20 to 20 strokes per minute; slide-valves, with balance cut-off; jet-condenser.
GENESEO—Continued.

Description of boilers: Two horizontal tubular, 12 feet long, 42 inches diameter; fuel, soft coal.

Description of engines: Non-condensing, single or duplex; 14 by 12 inches, 8 to 150 or 200 strokes per minute; common slide-valves.

Cost of engine and pump: $1,750.

Daily of engines: 1,000,000 gallons in 24 hours (daily).

Remarks: The advantage of pumping direct to distributing mains is the control of pressure.

HYDE PARK:

Population: 15,716 inhabitants.

Name of corporation: Hyde Park Water-Works (municipal).

Water obtained from: Lake Michigan.

Water first introduced: In September, 1874.

Description of main conduit: 1,700 feet long, 16 inches diameter.

Sizes of distributing mains: 16 to 4 inches.

Available head: 110 feet (average).

Total length of distributing mains: About 59 miles.

Number of water-takers: 1,350.

Consumption of water: 1,289,634,450 gallons per year (exact).

First cost of water-works: $400,000.

Annual cost of maintenance and repairs: $6,024 in 1880.

Number of fire-plugs: 47.

Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 piston-pumps, 24 inches diameter, 24 inches stroke, 10 to 40 strokes per minute; pump-barrel, 92 by 22 inches; one made by Knowles, New York, plain plunger, 20 inches diameter, 16 inches stroke, 15 to 25 strokes per minute; pump-barrel, 12 inches long.

Time pumps are run: Constantly.

Time spent in repairs: $250 hours per year.

Description of force-main: 15 mile long, 16 inches diameter.

Description of water-valves: Holly, leather-faced hinge, 9 by 4 inches, 1 inch lift; Knowles, rubber disks, 24 inch diameter, 1 inch lift. Kind of power used: Steam.

Description of engines: Holly, non-condensing, condensing, or compound, at will; four cylinders, 14 by 24 inches, 10 to 40 strokes per minute; D-valve, pump cut-out; two air-pumps, 14 inches diameter, 12 inches stroke; jet-condenser.

Knowles, compound; high-pressure cylinder 20 inches diameter, low-pressure cylinder 38 inches diameter, 36 inches stroke, 15 to 25 strokes per minute; two air-pumps, 8 inches diameter, 12 inches stroke; D-valve worked by piston jet-condenser.

Cost of engines and pumps: $40,000.

Duty of engines: 20,210,000 foot-pounds daily; Knowles, 62,000,000 foot-pounds guaranteed.

Remarks: The advantages of pumping direct into mains are cheapness of construction, and no fire-engines.—Water-works to point of distribution built and maintained in common with the town of Lake, Illinois.

LAKE:

Population: 13,880 inhabitants.

Style of corporation: Municipal.

Water obtained from: Lake Michigan.

Water first introduced: In 1874.

Description of main conduit: 16 inches in diameter.

Discharging capacity: 5,000,000 gallons.

Sizes of distributing mains: 12, 10, 8, 6, 4, and 3 inches.

Available head: 20 pounds (average); water-supply deficient. Total length of distributing mains: 70 miles.

Number of water-takers: 2,400.

Consumption of water: About 160 gallons per head per day (estimated).

First cost of water-works: $700,000.

LAKE—Continued.

Average annual cost of maintenance and repairs: $18,000.

Number of fire-plugs: 300.

Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, piston-plunger, and, made by Knowles, plain plunger; 22 strokes per minute; pump-barrel, 9 by 20 inches.

Time pumps are run: Constantly.

Description of force-main: 8 miles long, 18 inches diameter, 60 pounds pressure on pumps.

Description of water-valves: Holly, foot-valves, 4 feet by 7 inches; Knowles, rubber, 4 inches. Kind of power used: Steam.

Description of boilers: Tubular, 60 pounds pressure; fuel, Indiana block bituminous coal.

Description of engines: Compound, 52 strokes per minute; slide-valves; ordinary air-pump; jet-condenser.

Cost of engine and pumps: $80,000.

Duty of engines: 28,000,000 foot-pounds daily; 60,000,000 foot-pounds guaranteed.

Remarks: Water-works at point of distribution built and maintained in common with the town of Hyde Park, Illinois.

MOLINE:

Population: 7,800 inhabitants.

Style of corporation: Municipal.

Water obtained from: Mississippi river, above government dam.

Water first introduced: In 1877.

Description of main conduit: 500 feet long, 12 inches diameter; cast iron.

Discharging capacity: 100 pounds steam will discharge 1,000 gallons per minute.

Sizes of distributing mains: 8 and 4 inches.

Available head: 100 pounds (average).

Total length of distributing mains: 3,727 feet and 6,378 feet.

Number of water-takers: 62.

Consumption of water: 720,000 gallons in 24 hours (estimated).

First cost of water-works: $12,700.

Average annual cost of maintenance and repairs: $300.

Number of fire-plugs: 47.

Design and dimensions of pumps and water-plungers: One Knowles and two Worthington duplex; two plain plungers, 10 inches diameter, 24 inches stroke, 150 strokes per minute; pump-barrels, 16 inches each.

Time pumps are run: 24 hours per day.

Description of force-main: 50 pounds pressure on pumps.

Description of water-valves: Vitreousized rubber, 3 inches diameter, 1 inch lift. Kind of power used: Steam.

Location of boilers: Located at saw-mill of Dunwoody, Gould, & Co.

Description of engine: Simple, non-condensing; 18 inches diameter, 24 inches stroke, 150 strokes per minute; Knowles patent valves.

Cost of engine and pumps: $2,300.

Remarks: The advantage of pumping direct into distributing mains is perfect control of pressure; the disadvantage is that water is lost partly.

RAVENSDOOD:

Population: 485 inhabitants.

Style of corporation: Municipal.

Water obtained from: Lake Michigan.

Water first introduced: In May, 1876.

Sizes of distributing mains: 14 to 4 inches.

Available head: 40 pounds (average).

Total length of distributing mains: 21 miles.

Consumption of water: 500,000 gallons per day (estimated).

First cost of water-works: $800,000.

Average annual cost of maintenance and repairs: $5,000.

Number of fire-plugs: 78.
PUMPING DIRECT INTO DISTRIBUTING MAINS.

Ravenwood—Continued.
Design and dimensions of pump and water-plungers: Made by Flanders, Vergennes, Vermont; plunger plungers, 5 to 35 strokes per minute; pump-barrels: No. 1, 50 by 14 inches; No. 2, 30 by 12 inches.
Time pump is run: Constantly.
Description of force-main: 52 miles long, 14 to 4 inches diameter.
Description of water-valves: Hard rubber.
Kind of power used: Steam.
Description of boilers: Two tubular, 10 feet long; 50 lines; 80 pounds pressure.
Description of engines: Condensing; one set 20 by 14 inches; one set Harris-Corliss, 20 by 14 inches; 20 strokes per minute; No. 1, slide-valves; two single-acting air-pumps; No. 2, Corliss valve, drop cut-off; one double-acting air-pump; jet-condenser.
Cost of engines and pump: $25,000.

Rochelle:
Population: 1,893 inhabitants. Style of corporation: Municipal. Water obtained from: Water-shed, fed by springs. Capacity of reservoir: 7,000,000 gallons. Water first introduced: In 1877. Sizes of distributing mains: 8 and 6 inches. Available head: 40 pounds (average). Total length of distributing mains: 8,000 feet. Number of water-takers: 70. First cost of water-works: $10,000. Average annual cost of maintenance and repairs: $4,000. Number of fire-plugs: 24. Description of pumping engines and water-plungers: Two; made by Worthington; duplex, 16 by 10 by 104 inches; bucket-plunger, 4 inches; 104 inches; 200 strokes per minute. Time pumps are run: 16 hours per day. Description of force-main: 4,335 feet long. Description of water-valves: Rubber and spiral springs, 21 inches diameter; lift, small. Kind of power used: Steam. Description of boilers: One horizontal; 30 4-inch flues; 14 feet long, 50 inches diameter; one 50 horse-power Fiermenick. Description of engines: Non-condensing; 10 inches diameter, 10 inches stroke. Cost of engines and pumps: $3,000. Duty of engine: 800 gallons per minute each, daily; 1,000 gallons per minute guaranteed.

Stockyard Station—Continued.
Kind of power used: Steam. Description of boilers: Tubular, 60 pounds pressure; 74 pounds water to 1 pound coal; fuel, Indiana black bituminous coal. Description of engines: Compound; 62 strokes per minute; slide-valves; common air-pump; jet-condenser. Cost of engine and pumps: $60,000. Duty of engine: 25,000,000 gallons daily. Remarks: The advantage of pumping direct to mains is the saving of stand-pipe.

Sycamore:

Indiana:

Columbus:
WATER-SUPPLY OF CITIES.

COLUMBUS—Continued.
Kind of power used: Steam.
Description of boilers: Two; 14 feet long, 48 inches diameter; 48 flues.
Description of engine: Condensing, simple; 14 inches diameter, 2 feet stroke, 40 strokes per minute; direct-acting slide-valves.
Cost of engine and pump: $45,000.

CONNERSVILLE:
Population: 3,228 inhabitants.
Name of corporation: Connersville Hydraulic Company.
Water obtained from: White Water river.
Character and dimensions of dam: 600 feet long, 6 feet high; frame.
Water first introduced: In 1839.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 18 feet (average).
Total length of distributing mains: About 4 miles.
Number of water-takers: 826.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $42,000.
Average annual cost of maintenance and repairs: About $5,000.
Number of fire-plugs: 50.
Design and dimensions of pump and water-plunger: Double 8-inch rotary pump.
Time pump is run: Constantly.
Time spent in repairs: One month per year.
Description of force-main: 3 miles long, 8, 6, and 4 inches diameter; 20 pounds pressure on pump.
Kind of power used: Water.
Description of water-wheels: Two turbines, one Holly, and one Eclipse, 30 and 36 inches diameter, made by Pierce Manufacturing Company; 14 feet head, 150 revolutions per minute.
Remarks: Water is from canal, and, of course, not good for drinking, but answers the purpose it is generally put to.

EVANSVILLE:
Population: 29,290 inhabitants.
Name of corporation: Evansville Water-Works (municipal).
Water obtained from: Ohio river.
Water first introduced: June, 1872.
Description of main conduit: 2,300 feet long, 24 inches diameter; cast iron.
Sizes of distributing mains: 20 and 12 inches.
Total length of distributing mains: 25 miles.
Number of water-takers: 1,308.
First cost of water-works: $328,319 00.
Filtering system: Sand and gravel.
Number of fire-plugs: 292.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; four buckeet-plungers, 36 inches diameter, 15 inches stroke, double-acting, 16 strokes per minute; pump-barrel, 15 by 30 inches.
Time pump is run: Constantly.
Description of force-main: Head, 164 feet on pump.
Description of water-valves: Four; rubber; 8 inches diameter, 12 inch lift.
Kind of power used: Steam.
Description of boilers: Four; 16 feet long, 4 feet diameter; 12 tubes; 6 inches each; 50 pounds pressure; 2,856 pounds of water to 1 pound coal; fuel, anthracite coal.
Description of engine: Compound condensing; high-pressure cylinder 24 inches diameter, low-pressure cylinder 41 inches diameter, 36 inches stroke; balanced pump operated by cams; Buckley injector condenser.
Cost of engine and pump: $96,000.
Duty of engine: 88,000,000 foot-pounds daily; 80,000,000 foot-pounds guaranteed.

LOGANSPORT—Continued.
Character and dimensions of dam: 500 feet long, 6 feet deep (average); wooden.
Cost of dam: $7,000.
Water first introduced: In 1876.
Description of main conduit: 2,000 feet long, 30 inches diameter; cast iron.
Discharging capacity: 3,000,000 gallons per 24 hours.
Sizes of distributing mains: 20, 10, 8, 6, 4, and 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 104 miles.
Number of water-takers: 400.
Consumption of water: 500,000 gallons per day (estimated).
First cost of water-works: $135,000.
Average annual cost of maintenance and repairs: $25,000.
Number of fire-plugs: 84.
Design and dimensions of pumps and water-plungers: Made by Cope & Maxwell, Hamilton, Ohio; 4 piston-pumps, 11 inches diameter, 21 inches stroke; pump-barrel, 11 by 24 inches.
Time pumps are run: Constantly.
Description of water-valves: Rubber, 6 inches thick.
Kind of power used: Steam and water.
Description of water-wheels: 3 Little Giant turbines; two 54 inches, one 42 inches; 11 foot head.
Description of boilers: Two; 13 feet long, 93 inches diameter; 100 tubes, 25 inches diameter.
Description of engines: Compound; two 10 inches and two 30 inches, 8-inch crank, 11 strokes per minute; slide eccentric valves.
Cost of engines and pumps: $21,000.
Duty of engines: 8,370,535 foot-pounds daily; 4 tons coal per day.

MARION:
Population: 3,182 inhabitants.
Name of corporation: Marion Water-Works (municipal).
Water obtained from: Flowing river.
Water first introduced: In 1877.
Sizes of distributing mains: 18, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 7 miles.
Number of water-takers: 300.
Consumption of water: 330,000 gallons per day (estimated).
First cost of water-works: $34,000.
Number of fire-plugs: 44.
Design and dimensions of pump and water-plungers: Made by Deane Brothers, Indianapolis, Indiana; two plain plungers, 10 inches diameter, 14½ inches stroke, 8 strokes per minute; pump-barrel, 14½ by 10 inches.
Time pump is run: Constantly.
Description of force-main: ¾ mile long, 12 inches diameter, 40 pounds pressure on pumps.
Description of water-valves: Rubber, 6 inches.
Kind of power used: Steam.
Description of boilers: 13 foot long, 48 inches diameter, 35 pounds pressure; fuel, Pittsburgh coal.
Description of engine: Duplex, 18 inches diameter, 14 inches stroke; 8 strokes per minute; independent cut-off, double valve.
Cost of engine and pump: $4,000.
Duty of engine: 465,000 gallons per day.

UNION CITY:
Population: 2,473 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Water first introduced: January, 1874.
Description of main conduit: 10 inches diameter; wood, coated with coal-tar or asphaltum and bound with strap-iron.
Sizes of distributing mains: 10, 8, 6, 4 inches.
Available head: 60 to 70 pounds.
Number of water-takers: 107.
Consumption of water: 150,000 gallons per day (estimated).
First cost of water-works: $60,000.
PUMPING DIRECT INTO DISTRIBUTING MAINS.

UNION CITY—Continued.
Average annual cost of maintenance and repairs: $2,700 to $5,600.
Number of fire-plugs: 29.
Design and dimensions of pump and water-plungers: Deane Brothers, makers, Indianapolis, 1873; plain plungers. Time pump is run: Constantly.
Kind of power used: Steam.
Description of boilers: Tubular, 60 to 70 pounds pressure; fuel, Hocking Valley and Pittsburgh coal.

IOWA.

CEDAR RAPIDS.
Population: 10,104 inhabitants.
Name of corporation: Cedar Rapids Water Company (private).
Water obtained from: Cedar river.
Water first introduced: In 1875.
Sizes of distributing mains: 10 to 4 inches.
Total length of distributing mains: 74 miles.
Number of water-takers: 330.
Consumption of water: 800,000 gallons per day (estimated).
First cost of water-works: $109,045.
Average annual cost of maintenance and repairs: $13,000.
Number of fire-plugs: 76.
Design and dimensions of pumps and water-plungers: Made by McGowan Pump Company, Cincinnati, Ohio, 1875; 4 duplex double-acting plungers; 2 cylinders, 30 inches diameter, 30 inches stroke; 2 cylinders, 18 inches diameter, 24 inches stroke; two 20 and two 40 strokes per minute; pump-barrels, 18 by 42 inches and 14 by 30 inches.
Time pumps are run: Constantly.
Time spent in repairs: 620 hours per year.
Description of force-main: 1,800 feet long, 16 inches diameter, 69 pounds pressure on pumps.
Description of water-valves: Disk, in 2 cylinders, 8 inches diameter, 1 inch lift; clamped in 2 cylinders, 6 feet by 9 inches, 3 inches lift.
Kind of power used: Steam.
Description of boilers: Two, tubular, 14 feet long, 60 inches diameter, 70 pounds pressure; fuel, bituminous coal.
Description of engines: One compound condensing, 204 by 30 inches, and 28 by 30 inches; 20 strokes per minute; 1 piston-valve; 1 condensing or non-condensing, 18 inches diameter, 24 inches stroke, 40 strokes per minute; 1 slide-valve; piston air-pump, and jet-condenser, 100 gallons per minute.
Cost of engines and pumps: $24,760.
Duty of engines: 600,000 gallons with 80 pounds pressure daily; 4,000,000 gallons per 24 hours guaranteed.
Remarks: The advantage and disadvantages of pumping direct to mains are best system for fire purposes, but more expensive for general use.

DAVENPORT.
Population: 21,831 inhabitants.
Name of corporation: Davenport Water Company (private).
Water obtained from: Mississippi river.
Water first introduced: In 1874.
Description of main conduit: 150 feet long, square, and arched on top, brick; extends into river.
Sizes of distributing mains: 14, 12, 10, 8, 6, and 4 inches.
Available head: 80 to 90 pounds.
Total length of distributing mains: 28 miles.
Number of water-takers: 650.
Consumption of water: 3,000,000 gallons per day (estimated).
First cost of water-works: About $500,000.
Average annual cost of maintenance and repairs: About $26,000.
Number of fire-plugs: 342.
Design and dimensions of pump and water-plungers: Made by Todd & Rafferty, Paterson, New Jersey, 1874; two plain plungers, 17 inches diameter, 6 feet stroke, double-acting, 6 to 24 strokes per minute; pump-barrel, 17 inches diameter.

DAVENPORT—Continued.
Time pumps are run: Constantly.
Description of force-main: 14 inches diameter, 80 to 90 pounds pressure on pump.
Description of water-valves: Rubber disks, 14 inches diameter, 4 to 1 inch lift.
Kind of power used: Steam.
Description of boilers: Two-two, 24 feet long, 60 inches diameter, 75 pounds pressure; 5 pounds water to 1 pound coal; fuel, bituminous coal.
Description of engines: Non-condensing, 24 inches diameter, 36 inches stroke, 60 strokes per minute; slide-valves.

DES MOINES.
Name of corporation: Des Moines Water-Works Company (private).
Water obtained from: Raccoon river.
Water first introduced: In 1872.
Description of main conduit: 1,000 feet long, 16 inches diameter; iron.
Sizes of distributing mains: 16, 14, 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 20 miles.
Number of water-takers: 1,300.
Consumption of water: 2,000,000 gallons per day (estimated).
First cost of water-works: $325,000.
Filtering apparatus: One 14 inches diameter and one 8 inches diameter, made of boiler-iron.
Number of fire-plugs: 127.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1871; 6 bucket-plungers, 14 inches diameter, 12 inches stroke; pump-barrels, 14 inches diameter; 1 rotary pumps, 12 by 10 inches; 80 to 150 pounds pressure on pumps.
Time pumps are run: Constantly.
Description of water-valves: Rubber, 13 inches diameter, 2 inches lift.
Kind of power used: Steam.
Description of boilers: 2 vertical and 2 horizontal; 70 pounds pressure; fuel, bituminous coal.
Description of engines: Interchangeable, 14 inches diameter, 24 inches stroke, Holly valve; air-pump, 14 by 14 inches; surface-condenser, 12 feet high, 30 inches diameter.
Cost of engine and pumps: $50,000.

KNOX.
Population: 13,117 inhabitants.
Name of corporation: Knox Water-Works Company (private).
Water obtained from: Mississippi river.
Water first introduced: July, 1878.
Description of main conduit: Length 250 feet, diameter 20 inches; cast iron.
Discharging capacity: 920,000 gallons per 24 hours.
Sizes of distributing mains: 14 to 6 inches.
Available head: 25 to 75 pounds.
Total length of distributing mains: 11 miles.
Number of water-takers: 300.
Consumption of water: 70 gallons per head per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $5,000.
Filtering apparatus: Size, 60 feet long, 15 feet deep; filled with fine and coarse sand, gravel, charcoal, and broken rock, in layers; cleaned once in two years.
Number of fire-plugs: 70.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1875; four plain plungers, 8 inches diameter, 22 inches stroke; pump-barrel, 6 inches diameter.
Time pump is run: Constantly.
Description of force-main: 14 inches diameter, 60 to 120 pounds pressure on pump.
Kind of power used: Steam.
KRONKUK—Continued.
Description of boilers: Two; 16 feet long, 5 feet diameter; 34 fires, 31 inches diameter, 60 to 90 pounds pressure; 7 to 8 pounds water to 1 pounding coal; fuel, Iowa bituminous coal.
Description of engines: Interchangeable, 4 cylinders, 14 inches diameter, 22 inches stroke; slide-valves operated by eccentric; air-pump, 14 by 12 inches; condenser, 12,200 cubic inches.
Cost of engine and pump: $20,000.
Duty of engine: 400,000 gallons daily.
Remarks: The advantage and disadvantage of pumping direct to mains are control of pressure, but it is wearing on machinery.

MARSHALL:
Population: 1,728 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mill-dam.
Water first introduced: In 1875.
Sizes of distributing mains: 6 and 4 inches.
Total length of distributing mains: 14 miles.
First cost of water-works: $5,000.
Average annual cost of maintenance and repairs: $100.
Number of fire-plugs: 10.
Design of pump and water-plunger: Made by Worthington, New York.
Kind of power used: Steam.
Description of water-wheels: Two turbines.

MONTICELLO—Continued.
Design and dimensions of pump and water-plunger: Made by Blake & Co., Boston, Massachusetts; plain plunger, 3 inches diameter, 12 inches stroke, 80 to 120 strokes per minute; pump-barrel, 8 by 12 inches.
Time pump is run: 20 to 25 hours per week.
Time spent in repairs: 250 hours per year.
Description of force-main: Head, 125 feet on pump.
Description of water-valves: Rubber, 3 inches diameter.
Kind of power used: Steam.
Description of boilers: Upright, 10 feet high, 4 feet diameter; fuel, wood.
Description of engine: Non-condensing, simple, 14 inches diameter, 12 inches stroke, 90 strokes per minute.
Cost of engine and pump: $1,000.

OSKALOOSA:
Population: 4,693 inhabitants.
Name of corporation: Oskaloosa Water Company (private).
Water obtained from: Skunk river.
Water first introduced: August, 1880.
Description of main conduit: 10 miles long, 10 inches diameter; cast iron.
Discharging capacity: 2,000,000 gallons per day, 00 to 80 pounds pressure.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 36 pounds (average).
Total length of distributing mains: 4 miles.
Number of water-takers: 00.
First cost of water-works: $102,000.
Filtering apparatus: Pit in solid rock, 40 by 15 feet, 3 feet below bed of stream; charcoal, sand, and gravel in alternate layers; cleaned once a year.
Number of fire-plugs: 49.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plunger; pump-barrel, 10 inches diameter.
Time pump is run: Constantly.
Description of force-main: 4 miles long, 10 inches diameter; head, 114 feet on pump.
Description of water-valves: Iron and rubber.
Kind of power used: Steam.
Description of boilers: 18 feet long, 36 inches diameter; 40 tubes.
Description of engine: One quadruple compound condensing; 4 pumps; 1 duplex high-pressure pump.

EMPIRIA:
Population: 4,631 inhabitants.
Name of corporation: Emporia Water-Works (municipal).
Water obtained from: Cottonwood river.
Total area of water-shed available: 1 mile.
Water first introduced: June, 1880.
Description of main conduit: 8 inches diameter.
Discharging capacity: 2,000,000 gallons per day; 100 pounds pressure (average).
Sizes of distributing mains: 12 to 8 inches.
Available head: Variable.
Total length of distributing mains: 11½ miles.
Number of water-takers: 164.
Consumption of water: 10,000 gallons per day (estimated).
First cost of water-works: $92,500.
Average annual cost of maintenance and repairs: $4,500.
Number of fire-plugs: 47.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; plain plunger, 6 inches diameter, 21 inches stroke, 12 strokes per minute; pump-barrel, 6 by 21 inches.
Time pump is run: Constantly.
Description of force-main: 5,000 feet long, 8 inches diameter, 45 pounds pressure on pump.
Description of water-valves: Hinges, by 6 inches, 4 inch lift.

KANSAS.
EMPORIA—Continued.
Kind of power used: Steam.
Description of boilers: Tubular, 64 inches diameter, 50 pounds pressure; fuel, Little Pittsburgh coal.
Description of engine: Condensing compound, 16 by 21 inches, 6 strokes per minute; slide-valves by eccentric; surface condenser.
Cost of engine and pump: $15,000.
Advantage of pumping direct into main: Economy in fuel, and control of pressure.

KENTUCKY.

OWENSBOROUGH:
Population: 6,231 inhabitants.
Name of corporation: Owensborough Water Company (private).
Water obtained from: Ohio river.
Water first introduced: July, 1879.
Sizes of distributing mains: 10, 6, 4, and 3 inches.
Available head: 80 feet (average).
Total length of distributing mains: 9 miles and 50 feet.
Number of water-takers: 254.
Consumption of water: 10 gallons per day per head (estimated).
First cost of water-works: $80,000.
Average annual cost of maintenance and repairs: $1,000.
Number of fire-plugs: 74.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1879; two plain and solid plungers, 14 inches diameter, 30 inches stroke, 10 strokes per minute; pump-barrel, 14 by 36 inches.
Time pump is run: Constantly.
Time spent in repairs: 7 days per year.
Description of force-main: 300 feet long, 10 inches diameter, 40 to 45 pounds pressure on pump.
Description of water-valves: Hinge or gate, 10 degrees from horizontal; size, 19 by 5 inches; 11 inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 18 feet long, 5 feet diameter; evaporation, 2,100 pounds water per hour with 250 pounds coal.
Description of engine: Non-condensing or condensing; 26 inches diameter, 30 inches stroke, 20 strokes per minute; throttle-valve; horizontal air-pump, 9 by 19; Holly condenser.
Cost of engine and pump: $45,000.
Duty of engine: 75,000 gallons of water, daily; 2,000,000 gallons guaranteed.
Disadvantage of pumping direct into main: Not economical, either in labor or fuel.

MASSACHUSETTS.

TAUNTON:
Population: 21,213 inhabitants.
Name of corporation: Taunton Water-Works (municipal).
Water obtained from: Taunton river.
Water first introduced: December, 1876.
Sizes of distributing mains: 20, 16, 12, 10, 8, 6, and 4 inches.
Available head: 80 feet.
Total length of distributing mains: 35 miles.
Number of water-takers: 1,800.
Consumption of water: 1,500 gallons per day (exact).
First cost of water-works: $850,000.
Average annual cost of maintenance and repairs: About $9,000.
Filtering system: Old basin is a canal 400 feet long, 100 feet wide on top; inner slope, 2 to 1; bottom 8 feet below mean water-mark. New basin is an egg-shaped conduit, laid along river, distant 30 feet; supplied by driven wells; bricks laid in hydraulic cement, with end-joints left open and un cemented material, gravel.

TAUNTON—Continued.
Number of fire-plugs: 369.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 plain plungers, 9½ inches diameter, 24 inches stroke; strokes per minute according to demand; pump-barrel, 9½ inches diameter.
Time pumps are run: Constantly.
Description of water-valves: Cylindrical; plungs, iron stems, covered with lead, 1 ½ inch diameter, ½ inch lift.
Kind of power used: Steam.
Description of boilers: Three tubular, 16 feet long, 60 inches diameter; 54 inches, 21 inches diameter; 80 pounds pressure; fuel, Hazleton Lehigh egg coal.
Description of engine: Compound, 14 inches diameter, 24 inches stroke. Two rotary pumps, 20½ inches diameter, 20 inches stroke; strokes per minute variable.
Cost of engine and pumps: $69,000.
Duty of engine: 37,311,624 foot-pounds daily; 40,000,000 foot-pounds guaranteed.
Advantage of pumping direct into mains: Very best protection against fire. Extraordinary power can be had almost instantly.

MICHIGAN.

ALLEGAN:
Population: 2,305 inhabitants.
Style of corporation: Municipal.
Water obtained from: Wells.
Water first introduced: In 1871.
Description of main conduit: 12 and 4 inches diameter.
Sizes of distributing mains: 12 to 4 inches.
Available head: 60 feet (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 150.
Consumption of water: 43,000 gallons per day (exact).
First cost of water-works: $60,000.
Average annual cost of maintenance and repairs: $1,500.
Number of fire-plugs: 20.
Design of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; rotary pump, 60 strokes per minute.
Time pump is run: Constantly.
Kind of power used: Water.
Description of water-wheels: Two Holly turbines, 8 feet head, 30 revolutions per minute.
Cost of engine and pump: $12,000.
Advantage of pumping direct into mains: Keeps pressure on.

ALPENA:
Population: 6,153 inhabitants.
Name of corporation: Alpena City Water-Works (private).
Water obtained from: Lake Huron.
Water first introduced: October, 1879.
Description of main conduit: Wood.
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 50,419 feet.
Number of water-takers: 350.
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $3,000.
Number of fire-plugs: 20.
Time pump is run: Constantly.
Time spent in repairs: None.
Kind of power used: Water.
Description of water-wheels: One 56-inch and one 84-inch Leffel; one duplex pump, 9 by 9 by 18 inches; two Holly rotary No. 10.

BAY CITY:
Population: 20,023 inhabitants.
Style of corporation: Municipal.
Water obtained from: Saginaw bay.
Water first introduced: December, 1872.
BAY CITY—Continued.
Description of main conduit: 4,416 miles long, 30 and 18 inches diameter; wooden staves, 3 inches thick, banded together every 2 feet with elm bands, laid in lengths of 8 feet.
Discharging capacity: 5,000,000 gallons in 24 hours; head, 10 foot (average).
Sizes of distributing mains: 16, 12, 10, 8, 6, and 4 inches. Available head: About 60 feet (average).
Total length of distributing mains: 1½ miles.
Number of water-takers: 200.
Consumption of water: 3,265,000 gallons per day (exact).
The first cost of water-works: $935,000.
Average annual cost of maintenance and repairs: $10,000.
Number of fire-plugs: 133.
Design and dimensions of pumps and water-plungers: Made by Holly Manufacturing Company, Lockport, New York, in 1872: 4 double-acting pistons, 9 inches diameter, 24 inches stroke, 30 strokes per minute; pump-barrel, 9 by 24 inches, two rotors; 40 pounds pressure on pumps.
Time pumps are run: Constantly.
Description of water-valves: Hinged, packed with leather, 6 by 10 inches.
Kind of power used: Steam.
Description of boilers: Horizontal tubular, 16 feet long, 54 feet diameter, 70 pounds pressure; fuel, pine shingles.
Description of engines: Simple, compound condensing or non-condensing at will—14 by 24 inches, 140 strokes per minute; one high-pressure non-condensing, 18 and 28 inches, 330 strokes per minute; plain slide-valve, automatic cut-off, worked by cams; single-acting air-pump, 14 inches diameter, 54 inches stroke; jet-condenser.
Cost of engines and pumps: $99,000.
Duty of engines: 40,000,000 foot-pounds daily.
Advantage of pumping direct into mains: Control of pressure.

BIG RAPIDS:
Population: 3,553 inhabitants.
Name of corporation: Big Rapids Water-Works (municipal).
Water obtained from: Muskegon river.
Water first introduced: In 1871.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: Domestic purposes, 65 pounds pressure (average); fire purposes, 100 pounds pressure (average).
Total length of distributing mains: 34 miles.
Number of water-takers: 200.
Consumption of water: 2,245,000 gallons per month (estimated).
The first cost of water-works: $95,000.
Average annual cost of maintenance and repairs: $3,500.
Number of fire-plugs: 24.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; and two Blake (New York) plain plungers; 6 to 25 strokes per minute; pumps-barrels, Blakes, 14 by 16 inches and 10 to 12 inches.
Time pump is run: Constantly.
Description of water-valves: Rubber, 3 inches size, 4 inch lift.
Kind of power used: Steam.
Description of boilers: 10 feet long, 5 feet diameter; fuel, pine wood.
Description of engines: Holly compound, 10 inches diameter, 21 inches stroke; Ingers Blakes, 20 inches diameter, 24 inches stroke; small Blakes, 13 inches diameter, 14 inches stroke; 5 to 150 strokes per minute; D-valves; Holly af-pump.
Cost of engines and pump: $12,000.
Duty of engines: 8,000,000 gallons in 24 hours guaranteed.

CADILLAC:
Population: 2,613 inhabitants.
Name of corporation: Cadillac City Water-Works (private).
Water obtained from: Clam lake.

CADILLAC—Continued.
Total area of water-shed available: 200 square miles.
Water first introduced: In 1879.
Sizes of distributing mains: 6 and 4 inches.
Available head: 60 pounds (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 400.
The first cost of water-works: $15,000.
Average cost of maintenance and repairs: $1,010.
Number of fire-plugs: 14.
Design and dimensions of pump and water-plungers: Made by Dixon, Ferrisburg, Michigan, 1879: plain plungers, one 10 by 24 inches and one 6½ by 12 inches; small, 200 strokes per minute; large, 140 strokes per minute; pump-barrels, 6½ by 12 inches and 9 by 24 inches.
Time pump is run: Constantly.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Two tubular, 10 feet long, 44 inches diameter; 15 feet long, 56 inches diameter; fuel, wood.
Description of engines: Simple, non-condensing; one 18 by 94 inches and one 19 by 12 inches; 140 and 200 strokes per minute; one exhaust- and one slide-valve, operated by puppet-arm.
Cost of engines and pump: $2,000.

CONSTANTINE:
Population: 1,405 inhabitants.
Style of corporation: Municipal.
Water obtained from: Fawn river.
Water first introduced: In 1876.
Sizes of distributing mains: 10 inches.
Total length of distributing mains: 1 mile.
The first cost of water-works: $5,000.
Average annual cost of maintenance and repairs: About $60.
Number of fire-plugs: 7.
Design and dimensions of pump and water-plunger: Ferry pump, built at Ottter Iron Works, Ferrisburg, Michigan, in 1878; plunger, 9 inches diameter, 18 inches stroke, 80 strokes per minute; pump-barrel, 9 inches diameter.
Time pump is run: Constantly.
Description of force-main: 1 mile long, 10 inches diameter; head 30 feet on pump.
Description of water-valves: Common lap, 6 by 3 inches.
Kind of power used: Water.
Description of water-wheels: Two Lefol turbines, 36 and 42 inches diameter, 15 feet head, 120 revolutions per minute.

EAST SAGINAW:
Population: 10,016 inhabitants.
Name of corporation: East Saginaw Water-Works (municipal).
Water obtained from: Saginaw river.
Water first introduced: January, 1871.
Description of main conduit: 565 feet long, 30 inches diameter; wood.
Sizes of distributing mains: 16 to 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 21½ miles.
Number of water-takers: 800.
Consumption of water: 72 gallons per head per day (estimated).
The first cost of water-works: $300,000.
Average annual cost of maintenance and repairs: $8,571.
Number of fire-plugs: 140.
Design and dimensions of pump and water-plunger: Made by Holly Manufacturing Company, Lockport, New York; 4 plain plungers, 8 inches diameter, 24 inches stroke, 30 strokes per minute; pump-barrel, 21 by 9 inches.
Time pump is run: Constantly.
Description of water-valves: Leather, 5 by 9 inches, 2 inches lift.
Kind of power used: Steam.
Description of boilers: Three horizontal, 10 feet long, 5 feet diameter; 58 sides, 34 inches diameter.
PUMPING DIRECT INTO DISTRIBUTING MAINS.

EAST SAGINAW—Continued.
Description of engines: Two pair, double-cylinder, condensing, 21 strokes per minute; slide-valves operated by eccentric; one Holly rotary, 150 horse-power.
Cost of pump and engines: $32,000.

HOLLY:
Population: 1,448 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mill-pond and Shiawassee river.
Water first introduced: In 1869.
Sizes of distributing mains: 6 and 8 inches.
Total length of distributing mains: About 2 miles.
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: $1,900.
Number of fire-plugs: 16.
Design and dimensions of pump and water-plungers: Pattee & Perkins patent, Sterling, Illinois; two plain plungers, 7 inches diameter, 10 inches stroke, 100 strokes per minute; pump-barrel, 12 inches diameter.
Time pump is run: Constantly.
Kind of power used: Steam.
Description of water-valves: Rubber.

JACKSON:
Population: 16,105 inhabitants.
Name of corporation: Jackson City Water-Works (municipal).
Water obtained from: Artesian wells.
Water first introduced: In 1870.
Sizes of distributing mains: 16, 12, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 12 miles.
Number of water-takers: About 600.
Consumption of water: 722,000 gallons per day (estimated).
First cost of water-works: $140,000.
Average annual cost of maintenance and repairs: $6,600.
Number of fire-plugs: 11.
Design and dimensions of pump and water-plungers: Two rotary and piston, made by Holly Manufacturing Company, Lockport, New York, in 1870-72; two piston plungers, 27 by 10 inches, 30 strokes per minute; pump-barrel, 10 inches diameter.
Time pumps are run: Constantly.
Description of force-main: 12 miles long, 15 to 4 inches diameter; head, 115 feet on pumps.
Description of water-valves: Flat, 44 by 10 inches, 3/4 inch life.
Kind of power used: Steam.
Description of boilers: Tubular, 14 feet long, 5 feet diameter; fuel, bituminous coal.
Description of engines: Two condensing, 10 inches diameter, 27 inches stroke, 100 strokes per minute; common slide-valves, with poppet cut-off; simple acting air-pump, 14 inches stroke, half of area of cylinder; one rotary 150 horse-power.
Cost of engines and pumps: $40,000.
Duty of engines: 15,021,400 feet-pounds daily.

MUSKEGON:
Population: 11,263 inhabitants.
Name of corporation: Muskegon City Water-Works (municipal).
Water obtained from: Springs.
Total area of water-works available: 30 acres.
Capacity of reservoirs: 5,000,000 gallons.
Water first introduced: In 1875.
Sizes of distributing mains: 10, 12, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 15 miles.
Number of water-takers: 463.
Consumption of water: 70 gallons per head per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $1,000.
Number of fire-plugs: 16.
Design and dimensions of pump and water-plungers: Plunger, made at Vergennes, Vermont; two sets plain double plungers, 14 by 20 inches, 8 to 34 strokes per minute.
Time pump is run: Constantly.
Time spent in repairs: 80 hours per year.
Description of force-main: 2,115 feet long, 16 inches diameter, 40 to 70 pounds pressure on pump.
Description of water-valves: Hard rubber, 6 inches.
Kind of power used: Steam.
Description of boilers: Two tubular, 10 feet long, 6 inches diameter, 70 pounds pressure; fuel, pine slabs.
Description of engines: Simple; 10 by 32 inches, 94 to 192 strokes per minute; globe-valves.
Cost of pump and engine: $27,000.
Remark: Only trouble is from vegetable matter in reservoir.

POINT PIROUX:
Population: 8,681 inhabitants.
Style of corporation: Municipal.
Water obtained from: Saint Clair river.
Water first introduced: In 1873.
Sizes of distributing mains: 10 to 2 inches.
Available head: 70 feet (average).
Total length of distributing mains: 18 miles.
Number of water-takers: About 1,000.
Consumption of water: 500,000 gallons per day (estimated).
First cost of water-works: $170,000.
Average annual cost of maintenance and repairs: About $8,500.
Number of fire-plugs: 105.
Design and dimensions of pump and water-plungers: Made by Holly Manufacturing Company, Lockport, New York; 4 plain plungers, 8 inches diameter, 24 inches stroke, 18 strokes per minute; pump-barrel, 0 by 24 inches.

741
WATER-SUPPLY OF CITIES.

MANKATO—Continued.

First cost of water-works: $15,047 67.
Average annual cost of maintenance and repairs: $3,500.
Number of fire-plugs: 30.
Design and dimensions of pump and water-plungers: One
Knowles, made at Warren, Massachusetts; one plain plunger,
1 to 175 strokes per minute; pump-barrel, 12 by 40 inches.

PORT HURON—Continued.

Time pumps are run: Constantly.
Description of force-main: 20 pounds pressure on pumps.
Description of water-valves: Leather hinge, 3 by 7 inches.
Kind of power used: Steam.
Description of boilers: Two tubular, 16 feet long, 5 feet di-
ameter; 72 tubes, 4 inches each; 35 pounds pressure; fuel,
bituminous coal.

Description of engines: Condensing or compound, at will; 4
cylinders, 14 by 24 inches, each, 60 strokes per minute; slide-
valves with variable cut-off; common bucket air-pump, 14
by 16 inches; jet-condenser.

Cost of engine and pump: $95,000.

SAKINAW:

Population: 10,535 inhabitants.
Name of corporation: Sakina Water-Works (municipal).
Water first introduced: In 1872.
Size of distributing mains: 16, 10, 6, 6, and 4 inches.

Available head: 45 pounds (average).
Total length of distributing mains: 84 miles.
Number of water-takers: 250.
Consumption of water: 1,500,000 gallons per day (estimated).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $8,500.
Number of fire-plugs: 104.
Design and dimensions of pumps and water-plungers: Made by
Holly Manufacturing Company, Lockport, New York; 4
plain piston-plungers, 9 inches diameter, 24 inches stroke,
18 to 60 strokes per minute; pump-barrel, 9 by 24 inches,
double-acting; two rotary pumps No. 10.

Time pumps are run: Constantly.
Description of water-valves: Ninga, with leather, 10 to 8-
inch long, 4 inches wide, 1 inch lift.

Kind of power used: Steam.

Description of boilers: Two tubular, 16 feet long, 5 feet di-
ameter, 70 pounds pressure; fuel, wood.

Description of engines: Compound condensing, 14 by 24 inches
4 cylinder, slide-valves, rock-shaft; single air-pump; jet
condenser; one rotary engine.

Cost of engines and pumps: $13,000.

SAINT LOUIS:

Population: 1,975 inhabitants.
Style of corporation: Municipal.
Water obtained from: Pino river.
Character and dimensions of dam: 600 feet long, running ob-
liquely across Pino river.

Water first introduced: In 1893.

Sizes of distributing mains: 8, 6, and 4 inches.

Total length of distributing mains: 14 mile.
Number of water-takers: 69.
First cost of water-works: $7,500.
Average annual cost of maintenance and repairs: $50.

Number of fire-plugs: 23.

Time pumps are run: Steam 2 months, water 10 months per
year.

Kind of power used: Steam and water.

Cost of engine and pumps: Steam $2,000, water $500.

MINNESOTA.

MANKATO:

Population: 5,500 inhabitants.
Name of corporation: Mankato Water-Works (municipal).
Water obtained from: Minnesota river.

Total area of water-sheer available: About 5,000 square miles.

Water first introduced: September, 1879.

Description of main conduits: 453 feet long, 12 inches di-
ameter; iron.
Sizes of distributing mains: 19, 10, 8, 6, and 4 inches.

Available head: 40 pounds, or 92 feet (average).

Total length of distributing mains: 13,575 feet.

Number of water-takers: 6.

MINNEAPOLIS:

Population: 46,687 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mississippi river.

Capacity of reservoir: 19,588 gallons.

Cost of dams: $88,000.

Water first introduced: In 1877.

Sizes of distributing mains: 2 to 16 inches.

Available head: 40 pounds (average).

Total length of distributing mains: 82 miles.

Number of water-takers: 1,300.

Consumption of water: 3,500,000 gallons per day (exact).

First cost of water-works: $450,000.

Average annual cost of maintenance and repairs: $11,000.

Number of fire-plugs: 208.

Design and dimensions of pumps and water-plungers: No. 1
James Waters, built by Charles M. Hardenburg, Minneapolis,
Minnesota; double-acting plunger with low piston, 8 inches
diameter, 24 inches stroke, 60 strokes per minute; pump-
barrel, 9 by 60 inches. Nos. 2 and 3, built by Holly Manufact-
uring Company, Lockport, New York; double-acting plunger,
with low piston, 16 inches diameter, 24 inches stroke, 30
strokes per minute; pump-barrels, 16 by 60 inches.

Time pumps are run: 5,500 hours per year.

Time spent in repair: 410 hours per year.

Description of force-main: 16 inches diameter.

Description of water-valves: Rubber, 5 by 4 inches, 4 inch
lift.

Kind of power used: Water.

Description of water-wheels: Two American turbines, 48
inches diameter, 31 feet head, 120 revolutions per minute;
10.75 gallons of water required to lift 1 gallon.

NEW JERSEY.

RAILWAY:

Population: 6,455 inhabitants.
Name of corporation: Railway Water-Works (municipal).
Water obtained from: North branch of railway river.

Total area of water-sheer available: About 30 square miles.

Water first introduced: In 1872.

Sizes of distributing mains: 14 to 6 inches.

Available head: 120 feet (average).

Total length of distributing mains: About 5 miles.

Number of water-takers: 700.

Consumption of water: 500,000 gallons per day (average).

First cost of water-works: $135,000.

Average annual cost of maintenance and repairs: $5,500.

Filtering apparatus: Clerk filter, 10 feet square; sand, 6 inches
depth, on fine wire-cloth; cleaned once in 24 hours.

Number of fire-plugs: 130.

Design and dimensions of pumps and water-plungers: Two
 duplex Worthington, New York, 1872; plain plungers, 10
and 14 inches diameter, 24 inches stroke, 92 strokes per minute
(average), or 7 counter-strokes; pump-barrel, 5 feet by 18
inches.
PUMPING DIRECT INTO DISTRIBUTING MAINS.

RAILWAY—Continued.

Time pumps are run: One always in motion, 45 pounds pressure on pumps (average).
Time spent in repairs: 600 hours per year.
Kind of power used: Steam.
Description of boiler: Tubular, 16 feet long, 5 feet diameter, 50 pounds pressure; 10 pounds water to 1 pound coal; fuel, extra good pea coal.
Description of engine: Compound high-pressure cylinder 20 inches diameter, low-pressure cylinder 33 inches diameter, 24 inches stroke; average, 7 counter-strokes per minute; slide-valve worked by opposite piston; 2 air-pumps, single; capacity, 2, of cylinder; jet-condenser, capacity, 1, of cylinder.
Duty of engine: Average 30,000,000 foot-pounds daily.
Remarks: The advantage of pumping direct into mains is that it saves expense of reservoirs and long conduits; also fire apparatus.—Water generally good; in spring polluted by refuse of fall factory above, also dead vegetable matter.

NEW YORK.

AUBURN:
Population: 21,924 inhabitants.
Name of corporation: The Auburn Water-Works Company (private).
Water obtained from: Owasco lake.
Total area of water-shed available: 100,000 acres.
Water first introduced: In 1886.
Size of distributing mains: 18 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 23 miles.
Number of water-tanks: 1,000.
Consumption of water: 87 gallons per head per day (estimated).
First cost of water-works: $475,000.
Number of fire-plugs: 550.
Time pumps are run: Constantly.
Description of force-main: 3 miles long, 18 inches diameter.
Kind of power used: Steam and water.
Description of water-wheels: Two American turbines, 64 and 68 inches diameter; head, 16 feet (maximum). One Holly turbine, 68 inches diameter; head, 12 feet (average).
Description of boilers: One tubular upright, 7 feet diameter; one horizontal, 5 feet diameter; 60 pounds pressure.
Description of engines: Four Holly; cylinders, 14 x 18 inches; can be changed to high-pressure or compound at will; Buckley condenser.
Duty of engines: 60,000,000 foot-pounds daily.

BATAVIA:
Population: 4,848 inhabitants.
Style of corporation: Municipal.
Water obtained from: Tonawanda creek.
Total area of water-shed available: 20 square miles.
Character and dimensions of dam: Mill-dam, 59 feet wide, 14 feet high.
Cost of dam: It is owned by Batavia Mills; water supplied at $1,000 per year for ten years.
Water first introduced: In 1874.
Size of distributing mains: 8 inches.
Total length of distributing mains: About 2 miles.
Consumption of water: 4,000 gallons per day (estimated).
First cost of water-works: $28,000.
Average annual cost of maintenance and repairs: $1,000.
Number of fire-plugs: 41.
Time pumps are run: 3 hours per week.
Kind of power used: Steam and water.
Description of water-wheel: Ordinary mill-wheel.

COLLEGE POINT—Continued.
Total area of water-shed available: 94 square miles.
Capacity of reservoir: 2,500,000 gallons, fed by springs.
Cost of dam: $18,000.
Water first introduced: January, 1875.
Description of main conduit: 40 feet long, 8 feet diameter; brick and plank bed bottom.
Sizes of distributing mains: 12, 10, 8, and 6 inches.
Available head: 50 pounds, or 133 feet (average).
Total length of distributing mains: 12.8 miles.
Number of water-tanks: 410.
Consumption of water: 364,602 gallons per day, or 81 gallons per head (estimated).
First cost of water-works: $512,500.
Average annual cost of maintenance and repairs: $6,000.
Filtering apparatus: 3 gradated galvanized-iron screens.
Number of fire-plugs: 55.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York, in 1874; plain plungers, 13 and 14 inches diameter, 24 inches stroke, 8 strokes per minute.
Time pump is run: Constantly.
Time spent in repairs: 2 hours per day per year.
Description of force-main: 24,747 feet long, 13 inches diameter, 50 pounds pressure on pump.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Two tubular flue, 15 feet long, 50 inches diameter, 50 pounds pressure; fuel, Lehigh egg coal.
Description of engine: One compound high-pressure cylinder, 172 inches diameter; low-pressure cylinder, 34 inches diameter, 84 inches stroke; one high-pressure, 30 inches diameter, 18 inches stroke; 18 strokes per minute each; ordinary slide-valves, worked by piston-rod; 12 air-pumps, and tank for steam.
Cost of engine and pump: $17,500.
Duty of engines: 37,836,900 foot-pounds daily; 63,927,100 foot-pounds guaranteed.
Remark: A gradual accumulation of silt matter in hot months.

COOPERTOWN:
Population: 2,119 inhabitants.
Name of corporation: Cooperstown Aqueduct Association (private).
Water obtained from: Otsego lake.
Total area of water-shed available: About 60 square miles.
Area and capacity of reservoir: 15 square miles, 40 feet deep (average).
Water first introduced: In 1885.
Description of main conduit: 4,300 feet long, 10 inches diameter; cast iron.
Sizes of distributing mains: 6, 8, and 4 inches.
Available head: 45 to 70 feet.
Consumption of water: 60 gallons per head per day (domestic); 100 gallons per minute for fire.
Average annual cost of maintenance and repairs: $400.
Number of fire-plugs: 35.
Design and dimensions of pumps and water-plungers: Two built by H. R. Worthington, New York, in 1885; direct double-acting, 4 cylinders, 24 inches diameter, 10½ inches stroke.
Time pumps are run: Constantly.
Description of force-main: 40 to 100 pounds pressure on pumps.
Description of water-valves: Rubber, 1 inch lift.
Kind of power used: Water.
Description of water-wheels: Two 60-inch Leffel turbines, direct double-acting, special, 7 feet head, 90 revolutions per minute.
Cost of engine and pump: $4,000.

DUNKIRK:
Name of corporation: Dunkirk Water-Works (municipal).
Water obtained from: Fresh Meadow springs.

743
DUNES—Continued.

Water obtained from: Lake Erie.
Water first introduced: July, 1872.
Description of main conduit: 600 feet long, 12 inches diameter; iron, extending into lake with 40 square feet crib at end, made of wood.
Discharging capacity: 2,500,000 gallons.
Sizes of distributing mains: 12 to 3 inches.
Available head: 100 feet (average).
Total length of distributing mains: About 14 miles.
Number of water-takers: 999.
Consumption of water: 1,000,000 gallons per day (estimated).
First cost of water-works: $107,000.
Average annual cost of maintenance and repairs: $6,000.
Number of fire-plugs: 80.
Design and dimensions of pumps and water-plungers: Built by Holly Manufacturing Company, Lockport, New York; 4 plain piston, 94 inches diameter, 24 inches stroke, 24 strokes per minute; pump-barrel, 94 by 24 inches; two rotary pumps.
Time pumps are run: Constantly.
Description of main conduit: 14 miles long, 47.64 pounds pressure on pumps.
Description of water-valves: Leather hinge, 10 by 5 inches, 3 inches lift.
Kind of power used: Steam.
Description of boilers: Return tubular, 16 feet long, 60 inches diameter; 7 pounds of water to 1 pound coal, 45 pounds pressure; fuel, slack coal.
Description of engine: Non-condensing, 14 by 24 inches, 48 strokes per minute; slide-valve operated by eccentric from shaft.
Cost of pumps and engine: $45,000.
Duty of engine: 50,000,000 foot-pounds daily.

GARDIN CITY:
Population: 574 inhabitants.
Water obtained from: Well.
Total area of water-logged available: About 50 square miles.
Number of water-takers: 125.
Consumption of water: 500,000 gallons per day (estimated).
Average annual cost of maintenance and repairs: About $2,000.
Number of fire-plugs: 25.
Description of water-valves: Solid rubber, 1 3/4 inches diameter, 3 inches lift.
Kind of power used: Steam.
Description of boilers: Plain cylinder, 35 pounds pressure; fuel, white ash coal, grate size.
Description of engine: 20 strokes per minute; slide-valve operated by eccentric; Holly air-pump and condenser.
Cost of engine and pump: About $45,000.

GOUVERNEUR—Continued.
Average annual cost of maintenance and repairs: $500.
Number of fire-plugs: 14.
Design and dimensions of pump and water-plungers: Green rotary, built by Bailey & Sewall, Watertown, New York; 100 to 175 strokes per minute; pump-barrels, 15 and 18 inches diameter.
Time pump is run: Constantly.
Water spent in repairs: 304 hours per year.
Description of force-main: 32 pounds pressure on pump.
Description of water-valves: Slide and tumblers.
Kind of power used: Water.
Description of water-wheels: One Holly and one Weaver turbine; 7 to 9 revolutions per minute.
Remarks: The disadvantage of pumping direct into mains is that when pressure is used for fire purposes it is felt by all dwellings.

JORDAN:
Population: 1,344 inhabitants.
Name of corporation: S. L. Rockwell & Co. (private).
Water obtained from: Skaneateles outlet.
Water first introduced: In 1886.
Description of main conduit: 2,300 feet long, 3 1/2 inches diameter; wrought iron.
Size of distributing mains: 3 1/2 inches.
Total length of distributing mains: 2,300 feet.
First cost of water-works: $2,000.
Number of fire-plugs: 4.
Design and dimensions of pump and water-plunger: Built by S. Button & Son, Watertown, New York, in 1848; one plain plunger, 6 inches diameter, 6 inches stroke, 200 strokes per minute; pump-barrel, 6 by 6 inches.
Description of water-valves: Plain brass.
Kind of power used: Water.
Description of water-wheels: One Bodine-Jouville turbine, 40 inches diameter, 10 feet head, 114 revolutions per minute.
Remarks: Water used only for fire purposes.

LOCKPORT:
Population: 13,234 inhabitants.
Name of corporation: No specific name; the Holly Manufacturing Company owns the machinery and the city owns the pipes.
Water obtained from: Erie canal.
Water first introduced: In 1880.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 250 feet on pumps, 150 feet on distribution (average).
Total length of distributing mains: About 7 miles.
Number of water-takers: 430.
Consumption of water: 80 gallons per head (estimated).
Average annual cost of maintenance and repairs: About $2,000.
Number of fire-plugs: 110.
Design and dimensions of pump and water-plungers: Built by Holly Manufacturing Company, Lockport, New York; in 1871; 4 plain plungers, 9 inches diameter, 20 to 60 strokes per minute; pump-barrel, 9 by 24 inches.
Time pump is run: Constantly.
Description of force-main: 12 inches diameter, 100 to 140 pounds pressure on pump.
Description of water-valves: Plain hing-valves, faced with leather.
Kind of power used: Water.
Description of water-wheels: American turbine, 48 inches diameter, made by Stout, Mills & Temple, Dayton, Ohio; 50 feet head; revolutions, according to consumption.
Cost of engine and pump: $10,000.
Remarks: The advantage of pumping direct into mains consists in this, that the head can be varied to meet demand.—Water is unfit for domestic use, owing to impurities resulting from seawage.
**PUMPING DIRECT INTO DISTRIBUTING MAINS.**

**LONG ISLAND CITY:**
- Population: 17,192 inhabitants.
- Name of corporation: Long Island City Water Company (municipal).
- Water obtained from: Driven wells.
- Water first introduced: In 1876.
- Description of main conduit: 16 inches diameter; cast iron.
- Sizes of distributing mains: 12, 18, 10, 8, and 6 inches.
- Available head: 40 pounds (average); water-supply deficient.
- Total length of distributing mains: 14 miles.
- Number of water-takers: 851.
- Consumption of water: About 1,250,000 gallons per day (estimated).
- First cost of water-works: $200,000.
- Average annual cost of maintenance and repairs: $10,000.
- Time pumps are run: Constantly.
- Kind of power used: Steam.
- Remarks: The advantage of pumping direct into mains is that the force can be increased to meet the wants of extinguishing fires without steam or hand fire-engines.

**NIAGARA FALLS:**
- Population: 3,320 inhabitants.
- Name of corporation: Niagara Falls Water Works Company (private).
- Water obtained from: Niagara river.
- Cost of main: Water-works to point of distribution owned by Suspension Bridge Water-Works Company.
- Water first introduced: July, 1877.
- Sizes of distributing mains: 10 to 4 inches.
- Available head: 70 pounds (average).
- Total length of distributing mains: 5 miles.
- Consumption of water: 1,000,000 gallons per day (estimated).
- First cost of water-works: $30,000.
- Average annual cost of maintenance and repairs: $100.
- Number of fire-plugs: 31.
- Kind of power used: Water.
- Remarks: The advantage of pumping direct into mains is economy; the disadvantage, that supply ceases when pumps stop for repairs.

**OGDENSBURG:**
- Population: 10,341 inhabitants.
- Name of corporation: Ogdensburg Water-Works (municipal).
- Water obtained from: Oswegatchie river.
- Water first introduced: November, 1898.
- Sizes of distributing mains: 10, 12, 14, 6, 4, and 3 inches.
- Available head: 40 pounds (average).
- Total length of distributing mains: 14 miles.
- Number of water-takers: 106.
- Consumption of water: 1,000,000 gallons per day (exact).
- First cost of water-works: $115,000.
- Average annual cost of maintenance and repairs: Extension, $6,400; materials, $176, 62.
- Number of fire-plugs: 32.
- Design and dimensions of pumps and water-plungers: One Lang, built at Burlington, Vermont; one Flanders, built at Vergennes, Vermont; two plain plungers to each pump; one 14 inches diameter, 30 strokes; one 14 inches diameter, 28 inches diameter, 28 strokes per minute; pump-barrel, 14 inches diameter; total capacity, 5,000,000 gallons. Fire pumps are run: Constantly.
- Description of force-main: 40 pounds pressure on pumps.
- Description of water-valves: Rubber disks; Lang, 14 inches diameter; Flanders, 9 inches diameter; 1 inch lift (average).
- Kind of power used: Steam and water.
- Description of water-wheels: Two Holly turbines, 72 inches diameter; one Gates-Curtis turbine, 56 inches diameter; 4 to 13 feet head (dissipating); 40 to 75 revolutions per minute.
- Description of boilers: Marine return-flue; fuel, bituminous coal.

**OLDENBURG—Continued.**
- Description of engine: Non-condensing, 16 inches diameter, 36 inches strokes, 45 strokes per minute; slide-valves operated by eccentric on crank-shaft, with graduating out on main-valve driven by eccentric.
- Cost of engine and pumps: $15,000.
- Remarks: The advantage of pumping direct into mains is that but 40 pounds pressure are maintained under ordinary circumstances.

**OLMAN:**
- Population: 3,036 inhabitants.
- Name of corporation: Olmua Water Works (municipal).
- Water obtained from: Olean creek.
- Water first introduced: In 1877.
- Sizes of distributing mains: 6 and 4 inches.
- Total length of distributing mains: 3 miles.
- Consumption of water: 100,000 gallons per day.
- Average annual cost of maintenance and repairs: $1,500.
- Design and dimensions of pump and water-plunger: Built by W. H. Kelly, New Brunswick, New Jersey; plain plunger, 8 inches diameter, 75 strokes per minute; pump-barrel, 6 inches diameter.
- Time pump is run: Constantly.
- Description of force-main: 50 pounds pressure on pump.
- Description of water-valves: Metallic; seat, rubber.
- Kind of power used: Steam.
- Description of boiler: Two, 11 feet long, 40 inches diameter; fuel, soft coal.
- Description of engine: Simple; cylinder, 12 inches diameter, 150 strokes per minute.
- Cost of engine and pump: $1,500.

**POTTSBAM:**
- Population: 2,762 inhabitants.
- Style of corporation: Municipal.
- Water obtained from: Roched river.
- Character and dimensions of dams: Two, wooden; 100 feet long each.
- Water first introduced: In 1871.
- Sizes of distributing mains: 6, 4, and 4 inches.
- Available head: 75 feet (average).
- Total length of distributing mains: About 2 miles.
- Number of water-takers: 108.
- Consumption of water: 30 gallons per head per day (estimated).
- First cost of water-works: $50,000.
- Average annual cost of maintenance and repairs: $305.
- Filtering apparatus: Wooden well, about 50 feet square; small stone and gravel; cleaned three times a year.
- Number of fire-plugs: 32.
- Design and dimensions of pump and water-plunger: Built by Holly Manufacturing Company, Lockport, New York; in 1871; also No. 6; 30 revolutions per minute; pump-barrel, 12 by 14 inches; head, 75 feet (average) on pump.
- Time pump is run: Constantly.
- Time spent in repairs: About 200 hours per year.
- Description of water-valves: Flap; size, 9 inches; lift, 300.
- Kind of power used: Water.
- Description of water-wheels: One Holly turbine, 7 feet diameter, drawing 1,500 inches water; one American turbine, 48 inches diameter, drawing 325 inches water; about 0 feet head.
- Cost of engines and pump: $10,000.

**SARATOGA SPRINGS:**
- Population: 8,421 inhabitants.
- Style of corporation: Municipal.
- Water obtained from: Creek and springs.
- Area and capacity of reservoir: Lake, 108 acres; average depth, 18 feet.
- Cost of dam: About $80,000.
- Water first introduced: July, 1871.
- Description of main conduit: 500 feet long, 3 foot diameter, brick; 300 feet long, wood; head, 8 feet.
- Sizes of distributing mains: 12 to 3 inches.
- Available head: 62 to 170 feet; water-supply deficient.
WATER-SUPPLY OF CITIES.

SARATOGA SPRINGS—Continued.

Total length of distributing mains: 17444 miles.
Number of water-takers: 1,346.

Consumption of water: 117 gallons per head per day (exact).
First cost of water-works: $250,000.
Average annual cost of maintenance and repairs: $7,368 07.
Number of fire-plugs: 133.

Design and dimensions of pump and water-plungers: Built by Holly Manufacturing Company, Lockport, New York, in 1870-71; plain piston-plunger; square rubber packing; 8 to 20 strokes per minute; pump-barrel, 10 by 24 inches.

Time pump is run: Constantly.

Description of force-main: 9,078 feet long, 12 inches diameter, 172 to 184 feet head on pump.

Description of water-valves: Leather hinge, iron shod; 9 by 3/4 inches size, 14 inch lift.

Kind of power used: Steam and water.

Description of water-wheels: Two Lefol turbins, 36 and 6 inches diameter, 50 feet head.

Description of boilers: One double return-flue, one marine and one upright flue, fuel, Scott's grate coal.

Description of engines: Condensing or high-pressure, at will, 14 inches diameter, 24 inches stroke, 20 to 50 strokes per minute; balanced lif-valve, worked by cans, governed by water in pipes; 2 air-pumps, 10 inches diameter, 14 inches stroke; jet-condenser.

Cost of engine and pump: $40,000.

Duty of engines: 25,000,000 to 50,000,000 foot-pounds daily.

Remark: The advantage of pumping direct into mains is economy.—In hot weather a green vegetable growth pollutes the water.

Schenectady.

Population: 13,935 inhabitants.

Name of corporation: Schenectady Water Company (private).
Water obtained from: Mohawk river.

Character and dimensions of dam: 20 feet from river, 114 feet long, 10 feet wide, 18 feet deep, arched with brick to keep out surface-water.

Water first introduced: September, 1872.

Description of main conduit: 11 miles long, 12, 10, 8, 6, and 4 inches diameter; head, 140 feet (average).

Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.

Available head: 60 to 80 pounds.

Total length of distributing mains: 11 miles.

Number of water-takers: 411.

Consumption of water: 80 gallons per head per day (estimated).

First cost of water-works: $115,000.

Average annual cost of maintenance and repairs: $7,000.

Filtering apparatus: Well, 114 by 0 feet; coarse sand and gravel.

Number of fire-plugs: 123.

Design and dimensions of pumps and water-plungers: Six, built by Holly Manufacturing Company, Lockport, New York; 12 inches diameter, 12 inches stroke, 12 to 20 strokes per minute; pump-barrel, 10 by 15 inches.

Time pumps are run: Constantly.

Description of force-main: 11 miles long, 75 pounds pressure on pumps.

Description of water-valves: Brass; 7 by 4 inches size, 24 inches lift.

Kind of power used: Steam.

Description of boilers: One upright flue, one locomotive, 150 horse-power each; fuel, anthracite coal.

Description of engines: Condensing or non-condensing; 16 by 24 inches, 15 to 25 strokes per minute; plain D-valves, automatic cut-off.

Cost of engine and pumps: $20,000.

DAYTON—Continued.

Water obtained from: Wells.
Water first introduced: In 1879.

Sizes of distributing mains: 20, 16, 12, 10, 8, 6, 4, 3, and 2 inches.

Total length of distributing mains: 32444 miles.

Consumption of water: 1,000,000 gallons per day (estimated).

First cost of water-works: $355,000.

Average annual cost of maintenance and repairs: $16,000.

Filtering system: A tunnel 300 feet long, 20 feet below surface of ground.

Number of fire-plugs: 261.

Design and dimensions of pumps and water-plungers: Made by Holly, in 1870; pump-barrels, 12 by 28 inches.

Description of force-main: 4,410 feet long, 20 inches diameter, and 100 feet long, 12 inches diameter; 50 pounds pressure on pumps.

Kind of power used: Steam.

POCKETS.

Population: 8,827 inhabitants.

Name of corporation: City Water-Works (municipal).
Water obtained from: Ohio river.
Water first introduced: July, 1873.

Sizes of distributing mains: 12 to 4 inches.

Available head: 30 pounds (average).

Total length of distributing mains: About 8 miles.

Number of water-takers: 800.

Consumption of water: 650,000 gallons per day (estimated).

First cost of water-works: $175,000.

Number of fire-plugs: 114.

Design and dimensions of pumps and water-plungers: Six bucket-plungers, 14 inches diameter, 14 inches stroke, 10 strokes per minute; pump-barrels, 14 inches diameter.

Time pump is run: Constantly.

Description of water-valves: Rubber, 12 inches, 1 inch lift.

Kind of power used: Steam.

Description of boilers: Tubular, 16 feet long, 5 inches diameter; fuel, bituminous coal.

Description of engines: Two non-condensing, 14 inches diameter, 24 inches stroke, 20 strokes per minute; slide-valve with cut-off.

Cost of engines and pump: $35,000.

Duty of engines: 2,600,000 gallons in 24 hours guaranteed.

Remarks: The disadvantage of pumping direct into main is muddy water sometimes; the river brings down leaves and drift-wood, which are an annoyance in pumping.

MANSFIELD.

Population: 9,659 inhabitants.

Name of corporation: Mansfield Water-Works (municipal).
Water obtained from: Springs.
Water first introduced: August, 1872.

Sizes of distributing mains: 14, 12, 8, 6, 5, and 4 inches.

Available head: 60 pounds (average).

Total length of distributing mains: 15 miles.

Number of water-takers: 550.

Consumption of water: 50,000 gallons per day (estimated).

First cost of water-works: $175,000.

Average annual cost of maintenance and repairs: $7,000.

Number of fire-plugs: 100.


Time pump is run: Constantly.

Description of force-main: 2,888 feet long, 14 inches diameter, 80 pounds pressure on pump.

Description of water-valves: Brass, 4 by 11 inches, 14 inch lift.

Kind of power used: Steam.

Description of boilers: Three; 12 feet long, 60 inches diameter, 60 pounds pressure; fuel, slack coal; one boiler used at a time.

OHIO.

Population: 38,678 inhabitants.

Name of corporation: Dayton City Water-Works (municipal).

746
PUMPING DIRECT INTO DISTRIBUTING MAINS.

MANSTFELD—Continued.
Description of engine: Condensing and non-condensing; 2 cylinders, 14 inches diameter, 24 inches stroke, 24 strokes per minute; slide-valvo, puppet cut-off.
Cost of engine and pump: $92,000.
Remarks: The advantage of pumping direct into mains is great pressure for fire purposes.

NORMAUX:
Population: 6,704 inhabitants.
Name of corporation: Norwalk Water-Works (municipal).
Water obtained from: Huron river.
Character and dimensions of dam: Stone, 55 feet long; bottom 13 feet wide; top 2 feet 6 inches wide; laid in Portland cement; top stones clapped with 14 inch square iron.
Cost of dam: $3,400.
Water first introduced: In 1876.
Description of main conduit: 3 inches long; diameters, 10, 8, 6, 4, and 3 inches; cast iron; 75 pounds pressure (average).
Sizes of distributing mains: 10 to 3 inches.
Available head: 70 pounds (average).
Total length of distributing mains: 11 miles.
Number of water-takers: 660.
Consumption of water: 600,000 gallons per day (estimated).
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $4,500.
Number of fire-plugs: 94.
Design and dimensions of pump and water-plungers: Built by Worthington, New York; four plain plunger, 25 by 14 inches and 15 by 12 inches; 24 strokes per minute; pump-barrel, 22 inches long, 14 inches diameter.
Time pump is run: Constantly.
Description of force-main: 200 feet long, 175 pounds pressure on pump.
Description of water-valves: Rubber, 6 inches diameter, 14 inch lift.
Kind of power used: Steam.
Description of boilers: Holly, 16 feet long, 5 feet diameter, 44 pounds pressure; fuel, Anthracite coal.
Water obtained from: Well.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Design and dimensions of pumps and water-plungers: Built by Holly Manufacturing Company, Lockport, New York; 18 inch diameter, 2 feet stroke; 4 cylinders; 24 strokes per minute; slide-valve operated by eccentric; air-pump piston, with rubber valve; jet-condenser.
Cost of pump and engines: $13,000.

PORTSMOUTH:
Population: 11,291 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Ohio river.
Water first introduced: In 1871.
Discharging capacity of conduit: 650 gallons per minute.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 40 pounds (average).
Design and dimensions of pumps and water-plungers: Built by Holly Manufacturing Company, Lockport, New York; six plain plunger, 14 inches diameter, 24 inches stroke, 22 strokes per minute; pump-barrel, 14 by 24 inches.
Time pumps are run: Constantly.
Description of force-main: 40 pounds pressure on pumps.
Description of water-valves: Leather, 2½ by 5 inches in size, 2 inches lift.
Kind of power used: Steam.
Description of boilers: Retort, 10 feet long, 6 feet diameter, 60 pounds pressure; 12½ pounds water to 1 pound coal; fuel, Anthracite coal.
Water obtained from: Mahoning river.
Water first introduced: In 1871.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 70 to 80 pounds.
Total length of distributing mains: 11 miles.
Number of water-takers: 340.
Consumption of water: 1,500,000 gallons per day (estimated).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $7,500.
Number of fire-plugs: 105.

SYDNEY:
Population: 3,823 inhabitants.
Style of corporation: Municipal.
Water obtained from: Mosquito creek.
Water first introduced: October, 1873.
Sizes of distributing mains: 12, 10, and 8 inches.
Available head: 175 pounds (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 100.
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $4,400.
Number of fire-plugs: 33.
Time pump is run: 12 hours per day.
Time spent in repairs: 1 week per year.
Kind of power used: Water.
Description of water-wheels: Two; Holly patent, 20 feet high.
Remarks: The disadvantage of pumping direct into mains is that the pressure on the pipe is too uneven.—Water is muddy after rains.

URBANA:
Population: 6,592 inhabitants.
Name of corporation: Urbana Water-Works Company (private).
Water obtained from: Well.
Area and capacity of reservoir: Well, 20 feet diameter, 20 feet deep.
Water first introduced: February, 1876.
Sizes of distributing mains: 12 to 4 inches.
Available head: 125 feet (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 253.
Consumption of water: 300,000 gallons per day (estimated).
Average annual cost of maintenance and repairs: $3,900.
Number of fire-plugs: 73.
Design and dimensions of pump and water-plunger: Built by Holly Manufacturing Company, Lockport, New York; in 1877; piston-plunger, 7½ inches diameter, 2 feet stroke, 24 strokes per minute; pump-barrel, 7½ inches diameter.
Time pump is run: Constantly.
Time spent in repairs: None.
Description of force-main: 9 miles long, 46 pounds pressure on pump.
Description of water-valves: Brass kingo, 8 by 4 inches, 1 inch lift.
Kind of power used: Steam.
Description of boilers: Return-flow, 10 feet long, 6 feet diameter, 60 pounds pressure; 14½ pounds water to 1 pound coal; fuel, bituminous coal.
Water obtained from: Mahoning river.
Water first introduced: In 1871.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 70 to 80 pounds.
Total length of distributing mains: 11 miles.
Number of water-takers: 340.
Consumption of water: 1,500,000 gallons per day (estimated).
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $7,500.
Number of fire-plugs: 105.
WATER-SUPPLY OF CITIES.

TITUSVILLE—Continued.
Number of water-takers: 750.
Consumption of water: 400,000 gallons per day (estimated).
First cost of water-works: $130,000.
Average annual cost of maintenance and repairs: $7,000.
Number of fire-plugs: 63.
Design and dimensions of pump and water-plunger: Holly;
20 strokes per minute.
Time pump is run: Constantly.
Kind of power used: Steam.
Description of boilers: Two 40 horse-power flue; fuel, slack
and nut bituminous coal.
Cost of engines and pump: $30,000.

OREGON.

ALBANY:
Population: 1,667 inhabitants.
Name of corporation: Crawford & Foster (private).
Water obtained from: Santiam canal and Colopeanu river.
Water first introduced: July, 1895.
Sizes of distributing mains: 6, 4, 3, and 2 inches.
Available head: 100 feet (average).
Total length of distributing mains: About 3 miles.
First cost of water-works: About $20,000.
Number of fire-plugs: 2.
Design and dimensions of pumps and water-plungers: Built by
S. H. Moore, Portland, Oregon; two pumps, 24 by 12 inches,
12 to 24 strokes per minute; pump-barrel, 24 by 24 inches.
Time pumps are run: Constantly.
Description of force-mains: A tank 75 feet high; 45 pounds
pressure on pumps.
Kind of power used: Water.
Description of water-wheels: One Burnham and one Lefol;
24 feet head.

PENNSYLVANIA.

DANVILLE:
Population: 8,346 inhabitants.
Name of corporation: Danville Water-Works (municipal).
Water obtained from: Well on river-bank.
Area and capacity of reservoirs: 70 feet long, 74 feet wide, 10
feet deep.
Cost of dam: $4,000.
Water first introduced: In 1879.
Sizes of distributing mains: 12, 8, 6, 4, and 2 inches.
Available head: 65 pounds (average).
Number of water-takers: 800.
First cost of water-works: $125,000.
Average annual cost of maintenance and repairs: $4,000.
Filtering system: Gravel and sand.
Number of fire-plugs: 97.
Design and dimensions of pumps and water-plungers: Built by
the Holly Manufacturing Company, Lockport, New York;
six plain plungers 14 inches diameter, and six 18 inches di-
diameter two retary, capacity 215,000 gallons, 10 strokes per
minute.
Kind of power used: Steam.
Description of boilers: One horizontal, 18 feet long, 5 feet di-
ameter; one upright, 20 feet high, 7 feet diameter.
Description of engines: One double, 150 horse-power; one ro-
try, 200 horse-power.
Cost of engines and pumps: $30,000.
Remarks: The advantage of pumping direct into mains is the
marked control of pressure.

TITUSVILLE:
Population: 9,406 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Dug well.
Water first introduced: January, 1873.
Sizes of distributing mains: 15, 12, 8, 6, 4, and 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 94 miles.

NORFOLK:
Population: 21,366 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Springs and lake Lawson.
Total area of water-shed available: 500 acres.
Capacity of reservoirs: One lake, 470,000,000 gallons; Lawson,
120,000,000 gallons; Morris, 40,000,000 gallons.
Character and dimensions of dams: All puddled clay.
Cost of dams: $500,000.
Water first introduced: In July, 1874.
Description of mains carried: 4.6 miles long, 12 inches diam-
eter; cast iron.
Discharging capacity: 600,000 gallons per day, 40 pounds
pressure (average).
Description of settling reservoirs: Two; one, capacity 5,000,000
gallons, and one, capacity 3,000,000 gallons; water is pumped
into these from lake Lawson and thence into mains.
Sizes of distributing mains: 10, 8, 6, 4, 3, and 2 inches.
Available head: 40 pounds (average).
Total length of distributing mains: 23 miles.
Consumption of water: 70 gallons per head (estimated).
Number of water-takers: 9,700.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $12,000 to
$13,000.
Filtering system: Use settling reservoirs.
Number of fire-plugs: 95.
Design and dimensions of pumps and water-plungers: One set
Holly and two Worthington; plain plungers; two 14 inches
diameter, 24 inches stroke; two 14 inches diameter, 20 inches
stroke.
Time pumps are run: Constantly.
Description of force-main: 4.6 miles long, 12 inches diameter,
40 pounds pressure on pumps.
Description of water-wheels: Rubber disks, 6 inches diameter,
½ inch lift.
Kind of power used: Steam.
Description of boilers: Two; fuel, Georgia Creek coal.
Description of engines: One Worthington compound and one
high-pressure, 44 strokes per minute; slide-valves operated
by connecting-rod and rock-shaft; one set Holly pumps.
Cost of engines and pumps: $50,000.
Remarks: The advantage of pumping direct into mains is the
perfect control of pressure for fire service.

WEST VIRGINIA.

TITUSVILLE—Continued.
Number of water-takers: 750.
Consumption of water: 400,000 gallons per day (estimated).
First cost of water-works: $130,000.
Average annual cost of maintenance and repairs: $7,000.
Number of fire-plugs: 63.
Design and dimensions of pump and water-plunger: Holly;
20 strokes per minute.
Time pump is run: Constantly.
Kind of power used: Steam.
Description of boilers: Two 40 horse-power flue; fuel, slack
and nut bituminous coal.
Cost of engines and pump: $30,000.

MARTINSBURG:
Population: 6,335 inhabitants.
Style of corporation: Municipal.
Water obtained from: Springs.
Water first introduced: In 1874.
Sizes of distributing mains: 12 to 1½ inches.
Available head: 30 pounds (average).
Total length of distributing mains: About 6 miles.
Number of water-takers: 490.
Consumption of water: 200,000 gallons per day (estimated).
First cost of water-works: $80,000.
PUMPING DIRECT INTO DISTRIBUTING MAINS.

Martinsburg—Continued.
AVERAGE ANNUAL COST OF MAINTENANCE AND REPAIRS: $1,400.
NUMBER OF FIRE-PLUGS: 42.
DESIGN AND DIMENSIONS OF PUMPS AND WATER-PLUNGERS: BUILT BY THE HAYDEN MANUFACTURING COMPANY, LOCKPORT, NEW YORK; FOUR DOUBLE-ACTING PISTON, 7½ INCHES BORE, 42 INCHES STROKE.
TIME PUMPS ARE RUN: CONSTANTLY.
DESCRIPTION OF FORCE-MAIN: 4½ MILES LONG, 60 POUNDS PRESSURE ON PUMPS.
DESCRIPTION OF WATER-VALVES: LEATHER, 3 BY 6 INCHES.
KIND OF POWER USED: STEAM AND WATER.
DESCRIPTION OF WATER-VALVES: TWO AMERICAN TURBINE; ONE 30 INCHES AND ONE 54 INCHES DIAMETER; MADE BY STOUT, MILLS, & TEMPLE, DAYTON, OHIO; 10 FEET HEAD.
DESCRIPTION OF BOILER: HORIZONTAL, 18 FEET LONG, 60 INCHES DIAMETER; 54 TUBES, 2½ INCHES DIAMETER.
DESCRIPTION OF ENGINE: CONDENSING OR NON-CONDENSING, 16 BY 27 INCHES; PUPPET-VALVE, OPERATED BY CAMS; PLAIN AIR-PUMP, 14 BY 24 INCHES.
COST OF ENGINE AND PUMPS: $30,000.

Wisconsin.
Black River Falls—Continued.
POPULATION: 1,427 INHABITANTS.
STYLE OF CORPORATION: MUNICIPAL.
CHARACTER AND DIMENSIONS OF DAM: ONE ACROSS BLACK RIVER, AT HEAD OF FALLS, MADE OF BRUSH AND STONE; HEAD OBTAINED, 11 FEET.
WATER FIRST INTRODUCED: IN 1875.
SIZE OF DISTRIBUTING MAINS: 6 INCHES.
FIRST COST OF WATER-WORKS: $6,000.
AVERAGE ANNUAL COST OF MAINTENANCE AND REPAIRS: $125.
NUMBER OF FIRE-PLUGS: 6.

Black River Falls—Continued.
Design and dimensions of pump and water-plunger: Rotary, Johnson's patent, built by B. F. Babbitt, Utica, New York; 350 revolutions per minute; pump-barrel, 12 inches diameter.
Description of force-main: 100 feet long, 6 inches diameter; head, 12 feet on pump.
KIND OF POWER USED: WATER.
Description of water-wheels: Two turbines, 60 inches diameter, Houston patent, Racine, Wisconsin, 11 feet head, 115 revolutions per minute.

La Crosse:
POPULATION: 14,566 INHABITANTS.
STYLE OF CORPORATION: MUNICIPAL.
WATER OBTAINED FROM: MISSISSIPPI RIVER.
WATER FIRST INTRODUCED: IN 1877.
SIZES OF DISTRIBUTING MAINS: 16, 18, 20, AND 6 INCHES.
AVAILABE HEAD: 40 POUNDS (AVERAGE).
TOTAL LENGTH OF DISTRIBUTING MAINS: 94 MILES.
NUMBER OF WATER-TAKERS: 335.
FIRST COST OF WATER-WORKS: $60,000.
NUMBER OF FIRE-PLUGS: 90.
DESIGN AND DIMENSIONS OF PUMPS AND WATER-PLUNGERS: DUPLEX, BUILT BY G. F. BLAKE MANUFACTURING COMPANY, BOSTON, MASSACHUSETTS; 30 INCHES STEAM, 18 INCHES WATER, 2 FEET STROKE EACH; PUMP-BARREL, 16 INCHES DIAMETER.
TIME PUMPS ARE RUN: CONSTANTLY.
KIND OF POWER USED: STEAM.
DESCRIPTION OF BOILERS: TWO; 10 FEET LONG, 5 FEET DIAMETER; STEAM, PINE STIRES.
DESCRIPTION OF ENGINE: SIMPLE, HIGH-PRESSURE; CYLINDER, 30 INCHES DIAMETER, 34 INCHES STROKE.
COST OF ENGINE AND PUMPS: $10,000.
REMARKS: THE ADVANTAGE OF PUMPING DIRECT INTO MAINS IS CHEAPNESS; THE DISADVANTAGE, NON-UNIFORMITY OF PRESSURE.
WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIR.

SAN FRANCISCO:
Name of corporation: Spring Valley Water-Works (private).
Total area of water-shed available: 26 square miles.
Capacity of receiving reservoirs: Pilarcitos, 140,000,000 cubic feet; San Andreas, 1,800,000,000 cubic feet; Crystal Springs, 1,200,000,000 cubic feet.
Character and dimensions of dam: Pilarcitos, 95 feet high, 680 feet long, 26 wide on top; water-slope, 24 to 1; dry-slope, 3 to 1. San Andreas, 95 feet high, 540 long, 55 wide on top; water-slope, 24 to 1; dry-slope, 3 to 1. Crystal Springs, 90 feet high, 500 feet long, 36 wide on top; water-slope, 34 to 1; dry-slope, 3 to 1.
Water first introduced: In 1858.
Description of main conduits: Pilarcitos, 7,840 feet long, 3 feet 6 inches by 4 feet 6 inches cross-section, oval, brick masonry; also 38 miles long, 30 inches diameter, tarred wrought iron. San Andreas, 8,050 feet long, 3 feet 6 inches by 4 feet 3 inches cross-section, oval, brick masonry; also 12 miles long, 30 inches diameter, tarred wrought iron. Los Angeles, 2,000 feet long, 34 by 4 feet cross-section, brick; also 8,000 feet long, 24 inches diameter, cement pipe; also 2 miles redwood pipe, 22 inches to 10 inches.
Discharging capacity: Pilarcitos, 11,000,000 gallons per day; head, 375 feet (average). San Andreas, 9,500,000 gallons per day; head, 290 feet (average). Los Angeles, 7,000,000 gallons per day; head, 200 feet (average).
Description of distributing reservoirs: Lake Honda, heavy masonry work; capacity, 36,000,000 gallons; elevation, 377 feet. Collings Hill, capacity, 16,000,000 gallons; elevation, 292 feet. Market Street, capacity, 5,250,000 gallons; elevation, 220 feet. Upper Russian Hill, capacity, 4,500,000 gallons; elevation, 265 feet. Lower Russian Hill, capacity, 4,000,000 gallons; elevation, 148 feet. Clay Street Hill tank, capacity, 140,000 gallons; elevation, 305 feet.
Sizes of distributing mains: 12 to 3 inches.
Available head: 60 to 100 pounds.
Total length of distributing mains: 176 miles.
Number of water-takers: 20,500.
Consumption of water: 62.5 gallons per head per day (estimated).
Number of fire-plugs: 1,350.
Design and dimensions of pumps and water-plungers: Built by Pacific Iron Works and Vulcan Iron Works, San Francisco, in 1858 and 1868; Riisdon Iron Works, San Francisco, in 1877; plain plungers, 6 to 18 strokes per minute; pump-barrels, L. C. 2 F. 14 inches diameter, 7 feet stroke; C. S. 2 F. 12 inches diameter, 5 feet stroke; L. M. 2 F. 20 inches diameter, 6 feet stroke.
Time pumps are run: 12 hours per day in summer and 6 hours per day in winter.
Number of fire-plugs: 1,350.
Design and dimensions of pumps and water-plungers: Built by Pacific Iron Works and Vulcan Iron Works, San Francisco, in 1858 and 1868; Riisdon Iron Works, San Francisco, in 1877; plain plungers, 6 to 18 strokes per minute; pump-barrels, L. C. 2 F. 14 inches diameter, 7 feet stroke; C. S. 2 F. 12 inches diameter, 5 feet stroke; L. M. 2 F. 20 inches diameter, 6 feet stroke.

SAN FRANCISCO—Continued.
Description of water-valves: Crystal Spring and L. M., double-bolt crown.
Kind of power used: Steam.
Description of boilers: Lobos Creek, 4 tubular, 16 feet long, 42 inches diameter; tubes, 3 inches diameter; evaporation, 1,000 pounds; Mount Diablo coal, 6 to 1, and for natural gas, 10 to 1.
Description of engines: Lobos Creek, condensing; cylinder, 40 inches diameter, 48 inches stroke; Crystal Spring, distinct acting compound condensing; L. M., direct compound condensing, 30 strokes per minute; Lobos Creek, ordinary lift-valve with screw; air-pump, 30 by 24 inches; jet-condenser, 24 by 26 inches.
Duty of engines: Lobos Creek, with natural gas coal, 50,000,000 foot-pounds daily; with Mount Diablo coal, 4,000,000 foot-pounds daily.

VALLEJO:
Population: 5,857 inhabitants.
Name of corporation: Vallejo City Water Company (private).
Water obtained from: Surface-water.
Total area of water-plex available: About 100 square miles.
Capacity of reservoir: 500,000,000 gallons.
Character and dimensions of dam: 35 feet long, 40 feet high 150 feet base; built in sections; dirt and clay; best material in front section; stone rubbish and course material in back section.
Cost of dam: $10,000.
Water first introduced: In 1871.
Description of main conduit: 34 miles long, 12 inches diameter; cast iron.
Description of distributing reservoirs: Situated at an elevation of 150 feet above tide-water.
Sizes of distributing mains: 12, 6, 4, and 2 inches.
Total length of distributing mains: About 13 miles.
Number of water-takers: About 1,000.
Consumption of water: 100,000 gallons per day (estimated).
First cost of water-works: $200,000.
Number of fire-plugs: 15.
Design and dimensions of pump and water-plunger: Hooker, built by W. F. Garrett, San Francisco; plain No. 8 plunger, 14 inches stroke, 100 strokes per minute; pump-barrel, 6 by 18 inches.
Time pump is run: 12 hours per day in summer and 5 hours per day in winter.
Description of force-main: 34 miles long.
Description of water-valves: Rubber, 6 inches diameter.
Kind of power used: Steam.
Description of boiler: 60 horse-power, 40 pounds pressure.
Cost of pump: $700.

COLORADO.

LEADVILLE:
Population: 14,829 inhabitants.
Name of corporation: Leadville Water Company (private).
Water obtained from: Stream in Big Evans gulch.
Total area of water-plex available: About 6 square miles.
Dimensions of dam: 200 by 300 feet, 12 feet deep (average).
MUSCATINE—Continued.

Description of distributing reservoir: Puddled and faced with two thicknesses of brick laid in cement; discharge-pipes enter at bottom; depth of water, 20 feet; overflow 2 feet from top.

Sizes of distributing mains: 12, 10, and 6 inches.

Number of water-takers: 300.

Consumption of water: 200,000 gallons per day (estimated).

First cost of water-works: $32,000.

Average annual cost of maintenance and repairs: $3,500.

Number of fire-plugs: 49.

Design and dimensions of pump and water-plungers: Built by Cope & Maxwell, Hamilton, Ohio; two plain plungers, 16 inches diameter, 36 inches stroke, 25 strokes per minute; pump-barrels, 16 by 30 inches.

Time pump is run: 4 days per week.

Description of force-main: 4 mile long, 10 inches diameter, 30 pounds pressure on pump.

Description of water-valves: Rubber, 8 inches, 1 inch lift.

Kind of power used: Steam.

Description of boilers: Tubular, 12 feet long, 48 inches diameter; flues, 3 inches diameter, 80 pounds pressure.

Description of engine: Non-condensing; cylinder, 18 inches diameter, 30 inches stroke, 20 to 35 strokes per minute; combination and slide-valves.

Cost of engine and pump: $8,500.

MARYLAND.

BALTIMORE.

Population: 382,315 inhabitants.

Name of corporation: City Water-Works (municipal).

Water obtained from: Jones' Falls and Gunpowder river.

Area and capacity of reservoirs: Jones Falls supply, 116 acres, 490,000,000 gallons; Gunpowder River supply, 232 acres, 510,000,000 gallons.

Character and dimensions of dams: Lake Roland, rubble and cut stone on rock, backed with clay, 330 feet long; thickness of masonry at foundation of overfall, 69 feet. Loch Raven, built of stone, 560 feet long; thickness of masonry at foundation of overfall, 62 feet. Both 20 feet high, backed with 60 feet of clay at foundation.

Cost of dams: Lake Roland, $129,000; Loch Raven, $350,000; reservoirs cost $8,050,000.

Water first introduced: In 1870.

Description of main conduits: Jones' Falls, 3.8 miles long, 6 feet wide, 36 feet high, 434 square feet; built of stone and brick masonry; fall, 1 foot per second. Gunpowder, a tunnel, 7 miles long, 2 miles arched with brick, 5 miles through solid rock; circular; diameter, 12 feet; fall, same as the other.

Discharging capacity: Jones' Falls, 200,000,000 gallons per day; head, 4 feet. Gunpowder, 170,000,000 gallons per day; head, 7 feet.

Description of distributing reservoirs: Various forms; earth and clay, lined on each side with stone; outside slopes all 2 to 1; inside slopes, 14 to 1, 5 to 1, and 4 to 1; puddled cores in all embankments going below bottom of basin and running well up into excavation on the sides; width of embankment, 15 feet; for lakes, 60 and 80 feet.

Sizes of distributing mains: 12. 10, and 6 inches.

Available head: Water-supply slightly deficient at dividing line of service.

Total length of distributing mains: 275 miles.

Number of water-takers: 46,000.

Consumption of water: 45 gallons per head per day (estimated).

First cost of water-works: Purchased from old water company for $2,500,000.

Average annual cost of maintenance and repairs: $5,500.
Baltimore—Continued.

Number of fire-plugs: 805.

Design and dimensions of pumps and water-plungers: Built by H. R. Worthington, Brooklyn, New York; plain plungers, duplex; two sets, 11/16 inches diameter, 36 inches stroke; two sets, 22 inches diameter, 48 inches stroke; 24 strokes per minute.

Time pumps are run: Two sets 58 days per year; two sets 60 days per year.

Time spent in repairs: Two sets 50 hours per year, and two sets 75 hours per year.

Description of force-main: 6,169 feet long, 20 pounds pressure on pumps; 34 miles long, 25 pounds pressure on pumps.

Description of water-valves: Worthington gum disks.

Kind of power used: Steam.

Description of boilers: Horizontal tubular, 45 pounds pressure; fuel, bituminous and semi-bituminous coal.

Description of engines: Worthington compound, duplex, 24 strokes per minute; slide-valves operated by opposite engine; lifting-pump cylinder-condenser.

Cost of engines and pumps: Two sets $50,000; two sets $65,000.

Massachusetts.

Chelsea:

Population: 21,752.

Supplied by Boston water-works.

Dorchester:

Population: (Included in Boston.)

Supplied by Boston water-works.

Haverhill:

Population: 15,472 inhabitants.

Name of corporation: Haverhill Aqueduct Company (private).

Water obtained from: Kenose, Saltonstall, and Pentucket lakes.

Water first introduced: In 1892.

Description of main conduit: 10, 12, and 10 inches diameter; wrought iron and cement; head, 3,500 feet (average).

Description of distributing reservoir: Wrought iron, 40 feet high, 30 feet diameter, with stand-pipe in center 50 feet high, 24 inches diameter.

Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.

Available head: 150 feet (average).

Total length of distributing mains: About 25 miles.

Number of water-takers: About 2,000.

Consumption of water: 100 gallons per head per day (estimated).

First cost of water-works: $350,000.

Average annual cost of maintenance and repairs: $8,000.

Number of fire-plugs: 22; 63 hydrants.

NEW JERSEY.

Burlington—Continued.

Description of distributing reservoirs: Eight, iron; seven of them 7 feet diameter, 9 feet high; one, 90 feet diameter, 26 feet high; inclosed in building for the purpose.

Sizes of distributing mains: 24, 12, 10, 8, 6, and 4 inches.

Available head: 50 feet (average).

Total length of distributing mains: 9 miles.

Number of water-takers: 1,927.

Consumption of water: 145,500 gallons per day (exact).

First cost of water-works: $50,000.

Average annual cost of maintenance and repairs: $4,000.

Number of fire-plugs: 84.

Design and dimensions of pumps and water-plungers: Old, unknown; now, built by Worthington, New York, in 1878; two plain plungers, 10 inches diameter, 184 inches stroke, 45 strokes per minute (average).

Time pumps are run: 6 hours per day.

Description of force-main: 12 inches diameter, 22 pounds pressure on pumps.

Description of water-valves: Gum, circular.

Kind of power used: Steam.

Description of boilers: Tubular, 40 horse-power, 50 pounds pressure; fuel, anthracite coal.

Description of engines: Compound condensing; high-pressure cylinder, 10 inches diameter; low-pressure cylinder, 24 inches diameter; 184 inches stroke, 45 strokes per minute; ordinary slide-valves, worked by opposite engine; air-pump at end of pump on low-pressure side, same capacity as water-pump; condenser, 12 inches diameter, 3 feet high.

Cost of engines and pumps: About $5,000.

Remarks: The advantage of pumping to reservoir consists in this, that it gives security in case of fire.—Generally water is pure. In summer spungy fungus is sometimes found in the mains.

Newark:


Name of corporation: The Newark Aqueduct Company (municipal).

Water obtained from: Passaic river at Belleville.

Total area of available water-shed: 961 square miles.

Cost of dams: $5,071,520 40.

Description of main conduit: 3 miles long, 30 inches diameter; iron; head, 100 feet (average).

Description of distributing reservoir: Surface elevation, 114 feet above tide-water; capacity, 23,000,000 gallons.

Sizes of distributing mains: 20 to 3 inches.

Available head: 114 feet (average); water-supply sufficient.

Total length of distributing mains: 136 miles.

Number of water-takers: 11,000.

Consumption of water: 9,388,000 gallons per year (estimated).

First cost of water-works: $150,000.

Average annual cost of maintenance and repairs: $13,000.

Number of fire-plugs: 1,126.

Design and dimensions of pumps and water-plungers: Five, built by Worthington, New York city; two in 1830-70, capacity, 5,000,000 gallons each; one in 1874, capacity, 8,000,000 gallons; one in 1876, capacity, 3,000,000 gallons. Plain plungers; on 5,000,000-gallon pumps, 23 inches diameter, 4 feet nominal stroke, 3 feet 3/6 inch working stroke; on 8,000,000-gallon pump, 28 inches diameter, 60 inches full stroke, 4 feet 14 inch working stroke; pump-barrels, 22 and 26 inches diameter.

Description of force-mains: 30 inches diameter; head, 165 feet on pumps.

Description of water-valves: Rubber, 9 and 10 inches diameter; 180, about 1 inch.

Kind of power used: Steam.

Description of boilers: Seven tubular, 18 feet long, 5 feet diameter, and 16 feet long, 6 feet diameter; fuel, Schuylkill hard white-ash coal.
GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIRS. 237

NEW YORK.

CANALIEHAR:
Population: 9,013 inhabitants.
Name of corporation: Canoaharie Water-Works Company (private).
Water obtained from: Springs.
Capacity of reservoirs: Conduit, 5,000 to 10,000 gallons; tank, 800 gallons.
Cost of dam: $10,000.
Water first introduced: In 1829.
Description of main conduit: 90 feet long, 4 inches wide, 4 feet deep; stone wall in masonry, and clay pudding; head, 32 feet (average).
Description of distributing reservoir: Area, 16 by 26 feet, 3 feet deep.
Sizes of distributing mains: 12, 6, 4, 3, and 2 inches.
Available head: 40 to 70 pounds.
Total length of distributing mains: 10,019 feet.
Number of water-takers: 90.
Consumption of water: 75 gallons per head per day (estimated).
First cost of water-works: $10,000.
Average annual cost of maintenance and repairs: About $100.
Number of fire-plugs: 11.
Design and dimensions of pumps and water-plungers: Two, built by Ramsey & Co., Seneca Falls, New York; plain plungers, 4 by 16 inches diameter, 8 inches stroke, 6 to 8 strokes per minute; pump-barrel, 4 by 16 inches.
Time pumps are run: Constantly.
Time spent in repairs: Not over four hours per year.
Description of force-main: 11 miles long, 75 pounds pressure on pumps.
Description of water-valves: Brass.
Kind of power used: Water.
Description of water-wheel: Overshot, wooden, 12 feet diameter, 1 foot wide, with buckets 4 by 12 inches; home design; 6 feet head, 6 to 8 revolutions per minute; 51 gallons per minute; discharge 0 gallons per minute at reservoir.
Cost of wheel and pumps: Wheel, etc., $200; pumps, $100.

CORNING—Continued.

Description of water-valves: Rubber, 7 inches diameter.
Kind of power used: Stein.
Description of boilers: 16 feet long, 24 feet diameter.
Description of engines: Simple, one 24 by 24 inches, and one 24 by 12 inches, 40 to 120 strokes per minute.
Cost of engines and pumps: $5,000.

ELMIRA:
Population: 9,041 inhabitants.
Name of corporation: Elmira Water-Works Company (private).
Water obtained from: (A) spring, Carr's creek; (B) spring, Chemung river.
Total area of water-shed available: (A) supply, 9 square miles. Character and dimensions of dam: Access ravine forming storage reservoir, 770 feet long, 30 feet high; built of earth; clay and puddled wall in center; slopes 2 to 1 on both sides; upper side lined; stone rip-rap 18 inches thick; flows 29 acres (about).
Cost of dam: First, $81,928 96; second, $81,715 33.
Water first introduced: In 1836.
Description of main conduit: Two pipes, 10 inches diameter, sheet-iron and cement lined; one Wyckoff patent wood pipe, 2 miles long, 12 inches diameter; head, 88 feet (average).
Description of distributing reservoir: Area, about 200 foot square; elevation, 88 feet; capacity, 6,000,000 gallons; water from distributing reservoir is let in through a fountain discharging-trough; cluster of holes for aerating and purifying.
Sizes of distributing mains: 10 to 8 inches.
Available head: 60 feet (average).
Total length of distributing mains: About 37 miles.
Number of water-takers: 772.
Consumption of water: 3,500,000 gallons (estimated).
First cost of water-works: $243,450 70.
Average annual cost of maintenance and repairs: $9,000.
Filtering apparatus: Gallery; 75 feet long, 75 feet distant from river; bottom 5 feet below low-water; gravel; no cleaning.
Number of fire-plugs: 148.
Design and dimensions of pumps and water-plungers: One rotary, built by La France Manufacturing Company, Elmira, New York; one Knowles pump, Warren, Massachusetts, in 1880; plain plunger, 22 inches diameter, 50 inches stroke, 28 strokes per minute; pump-barrel, 22 inches diameter.
Time pumps are run: Constantly for 6 months.
Description of force-main: 12 inches diameter.
Description of water-valves: Rubber, 3 inches diameter, 2 inches lift.
Kind of power used: Steam.
Description of boilers: Two; 60-horse power, 40 to 60 pounds pressure; fuel, bituminous coal, from Mahatico mines.
Description of engines: Knowles simple condensing; cylinder, 30 inches diameter, 36 inches stroke, 55 strokes per minute; mild-valves operated by piston; Knowles condenser.
Cost of engine and pumps: Knowles, about $5,000.

PORT JERVIS:
Population: 1,148 inhabitants.
Style of corporation: Municipal.
Water obtained from: Owasee lake.
Cost of dam: $1,600.
Water first introduced: In 1872.
Description of main conduit: 175 feet long, 4 and 6 inches diameter; iron.
Description of distributing reservoir: Area, 150 by 50 feet, and 12 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: 175 feet (average).
Total length of distributing mains: 35 miles.
Number of water-takers: 30.
First cost of water-works: $18,000.
Average annual cost of maintenance and repairs: $150.
Number of fire-plugs: 30.
PORT BYRON—Continued.
Design of pump and water-plungers: Built by Rumsey, Seneca Falls, New York.
Description of water-wheel: Turbine, 36 inches diameter, 7 feet head, 150 revolutions per minute.

PENNSYLVANIA.

BELLEFAIRE:
Population: 3,026 inhabitants.
Style of corporation: Municipal.
Water obtained from: Spring discharging 14,600 gallons per minute.
Capacity of reservoir: 300,000 gallons.
Cost of dam: $75,000 to $90,000.
Water first introduced: In 1890.
Description of main conduit: 6 inches diameter.
Description of distributing reservoir: Built in shape of section of pyramid, small end down; stone and brick, cemented; no cover; capacity, 300,000 gallons; 1,000 feet from and 196 feet above spring.
Size of distributing mains: 6 inches.
Available head: 10 to 200 feet.
Total length of distributing mains: 2 mile.
Number of water-takers: 560.
Consumption of water: 80 to 100 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $3,000.
Number of fire-plugs: 40.
Design and dimensions of pumps and water-plungers: Steam pump built by Knowles, Warren, Massachusetts; plain plunger, 24 inches diameter, 45 strokes per minute; pump-barrel, 24 inches diameter. Water-pump built by W. P. Duncan & Co., Bellefonte, Pennsylvania; plunger, 32 inches stroke, 152 strokes per minute; pump-barrel, 6 inches diameter.
Time pumps are run: Water, constantly; steam, 2 to 3 hours per day.
Description of force-main: 1,900 feet long, 8×3 pounds pressure on pumps.
Description of water-valves: 3 inches diameter.
Kind of power used: Steam and water.
Description of water-wheel: Horizontal, 35 inches diameter, 6 feet head, 50 revolutions per minute; 100 gallons required to lift 1 gallon to reservoir.
Description of boilers: Tubular, 14 feet long, 4 feet diameter; fuel, Snowshoe coal.
Description of engine: Simple; 45 strokes per minute; ordinary valves.

COLENSIA—Continued.
Design and dimensions of pumps and water-plungers: Built by Morris, Tashler & Co., Philadelphia, Pennsylvania, and one by Worthington; two plungers, Worthington, iron, with brass packing, 12 inches diameter, 55 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: 10 to 18 hours per day.
Description of force-main: 4,500 feet long; head, 150 feet on pump, or 9,000 pounds.
Kind of water-valves: Gun, 4 and 3 inches.
Description of boiler: Two; plain cylinder, 65 to 70 pounds pressure, and one fire-boxer.
Description of engine: Non-condensing simplex; cylinders, 18 inches diameter, 65 strokes per minute; globe-valves.
Cost of engine and pump: About $10,000.
Duty of engine: 3,400,000 foot-pounds per 15 hours daily.

LEWISTOWN:
Population: 3,222 inhabitants.
Name of corporation: Lewistown Water Company (private).
Water obtained from: Creek and springs.
Total area of water-shed available: About 4 square miles.
Area and capacity of reservoir: 2,500 sq. ft.; 17,500 cu. ft.
Cost of dam: $34,000.
Water first introduced: In 1830.
Description of main conduit: 3 miles long, 6 inches diameter; iron; head, 80 feet (average).
Description of distributing reservoir: Ordinary; 60 square and 7 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: About 50 feet (average).
Total length of distributing mains: 6 miles.
Number of water-takers: About 500.
First cost of water-works: $20,000.
Average annual cost of maintenance and repairs: $1,600.
Number of fire-plugs: 14.
Design and dimensions of pumps and water-plungers: Built by Worthington, New York, in 1870; two plain plungers, 9 inches diameter, 8 inches stroke, 60 strokes per minute.
Time spent in repairs: 75 hours per year.
Description of water-wheel: 14 miles long; head, 15 feet on pump.
Description of water-valves: Rubber, 2 inches, ¾ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular, 8 feet long, 3 feet diameter; fuel, bituminous coal.
Description of engine: 60 strokes per minute; globe-valves; Worthington duplex pump condenser, etc.
Cost of engine and pump: $3,000.
Remarks: The disadvantage of pumping to mains is that when water is being shut off at the hydrants it is forced back on pumps, causing wear. When pumping from creek after rain water is muddy; water is little hard on account of lime.

VIRGINIA.

STAUNTON:
Population: 6,004 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Springs.
Capacity of reservoir: 2,500,000 gallons.
Cost of dam: $28,000.
Water first introduced: In 1876.
Description of main conduit: 5,802 feet long, 12 inches diameter; cast iron.
Discharging capacity: Head, 150 feet (average); 1,195,000 gallons per day.
Description of distributing reservoir: Circular, 295 feet diameter at top, 16 feet deep; has a receiving well with a wire strainer through which the water passes.
Sizes of distributing mains: 12, 6, and 3 inches.
Available head: 120 feet (average).
Total length of distributing mains: About 8 miles.
GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIRS.

STAUNTON—Continued.

Number of water-takers: 1,500.
Consumption of water: 67 gallons per Lead per day (estimated).
Average annual cost of maintenance and repairs: $2,000.
Number of fire-plugs: 23.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York; two plain plungers, 13 inches diameter, 24 inches stroke, 15 strokes per minute; pump barrel, 23 by 50 inches.
Time pump is run: 10.53 hours of 360 days per year.
Time spent in repairs: 7 to 8 days per year.
Description of force-main: 1,500 feet long, 19 inches diameter, 77 pounds pressure on pump.
Description of water-valves: Gum.
Kind of power used: Steam.
Description of boiler: 16 feet long, 5 feet diameter; fuel, New River soft coal.
Description of engine: Condensing duplex compound; high pressure cylinder, 17½ inches diameter; low-pressure cylinder, 35 inches diameter; 24 inches stroke, 15 strokes per minute; slide-valves; ordinary lifting air-pumps, 6 inches; condenser, 24 by 48 inches.
Cost of engine and pumps: $2,500.
Duty of engine: 49,800,892 foot-pounds daily.

WASHINGTON TERRITORY.

OLYMPIA:
Population: 1,232 inhabitants.
Name of corporation: Olympia Water Company (private).
Water obtained from: Springs and river.
Cost of dam: $500.
Water first introduced: In 1865.
Description of main conduit: Wyckoff wood pipe, 4 inches diameter; head, 120 feet (average).
Description of distributing reservoir: Tank, 50 feet square and 12 feet deep.
Sizes of distributing mains: 6 and 4 inches.
Available head: 80 feet (average).
Total length of distributing mains: 9 miles.
Number of water-takers: 100.
First cost of water-works: $20,000.
Number of fire-plugs: 2.
Design and dimensions of pump and water-plungers: Hooker pump, 90 strokes per minute; pump-barrel, 6 inches diameter.
Time pump is run: Constantly.
Description of water-valves: Composition rubber.
Kind of power used: Water.
Description of water-wheel: Looff turbine, 23 inches diameter, 31 feet head, 320 revolutions per minute.
WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO STAND-PIPE.

MINNESOTA.

Population: 9,655 inhabitants.
Name of corporation: Stillwater Water Company (private).
Water obtained from: Lake Mcknissick.
Total area of water-shed available: 40 square miles.
Area of reservoir: Lake, 30 acres.
Character and dimensions of dams: Filtering, 100 by 60 feet, and 10 feet deep; reservoir, 100 by 150 feet, and 12 feet deep.
Cost of dams: $4,000.
Water first introduced: December, 1890.
Description of main conduit: 200 feet long, 20 inches diameter; tile.
Discharging capacity: 5,000,000 gallons per day; head, 8 to 10 feet.
Description of stand-pipes: Tanks, on two hills; capacity, 100,000 gallons each; 1 mile from pumping station.
Sizes of distributing mains: 10, 12, 10, 8, 6, and 4 inches.
Available head: 60 to 200 feet.
Total length of distributing mains: 74 miles.
Number of water-takers: 61.
Consumption of water: 25 gallons per head per day (estimated).
First cost of water-works: $150,000.
Filtering apparatus: Gallery, 50 by 100 feet, and 10 feet deep; sand and gravel, underhilid by 4 to 4 feet long and 24 by 4 inch timbers; cleaned once a year.
Number of fire-plugs: 25.
Design and dimensions of pump and water-plungers: Harrison, built by Blake Manufacturing Company, Boston, Massachusetts; piston, 1 to 150 strokes per minute; pump-barrels, 10 by 24 inches.
Time pump is run: 2 hours per day.
Description of force-main: 3 miles long, 16, 12, and 8 inches diameter, 60 pounds pressure on pump.
Description of water-valves: Hard rubber, 4 inches diameter, ½ inch lift.
Kind of power used: Steam.
Description of boilers: Two; 18 feet long, 48 inches diameter.
Description of engines: High-pressure, 24 inches stroke, 1 to 150 strokes per minute; slide-valves operated with piston-valves.
Cost of engine and pump: $4,500.

SOUTH BETHLEHEM—Continued.
First cost of water-works: $29,184 22.
Average annual cost of maintenance and repairs: $35 83.
Number of fire-plugs: 36.
Design and dimensions of pumps and water-plungers: John Fritz, built by Bethlehem Iron Company; pump-barrels, 18 by 30 inches.
Time pumps are run: One pump constantly.
Description of force-main: 60 to 90 pounds pressure on pumps.
Kind of power used: Steam.
Remarks: The disadvantage of pumping is that muddy water is pumped into mains after rains.

CLARKSVILLE.

Population: 3,689 inhabitants.
Name of corporation: Clarksville Water Company (private).
Water obtained from: Cumberland river.
Water first introduced: June, 1879.
Description of main conduit: 10,200 feet long, 8 inches diameter; cast iron.
Discharging capacity: 500,000 to 1,000,000 gallons per day; head, 150 to 250 feet.
Description of stand-pipe: Riveted plate iron; 15 feet interior diameter; 162 feet high; on stone foundation.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 150 to 200 feet.
Total length of distributing mains: 44 442 miles.
Number of water-takers: 102.
Consumption of water: 31 gallons per head per day (estimated).
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $2,500.
Number of fire-plugs: 40.
Design and dimensions of pumps and water-plungers: Two; built by Blake Manufacturing Company, Boston, Massachusetts; bucket-plungers; steam, 20 inches; water, 12 by 24 inches; 48 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: Five hours per day, four days per week.
Description of force-main: 10,500 feet long, 8 inches diameter; head, 281 feet on pumps.
Description of water-valves: Composition of gum and metal; 42 inches diameter, 1 inch lift.
Kind of power used: Steam.
Description of boilers: 22 feet long, 44 inches diameter; 5 riveted flues, 8 inches diameter; fuel, bituminous coal.
Description of engine: Simple; high-pressure; cylinder, 20 inches diameter, 24 inches stroke, 48 strokes per minute; Blake patent valves.
Cost of engine and pumps: $3,000.
Remarks: The disadvantage of pumping is the uneven strain on pipe-joints.—Water slightly impregnated with lime.

PENNSYLVANIA.

Population: 4,926 inhabitants.
Name of corporation: South Bethlehem Gas and Water Company (private).
Water obtained from: Lehigh river.
Water first introduced: In 1875.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Available head: 60 pounds pressure (average).
Total length of distributing mains: 3,900 feet.
Number of water-takers: 140.

786-740
WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING DIRECT INTO DISTRIBUTING MAINS.

NEBRASKA.

Omaha:
Population: 30,658 inhabitants.
Name of corporation: City Water-Works (private).
Water obtained from: Missouri river.
Capacity of reservoir: 9,000,000 gallons.
Description of main conduit: 16 and 24 inches diameter; cast iron.
Discharging capacity: 5,000,000 gallons per day of 12 hours; head, 235 feet (average).
Description of distributing reservoir: Two chambers, 204 by 162 feet; 24 feet deep, each; embankment, 12 feet wide at top; slope, 1:1 to 1; elevation of top of embankment, 307 feet above low water of river; interior paved and lined with broken stone at bottom, and brick on slopes.
Sizes of distributing mains: 24 to 8 inches.
Available head: 160 feet (average).
Total length of distributing mains: 31 miles.
Number of water-takers: 356.
Consumption of water: 50 gallons per head per day (estimated).
First cost of works: $500,000.
Filtering system: Water pumped from river into three settling basins, capacity 3,000,000 gallons, from whence it is drawn into clear water basin, and from thence into distributing reservoir.
Number of fire-plugs: 256.
Design and dimensions of pumps and water-plungers: Knowles plain compound, 24 inches diameter, 42 inches stroke; high pressure, 19 inches diameter, 36 inches stroke; pump barrel, 24 inches diameter.
Time pumps are run: 12 hours per day.
Description of force-main: 2 1/2 miles long, 16 inches diameter; head, 283 feet; pumps.
Description of water-valves: Rubber, with leather face, 34 inches in size, 3 to 4 inch lift.
Kind of power used: Steam.
Description of boilers: Return-flue; fuel, bituminous coal.
Description of engines: One compound condensing; high-pressure cylinder, 33 inches diameter; low-pressure cylinder, 61 inches diameter; 49 inches stroke. One extra engine; cylinder, 38 inches diameter; 36 inches stroke; rotary piston; slide-valves, operated by rocker-valve attached to piston; air-cylinder, 19 inches diameter; one 20-inch jet-condenser.
Cost of engines and pumps: $10,000.
Duty of engines: 80,000,000 foot-pounds guaranteed.

NEW YORK.

Yonkers:
Population: 18,892 inhabitants.
Name of corporation: Yonkers Water-Works (municipal).
Water obtained from: Sprain and Grassy Sprain brooks.
Total area of water-shed available: 8 square miles possible; 6 square miles at present.

Yonkers—Continued.
Area and capacity of reservoir: 104 acres; 405,000,000 gallons.
Character and dimensions of dam: Earth, with paddle core; width on top, 20 feet; slopes, 2 to 1; faced on water side with rubble 18 inches thick; greatest depth of water, 26 feet; foundation mainly on sand and gravel, also on rock and hard pan; heavy base of concrete for paddle-wall, secured by sheet-piling and core-walls where necessary.
Cost of dam: $75,000.
Water first introduced: September, 1875.
Description of main conduit: 3,000 feet long, 24 inches diameter; cast iron.
Discharging capacity: About 4,000,000 gallons per day; head, 20 feet (maximum).
Description of distributing reservoir: Very small; holds about 2 days' supply.
Sizes of distributing mains: 18, 12, 8, 6, and 4 inches.
Available head: 0 to 217 feet.
Total length of distributing mains: 6,500 feet of 12 inches, 25,021 feet of 18 inches, 15,683 feet of 8 inches, 47,002 feet of 6 inches, 14,619 feet of 4 inches.
Number of water-takers: 356.
Consumption of water: 80 gallons per head per day (estimated).
First cost of works: To December 1, 1870, $800,000.60.
Average annual cost of maintenance and repairs: $3,500.
Number of fire-plugs: 265.
Design and dimensions of pumps and water-plungers: One built by W. Wright, Newburgh, New York, in 1875; one bucket-plunger, 15 inches diameter, 30 inches stroke, 17 strokes per minute; pump-barrel, 22 inches diameter. One H. R. Worthington, New York, in 1881; two plain plungers, 15 inches diameter, 36 inches stroke, 50 strokes per minute.
Time pumps are run: 3,217 hours in 1880.
Time spent in repairs: Nominal.
Description of force-main: 5,500 feet long, 18 inches diameter; head on Wright's pump, 108 feet; head on Worthington pump, 410 feet.
Description of water-valves: Wright, double-heat; Worthington, disk.
Kind of power used: Steam.
Description of boilers: Drop return tubular, 18 feet long, 5 1/2 feet diameter; fuel, anthracite coal.
Description of engines: Condensing compound; Wright, 32 and 36 inches diameter, 5 feet stroke, 17 strokes per minute; slide-valves operated by eccentrics on shaft. Worthington 31 and 36 inches diameter, 3 feet stroke, 50 strokes per minute; balanced slide-valve; single-acting, beam-lined air-pumps.
Cost of engines and pumps: Wright, $17,000; Worthington, $21,000.
Duty of engines: Wright, 61,000,000 foot-pounds daily in 1880; 61,000,000 foot-pounds guaranteed. Worthington, 70,000,000 foot-pounds guaranteed.
WATER-SUPPLY OF CITIES.

PENNSYLVANIA.

Shamokin:
Population: 8,184 inhabitants.
Name of corporation: Shamokin Water Company (private).
Water obtained from: Trout run.
Total area of water-shed available: 2,000 acres.
Capacity of reservoir: 250,000 cubic feet.
Character and dimensions of dam: Two; one ¾ mile above the other.
Cost of dam: $4,000.
Water first introduced: In 1874.
Description of main conduit: 2¼ miles long, 12 inches diameter; wood, iron-bound; and 3½ miles long, 12 inches diameter, iron.
Discharging capacity: Lower dam, 49 feet, upper dam, 130 feet; 800 gallons per minute.
Description of stand-pipes: 250 feet, up the mountain.
Size of distributing mains: 10 to 4 inches.
Available head: 130 feet (average).
Total length of distributing mains: About 9 miles.
Number of water-tanks: About 1,000.
Consumption of water: 100 gallons per day per family (estimated).
First cost of water-works: $110,000.
Average annual cost of maintenance and repairs: $2,000 to $3,000.
Number of fire-plugs: 30.
Design and dimensions of pumps and water-plungers: Built by the Niagara Pump Works, Bingham, New York; double plungers, 8½ inches diameter, 18 inches stroke, 20 to 40 strokes per minute; pump-barrel, 8½ inches diameter.
Time pumps are run: About 3 months per year.
Time spent in repairs: 600 hours per year.
Description of water-valves: Brass.
Kind of power used: Steam.
Description of boilers: Steam, from Cameron colliery; fuel, anthracite coal.
Cost of engine and pump: $770.

Wilkesbarre—Continued.
Total length of distributing mains: About 55 miles.
Number of water-takers: About 2,900.
First cost of water-works: $150,000.
Average annual cost of maintenance and repairs: $2,000.
Number of fire-plugs: 94.
Design and dimensions of pumps and water-plungers: Built by Q. F. Haake Manufacturing Company, in 1877; bucket-plungers, 50 to 60 strokes per minute; pump-barrels, 10 inches diameter; head, 130 feet on pumps.
Time pump is run: 2 days per year (average).
Description of water-valves: Leather.
Kind of power used: Steam.
Description of boilers: 55 pounds pressure; fuel, No. 3 anthracite coal.
Description of engine: 50 to 60 strokes per minute.
Cost of engine and pump: $4,100.
Remarks: The advantages of pumping to mains are that it saves trouble and that it is easy to get the water quickly.

VERMONT.

Saint Johnsbury:
Population: 5,800 inhabitants.
Name of corporation: Saint Johnsbury Aqueduct Company and Village of Saint Johnsbury Water-Works (private).
Water obtained from: Saint Johnsbury Aqueduct, springs; Village, from river.
Total area of water-shed available: 1,600 acres.
Water first introduced: Saint Johnsbury Aqueduct, in 1861; Village, in 1876-77.
Description of main conduit: Saint Johnsbury Aqueduct Company, 4 miles long, 6 inches diameter; iron, cement-lined; head, 170 feet (average).
Size of distributing mains: Saint Johnsbury Aqueduct Company, 4 and 3 inches; Village, 8, 6, and 4 inches.
Available head: 170 feet (average).
Consumption of water: 2,000 gallons per day (estimated).
First cost of water-works: Saint Johnsbury Aqueduct Company, $30,000; Village, $80,000.
Filtering apparatus: Size, 12 by 15 feet; filled with sand; cleaned once in two weeks.
Number of fire-plugs: 50.
Design and dimensions of pumps and water-plungers: Village pumps, built by J. P. Plandore, Vergennes, Vermont, in 1874; buckets, small pump, 18 inches stroke; large pump, 8 inches stroke; 20 strokes per minute; pump-barrels, 12 by 15 inches; 80 to 100 pounds pressure on pumps.
Time pumps are run: Constantly.
Description of water-valves: Plain metallic; small pump, 12 inches and ½ inch lift; large pump, 16 inches and ½ inch lift.
Kind of power used: Water.
Description of water-wheels: One for each pump; Buzzell make; 30 and 60 inches diameters; 12 feet head.
WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIR AND STAND-PIPE.

ALABAMA.

MOBILE:
Name of corporation: Mobile Water Company (private).
Water obtained from: Springs and creek.
Water first introduced: In 1824.
Description of distributing reservoir and stand-pipe: Rectangular embankment; paddle-faced and riprap of brick; inner slope, 2 to 1; outer slope, 14 to 1; stand-pipe, cast iron, 9 inches diameter; 85 feet high; with an exterior of 3 inches; pipe, 12 feet high; the whole supported in a skeleton framework.
Sizes of distributing mains: 14, 10, 8, 6, and 4 inches.
Water supply: Deficient.
Number of water-takers: About 1,000.
Consumption of water: About 250,000 gallons per day.
First cost of water-works: $300,900.
Average annual cost of maintenance and repairs: $12,000.
Number of fire-plugs: 172.
Design and dimensions of pumps and water-plungers: Two; built by Wooding, Kemple & Co., West Point; plain double-acting piston-plunger; 10 inches diameter; 45 inches stroke; 37 strokes per minute.
Time pumps are run: Constantly.
Description of force-main: 16,000 feet long; 8 inches diameter; head, 20 feet on pumps.
Description of water-valves: Hinge; 6 by 12 inches; free lift.
Kind of power used: Water.
Description of water-wheels: Two breast-wheels; 16 inches diameter; 7 feet wide; 10 inches deep; 23 feet head; 6 revolutions per minute.
Remarks: Two Blake pumps are being introduced.

MASSACHUSETTS.

BROOKLINE:
Population: 53,000 inhabitants.
Name of corporation: Brookline Water-Works (municipal).
Water obtained from: Fresh pond.
Total area of water-shed available: 1,200 acres.
Water first introduced: In 1856.
Description of distributing reservoir and stand-pipe: Stand-pipe near reservoir; pumping mains enter it at bottom and connect with distributing mains, these connect with reservoir; an outlet from reservoir connects direct with stand-pipe.
Sizes of distributing mains: 24, 20, 16, 12, 10, 8, 6, 4, and 3 inches.
Available head: 180 feet (average); water-supply deficient.
Total length of distributing mains: About 25 miles.
Number of water-takers: 896.
Consumption of water: 10,000 gallons per head per day.
First cost of water-works: $301,400.
Average annual cost of maintenance and repairs: $25,000.
Filtering apparatus: Gallery excavated near edge of little pond; size, 40 by 50 feet; gravel; no cleaning.

BROOKLINE—Continued.
Average annual cost of maintenance and repairs: $6,890.
Filtering apparatus: Size, 200 by 4 feet; filtering required only occasionally; gravel; cleaned once a month, while in use.
Number of fire-plugs: 158.
Design and dimensions of pumps and water-plungers: Built by Worthington, New York, in 1874 and 1880; two plain plungers; one 10 inches diameter and one 14 inches diameter; 23½ inches stroke; 24 strokes per minute; pumps: about 2 feet.
Time pumps are run: About 1,000 hours per year.
Time spent in repairs: About 300 hours per year.
Description of force-main: 2½ miles long; 16 and 14 inches diameter.
Description of water-valves: Vulcanized rubber; 7 by 1 inch; 4 inch lift.
Kind of power used: Steam.
Description of boilers: Two horizontal tubular; 10 feet long; one 5 feet 3 inches diameter; one 5 feet 6 inches diameter; evaporation, 40 pounds of water to 1 pound of coal; 55 pounds pressure; fuel, anthracite coal.
Description of engine: Compound condenser, intermediate receiver; high-pressure cylinder, 34½ inches diameter; low-pressure cylinder, 45½ inches diameter; 25½ inches stroke; 45 strokes per minute; slide-balanced valves, worked by opposite bell-crank; two single-acting air-pumps, volume, 5,304 cubic inches; condenser volume, 25,000 cubic inches.
Cost of engine and pumps: $16,000.
Duty of engine: 53,000,000 foot-pounds, daily; 50,000,000 foot-pounds guaranteed.

CAMBRIDGE:
Population: 53,800 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Fresh pond.
Total area of water-shed available: 1,390 acres.
Water first introduced: In 1856.
Description of distributing reservoir and stand-pipe: Stand-pipe near reservoir; pumping mains enter it at bottom and connect with distributing mains, these connect with reservoir; an outlet from reservoir connects direct with stand-pipe.
Sizes of distributing mains: 24, 20, 16, 12, 10, 8, 6, 4, and 3 inches.
Available head: 60 feet (average); water-supply deficient.
Total length of distributing mains: 80 miles.
Number of water-takers: 10,400.
Consumption of water: 40 gallons per head per day.
First cost of water-works: $281,400.
Average annual cost of maintenance and repairs: $8,400.
Filtering apparatus: Gallery excavated near edge of little pond; size, 40 by 50 feet; gravel; no cleaning.

729—843
CAMBRIDGE—Continued.
Number of fire-plugs: 315.
Design and dimensions of pumps and water-plungers: Two
built by Worthington, New York, in 1866 and 1872; two
plain plungers to each; 22 inches diameter; 48 inches stroke;
26 strokes per minute; pump-barrels 22 by 48 inches.
Time pumps are run: 11 hours per day.
Description of force-main: 2,400 feet long; one 30 inches diame-
ter and one 24 inches diameter; 25 pounds pressure on pumps.
Description of water-valves: Rubber; 9 inches diameter; ½
inch lift.
Kind of power used: Steam.
Description of boilers: Four horizontal tubular; two 13 feet
long, 63 inches diameter; two 15 feet 6 inches long, 60 inches
diameter; 35 pounds pressure; fuel, Cumberland coal.
Description of engine: Compound condensing; high-pressure
cylinder, 14 inches diameter; low-pressure cylinder, 24
inches diameter; 48 inches stroke; 28 strokes per minute
(average); slide-valves with piston counter-balances op-
erated from opposite cross-head; single-acting air-pump; jet-
condenser.
Cost of engine and pumps: $68,000.
Duty of engine: 50,000,000 foot-pounds daily.

OHIO.

WEST CLEVELAND:
Population: 4,650 inhabitants.
Supplied by Cleveland water-works (see pages 112 and 113).

ZANESVILLE:
Population: 18,113 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Muskingum river.
Water first introduced: In 1854.
Discharging capacity of conduit: 5,000,000 gallons in 24 hours;
head, 150 feet (average).
Description of distributing reservoirs and stand-pipe: Two
reservoirs for low service; capacity, 5,000,000 gallons; stand-
pipe for high service; head, 60 feet above reservoir.
Sizes of distributing mains: 10 to 3 inches.
Available head: 160 feet (average).
Total length of distributing mains: 54 miles.
Number of water-takers: 3,000.
Consumption of water: 90 gallons per head per day (estimated).
First cost of water-works: $250,000.
Average annual cost of maintenance and repairs: $12,000.
Number of fire-plugs: 169.
Design and dimensions of pump and water-plunger: Wor-
thington, New York, duplex; plate plunger, 18 inches diame-
ter; 28 inches stroke; 60 strokes per minute; pump-barrel, 37
by 30 inches.
Time pump is run: 15 hours per day.
Description of force-main: 2,000 feet long; 20 inches diameter;
70 pounds pressure on pump.
Description of water-valves: Gum; 7 inches diameter; 1 inch
lift.
Kind of power used: Steam.
Description of boilers: Four tubular; 14 feet long, 54 inches
diameter; 60 inches, 3 inches diameter each; 35 pounds pres-
sure; fuel used, slack.
Description of engine: Non-condensing; cylinder, 30 inches
diameter; 35 inches stroke; 60 strokes per minute; globe
throttle-valves.
Cost of engine and pump: $17,000.

PENNSYLVANIA.

ALLENTOWN—Continued.
Water first introduced: In 1823.
Description of main conduit: 2,230 feet long; 12 inches diam-
eter; cast iron.
Discharging capacity of distributing reservoir and stand-pipe: The
former, 48 by 28 feet and 33 feet deep; bottom 142 feet above
level of pump; capacity, 275,000 gallons. The latter, 57 feet
high, 6 feet diameter; base 128 feet above pump; capacity, 134,222
gallons.
Sizes of distributing mains: 10 to 6 inches.
Available head: 8 to 126 feet; water-supply deficient.
Total length of distributing mains: 22 miles.
Number of water-takers: 2,350.
Consumption of water: About 2,000,000 gallons per day (esti-
imated).
First cost of water-works: $87,000.
Number of fire-plugs: 99.
Design and dimensions of pump and water-plunger: Built
two plain plungers; 5 feet 6 inches; 124 strokes per minute;
pump-barrel, 16 inches diameter.
Time pump is run: Constantly.
Description of force-main: 1,000 feet long; 10 inches diam-
eter; 132.5 pounds pressure on pump.
Description of water-valves: Brass; 10 by 14 inches; 1 inch
lift.
Kind of power used: Water.
Description of water-wheel: Wolse's patent turbine; 6 feet
* diameter; 6 feet head; 30 revolutions per minute.

WISCONSIN.

MILWAUKEE:
Population: 156,557 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Lake Michigan.
Water first introduced: In November, 1873.
Description of main conduit: From lake-crib to pump
well, 2,100 feet long; 36 inches diameter; cast iron; the
head or difference of level between lake and pump-well
depends on speed of pumps, being 3 feet 2 inches when
engines are pumping at the rate of 16,000,000 gallons per 24
hours.
Description of distributing reservoir and stand-pipe: Reser-
voir capacity, 21,000,000 gallons; embankment, 10 feet wide
on top; inner slope, 12 to 1; outer slope, 12 to 1; inner slope
and bottom covered with, first, clay subdyle 2 feet thick;
second, 9 inches broken stone; third, paving 15 inches thick,
laid in cement and mortar; water enters on cast-iron di-
fluent-chamber, stop-valves, waste- and overflow-pipes on west
side; influent- and effluent-pipes connected by main on bot-
tom of reservoir for direct supply in case of necessity. Stand-
pipe, wrought iron; 4 feet diameter; 130 feet high; in-
closed in stone tower.
Sizes of distributing mains: 30, 24, 20, 16, 12, 8, and 6
inches.
Available head: 90 to 140 feet, according to location.
Total length of distributing mains: 90 miles.
Number of water-takers: 7,524.
Consumption of water: 12,200,000 gallons per day; about 100
gallons per head (average) at valves.
First cost of water-works: $4,367,600.
Average annual cost of maintenance and repairs: $30,000.
Number of fire-plugs: 716.
Design and dimensions of pumps and water-plunger: R. W.
Hamilton, built by E. P. Allis & Co., Milwaukee, Wisconsin,
in 1873; two bucket-plungers; 38½ inches diameter; 7 feet
stroke; 60 strokes per minute; pump-barrel, 3 feet 4 inches
diameter.
Time pumps are run: About 18 hours per day.
PUMPING TO DISTRIBUTING RESERVOIR AND STAND-PIPE.

MILWAUKEE—Continued.
Description of force main: 225 feet long; 36 inches diameter; head, about 170 feet on pumps.
Description of water-valves: Bucket, double-seated; outside diameter lower seat, 34 inches; inside diameter, 20 inches; 1½ inch lift.
Kind of power used: Steam.
Description of boilers: Drop return-due; 24 feet long; 7 feet diameter; 60 pounds pressure; evaporation, 0.15 pounds of water to 1 pound of coal; fuel, anthracite coal.

761

MILWAUKEE—Continued.
Description of engines: Condensing compound; high-pressure cylinder, 36 inches diameter, 62.14 inches stroke; low-pressure cylinder, 58 inches diameter, 60 inches stroke; 26 strokes per minute; ordinary steam-valve, operated by cam cut-off; single-acting air-pump, 30 inches diameter, 32 inches stroke; common condenser, 36 inches diameter, 84 inches high.
Cost of engines and pumps: $170,000.
Duty of engines: 75,000,000 to 80,000,000 foot-pounds, daily; 60,000,000 foot-pounds guaranteed.
WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

ALABAMA.

BIRMINGHAM:

Population: 3,686 inhabitants.
Name of corporation: Elton Land Company (private).
Water obtained from: Creek.
Total area of watershed available: 40 square miles.
Capacity of reservoir: 1,000,000 gallons.
Cost of dam: $7,500.
Water first introduced: In May, 1873.
Description of main conduit: Part of stone, 30 by 30 inches square; part cast iron, 4,600 feet long; 12 inches diameter.
Discharging capacity: 3,000,000 gallons per day.
Description of distributing reservoir: Dimensions—68 by 95 feet, bottom; 100 by 150 feet, top; 12½ feet deep; embankment of earth, lined inside with one course of brick, and one edge laid in cement.
Sizes of distributing mains: 8, 6, 4, 3, and 2 inches.
Available head: 130 feet (average).
Total length of distributing mains: About 8 miles.
Number of water-takers: 450.
Consumption of water: 100 gallons per head per day (estimated).
First cost of water-works: About $50,000.
Average annual cost of maintenance and repairs: $200 to $500.
Number of fire-plugs: 15.
Design and dimensions of pumps and water-plungers: One Worthington; pump-barrel, 10 by 10 inches. One Blake; pump-barrel, 14 by 14 inches. One Williamson; pump-barrel, 10 by 24 inches; 180 strokes per minute. Time pumps are run: 8 hours per day for 2 pumps. Description of force-main: 4,600 feet long; 12 inches diameter; head, 175 feet on pumps. Description of force-valves: Rubber; 3 and 3½ inches diameter; ½ inch lift. Kind of power used: Steam.
Description of boilers: Return tubular; 10 feet long; 5 feet diameter; 64 tubes, 4 inches diameter each; fuel: wood.
Description ofengines: One compound condensing, 14 by 14 inches; 24 by 14 inches; one high-pressure, 14½ by 10 inches; 2½ strokes per minute; slide-valves operated by opposite engine; four single-acting-air-pumps, 12 inches diameter; 10 inches stroke; jet-condenser, 18 by 26 inches.
Cost of engines and pumps: $20,000.

JACKSONVILLE—Continued.

Description of stand-pipe: 10 inches; cast iron; 100 feet high; in case of fire this is shut off and direct pumping is practiced.
Sizes of distributing mains: 14 to 6 inches.
Available head: 100 feet (average).
Total length of distributing mains: 6 miles.
Number of water-takers: 150.
Consumption of water: 50,000 gallons per day (exact).
First cost of water-works: $65,000.
Number of fire-plugs: 87.
Design and dimensions of pumps and water-plungers: Built by Worthington, New York, in 1869; plain plungers; 6½ strokes per minute; pump-barrel, 18 by 30 inches and 16 by 24 inches.
Time pump is run: Constantly.
Description of force-main: 1,420 feet long; 14 inches diameter; 45 pounds pressure on pump.
Description of water-valves: Rubber; 6½ inches diameter; 1 inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 16 feet long; 5 feet diameter; 62 tubes, 4 inches diameter each; fuel: wood.
Description of engines: One compound condensing, 14 by 14 inches; 24 by 18 inches; one high-pressure, 14½ by 10 inches; 2½ strokes per minute; slide-valves operated by opposite engine; four single-acting-air-pumps, 12 inches diameter; 10 inches stroke; jet-condenser, 18 by 26 inches.
Cost of engines and pumps: $20,000.

ILLINOIS.

ALTON:

Population: 8,975 inhabitants.
Name of corporation: Alton Water-Works (private).
Water obtained from: Mississippi River.
Water first introduced: January, 1876.
Description of main conduit: 5 feet high by 2 feet wide; stone laid in cement; head, 3 to 50 feet.
Description of distributing reservoirs: Two tanks, elevated 30 feet above highest point of city; one 40 feet diameter, 24 feet high; the other 30 feet diameter, 16 feet high, set on trestle, making top of tanks 250 feet above pumps.
Sizes of distributing mains: 16, 10, 8, and 6 inches.
Available head: 150 to 250 feet.
Total length of distributing mains: 12 miles.
Number of water-takers: 150.
Consumption of water: 200,000 gallons per day (estimated).
First cost of water-works: $50,000.
Average annual cost of maintenance and repairs: $2,000.
Filtering apparatus: Box filled with sponges; cleaned once a month.
Number of fire-plugs: 87.
Design and dimensions of pumps and water-plungers: Built at Indianapolis; 26 to 30 strokes per minute; pump-barrel, 12 by 30 inches. Worthington, New York, pump being put in now.

FLORIDA.

JACKSONVILLE:

Population: 7,650 inhabitants.
Name of corporation: Jacksonville Water-Works (municipal).
Water obtained from: Well and stream.
Water first introduced: July, 1880.

702—4-40
PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

ALTON—Continued.
Time pump is run: 14 hours per day.
Description of force-main: 14 miles long; head, 250 feet on pump.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Four, 10 feet long; 48 inches diameter; 60 to 70 pounds pressure; fuel, bituminous coal.
Description of engines: Dean; 24 inches diameter; 24 inches stroke; Worthington; 18½ by 14 by 10 inches; double.
Cost of engines and pump: Dean, $5,000.

JACKSONVILLE.
Population: 10,027.
Name of corporation: Jacksonville Water-Works (municipal).
Water obtained from: Reservoir and creek.
Total area of water-shed available: Reservoir, 4 square miles; creek, 20 square miles.
Capacity of receiving reservoir: 6,000,000 gallons.
Chamber and dimensions of dam: 18 feet high across valley.
Cost of dam: $25,000.
Water first introduced: February, 1874.
Description of distributing reservoir: Circular; 136 feet diameter on bottom; 78 feet diameter on top; 15 feet deep; capacity, 2,000,000 gallons; situated on an elevation.
Sizes of distributing mains: 10 to 4 inches.
Available head: 86 feet (average); water-supply deficient.
Total length of distributing mains: 9 miles.
Number of water-towers: 3.
Consumption of water: $12,000 gallons per day (exact).
First cost of water-works: $60,000.
Average annual cost of maintenance and repairs: $8,500 to $4,000.
Number of fire-pluggs: 75.
Design and dimensions of pump and water-pluggers: Built by Worthington, New York, in 1878; two plain pluggers, 15 inches diameter; 16 inches stroke; 16 to 18 strokes per minute; pump-barrel about 31 inches diameter.
Time pump is run: About 18 hours per day.
Time spent in repairs: None.
Description of force-main: 14 miles long; 10 inches diameter; head, 120 to 134.35 feet on pump.
Description of water-valves: Soft rubber, 1 inch thick; 8 inches diameter; 4 inch lift.
Kind of power used: Steam.
Description of boilers: Two tubular, 10 feet long; 60 inches diameter; 48 tubes, 4 inches diameter; 60 pounds pressure; fuel, bituminous coal.
Description of engine: Non-condensing, Worthington duplex; common "T" valve, operated by opposite rocket-shaft.
Cost of engine and pump: $4,000.
Remarks: Water somewhat unpleasant in hot weather.

MORRISON—Continued.
Description of water-valves: Pumped.
Kind of power used: Steam.
Description of boilers: Two tubular, 12 feet long; 42 inches diameter; 34 tubes, 3 inches diameter; fuel, soft coal.
Description of engines: Simple; cylinder, 12 inches diameter; 12 inches stroke; water-cylinder, 7 inches diameter.
Cost of engine and pump: $700.

SPRINGFIELD.
Population: 19,743 inhabitants.
Name of corporation: Springfield Water-Works (municipal).
Water obtained from: Sangamon river.
Water first introduced: In 1858.
Description of distributing reservoir: Square embankment with rounded corners; 275 feet square at top, 236 feet deep; inner slope, 4 1/2 to 1; outside, 2 to 1; paddle facing, 18 inches; stone riprap, 5 inches; bottom, 2 feet of fine clay and 24 feet of concrete; capacity, 4,000,000 gallons; stand-pipes in center, 75 feet high, 30 inches diameter; wrong side.
Sizes of distributing mains: 16, 10, 6, and 4 inches.
Total length of distributing mains: 59 miles.
Number of water-towers: 7.
Consumption of water: 4,350,000 to 2,000,000 gallons per day.
First cost of water-works: $90,000.
Average annual cost of maintenance and repairs: $32,000 to $16,000.
Number of fire-pluggs: 91.
Design and dimensions of pump and fire-pluggers: Built by Worthington, New York, in 1878; plain pluggers, 18 inches diameter; 30 inches stroke; 38 strokes per minute.
Time pump is run: 15 hours per day.
Description of force-main: 20 miles long; 15 inches diameter; cast iron.
Description of water-valves: Rubber disk; 6 inches diameter; 14 inch lift.
Kind of power used: Steam.
Description of boilers: Four tubular, 16 feet long, 5 inches diameter; two with 52 tubes, 4 inches diameter; two with 48 tubes, 4 inches diameter; 60 pounds pressure; fuel used, bituminous coal.
Description of engine: Non-condensing; 30 inches stroke; 48 strokes per minute; slide-valves.
Cost of engine and pump: $13,500 without boilers.

NEW CARLISLE.
Population: 630 inhabitants.
Style of corporation: Municipal.
Water obtained from: Well.
Water first introduced: In 1870.
Description of distributing reservoir: Wooden tank; 40 feet above ground-level; 103 feet from suction at pump-house.
Sizes of distributing mains: 6 and 4 inches.
Available head: 30 feet (average).
Total length of distributing mains: 7,000 feet.
Consumption of water: 3,000 gallons per day (estimated).
First cost of water-works: $7,000.
Average annual cost of maintenance and repairs: $302 95.
Number of fire-pluggs: 13.
Design and dimensions of pump and water-pluggers: Built by Worthington, New York; bucket-pluggers, 7 inches diameter; pump-barrels, 7 inches diameter.
Time pump is run: One hour per day.
Time spent in repairs: None.
Description of force-main: 6 inches diameter; 40 pounds pressure on pump.
Description of water-valves: Rubber; 3 inches diameter; 4 inch lift.
Kind of power used: Steam.
Description of boiler: 60 pounds pressure.
Description of engine: Non-condensing; 14 by 10 inches; slide-valves.

INDIANA.
WATER-SUPPLY OF CITIES

PERU:
Population: 5,230 inhabitants.
Name of corporation: Peru Water-Works (municipal).
Water obtained from: Wabash river.
Total area of water-shed available: 250 square miles.
Cost of dam: $11,811.62.
Water first introduced: In March, 1876.
Description of main conduit: 370 feet long; 20 inches diameter; iron.
Description of distributing reservoir: Square embankment, 20 feet high; water-level, 16 feet above bottom; embankments all puddled 1 foot thick, and with brick laid without mortar.
Sizes of distributing mains: 6, 12, 10, 8, 6, and 4 inches.
Available head: About 33 feet (average).
Total length of distributing mains: 11 miles and 4,454 feet.
Number of water-takers: 100.
First cost of water-works: $100,540.00.
Average annual cost of maintenance and repairs: About $2,000.
Filtering apparatus: Cleaned once a year.
Number of fire-plugs: 102; various designs.
Design of pump and water-plungers: Built by Worthington, New York, in 1870.
Kind of power used: Steam.
Description of boilers: Nasuha steel return-tubular; 10 feet long; 5 feet 4 inches diameter; 65-tubes, 4 inches diameter each; flue, Indiana black coal.
Cost of engine and pump: $47,962.35.
Duty of engine: 50,000,000 foot-pounds guaranteed.

ANAMOSA:
Population: 2,633 inhabitants.
Name of corporation: Anamosa Water-Works Company (private).
Water obtained from: Wapsipiten river.
Cost of dam: $400.
Water first introduced: August, 1875.
Description of distributing reservoir: Built with curved sides and square ends; 60 feet long; 144 feet wide; 16 feet deep.
Size of distributing mains: 60 inches.
Available head: 75 pounds (average).
Total length of distributing mains: 2 miles.
Number of water-takers: 300.
Consumption of water: 25,000 gallons per day (estimated).
First cost of water-works: $15,000.
Average annual cost of maintenance and repairs: $300.
Number of fire-plugs: 7.
Design and dimensions of pumps and water-plungers: Built by Cope & Maxwell, Hamilton, Ohio; boiler-plungers; 10 inches diameter; 30 inches stroke; 25 strokes per minute; pump-barrel, 10 inches diameter.
Time pump is run: 18 hours per week.
Time spent in repairs: 20 hours per year.
Description of force-main: 6 mile long; 6 inches diameter; 75 pounds pressure on pump.
Description of water-valves: Leather; 10 inches diameter.
Kind of power used: Steam.
Description of boiler: Tubular; 40 horse-power; fuel, wood. Description of engine: Simple; cylinder, 16 inches diameter; 34 inches stroke; 25 strokes per minute; slide-valves.
Cost of engine and pump: $2,900.

LYON:
Population: 4,005 inhabitants.
Name of corporation: Lyons Water-Works Company (private).
Water obtained from: Mississippi river.
Capacity of reservoir: 60,000 gallons.
Cost of dam: $2,493.
Water first introduced: March, 1876.
Description of main conduit: 10 inches diameter; cast iron.

LYON—Continued.
Description of distributing reservoir: An excavation on high ground, with massive banking around it; bottom and sides, puddled clay, 18 inches thick; one course of brick laid in water-line over a rubble and water-line coating over puddled clay.
Sizes of distributing mains: 12 to 3 inches.
Available head: 110 feet (average).
Total length of distributing mains: 3 miles.
Number of water-takers: 300.
Consumption of water: 150,000 gallons (estimated).
First cost of water-works: $65,000.
Average annual cost of maintenance and repairs: $1,047.
Number of fire-plugs: 37.
Design and dimensions of pumps and water-plungers: Built by Knowles, Warren, Massachusetts, in 1875; plain plungers, 3 feet 10 inches, 25 strokes per minute; pump-barrel, 30 inches diameter. Built by Cope & Maxwell, Detroit, Michigan, in 1874; plain plunger, 12 inches; 40 strokes per minute; pump-barrel, 24 inches diameter.
Time pumps are run: 8 hours; 2 days per week.
Time spent in repairs: 00 hours per year.
Description of force-main: 1,500 feet long; 10 inches diameter; 80 to 130 pounds pressure on pumps.
Description of water-valves: Lauflow.
Kind of power used: Steam.
Description of boilers: Two 3-1/2; 90 to 100 pounds pressure.
Description of engine: Simple; cylinder, 24 inches diameter; 34 inches stroke; Lauflow valves.
Cost of engine and pumps: $7,500.
Remarks: During low water the water can not be used for domestic purposes.

OTTUMWA:
Population: 9,004 inhabitants.
Name of corporation: Ottumwa Water-Works (private).
Water obtained from: Des Moines river.
Charater and dimensions of dam: Two; stone and wood; 150 feet long; 12 feet wide.
Water first introduced: In 1873.
Description of main conduit: 20 inches diameter; iron.
Discharging capacity: 3,000,000 gallons per day.
Description of distributing reservoir: Built on high elevation.
Sizes of distributing mains: 10 to 4 inches.
Available head: 90 pounds (average).
Total length of distributing mains: 8 miles.
Number of water-takers: 340.
Consumption of water: 75 gallons per head per day (estimated).
Filtering apparatus: Gallery divided into compartments 30 feet square; charcoal; cleaned once a month.
Number of fire-plugs: 76.
Design and dimensions of pumps and water-plungers: Fladers, Vergennes, Vermont; Knowles/steam-pump; four plain plungers; 12 to 30 strokes per minute; pump-barrels, 10, 12, and 14 inches.
Time pumps are run: Constantly.
Description of force-main: 1 mile long; 10 inches diameter; head, 220 feet on pumps.
Description of water-valves: 10 and 12 inches diameter.
Kind of power used: Steam and water.
Description of water-wheels: Eclipse turbine, 72 inches diameter; American turbine, 66 inches diameter; 8 to 10 feet head; about 60 gallons of water required to lift 1 gallon to reservoir.
Description of boiler: Tubular; 70 pounds pressure.
Description of engine: 30 strokes per minute.
Remarks: River is always navigation when the water is high; a slaughter-house above the works imparts a good deal of filth to water.
PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

KENTUCKY.

Bowling Green:
Population: 5,114 inhabitants.
Name of corporation: Bowling Green Water-Works (municipal).
Water obtained from: Barren river.
Water first introduced: In 1858.
Discharging capacity of conduit: Head, 237 feet (average).
Description of distributing reservoir: Oval in shape; on elevation 237 feet above town; capacity, 1,000,000 gallons.
Sizes of distributing mains: 8, 8, and 6 inches.
Available head: 65 pounds (average).
Total length of distributing mains: 7 miles.
Number of water-takers: 500.
Consumption of water: 300,000 gallons per day, or 60 gallons per head (estimated).
First cost of water-works: $100,000.
Number of fire-plies: 46.
Design and dimensions of pump and water-plungers: Designed by C. Hennary; built by Dennis Long & Co., Louisville, Kentucky, in 1871; one plain double-acting plunger; 12 inches diameter; 80 inches stroke; 27 strokes per minute; 12 inches diameter pump-barrel.
Time pump is run: 12 hours per day.
Description of force-main: 6,800 feet long; 8 inches diameter; 100 pounds pressure on pumps.
Description of water-valves: Leather.
Kind of power used: Steam.
Description of boilers: Two flue, 20 feet long, 40 inches diameter; one tubular, 14 feet long, 00 inches diameter, 81 flue; fuel, Green River coal.
Description of engine: Simple; 16 inches diameter; 30 inches stroke; 27 strokes per minute.
Cost of pump and engine: $14,000.

MASSACHUSETTS.

Attleborough:
Population: 11,111 inhabitants.
Name of corporation: Attleborough Water-Supply District (municipal).
Water obtained from: Springs.
Water first introduced: In 1874.
Description of distributing reservoir: Wrought iron; 40 feet high; 50 feet deep; located in brick and covered; capacity, about 280,000 gallons.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 25 to 30 pounds.
Total length of distributing mains: 8 miles.
Number of water-takers: 500.
Consumption of water: 50 gallons per head per day (estimated).
First cost of water-works: $80,000.
Number of fire-plies: 70.
Design and dimensions of pumps and water-plungers: One Blake, Boston; one Worthington, New York, 1871; plain plungers; diameters, 12 and 14 inches.
Time pumps are run: 6 to 8 hours per day.
Time spent in repairs: About 24 hours per year.
Description of force-main: 1 mile long; 32 pounds pressure on pumps.
Kind of power used: Steam.
Description of boilers: Power-reared; fuel, anthracite coal.
Cost of engine and pumps: $1,600.

LAWRENCE:
Population: 30,151 inhabitants.
Style of corporation: Municipal.
Water obtained from: Merrimack river.
Total area of water-shed available: 4,130 square miles.
Water first introduced: December, 1875.
Sizes of distributing mains: 30, 24, 20, 16, 12, 10, 8, and 6 inches.
Available head: 160 feet (average).

LAWRENCE—Continued.
Total length of distributing mains: 42.17 miles.
Number of water-takers: 8,921.
Consumption of water: 681,539,174 gallons in 1880.
First cost of water-works: $1,000,000.
Average annual cost of maintenance and repairs: $15,000.
Filtering apparatus: Gallery, 300 feet long; 2 feet wide; 8 feet high; 15 feet below crest of Essex dam; gravel and sand.
Number of fire-plies: 44.
Design and dimensions of pump and water-plungers: E. D. Leavitt pump, built by L. P. Morris & Co., Fort Richmond Iron-works, Philadelphia, Pennsylvania, in 1875; two bucket-plungers; 12 inches diameter; 28 inches stroke; 14.64 strokes per minute; pump-barrel, 28 inches diameter, 8 feet stroke.
Time pump is run: 11 hours 53 minutes per day (average); 305 days per year.
Time spent in repairs: About 48 hours per year.
Description of force-main: 5,000 feet long; 30 inches diameter; head, 150 feet on pump.
Description of water-valves: Double bevel; cast-iron casing, enclosed rubber ring; 104 inches diameter; 4 inch lift.
Kind of power used: Steam.
Description of boilers: Two fire-box tubular; 26 feet 54 inches long; 5 feet 3 inches diameter; 20 tubes, 3 inches diameter each; 80 pounds pressure; evaporation, 11.99 pounds of water to 1 pound of coal.
Description of engine: Compound; high-pressure cylinder, 18 inches diameter; low-pressure cylinder, 28 inches diameter; 8 feet stroke; grid-iron slide-valves worked by revolving "cann." Double-acting air-pump; 16 inches diameter; 28 inches stroke; internal jet-condenser.
Cost of engine and pump: $120,000.
Duty of engine: 193,299,037 feet-pounds in 1880, daily; guaranteed for 95,000,000 feet-pounds.
Remarks: The advantage in pumping to mains is its prompt availability in case repairs are needed in other systems.

PLYMOUTH:
Name of corporation: Plymouth Water-Works (municipal).
Water obtained from: (1) Great, and (2) Little South ponds; (2) Booi pond; (3) a small lake.
Area of reservoirs: No. 1, 318 acres; No. 2, 24 acres; No. 3, 74 acres; No. 4, 5 acres; all natural reservoirs with artificial connections; no dam required.
Cost of reservoir improvements: $3,000.
Water first introduced: In 1858.
Description of main conduit: 60 feet, 20 inches; 7,100 feet, 10 inches; and 9,000 feet, 10 inches; wrought-iron pipe, coated and lined with cement.
Discharging capacity: 3,000 gallons per hour; head, 10 feet (average).
Description of distributing reservoirs: Oblong; 110 by 200 feet; 10 feet deep; slope 1 to 1; bottom and sides clay paddded 13 feet thick; cost of gravel and sand, 2 feet thick, over which is stone flooring, 10 feet above low-water mark; capacity, 1,800,000 gallons.
Sizes of distributing mains: 8 to 2 inches.
Available head: 50 to 90 feet; water-supply deficient for dwellings; relying on pumps.
Total length of distributing mains: 102,291 feet.
Number of water-takers: 1,900.
First cost of water-works: $100,000.
Average annual cost of maintenance and repairs: $8,900.
Filtering apparatus: Only a wire-screen; cleaned once a month.
Number of fire-plies: 62.
Design and dimensions of pump and water-plungers: Built by H. R. Wethington, New York, in 1879; two plain plungers; 14 inches diameter; 18 inches stroke; 42 strokes per minute; pump-barrel, 20 inches diameter.

705
PLYMOUTH—Continued.

Time pump is run: 14 hours per day.
Description of force-main: 9,000 feet long; 10 inches diameter; head, 60 feet on pump.
Description of water-valves: Rubber; 6 inches diameter; 1½ inch lift.
Kind of power used: Steam.
Description of boilers: Rumford tubular; 14 feet long; 4 feet diameter; 30 pounds pressure; fuel, anthracite coal.
Description of engine: Compound, condensing; duplex; high-pressure cylinder, 14 inches diameter; low-pressure cylinder, 244 inches diameter; 18 inches stroke; 84 strokes per minute; slide-valves operated by plunger; four bucket air-pumps, 9 inches diameter.
Cost of engine and pump: $7,000.
Duty of engine: 53,484,766 foot-pounds, daily; 50,000,000 foot-pounds guaranteed.
Remarks: Water has a fishy taste and smell sometimes, but this never lasts more than two or three weeks.

WEST NEWTON:

Population: (Population included in Newton.)
Style of corporation: Municipal.
Water obtained from: Charles river.
Area and capacity of reservoir: 126,600 square feet; 1,500,000 gallons.
Water first introduced: In 1876.
Sizes of distributing mains: 1½, 2, 3, and 4 inches.
Available head: 0 to 80 pounds.
Total length of distributing mains: 61 miles.
Number of water-takers: 2,521.
Consumption of water: 70,803 gallons per day (estimated).
First cost of water-works: $73,157.22.
Average annual cost of maintenance and repairs: $5,500.
Filtering apparatus: Gallery; gravel; cleaned once a year.
Number of filter-plants: 124.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York, in 1875; two plain plungers, 21 and 21½ inches diameter; 50 inches stroke; 10 strokes per minute; pump-barrels, 3 feet 4 inches diameter; 10 feet 2 inches long.
Time pump is run: 30 hours per week.
Description of force-main: 21,120 feet long; 20 inches diameter; head, 200.75 feet on pump.
Description of water-valves: Rubber; 9½ inches diameter; 1½ inch lift.
Kind of power used: Steam.
Description of boilers: Tubular; 20 feet long; 5 feet 5 inches diameter; 50 pounds pressure; evaporation, 8 pounds of water to 1 pound of coal; fuel, hard coal.
Description of engine: Compound, condensing; high-pressure cylinder, 30 inches diameter; low-pressure cylinder, 60½ inches diameter; 50 inches stroke; 20 strokes per minute; slide-valves piston-valves by rocker-arm; air-pumps, 2 feet 8 inches diameter; 2 feet stroke; jet-condenser.
Cost of engine and pump: $48,000.
Duty of engine: 63,245.110.1 foot-pounds, daily; 50,000,000 foot-pounds guaranteed.

WORCESTER—Continued.

First cost of water-works: $400,000.
Average annual cost of maintenance and repairs: $8,000.
Filtering apparatus: Gallery, 12 by 28 feet; 5 feet deep (average); connected with pump-wells, 20 feet distant, by 24-inch conduit; loose stone wall; no cleaning.
Number of filter-plants: 16.
Design and dimensions of pumps and water-plungers: One built by Worthington, New York, in 1873; two plain plungers, 15 inches diameter; 24 inches stroke; 40 strokes per minute; pump-barrel, 21 inches diameter; 4 feet 2 inches long; one built by G. F. Blake, Boston, in 1880.
Time pumps are run: 313 days per year (average).
Time spent in repairs: About 500 hours per year.
Description of force-main: 1,000 feet long; 14 inches diameter; 90 pounds pressure on pumps (average).
Description of water-valves: Rubber; 6 inch size; ½ inch lift.
Kind of power used: Steam.
Description of boilers: 16 feet long; 5 feet diameter; 88 tubes, 3 inches diameter; 47 pounds pressure; evaporation, 84 pounds of water to 1 pound of coal; fuel, Cumberland coal.
Description of engine: Duplex, compound, condensing; high-pressure cylinder, 18 inches diameter; low-pressure cylinder, 33½ inches diameter; 34 inches stroke; 40 strokes per minute; D-valve operated by rocker-shaft and crank; jet-condenser.
Cost of engine and pumps: About $28,000.
Duty of engine: 50,000,000 foot-pounds, daily; 50,000,000 foot-pounds guaranteed.

MICHIGAN:

GRAND RAPIDS:

Population: 22,016 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Two creeks.
Total area of water-shed available: One, 6 square miles; and one 11.5 square miles.
Cost of reservoirs and dam: Distributing reservoir, $56,000; settling reservoir, $12,000; dam, $500.
Water first introduced: In 1874.
Description of main conduit: 1,993 feet long; 20 inches diameter; iron; head, 20 feet (average).
Description of distributing reservoir: Circular; 196 feet diameter at bottom, 271 feet diameter at top, 25 feet deep; depth of water, 20 feet (average); embankment, earth with rubble walls, 8 feet thick, 23½ feet high in center; capacity, 6,000,000 gallons.
Sizes of distributing mains: 50, 10, 14, 12, 10, 8, 6, and 4 inches.
Available head: 160 feet (average).
Total length of distributing mains: 32.28 miles.
Number of water-takers: 1,900.
Consumption of water: 1,107,424 gallons per day (estimated).
First cost of water-works: $404,000.
Average annual cost of maintenance and repairs: $9,000.
Number of fire-plunges: 325; various designs.
Design and dimensions of pump and water-plungers: Turner pump, built by Dutton & Sons in 1878; piston-plunger, 15 inches diameter, 15 to 20 strokes per minute; pump-barrel, 14½ by 15 inches.
Description of force-main: 2,578 feet long; 16 inches diameter; head, 150 feet on pump.
Description of water-valves: Rubber-feeder; 8 or 10 inches diameter.
Kind of power used: Steam.
Kind of fuel used: Wood.
Description of engine: Horizontal; direct-acting condensing; cylinder, 33 inches diameter; 6 feet stroke; 10 to 20 strokes per minute; balanced piston-valves; condenser, 24 feet diameter, 15 feet high.
Cost of engine and pump: $35,334.90.
MISSOURI—Continued.

Total area of water-supply available: About 40 square miles.
Capacity of reservoir: 100,000,000 gallons.
Character and dimensions of dam: 110 feet long; 12 feet high.
Cost of dam: $200,000; improvements, $75,000.
Water first introduced: March, 1854.
Description of main conduit: To basin, 1 mile long; 24 inches diameter; wrought iron, lined with cement.
Discharging capacity: About 10,000,000 gallons; head 12 feet (average).
Description of distributing reservoir: About 65 feet above water; capacity, 15,000,000 gallons.
Sizes of distributing mains: 24, 20, 10, 12, 10, 6, 4, and 2 inches.
Available head: 60 feet (average); water-supply deficient.
Total length of distributing mains: 40 miles.
Number of water-takers: 3,000.
Consumption of water: 20 gallons per head per day (estimated).
First cost of water-works: $250,000.
Average annual cost of maintenance and repairs: $45,000.
Filtering apparatus: In pumping basin; 160 feet long; 8 feet wide; 8 feet deep; alternate layers of gravel, sand, and charcoal; cleaned once in two years.
Number of fire-plugs: 200.
Design and dimensions of pumps and water-plainters: Built by Howes, A. Phillips & E. H. Judus, Newark, 1854, Elizabeth; plain plunger, packed with leather, 12, 14, and 30 inches diameter; 42 inches stroke; two, 30 strokes per minute, and one, 10 strokes per minute; pump-barrel, 12, 14, and 20 inches diameter.
Time pumps are run: 15 hours per day.
Time spent in repairs: 108 hours per year.
Description of force-main: 24 inches diameter; 35 pounds pressure on pumps.
Description of water-valves: Circular, 6 inches diameter; square strips of rubber in one; rings of rubber in one; central strips on one; about 4 inch lift.
Kind of power used: Steam and water.
Description of water-wheel: One turbine, 54 inches diameter; 12 feet head; 90 revolutions per minute; 17 gallons of water required to lift 1 gallon to reservoir.
Description of boilers: Foar, horizontal tubular, 16 feet long; 42 inches diameter; evaporation, 10 pounds of water to 1 pound of coal; fuel, No. 2 coal.
Description of engines: Condensing; one, 18 inches diameter; 4 feet stroke; one, 24 inches diameter; 4 feet stroke; 30 strokes per minute; D-valve, with cut-off at 4 inch stroke; air-pumps, single-acting, induction butterfly; eduction in the piston; jet-condenser.
Cost of engines and pumps: $10,000.

NEW JERSEY.

ELIZABETH—Continued.

Population: 9,561 inhabitants.
Water obtained from: Flat creek.
Character and dimensions of dam: Drop dam; 109 feet long; 4 feet high; stone piers.
Cost of dam: $150,000.
Water first introduced: In 1872.
Description of main conduit: 3 miles long; 12 inches diameter; cast-iron.
Description of distributing reservoir: Tank, 30 by 40 feet, placed upon treble-work, 40 feet high; total elevation, 60 feet.
Size of distributing mains: 18 inches.
Available head: 60 feet (average).
Total length of distributing mains: About 18 miles.
Number of water-takers: About 400.
Consumption of water: 25 gallons per head per day (estimated).
First cost of water-works: About $325,000.
Average annual cost of maintenance and repairs: About $7,000.
Number of fire-plugs: 32.
Design and dimensions of pumps and water-plungers: Holly; 15 strokes per minute; pump-barrel, 12 inches diameter; 85 pounds pressure.
Time pump is run: 8 hours per day.
Kind of power used: Steam.
Description of engine: Condensing compound; 16 strokes per minute.

BUFFALO.

Population: 155,134 inhabitants.
Water obtained from: Buffalo Water-Works (municipal).
Water first introduced: In 1831.
Description of distributing reservoir: Embankment of earth, 600 by 300 feet; 21 feet deep; slopes, inner, 1 to 1—outer, 14 to 1; width at top, 15 feet; puddle-head to depth of 12 inches; rippled with brick.
Sizes of distributing mains: 11, 12, 10, 8, 6, and 4 inches.
Total length of distributing mains: 108 miles.
Available head: Holly system, 40 pounds pressure; head from reservoir, 60 feet (average).
Number of water-takers: 3,000.
Consumption of water: 15,000,000 gallons per day.
First cost of water-works: $765,000.
Average annual cost of maintenance and repairs: $69,355.
Number of fire-plugs: 1,118.
BUFFALO—Continued.
Design and dimensions of pumps and water-plungers: Two sets built by Holly Manufacturing Company, Lockport, New York, in 1896 and 1877; plain piston-plungers; half of them 14 inches diameter, 24 inches stroke—the rest, 15¼ inches diameter, 36 inches stroke; 30 to 40 strokes per minute.
Two Worthington, New York, 1834-77; plain plungers; 4 feet stroke; 40 strokes per minute. One built by Shepard, Buffalo, New York, in 1867; plain piston-plunger; 24½ inches diameter; 10 feet stroke; 16 strokes per minute.
Time pumps are run: Holly, constantly; Worthington, both sets, total, 418 days; Shepard, seldom.
Time spent in repairs: Variable.
Description of force-main: 3,500 feet long; 20 and 36 inches diameter; 42 pounds pressure on Holly pumps, 30 pounds pressure on others.
Kind of power used: Steam.
Description of boilers: 3 Worthington multitudinal, 16 feet long, 5 feet diameter, 63 4-inch tubes, 35 pounds pressure. Four marine, 16 feet long, 8 feet diameter, 120 4-inch tubes; one 14 feet long, 9 feet diameter, 130 3-inch tubes. Fuel, anthracite coal.
Description of engines: Shepard’s—condensing cylinder, 05 inches diameter; 10 feet stroke; 10 strokes per minute; double-hast valves by name and plug; air-pump, 24 inches by 4 feet; jet-combustor, 4 by 4 feet. Holly—non-condensing or compound cylinders, 14 and 15½ inches diameter; per minute, 22 strokes; 30 to 40 strokes per minute; condenser, 5 by 18 inches; air-pumps, 20 by 18 inches stroke. Worthington—condenser, 40 strokes per minute; jet-combustor, 3 by 6 feet. Air-pumps, 24 by 24 inches and 18 by 24 inches. Cost of engines and pumps: Shepard, $25,000; Holly, $40,500; Worthington, $91,000.
Duty of engines: Shepard, 45,000,000 foot-pounds, daily; Holly, 65,000,000 foot-pounds, daily; Worthington, 45,000,000 foot-pounds, daily.
Remarks: Pumping used because no site sufficiently elevated for reservoir is available.

ROME:
Population: 12,104 inhabitants.
Name of corporation: Rome Water Company (municipal).
Water obtained from: Mohawk river.
Capacity of reservoir: 10,000,000 gallons.
Cost of dam: $20,000.
Water first introduced: In 1879.
Sizes of distributing mains: 10, 12, 10, 8, and 4 inches.
Available head: 20 pounds (average).
Total length of distributing mains: 15 miles.
Number of water-takes: 600.
Consumption of water: 300,000 gallons per day (estimated).
First cost of water-works: $400,000.
Average annual cost of maintenance and repairs: $2,000.
Number of fire-plugs: 125.
Design and dimensions of pump and water-plungers: Built by Watertown Steam-Engine Company, Watertown, New York; plain plungers, 12 by 24 inches; 1 foot diameter; 24 strokes per minute.
Time pump is run: 14 hours per day.
Description of force-main: Head, 65 feet; 20 pounds pressure on pump.
Description of water-values: Double-seated brass; size, 12 inches; 14 inch lift.
Kind of power used: Water.
Description of water-wheels: Two turbines, 6 feet diameter; made by Helen & Harris, Rome, New York; 8 feet head; 16 revolutions per minute.

PENNSYLVANIA.

BETHLEHEM—Continued.
Water obtained from: Spring.
Cost of dam: $20,300.
Description of main conduit: 15,000 feet long; 8, 6, 4, and 3 inches diameter; iron.
Discharging capacity: 777,700 gallons per day.
Description of distributing reservoir: Capacity of tank, 175,000 gallons; filled from mains.
Sizes of distributing mains: 8, 6, 4, and 3 inches.
Available head: 140 feet (average); water-supply deficient.
Total length of distributing mains: 15,000 feet.
Consumption of water: 107,000 gallons per day (estimated).
First cost of water-works: $20,300.
Average annual cost of maintenance and repairs: $1,500.
Design and dimensions of pumps and water-plungers: Cameroon pump, New York, 1874; plain plungers; one steam; 12 inches diameter, 30 inches stroke, 15 strokes per minute; one water, 48 inches stroke, 64-inch plunger, 10 strokes per minute; pump-barrel, 12 inches diameter.
Time pumps are run: Water, constantly; steam, 6 hours per day.
Kind of power used: Steam and water.
Description of water-wheel: One undershot; 8 feet diameter; 20 feet long; 28 inches head; 10 revolutions per minute.
Description of boilers: 25 feet long; 3 feet diameter; 40 pounds pressure; fuel, coal and wood.
Description of engines: Non-condensing; cylinder, 24 inches diameter; 36 inches stroke; 16 strokes per minute; all valves self-operated.
Cost of engine and pumps: $4,000.
Remarks: Water is fresh from the spring; pressure is good.

BLOOMSBURG:
Population: 3,702 inhabitants.
Name of corporation: The Bloomsburg Water Company (private).
Water obtained from: Fishing creek.
Cost of reservoir: $35,000.
Water first introduced: In September, 1880.
Description of distributing reservoir: Built by excavation and embankment; lined with clay and paved with brick; 82 feet 6 inches square at bottom; 127 feet 6 inches square at top; capacity, 1,000,000 gallons.
Sizes of distributing mains: 10, 8, 6, and 4 inches.
Available head: About 150 feet (average).
Total length of distributing mains: 44 miles.
Number of water-takers: 34.
Consumption of water: 800 gallons (estimated).
First cost of water-works: $30,000.
Number of fire-plugs: 40.
Design and dimensions of pumps and water-plungers: Berkline pumps; built by Camden Iron Works; plain plungers; one for each; 64 inches diameter; 20 inches stroke; 50 to 60 strokes per minute; pump-barrel, 64 to 20 inches.
Time pumps are run: 2 hours per day.
Description of force-main: 1,650 feet long; 8 inches diameter; 60 pounds pressure on pumps.
Description of water-values: Berkline, double-boat, water-cushioned; 1 inch lift.
Kind of power used: Steam.
Description of boilers: Two upright tubular; 6 feet long; 5 feet diameter; fire-box, 4 feet high; 157 2-inch flues.
Description of engine: High-pressure; cylinder, 19 inches diameter; 20 inches stroke; 50 to 60 strokes per minute; all valves by bell-stem.
Cost of engine and pumps: $2,500.
Remarks: The advantage and disadvantage of direct pumping are that as a fire protection it is a great success, but is not so for ordinary consumers.

CHAMBERSBURG:
Population: 6,777 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Mountian stream.
PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

**POTTS TOWN**

Population: 6,300 inhabitants.
Name of corporation: Pottstown Gas and Water Company (private).
Water obtained from: Schuylkill river.
Total area of water-shed available: 2,000 square miles.
Water first introduced: In 1870.
Description of main conduit: 5,000 feet long; 10 inches diameter; head, 140 feet.
Description of distributing reservoir: Built in two sections, nearly square, on a hill; partly excavated and partly embankment; puddled with clay; lined with brick laid in cement and cemented every; capacity, 1,600,000 gallons; water not filtered, but run through a screen.
Sizes of distributing mains: 8, 6, and 4 inches.
Available head: 99 to 139 feet.
Total length of distributing mains: 7 miles.
Number of water-takers: 490.
First cost of water-works: About $85,000.
Average annual cost of maintenance and repairs: About $5,000.
Number of fire-plugs: 45.
Design and dimensions of pump and water-plungers: Han- donson pump, built by Philadelphia Hydraulic Works; two plain plungers, 6 inches diameter; 24 inches stroke; 35 strokes per minute; pump-barrel, 8 inches diameter.
Time pump is run: 4 hours per week.
Description of force-main: About 65 pounds pressure on pump.
Description of water-valves: Brass.
Kind of power used: Steam.
Description of boilers: Tubular.
Description of engine: Condensing; cylinder, 10 inches diameter; 24 inches stroke; 35 strokes per minute.
Cost of engine and pump: $11,000.
Remarks: The advantage of pumping direct to mains in reduction of expense for pipes; the disadvantage consists mainly in that consumers are supplied with muddy water from river.

**TENNESSEE.**

Memphis:
Population: 33,302 inhabitants.
Name of corporation: Memphis Water Company (private).
Water obtained from: Wolf river.
Water first introduced: In 1879.
Description of distributing reservoir: Earthen embankment, with puddle face and brick riprap; 16 feet deep; slopes, 1:1; capacity, 5,000,000 gallons.
Sizes of distributing mains: 10, 8, 6, and 3 inches.
Total length of distributing mains: 28 miles.
Number of water-takers: 2,700.
Consumption of water: 4,500,000 gallons per day.
First cost of water-works: $450,000.
Average annual cost of maintenance and repairs: $20,000.
Number of fire-plugs: 184.
Design and dimensions of pumps and water-plungers: Illegible, in 1879; gang of 8 operated by 2-cylinder engine; 8 plain single-acting lift-plungers; 20 inches diameter; 24 inches stroke; 15 strokes per minute; pump-barrel, 20 by 36 inches.
Time pumps are run: Constantly.
Description of force-main: 2 miles long; 20 inches diameter; cast iron.
Description of water-valves: Rubber disk; 16 inches; 3 inches lift.
Kind of power used: Steam.
Description of boilers: Three multitubular; 16 feet long; 70 inches diameter; 120 3-inch tubes in each; 60 to 70 pounds pressure; fuel, best soft coal.
MEMPHIS—Continued.

Description of engine: Non-condensing; 2 cylinders; 20 inches diameter; 33 inches stroke; 37½ strokes per minute; slide-valves.

Duty of engine: 32,000,000 foot-pounds, daily.

Remarks: New engines are being built.

TEXAS.

SAN ANTONIO:


Name of corporation: San Antonio Water-Works Company (private).

Water obtained from: San Antonio river.

Capacity of reservoir: 5,000,000 gallons.

Cost of dam: $150,000.

Water first introduced: In July, 1878.

Description of main conduits: 2 miles and 4,100 feet long; 12 inches diameter; cast iron; head, 154 feet (average).

Description of distributing reservoir: 200 feet square; 20 feet deep.

Sizes of distributing mains: 10, 8, and 6 inches.

Available head: 20 pounds (average).

Total length of distributing mains: About 12 miles.

Number of water-takers: 665.

Consumption of water: 800,000 gallons per day (estimated).

First cost of water-works: $125,000.

Average annual cost of maintenance and repairs: About $10,000.

Number of fire-plugs: 100.

Design and dimension of pump and water-plungers: Built by Worthington, Pittsburgh, Pennsylvania, 1876; duplex; two plain plungers; 10 by 7 inches; 80 strokes per minute; pump-barrel, 20 by 20 inches and 10 inches.

Time pump is run: 6 hours per day.

Time spent in repairs: 46 hours per year.

Description of force-main: 1,400 feet long; 50 pounds pressure on pump.

Description of water-valves: Rubber; 4 inches diameter. One Eclipse, 20 inches diameter; built by Stillwell & Boicee, Dayton, Ohio; 8 feet head; 30 revolutions per minute.

770
WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO STAND-PIPE AND DISTRIBUTING MAINS.

ILLINOIS.

WILMINGTON:
Population: 1,872 inhabitants.
Style of corporation: Municipal.
Water obtained from: Branch of Kankakee river.
Character and dimensions of dam: Across river, 1,000 feet long, 16 feet high; across branch, 700 feet long, 5 feet high.
Cost of dam: $400,000.
Water first introduced: In 1877.
Description of main conduit: 6 inches diameter; cast iron.
Sizes of distributing mains: 4 and 4 inches.
Total length of distributing mains: About 6,000 feet.
First cost of water-works: $6,000.
Number of fire-plugs: 3.
Design and dimensions of pumps and water-plungers: Holly, No. 7; two rotary pumps, Nos. 4 and 7.
Kind of power used: Water.
Description of water-wheel: Lassel turbine; 54 inches diameter; 8 feet head; 75 revolutions per minute.
Remarks: Water used only for fire purposes.

IOWA.

CLINTON—Continued.
Number of fire-plugs: 95.
Design and dimensions of pumps and water-plungers: Built by Copo & Maxwell, Ohio, in 1874; 3 plain plungers, 10 inches diameter; 98 inches stroke; 33 strokes per minute; pump-barrel, 10 by 26 inches. Pressure on pumps—domestic use, 50 pounds; for fire, 100 pounds.
Time pumps are run: One constantly.
Description of water-valves: Rubber; 8 inches diameter; 2 inches lift.
Kind of power used: Steam.
Description of boilers: Two; 16 feet long; 5 feet diameter; 13 6-inch flues.
Description of engine: Non-condensing; cylinder, 10 inches diameter; 98 inches stroke.
Cost of engine and pumps: $13,500.

TEXAS.

HOUSTON:
Population: 10,513 inhabitants.
Name of corporation: Houston Water-Works Company (private).
Water obtained from: Buffalo bayou.
Character and dimensions of dam: Small one below works to keep out tide-water from bay.
Water first introduced: April, 1879.
Description of stand-pipe: 86 feet high; 20 feet diameter.
Sizes of distributing mains: 12, 10, 8, 6, and 4 inches.
Available head: 50 pounds (average); water-supply deficient when it is low in stand-pipe.
Total length of distributing mains: 10 miles.
Number of water-takers: 550.
Consumption of water: 220,000 gallons per day (estimated).
First cost of water-works: $75,000.
Average annual cost of maintenance and repairs: From $5,000 to $10,000, including extensions.
Number of fire-plugs: 91.
Design and dimensions of pump and water-plungers: Built by H. R. Worthington, New York.

771—265
WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIR AND STAND-PIPE.

DISTRICT OF COLUMBIA.

Washington:
Population: 147,203 inhabitants.
Style of corporation: Owned by United States and District of Columbia.
Water obtained from: Potomac river.
Character and dimensions of dam: One at Great Falls; built of rubble and solid masonry.
Cost of dam: $3,784,546.72 expended by the United States; $1,213,315.17 expended by Washington; $40,000 expended by Georgetown.
Water first introduced: In 1856.
Description of main conduit: 9 miles long; 9 feet diameter; brick.
Discharging capacity: 30,000,000 per 24 hours; head, 145 feet (average).
Description of stand-pipe: 63 feet high; 32 feet diameter.
Sizes of distributing mains: 30, 30, and 12 inches.
Water-supply: Deficient.
Total length of distributing mains: 175 miles and 3,777½ feet.

WASHINGTON—Continued.
Consumption of water: 36,000,000 gallons per day, or 176 gallons per head per day (estimated).
Average annual cost of maintenance and repairs: $70,000.
Number of fire-plugs: 550.
Design and dimensions of pumps and water-plungers: One Knowles; one Blake, built in New York; 3 plain plungers; 15 inches diameter; 34 inches stroke; 36 strokes per minute.
Time pumps are run: Constantly.
Time spent in repairs: About 180 hours per year.
Description of force-main: 3,000 feet long.
Description of water-valves: Rubber; 4 inches size; 2½ inches lift.
Kind of power used: Steam.
Description of boilers: 25 pounds pressure; fuel, Cumberland coal.
Description of engines: Condensing compound; 36 strokes per minute; slide and oval valves operated by steam; condenser, 6 by 12.
Cost of engines and pumps: $12,000.
WATER-WORKS EMPLOYING THE GRAVITY SYSTEM AND PUMPING TO DISTRIBUTING RESERVOIR AND MAINS.

MISSOURI.

KANSAS CITY:
Population: 55,785 inhabitants.
Water obtained from: Kansas river.
Water first introduced: In 1874.
Description of main conduit: 1,350 feet long; 24 inches diameter; siphon-pipes.
Discharging capacity: About 3,000,000 gallons per day.
Description of distributing reservoir: Clay embankment laid in 1-foot depths and rolled; bottom, concrete; 9 inches thick; sides paved with limestone 12 to 18 inches thick; dimensions, 300 by 250 feet; water, 21 feet deep; elevation flow-line, 256 feet; capacity, 10,000,000 gallons.
Sizes of distributing mains: 15, 12, 10, 8, 6, and 4 inches.
Available head: 60 to 270 feet.
Total length of distributing mains: About 25 miles.
Number of water-takes: About 1,700.
Consumption of water: 6,070,000 gallons per day (exact).
Average annual cost of maintenance and repairs: $23,000.
Filtering apparatus: Water stands two or three days in subsiding reservoir to allow sediment to settle, then passes through wall of finely broken stone; cleansed twice a year; capacity, 10,000,000 gallons.
Number of fire-plugs: 295.
Design and dimensions of pumps and water-plungers: Built by the Holly Manufacturing Company, Lockport, New York; part piston and part plungers; two, 15½ inches diameter, 30 inches stroke; four, 10 inches diameter, 30 inches stroke; four, 7½ inches diameter, 22 inches stroke; four, 10½ inches diameter, 33 inches stroke; two, 21 inches diameter, 34 inches stroke; 20 to 40 strokes per minute.
Time pumps are run: Constantly.
Description of force-mains: One, 2,100 feet, 20 inches diameter; 30 pounds pressure on pumps; the other, 4,100 feet long, 22 inches diameter, 135 pounds pressure on pumps.
Description of water-valves: Low-service, rubber disks, 15 inches diameter, 1 inch lift; high-service, brass breast, 3 by 10 inches, 5 inch lift; brass pump, rubber seats, 1¾ inch diameter, 1¾ inch lift.
Kind of power used: Steam.
Description of boilers: Return tubular; 16 feet long; 5½ feet diameter; 28 ½ inches lines; grate surface, 92 square feet; 100 square feet coal stanchion.
Description of engines: One set compound condensing, 21 by 30 inches each; one single condensing, 16 by 27 inches; one set of 4 compound condensing, 27 by 33 inches each; 30 to 40 strokes per minute; slide pump--valves; cut-off variable, on top of steam-chest; two single-acting air-pumps to each set; jet-condenser.

KANSAS CITY—Continued.
Duty of engines: Old, 10,000,000 foot-pounds guaranteed; new, 8,000,000 foot-pounds guaranteed.
Remarks: The advantage of pumping to mains consists in the supplying of heights not covered by reservoir; the disadvantage is that constant action is required.

NEW JERSEY.

LAMBERTVILLE:
Population: 4,183 inhabitants.
Name of corporation: Lambertville Water Company (private).
Water obtained from: Trap-dike (Great hill) and Delaware river.
Total area of water-shed available: 1,000 acres.
Capacity of reservoir: 6,007,057 gallons.
Character and dimensions of dam: 200 feet long; 9 feet high.
Cost of dam: $28,741.55.
Water first introduced: November, 1871.
Available head: 164 feet (average).
Number of water-takes: 111.
Description of water-valves: Rubber.
Kind of power used: Steam.
Description of boilers: Tubular; fuel, anthracite, Jeldio mines, Ledigh.
Cost of engine and pump: $1,656.35.
Remarks: The advantage of pumping to mains is that when water is required for fire or for houses use it is received quickly.—Vegetable matter is troublesome in reservoir; water otherwise good.

NEW YORK.

SYRACUSE:
Population: 61,728 inhabitants.
Name of corporation: Syracuse Water-Works (private).
Water obtained from: Brooks, springs, and creek.
Character and dimensions of dam: Earth; back slope, 2½ to 1; front slope, 2½ to 1; width on top, 15 feet; front slope faced 15 inches dry wall, backed with 8-inch lining; puddle wall in center; 6 feet wide on top, increasing 11 inches, 6 feet vertical depth.
Water first introduced: In 1849.
Sizes of distributing mains: 30, 24, 12, 10, 8, 6, and 4 inches.
Available head: 125 to 105 feet.
Total length of distributing mains: 40 miles.
Number of water-takes: 1,135.
Consumption of water: 4,000,000 gallons per day (average).
First cost of water-works: $650,000.
SYRACUSE—Continued.
Average annual cost of maintenance and repairs: $13,000.
Number of fire-plugs: 270.
Design and dimensions of pump and water-plungers: Two plain, hollow, air-tight plungers; 30 inches diameter; 50 inches stroke; 25 strokes per minute; pump-barrel, 35 inches diameter.
Time pump is run: 8 hours per day.
Description of water-valves: Rubber; 10 inches diameter; 1½ inch lift; in chambers above and below plungers.
Kind of power used: Steam.

SYRACUSE—Continued.
Description of boilers: Horizontal tubular; 16 feet long; 5 feet diameter; 60 4-inch tubes; 50 pounds pressure; evaporation, 7 pounds of water to 1 pound of coal.
Description of engines: Duplex compound condensing; 2 high-pressure cylinders, 29 inches diameter; 2 low-pressure cylinders, 50½ inches diameter; 50 inches stroke; 25 strokes per minute; balance D-valve, operated by opposite engine; jet-condenser; 4 air-pumps, 23 inches diameter, 24 inches stroke, bucket type.
Duty of engines: 59,000,000 foot-pounds, daily.
WATER-WORKS EMPLOYING THE GRAVITY SYSTEM: AND PUMPING TO STAND-PIPE AND DIRECT INTO DISTRIBUTING MAINS.

PENNSYLVANIA.

TIoga:
Population: 529 inhabitants.
Name of corporation: T. A. & O. H., Wickham (private).
Water obtained from: Bentley creek.
Total area of water-shed available: About 1 square mile.
Capacity of reservoir: 12,000,000 gallons.
Character and dimensions of dam: On creek; 270 feet long on top; 30 feet high; greatest depth, 25 feet; made of earth, with clay pudding starting from sheet-piling of foundation.
Cost of dam and reservoir: Dam, $2,100; reservoir, $3,000.
Water first introduced: December, 1874.
Description of main conduit: 6, 4, and 3 inches diameter; Wyckoff's patent wooden pipe.
Discharging capacity: 500 gallons per minute; head, 1137 feet (average).

TIoga—Continued.
Description of distributing reservoir: Excavated; size, 80 by 90 feet at water-line; lined with masonry wall faced with brick; slopes, 1 to 4 and 1 to 24; depth of water over discharge-pipe, 16 feet; capacity, 750,000 gallons.
Sizes of distributing mains: 6, 4, and 3 inches.
Available head: 210 feet (average).
Total length of distributing mains: 15,500 feet.
Number of water-takers: 93.
Consumption of water: 230,000 gallons per day (estimated).
First cost of water-works $20,000.
Average annual cost of maintenance and repairs: $30.
Filtering apparatus: One set galleries at reservoir; sand and gravel; cleaning depends on storms.
Number of fire-plugs: 14.
Design and dimensions of pumps and water-plungers: One La France, Elmira, New York; pumping done outside.

776—230
WATER-WORKS EMPLOYING SYSTEM OF PUMPING TO DISTRIBUTING RESERVOIR, STAND-PIPE, AND MAINS.

MASSACHUSETTS.

NEW BEDFORD—Continued.

Duty of engines: No. 1, 45,150,784 foot-pounds, daily; 60,000,000 foot-pounds guaranteed. No. 2, 34,000,875 foot-pounds, daily.

Remarks: A bed of peat under reservoir discolors waters slightly.

PENNSYLVANIA.

CATASAUQUA.

Population: 3,005 inhabitants.
Name of corporation: Crane Iron Company (private).
Water obtained from: Lehigh river.
Water first introduced: In 1843.
Description of main conduit: Open feeder, 1,500 feet long; 25 foot wide; 7 feet deep.
Description of distributing reservoir and stand-pipe: 50 feet square; 12 feet deep; earthen banks; brick laid in cement; stand-pipe, 120 feet high, 48 inches diameter at bottom, 30 inches diameter at top.
Sizes of distributing mains: 12, 10, 8 inches.
Available head: 15 to 40 pounds.
Total length of distributing mains: 2 miles.
Number of water-takers: 268.
First cost of water-works: $6,300.
Average annual cost of maintenance and repairs: $100.
Number of fire-plugs: 3.
Design and dimensions of pump and water-plungers: Homo made; two plain double-acting pistons; 8 inches diameter; 38 inches stroke; 8 strokes per minute; pump-barrel, 8 inches diameter.
Time pump is run: Constantly.
Description of force-main: 100 feet long; 65 pounds pressure on pumps.
Description of water-valves: Gum disk; size, 114 inches; lift, 1 inch.
Kind of power used: Water.
Description of water-wheel: 12 foot diameter; 3 feet head; 21 revolutions per minute.

ERIN.

Population: 27,737 inhabitants.
Name of corporation: City Water-Works (municipal).
Water obtained from: Lake Erie.
Cost of dams: $705,991 58.
Water first introduced: In 1800.
Description of main conduit: 1,400 feet long.
Description of distributing reservoir and stand-pipe: 28 feet deep; capacity, 33,000,000 gallons; stand-pipe, 250 feet high; made of iron, surrounded by a brick tower.
Sizes of distributing mains: 20, 16, 0, and 4 inches.
Available head: 100 to 200 feet.
Total length of distributing mains: 35 miles.
Number of water-takers: About 3,500.
Consumption of water: 77 gallons per head.
First cost of water-works: $107,000.
PUMPING TO DISTRIBUTING RESERVOIR, STAND-PIPE, AND MAINS. 261

Ems—Continued.
Average annual cost of maintenance and repairs: $19,327.45.
Number of fire-plugs: 130.
Design and dimensions of pumps and water-plungers: Built by West Engine Company, Norristown, Pennsylvania; 10 strokes per minute; pump-barrels, 10 foot by 21 inches.
Time pumps are run: Constantly.
Description of force-main: 2 miles long; 20 inches diameter.
Description of water-valves: Crown; 27 inches diameter; receiving-lift, 2 inches; delivery-lift, 1 1/2 inch.

Ems—Continued.
Kind of power used: Steam.
Description of boiler: Horizontal tubular; 60 pounds pressure; evaporation about 0 to 1; fuel, bituminous coal.
Description of engine: Condensing simple-acting; 60 inches diameter; 150 inches stroke; 10 strokes per minute; crown-valves operated by springs; air-pump single; jet-condenser; volume of air-pump, 35.5 foot.
Cost of engines and pumps: $85,000.
Duty of engine: 21,028,000 foot-pounds, daily.