THIRD ANNUAL ISSUE.

The Manual

OF

American Water-Works

COMPILED FROM SPECIAL RETURNS.

Containing the History, Distribution, Consumption, Revenue and Expenses, Cost, Debt and Sinking Fund, etc., etc., of the Water-Works of the United States and Canada.

WITH SUMMARIES
For Each State and Group of States,

AND CLASSIFICATION.
By Size, of Towns Having Works.

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CONSUMPTION OF WATER AND USE OF METERS.

In no department of water-works construction and management, it seems safe to say, is there a greater chance for improvement and economy than in connection with an increased use of meters. In submitting reports and estimates for new works engineers seldom, if ever, include the item of meters, although in the long run it would undoubtedly prove wise if this were done and meters considered as a part of the works. It is true that meters, like service connections, are put in after the main works are completed, and, also like the services, are perhaps more often than otherwise paid for directly by the consumer, or else are rented to him. But meters play so important a part in reducing or keeping down the consumption of water, and consequently the necessary size and corresponding cost of water-works, that they should be introduced at the start, considered a part of the system, and their cost included in the general construction account.

Works already in existence would do well when adding meters to charge their cost to the general construction account. In the case of both old and new works the opposition on the part of consumers would undoubtedly be greatly lessened if the course just named were adopted and the heavy charge to the consumer for the introduction of a meter, or the irksome annual rental often imposed, were thus done away with or avoided from the start. An additional consideration of great importance is that if the meters were considered the absolute property of the water department or company, it would naturally follow that they would be repaired without direct charge to the consumer, and thus unpleasant words would be avoided when the meters were inspected and repairs found necessary, and opposition to their use would be still further lessened. Perhaps of still greater importance would be the city's or company's unrestricted and unquestioned privilege to select just such a meter as it saw fit for any particular service connection, instead of, as is often the case, allowing the consumer to select such a meter as he sees fit, in which case cheapness rather than efficiency is the basis of the choice.

That there is a wide field open for the introduction of meters is shown by the facts regarding their use or non-use presented in the body of the MANUAL and set forth below, especially in Tables 7 and 8–S. The first named table gives a summary by states and groups of states regarding the use of meters and their ratio to the total number of taps in use. The second table is designed to aid in a study of the effects of meters upon the consumption of water.

Before considering the tables in detail it may be said that the statement regarding the field for the introduction of meters is borne out by the following facts regarding the United States as a whole : Of 2,037 water-works only 98 have 20 per cent. or over of their taps metered and these 98 works have about 61 per cent. of all the meters reported, or 109,474 out of a total of 163,178. It might be thought that these works taken together include a majority of all the taps in the United States, but this is not the case, the 98 works reporting but 281,967 out of a total of 2,212,913 taps, or only 13 per cent., against the 61 per cent. of meters on the same 98 works. The very small number of meters in use by some of the largest cities is shown by the first part of Table 8–S, from which it will be seen that but eight of the 50 largest cities of the United States have 20 per cent. or over of their taps metered.

TABLE 7—S.

UNITED STATES AND CANADIAN WATER-WORKS.—USE OF METERS BY STATES AND GROUPS OF STATES.

	Number of		P. ct. taps metr'd.	Number of works				P. ct. of wks. rep't'ng metrs.
				Using metrs.	Not using metrs.	Not report-ing.	Total.	
	Meters.	Taps.						
Maine	362	15,127	2.4	15	14	8	37	40 5
New Hampshire	1,956	17,056	11.5	15	7	14	36	41.7
Vermont	615	9,553	6.4	7	14	6	27	25.9
Massachusetts	31,859	249,499	12.8	92	28	8	128	71.9
Rhode Island	15,036	27,055	55.6	10	1	3	14	71.4
Connecticut	1,110	43,361	2.6	27	14	7	48	56.3
New England	50,938	361,651	14.1	166	78	46	290	57.2
New York	38,469	328,246	11.7	93	72	34	199	47.7
New Jersey	8,546	111,883	7.6	37	14	7	58	63.8
Pennsylvania	2,194	355,309	.6	74	102	40	216	34.3
Delaware	28	13,489	.2	1	4	1	6	16.6
Maryland	1,093	79,551	1.4	12	3	3	18	66.6
District of Columbia	87	35,270	.3	1	0	0	1	100
Middle	50,417	921,748	5.5	218	195	85	498	43.8
Virginia	294	27,382	1.1	12	14	15	41	29.3
West Virginia	6	10,980	.½	3	6	1	10	33.3
North Carolina	495	2.944	16.5	8	3	4	15	53.3
South Carolina	33	1.582	2.1	4	1	2	7	57.1
Georgia	3,806	15.269	24.9	9	5	7	21	42.9
Florida	454	4,055	11.2	6	2	4	12	50
South Atlantic	5,088	62,212	8.2	42	31	33	106	39.6
Alabama	1,304	11,158	11.7	9	7	4	20	45
Mississippi	29	1,550	1.8	3	1	3	7	42.9
Louisiana	39	5,165	.8	3	0	1	4	75
Tennessee	351	17,511	.2	8	2	6	16	50
Kentucky	1,702	28,029	6.1	15	3	5	23	65.2
South Central	3,425	63,413	5.4	38	13	19	70	54.3
Ohio	5,143	127,880	4.2	51	19	16	86	59.3
Indiana	927	17,860	5.2	28	13	9	50	56
Michigan	2,157	83,345	2.6	28	24	61	113	24.7
Illinois	6,121	198,937	3.1	45	13	44	102	44.1
Wisconsin	6,835	46,212	14.8	25	7	18	50	50
North Central	21,183	474,234	4.5	177	76	148	401	44.1
Iowa	2,439	21,086	11.1	32	20	25	77	41.6
Minnesota	1,291	26,759	4.1	13	9	12	34	38.2
Kansas	999	17,910	5.6	33	22	24	79	41.8
Nebraska	1,485	14,266	10.4	18	20	24	62	29.3
South Dakota	78	2,716	2.8	3	12	7	22	13.6
North Dakota	204	1,401	14.5	4	3	0	7	57.1
Wyoming	195	1,598	12.2	3	2	4	9	33 3
Montana	149	2,740	5.5	5	2	4	11	45.4
Northwestern	6,840	88,476	7.7	111	90	100	301	36 8
Missouri	5,924	61,046	9	23	2	11	36	63.9
Arkansas	132	4,399	3	7	5	0	12	58.3
Texas	1,753	33,818	5.2	28	16	16	60	46.7
Colorado	285	24,657	1.1	14	23	20	57	24.6
New Mexico	69	1,436	4.8	3	0	6	9	33.3
Southwestern	8,163	125,356	6.5	75	46	53	174	43.1
Washington	332	7,199	4.6	6	2	30	38	15.6
Oregon	83	11,631	.7	5	11	10	26	19.2
California	16,641	84,081	19.8	36	25	42	103	35
Arizona	55	1.038	5.3	2	0	2	4	50
Nevada	13	5,520	.2	1	3	5	9	11.1
Utah	0	4.684	..	0	4	3	7	0
Idaho	0	1,670	..	0	4	6	10	0
Pacific	17,124	115,823	14.8	50	49	98	197	25.4
Total United States	163,178	2,212,913	7.4	877	578	582	2,037	43.1
Total Canada	3,198	183,849	1.7	32	17	46	95	33.7

The general practice in the several States is shown by Table 7–S, referred to above. This table gives for each State the number of meters and taps and per cent. of taps metered; also the number of works reporting meters in use, number reporting no meters and number not reporting; also the total number of works in each State and the percentage of these which report meters.

For the whole country it will be seen that 877 works report meters in use (one or more), or 43.1 per cent. of all the works; 578 works report no meters, and 582 make no statement. While the number of works reporting meters in use is fairly large compared with the total, it is evident from the percentage of taps metered, 7.4 for the United States, and the fact that 61 per cent. of all meters are on the works having 20 per cent. or more of their taps metered, that many of the works reporting meters have but few in use ; in fact, there are at least 100 with only one, and several others with but two or three meters.

By groups of States the Pacific has the largest percentage of its taps metered, 14.8, and New England next, its percentage being nearly the same, 14.1. The percentages in the other groups range from 8.2 in the South Atlantic to 4.5 per cent. in the North Central, the figures for the whole United States being, as stated, 7.4 per cent. Canada has but 1.7 per cent. of its taps metered, only one works, Cote St. Antoine, P. Q., reporting over 20 per cent. of its taps metered.

By states Rhode Island has by far the largest percentage of taps metered, 55.6 per cent. But a large part of all the taps in the state, 78 per cent., are on three works, the figures for these works and the state being as follows :

	Taps.	Meters.	Per cent. of taps metered.
Providence	14,896	9,286	62.4
Pawtucket	5,322	3,539	66.5
Woonsocket	1,117	924	82.7
Total	21,335	13,749	64.4
Whole state	27,055	15,036	55.6

Pennsylvania has but 0.6 per cent. of its taps metered, 74 works, or 34 per cent. of the total, reporting but 2,194 meters, or an average of less than 30 each, and no works having as many as 20 per cent. metered. Some of the smaller states report a less percentage of meters and Utah and Idaho report none, but from the great state of Pennsyvlvania with its 216 works better things might well have been expected.

Philadelphia, with its 170,911 taps, nearly half of the total for the state, has but 522 meters, 0.3 per cent. of its taps. Chicago, also, reports but a few meters, 3,924 for at least 170,000 taps, the exact number not being known. New York has 20.2 per cent. of its taps metered and an average daily consumption per capita of but 79 galls., while Chicago has a per capita consumption of 138 and Philadelphia of 132 galls. True, New York would have used more water in the first half of 1890 had it been available to consumers, but during the latter half of the year, or a great part of it, an ample supply was furnished.

Chicago and Philadelphia have the largest water-works pumping plants in the country, if not in the world, the combined daily capacity of all the pumps at Philadelphia at the close of 1890 having been 185,290,000 and at Chicago 218,000,000 galls., the latter figures including pumps with a capacity of 20,000,000 galls. for which water was not always available. In addition, Chicago had 42,000,000 galls. pumping capacity not yet ac-

cepted, and both cities let contracts in 1891 for more pumps, those at Chicago to be primarily for use at the Columbian Exposition. In 1890 the total average daily consumption at Chicago was 152,000,000 and at Philadelphia 138,000,000 galls.

It may well be asked why do not these cities, and many others with a showing proportionately bad or worse, reduce their consumption by the use of meters and thus lessen their outlay for pumping machinery, new and larger mains, and other appurtenances and thus lessen, in turn, the fixed and current expenses of the works?

While the field for the introduction of meters is very large, yet advance has been made in the last three years, as is shown in some detail below. This advance is due to the growing enlightenment of the people on the subject, which has been furthered by the experience of cities where meters have been largely used with excellent results and through the educational work done by the American and New England Water-Works Associations at their conventions and in their publications, and, it may be added, by the technical journals. The advance is also very largely due to improvements in meters and possibly to a reduction in their price, together with the business enterprise of the meter manufacturers.

The figures relating to taps and meters given three years ago in the first issue of the MANUAL may be compared with those in the present volume. The number of meters reported in the 1888 and the 1891 MANUALS, the increase and increase per cent., and the per cent. of taps metered, as reported in the two volumes for the several groups of states and for the whole country, is as follows:

	Taps.				Meters.				Per cent. of taps metered.	
	1888.	1891.	Increase.	Increase per cent.	1888.	1891.	Inc.	Inc. per cent.	1888.	1891.
N. E....	315,404	361,651	46,247	14.6	37,913	50,938	13,025	34.3	12.	14.1
Mid....	890,021	921,748	31,727	3.6	34,346	50,417	16,071	46.7	3.9	5.5
S. Atl..	48,334	62,212	12,878	26.6	2,889	5,088	2,199	76.1	6.	8.2
S. Cent.	50,302	63,413	13,111	26.1	2,365	3,425	1,060	44.8	4.7	5.4
N. Cent.	352,463	474,234	121,771	34.6	12,085	21,183	9,098	75.3	3.4	4.5
N. W....	55,538	88,476	32,938	59.3	3,447	6,840	3,407	98.8	6.2	7.7
S. W....	89,756	125,356	45,600	50.8	4,425	8,163	3,738	84.5	4.1	6.5
Pac.....	87,926	115,823	27,897	31.7	9,945	17.124	7,179	72.2	11.3	14.8
U. S.....	1,889,744	2,212,913	323,169	17.1	107,415	163,178	55,763	51.9	5.7	7.4
Canada..	172,947	183,849	10,902	....	2,077	3,198	1,121	54.	1.2	1.7

The last two columns are of special interest, showing that in each group there has been in the past three years an increase in the percentage of taps metered, the Pacific group having increased from 11.3 to 14.8 per cent., and the United States from 5.7 to 7.4 per cent., a gain of 1.7 per cent., or about one-third in the three years.

In numbers the meters have increased 51.9 per cent. in the United States, or from 107,415 to 163,178, against an increase of but 17.1 per cent. in number of taps, or in other words the number of meters has increased at a rate three times as fast as the taps, which agrees with figures given at the close of the last paragraph. In the Northwestern group the number of meters has nearly doubled in the three years, the percentage of increase being 98.8, but the original number was only 3,447. Other details may be seen by referring to the table.

Passing from the use of meters alone to their effect upon consumption, reference may be made to Table 8–S for facts relating to the 50 largest cities of the United States and to all cities of smaller size having more than 50 per cent. of their taps metered. This table shows the population

TABLE 8—S.

CONSUMPTION OF WATER AND USE OF METERS IN THE FIFTY LARGEST CITIES OF THE UNITED STATES AND IN ALL OTHER CITIES, TOWNS OR VILLAGES HAVING FIFTY PER CENT. OR MORE OF THEIR TAPS METERED.

FIFTY LARGEST CITIES.

	Population, 1890.*		Ownership.	Source.†	Mode.†	Number taps.	Number meters.	P. c. taps metered.	Pop'n per tap.	Daily consumption. Total.	Per inhabitant.	Per tap.
1. New York	1,515,301		Pub.	S.	G.	108,884	22,072	20.2	13.9	121,000,000	79	1,111
2. Chicago[1]	1,099,850	(1,085,000)	Pub.	L.	P.	.....	3,924	....	....	152,372,288	140	...
3. Philadelphia[2]	1,046,964	(1,040,000)	Pub.	S.	P.	170,911	522	0.3	6.1	137,736,703	132	806
4. Brooklyn[3]	776,838		Pub.	...	P.	89,493	2,263	2 5	8.7	55,000,000	72	616
	29,505		Co.	S., U.	P.	3,732	.....	....	7.9	.....	...	....
5. St. Louis[4]	451,770		Pub.	S., U.	P.	38,183	3,115	8.2	11.8	32,479,000	72	851
6. Boston[5]	448,477	(527,606)	Pub.	L., S.	G., P.	80,238	4,018	5	6.6	42,173,100	80	525
7. Baltimore	434,439		Pub.	S.	G.	74,728	913	0.1	5.8	40,978,229	94	548
8. San Francisco[6]	298,997		Co.	S.	G.	30,200	12,505	41.4	9.9	18,359,000	61	608
9. Cincinnati[7]	296,908	(302,581)	Pub.	S.	P.	35,439	1,451	4.1	8.5	33,997,007	112	959
10. Cleveland[8]	261,353	(270,055)	Pub.	L.	P.	30,938	1,794	5.8	8.7	27,787,158	103	898
11. Buffalo	255,664		Pub.	S.	P.	40,331	94	0.2	6.3	47,517,137	186	1,178
12. New Orleans[9]	242,039		Co.	S.	P.	4,450	20	0.4	54	8,976,715	37	2,017
13. Pittsburg[10]	238,617		Pub.	S.	P.	25,000	57	0.2	....	36,000,000	144	....
			Co.	S.	P.	7,851	"Very few."	....	8.2	11,509,000	153	1,467
14. Washington[11]	230,392		Pub.	S.	G., P.	35,404	98	0.3	6.5	36,588,629	158	1,033
15. Detroit	205,876		Pub.	S.	P.	40,351	856	2.1	5.1	33,208,067	161	823
16. Milwaukee	204,468		Pub.	L.	P.	18,422	5,876	31.9	11.1	22,380,783	110	1,215
17. Newark[12]	181,830	(185,317)	Pub.	S.	P.	21,532	520	2.4	8.6	14,079,793	76	654
18. Minneapolis	164,738		Pub.	S.	P.	9,990	633	6.3	16.5	12,416,117	75	1,243

* Populations are according to the 1890 census, except in two instances near the foot of the second part of the table. They are for the whole city, regardless of the proportion of the population supplied. When outside populations are supplied the total populations of all cities and towns supplied is given in parenthesis at the right.

† Sources of supply are divided into three classes, lakes, streams and underground, denoted by L., S. and U., respectively. Lakes are designed to include supplies from all bodies of water not artificial; streams, all supplies from springs, running and surface water, and from artificial ponds; and underground, supplies from wells of all kinds or from filter galleries. Modes of supply are divided simply into gravity and pumping.

[1] Chicago. Figures are for main city works. Estimated populations supplied by small public plant built by former village of Washington Heights and of former village of Pullman, supplied by a company, are excluded. Number of taps is unknown, but must be at least 170,000.

[2] Philadelphia. Estimated populations of Holmesburg and Tacony, supplied by companies, are excluded.

[3] Brooklyn. Long Island Water Supply Co. supplies 26th Ward. Figures for city are first given, then those for company. Total population, 806,343.

[4] St. Louis. Figures are for year closing Apr., 9, 1890, as these are nearer census population. Consumption for succeeding year was: Total average daily, 36,001,000; per capita, 80; per tap, 871.

[5] Boston. Supplies Somerville, with population of 40,152; Chelsea, 27,909; Everett, 11,068. About 65% of total supply is by gravity.

[6] San Francisco. Figures are for June 30, 1890. Special report made Dec. 16, 1891, gives following figures: Taps, about 35,000; meters, 14,842, or 42.4% of taps; total average daily consumption for calendar year 1891, with estimates for last 16 days of December, 19,372,000 galls.

[7] Cincinnati. Supplies Avondale and Clifton, with populations of 4,473 and 1,200, latter estimated.

[8] Cleveland. Supplies Brooklyn and West Cleveland, with populations of 4,585 and 4,117.

[9] New Orleans. In addition to taps given there were, April, '91, 5,880 not in use.

[10] Pittsburg. Monongahela Water Co. supplies "South Side" and outside towns with estimated aggregate population of 75,000.

[11] Washington. Figures are for July 1, 1891, and population is for the whole District of Columbia, the government of which and of Washington is now coextensive.

[12] Newark. Supplies Belleville, through meter, population of which is 3,487.

TABLE 8—S—CONTINUED.

	Population, 1890.*		Ownership.	Source.†	Mode.†	Number taps.	Number meters.	P. c. taps metered.	Pop'n per tap.	Daily consumption. Total.	Per inhabitant.	Per tap.
19. Jersey City[13]	163,003	(197,438)	Pub.	S.	P.	20,456	240	1.2	....	19,300,000	97	....
20. Louisville[14]	161,129		Co.	S.	P.	13,512	792	5.9	11.9	11,874,688	74	879
21. Omaha[15]	140,452	(148,478)	Co.	S.	P.	6,193	1,200	19.4	24.	14,000,000	94	2,261
22. Rochester[16]	133,896		Pub.	L., S.	G., P.	24,868	2,844	11.4	5.4	8,800,000	66	354
23. St. Paul	133,156		Pub.	L.	G., P.	10,458	440	4.2	12.7	8,000,000	60	765
24. Kansas City[17]	132,716	(171,032)	Co.	S.	P.	11,198	1,971	17.6	15.3	12,000,000	71	1,071
25. Providence[18]	132,146	(140,000)	Pub.	S.	P.	14,896	9,286	62.4	9.4	6,743,092	48	453
26. Denver	106,713		Co.	U.	P., G.	10,792	85	0.8	....	15,000,000	...	1,381
			Co.	U.	P.	4,500	.....	....	....	5,000,000	...	1,111
27. Indianapolis	105,436		Co.	S.	P.	2,963	226	7.6	35.6	7,500,000	71	2,537
28. Allegheny	105,287		Pub.	S.	P.	15,000	0	0	7	25,000,000	238	1,666
29. Albany[19]	94,923		Pub.	S.	G., P.	15,375	60	0.4	6.2	Unknown.	....	....
30. Columbus	88,150		Pub.	U.	P.	7,619	491	6.4	11.5	6,882,333	78	900
31. Syracuse[20]	88,143		Co.	S.	G., P.	4,100	660	14.6	21.5	6,000,000	68	1,464
32. Worcester	84,655		Pub.	S.	G.	9,450	8,451	89.4	8.9	4,971,340	59	526
33. Toledo	81,434		Pub.	S.	P.	4,374	411	9.4	18.6	5,842,768	72	1,336
34. Richmond	81,388		Pub.	S.	P.	10,383	143	1.4	7.9	13,597,102	167	1,310
35. New Haven	81,298		Co.	S.	P.	"No record."	60	....	...	11,000,000	135	....
36. Paterson	78,347		Co.	S.	P.	6,648	2	....	11.8	10,000,000	128	1,503
37. Lowell	77,696		Pub.	S.	P.	8,471	1,935	22.9	9.2	5,127,199	66	605
38. Nashville[21]	76,168		Pub.	S.	P.	5,098	40	0.8	14.9	11,153,885	146	2,188
39. Scranton	75.215		Co.	S.	G.	1,764	0	....	....	2,500,000	....	1,417
			Co.	S.	G.	.....	.....	....	....	....	....	....
40. Fall River	74,398		Pub.	L.	G	4,980	3,717	74.6	14.9	2,136,182	29	429
41. Cambridge	70,028		Pub.	S.	G., P.	10,554	254	2.4	6.6	4,489,180	64	425
42. Atlanta	65,533		Pub.	S.	P.	3,273	2,934	89.6	20.0	2,359,564	36	721
43. Memphis	64,495		Co.	U.	P.	5,400	200	3.7	11.9	8,000,000	124	1,482
44. Wilmington	61,431		Pub.	S.	P.	12,238	28	0.2	5	6,934,912	113	567
45. Dayton	61,220		Pub.	U.	P.	3,044	117	3.8	20.1	2,848,926	47	936
46. Troy	60,956		Pub.	S.	P.	5,786	226	3.9	10.5	7,698,468	125	1,315
47. Grand Rapids,[22]	60,278		Co.	U.	P.	1,000	150	15	.....	....	.....	.....
			Pub.	S.	P.	3,819	459	12.0	.....	4,392,193	.....	1,150
48. Reading	58,661		Pub.	S.	P.	10,000	6	0.1	5.8	5,000,000	75	439

* See note p, xxiii.

† See note p, xxiii.

[13] Jersey City. Figures are for 1889. Supplies Bayonne, population of 19,033, Harrison, 8,338 and Kearney, 7,064. All towns supplied by meter measure, and Bayonne has large percentage of taps metered, all of which reduces consumption for Jersey City. *Report did not state* whether total average daily consumption includes supply to above places, but it is assumed that it did.

[14] Louisville. City owns practically all of company's stock.

[15] Omaha. Supplies South Omaha; population, 8,026.

[16] Rochester. Domestic supply by gravity from lakes; remainder by direct pumping from river.

[17] Kansas City. Supplies Kansas City, Kan., with population of 38,316.

[18] Providence. Supplies population in adjacent towns, estimated at 10,000, which estimate is low rather than high.

[19] Albany. Taps and meters are for December, 1891.

[20] Syracuse. Figures are for December, 1891, and are approximate.

[21] Nashville. Meters, Dec. 29, 1891, had increased to 172.

[22] Grand Rapids. Company figures, first line, are for 1889.

TABLE 8—S—CONTINUED.

	Population, 1890.*	Ownership.	Source.†	Mode.‡	Number taps.	Number meters.	P. c. taps metered.	Pop'n per tap.	Daily consumption. Total.	Per inhabitant.	Per tap.
49. Camden,[23]	58,313	Pub.	S.	P.	12,336	10	.....	.....	7,660,000	131	.....
50. Trenton,[24]	57,458	Pub.	S.	P.	9,500	46	.....	6.	3,569,150	62	376
CITIES NOT INCLUDED ABOVE HAVING FIFTY PER CENT. OR MORE OF THEIR TAPS METERED.											
Hoboken, N. J.,[25]	48,546 (87,163)	Co.	S.	P.	7,249	4,635	62.4	12.2	5,527,000	63	762
Des Moines, Ia.	50,093	Co.	S.	P.	2,500	1,500	60	20	2,750,000	55	1,100
Pawtucket, R. I.,[26]	23,667 (50,000)	Pub.	S.	P.	5,322	3,539	66.5	9.4	3,216,555	64	604
Utica, N. Y.	44,007	Co.	S.	G.	3,000	2,500	83.3	14.6	.....	.....	.....
Yonkers, N. Y.	32,033	Pub.	S.	P.	2,683	2,212	82.4	12	2,176,396	68	811
Brockton, Mass.	27,294	Pub.	S.	G.	2,700	1,626	60.2	10.1	.....	.....	.....
Newton, Mass.	24,379	Pub.	S.	P.	4,440	2,995	67.4	5.5	985,396	40	224
Joliet, Ill.,[27]	23,264	Pub.	S., U.	P.	365	365	100	.....	1,747,134	75	.....
Lexington, Ky.	21,567	Co.	S.	P.	806	558	69.2	26.7	800,000	37	993
Woonsocket, R. I.	20,830	Pub.	S.	P.	1,117	924	82.7	18.7	326,455	16	292
Bayonne, N. J.,[28]	19,033	Pub.	Jersey City.		870	1,100	.....	.....	.....	.....	.....
Columbus, Ga.	17,303	Co.	S.	G.	818	722	88.3	21.1	.....	.....	.....
San Diego, Cal.,[29]	16,159	Co.	L.	G.	2,394	1,252	52.3	6.8	651,286	40	272
Alameda, Cal.,[30]	11,165	Co.	U.	P.	1,600	1,600	100	.....	.....	.....	.....
Jacksonville, Ill.	10,740	Pub.	S., U.	P.	550	290	52.7	19.5	500,000	47	909
El Paso, Tex.	10,338	Co.	S.	P.	800	450	56.3	12.9	600,000	58	750
Laconia & Lake Village, N. H.,[31]	9,140	Co.	L.	P.	918	500	54.5	9.9	317,739	35	346
Flushing, N. Y.	8,436	Pub.	U.	P.	1,297	675	52	6.5	512,000	61	395
Paris, Tex.	8,254	Co.	U.	G.	196	121	61.7	42.1	150,000	18	765
New Rochelle, N. Y.	8,217	Co.	S.	P.	608	560	92.1	13.5	130,000	16	213
Winston, N. C.	8,018	Co.	U.	P.	155	100	64.5	51.7	150,000	19	968
Westerly, R. I.	6,813	Co.	S.	P.	380	225	59.2	17.9	203,000	30	534
Gainesville, Tex.	6,594	Co.	S.	P.	369	202	54.8	17.9	.....	.....	.....
Pasadena, Cal.,[32]	4,882	Co.	S.	G.	300	300	100	.....	150,000	.....	500
Tarrytown, N. Y.	3,562	Pub.	S.	P.	300	300	100	11.8	.....	.....	.....
Princeton, N. J.	3,422	Co.	S.	P.	288	265	92	11.9	65,000	19	226
Salem, N. C.	2,771	Co.	S., U.	P.	124	105	84.7	22.4	.....	.....	.....
Clyde, N. Y.	2,688	Co.	S.	P.	70	38	54.3	38.4	40,000	15	572
Irvington, N. Y.,[33]	2,299	Pub.	S., U.	P.	100	100	100	.....	15,000	7	.....
Bridgeport, Ala.	1,000 est.	Co.	S.	G.	40	25	62.5	25	.....	.....	.....
Wakefield, R. I.	1,000 est.	Co.	S.	P.	209	143	68.4	4.8	75,000	75	359
Union, Md.	743	Co.	S.	P.	110	115	.....	6.8	40,000	54	364
Green River, Wyo.	723	Co.	S.	P.	310	190	61.3	2.3	500,000	692	1,613

* See note p. xxiii. † See note p. xxiii.

[23] Camden. Taps are for 1888.

[24] Trenton. Taps approximate. Meters for 1887.

[25] Hoboken. Supplies 11 outside towns with combined population of 43,515.

[26] Pawtucket. Supplies several outside towns with population estimated as 23,667.

[27] Joliet. Taps and meters for 1886.

[28] Bayonne, N. J., and Union, Md. Taps and meters are probably unmetered and metered taps, respectively, since reports give more meters than taps.

[29] San Diego. Works are now leased and operated by the city.

[30] Alameda. Supplies Fitchburg, of unknown population.

[31] Laconia and Lake Village. Population estimated.

[32] Pasadena. North Pasadena Land & Water Co.

[33] Irvington. Taps and meters for 1887.

of the several cities; the population on works (not the actual population supplied, but the population of the city in question and other towns supplied by it); the ownership of the works, whether by the public or by a company; the source and mode of supply; number of taps and meters and per cent. of taps metered, together with the population per tap; and under daily consumption the total amount, amount per inhabitant and per tap.

Attention is called to the fact that the populations and average daily consumptions correspond as nearly as possible in point of time, the 1890 census having been taken in June and the consumption being the average for the whole year. Some of the fiscal years do not correspond exactly with the calander years, but with two or three exceptions, indicated in the foot notes, there is not much divergence in this particular.

Unfortunately the population actually supplied by each works cannot be given, as only the total population is known. To supply this lack so far as possible the population per tap has been included for the several works. While this is far from being an absolute guide as to the relative proportion of population supplied, it helps materially in understanding many of the figures for consumption per inhabitant. For instance, New Orleans has the very low daily consumption of 37 galls. and but 0.4 per cent. of its taps metered. But it also has a population of 54 per tap, four times as great as New York with its dense population.

Some of the figures under average daily consumption are evidently estimated and that not very closely, as they are given in millions of gallons. All figures, however, are included as reported. The percentage of taps metered, of course, is more satisfactory than some of the other figures, as the exact number of service connections can always be known and, it is believed, has generally been given.

The above general remarks, together with the foot notes to the table, will enable the reader to form an opinion regarding the value of all figures given. The figures are the best that can be obtained, and are more complete, uniform and more nearly up to date, it is believed, than any ever before published. They give certain facts regarding the consumption of water and use of meters in the 50 largest cities of the United States and in others both large and small which, although they must be taken with qualifications, are for comparative purposes of great general value and are unsurpassed as relating to the several cities in question.

Aside from its value as a convenient reference table the figures above are of chief use in connection with a study of the effect of meters upon the consumption of water. It is true that they do not show what has been done in any of the cities in question by means of inspection of fixtures and other measures to prevent waste, but the use of meters alone has a sufficient effect upon consumption to warrant a study from which all other waste-preventing factors are eliminated. To facilitate this study the 50 largest cities, those in the first part of the table, which are there arranged by size, are given below, first in order of consumption, greatest to least, and then in order of percentage of taps metered. The latter arrangement is placed beside the former and the order reversed from least to greatest, in order that it may be seen how nearly consumptions and meter percentages correspond. The percentage of taps metered is given in connection with the first and the consumption with the last arrangement, and with each the population per tap is included, as well as the

rank of the city in size and also in the classification under immediate consideration. The figures are as follows:

Works arranged in order of

Consumption, greatest to least.

Rank in: Size.	Consumption.	City.	Consumption per inhabitant.	Per cent. taps metered.	Population per tap.
28	1	Alleghany	238	0	7
11	2	Buffalo	186	0.2	6.3
34	3	Richmond	167	1.4	7.9
15	4	Detroit	161	2.1	5.1
14	5	Washington	158	0.3	6.5
13	6	Pittsburg (Co.)	153	small	8.2
38	7	Nashville	146	0.8	14.9
13	8	Pittsburg(Pub)	144	0.2	....
2	9	Chicago	140	...	....
35	10	New Haven	135	...	....
3	11	Philadelphia	132	0.3	6.1
49	12	Camden	131	small	...
36	13	Paterson	128	small	11.8
46	14	Troy	125	3.9	10.5
43	15	Memphis	124	3.7	11.9
44	16	Wilmington	113	0.2	5
9	17	Cincinnati	112	4.1	8.5
16	18	Milwaukee	110	31.9	11.1
10	19	Cleveland	103	5.8	8.7
19	20	Jersey City	97	1.2	....
7	21	Baltimore	94	0.1	5.8
21	21	Omaha	94	19.4	24
6	22	Boston	80	5	6.6
1	23	New York	79	20.2	13.9
30	24	Columbus	78	6.4	11.5
17	25	Newark	76	2.4	8.6
48	26	Reading	75	0.1	5.8
18	26	Minneapolis	75	6.3	16.5
20	27	Louisville	74	5.9	11.9
33	28	Toledo	72	9.4	18.6
4	28	Brooklyn	72	2.5	8.7
5	28	St. Louis	72	8.2	11.8
27	29	Indianapolis	71	7.6	35 6
24	29	Kansas City	71	17.6	15.3
31	30	Syracuse	68	14.6	21.5
37	31	Lowell	66	22.9	9.2
22	31	Rochester	66	11.4	5.4
41	32	Cambridge	64	2.4	6.6
50	33	Trenton	62	small	6
8	34	San Francisco	61	41.4	9.9
23	35	St. Paul	60	4.2	12.7
32	36	Worcester	59	89.4	8.9
25	37	Providence	48	62.4	9.4
45	38	Dayton	47	3 8	20.1
12	39	New Orleans	37	0.4	54
42	40	Atlanta	36	89.6	20
40	41	Fall River	29	74.6	14.9
47	..	Gra'd Rapids(Co)	..	15	....
47	..	G'd Rapids (Pub)	..	12	....
39	..	Scranton (2 Co.'s)	..	....	....
29	..	Albany	..	0 4	6.2
26	..	Denver (2 Co.'s)	..	....	....

Taps metered, least to greatest.

Rank in: Size.	Taps metered.	City.	Per cent. taps metered.	Consumption per inhabitant.	Population per tap.
28	1	Allegheny	0	238	7
49	2 to 5	Camden	small	131	....
36	2 to 5	Paterson	small	128	11.8
50	2 to 5	Trenton	small	62	6
13	2 to 5	Pittsburg (Co)	small	153	8.2
48	6	Reading	0.1	75	5.8
7	6	Baltimore	0.1	94	5 8
13	7	Pittsburg (Pub)	0.2	144	....
11	7	Buffalo	0.2	186	6.3
44	7	Wilmington	0.2	113	5.
3	8	Philadelphia	0.3	132	6.1
14	8	Washington	0.3	158	6.5
12	9	New Orleans	0.4	37	54.
29	9	Albany	0.4	unk'n	6.2
38	10	Nashville	0.8	146	14.9
26	11	*Denver	0.8	....	....
19	12	Jersey City	1.2	97	....
34	13	Richmond	1.4	167	7.9
15	14	Detroit	2.1	161	8.7
41	15	Cambridge	2.4	64	6.6
17	15	Newark	2.4	76	8.6
4	16	Brooklyn	2.5	72	8.7
43	17	Memphis	3.7	124	11.9
45	18	Dayton	3.8	47	20.1
46	19	Troy	3.9	125	11.5
9	20	Cincinnati	4.1	112	8.6
23	21	St. Paul	4.2	60	12.7
6	22	Boston	5.	80	6.6
10	23	Cleveland	5.8	103	8.7
20	24	Louisville	5.9	74	11.9
18	25	Minneapolis	6.3	75	16.5
30	26	Columbus	6.4	78	11.5
27	27	Indianapolis	7.6	71	35.6
5	28	St. Louis	8.2	72	11.8
33	29	Toledo	9.4	72	18.6
22	30	Rochester	11.4	66	5.4
47	31	Gr. R'pids(Pub)	12	...	....
31	32	Syracuse	14.6	68	21.5
47	33	Gr'd R'pids(Co)	15	...	....
24	34	Kansas City	17.6	71	15.3
21	35	Omaha	19.4	94	24
1	36	New York	20.2	79	13.9
37	37	Lowell	22.9	66	9.2
16	38	Milwaukee	31.9	110	11.1
8	39	San Francisco	41.4	61	9.9
25	40	Providence	62.4	48	9.4
40	41	Fall River	74.6	29	14.9
32	42	Worcester	89.4	59	8.9
42	43	Atlanta	89.6	36	20
35	..	New Haven	....	135	....
39	..	Scranton	....	...	....
2	..	Chicago	....	140	....

*Denver City Water Co.

It will be seen from the foregoing that Allegheny has the highest consumption and that it has no meters. It will also be seen that all the places with a high consumption have but a few meters, none of the 17 highest on the list having more than 4.1 per cent. of their taps metered, and Milwaukee being the only city with a consumption of more than 100 galls., which has over 6 per cent. of its taps metered, this percentage at Milwaukee being notably large, 31.9. Glancing down the list it will be seen that as the consumption decreases the percentage of taps metered shows a

general increase until with the two lowest consumptions, 36 and 29 at Atlanta and Fall River, respectively, the percentages of taps metered are 89.6 and 74.6. There are some instances of a low consumption in connection with a very few meters, the most notable one being New Orleans, with a consumption of only 37 galls. and with but 0.4 per cent. of its taps metered. This low consumption, however, is apparent rather than real, the population per tap, as noted above, being 54 against 13.9 in New York, which shows that a very large part of the population is not supplied, a statement which is further proven by the fact that there are more taps in the city not in use than in use.

The classification by percentage of taps metered makes clear, from another point of view, the facts already considered, but does not need further comment than has already been made.

It should be stated before leaving this part of table 8–S that some of the works in question have a rigid system of inspection of fixtures by which the consumption is reduced, as for instance Boston.

The second part of table 8–S shows the same facts as are given in the first part for such of the remaining works of the United States as have over 50 per cent. of their taps metered, arranged in order of size. There are 33 such works, and in addition, four of the 50 largest cities come in this class, as follows: Atlanta, 89.6 per cent.; Worcester, 89.4 ; Fall River, 76.6, and Providence, 62.4 per cent.

No attempt is made to classify works with more than 50 per cent. of taps metered except by size, owing to the wide differences between the several towns and the incompleteness of some of the returns upon which the table is based. It may be said, however, that all the consumptions are low, with the exception of Green River, where, it is believed, a large number of collieries are supplied, beside several railway shops and buildings. None of the other consumptions go above 75 and 12 out of 23 are at or below 30, with 6 below 20. But these figures are often much too low, owing to the large population not supplied, as shown by the high figures in the population per tap column. In addition some of the total average daily consumptions reported are probably not even estimates but mere guesses.

OWNERSHIP.

Those who attended the earlier meetings of the American or New England Water-Works Associations will remember that a favorite subject for discussion was the relative advantages of public and private ownership of water-works. In later years the subject has not been so much discussed by these bodies, possibly because it has been seen that neither side has been making converts, actual connection with public or private works being more forcible than arguments.

Only a few years ago even the total number of water-works was not known, and the ownership still less completely. In collecting information for this issue of the MANUAL, a special effort, which proved successful, was made to close the comparatively few gaps still remaining in the list of ownerships. In addition great pains were taken to ascertain how, in the case of private works, the interests of the public had been guarded in the granting of franchises.

The final results of the above investigations are summarized and commented upon below, but with idea of presenting facts rather than of pleading for either private or public works. It is believed that the facts