feet against 651,642 by the service meters, an under-registration of 176,587 or 21.3%, representing on the 15 meters a revenue loss of $176.58 per month, or 2,119 per annum. Out of the 15 service meters, three over-registered, two, four and eleven per cent., respectively. The under-registrations of the other 12 ran from 6 to 95 per cent. While the results secured on these meters may not be accurately representative, they are at least suggestive of the possible loss of revenue being sustained by lack of proper compounding of the 3,500 odd meters three-inch and larger now in service in the city. (You may note that if the tests were representative of the actual conditions, the annual loss to the city would be upwards of one-half million dollars).

Accuracy and Pressure Loss

Other and more striking examples might be mentioned as illustrations of the possible saving to be secured by compounding. In one instance, the replacing of an old 8-inch Standard meter by a compound combination of an 8-inch current meter, 8-inch regulating valve and 2-inch by-pass meter, resulted in raising the monthly registration from 1,645 to 56,480 cubic feet, a saving of $650 per year.

Tests for accuracy and pressure loss at varying rates of flow have to date been made by the department on five makes of 4-inch compound meters. By a study of resulting curves some features of possible improvement are suggested. On all meters tested, the by-pass meter usually about ¾-inch, is sufficiently small to register with accuracy, very minute flows as low as 0.01 c.f.m., but on the other hand does not seem to be of sufficient capacity to carry the load to a rate which can be accurately registered on the large meter before reaching the pressure loss at which the regulating valve opens, resulting in an under-registration immediately following the opening of the valve and between the total rates of about 1½ and 3 or 4 cubic feet a minute. It would seem from the average curves obtained, that accuracy at these rates which could easily represent a large portion of actual use or continuous fixture leakage was being sacrificed in order to secure registration of the extremely small flows of say less than 0.1 cubic foot per minute which on all services of this size are relatively unimportant.

Under-registration of such service flows may also be due in a large measure to the very gradual opening of the regulating valve, while the by-pass meter subjected as in some makes to the pressure difference, continues to operate on high flow, leaving the increase of flow only to be deflected through the large meter with but slight, if any registration. Instead of this gradual opening regulating valve it would seem that one designed to more abruptly deflect practically the full flow from the by-pass to the main line would be preferable.

On some compound meters the stem of the regulating valve carries within a cylinder a small close fitting piston, one side of which receives the water pressure of the main tending to hold the valve closed while the other side of the piston is open to atmosphere. If this piston were so designed that a slight opening movement of the valve would allow water pressure to replace the atmospheric an opening impulse would be given the valve tending to suddenly reduce the pressure loss, thereby transferring a large portion of the by-pass flow to the large meter and favoring its more accurate registration.

Improvements Suggested

From these more or less superficial observations, the following improvements are suggested:

1. An increase in the capacity of the by-pass meter to cover all service rates too small for accurate registration on the main line meter and at a pressure loss that is sufficiently low to avoid opening of the regulating valve until the flow is well within the range for accuracy on the large meter.

2. A regulating valve so designed as to open more abruptly with either simultaneous closing of the by-pass or with a sufficient reduction of pressure loss to materially relieve the by-pass meter and deflect the bulk of its flow through the main line, thereby setting up a flow through the main line sufficient for accurate registration on the large meter.

RAINFALL RECORDS*

By L. M. Hastings
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At the December meeting of the New England Water Works Association, a letter was read from Robert E. Horten suggesting that an effort be made to get officials in charge of water works to establish rain gauges at the water sheds upon which their water supply depends. While there are a fairly good number of rain gauges established in various parts of New England now, the number might be greatly increased with good results, especially if they were established in locations not already closely covered by existing observers.

The southeasterly corner of New England is well supplied with rain gauges, but there are in the remaining sections of New England large areas where the gauges are very widely separated. Many of these sections are well elevated with many streams, and opportunities for reservoirs, dams, etc., for the development of power or water supplies.

Wide Distribution of Rain Gauges

If, as is recommended so strongly at the present time, a careful study of the streams and water courses of the country is to be made with a view to their more complete development as a source of power in order to conserve the consumption of coal as a power producer, the establishment of numerous rain gauges in various parts of the country will be found exceedingly useful in the study of that important question, as well as the one in which the members of this association are more directly interested, viz.: the development and conservation of our streams as sources of domestic water supplies.

It is proposed in this paper to give a few simple illustrations of ways in which rainfall records may be put to practical use in the study of questions relating to water supply, and so encourage the establishment of additional gauges.

Stations Should Check Results

One advantage to be gained by having gauging stations located at relatively short distances apart would be to check the results obtained at other stations and correct any variation which may appear in the gauging due to special or unusual topographical conditions in the water shed, such as elevation, nearness to large hills, mountains, or water surfaces, directions of prevailing winds, etc. As the amount of rain which may be expected to fall on a given district is often the only basis upon which its values as a power or water producer can be formed, it follows that it is desirable to have the very best data that it is possible to obtain on that vital point.

Location	Average Yearly Rainfall 1874-1913 (40 years)	Rainfall for Year 1880	Rainfall for Year 1883
Manchester, N. H.	38.27	27.30	31.47
Concord, N. H.	38.63	35.28	39.84
Lowell	42.01	35.28	39.84
Waltham	43.36	31.73	29.32
Cambridge, Harvard College	43.49	35.22	32.65
Framingham, Sudbury River	44.26	37.87	31.95
New Bedford	46.65	40.06	43.51
Providence, R. I.	47.20	41.29	39.54

It may be thought that with so many rain gauges already set up, especially in eastern New England, it would be easy to obtain accurate and reliable data for almost any location in that section; but any one not familiar with the subject will be surprised and puzzled at the wide variation in the results obtained at locations not far apart, which often renders any close estimates impossible. As illustrating this fact, the above table has been prepared showing

*Excerpts from a paper read before the February meeting of the New England Water Works Association.