operating the waterworks plant was reduced by 33 per cent. over 1914.

The city's water supply is pumped from Caron, Sask., by kerosene engine power at a cost of $26.57 per million gallons, and is pumped again at Rosedale by electrical power at a cost of $30.29 per million gallons; hence the cost is about 5½ cents per thousand gallons, excluding interest, depreciation of machinery and water mains, etc. Repairs to the steel main from Caron cost $44 per mile, and to the wood pipe line from Snowdy Springs $122 per mile. Repairs to the cast iron mains in the distribution system cost $11.76 per mile.

The total length of sanitary sewers in the city is 37 miles, of which 1 2/5 miles were laid this year, the extension being an 18-inch intercepting sewer laid by day labor at an average depth of 18 ft. and costing $33,893. Considerable difficulty was experienced owing to underground water requiring the operation of two electrically driven pumps day and night for over six weeks. In jointing the sewer to affect watertightness, a composition of asphalt and cement was used. Special care was exercised to prevent the infiltration of ground water into the sewer, the discharge of which must be taken care of at the sewage disposal works.

In the sewage disposal plant, work was in progress all year in connection with the modernizing of sedimentation tanks, installation of traveling distributors over the filter beds, etc., improvements which will be completed before the close of the year. The sludge from the sedimentation tanks is deodorized with chloride of lime before being placed in the sludge beds. The sewage is analyzed by assistant engineers, one day a week being set aside for the purpose. The plant cost $8,788 for operation, being a saving of 28 per cent. over 1914 and 61 per cent. over 1913. The cost of pumping the sewage at the sewage disposal works amounted to $28.37 per million gallons.

The municipally operated power house had an increase of 7.42 per cent. in output over 1914, with a decrease in operating charges, inclusive of fixed charges, of 11 per cent. Owing to the reduction of rates which took effect in July, 1914, the net revenue for the ten months was 14.7 per cent. below the corresponding period of last year. The total revenue for the ten months was $124,440. The operating charges were $119,391. The fuel bill itself was reduced 27 per cent., while the controllable operating expenditures were reduced 21.9 per cent. The cost of production at the power house switchboard was 3.668 cents per kw.-hour, as compared with 4.441 cents per kw.-hour in 1914. The number of consumers shows an increase of 4.8 per cent. The only new work carried out in this department during the year involved the installation of an economizer and an induced draught plant.

The report covers also questions of refuse removal and destruction, health and relief, parks and boulevards, fire department, street lighting, building department, employment bureau and finance.

According to the returns made to the Ontario Bureau of Mines for the nine months ended September 30th, 1915, the nickel mines at Sudbury are being worked to the maximum capacity, and the production of nickel for the nine months nearly equals the largest previous output for a full year. Over 75 per cent. of the output is made by the Canadian Copper Company, but the operations of the Mond Company are now more extensive than formerly and its output has correspondingly increased. The yield of copper was also much greater than in the corresponding period of 1914 and nearly equalled the total output of that year.

RURAL HIGHWAYS.*

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THE fundamental problems which confront an engineer in dealing with public road improvement are concerned with determining, first, which roads should be improved; second, what types of improvement should be employed; and, third, what methods of construction and maintenance are most efficient. To solve these problems intelligently requires skill in handling questions of economics in addition to engineering ability. In other words, the highway engineer should be able to determine what to build and where to build it, as well as how the building is to be done, and he should bear in mind that as much waste is likely to result from improving the wrong roads or employing wrong types of improvement as from using faulty materials or methods in making the improvements. It seems well to consider briefly, therefore, the extent to which determinations of each character may be rationalized.

The only reasonable basis for determining which of perhaps a great number of public roads in a community should be improved, or the order in which improvements should take place, is public convenience. In order to make each improvement add the maximum amount to the convenience of the public, however, it is necessary that the engineer who plans the improvements must have a comprehensive understanding of the economic and social relationship which exists between different parts of the community under consideration and also the effect which different roads, if improved, would have in making this relationship more advantageous.

In order to gain a comprehensive understanding of this kind it is usually necessary for the engineer to prepare a plan showing the various highways in proper relation to each other, and showing also how population and industries are distributed. The amount and character of traffic using each important road, or which would use an improved road having the same location, may be estimated by means of traffic counts or otherwise, and should be shown on the plan.

With such a plan before him, it is practicable for an engineer to lay out an intelligent system of improved highways which would accommodate the entire community, and to assign relative weights to each unit of the system according to its importance. This system would serve as a model toward the development of which all road improvement work should be directed, but which might be readily modified to meet the exigencies arising as the system developed.

The proper type of improvement for any particular road ordinarily depends for the most part on purely economic considerations. That is, the type selected should ordinarily be shown to have a net economic advantage over any other type which might be selected. The economic efficiency of improved roads is affected by a number of factors, some of which are usually more or less indeterminate, but an intelligent evaluation of these factors evidently forms a much more satisfactory basis for making comparisons than would be formed by any set of arbitrary assumptions. Attempting to compare types of improved roads without first evaluating the factors which affect their economic efficiency is in fact very much like attempting to estimate volumes of solids without first

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