The Geological & Natural History Survey

—OF—

MINNESOTA.

HYDROLOGY AND WATER POWERS.

—THE—

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OF MINNESOTA.

[HYDROLOGY OF MINNESOTA.]

To Owners of Mills and unimproved Water-Powers:

It is the aim of the geological and natural history survey to present in a concise form, a statement of the nature and distribution of the waters of the State. This will include some account of the physical phenomena attending the lakes and river-systems, the sources of the water supply, nature of the water, natural and artificial reservoirs, and a history of natural changes that have taken place in the water surface of the State. One of the most important resources of the State of Minnesota lies in the frequent water-powers with which many of its streams are diversified. It is one of the main objects of this branch of the survey to enumerate and describe these various water-powers, and to estimate, as nearly as may be, their capacity and value to the manufacturer. For this purpose the following questions are presented to the owners of water-powers, and a few rules or principles are stated for their guidance in furnishing information to the survey. Many of the water-powers are still unimproved, and practically unknown. In the future development of the State, as in the past, the first settlements, and often the important towns, will be located at those points where water-powers invite the establishment of manufactures. To make this examination of practical utility, the attention of all interested is called to the following points on which information is desired. In many cases the agents of the survey have obtained, or will, the precise data for setting forth the capacity of water-powers, but in many others the owners, or others interested in the development of the State, will be depended on to furnish the information.

1. *Location.* On what stream, and in what town, range and section or township and county.

2. *Amount of head or fall*, i. e., from the surface of the tail-race to a point at 4-9 of the depth of the water from the top, on the weir or dam, or on the brink of the fall.

3. *Width of stream.* Summer stage and freshet stage—on the dam if one has been constructed over which water is allowed to flow; if no dam has been built, then the width of the stream at the brink of the fall.

4. *Average depth of the water*—at summer stage and at freshet stage, measured on the brink of the fall or dam; if no dam has been built, and the fall is too irregular to be measured in this way, the average depth of the stream at a chosen point above or below may be ascertained by taking the mean of several soundings at equal distances across the stream.

5. *Mean velocity of flow per second.* If the average velocity of flow on the brink of the dam, where its depth was taken, can be ascertained, that is all that is needed, in combination with other measurements; if not, the average velocity of the stream at the point at which its mean depth was ascertained must be got. This can be done by getting, first, the surface velocity per second, by means of floats passing in the center of the current where the stream is straight and free from eddies and of uniform depth, and multiplying the result by .82. If the flow be very rapid, or the stream very shallow, this multiplier should be diminished to .65 in extreme cases, and in very sluggish and deep streams it should be increased to .95.

6. *Volume of water per second, in cubic feet.* This is obtained by multiplying the mean velocity per second (No. 5.) by the area of a cross-section of the stream in square feet. The area of the cross-section is found by multiplying the average depth (No. 4.) by the width (No. 3). The depth, width, velocity and the cross-section should all be taken from the same point; and the volume should be given for the stream at summer and at freshet stage. The cubic feet of volume multiplied by 62.5 gives the avoirdupois pounds per second.

7. *Calculated or estimated power of the fall.* The number of horse-powers is ascertained by multiplying the avoirdupois pounds per second (No. 6) by the height of the fall (No. 2), and dividing the product by 550. If the foregoing measurements and calculation cannot be made, an estimate of a water-power, in horse-powers or in mill-powers, is of much value.

8. A theoretical horse-power is the force exerted by the fall of 550 pounds, or 8.8 cubic feet of water, through the space of one foot per second, and a theoretical "mill power" is equal to 62.5 horse-powers. Even with perfect machinery one-third of the power, as above calculated, is lost in transmission to a mill, and hence a mill power in action will require about 93.7 theoretical horse-powers.

9. *Available reservoirs for storage of water.* Their area, whether natural or artificial, and their average depth, should be stated.

10. *To what extent improved.* The number, kind and capacity of the mills erected, so far as the facts can be ascertained, either in horse-powers or in work done.

11. *Names of owners.* Both of the water-power and of the mills erected.

12. Any other facts bearing on the value, either present or prospective, of the water-powers that may be enumerated, such as the presence and accessibility of timber or stone, the nature of the banks or bottom of the stream, and means of exporting products to the nearest market, may be appended to these data.

N. H. WINCHELL,
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