mediate future, and that if a comprehensive policy were to be mapped out into which new developments could be incorporated as component units, there could be no delay in commencing the investigations. So, early in 1911 a survey party was placed in the field.

Scope of the Investigation.—It was intended that the investigation should be sufficiently extensive in scope to furnish the department with all information and data necessary to design a power scheme suitable for the development of the entire water resources of the river in the province of Manitoba. This necessitated extensive investigation into the storage resources of the upper watershed. The scope of the investigation was therefore outlined to include the following:—

A preliminary reconnaissance of the power reach; a continuous base profile; detailed contour surveys with soundings of all falls or rapids at which power concentration was possible; contour surveys of the river banks throughout the entire power reach; determination of the best points of concentration; design of power layouts for such locations; estimates of capital and operating costs of proposed plants; establishment of metering stations at strategic points; establishment of evaporation stations; study of existing rainfall and temperature records; investigation into the question of storage in the upper watershed; study of prior water rights and relative value and effect of same; comprehensive provision for future navigation; close study of all existing power plants and interests; study of present market conditions and future prospects; investigation into cost of power from coal, gas and oil; recommendations for the carrying out of an aggressive policy of development; and recommendations insuring government supervision over regulation, both in connection with individual power plants and of the storage conditions as a whole.

River Discharge.—Owing to the extensive forest cover and to the innumerable lakes throughout the watershed, the Winnipeg River is naturally one of the best-regulated rivers on the continent. In a normal year the flood flow seldom exceeds four times the minimum. Continuous discharge records are available at Slave Falls in Manitoba, at the outlets of the Lake of the Woods, and at Fort Frances, from the beginning of 1907 to date. Actual records over this period show a minimum flow of 11,700 and a maximum of 53,440 cubic feet per second in the power reach in Manitoba. Well-defined water marks along the shores would indicate that a flood of possibly 100,000 second-feet has taken place in the past.

While the natural regulation of the run-off is excellent, there are fine facilities for aiding nature by utilizing reservoir opportunities in the upper basin. Among these natural reservoirs might be listed: Lake of the Woods, 1,500 square miles in area; Rainy Lake, 330 square miles in area; Namakan Lake, 100 square miles in area, and Lac Seul, 340 square miles in area.

A review of the run-off records and a study of the storage opportunities warrants the conclusion that a systematically controlled regulation of the reservoirs in the upper watershed will increase the minimum dependable flow in the power reach to 20,000 cubic feet per second.

The splendid facilities of the Lake of the Woods as a storage reservoir are best illustrated by the mass curve, Fig. 2, in which an assumption is made that the lake had been so operated since 1907 (from which date discharge records are available) as to maintain a dependable flow of 20,000 second-feet in the power reach of the Winnipeg River in Manitoba, and at the same time maintain an outflow from the lake, at all times amply sufficient to meet the needs of the existing power developments at the lake outlets. The mass curve indicates that with systematic supervision, these ends could have been attained with a maximum change in the surface level of some 3.1 feet during the period, against a change of 5½ feet which has actually been experienced with the unsupervised regulation which has been maintained. It might also be noted that the cycle considered covers a prolonged period of exceptionally low run-off.

Field and Office Investigations.—In June, 1911, active field work was commenced by running a continuous line of base levels, to sea level datum, from Lake Winnipeg to the Lake of the Woods. While this was under way a preliminary reconnaissance was made of the entire power reach and the necessary steps taken to continue systematic field studies. Actual contouring was commenced in September at Du Bonnet Falls and was thereafter continued systematically until the entire power reach was covered.

Detailed attention was given to all falls and rapids and possible points of power concentration. The survey work was plotted in the field to a scale of 400 feet to the inch, on standard sized sheets 30 by 37 inches, fifty-five sheets being necessary to cover the power reach from Lake Winnipeg to and including the pond of the Point du Bois plant. Detailed plans to a large scale were made of all important locations.

This immediate plotting on the ground was greatly aided by the loose-leaf field note books adopted throughout the work. Standard sized leather covers with 5 x 8-inch

Fig. 3.—Pine Falls, Site of Proposed Power Station.

Initial development proposed, 60,000 h.p.; final development, 100,000 h.p. Capital cost per h.p.—$50.95 for initial installation, $44.07 for complete installation.