splendid teamwork of the past in collecting and analyzing data be expanded in the future. The friendly and cooperative efforts of all interested Canadian and United States agencies and individuals can be guided towards those objectives of common interest. This is not a task for a single individual or agency but it relies upon the collective efforts of all of us working together for the future.

FORECASTING POWELL LAKE RUNOFF

by

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Our snow course is perhaps somewhat unique to many of you in that it is so close to tidewater. To get up to the course, we start practically from scratch and in 2-1/2 miles (7 hours) of hiking we go from green grass on the edge of Powell Lake at 180 feet above sea level to as much as 12 feet of snow at the course, 3,000 feet in elevation.

All of the 580 square miles of Powell Lake watershed is within 20 miles of tidewater. In the upper reaches, which has peaks up to 7,000 feet elevation and a good deal of which is snowfields at 4,000 to 6,000 feet in elevation, the precipitation is annually around 100 inches and in some of the lower valleys at the head of Powell Lake it is considerably more. In these valleys the vegetation is very dense and the heavy hanging moss growths on the trees gives the weird effect which is also seen in the "rain" forests of the Olympic peninsula and the West Coast of Vancouver Island. Calculations show that the average annual precipitation over the whole watershed must be more than 80 inches to give the actual average runoff of 3,000 c.f.s. from Powell Lake, and this allows nothing for transpiration and evaporation losses. The fact which shows the importance of the snow pack to the runoff is that about one third of the total runoff comes directly from melting snow.

This Snow Course measurement is also used to estimate the runoff into Lois (Gordon Pasha Lakes). Its watershed areas of 184 square miles is adjacent to Powell and is comparatively close to tidewater also. It is generally lower in elevation, has less annual precipitation and less runoff per square mile, than Powell.

More than 100,000 horsepower is generated from the two hydro developments, and this power is used to operate the world's largest newsprint mill at Powell River, turning out now, more than 1,250 tons of newsprint daily. Three hundred tons of newsprint production will be added to this making a total production of 1,550 tons per twenty four hours after our new No. 9 Paper Machine gets started the latter part of this year.

How the Snow Survey Information is Used and its Value

Measurements are made twice during the winter, about January 15th and March 20th. As yet there are only three years or records for the January surveys but the measurement usually has given a very good idea of how much snow water content may be expected in March. For instance, this year we measured twenty-five point nine inches of water content in January which was high compared to the other years and the March measurement was consistent with this, in that there was 46.5 inches which is 50% above our seventeen year March average and close to the peak of fifty inches measured in March 1954.

With the indication from the January measurements we can determine how to operate our power plant until the March survey. If our Lake storage is low and the snow pack is poor we may have to use additional steam power. Also, if the lakes are very low even though the snow pack is good we may have to use additional steam power to make certain of enough water to last until the Spring runoff starts. In this latter case if the January snow pack was heavy we would only use enough additional steam power to get us by until the runoff started, but if the snow pack was low we would use all our available steam power to try to save water for the following summer and fall.

There are similar decisions to be made after the March surveys. This year even though the March snow pack was about 50% above average the Powell Lake level was so low that it was necessary to use extra steam generated power to prevent the Lake from dropping too low before the Spring runoff started. On the average the Spring runoff starts April 15th but last year, 1955, it was May 15th. This year the runoff actually started April 10th and as the snow pack was very good the additional steam generated power was shut down a few days later on April 16th, because with normal Spring, Summer and Fall precipitation, Lake elevations will not drop to dangerous levels.

Information obtained from the snow surveys is valuable in two ways:

1. In order that additional steam power generating equipment may be used in time to keep the Lake elevations from getting dangerously low and possibly causing the shut down of newsprint machines because of lack of power.

2. So that steam power generating equipment can be used as little as possible and keep costs down.

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The value of either of these could run into many thousands of dollars.

Method of Forecasting Runoff

Three sources of data are used in forecasting runoff. These are:

1. Snow surveys
2. Records of precipitation at the townsite of Powell River, B. C.
3. Long range weather forecasts.

From a study of the snow surveys and precipitation records, an empirical formula was set up for runoff to be obtained from the rainfall as measured at Powell River. Incidentally, the precipitation at the townsite of Powell River, nearly all of which is rainfall, only averages 36 inches annually, which is quite different from the 100 inches or more at the head of Powell Lake just 30 miles north.

Curves were made showing the net runoff to be expected from the snow water content at the snow course. Most actual points on the curve are within plus or minus 5%, the worst being about plus or minus 10%. The poor points are nearly all for very low snow water content years. The significance of this latter fact is not known.

Following is a sample calculation of the runoff for 1956:

Snow water content March 20th From the curve this is equivalent to 30.6 feet of Lake storage - (Approximately 29,000 acre feet per foot)	46.5 inches
Add 7% because of a new water diversion = 1.07 x 30.6 =	32.8 feet
On the average 76% of the snow runoff occurs by June 30th.	
Therefore we expect from snow - .76 x 32.8 =	24.9 feet
Rainfall expected to June 30th (average)	7.3 inches
Runoff due to the rainfall = 1.6 x 7.3 =	11.7 feet of Lake
Total runoff to June 30th - 24.9 + 11.7 =	36.6 feet
Average estimated usage to June 30th =	20.3 feet
Left for Storage - 36.6 minus 20.3 =	16.3 feet
Lake elevation at start of period -	268.4 feet
Add 16 feet -	16.3 feet
Estimated final Lake elevation June 30th	284.7 feet

The crest of our dam is 285 feet so we expect it will almost fill by June 30th. Note that this is actually only 185 feet above sea level.

Use of Long Range Weather Forecasts

Last Fall and this Winter we have made use of long range (three months) weather forecasts to aid in predicting our lake position. These forecasts have been reasonably accurate and have helped us considerably. The forecasts were generally that the weather would be colder than normal and that there would be a scarcity of the warm rains which sometimes occur and bring down considerable of the snow pack as runoff in the middle of the winter. Even though these forecasts were not optimistic to us, we have come to place considerable reliance on them. Unfortunately, this year the forecasts proved true and the lake continued to drop until the spring runoff started.

Conclusion

Snow Surveys have been very useful to the Powell River Company in regulating the amount of Hydro Power used, and by letting us predict when we should use additional steam power. For example this year we know from the March Snow Survey, that providing we have average Spring precipitation, Powell Lake will nearly fill from the Spring runoff. Without the snow survey data, and with the reservoir nearly empty, we would, in order to safeguard our position, have had to use additional steam power, until the lake was nearly full. As it was, as soon as we were certain that the runoff had definitely started we were able to shut off our additional steam power.