EFFECTIVE USE OF STORAGE

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ABSTRACT

The operation of a storage system to redistribute nature's excesses to deficient periods of precipitation is a test of man's ability to deal effectively with the weather. The most abundant excess comes during the spring snow melt months. In order to be able to collect all of the excess for distribution at a later time, sufficient room must be made in the reservoir system. However, should too much room be left by mismanagement of the resource, the reservoirs will not fill, thus creating a summer time situation contrary to recreational interests along all of the water ways. Maintaining a balance between excess draft from storage and excess river flows is the subject of this talk.

ORIENTATION

The text of this talk is taken from the operating records of The Union Water-Power Company, Lewiston, Maine. This company regulates the Androscoggin River by utilizing the Rangeley chain of lakes located in northwestern Maine. Regulation is accomplished by first storing the excess spring run-in from 1045 square miles of drainage. These stored waters are released in amounts to maintain the Androscoggin River at as high and uniform a flow as possible on a year-round basis.

BACKGROUND

These data seem to present a contrary picture of a regulating/storage operation. The minimum yield or run-in shows that the storage reservoirs could have filled 1.3 times in the worst year (1980). The contradiction is that the reservoirs did not fill by 26 percent. This difference is explained by some fairly simple arithmetic showing water in (run-in) equals water out (river flow). The reason for a reservoir shortfall is lack of precipitation, or the natural effect, and not reducing flows accordingly, or the man-made effect. Operation of a system of this sort can be termed the "real world". There are no "ifs" or "might have beens". Using more of what mother nature provides leads to reduced reservoir levels and unhappy shoreline owners.

FULL LAKES REGULATION

When the system is well above storage capacity, regulation becomes somewhat easier. Precipitation that will allow maximum hydro use will satisfy industrial needs, and nature's requirements, as well as the tourists'. During above normal water years, storage use, or draw, is little more than 50 percent of reservoir capacity. The problem with above normal years arises when insufficient amounts of water are released in a timely fashion, so that water is not wasted at a later date.

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LOW WATER REGULATION

It is when the system is below the long term average that regulation becomes more significant and more difficult. The river controller's attempt to use the storage system to its maximum capability is deterred by the reality of running out of water. In determining specific monthly flows, the operator must be aware of antecedent and prevailing climatic conditions. A knowledge of local topography and how it influences surface water patterns is essential. Previous weather data, storms, and flows must be studied diligently. While averages of anything are a necessary value to know, they can be virtually worthless when making tomorrow's decision.

We are, after all, dealing with the weather on a fairly large scale. Overall weather patterns, as predicted by the National Weather Service, are of no real value in the long term operation of a system of this nature. It is akin to two adjoining farmers who are trying to get their hay in. The one in the valley is getting a downpour, while the one on a hillside is enjoying sunny skies. Our records show near flood conditions on one side of the drainage, while a mere sixty miles away no rain has fallen for several days.

In evaluating the use of storage, one must ask why storage is provided. Storage in this case, and probably in most other cases, is to augment river flows or water supplies during periods of low flow and poor yields. When viewed in this way, storage use becomes secondary to river regulation. The emphasis is on the flow in the river and not on use of storage. The storage is there to be used, but the use is for another purpose (regulation). It is not there (in storage) for the sake of filling and withdrawing. Storage in our case also provides some degree of local flood control in a very limited way.

EXAMPLE

On the Androscoggin watershed, one must look to river regulation to determine effective use of storage. During the eight months of normally low flow conditions, the long term average regulated flow varies less than seven percent, (eight months average flow is 2030 cfs).

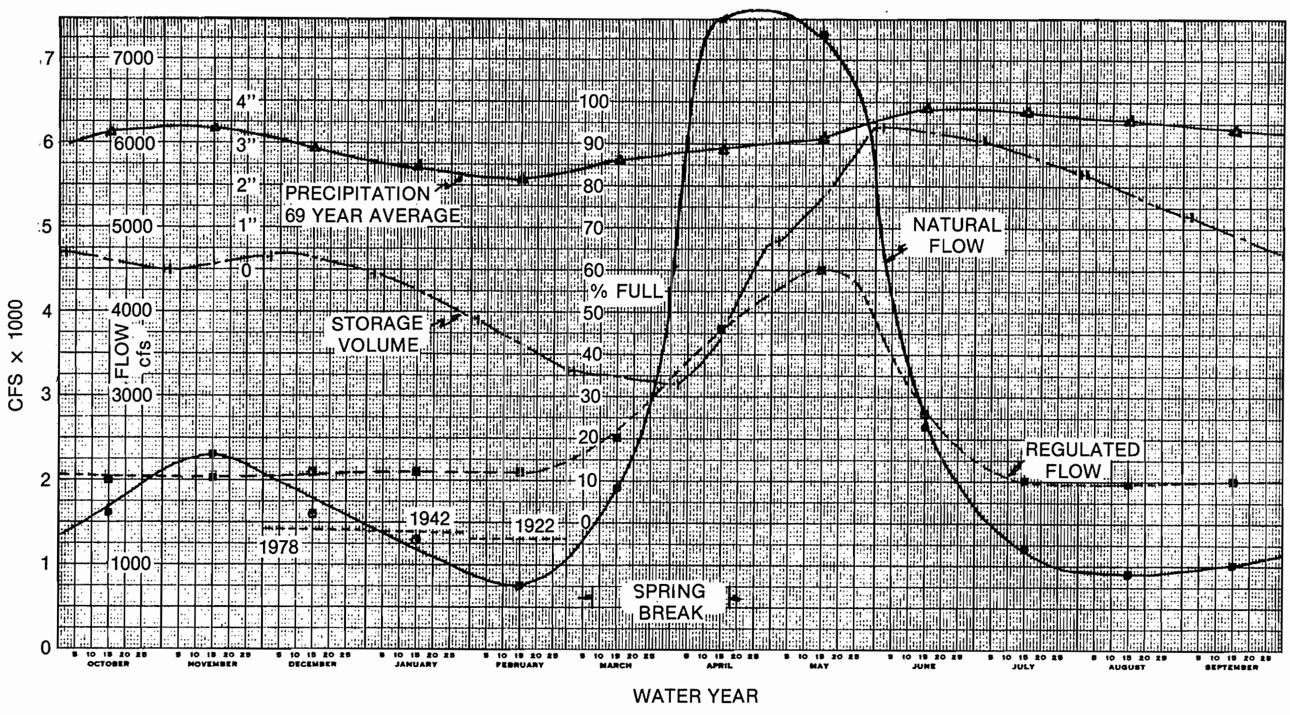

Figure 1: Androscoggin Watershed - The Average Water Year

The remaining four months are in the spring fill period when regulation becomes a function of prevailing climatic conditions. Fluctuation of storage averages 63.2 percent of total storage available.

Extreme minimum thirty day average regulated flows were 1300 cfs (63% LTA) in February 1922, 1390 cfs (66% LTA) in January 1942, and 1432 cfs (67% LTA) in December 1978. These three periods show record low yearly precipitation of 27.32 inches (1921) which is 73% LTA, 29.04 inches (1941) which is 78% LTA, and 35.23 inches (1978) which is 94% of the long term average. With precipitation at 73%, 78%, and 94% of normal, why were the flows at 63%, 66% and 67% of normal? Once again the answer is at least twofold. The precipitation was not spread uniformly throughout the season and management of the storage system was not so prudent as hindsight would have permitted.

In the first two cases cited (1921 & 1941), the precipitation deficiency was uniform throughout the entire year. In 1978, precipitation was 115% above the long term average through July but dropped to 68% through the rest of the year. This resulted in a 94% average for 1978. The problem was that the deficiency occurred in the last five months of the year and at a time when normal recharge can be expected. Regulation during the first half of the year was predicated upon above normal precipitation. By the time reduced precipitation was recognized, the storage system became depleted too much in spite of several cutbacks in regulated flow. This is purely an operational problem but one that is not readily forecast. On a month to month basis, the operator must make assumptions that may not transpire, nor is indecision the answer. Herein lies the fallacy of averages which are made up of highs and lows. Long term river flows average out fairly well with the exception of extreme minimum flows that have occurred at approximately thirty year intervals. The job of the river regulator is to maintain the highest <u>uniform</u> flow throughout the year. He must not run out of water, thereby losing control. He must be able to maintain a predetermined flow.

In order to accomplish this, the operator must estimate how much run-in the system will receive in the forthcoming spring months. This is where the effect of all those little snowflakes comes into the picture. Careful monitoring of water content on the entire drainage is a major tool of projecting fill potential. Figure 2 shows the snow station locations that are measured on March 1st each year. These measurements provide an index from which fill projections can be made. Additional readings are taken at the four principal dams at Errol, Middle, Upper, and Aziscohos. Some care must be exercised in using these water content readings as they are not infallible. Local spring weather conditions play an important part in the snow melt/run-off process.

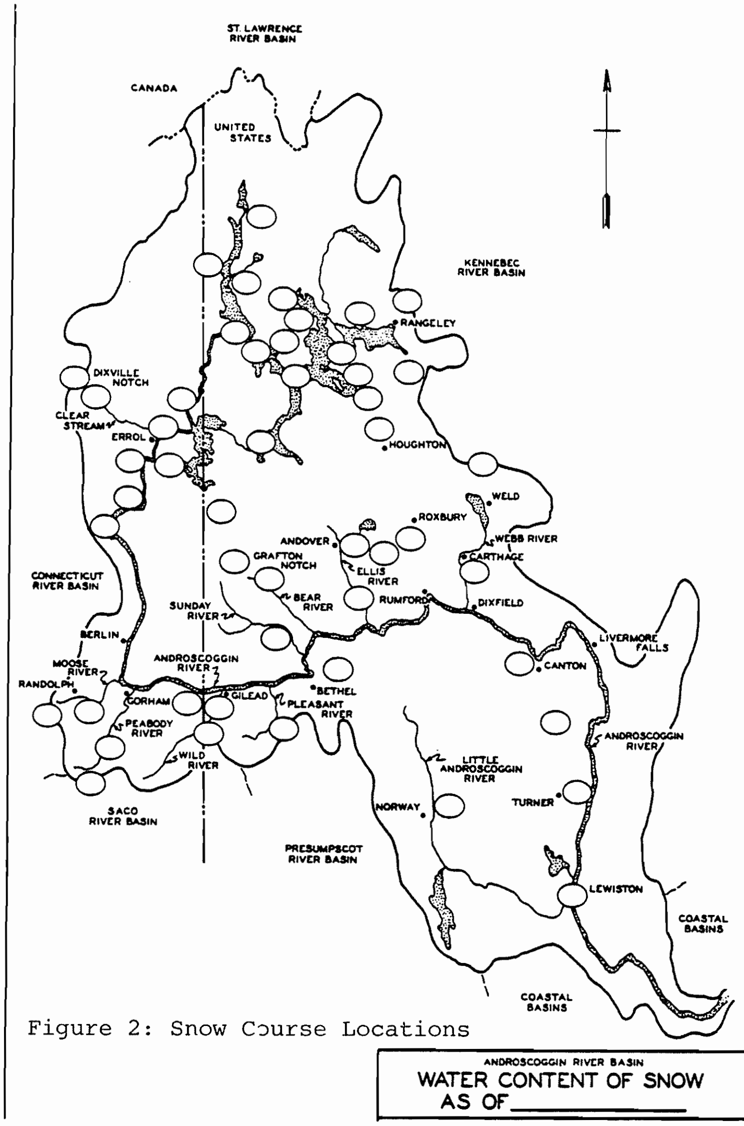

Figure 2: Snow Course Locations

A second tool is precipitation patterns that seem to show a sufficient trend to help the operator with the basic decision of regulating on the high side or low side of the original estimate. When making a projection of upcoming flows, a further consideration is the particular weather pattern of at least six months duration. Once this pattern is recognized, a decision can be made that will allow a flow correction to coincide with the pattern. You may be into the pattern by several months before fully recognizing the change, but sufficient data exists to allow this type of flow correction to be made.

Snowfall is a good example of being forewarned of a pattern. During the winter, regulated flows come largely from stored water and are less dependent on run-in. As the snow pack builds, or fails to build, adjustments can be made in the amount of water released from storage. These releases are further tempered with the above mentioned prevailing weather patterns. For instance, after studying the long term record and present storage conditions, you determine that a flow of 2000 cfs is justified. The next step is to look at the long term (6 - 9 months) weather pattern to see if the flow needs further adjustment. A below normal precipitation pattern will require reduced flows. An above normal pattern will allow increased flows.

CONCLUSION

With optimum system management, the storage should be at its lowest level on the day of spring break, yet be full when the run-in stops. Effective use of storage, therefore, demands that some water always be in storage. Otherwise reliable river flow cannot be guaranteed.