

PRAIRIE PROVINCES WATER BOARD

WATER BOARD REQUIREMENTS

FOR

METEOROLOGICAL DATA AND SERVICES

October 1964.

614 Motherwell Bldg.,
Regina, Saskatchewan.

Members,
Prairie Provinces Water Board.

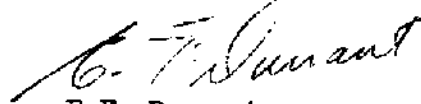
Gentlemen:

The attached brief has been prepared in compliance with your instructions which are recorded in minute 29-07 as follows, "Mr. Boyson suggested that the Secretary prepare a brief on the Board's needs for meteorological information, and on existing arrangements for making Provincial needs known to the Meteorological Branch before entering into correspondence or establishing committees. The Board agreed to Mr. Boyson's comments."

This brief summarizes the needs of the PPWB for meteorological information, the interest of the Board in meteorologic networks, describes the existing channels of communication to the Meteorological Branch, and makes a specific suggestion as to the manner in which the Board could make known its interest to the appropriate authorities. It is suggested herein that a committee be established by the Board for this purpose. Suggested terms of reference for such a committee have been included.

As recorded in minutes 29-04 and 29-06 the Board may wish to consider jointly the matters of hydrometric and meteorologic networks. If this should be the approach adopted by the Board, some modification would be necessary to the terms of reference of the suggested committee.

Respectfully submitted,



E.F. Durrant,
Engineering Secretary,
Prairie Provinces Water Board.

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I.

INTRODUCTION

The Prairie Provinces Water Board Agreement of 1948, charged the members with duties as follows:-

- "(a) to collate and analyze the data now available relating to the water and associated resources of interprovincial streams with respect to their utilization for irrigation, drainage, storage, power, industrial, municipal, navigation and other purposes;
- "(b) to determine what other data are required from time to time in order to reach decisions on questions referred to it and to make recommendations to the appropriate governmental organizations concerned for the carrying out of such field surveys, power investigations, soil surveys, establishment of gauging stations, economic studies relating to drainage and flood control and all similar work which the Board considers necessary to supply information required for the proper performance of its duties."

The minutes of the Board record many discussions as to the urgent needs of the Board for both hydrometric and meteorological data; they record the response of data collection agencies to Board requests; and they record the concern of the Board as to the most effective manner in which the Board could continue its review of such networks.

At the PPWB meeting of August 20, 1964, the Board noted that an hydrometric committee would be established for the three Prairie Provinces, and it expressed its intention to form a similar committee on meteorological matters (or to have a data network committee responsible for both) provided that the need could be clearly shown.

The Secretary was instructed to prepare this brief illustrating the need for a constant review of meteorological data networks and suggesting how the Board might participate most effectively in this review.

In framing this brief, "the Board" was considered as a group which can (and does) represent each Province individually as well as representing the Prairie region as a whole. In this context, the chapter on current needs for, and uses of, meteorological data was prepared. It is followed by a chapter on projected needs for meteorological data and services. With current and projected data needs for a background, the next chapter deals with briefly network adequacy. Then a possible role for the Board in meteorological matters is outlined. The last section is a short statement of the conclusions developed in this brief.

II.

CURRENT NEEDS FOR METEOROLOGICAL DATA

One of the functions of the Prairie Provinces Water Board is to recommend the "best use of water." To implement a "best use" policy the Board must be able to estimate with confidence, quantities of water supply and water use; both of which are highly dependent on weather. Indeed weather data and services are of fundamental importance in planning, administering and regulating water, and they should be fully exploited to achieve "best use." This can be realized only when there is a continuing definition of requirements on the one hand, and on the other hand regular communication of requirements to the Meteorological Branch.

In general terms, the need for meteorological data is clearly indicated by their extensive use. Precipitation data are the basis of many investigations and decisions relating to irrigation, floods, drought, water supplies and regulating structures. Temperature records are commonly used to estimate consumptive use, evaporation, and snow melt. More recently current weather data and forecasts have been used in flood forecasting. Attempts have been made to augment water supplies through weather manipulation. In the next few pages an attempt is made to show more specifically the manner in which meteorological data are used for many purposes.

A. BROAD HYDROLOGY STUDIES BASIC TO
WATER ADMINISTRATION DECISION

The first four PPWB reports are concerned mainly with hydrometric measurements. Subsequent reports, with few exceptions, have relied extensively on climatological records. These are noted below:-

Report #5, 1952: "Evaporation from Lakes and Reservoirs on the Canadian Prairies."

Report #6, 1957: "Precipitation and Streamflow in the Mountain and Foothill Regions of the Saskatchewan River Basin."

Report #8, 1964: "Water Deficiency Patterns in the Prairie Provinces."

Report #9, 1964: "Estimated Water Requirements, Qu'Appelle and Assiniboine River Basin."

The role in the latter report is not great, but significant.

The following reports prepared by Board members have also made extensive use of weather records:-

- 1) Report on Irrigation Water Use Study; Government of the Province of Alberta, Department of Water Resources, 1962.
- 2) A Preliminary Evaluation of Gauging Network Requirements for Operation of the South Saskatchewan Reservoir; South Saskatchewan River Development Commission, 1963.
- 3) Irrigation Land Classification Handbook; Canada Department of Agriculture.
- 4) Climatic Records for the Saskatchewan River Headwaters; Canada Department of Agriculture, PFRA, 1963.
- 5) Weather Observation Network in the Eastern Rockies; Canada Department of Agriculture, PFRA, 1961.

B. RIVER FORECASTING

1) Floods

A discussion of weather services required for flood forecasting is contained in PPWB memo "The Use of Hydrometeorological Information for Flood Forecasts on the Prairies." Some of the examples contained in this memo are noted below:-

- a) Forecasts for the Red River at Winnipeg, use the following meteorological information:
 - (i) Accumulated snowfall
 - (ii) Temperature during the melt period
 - (iii) Precipitation during the melt period
 - (iv) Insolation
- b) Heavy rainfall advisories are provided to Board members to aid in the planning of remedial action, or to implement supplementary stream gauging. These are issued by Edmonton and Winnipeg Forecast Offices whenever rainfall exceeds a specified amount and rate. Complimentary isohyetal maps for these events are issued by the Edmonton Office.
- c) Heavy rainfall advisories are supplied for the experimental watershed at Wilson Creek. These help to ensure the proper functioning of the research program during critical storm periods.

2) Water Yield

Water yield forecasts, are required for the economic and efficient operation of reservoirs and hydraulic structures. Present forecasts are based mainly on snow surveys, e.g., the Bow and St. Mary's river forecasts.

C. DESIGN

Weather records are considered in the design of water supply reservoirs, spillways and in bank protection. The importance of the records in these studies is noted below.

1) Water Supply

Runoff, precipitation and evaporation mainly determine the useful storage in a reservoir. Supplies must be able to withstand a design drought, which is determined from historical streamflow, precipitation, and temperature records. The temperature records are used to compute evaporation.

2) Evaporation

Evaporation averages 2 to 3 feet annually across the prairies. It is the largest water use for many reservoirs, and it places a limit on reservoir development within a watershed. It is commonly computed from records of air, temperature, humidity, and wind speed. An important fourth parameter, water temperature, is also estimated from air temperature.

Evaporation may be also estimated from "pan" evaporation measurements. This procedure is followed in the apportionment of the water of several international streams.

3) Storm Rainfall

Storm analyses, maximized storm rainfall, and statistical rainfall analyses are used in spillway design. Rainfall statistics are also used in culvert and drainage-ditch design.

The Canada Department of Agriculture, PFRA has participated in the analysis of about 80 major rainstorms which have occurred during the past sixty years. Maximization studies have been made for some of these storms, and when possible, "bucket surveys" were made to obtain more precise information on the character of intense rainstorms and attendant runoff. Statistical analyses of 24-hour rainfall have been made to supplement these analyses.

4. Shoreline Protection

Wave heights may be predicted from information on the wind, reservoir geometry and exposure. Predicted values can be used in the selection and placing of rip rap, and in the planning of recreational beaches.

III.

PROJECTED NEEDS FOR METEOROLOGICAL DATA AND SERVICES

Present and future requirements for water will impose new demands for meteorological services and data. In planning for the best use of water, economic studies which use climatic data may become necessary. Land classification, projected agricultural land use, multi-purpose planning, and industrial development are each concerned with weather. The development and operation of reservoirs, and future agricultural and industrial practices concerning water will also result in increased demands.

The following paragraphs list and describe more specifically the types of meteorological data which will be in demand as time goes on.

A. IRRIGATION

There is a growing need for more rigorous definition of the water required for irrigation. Investigations relating to the correlation of return flows with rainfall, and the natural inflow accretions as related to weather parameters are required. Additional climatic data are required for the application and transposition of consumptive use formulae.

B. FLOOD AND RIVER STAGE FORECASTS

Flood forecasts are used to:-

- 1) reduce property damage and loss of life;
- 2) aid in flood control and management.

These services may be expected to increase because of continued development and through the construction of multi-purpose reservoirs. For example, the Qu'Appelle Valley may be more prone to flooding than formerly because of the operation of the South Saskatchewan Dam. Additional weather information will be required to provide these services.

River stage and streamflow forecasts are required for the economic and efficient operation of reservoirs and hydraulic structures. They contribute to water conservation, and are useful in the operation of power plants, discharge of industrial waste, irrigation and navigation. Forecasting procedures are now being developed for the South Saskatchewan Reservoir, and increased forecasting can be expected in the future. This will emphasize the need for greater precision and rapid communication. Further, the use of computers will lead to the use of even more parameters in river forecasting. Temperature, insolation and evaporation data, and antecedent precipitation indices may be used in future prediction methods. Both forecasting procedures and water conservation

generally would benefit from accurate quantitative precipitation forecasts, and temperature forecasts, both long- and short range. Radar may also prove a useful forecasting tool.

C. DESIGN

More information concerning precipitation, the snowpack, snow melt, and drought would improve the hydrologic design of water projects. This need is particularly great in sparsely settled areas. Bucket surveys should also be increased.

Radar and "meso-scale" precipitation networks may aid in defining storm rainfall character and areal statistics. Improved instrumentation is required to obtain information from remote areas and to overcome limitations of present instruments.

D. MISCELLANEOUS

Meteorological data or studies may some day be required for the following:-

- 1) Drought analysis and statistics.
- 2) Ice forecasting including frazil ice.
- 3) The water balance of ungauged northern basins.
- 4) Wildlife habitat studies and the water balance of wetlands.
- 5) Watershed management for improved water yields.
- 6) Algae and weed control.
- 7) Snowpack management, prairie snowpack-runoff analysis and prediction.
- 8) Groundwater recharge.
- 9) Recreational requirements.
- 10) Other.

Changes in the format and context of weather publications may be desirable; and arrangements made for the immediate transmission of information as required for River Forecasting.

IV.

NETWORK ADEQUACY

Data inadequacies have been frequently referred to in PPWB reports and by those concerned with design and planning. Some of these inadequacies have been remedied, however, others will arise as the demands for water increase.

Some of the inadequacies which have been noted are listed below:-

- 1) PPWB Report #5, 1952, in referring to water temperatures observed, "this phase of basic data collection has been almost entirely neglected on the prairies." It also notes, "the unreliability of some of these records (meteorological.....ed.) in the years 1921-1935 forced the use of many diverse methods to estimate the missing records and obvious errors." The report also notes that, at that time, no governmental agency had the responsibility of collecting evaporation data; and that the logical one, the Meteorological Branch, made no observations of this type on the prairies.
- 2) PPWB Report #6, 1947, outlined precipitation and streamflow characteristics and used these with evapotranspiration estimates to speculate on the effects of watershed management on water yields. It is noted that "most official climatological stations are located in the outer foothills or low-lying mountain valleys" and also, "only the foothills and plains stations are moderately representative of their areas."
- 3) Irrigation water use studies have noted the inadequacy of the weather network for detailed analyses of consumptive use based on Blaney-Griddle procedures, and for the transposition of techniques using "pan" data.
- 4) The lack of continuity in weather records has often been criticized and hampered many studies. There is a need to continuously maintain long-term weather stations, with "bench-mark" characteristics in all *Areas*.

The observational networks are not adequate for many planning and design studies, particularly in sparsely settled areas. Outside of the prairies the precipitation network density falls far below the standard accepted by other nations in the world. In noting this it should also be emphasized that the network is improving rapidly. However, there are inadequacies in type of data as well as density of stations. For example, the standard rain gauge network on the Prairies is reasonably good but the recording rain gauge network is below recommended levels in all areas. Again, the responsibility for "bucket surveys" has not been assigned. These are necessary since present networks are not adequate for the definition of many intense storms.

The need for improved networks in sub-arctic areas is urgent. For example, the recent floods on the Beaver River led to studies of precipitation patterns in the area north and west of Cold Lake. By studying recent data from Forestry Stations, long-term average annual precipitation previously estimated from a sparse network, was revised upwards by almost 10 inches. Until recently it has been necessary to accept very generalized isohyetal charts for these areas. Additional information received in the past decade indicates there may be a substantial risk in accepting generalized analyses. Data collection should also be planned well in advance so that statistical analyses may be performed in periods of development. The lack of historic records may result in costly water shortages or excess.

Recent studies in evaporation and water quality indicate there is a need for a water-temperature network. A start has been made in this direction by the Meteorological Branch. The Branch is also developing its evaporation pan network.

THE BOARD AND THE METEOROLOGICAL NETWORK

Data deficiencies and increasing demands for data and services are apparent. In the interest of the "best use of water" these deficiencies should be defined and if possible removed. The PPWB is in an excellent position to present from time to time the combined needs of the three Prairie Provinces. To be effective in this role the Board must be well-informed on current facilities, the significance and use of meteorological data, and overall requirements.

The Board could accomplish this through the appointment of a committee. The terms of reference of the committee should include the following:-

- 1) Determine present and projected requirements for meteorological data and services, and the measure in which these are being satisfied.
- 2) To remain current in this problem.
- 3) To report regularly to the Board, advising it of deficiencies, and of services which are no longer required.

The committee would be expected to examine the network in detail and in co-operation with the Meteorological Branch. The Board would consider, and if necessary act on the recommendations of the committee.

COMMUNICATION OF NEEDS TO METEOROLOGICAL BRANCH

Several channels of communication now exist for making needs known to the Meteorological Branch. Major policy issues should be negotiated at the ministerial level. Requests for services of an interprovincial

nature or requiring major financial outlay are normally sent to the Director, Meteorological Branch. Local or regional needs may be negotiated through the Regional Directors of Air Services who are located at Winnipeg (for Manitoba and Saskatchewan) and at Edmonton. These channels are open to all members of the Board individually or to the Board as the spokesman for all of the Provinces together.

V.

CONCLUSIONS

The Prairie Provinces Water Board is, in the performance of its duties, concerned with weather data and services. Requirements for these will increase. To exploit fully available services, and to ensure that resource development and the operational needs of water agencies are not hampered by deficiencies in weather data and services, the Board must remain fully informed on these matters, and communicate needs to the Meteorological Branch. This can be achieved most efficiently by a committee which will become authoritative in these matters and which will report to the Board. Existing channels of communication between the Board and the Meteorological Branch are adequate but would function even better if the Meteorological Branch had representation on the committee.