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WATER QUANTITY STUDIES UNDER THE CANADA-BRITISH COLUMBIA OKANAGAN BASIN AGREEMENT FOR THE YEAR 1970

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INTRODUCTION

Under the terms of reference of the Okanagan Basin Agreement, the following studies are included as part of the program.

(I) Water Demand Studies - as required, to provide an estimate of current demands and a forecast of future water demands by sector - Municipal, Industrial, Agricultural, Transportation, Fisheries, Recreational - to the year 2020 A.D.

(II) Water Quantity Studies - as required, to evaluate the existing hydrologic regime of the basin, including studies of runoff, lake levels, flows, groundwater and geological structure; climatology and meteorology; to evaluate means of regulating flows through storage and diversion; and to evaluate means of augmenting supplies within the Okanagan Basin.

PREVIOUS STUDIES

An estimate of current water demands was originally made in 1966 by the British Columbia Water Resources Service. At that time, it was found that irrigation made up over 90% of the total consumptive use with the remaining portion going to municipal and domestic water requirements and industrial use. Most of this irrigation was found to be within the Okanagan Lake Basin north of Penticton where some 48,000 acres of land are served mostly from tributary streams. An additional 12,000 acres are also irrigated in the southern part of the valley between Penticton and the international border. In 1966, the census figures for the whole watershed indicated a population of 90,000 people.

One of the first tasks undertaken by the Socio-Economic Group and the British Columbia Water Resources Service has been the revision of these figures to arrive at the equivalent 1970 figures. This work is now nearing completion and will be followed by future projections of probable development.

Between 1966 and the signing of the Okanagan Basin Agreement in October, 1969, the British Columbia Water Resources Service prepared several reports related to the Okanagan Study and pertinent information from these studies as well as more recent determinations have been made available to participating agencies under the following publications:

(1) Okanagan Basin Inflow Determinations (distributed in September 1970).
(2) Monthly Hydrometric and Meteorological Data - Okanagan Basin in Canada (distributed in December 1970).

The reports include inflow data, evaporation, and precipitation on Okanagan Lake, the determination of consumptive use, etc., over the 49-year study period between April 1921 and March 1970 inclusive.

PRE⁻⁻NT INVESTIGATIONS AND STUDIES

In addition to reports on the past work are the on-going programs in the hydrology, meteorology and groundwater fields. Thus, it is stated in the Agreement that the study may include "the expansion of the present hydrologic and water quality collection system".

Those familiar with the hydrology of the Okanagan have recognized the lack of basic hydrometric and meteorological data in the planning and operations not only of the Okanagan Flood Control Works but also the numerous reservoirs located in the upper portions of the watershed. Ideally, we would like to know the total precipitation which falls, its distribution within the watershed, the amount lost by evapotranspiration and the residual water remaining as runoff or what is often referred to as the natural or virgin flow.

The existing meteorological station coverage at the start of the present program was confined essentially to the main valley where observers could be obtained. Thus, only one or two stations were above the average elevation of the watershed (3,850 feet) in which area most of the runoff occurs.

A co-ordinated program between the Meteorological and the British Columbia Water Resources Services has resulted in the installation of some 11 high level stations and work is proceeding on the remaining 14 at lower levels for a total of 25 stations. The types of instruments included are rain gauges, maximum-minimum thermometers, hygrothermographs, sunshine recorders, anemometers and net radiometers. However, evaporation pans will not be installed until the ground is free of snow, possibly in April.

It is fortunate that Water Survey of Canada, Inland Waters Branch at Vancouver, was able to initiate an intensive construction program during the last summer which is now practically complete. This program has included the installation of some 18 hydrometric stations scattered through nine tributary basins under Task 43. In addition, the Inland Waters Branch has provided a continuing summer program of discharge measurements at a number of water quality stations within the Basin.

While records from the new hydrometric stations will only be available for about two years prior to the preparation of the final report, they will nevertheless provide a basis for the naturalization of the flow within key tributaries of the basin and of course will become increasingly important in the operation of the various reservoirs after the end of the Agreement. In the meantime, it will be necessary to use the existint historic flow records corrected for consumptive use and storage changes to arrive at the various tributary virgin flows. These flows can then be compared with the demands under the present and future developments to arrive at the water deficient and water surplus areas of the Basin.

In effect, this means the development of a water quantity model which will simulate the hydrologic conditions in the Okanagan Basin for the 49-year study period under present and future developments.

The development of the first quantity model now being carried out by the Civil Engineering Department of the University of British Columbia will, of necessity, be rather crude. The results, however, will be improved over the next two years as hydrometric data becomes available and also as the physical aspects of the hydrology of the basin are explored in some detail.

A very basic approach to the hydrology of the basin is now underway by the Water Investigations Branch through what is known as the grid square technique. Under this system, the study area has been divided into five kilometric squares. Through multiple regression equations which relate precipitation and temperature, precipitation and evapotranspiration to physiographic parameters, it is possible to compute precipitation & evapotranspiration for each square. Runoff is obtained by subtracting evaporation from precipitation for each square and summing these up to obtain a first estimate of the runoff. If the computed runoff disagrees with the recorded, the precipitation for each square is adjusted and the procedure repeated until the computed runoff checks the observed runoff.

The grid square technique provides an estimate of the mean annual runoff from computed mean annual precipitation and evapotranspiration. A computed mean annual temperature is also obtained from this procedure. An attempt will be made to distribute mean annual runoff on a monthly basis.

In support of this program, the Meteorological Service has been asked to provide monthly estimates of precipitation, free water evaporation and evapotranspiration for the years 1971 and 1972 as determined by its new instrumentation. Its work will be based on the standard grid square already established by the Water Investigations Branch and the results will provide an independent check of the latter work.

It will be recognized that the grid square approach requires records of the natural flow to provide a check on the iterations carried out. Such information is available for Okanagan Lake and River as a whole. However, in the application to tributary contributions these total inflow figures will have to be broken down using whatever local hydrometric data is available corrected for consumptive use and storage changes. In some cases, this will require extrapolation from streams with records to ungauged areas.

The interim and final reports on the grid square studies as they become available in the next two years will modify the improve the first water quantity model which we hope to have from the University of British Columbia within the next two months. It will also, we hope, improve our knowledge of the meteorological and hydrological conditions of the basin which are so important in its operation.

In parallel with the development of the water quantity model of the various tributaries has been the continuing program by the Water Investigations Branch with respect to the regulation of the main lakes and rivers referred to as the Okanagan Flood Control works. The present structures which make up these works include the Okanagan, Skaha and Vaseux Lake Dams as well as the improved channel and drop structures between Okanagan and Osoyoos Lakes.

The ··· ›rks, which are of comparatively recent development, were constructed between 1948 and 1956 by the Federal and Provincial Governments under the Okanagan Flood Control Act. The main control point in the whole system is, of course, Okanagan Lake, which provides major regulation to all stream inflow upstream of Penticton. The British Columbia Water Resources Service, is in frequent contact with the District Engineer, Department of Highways at Penticton in the regulation of Okanagan and Skaha Lake Dams and the maintenance of the channel ways and drop structures.

An important part of the Quantity Model development will be the operation of Okanagan Lake under present-day development and under the projected requirements of the future. The Water Investigations Branch is presently undertaking a study of the first problem assuming that the existing lake elevation restraints exist and that downstream channels are limited to their present capacities. In effect, the Branch is attempting to computerize the lake operation as it is carried out today using its inflow forecasts as obtained from snow survey sampling and other hydrologic parameters.

Unfortunately, forecasts based on present-day procedures are only available since 1950 while the study period over which the system is being operated extends from 1921 to 1970. Thus, in order to be as realistic as possible, it is necessary to generate hypothetical forecasts for the earlier period which reflect the magnitude of error occurring the last 20 years. It is expected that this report will be available in the near future and should be of interest to all study groups.

The key to the operation of Okanagan Lake is accurate forecasts which can be continually up-dated as the reason progresses. Ideally, this would require detailed forecasts of temperature and precipitation several months in advance which is not available today.

Forecasting procedures are being continually reviewed by the Water Investigations Branch. It is expected that the Civil Engineering Department at the University of British Columbia will be able to assist in the determination of an improved forecasting procedure during the next two years.

A1 One important factor in the Water Quantity Studies is the contribution which ground water makes to the total inflow in the basin and the possibility of groundwater sources of supply. Thus, in the preamble to the Agreement, mention is made of "the augmentation of water supply from ground water" and again under water quantity studies "groundwater and geological structures" are mentioned.

At present, observations of water quantity are limited to surface inflow and outflow measurements and changes in storage. If all the streams contributing to inflow to Okanagan Lake or River could be carefully measured and all consumptive use, evaporation and other losses accurately determined then any inbalance in the quantity equation could be attributed to ground water. However, the limited surface flow data available precludes this approach and even if such a procedure was possible, it would not provide us with the location and potential of each groundwater source.

Witl'n the limitations of time and money, it would seem at least the following questions should be investigated:

(1) Is there an appreciable groundwater component into Okanagan Lake or River from the tributaries?

(2) Is the main valley containing Okanagan and Skaha Lakes a relatively tight reservoir or is it feed from underground sources outside the drainage area such as the Shuswap or Salmon Rivers?

(3) Is water escaping from Okanagan or Skaha Lakes through underground aquifers and if so, does this re-appear as surface water further downstream?

(4) If these main valley aquifers do exist in the north and south parts of the valley, are they significant in terms of quantity.

The first question dealing with groundwater component of the tributaries has already been looked at in a limited way under Task 38 entitled - Selected sub-basin hydro-geologic surface investigations. Thus, during last summer three engineers from the Water Investigations Branch and one from the Hydrologic Science Division, Inland Waters Branch, investigated Pearson, Penticton and Vaseux Creeks all on the east side of the valley as well as Lambly and Greata Creeks on the west side, and draft reports have been completed. The reports indicate that if these streams are representative of many of the 35 tributaries of the basin that ground water is not a significant factor in the total annual inflow of the tributary streams. Such generalization, however, does not apply to major tributaries such as Mission Creek in the Kelowna area or the Coldstream Valley near Vernon.

The second question dealing with the possibility of a major aquifer between the north end of Okanagan Lake and the northeast valley running through to Enderby as well as the northwest valley through to the Salmon River, was also investigated last summer.

Initially, in order to keep the amount of test well drilling down to a minimum and to find out what type of drilling equipment would be needed, a relatively inexpensive seismic exploration program was undertaken as Task 39.

The initial seismic data was obtained across the valley where wells had previously been drilled. This provided an immediate check on the accuracy of this method and because of its success in the north end, the same procedure was also carried out in the south at Okanagan Falls and Vaseux Creek.

The seismic results in the main valley showed a "fiord-like" shaped valley filled primarily with silt, sand and some gravel ranging in depth from 800 feet at Enderby to 1,600 feet at Armstrong and about 800 feet south of Okanagan Falls. Actual drilling went as much as 250 feet deeper than the 1,600-foot depth.

The depths of the overburden indicated the need for heavy drilling rigs such as are used in oil exploration in undertaking the rotary drilling program (Task 40) which followed the preliminary seismic work.

In the original planning, only part of Task 40 was proposed for 1970. However, the mobilization of such heavy drilling equipment is high and its availability is limited and for these reasons, it was decided that Task 40 insofar as drilling went should be completed as one continuous job. A total of seven test wells were drilled in the Enderby to Okanagan Lake portion of the main valley. In addition, one test well was located in the pass area between Okanagan Lake and the Salmon River and a final one immediately south of Okanagan Falls. Five of these nine wells can be classified as deep holes ranging from 1,050 to 1,890 feet while the remaining four shallow holes were up to 950 feet deep.

This work was terminated in the fall of 1970 with the installation of screens and rather than wash and develop the wells at that time using the large oil rig, it was decided the work could be accomplished at a considerable lesser cost using a one-man cable-tool rig.

In order to make the nine holes into observation wells, it will be necessary to clean out the wells and provide the necessary instrumentation to record the elevation. In addition to a continuing program of well level observation short pump tests on these wells will provide data for the determination of transmissibility. This will provide information with respect to the significance of any appreciable ground water fed in from the north and also the capacity of the local aquifer. ($15,308.22).

The well tests at the south end of the valley will provide information with respect to groundwater potential there although further exploratory work would be required to determine if there is appreciable seepage from Okanagan and Skaha Lake. This work is covered under Task 41.

The significance of groundwater inflow and outflow upon the overall water budget will depend upon whether an appreciable portion of the annual runoff of the watershed particularly in a drought period when less than 100,000 acre-feet of inflow may be available. Within the order of accuracy of these measurements anything less than 5,000 acre-feet may not be considered significant to the water balance although half this amount of ground water in a local area would be sufficient to serve an irrigation district of 1,000 acres.

CONCLUSIONS

In conclusion, it is apparent that this has been a very busy year for Water Quantity investigations and studies. This is to be expected in a short-term study such as the Okanagan because additional basic data should be available at an early date if it is to be used in the final report due in 1973. Subsequent information which is too late for the final report will not be lost for it will be used not only in improving the operation of the system but also in later reports which will follow.

The telescoping of some 150 tasks or more over the next three years requires many interim reports must be completed with the information at hand and revised as additional data becomes available. Those charged with doing the work must have a sense of urgency and a very practical approach to a number of scientific problems. D.le B. 29 March 1971