

TIDES AND WATER LEVELS

ANNUAL REPORT 1970

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Throughout 1970 the Section continued its national responsibility in the field of tides and water levels. A Workshop was organized and held during the early part of the year, with participation and attendance by the staff members of both the Inland Waters and Marine Sciences Branches. In addition, the Section was visited by several members of the aforementioned branches and appropriate courses and familiarization seminars connected with our work were given.

Several staff members attended managerial and technical courses given within the Department or at outside institutions.

Over one hundred and fifty tidal analysis have been made from the available hourly tidal data. In many instances, these analyses were used to solve for over two hundred unknowns. The 1972 predictions of high and low water times and heights were prepared for approximately fifty localities, and special hourly short period predictions have been made for several projects.

A combined metric and feet format for the Tide and Current tables was devised and will be used in accordance with branch policy on metrication.

The auto-spectra of the monthly mean water level has been calculated by the Fast Fourier Transform method, to indicate the periodic components of the mean water level variation. An information and retrieval systems for the tides and water level data, to provide users with information according to their specific requirements is now available.

Emphasis has been placed on the development of accurate and reliable instrumentation to record tide levels digitally and under various environmental conditions. Telex equipment has been rented and tested throughout the year to interrogate paper tape recorders on a real time basis and for direct computer application.

A permanent gauging network of approximately 130 stations was operational and subsequent data processing has been carried out. The data are being filed on microfilm, on punch cards for the current and last year, and on magnetic tapes for the Tides and Water Level Data Inventory.

Telemetry systems for about twenty stations across Canada were maintained for the benefit of Marine Traffic Control, Tsunami Warning purposes and Hydrographic Charting.

A program has been started to compare hydrostatic levelling with instrumental levelling around and across large bodies of water. It is hoped that such a study will provide surveyors and geodesists with the necessary information to carry out and to assess water level transfers in tidal and non-tidal waters.

The permanent gauging network has been extended into the Canadian Arctic to provide at selected stations, mean water level data for crustal movement studies and for the assessment and extension of the National Vertical Control System. A prerequisite for this program was the design and acquisition of special tide gauges working on the pressure principle rather than the standard float counter weight arrangement.

Some work on the semi-annual, annual, and other longer period fluctuations of mean sea level has been started. The levelling section of the Geodetic Survey of Canada carried out since 1968, vertical control surveys at gauging stations and provided data on the stability of bench marks required for gauging between Kingston and Pointe-au-Pere. This service may be extended to the complete Great Lakes System and to all coastal gauges used for the zero determination of the national and international vertical control networks.



G.C. Dohler,
Head, Tides and Water Levels.

Ottawa February, 1970.

THE ESTABLISHMENT OF
TIDES & WATER LEVELS BY THE END OF
1970

G. Dohler (Head) MS-758
S. Spires (Mrs.) MS-773 .

ANALYSES, PREDICTION & PUBLICATION

R. Mackenzie (Officer-in-Charge) MS-759
D. Mitchell MS-771
Vacant MS-764
M. Richer (Miss) MS-757
Vacant MS-762

DATA CONTROL & COMPUTER SYSTEMS

S. Eldring (Officer-in-Charge) MS-761
W. McCree MS-770
G. LeBlanc MS-760
J. Morrison (Mrs.) MS-769
A. King MS-765
T. MacLeod (on loan)

INSTRUMENT DEVELOPMENT & MAINTENANCE

W. Zubrycky (Officer-in-Charge) MS-756
H. Thurm MS-768
H. Holdsworth MS-766
M. Baron MS-767

APPLIED RESEARCH

L. Ku (Officer-in-Charge) MS-763
P. Bolduc MS-664
A. Kruschel MS-772
J. Minaker (on loan)

ANALYSIS PREDICTIONS AND PUBLICATIONS UNIT

The unit has continued throughout the year to act as a National Prediction and Tidal Data Centre. Photo copy of all six volumes of the 1971 edition of the Canadian Tide and Current tables were completed in mid January and passed to the editorial division for transmission to the Queen's Printer. All volumes were printed and distributed by early summer.

The international obligations were fulfilled by supplying 42 sets of yearly advance predictions to various maritime agencies throughout the world. 41 sets of yearly advance predictions were also supplied to the Pacific Region's tidal group. In addition, eighty-eight months of advance high and low tide predictions and three months of hourly predictions were prepared for other users in the private and public sectors. The quality of the predictions was maintained as in previous years by continuity checks and thorough visual sequence checks. An examination was made of error patterns in tidal predictions over the past five years.

In conformity with government policy, a study was made of the problems inherent in the conversion of the tide tables to a metric format, for use with the new metric charts. Preparation of an extra edition of Volume 4 as a prototype for the metric format was commenced and will be published as single volumes only for 1972. The composite edition for 1972 will contain a volume 4 identical to previous years. The new feet and metres format will be used for all six volumes of the tide tables in 1973.

The format of a new set of hourly tidal height tables was devised and two sample volumes will be prepared for free distribution. It is intended that these predictions will be made and the tables printed in response to specific requests only and on payment of our standard prediction fee.

In "Water Levels" Volume 1 and 2, the gauge stations change little from year to year and as the contents and format have been standardised, the time required to prepare the manuscript of these volumes is relatively short. However, with volume 3, because of the complete annual change of gauge stations and the variety of its sources of data, preparation is extremely time consuming.

The manuscript of a booklet containing samples of the output from many of the computer programmes presently in use within the section was prepared and passed to the printer. It is intended to stimulate interest in the potential application of the programmes to investigations requiring the use of tide and water level data.

The manuscript of an enlarged edition of our publication "Monthly and Yearly Mean Water Levels with 10 year and all time averages - Volume 2 - Tidal" was prepared and passed to the printer. Its function is to present a complete and up to date record of these data as recorded at all past and present permanent tide gauges and is an annual supplement to "Water Levels - Volume 2 - Tidal".

The manuscript of a booklet of "Yearly Extreme Tide Levels" was prepared and passed to the printer. It will provide a convenient reference to extreme high and low tide levels, recorded prior to 1962 or 1963, at certain tide gauging stations around the coast of Canada, which are not published elsewhere. Since 1962, or 1963 for the Pacific Coast, these extremes have been published annually in "Water Levels". Annual supplements were issued for six of our seven "Tide and Water Level Bench Mark" books and additional information was printed for inclusion in our publication "Harmonic Constants and Associated Data".

The proceedings of the 1970 "Tide and Water Level Workshop" were published and a third edition of the "Hydrographic Tidal Manual" was printed. A total of forty-two requisitions were made out to fulfill the section's printing requirements. Sixty, one year analyses were made from tidal observations obtained from permanent and temporary tide gauges, for which sufficient records were available. One hundred short period analyses were made from other observations. All sounding datums were verified before acceptance as chart datum or for use as the datum of published tide or water level observations. Where appropriate, lunitidal data and secondary port differences were subsequently computed, for the tide tables.

Datum adjustments to source material, used in compiling charts, and related datum or cautionary notes, tidal heights, bench mark descriptions and elevations and up to date hydrographs etc. were supplied to the Chart Compilation Section, by specified deadlines, for one hundred and six charts which included thirty-seven first editions. All elevations or tide heights are now supplied in both feet and metres.

Five of the section's computer programmes were modified by programming staff to facilitate and expedite computer processing of tidal data. A brief course was attended on programming the Friden flexowriter. New programmes were devised and written, programme drums cut and panels wired. The gradual change from punched cards to magnetic tape for the storage of data within the section has resulted in a decrease in the potential use of the flexowriter and automatic card reader for listing data. However, it was used regularly for listing data received on punched tape from other equipment.

Several special assignments were undertaken, e.g. A study was made of Lower Low Water datum in the St. Lawrence River. Investigations for establishing or verifying chart datum in Lake Winnipeg, Lake of the Woods, the Ottawa River, Sept. Isles and the St. Lawrence River at Chrysler.

Throughout the year the routine tasks of the unit continued to be carried out. Over one hundred letters and one hundred and eighty-four memos were prepared in reply to requests for information or in connection with the activities of the unit. Many verbal or personal enquiries were also answered. Microfilm prints of gauge records or tabulations were supplied on request.

The back data for the monthly water level bulletin were revised and 12,000 copies printed by the Queen's Printer as the 1970 stock. Each month the hydrographs were updated and new data tabulations prepared. The routine microfilming of 1969 tide and water level records, tabulations and plots, was carried out and work was completed on the scrutiny of all our microfilms. Compilation of lists of the contents of our microfilm library, to facilitate future access to these data, is now in progress.

During the coming year the manuscript of the following publications will be prepared:

- "Canadian Tide and Current Tables 1973", Volumes 1-6
- "Canadian Tide and Current Tables 1972", Volume 4, metric and feet prototype edition,
- "Canadian Hourly Tide Tables" - two sample volumes.
- "Water Levels 1970", Volumes 1, 2 and 3.
- "Monthly and Yearly Mean Water Levels", 1970 edition, Volumes 1 and 2.
- Booklets of "Daily Mean Levels" for Pacific Coast past and present tide gauges.
- A book of abstracts of Tide and Water Level reports and papers.
- Amendments, as required, to volumes 1-7, "Tide and Water Level Bench Marks".
- Additions to "Harmonic Constants and Associated Data".

The feasibility of preparing the manuscript of the "Canadian Tide and Current Tables" directly from computer magnetic tape instead of utilizing punched cards, punched paper tape and the flexowriter, will again be investigated. Similar action is proposed in respect to "Water Levels". A method will be devised to automate reproduction of current predictions prepared by the U.S. Department of Commerce.

A proposal, deferred from 1970, to identify datums presently in use in Canadian Waters and those which we recommend be used, in order to conform more accurately to our Lowest Normal Tide datum plane, will be carried out.

INSTRUMENT DEVELOPMENT AND MAINTENANCE UNIT

During the 1970 calendar year the Unit directed most of its efforts towards refining existing recording and data acquisition systems so that they will operate over longer periods of time, produce data in a reliable format, and have the capability of transmitting the same from the source point to a terminal in Ottawa with a minimum of time delay and human effort.

Ott Punch Tape Water Level Recorders

The Ott Punch Tape water level recorder has finally been carried through most of its growing pains and is beginning to perform satisfactorily.

The problem of timing is also being overcome since methods have been developed by both field personnel and ourselves by which instrument clocks can be adjusted over a period of 1 or 2 months, to match a particular gauge house environment and keep proper time for long periods thereafter.

The latest Ott Recorders have incorporated in them, in addition to the improved components, a feature which enables the recorder to punch a special character on the tape every 24 hours, separating daily blocks of data from each other. This is a definite advantage to the processing of data.

Servo-Operated Water Level Recorders

Ten Servo-Operated Water Level Recorders were manufactured for the Unit by Instronics Ltd. of Ottawa. We have found certain shortcomings in these instruments, the most serious of which is their tendency to become unstable. The Unit has found ways and means of rectifying these problems, and as the recorders come in for service these modifications are carried out. Arrangements have been made with E.D.A. Electronics to supply us with five additional Servo-Operated Recorders. Strict precautions have been taken to ensure that the recorders will be properly designed and produced.

Training Course on Servo-Operated Water Level Recorders

This summer after the Servo-Operated Recorders were prepared for the field, the Instrument Unit gave a one week training course for approximately 15 field personnel and interested parties on all aspects of the installation and maintenance of these recorders.

The exchange of ideas was quite valuable and personal contact with the field personnel has improved subsequent communications considerably. A field service and installation manual was produced as a result of this course.

A certain amount of success has been achieved with these new Servo-Operated Water Level Recorders, stemming both from the Instruction Course and Manual and the improvements in the transducer housings, connectors and splicing techniques.

Instrumentation has been supplied for eight new installations in the Canadian Arctic. With the inclusion of Spence Bay and Churchill the total number of installations are now ten. The instrumentation for Coral Harbour was prepared for dry-battery operation. A considerable amount of interest has been generated in this installation as the choice of gauge sites previously had been limited by the availability of electrical power.

On-Site Telex Interrogation of Punch Tape Water Level Records

After initial tests with a prototype tape reader, two installations were made at Port Weller, Ont.; and Riviere-du-Loup, Quebec. These installations, using CN-CP Telecommunications equipment and our 8-level Hagenuk Punch Tape Recorders, enables personnel in Ottawa to interrogate the gauge record at any time in a matter of seconds. The record received is a duplicate punch tape record to that produced at the recording site and is ready for further processing. Due to the success that has occurred with this type of equipment, additional installations are being planned.

A modification, yet to be carried out, is the conversion from the Friden to ASCII code. This will enable personnel in Ottawa to get a simultaneous printout of the data as well as the punched tape. The ASCII data on the tape can also be immediately processed on the Data Line computer terminal available to this section.

Radio-Telemetry Links

Two new radio-telemetry links have been established. One is between a station in Hull, P.Q., and our office. It employs a float-operated Hagenuk Telemetry-System and has been working well.

The other link, which is much more elaborate, has been established between Langara Island, B.C. and Prince Rupert, B.C. The transmission path is 110 miles long and required a receiver site on top of a mountain to obtain good reception. The original receiver site, near sea level, proved inadequate. Arrangements have been made to link the mountain receiver site to our recording site in Prince Rupert Airport Terminal Building by means of land lines. The land lines in the future may be replaced by a UHF radio link. This radio link is now dormant because the water level sensing transducer system is inoperative.

Weather Data Acquisition Systems

Two Ott Weather Stations were supplied for the use of the Applied Research Unit. New wind probes were installed complete with probe de-icers and power supplies. The stations have had quite a few malfunctions at the Point Petre installation which had to be rectified. The wind speed range of the recorder will have to be extended so that high wind velocities can be measured.

In addition Hagenuk and Aviation Electric Weather Stations have been lab tested. The Hagenuk instrument has the additional feature to operate with one of our underwater pressure transducers and record water level as well. Some malfunctions have occurred in the instrument, and will have to be eliminated. The instrument will be installed at nearby Britannia Bay for testing throughout the winter and part of spring. The Aviation Electric Weather Station is not in service, and much work is required to put same into operation.

In-Situ Tide Gauges

Modifications to the design of the valve-mechanism control-circuitry and temperature sensors have been carried out on the two existing Servo Operated in-situ gauges. The new design is intended to enable the gauge to be used without any auxiliary equipment to pre-pressurize the unit or monitor its state before submergence. Also the units recorded will now be directly in feet of water and degrees centigrade. Tests are in progress and some design refinements are still foreseen before the instruments can be field tested. For this program, five acoustic release devices and a quantity of flashing beacons have been acquired.

Tides and Water Levels Workshop

Every member of the Instrument Unit prepared and submitted papers at the workshop held in March, or demonstrated the operation of some of our instrumentation. Members also attended the workshop when topics of interest were being discussed.

Proposals for 1970

The efforts of the Instrument Development and Maintenance Unit will be directed towards the following major objectives:

- 1) developing more reliable Servo-Operated Punch Tape Water Level Recorders in co-operation with the manufacturers of our latest order of servo-instruments.

- 2) modifications, improvements and further tests on the in-situ underwater recorders and the use of acoustic release devices for their recovery.
- 3) installation of Hagenuk recorders and Telex interrogation facilities for all of the stations which require processing their data every seven days. There are fourteen such stations.
- 4) re-establishing the operation of transducer-activated telemetry and recording systems at St. Francois, P.Q. and Langara Island, B.C.
- 5) investigations will be carried out to find techniques of sensing water level using transducers that do not need to be submerged. These could find immediate applications in locations where wharfs or steep cliffs are available. These conditions exist at both St. Francois and Langara Island.
- 6) investigations will be carried out to find methods of activating telemetry systems by means of transducers without the intermediate use of a servo system.
- 7) continuing efforts will be put forward to overhaul as many Ott Punch Tape Recorders as possible so that they will all be supplied with the latest design punch dies, counters and coding mechanisms.
- 8) establishment of a fully automatic Tsunami warning system from Langara Island, after the water level monitoring equipment is re-installed.
- 9) instrumentation will be supplied for at least five more Servo-Operated Water Level Recorder installations.
- 10) float operated Ott punch tape recorders will be tested and supplied for several gauge houses equipped with wells.

APPLIED RESEARCH UNIT

Six papers on the past activities of the unit were presented during the Tides and Water Level Workshop held in March at Ottawa. Papers were also given at the 13th conference on Great Lakes Research in Buffalo, N.Y., the Symposium on Coastal Geodesy in Munich, Germany, and the Canadian Hydrographic Conference in Ottawa.

The system for providing sounding reductions for automated hydrographic surveys had its first trial during the summer. Except for several data transmission problems experienced at the beginning of operation, the system worked satisfactorily. Because of the possible demand for higher accuracy, investigation will be carried out during 1971 to modify the computation model.

An inventory of water level data for permanent stations, starting from 1961 to date, and for all temporary stations, except for a few stations around the Great Lakes, had been compiled and stored in the file of the Water Level Inventory Retrieval System in the Data Line Computer. The development of the system is completed, and it is now in operation. All information relating to water level data, such as the period of records, the location of gauging stations, etc, can be retrieved according to the specification input to the system.

In analysing the water level data around Lake Ontario, it is found that the water level difference between any two stations can be computed within an error of ± 1.5 ft., which is in the same order of the accuracy of land surveying. Therefore, the application of hydrostatic levelling is very adequate in this lake. The same investigation will be carried out in other lakes and the Gulf of St. Lawrence.

The Department of Transport proposed to lower the present chart datum along the St. Lawrence River. After carrying out a comprehensive investigation, it was found that the present datum is very close to the guideline agreed upon during the International Hydrographic Conference in 1919.

Not much effort was devoted to the investigation of the short term water level prediction along the St. Lawrence River. Up to now, we only have identified the significant additional shallow water constituents to be included in the prediction, the effect of the Ottawa River water level variations and the frequency distribution of the storm surges. Although the use of the numerical hydrodynamical model could be the most directly available method, its requirement for small time and space increments makes it too costly to be used as an operational model, and the accuracy it can provide is also doubtful. Therefore, our efforts will be spend in developing an economical and accurate model for making short term tidal prediction.

Other projects carried out includes: experiments with the new data checking program; the assessment of methods to be used in filling gaps in the records; the printing of tidal data by plotter, such as the amplitude of a specified constituent in an area; the examination of Doodson's method for reducing the variation of M2 constituent at Saint John; the development of computer programs for the numerical hydrodynamic model; the assessment of tidal prediction; the mean water level variations along the Canadian Coasts and the Great Lakes; the processing of meteorological data.

The following work was requested by other groups:

- 1) The water level data measured from several wells near the coast of P.E.I. were analyzed to investigate the effect of ocean tide to the ground water, this request came from the Ground Water Sub-division of the Inland Waters Branch.
- 2) The current data measured in the Strait of Georgia by the Pacific Region were analyzed to investigate the tidal components in the data.
- 3) The atmospheric pressure data on the Atlantic Coast of Nova Scotia were analyzed to investigate the effect to the mean sea level in the area. This project was requested by the Bedford Institute.

Besides the continuation of some projects previously indicated, the following additional projects are planned for the 1971 activities:

- 1) The tides at several important localities are predicted for marine traffic control centres, and plotted on strip charts. These charts are then installed on the water level recorder to assist the agencies in planning their activities.
- 2) The tides along the St. Lawrence River are predicted at several key stations and then interpolated for every two nautical mile. They are listed on a format so that the user can easily utilize the tidal head for navigation or other purposes.
- 3) The computation of co-tidal chart using hydrodynamical numerical model.
- 4) The test of the performance of in-situ recorders.

The development of the in-situ recorder by the Instrument Development and Maintenance Unit is nearly completed. This recorder will be tested to determine its reliability and accuracy.

Besides the use for retrieving water level information, the Data Line Computer terminal has been extensively used in executing computer programs which do not require large amounts of input data.

DATA CONTROL AND COMPUTER SYSTEMS UNIT

During 1970 the Data Control and Computer Systems Unit has provided invaluable service to Public and Government Agencies by abstracting, checking, storing and disseminating tidal and water level data from 134 gauging stations. It has also maintained 92 computer programs for use by the Section.

Reduction of New Data, Quality Checking and Dissemination

The quality of the documentation of the analogue recording has improved during this year. A total of 52 memoranda (106 during 1969) were sent to the various District Offices, pointing out irregularities in the documentation. The quality of digital recordings (33 stations) varies widely from one district to another.

Data from 134 permanent stations had been processed. One hundred and twenty of these are operated on a monthly basis, 14 on a weekly basis. Approximately 2,500,000 data points have been abstracted during the year. In addition to hourly heights, high/low waters are being abstracted from 60 stations.

The following data are disseminated on a scheduled basis:

- (a) Weekly water level bulletins to 22 agencies,
- (b) hourly heights and daily means to 11 agencies (157 sheets every week),
- (c) hourly heights to 22 agencies (610 sheets every month),
- (d) daily means to 55 agencies (230 sheets every month),
- (e) weekly means for the Great Lakes (telex messages to 7 radio stations),
- (f) listings for 12 temporary stations are being sent to the originating office.

Questionnaires were sent to agencies receiving hourly height and daily mean data. The returns showed that some agencies no longer required these data, others required them on a less urgent basis than previously assumed. A clearer format of the mailing list has resulted in increased accuracy.

Implementation of New Data Processing Systems

Starting with the August data, the hourly heights are being stored on BCD tape files. Efficient design of the new system has reduced the number of computer jobs to store the data by approximately 70%. The same reduction will apply to the number of magnetic tapes, when the files will be converted.

Programming work on the computer program system to process paper tape data has been completed, except for one minor modification. It has been tested extensively and the program documentation is up to date.

Maintenance of Computer Programs and Documentation

Starting with the 1971 data, the water level stations will use 5-digit station-numbers. This allows adequate space for future expansion. The daily mean and the monthly mean card input (including hourly height cards) have been modified. The maintenance of the program documentation is a time consuming task and new procedures are being planned. Many revisions and corrections have been made to various programs.

Future Projects

- a) Starting with the 1971 data, a new checking procedure for hourly heights (tidal stations only) and high/low waters will be used. This method is being developed and tested by the Applied Research Unit.
- b) A program will be written to transfer 15-minute-data from cards to magnetic tape and to add the appropriate header for our storage system. After storing the cards on tape, the cards will be discarded.
- c) Listings of all daily mean data for the West Coast station will be prepared.
- d) Checking of back data (this is a low-priority project)
 - i) Checking of daily means. A SIMSCRIPT program has been written to check the monthly means against the daily means.
 - ii) Checking of hourly heights with program 330.

- e) 9 computer programs use binary tape files, thus a conversion run is required before they can use the BCD files. The programs will be converted as soon as feasible. Two retrieval programs are required more urgently than the other programs. When most of these programs have been converted, the binary file will be converted to BCD and discarded, resulting in a significant saving of magnetic tapes and computer time. The conversion will include re-numbering the stations and resorting the files.

PARTICIPATION AT
CONFERENCES, SEMINARS, WORKSHOPS E.T.C.

1. Data Processing Institute Conference, February at Ottawa (Ku, Bolduc, Minaker, Mackenzie, Eldring, MacLeod).
2. Tides and Water Level Workshop, March at Ottawa (Staff Tides and Water Levels).
3. 13th Conference on Great Lakes Research, April at Buffalo (Ku, Bolduc, Mackenzie).
4. Canadian Institute of Surveying, April at Halifax (Dohler).
5. International Co-ordinating Group of the Tsunami Warning System in the Pacific Ocean, May at Vancouver (Dohler).
6. Symposium on Coastal Geodesy, July at Munich (Dohler, Ku).
7. Joint Oceanographic Assembly of APSO, September at Tokyo (Dohler).
8. Seminar on UNIVAC 1108, September at Ottawa (MacLeod, Bolduc, Minaker, Kruschel).
9. First International Workshop for the IFYGL, September at Hamilton (Bolduc).
10. Meeting of the Terrestrial Water Balance Group IFYGL, November at Toronto (Dohler, Ku).
11. Gulf of St. Lawrence Co-ordinating Meeting, December at Halifax (Ku).

LIST OF PUBLICATIONS
PREPARED IN 1970

1. Field Programs and Gauging Requirements, (G. Dohler). Unp. MS. Rp.
2. Possible Determination of Chart Datum, (L.F. Ku). Unp. MS. Rp.
3. Tide Tables and Associated Publications, Their Utilization and Usefulness to the Canadian Maritime Public, (R.J.D. Mackenzie).
Unp. MS. Rp.
4. Paper Tape Processing System, (T. MacLeod). Unp. MS. Rp.
5. The Possible Utilization of Data Line Computer Terminal for Predictions and the Data Bank on Tide and Water Level Information, (L.F. Ku). Unp. MS. Rp.
6. Present Quality Checking Procedures of the Collected Data prior to Publication, (S.E. Eldring). Unp. MS. Rp.
7. The Reconstruction of the Tidal Curve from High and Low Tidal Data, (L.F. Ku). Unp. MS. Rp.
8. The Change of Water Level Caused by the Variation of the Inflow - Outflow on Lake Ontario, (P.A. Bolduc). Unp. MS. Rp.
9. The Evaluation of the Performance of Water Level Recording Instruments, (L.F. Ku) in Press.
10. Telemetry and Announcing Systems Available across Canada and New Developments for Real Time Data Acquisition, (W. Zubrycky).
Unp. MS. Rp.
11. Potentiometric Gauge System, (H. Thurm). Unp. MS. Rp.
12. In-Situ Water Level Recorders, (H. Holdsworth). Unp. MS. Rp.
13. A report on the Servo Operated Ott Punch Tape Water Level Recorder Instronic Models, Serial Nos. 20868-20877, (B. Casey). Unp. MS. Rp.
14. Field Service and Installation Manual for Servo Operated Ott Punch Tape Water Level Recorders, (Instrument Unit). Unp. MS. Rp.
15. Instruction on the Installation and Operation of the Hagenuk Punch Tape Recorder, (W. Zubrycky). Unp. MS. Rp.
16. Tides and Water Level Workshop Proceedings, (Tides and Water Levels Section). Unp. MS. Rp.

17. The Mean Water Level at Pointe-au-Pere as used for the International Great Lakes Datum (1955), (G. Dohler) in Press.
18. The Spectral Analyses of Current Data in the Strait of Georgia, (L.F. Ku). Unp. MS. Rp.
19. Spectral Analyses of Residues and Daily Mean Sea Levels at Halifax, (L.F. Ku). Unp. MS. Rp.
20. Current Analyses at Rio De La Plata, Argentina, (L.F. Ku).
Unp. MS. Rp.
21. Spectra of Monthly Mean Water Level in the Great Lakes, (L.F. Ku) in Press.
22. Chart Datum Analyses Between Montreal and Quebec City, (P.A. Bolduc).
Unp. MS. Rp.
23. The Variation of Mean Sea Level Along Canadian Coast Lines, (L.F. Ku) in Press.
24. Samples of Computer Output from Operational Programmes of Tides and Water Levels.