1. INTRODUCTION

This manual was prepared by Mr. W.J. Ozga, Head, Data Control Section, and approved b y Mr. P.I. Campbell, Chief, Water Survey of Canada, and contains detailed instructions to ensure that national standards and uniformity are maintained throughout the Water Survey of Canada in the office procedures involved in the computation and compilation of hydrometric survey data, the preparation of manuscript for the regular series of data publications and the dissemination of streamflow and water level data in computer-compatible form.

Basic data are collected and computed by Regional personnel and Submitted to Ottawa for publication. Although many parts of hydrometric data computation procedures have been automated, certain operations are and will continue to be, performed manually. A digitizer/card punch system is operational in each Region. Computer programs for digitizer applications and related computations are written by Data Control Section staff at Ottawa and then implemented in the Region at local Computer Centres. Automated procedures have been developed at Ottawa for the preparation of camera-ready manuscripts for the biennial Surface Water Data publications containing daily discharges and water levels, eight quinquennial Historical Water Levels Summary publications; data are available to users on magnetic ape (historical daily streamflow and water level data prior to 1979 are also available on microfiche).

This manual and related manuals listed herein are intended for internal use within the Water Resources Branch. However, these manuals may be distributed to “outside” agencies for general information on the understanding that the instructions contained therein are subject to change without notice.

This is the fifth edition of a “Manual of Hydrometric Data Computation and Publication Procedures” and replaces all previous editions. Major changes have been made to incorporate metric conversion. Experience in the use of this manual may result in suggestions for further revision to some of the procedures. All such suggestions will be given careful consideration and addendum sheets will be issued to cover any such suggestions that are adopted. Revised editions of the manual will be issued when extensive addenda or changes make this necessary.

1.1 Definition of National Standards

The term National Standards as used in the Federal-Provincial Cost haring Agreements for Water Quantity Surveys and other contexts refers to the suitabilty of data for distribution to users, including publication, and to the manner in which hydrometric and sediment surveys are conducted in the Water Resources Branch. This refers to data that have been observed, recorded and computed by a trained person in accordance with the following manuals and other standards. This list supersedes the previous list dated August 13, 1979.

1.1.1 Field Manuals

a) Hydrometric Field manual - levelling, 1973
b) Hydrometric Field manual - Measurement of stage, 1976
c) Hydrometric Field manual - Measurement of Discharge
(under preparation)
d) Hydrometric Field manual - Moving Boat Method, 1978
e) Hydrometric Field manual - Fluorometric Techniques
f) Telemark manual, 1971
g) A Guide to Gauging Station Inspection, 1972
h) Safety Guide - Construction and Operation of Stream-Gauging Cableways, 1977
i) Auxiliary document - Hydrometric Equipment Handbook.

1.1.2 Office Manuals

a) Manual of Hydrometric Data Computation and Publication Procedures, Fifth Edition, 1980
b) Manual of Hydrometric Data Review Procedures, Fifth Edition, 1980
c) HYDEX System Operations Manual , 1976
d) Automated Hydrometric Computation Procedures, 1977
e) Automated Procedures for Area, Length and Point Location Computations, Second Edition,1977
f) SAVE System Operation manual, 1975
g) FLOW File Operations Manual, Second Edition, 1979
h) LEVELS File Operations Manual, First Edition 1979
i) PEAKS File Operations Manual, 1975
j) Supplying Hydrometric and Sediment Data to Users, Second Edition,1980
k) Publication Procedures for the Surface Water Data Reference Index, 1975
l) Publication Procedures for Surface Water Data, 1975
m) Publication Procedures for the Historical Streamflow Summary, 1975
n) Publication Procedures for the Historical Water Levels Summary (under preparation)
o) Automated Thermograph Computations, First Editions, 1980
p) A start has been made on three manuals;
Extending Records, Stage-Discharge Relation and Winter Computations

1.1.3 Sediment Manuals

a) Office Procedures for Sediment Data Computations, 1978
b) SEDEX System Operation Manual, 1977
c) Sediment Data File Operations Manual, 1977
d) Automated Suspended Sediment Computations, 1978

e) Automated Suspended Sediment Pump Sampling. First Edition 1979
f) Publication Procedures for Sediment Data, First Edition, 1979
g) Sediment laboratory Procedures (draft only)

1.1.4 International Standards Organization Manuals

a) Standards from Technical Committee 113

Number		Title
555	-	Dilution Methods for Measurement of Steady Flow-Constant Rate Injection Method
555/II	-	Dilution Methods for Measurement of Steady Flow-Integration (Sudden Injection) Method
748	-	Velocity -Area Methods, 1979 edition
772	-	Vocabulary of Terms and Symbols (bilingual), 1978 edition
1070*	-	Slope-Area Method
1088*	-	Collection of Data for Determination of Errors in Measurement
1100*	-	Establishment and Operation of Gauging Station and Determination of the Stage-Discharge Relation
1438**	-	Thin Place Weirs
2425	-	Measurement of Flow in Tidal Channels
2537	-	Cup-type and Propeller-type Current Meters
3454*	-	Sounding and Suspension Equipment
3455	-	Calibration of Current Meters in Straight Open Tanks
3716	-	Functional Requirements and Characteristics of Suspended Sediment Load Sampler
3846	-	Free Overfall Weirs in Finite Crest Width (Rectangular Broad-Crested Weirs)
3847	-	End-Depth Method for Estimation of Flow in Rectangular Channels With Free Overfall
4360	-	Triangular Profile Weirs
4363	-	Methods for Measurement of Suspended Sediment
4364	-	Bed Material Sampling
5168	-	Calculation of the Uncertainty of a Flowrate Measurement

Available From: Standards Council of Canada
International Standardization Branch
Foreign Standards Sales Section
Suite 2-401, 2000 Argentia Road
Mississauga, Ontario L5N 1V8
Telephone No. 186-9-826-8110 (from Ottawa)

b) Draft International Standards

4359	-	Flumes
4366**	-	Echo Sounders
4369**	-	Moving Boat Method
4373**	-	Water Level Measuring Devices
4375**	-	Cableway Systems

c) Draft Proposals

555/III	-	Dilution Methods Using Radio Active Tracers
4365	-	Analysis of Sediment
4371	-	End Depth Method in Non-Rectangular Channels
4374	-	Round Nose Horizontal Crest Weirs
4377	-	Flat-V Weirs
6418	-	Ultrasonic Velocity Meters
6420	-	Position Fixing for Hydrometric Boats
6421	-	Methods for Measurement of Sedimentation in Reservoirs
	-	Assessment of Uncertainties in Calibration of Gauging Station and Flowmeters
	-	Compound Weirs
	-	Telemetry

* Under revision
** Approved in voting

1.1.5 Canadian Standards Association Publication

a) CSA Standard CAN3-Z234.1-79, Canadian Metric Practice Guide
b) CSA Standard CAN3-Z234.2-76, The International System of Units (SI)
c) CSA Standard CAN3-Z234.4, All-Numeric Dates and Times
d) CSA Standard Publication Z351-1978, Glossary of Metric Units

1.1.6 General Comments

Where the above documents do not fully cover all aspects of WSC work, as for example in the sediment survey field work, they will be supplemented by the USGS Series of “Techniques of Water-Resources Investigation”.

All sediment laboratory word conducted by the Water Survey of Canada is carried out under uniform standard procedures, but the manual is in draft stage only.

All manuals are under continuing review and revision.

2. GENERAL INSTRUCTIONS

The source data for the office computation of hydrometric survey data are the notes and records received from the field. For this reason, when field records are drawn from file for carrying out computations, care must be taken to ensure that any necessary corrections or explanations are made in such a way as to preserve the original data. The data which are to be computed will normally fall into one of the following categories:

a) Miscellaneous Discharge Measurements

b) Stream, Lake or Reservoir Stage
c) Lake or Reservoir Stage and Contents
d) Stream Stage and Discharge (Streamflow)

With the introduction of automatic data processing, many of the repetitious computations and tabulations have been eliminated. Streamflow and water level computations have been automated using a digitizer and related computer programs. Automated techniques can be used for various phases and the selection will vary from station to station, but spot checks will performed using "manual" procedures. Therefore, a decision must first be made regarding which computer programs will be used - this should be explained on detail on Station Analysis form 067-2130.

It is essential that all data be identified at every step in the computation process. Therefore, on each form used in computation enter the official name of the gauging station, the station number, the period for which data are being computed and, where applicable, the drainage area. All tabulations and those computations not done by electronic computer must e checked prior to submission of data for publication.

Gauging Station Inventory Updating form 067-2006 should be submitted when a new station is established. Changes or revisions to any of the conditions at an existing station should be submitted on the Gauging Station Inventory printout.

The review of historical hydrometric data is not considered a separate activity and therefore should be considered as part of the computations for the publication year wherever feasible.

The general procedures to be followed in the computation of data have been outlined in this section. For detailed instructions, procedures and comments for each particular step, reference should be made to the appropriate section herein or to one of the manuals listed in section 3.

2.1 Miscellaneous Discharge measurements

(a) Prepare Gauge Corrections form 067-2128 from original level notes, if appropriate.

(b) Enter pertinent data from original discharge measurement notes on form 067-2123.

(c) Submit new or revised Gauging Station Inventory Updating form 067-2006 or printout, if appropriate.

(d) Complete Station Analysis form 067-2130 if measurement(s) was obtained at a gauging station

(e) For miscellaneous measurements not obtained at a "gauging station" file forms 067-2123 under the appropriate drainage basin and identify the subdivision (e.g.04AB) in which the measurements were obtained.

2.2 Stream, Lake or Reservoir Stage

(a) Prepare Gauge History form 067-2127 from original level notes and field reports.

(b) Prepare Gauge Corrections form 067-2128 from Gauge History form 067-2127 and original level notes. These corrections may also be punched on cards for input to the STREAM or MANUAL computer programs.

(c) Compute the daily stage record and plot the stage hydrograph; extract the maximum and minimum daily and the maximum instantaneous water levels for the year and enter on form 067-2121. Alternatively, digitize the strip charts for input to the STREAM program or keypunch the manual gauge readings for input to the MANUAL program and check the printouts and hydrograph produced by computer

(d) Enter the maximum instantaneous water level for the year on form 067-2081.

(e) If the daily water level record is incomplete for the year or for the standard period, indicate on form 067-2080 if there is a valid annual maximum and/or minimum daily water level.

(f) Review past data and revise where necessary (see section9.2 of the Manual of Hydrometric Data Review Procedure, Fifth Edition).

(g) Submit data to Ottawa for publication

(h) Verify data on computer printouts sent from Ottawa.

(i) Complete Station Analysis from 067-2130.

2.3 Lake or Reservoir Stage and Contents

(a) The instructions given in section 2.2 above also apply here except that "Contents" data are not submitted to Ottawa for publication.

(b) Compute or estimate the month-end water levels, if required.

(c) Compute the stage-contents table where required and indicate whether contents are "live " or "total:.

(d) Enter the month-end stage on form 067-2131, compute contents and change in contents in cubic decametres and the equivalent in cubic metres per second. The "equivalent in m^3 /s" is computed by dividing the cubic decametre figure by (8604 x no. of days).

(e) Extract the annul maximum and minimum stage and contents and the maximum instantaneous stage and contents for the year and enter on form 067-2131.

(f) Complete Station Analysis form 067-2130.

2.4 Stream Stage and Discharge (Streamflow)

(a) Prepare Gauge history form 067-2127 from original level note and field reports.

(b) Prepare Gauge Corrections form 067-2128 from original level notes and Gauche History form 067-2127. These corrections may also be punched on cards for input to the STREAM or MANUAL programs.

(c) Enter the discharge measurement results on form 067-2122. Do not enter visits when only gauge readings or level checks were obtained.

(d) Compute the daily stage record, determine the maximum and minimum stage and enter on form 067-2124. Alternatively, digitize the strip charts for input to the STREAM program or keypunch the manual gauge readings for input to the MANUAL program.

(e) Plot the open-water discharge measurements and draw the stage-discharge curve (s), if necessary.

(f) Compute the stage-discharges for open-water periods and daily water levels for ice periods, using the STREAM or MANUAL programs.

(g) Compute daily discharges for open-water periods and daily water levels for ice periods, using the STREAM or MANUAL programs if desired.

(h) Compute daily discharges during ice periods using Winter Hydrograph form 067-2035 and/or form 067-2126. Daily discharges may be keypunched as updating corrections and used as input to the STREAM or MANUAL programs or keypunched on format 71-102 and submitted separately.

(i) Compute data for missing periods and keypunch as updating corrections or in format 71-102.

(j) Plot discharge hydrographs. This is usually done by computer as one of the options of the STREAM or MANUAL programs or obtained from Ottawa if for past data.

(k) Extract maximum and minimum daily discharges for the year or for the standard period - this is done automatically if using the STREAM or MANUAL programs. Also, if the daily discharge record is incomplete for the year or the standard period, indicate on form 067-2080 if there is a valid annual maximum and/or minimum daily discharge.

(l) Enter the maximum instantaneous daily discharge for the year on form 067-2081.

(m) Compute the monthly and annual summary on form 067-2124. This is computed automatically for the final records, which are on printouts.

(n) Review past data and revise where necessary (see page 21 of the Manual Of Hydrometric Data Review Procedures, Fifth Edition).

(o) Submit data to Ottawa for publication.

(p) Verify data on computer printouts sent from Ottawa

(q) Review Gauging Station Inventory listing.

(r) Complete Station Analysis form 067-2130.

2.5 Decisions Concerning Metric Conversion

The following standards are for the normal case (deviations are expected for unusual circumstances, e.g. gauge heights may be observed to 0.001 m at accurate weirs or increments of stream widths my be smaller than 0.1 m on very small streams). Paper size and date representation are not “metric” issues and are explained in other national standards.

2.5.1 Water level	■ observation: 0.002m ■ computations and publications: 0.001m
2.5.2 Level rod reading	■ have suggested 0.002 m in order to be the same as observation of water levels and divisions on the staff gauge but may eventually use 0.001 m (either figure requires an interpolation of the 0.01 m divisions on standard survey level rods)
2.5.3 Stream width	■ a sliding scale so as to have a minimum of 20 observation positions but no closer than 0.1 m ■ cableway markings should be in increments of 1 m, 2 m, 5 m, 10 m, and 20 m with an unambiguous marking code to designate 10-mmarks and 100-mmarks, etc.. (the increment should be painted on the A-frame cable support
2.5.4 Stream width	■ kilometres (km) to three significant figures but not more than one decimal place
2.5.5 Water depth	■ 0.01 m (may change with varying conditions)
2.5.6 Water velocity	■ metres per second (m/s) to three significant figures but not more than three decimal places
2.5.7 Area	■ generally, square metres will be used to re place square feet, hectares to replace acres and square kilometres to replace square miles ■ specifically: cross-section area, square metres (m^2) water surface area, hectares (ha) drainage area, square kilometres (km^2) ■ all areas expressed to three significant figures but not more than two decimal places
2.5.8 Water discharge	■ cubic metres per second (m^3 /s)to three significant figures but not more than three decimal places
2.5.9 Volume of water or ice	■ cub decametres (dam^3)to three significant figures but not more than two decimal places
2.5.10 Rate of runoff per unit area	■ litres per second from a unit area (square kilometre) - l/(s.km^2)
2.5.11 Sediment concentration	■ milligrams per litre (mg/L)
2.5.12 Sediment load	■ tonnes per day (t/d); 1t = 1000 kg
2.5.13 Volume of sample of water plus sediment	-cubic centimetres (cm^3)
2.5.14 Snow depth	■ to nearest centimetre (cm)

2.5.15 Snow water equivalent or rainfall
- to nearest millimetre (mm) (AES standard)

2.5.16 Water temperature
- observations: o.5^{o}C (some observations and conversion of past data will be to 0.1^{o}C)

2.5.17 Recorder chart scales (the gauge height grid will be 25 cm wide)

(a) rectilinear grid:

gauge height; 1:5 standard
1:10 optional
1:1 optional (weirs and flumes)
time scale standard is 60mm/d (2.50 mm/h)
(30, 120, 180 and 240 mm /d are optional, where warranted)

(b) curvilinear gird (equal) increments along arc):

gauge height range is 0-3 m or 0-6 m
time scale is same as for rectilinear

2.5.18 Computation procedures
- sequence and rules of rounding same as at present (see manuals)

2.5.19 Notation
- in published tables of data, blanks will be used to separate thousands, e.g. 12.500
- the negative sing is handled the same as a digit, e.g. 12 500 or - 412
- if a numeric value is less than one, a zero should precede the decimal marker, e.g. 0.123
- symbols for use with computers with limited character sets will be in Form II representation, e.g.M3/S (cubic metres per second), DAM3 (cubic decametres), etc.; symbols otherwise will be in the standard international form m^3/s, dam^3 , etc.

2.5.20 Conversion equations
- five significant figures (using for figures to convert as compared to five figures causes differences in the answers when rounded to three significant figures)

2.5.21 Canadian Standard Association publications

(a) CSA Standard CAN3-Z234.1-79, Canadian Metric Practice Guide
(b) CSA Standard CAN3-Z234.2-76, The International System of Units (SI)

2.6 Significant Figures for Imperial Units

(a) Express daily discharges, monthly and annual means, acre-feet, drainage areas, widths, cross-sectional areas and measured discharges to three significant figures above 10, to the nearest tenth from 1 to 10 and to the nearest hundredth below 1. Values below 0.005 will be shown as "0".

For example:

below 0.005	0
0.5 to 0.99	to nearest hundredth
1.0 to 99.9	to nearest tenth
100 to 999	to nearest 1
1,000 to 9,990	to nearest 10
10,000 to 99,900	to nearest 100
100,000 to 999,000	to nearest 1,000

(b) If the figure following the last significant figure is exactly 5, round up to the nest digit.

For example:

6885	=	6890
6.35	=	6.4
0.5 =		0.01

(c) Express cfs per square mile, depth in inches on drainage basin, gauge heights, elevations, gauge corrections and velocities to the nearest hundredth except in the few cases where observations to a greater degree of accuracy are available, i.e. for weirs of flumes.

(d) The "Procedural Guide for Operation of International gauging Stations" dated November 4, 1969 permits data to be published or retrieved from magnetic tape according to each country<s rule for significant figure. Therefore, there may be some minor differences in the daily discharge values between 10 and 100 cfs because of this.

2.7 Symbols and Footnotes

(a) "A" - Manual gauge

Use this symbol during open-water periods to identify the use of one or more manual gauge observations to obtain a daily stage at a station where the water-stage recorder was temporarily out of operation. Enter this symbol to the right of the daily discharge figure or to the right of the daily stage figure if no discharge data are shown. This symbol will also be used when the chart record for only part of a day is available. During a year when a recorder is installed the symbol "A" will be used on all days prior to the chart records to identify manual gauge readings. Do not enter this symbol in any monthly or annual summary data, except for the extremes in the annual summary if applicable. Do not use this symbol during ice periods. However, a footnote will be required if the recording gauge was not in operation in winter periods. Use of this symbol must be accompanied by an appropriate reference in a footnote, i.e. A _ Manual gauge. The symbols "B" or "E" have precedence over the symbol "A".

(b)"B" - Ice conditions.

Use this symbol to indicate that ice conditions in the stream have altered the open water stage-discharge figure. This symbol will not be used for water level data. However, if it is required for specific stations an appropriate explanation should be given in the Station Analysis form 067-2130. Do not enter this symbol in any monthly or annual summary data, except for the extremes in the annual summary if applicable. Use of this symbol must be accompanied by an appropriate reference in a footnote, i.e. B - Ice conditions. The symbol "B" has precedence over the symbols "A" and "E".

(c) "D" - Dry

Use this symbol to indicate hat the stream or lake is "dry" or that there is no water at the gauge. This symbol is used as an updating correction in the MANUAL program or as input to the LEVELS file and the word "DRY" will appear in the gauge height column, without a footnote.

(d) "E" - Estimated

Use this symbol whenever the discharge during open-water periods was determined by some indirect method such as interpolation, significant high-water extension, comparison with other streams or y correlation with meteorological data, If desired, the method of estimate may be given in a suitable footnote. Enter this symbol to the right of the daily discharge or daily water level figure. Do not use this symbol during ice periods. Do not enter this symbol in any monthly or annual summary data, except for the extremes in the annual summary if applicable. Use of this symbol must be accompanied by an appropriate reference in a footnote, i.e. E - Estimated. The symbol "E:" has precedence over the symbol "A".

Where one of the symbols "A", "B", or "E" is applicable, show either a symbol for each day or only a reference in a footnote. Show a symbol for each day if the symbol applies to more than two periods, other wise show only a reference in a footnote. However, the output listing from the FLOW or LEVELS files or the digitizer applications and related programs will show a symbol for each day where applicable, regardless of the duration.

Examples of footnotes without symbols are as follows:

Manual gauge, May 20 to July 20 and August 21 to 23

Ice conditions, January 1 to April 10 and October 27 to December 31.

Estimated, June 1 to 29.

(f) "V" - Subdivided

Use this symbol when the daily gauge height record is subdivided into two or more periods to compute the daily discharge. Enter this symbol in the gauge height column and omit the daily mean gauge height for that day. However, if a daily water level is required to compute monthly mean water levels, it is to be computed from the continuous water level record and not from the daily discharge (the symbol "V" in this case would be shown to the right of the daily water level)..Use of this symbol must be accompanied by an appropriate reference in a footnote, i.e. V - Subdivided. However, note that his symbol will not appear in any publications.

(g) Enter the following footnote on the Station Analysis form 067-2130, with the appropriate dates, when any part of a streamflow or water level record has been prepared by computer methods:

Data to processed by digitizer and computer methods.

(h) In summary although only the symbols “A”, “B”, “D”, “E” or “V” will be used, only the symbols “A”, “B”, or “E” will be accompanied by a footnote in the data publications or on printouts. Explanatory footnotes may be used if the symbol applies to one or two periods or to explain that the recording gauge was not in operation during all or p art of winter periods or that a gauge height graph was used for a certain period.

Examples of footnotes are as follows:

Recording gauge not in operation during ice periods.

Recording gauge not in operation, January 1 to March 5 and November 15 to December 31.

Recording gauge not in operation continuously during ice periods.

Gauge heights from graph of observed reading, may 20 to June 10.

(i) The computer printouts for daily discharges and water levels will show a symbol for each day where applicable.

3. LIST OF MANUALS

3.1 Manual of Hydrometric Data Review Procedures

This manual has been prepared to provide a uniform set of standards and procedures for use in the review of historical hydrometric survey data.

The primary purpose of hydrometric data review is to discover and correct, as far as possible, significant errors in the existing historical records. It is part of the current office computations, and should not be considered a separate activity. The review also serves broadly to assess the reliability of the records produced, and also serves and a means for recommending future improvements where possible.

3.2 HYDEX System Operations Manual

This manual describes the procedures for submitting and processing descriptive information for hydrometric gauging stations (streamflow and water level operated during the history of the Water Survey of Canada since about 1908.

Gauging Station Inventory Updating forms 067-2006 are submitted for new stations by the Regional Offices and the information is coded and keypunched in Ottawa for subsequent storage on the magnetic tape file, HYDEX. Revised or corrected information is entered on printouts which are then submitted to Ottawa for updating. This file is maintained on the CDC CYBER 74 computer at the Department of Energy, Mines and Resources, Ottawa, and is updated at least monthly. The purpose of the HYDEX file is to:

(a) Provide “management statistics”, e.g. number and /or name of active streamflow stations in Alberta., cableways in Manitoba, sediment stations in Canada, number of active streamflow and water level

stations in Canada by province or by Region, breakdown into various categories for cost-sharing agreements, etc..

(b) Produce computerized listings suitable for publishing the biennial Surface Water Data Reference Index for Canada.

(c) Produce computerized listings suitable for distribution to users or for the annual Surface Water Data and quinquennial Historical Streamflow and Water Levels Summary publications when combined with the following data files which are also on magnetic tape:

FLOW	daily discharges
LEVELS	daily water levels
PEAKS	annual maximum instantaneous discharges and water levels

3.3 Automated Hydrometric Computation Procedures

This manual contains detailed instructions for automating streamflow and water level computations using three separate programs: STEAM, HOURLY and MANUAL. Three other programs, GCSC, TIDAL and MANRES (which were formerly separate) have been incorporated in these programs as options.

The input to these programs can be in either imperial or metric units and the output also in either unit.

This manual also contains a description of the digitizer system, chart documentation, procedures for digitizing charts and card formats.

3.3.1 STREAM Computer Program

This program is used to obtain daily mean gauge heights and/or daily discharges or daily capacities (for reservoirs), along whit the appropriate symbols. Water level recorder charts are digitized to obtain punched cards containing the X-Y co-ordinates of straight-line segments of the water level trace. These cards are combined with the card decks which define the stage-discharge (capacity) relationship and the gauge, shift and updating corrections and then submitted for computer processing.

This section contains procedures for the deck set-up for computer runs and a description of the various types of output as indicated on the “Options” card, e.g. printouts of daily discharges and water levels, including monthly and annual summaries, plot of digitized chart or annual Hydrograph, print expanded stage-discharge table, print annual page or gauge and shift corrections convert and punch stage-discharge table or updating corrections punch output cards etc..

Detailed documentation for the STREAM computer program is given in the “STREAM Programmers’ Manual” dated January 15, 1974, which is now mostly out-of-date.

3.3.2 HOURLY Computer Program

This program is used to compute instantaneous gauge heights and/or discharges at selected time intervals of 15 minutes or 1, 2, 3, 4, 6, or 8 hours, and for a selected number of days. The same card input is used as for the STREAM program except for the “Options” card.

Another option is to process “tidal stations:” to obtain instantaneous hourly water levels on printouts or punched cards in format TWL 501. This information is obtained by the Regions solely for submission to the Tides and Water Levels Section, Marine Sciences Directorate, DFO, Ottawa, who then use these water levels either for their publication of water levels or for tidal predictions.

This section contains procedures for the deck set-up for computer runs and a description of the various types of output as indicated on the “Options” card.

3.3.3 MANUAL Computer Program

His program is used to compute daily mean gauge heights and/or daily discharges or daily capacities (for reservoirs) for those stations equipped with only a manual gauge. The main difference between this program and the STREAM program is in the input data decks: STREAM uses “chart decks” of digitized points and MANUAL uses keypunched gauge readings or discharges.

This section contains procedures for the deck set-up computer runs and a description of the various types of output as indicated on the “(Options” card.

3.4 Automated Thermograph Computations

This manual contains detailed instructions for automating water temperature computations using a digitizer interfaced with a card punch.

Detailed instructions are given for digitizing continuous water temperature charts as well as procedures for the deck set-up for processing by a modified version of the STREAM program called TGRAPH, to give printouts showing the daily maximum, minimum and mean temperatures. This new program can process records in either degrees Fahrenheit or Celsius and produces computer listings and punched cards only in degrees Celsius. The outputs will eventually be stored in a magnetic tape file which is only in the planning stage at present.

3.5 Automated Procedures for Area, Point and Length Computations

This manual contains detailed instructions for processing digitized data from topographical maps using the MAP computer program to calculate:

(a) the drainage area and the perimeter of a drainage basin;
(b) the river length; or
(c) the latitude and longitude of a point, e.g. gauging station location.

Modified versions of the MAP program have been implemented in some Regions which use a reference area to compute the drainage area rather than the geographical coordinates.

3.6 SAVE System Operations Manual

This manual contains instructions for the permanent storage, on magnetic tape, of the punched cards used as input in the STEAM and MANUAL computer programs. This manual also contains instructions for the retrieval of these cards for use as input on other computer programs such as the HOURLY program, or for revisions of past data, or for special studies; this also ensures that the same results as the original computations can be reproduced, The accumulation of punched cards from digitized data and related computations could present a storage problem since nearly one million cards are produced annually by the Regions. Therefore, it was decided to store these cards as images on magnetic tape using utility programs at local Computer centres and to write computer programs for the retrieval of cards as required, without having

to re-digitize charts or re-punch gauge/shift corrections. Stage-discharge tables, etc. . The general procedure is as follows:

(a) Regions assemble the data cards for one year's operation in stations number order, create a SAVE magnetic tape using a utility program at their Computer Centre, and produce a listing of the station numbers for which cards have been stored using the LIST computer program. A copy of this tape is sent to Ottawa.

(b) Ottawa produces a listing using the CHEKSAV computer program which is a more elaborate LIST program in that it gives not only a count of the cards stored under each station number but also gives the dates of the first and last chart sections, number of update, gauge/shift correction, stage-discharge cards, etc. This listing is returned to the Region, at which time the punched cards may be destroyed.

(c) These cards can be retrieved from either copy of the SAVE tape by either Ottawa or the Region using the VE computer program (or a utility program at the local Computer Centre, if available) and then used as input to another computer program.

Historical SAVE data for several Regions have been edited, sorted and then merged in multiple files in chronological and station number order for more efficient retrieval.

3.7 FLOW File Operations Manual

This manual contains a detailed description of the FLOW magnetic tape file of historical daily discharges and also detailed instructions and an explanation of the computer programs for the storage and retrieval of these data on the CDC CYBER 74 computer at Ottawa. This manual also contains instructions for plotting annual daily discharge hydrographs using the CYBER 74 computer and CALCOMP plotter at Ottawa.

These data are submitted annually to Ottawa by the Regions on punched cards or card images on magnetic tape for the automated preparation of camera-ready manuscripts for the eight annual Surface Water Data publications. The historical master FLOW file is then updated to include these annual data along with any corrections, revisions or additions for earlier years. Data are stored by Region and by stations number order within each Region. To facilitate the retrieval and publication of monthly and annual mean discharges and total discharges, a TOTALS file is created form the FLOW file and contains the monthly totals for all stations on one reel of tape. Various data files are then used for the automated preparation of camera-ready manuscripts for the eight Historical Streamflow Summary publications which are now to be published every five years.

Historical daily, monthly and annual streamflow data can be supplied to users on punched cards or magnetic tape for computer processing.

3.8 LEVELS File Operations Manual

This manual contains a detailed description of the LEVELS magnetic tape file of historical daily water levels for "water level only" stations and for selected stations where streamflow data are also collected, and also detailed instructions and an explanation of the computer programs for the storage and retrieval of these data on the CDC CYBER 74 computer at the Department of Energy, Mines and Resources, Ottawa. This manual also contains instructions for plotting annual daily water level hydrographs using The CYBER 74 computer and CALCOMP plotter at Ottawa.

Data are now submitted annually to Ottawa by the Regions on punched cards or card images on magnetic tape for the automated preparation of camera-ready manuscripts for the eight annual Surface Water Data publication. The historical master LEVELS file is then updated and used for the automated preparation of camera-ready manuscripts for the eight Historical Water Levels Summary publications which are now to be published every five years.

Historical daily, monthly and annual water level data can be supplied to users on punched cards or magnetic tape computer processing.

3.9 PEAKS File Operations Manual

This manual contains a detailed description of the PEAKS magnetic tape file of historical annual maximum instantaneous discharges and water levels and also detailed instructions and an explanation of the computer programs for the storage and retrieval of these data on the CDC CYBER 74 computer at Ottawa..

All data for all stations for all Regions are stored on one tape. Data are submitted annually to Ottawa by the Regions an punched cards or from067-2081 for the automated preparation of camera-ready manuscripts for the eight annual Surface Water Data publications. The historical master PEAKS file is then updated to include these annual data along with any corrections, revisions or additions for earlier years; various data files are then used for the automated preparation of camera-ready manuscripts for the eight Historical Streamflow Summary and the eight Historical Water Levels Summary publications which are now to be published every five years.

Historical annual maximum instantaneous discharges can be supplied to users on punched cards or magnetic tape for computer processing.

3.10 Supplying Hydrometric and Sediment Data to Users

Streamflow, water level and sediment data can be supplied in card format either on punched cards or magnetic tape by the Data Control Section, Ottawa, More up-to-date or related or miscellaneous data are available form the Regional Offices. Daily discharges and water levels prior to 1979 and sediment data prior to 1978 are also available on microfiche on metric units.

This manual contains a description of the regular publications that are available and a description of the various card formats in which data can be supplied, as well as the procedures for requesting data, including how to be placed on a mailing list.

3.11 Publication Procedures for the Surfaces Water Data Reference Index

This manual contains detailed procedures for the automated preparation of camera-ready manuscripts for the biennial Surface Water Data Reference Index publication, including a description of the various computer programs and instructions for setting up computer runs on the CDC CYBER 74 at Ottawa

The 1966 edition of the Reference Index was published in seven volumes, by province or region, and included coloured maps showing the location of gauging stations. The 1968 edition was an update of the 1966 edition (including maps). The 1970 edition was similar to the previous editions except that t was bound in one book for Canada and maps ere not included and was published annually from 1970 to 1979. The 1979 edition is the first publication showing data in metric units. The format was changed for the 1973 edition when automated techniques were introduced. A Hydrometric Map Supplement was issued with the 1972 editions. Each new edition of the Index and Map Supplements supersedes the previous edition.

Gauging station Inventory Updating forms 067-2006 for all active and discontinued gauging stations operated by the Water Survey of Canada (and co-operating agencies) have been submitted to Ottawa by the Regional Offices. Selected descriptive information on these forms is stored on the HYDEX magnetic tape file. New or revised forms 067-2006 or "inventory" printouts are submitted when conditions change. The Reference Index is prepared at Ottawa From these forms. Initially the manuscript as typed by the Publications Office and required proofreading.. Since 1973, the entire manuscript has been produced using automated techniques described herein.

3.12 Publication Procedures for Surface Water Data

This manual contains detailed procedures for the automated preparation of camera-ready manuscripts for the eight annual Surface Water Data publications, including a description of the various computer programs and instructions for setting up computer runs on the CDC SYBER 74 at Ottawa.

The Surface Water Data publications contain tables of daily water level or discharge data, along with an annual summary, using the following data files: HYDEX (gauging station description), FLOW (daily discharges), LEVELS (daily water levels). Data are published in 8 volumes, one volume for the Atlantic Provinces, one volume for the Yukon and Northwest Territories and 6 volumes for the remaining provinces.

The data for these publications are submitted annually by the Regional Office and should arrive at Ottawa no later than four months after the and of the publication year i.e. no later than May 1st. The data files mentioned above are maintained separately from the historical files and are updated as soon as additions or corrections are received at Ottawa The verification of the data, which includes updating the data files and verification of the computer printouts by the Regional offices, usually requires one to two months for completion.

Data were published in metric units for the first time in 1979. Historical daily data prior to 1979 are available in metric units on microfiche but not in published form.

3.13 Publication Procedures for the Historical Streamflow Summary

This manual contains detailed procedures for the automated preparation of camera-ready manuscripts for the eight quinquennial Historical Streamflow Summary publications, including a description of the various computer programs and instructions for setting up computer runs on he CDC CYBER 74 at Ottawa.

These publications contain a summary of monthly and annual mean discharges, annual maximum instantaneous discharges, annual maximum and minimum daily discharges and annual total discharges, using the following data files: HYDEX (gauging station description), FLOW (daily discharges) and PEAKS (annual maximum instantaneous discharges). Data are published by province or region as for the annual Surface Water Data publications. Data are submitted at least annually by the Regional Offices and the appropriate files are updated. These Summaries were first publication to show data entirely in metric units. The latest edition supersedes all previous editions since it includes any corrections or additions made since the previous publication.

3.14 Publication Procedures for the Historical Water Levels Summary

This manual is under preparation and will contain detailed procedures for the automated preparation of camera-ready manuscripts for the eight quinquennial Historical Water Levels Summary publications, including a description of the various computer programs and instructions for setting up computer runs on the CDC CYBER 74 at Ottawa

These publications contain a summary of monthly and annual mean water levels, annual maximum instantaneous water levels and annual maximum and minimum daily water levels, using the following data files: HYDEX (gauging station description), LEVELS (daily water levels) and PEAKS (annual maximum instantaneous water levels). Data are published by province or region as for the annual Surface Water Data publications. Data are submitted at least annually by the Regional Offices and the appropriate files are updated; data are submitted for "water level only" stations and also for selected stations where streamflow data are collected. These Summaries were first published for 1976. The 1979 publications were the first to show data entirely in metric units. The nest edition will contain data to 1984. The latest edition supersedes all previous editions since it includes any corrections or additions made since the previous edition.

4. DATA FILES ON MAGNETIC TAPE

Data are submitted at least annually by the Regions on computation forms, on punched cards or as card images on magnetic tape. These data are then stored on one of four files (HYDEX, FLOW, LEVELS or PEAKS) and printouts returned to the Regions for verification. These data are then processed to automatically produce manuscripts for printing the various publications or are supplied to users on punched cards or magnetic tape for analysis by computer.

4.1 HYDEX File

This file contains descriptive information about gauging stations as extracted from Gauging Station Inventory Updating forms 067-2006 (or printouts), e.g. station no., name, province, latitude and longitude, type of gauge, period of record, regulated or natural flow, etc., including the REMARKS file. Nearly 8 million characters of information are stored on disk for some 2800 active and 2700 discontinues gauging stations. This file is updated at least monthly. Detailed instructions and procedures are outlined in the :HYDEX System Operations Manual".

4.2 FLOW File

This file contains about 61 500 stations-years of daily discharge data to 1979 on 8 magnetic tapes, or 180 million characters at 6250 cpi (characters per inch). One month of record is 300 characters long and is blocked 15. This file is updated at least annually. Detailed instructions and procedures are outlined in the :FLOW File Operations Manual".

4.3 LEVELS File

This file contains about 13 300 station-years of daily water level data to 1979 on 3 magnetic tapes, or 47 million characters at 6250 cpi. One month of record is 360 characters long and s blocked 14. This file is updated at least annually. Detailed instructions and procedures are outlined in the "LEVELS File Operations Manual".

4.4 PEAKS File

This file contains annual maximum instantaneous discharges and water levels to 1979. Over 1 million characters of data are stored on disk. This file is updated at least annually. Detailed instructions and procedures are outlined in the "PEAKS File Operations Manual".

5. PROCEDURES FOR MANUAL COMPUTATION OF DATA

This section contains detailed procedures for the "manual" computation of streamflow and water level data. General instructions are given in section 2 and detailed automated procedures are given in one of the manuals listed in section 3.

5.1 Gauge History (067-2127)

(a) Describe the type and location of existing bench marks and, if readily available, give the date of installation. Enter the elevation of each bench mark and state whether it is referred to an assumed or a standard datum. For Geodetic Survey of Canada bench marks, give the BM No. and the Publication No (and year of edition) from which the elevation was obtained.

(b) Enter the elevation of the gauge datum.

(c) When a change in the elevation of a bench mark or the gauge datum is made, explain the reason for the change on the bottom of the form and start a new form with the appropriate entries.

(d) Enter the results of all the level checks that were made on all the gauges at the gauging station for the period of record being computed; indicate in the "Notes" column if a gauge has been re-set, extended, destroyed, damaged, etc..

(e) Describe any changes in the location of gauges; also explain any major changes in equipment at a gauging station.

(f) The same sheet may be used from year to year of there is sufficient space to explain clearly what has occurred.

5.2 Gauge Corrections (067-2128)

(a) Enter on form 067-2128, the gauge corrections as shown on Gauge History form 067-2127 for the year for which record are being computed. "Circle" these corrections. Enter the last correction prior to the beginning of the year and the first correction after the end of the year; this may not be applicable in some cases for records collected on a part-year basis where the first gauge correction after the end of the year is not available until the following spring.

(b) If the date on which the change occurred is not known, assume that the change occurred uniformly and distribute the correction in accordance with one of the two following methods:

(i) Divide the change in the correction by the number of days to find the "change per day". For example: suppose the correction was found to be +0.005 on March 20 and +0.009 on March 30. The number of days involved is 10 and the change in correction is 0.004. The change per day is 0.0004. The corrections to be applied are shown to the nearest thousandth of a metre.

(ii) When the change is small and the number of days is large, the preferable method is to divide the number of days by the change in correction. For example: suppose the correction is +0.003 on May 25 and +0.006 on October 15. Dividing the period of 144 days by 3 gives 3 intervals of 48 days each. No change in correction will be applied during the first one-half interval of 24 days, i.e. the correction +0.003 will be continued from May 25 to June 17; an increase of 0.001

in the correction will be applied during each of the nest two intervals of 48 days, i.e. a correction of +0.004 from June 18 to August 4 and +0.005 form August 5 to September 21. The remaining 0.001 change will final correction of +0.006 will be applied from September 22 to October 15.

(c) The gauge correction sheet should be prepared up to the date of the first level check in the following year.

5.3 Discharge Measurements (067-2122)

(a) Enter the date of the discharge measurement. If a non-conventional technique (such as moving boat, fluorometric, etc.) was used in measuring the discharge, indicate the method of measurement in the "Remarks" column.

(b) Enter the name of the person who made the measurement. If the measurement was made by the USGS, PFRA, or any other co-operating organization, only the name of the organization need be indicated.

(c) Enter the air and water temperatures at obtained at the time of the measurement.

(d) Enter the width, area , mean velocity and discharge, using significant figures as shown in section 205. If ice is present in the stream or if the discharge is estimated, insert the appropriate reference or symbol in the "Remarks" column.

(e) Extract the weighted mean gauge observation corresponding to the measured discharge form the front sheet of the discharge measurement notes (from 067-2078). Apply the appropriate gauge correction from form 067-2128 to this observation and enter the result inn the "Mean Gauge Height:" column.

(f) If discharge measurements at a station are made at more than one location, a symbol should be entered under "Remarks" to distinguish them in the event that it is necessary to use the cross-sectional area or the mean velocity.

(g) If any other information pertinent to the discharge measurement is obtained, note this in the "Remarks" column.

5.4 Gauge Height Computations

Compute the mean gauge height for each day by applying appropriate corrections to the original gauge record and enter on form 067-2121 or 067-2124. For a manual gauge, a single observation per day or the mean of two or more observations per day is usually used to represent the mean gauge height for a day. Where gauge heights are shown and the relation between the gauge datum and a G.S.C. or other standard datum is known, indicate the adjustment necessary to convert the gauge heights to elevations, e.g. "Add…l m to convert gauge height to elevation above mean sea level (Geodetic Survey of Canada datum, Publication 24, 1951 Edition)".

5.4.1` Manual Gauge

(a) Transfer to the observer's book any pertinent observed water level data which have not already been entered and indicate the source. If there is a definite reason why some observations should not be used in determining the daily mean gauge heights, explain this in the observer's book and on the Station Analysis form 067-2130.

(b) Determine the daily mean gauge observations to be used and apply the appropriate gauge corrections to the mean observations. Enter the resulting daily mean gauge heights on form 067-2121 or 067-2124. When the stage is rapidly rising or falling, greater accuracy in determining the daily mean stages may be achieved by plotting the gauge heights on a graph. When more than two observations are made during any one day and a graph is not drawn, consideration should be given to weighting them rather than taking the mean.

(c) If the mean is obtained from more than one observation, enter this mean in the observer's book, If the mean is obtained from a graph, enter the mean and an explanatory note.

(d) Where applicable, follow the rules for subdivision as outlined in section 5.4.2 (k).

(e) Enter the maximum instantaneous water level for the year in the space provided on form 067-2121, 067-2131, stating the date and how it was obtained, e.g. "from high water mark", "estimated from graph" or "observation at peak"; delete the word "daily". When an extreme is the result of some unusual condition such as an ice jam, unusually heavy rain, stop log manipulation, etc., enter a suitable remark to that effect. If the maximum instantaneous gauge height for the year is not knoen, then either enter "Not known: or delete the word "Instantaneous" and enter the maximum and minimum daily mean gauge heights for the year.

(f) Do not enter extremes of stage for canals.

(g) Use symbols if necessary (see section 2.7).

5.4.2 Recording Gauge

(a) Good field practice requires that the following information be noted on recorder charts at the time they are removed from the recorder: (I) name of gauging station, (ii) scales of chart and, (iii) time and date on which the chart was started and removed and the gauge observations mad eon those dates; also a record of any re-setting between the terminal dates. These data should be entered on the chart if the field officer has omitted them.

(b) Inspect the times as recorded at the beginning and end of the chart, and on any intermediate days, to determine the total time correction that should be applied.. After inspecting the chart carefully to see that any difference between the chart time and the actual time is not due to re-setting, stoppage, etc.,. indicate the total time correction at the end of the chart, e.g. "T 3 hrs fast" or "T1 hr slow-used OK", etc.. The error in time may usually be neglected if the total error in a period of about one month is less than two divisions on the time scale. Distribute the total time correction according to one of the methods described in section 5.2 for distribution of gauge corrections. Apply time correction distributions only to the nearest division. For example, if a chart on a scale of 60 mm = 1 day were OK on June 1 and three hours fast on June 1`3, then three of those days (June 3, June 7 and June 11) would be increased by 1 hour (1 division) - these three days would have 25 hours and all the others 24. Indicate the corrected midnight by a vertical lime broken at the graph line. Enter the dates in the margin at the top or bottom of the chart at the respective noon lines.

(c) The recorder pen is usually set to read the same as the inside gauge (IG). If the IG is not used, indicate the reference gauge that was used at the beginning of the chart and on the Station Analysis form 067-2130. Inspect the observations given for the manual gauge and for the pen at the beginning, intermediate points, and end of the chart and determine the pen correction to be applied. Indicate the total pen correction at the end of the chart and at any place of re-setting. Distribute the total pen correction according to one of the methods described in section 3.2 for distribution of gauge corrections.

(d) Examine the chart to see if a reversal has occurred. If one has occurred, identify the point of reversal by the abbreviation "REV." and indicate the amount of correction to be applied due to the point of reversal not coinciding with the top or bottom of the chart.

(e) When the chart line is missing for part of a day, it may be estimated and marked on the chart by a dashed line for use in determining the daily mean observation. If the chart line is missing for one or more days, the daily mean observation may be based upon the available manual gauge observations. In either case, the resulting daily mean values should be identified by the symbol "A".

(f) When adding notes or corrections to the chart or interpolating for missing records, care must be taken to preserve the original record. Do not trace over the original pen or pencil record.

(g) Compute the daily mean observations by one of the following methods:

(i) Balance the areas on either side of the mean value by the use of a straight-edge or "scanner". A "scanner" is a clear rectangular plastic device approximately 3cm x 15 cm x 2 mm with a longitudinal hair line on the back bisecting a hole drilled at the mid-point to receive a pencil point.

(ii) Divide the day into two or four equal parts, determine the mean for each part and then mean these values to obtain the mean for the day. For example, suppose the day is divided into four parts or six hours each. The mean observation for the first period of six hours is indicated by a dot at the mid-line (the 03:00 line in this case). The mean for the second six-hour period is indicated by a dot at the mid-line (which is the 09:00 line). A line is drawn from the dot on the 03:00 line to the dot on the 09:00 line and the point at which this line crosses the 06:00 line is the mean observation for the first 12 hours of the day. Do the same for the last 12 hours of the day and connect the two 12-hour means y a straight line. The point at which this line crosses the noon line is the mean observation for the day.

(h) Compute the daily mean observations by applying the appropriate pen corrections and reversal corrections (where applicable). In arriving at the daily mean observations, the individual corrections applied to each daily mean observed value should be shown separately rather than as a net correction.

(i) Compute the daily mean gauge heights by applying to the daily mean observations, the appropriate gauge corrections for the inside gauge or other manual gauge to which the chart record is referred, Enter the gauge heights on form 067-2121 or 067-2124. This procedure may be delayed until the end of the year when the gauge corrections applicable to that year have been determined. Application of the gauge correction may or may not be shown on the recorder chart. If gauge corrections are applied on the chart, use the abbreviation "GC" after each gauge correction figure.

(j) The daily mean gauge height normally is used to compute the daily mean discharge. However, a daily mean discharge determined directly from the daily mean gauge height may be in error for a number of reasons, including the following:

(i) The rate of change in stage

(ii) The relative condition of the river (high or low)

(iii) The shape of the stage hydrograph for the day and the proportion of time during which the stage is relatively high or low.

(iv) The relative curvature in the stage discharge curve in the range of stage recorded during the day.

(k) To obtain a more accurate determination of the daily discharge, it may be necessary to subdivide the day into two or more parts, determine the mean gauge height for each part, determine the discharge for each mean gauge height and from these compute the weighted mean discharge for the day. IF the resultant weighted mean discharge differs from that determined using the mean gauge height by more than a selected allowable limit, say 2% for discharges above 0.3 m^3/s below 0.3 m^3/s, then subdivision is necessary for all similar conditions. Suggested method of determining the necessity for subdivision is to use an allowable range table which may be prepared by trial and error as follows:

(i) From the stage-discharge table select a range in stage during medium flow from, say, 3.0 to 4.0 m
Discharge at gauge height 3.0 m equals 186 m^3/s
Discharge at gauge height 4.0 m equals 339 m^3/s
Mean discharge equals 262 m^3/s

However, at a mean gauge height of 3.5 m, the discharge is 252 m^3/s. This is a difference of 4% (10 divided by 262, x 100) which is not allowable.

(ii) Select a smaller range, say from 3.0 to 3.4 m which gives a difference or 1% which is too low, but 3.0 to 3.6 gives 2%.

(iii) Now try between 4.0 and 4.6. This is 1% which is too low so the between 4.0 and 5.0 which is 3%. Therefore, an allowable range of 0.8 m is about right.

(iv) The range from 6.5 to 7.5 will give 2%

(v) After several such attempts an approximate allowable range table will evolve.

(vi) When in doubt, subdivide!

(l) Mark the maximum instantaneous gauge observation for the year on the chart.

(m) If the period of usable record and the period covered by the chart are not the same, the period of usable record should be indicated at the beginning of the chart with a note explaining why the remainder or the chart record is not to be used. Do not destroy a chart even if all of it is considered unreliable as the presence of it on the files will show that a useful record was not obtained from a recording gauge for that particular period.

5.5 Stage-Discharge Relationship

5.5.1 Stage-Discharge Curves

(a) Select scales on the curve sheet (from 067-2003 or 067-2004) so that the significant figures as required for the stage-discharge table can be red with reasonable accuracy. Gauge heights are plotted on the vertical scale and the discharges on the horizontal scale. Suggested scales for the gauge height are 1 cm = 2, 1, 0.5, 0/.2 or 0.1 m and for the discharge, 1cm = 20 000, 10 000, 5000, 2000, 1000, 500, 200, 100, 50, 20,

10, 5, 2 or 1 m^3/s. Make adequate provision for the entire range in stage which is know to have occurred during the history of the records. The stage-discharge relationship may have to be shown in one or more curves to obtain the degree of accuracy required for the computation of the stage-discharge table. Mark each curve "low water curve", "high water curve", etc.;' where feasible, carry each curve down to or near the "zero flow" stage. Allow for at least 0.3 m of overlap between curves and use more than one sheet if necessary to avoid cramping and confusion.

(b) When a new curve sheet becomes desirable, first plot all extreme high or low discharge measurements from former years on the new sheet. On the new sheet, plot the latest available stage-discharge curve. Finally, plot all the open water measurements for the current year and, if necessary, plot a new stage-discharge curve for the current year.

(c) Indicate the plotted point for each discharge measurement by a dot, surrounded by an open circle about 2 mm in diameter. Circles that indicate measurements for previous years may be filled in with ink which will distinguish them from the measurements made during he current year. Designate a discharge measurement by its date (e.g. June 12, 1967) with a diagonal line from the plotted point (use the same angle, say 60^o , on each sheet or draw the diagonal line about perpendicular to the curve). Measurements known to be affected by backwater may be plotted in pencil or by use of a distinctive symbol. If it is desired to identify measurements made by another organization, use a different symbol (e.g. a triangle, square or cross), with an explanatory note in the lower right-hand corner of the curve sheet).

(d) In many cases it is necessary to plot the measurements on log paper (form 067-2005) to determine the shape of the curve, particularly at high water stages. The gauge height corresponding to the point of zero flow is determined approximately, to the nearest decimetre or to the nearest metre depending on the size of the stream, and is entered in the space provided on form 067-2005. The discharges are plotted against the difference between the mean gauge height for the discharge measurement and the gauge height at zero flow. In most cases, this log plot of measurements will form a straight line in the "high water" range making it a useful tool in extending curves beyond the highest discharge measurement. The "curve" as determined in the log plot is then transferred to form 067-2003 or 067-2004.

(e) Another method of determining the shape of, or extending, the stage-discharge curve is to plot the cross-sectional areas and mean velocities against gauge height. From these two curves, the area and mean velocity corresponding to a selected high stage are used to determine a computed discharge which is then plotted on the stage-discharge curve sheet.

(f) If a log plot or an area-velocity study is used to determine the shape of any part of a stage-discharge curve, insert an explanatory note under "Remarks" in the title block on the basic stage-discharge curve sheet (form 067-2003).

(g) The following procedure will be used in labelling stage-discharge curves:

(i) The first curve used in the first year of operation will usually be designated "Curve No. 1." However, another number, such as 31, may be selected if desired but do not start with No. 1 if this method of labelling curves was in use in previous years.

(ii) Use a diagonal line from the curve to the notation.

(iii) Label any succeeding curves as "Curve No. 2", "Curve No 3", etc. (or "Curve No. 32", "Curve No 33", etc.).

(iv) Enter the dates for the period of use of each curve in the space provided.

(h) Complete all the information on the curve sheets in ink.

5.5.2 Stage-Discharge Tables

(a) Enter the number of the stage-discharge table, which must correspond with the stage-discharge curve number, in the space provided on form 067-2119 or 067-2120. Note that the initials of the computer and checker and the date the table was computed are also to be entered.

(b) When computing the stage-discharge table, deviate as little as possible from the figures as indicated by the curve. Express discharges to at least the same number of significant figures as required for daily discharges.

(c) In computing the table it may be necessary or desirable to show a discharge figure for each 0.001 m of gauge height as provided for in form 067-2120. This table is convenient where the flow during most of the year is confined to a relatively small range in stage.

(d) In computing the stage-discharge table certain refinements may have been made in the computations to adjust for the fact that the curve may not have been a smooth curve. When the stage-discharge table is completed, plot the values on the curve sheet to endure that the original delineation of the curve is consistent with the table.

(e) In some cases, a new stage-discharge curve is exactly the same as a former curve through part of the range in stage. In preparing the new stage-discharge table for these areas, copy the data from the former table through the range of stage in which the new curve and the former curve are identical, then compute the new table in the range of stage where the two curves diverge. The new table will cover the entire range of stage.

(f) If a stage discharge curve is extended above or below the original range, the same original no. and date identification may be used. However, an explanatory note should be added on form 067-2119 as well as the date when this extension was made, Note that this applies only if the curve is extended and not if it is revised.

(g) Enter the dates for the periods of use of each table in the space provided.

5.6 Discharge Computations

5.6.1 Shift and Backwater Corrections

(a) For many stations a shift in the station control or a backwater condition may occur at certain times during the year as a result of weed effect, beaver action or ice conditions. During such periods, shift or backwater corrections are determined from available discharge measurements; these corrections are entered on form 067-2122 and used subsequently to compute daily corrections which are applied in the determination of the daily discharges

(b) However, apart from these measurements which plot off the curve for reasons indicated above, the majority of the measurements will p lot somewhat off the curve as a result of normal scatter. For thse, no correction is computed; however, it is normally found useful for purposes of expressing mathematically the degree of scatter, to indicate for each measurement the percentage difference between measured

discharge and the discharge indicated by the "Diff." Column on form 067-2122. If desired, these differences may be expressed in cubic metres per second instead of percentage for discharges less than about 0.5 m^3/s.

(c) Following is an example of the computation of shift and backwater corrections, and the "difference" between measured discharge and the indicated discharge from the stage-discharge table:

(i) From a discharge measurement (form 067-2122), the mean gauge height is l.621 m and the discharge is 3150 m^3/s. From the stage-discharge table, the discharge of 3150 m^3/s corresponds to a gauge height of 1.323 m, indicating that a shift correction of -0.298 m would have to be applied to the mean gauge height for the day to produce results consistent with the discharge measurement.

(ii) From a discharge measurement (form 067-2122), the mean gauge height is 1.811 m and the discharge is 708 m^3/s. From the stage-discharge table, the gauge height of 1.811 m corresponds to a discharge of 696 m^3/s. The difference between the measured discharge and that indicated by the stage-discharge table is (708-696) divided by 696 x 100 = 1.7%.

(d) A discharge measurement made during the computation period may plot substantially off the stage-discharge curve. If after careful analysis and review, no satisfactory cause of its departure from the stage-discharge curve can be determined, the measurement should be eliminated from use in the computation. In this instance do not enter any figure in the "Shift" or "Diff." Columns but enter an explanatory note in the "Remarks" column on form 067-2122 as well as Station Analysis form 067-2130.

5.6.2 Open Water

(a) In the space provided on form 067-2124, enter the number and date of each stage-discharge table that is to be used and indicate the specific period for which each table applies.
(b) If no shift or backwater corrections are applicable, use the stage-discharge table and the gauge heights directly to obtain the daily discharges.

(c) If shift or backwater corrections are to be applied, rule in an extra column to the right of the gauge height column. Enter for the appropriate dates, the correction established by the respective discharge measurements. "Circle" these corrections. The distribution of the shift or backwater corrections from day to day will depend upon the interpretation of the cause of the shift; enter a brief explanation of the interpretation used on the Station Analysis form 067-2130. Distribution may be made on a straight-line basis in accordance with one of the methods described in section 5.2. Instead of using an extra column on form 067-2124 for entering shift or backwater corrections, it may be more desirable in some cases to apply these corrections by the use form 067-2126.

(d) Enter on form 067-2124, the daily discharge as computed on the subdivided-day work sheet.

5.6.3 Ice Conditions

(a) Because of the many variable factors involved, no single standard procedure is suggested for the computation of daily discharges during periods when the stage-discharge relation is affected by the presence of ice. Several methods of computing discharges under ice conditions are available and it is suggested that the Regional Offices use the method that best suits each individual stations.

(b) One method of computing discharges under ice conditions is as follows:

(i) or each ice-affected discharge measurement, enter on form 067-2126 the gauge height and discharge (from form 067-2122) and the effective gauge height and the backwater as computed from the stage-discharge table. To ensure continuity in the backwater interpretation, enter these data also for the last measurement before the beginning of the ice period and for the first measurement after the end of the ice conditions.

(ii) Transfer any pertinent remarks from the observer's record, measurement notes, weather records, etc., to the "Remarks" column of form 067-2126. These remarks should be of assistance in providing a basis for backwater interpretations.

(iii) Transfer the daily gauge heights from form 067-2124 to the "Daily Gauge Height" column in form 067-2126.

(iv) Arrange the scales on a Winter Hydrograph form 067-2035 or equivalent, to allow for plotting of the following: (1) maximum and minimum (or mean) temperatures, (2) backwater, (3) gauge heights (both daily and effective), and (4) discharge.

(v) Plot the following on form 067-2035: (1) daily maximum and minimum (or mean) temperatures obtained from the appropriate meteorological station, (2) the gauge height and discharge from each discharge measurement and the effective gauge height and backwater correction as computed from the stage-discharge table (from form 067-2126); "circle" these plotted points, and (3) the daily gauge heights.

(vi) Draw the backwater graph on form 067-2035. The method of drawing this backwater graph will probably vary with each gauging station and will be dependent upon such factors as: (1) formation, storage and release of slush, (2) rate of ice formation, (3) temperature, (4) precipitation, (5) ice-jamming, (6) amount of snow cover, etc.

(vii) Transfer the daily backwater corrections from form 067-2035 to form 067-2126 and compute the effective gauge heights; compute the discharges corresponding to these effective gauge heights.

(i) Plot the effective gauge heights and the corresponding discharges on form 067-2035.

(ii) The discharge hydrograph for an adjacent station may be plotted for comparison purposes. Certain previous interpretations may be changed to make the discharges appear more consistent, do not overlook the possibility that there may be some valid reason for the apparent inconsistency.

(iii) Transfer the daily discharges from form 067-2126 to form 067-2124.

(c) Where discharge measurements are made frequently during the ice period, it may be considered unnecessary to plot a "winter hydrograph". The computation of the daily discharges then may be made directly on form 067-2126 but in a manner similar to that outlined in section 5.6.3 (b) above.

(d) When a daily gauge height record is not obtained during the ice period, another method of computing discharges under ice conditions is as follows:

(I) Enter on form 067-2126, the measured discharges obtained during the ice period and any pertinent information which may be of value when drawing the daily discharge graph.

(II) Plot the following on Winter Hydrograph form 067-2035: (1) the daily maximum and minimum (or mean) temperatures obtained from the appropriate meteorological station, (2) the measured discharges ("circle" these plotted points), and (3) the discharge hydrograph for an adjacent stream, if available and if desirable.

(III) Draw a daily discharge graph using a hydrograph for an adjacent stream, the temperature plot and other pertinent information as a guide.

(IV) Transfer the daily discharges from form 067-2035 to form 067-2126.

(V) Transfer the daily discharges from form 067-2126 to form 067-2124.

(VI) If desirable, the use of form 067-2126 may be eliminated in this method and the daily discharges transferred from the "winter hydrograph" to form 067-2124.

5.6.4 Maximum and Minimum Discharge

(a) Enter in the space provided on form 067-2124, the maximum instantaneous discharge for the year and the corresponding gauge height and the time o occurrence; delete the word "daily". Note that the gauge height corresponding to the maximum instantaneous discharge may not be the same as the maximum instantaneous gauge height or discharge is not to be extracted unless required by the Region for a specific local purpose.

(b) Enter a note to indicate whether the maximum instantaneous discharge is based upon a high water mark, estimated from a graph, etc.. If the maximum discharge is not reasonably well-defined by discharge measurements, the method of extrapolation should be given with an indication of reliability, e.g. "by logarithmic extension" or "slope-area measurement". Similarly, if the minimum daily discharge occurred during an ice period and is not reasonably well-defined by a discharge measurement, an explanation should be given, e.g. "ice jam" or "regulated".

(c) If the maximum instantaneous discharge for the year is not available, either enter "not known" or "not determined" or delete the word "instantaneous" and enter the maximum daily discharge for the year. Also enter the minimum daily discharge for the year. If it is desired to show a certain extreme discharge that occurred within a specific period during a year, enter an explanatory note on form 067-2124 stating the period for which it applies.

(d) If desirable, to maximum instantaneous discharges may be shown on form 067-2124, for example, one during ice-break-up and another during summer or autumn rain.

(e) Do not enter a maximum instantaneous discharge or a minimum daily discharge for canals, i.e. only the maximum daily discharge will be shown.

(f) When an extreme is the result of some unusual condition such as an ice jam, unusually heavy rain, stop log manipulation, etc. enter a suitable remark to that effect.

5.6.5 Periods of Estimated Discharge

(a) If only one day's record is missing, it can usually be estimated by interpolation.

(b) A gauge height record sometimes is not available for a period of several days because (I) the recorder was not operating properly, (ii) the gauge was damaged or destroyed, (iii) the observations were unreliable, etc. For such periods it is normally desirable to estimate the discharge if it will complete a month of record, provided that reasonable accuracy can be assured

(c) Estimates of missing records can be determined by (I) correlation, (ii) comparison with the discharge hydrograph for an adjacent station, (iii) use of weather records, etc. A mean discharge must be shown for each day, i.e. do not use bracketed periods.

(d) Include a brief explanation of the method used in determining the estimated discharges on the Station Analysis form 067-2130.

5.6.6 Hydrographs

(a) Plot discharge hydrographs for all stations for comparison purposes (use form 067-2001 or 067-2002).

(b) Plot the discharge measurements made during the year. "Circle" the plotted point.

(c) Plot the discharge figures on the "day line" and connect the points with a straight line.

5.6.7 Monthly and Annual Summary (067-2124)

(a) Do not round off the monthly or annual totals in (cubic metres pre second) days - this is the summation of the daily discharges.

(b) If daily discharges are not available for a complete month, do not compute the summary data for that month.

(c) If the records cover only part of the year and this period varies from year to year, compute the monthly summary data but do not compute any annual summary data.

(d) Compute the monthly summary figures as follows:

(i) mean - divide the total of the daily discharges for the month by the number of days in the month.

(ii) cubic decametres (dam^3) - multiply the total of the daily discharges for each month by 86.4.

(iii) maximum (max) - enter the maximum daily discharge for the month.

(iv) minimum (min) - enter the minimum daily discharge for the month.

(e) Compute the summary figures for the year or period as follows:

(i) mean - divide the total of the daily discharges for the year or for the standard period by the total number of days, e.g. 245 days for March to October.

(ii) cubic decametres (dam^3) - add the rounded monthly figures and then round the total. Check this total by multiplying the total of the daily discharges for the year or period by 86.4. Note, however, that the rounded summation figure is entered.

5.6.8 Historical Summary of Monthly and Annual Mean Discharges

(a) Round the monthly mean discharges and mean monthly discharges according to the rule for significant figures shown in section 2.5.

(b) Round the annual mean discharge in cubic metres per second (m^3 /s) and the total discharge for the year in cubic decametres (dam^3) as above. If the summary represents a standard period (of say, March to October), enter the mean discharge (m^3 /s) and the total discharge (dam^3) for that period. Do not enter any figures of mean discharge or total discharge if the record is only for part of the standard period. If the mean discharge and total discharge for a standard period of say, March to October, are shown and monthly means ere obtained for months outside the standard period (say, February and November), compute the mean discharge and total discharge for the standard period with a footnote as follows: - "Mean discharge (m^3 /s) and total discharge (dam^3) for March to October inclusive".

(c) Divide the total for each column by the number of figures (years) for each column to obtain, for the period of record, the mean monthly discharges, the mean annual discharge (m^3 /s) and the mean total discharge (dam^3).

(d) Compute the mean total discharge (dam^3) for each month (except February) by multiplying the mean discharge for each month by 2592 for a 30-day month and by 2678.4 for 31-day month.

(e) Compute the mean total discharge (dam^3) for February as follows:

(i) Multiply the total of the monthly mean discharges by 28.

(ii) Add the monthly mean for each leap year in the period of record to the figure obtained in (I) above.

(iii) Multiply the figure obtained in (ii) above, by 86.4.

(iv) Divide the figure obtained in (iii) above, by the number of years of record.

5.7 Station Analysis (067-2130

This is a summary of the pertinent information with respect to the interpretations and procedures used in computing the hydrometric survey data for a gauging station.

(a) Stage Record

(i) Explain any major changes that were made during the year (such as installation of recorder or manual gauge, staff gauge extended, etc.) . It is not necessary to explain minor maintenance such as replacing of gauge plates r painting.

(ii) State the type of manual gauge (or gauges) installed and the frequency or observations and level checks; explain if any are or doubtful reliability.

(iii) If there is a water-stage recorder at the station, state the type and indicate whether the record is produced in ink or pencil. If the recorder pen is not set to the inside gauge indicate the gauge to which it is referred. Explain any unreliable or missing record.

(iv) State the period of use of each gauge where more than one gauge was used to derive the daily discharges during the year.

(v) Explain the method used in obtaining the month-end stage for lakes and reservoirs.

(b) Discharge Measurements

(i) Include a brief statement of the types of discharge measurement sections and their location with respect to the gauge; e.g. "Form cableway 50 m upstream from recorder, by wading or from ice cover about 200 m upstream, and from upstream side o highway bridge 2 km upstream". Explain any major changes such as construction or removal of cableway or bridge. Also explain if any measurements were obtained using non-conventional techniques, such as volumetric, fluorometric, moving boat, slope-area determination, etc.

(ii) State if any inflow occurs between the gauge and the discharge measurement section and what adjustment, if any , was made.

(c) Stage-Discharge Relationship

(i) State if there is an artificial or a natural control and if the stage-discharge relation is affected by weed growth, beaver action, shifting control, the presence of ice, stop logs, etc. and the period of such effect.

(ii) Include a brief statement explaining the period of use of stage-discharge tables, methods of distribution of shift or backwater corrections and method of extension.

(d) Digitizer Operation and Computer Programs

(i) Give the period for which records were computed using the STREAM computer program, or other programs such as HOURLY.

(ii) Explain any problems in digitizer operation.

(iii) Explain if other computer programs were used, e.g. MANUAL.

(e) Data Review

(i) Explain if historical data were reviewed and if any revisions were required and if a Review Report was prepared> In any case, enter an explanation in the "Revisions File" (see "Manual of Hydrometric Data Review Procedures").

(f) Remarks

(i) Explain any name or location changes.

(ii) Include a brief statement explaining the basis for estimated discharges.

(iii) Include a brief statement explaining the extent of co-operation with other organizations in computing or collecting hydrometric survey data for publication in Surface Water Data publications.

(iv) If records were provided by another organization include a statement, if available, explaining the method of computation and other pertinent information.

6. PROCEDURES FOR PUBLICATION OF DATA

Data are submitted to Ottawa at least annually and printouts are returned to the Regions for verification to ensure that the correct data are stored on tape for publication and also for distribution to users in computer-compatible form. The four data files which are involved are HYDEX. FLOW. LEVELS and PEAKS.

Various computer programs have been developed for the automated preparation of data publications. However, the procedures for producing photo-ready copies and then assembling manuscripts for printing are basically the same for the 4 data publication. Details are given in the following manuals:

(a) Publication Procedures for the Surface Water Data Reference Index

(b) Publication Procedures for Surface Water Data.
(c) Publication Procedures for the Historical Streamflow Summary.

(d) Publication Procedures for the Historical Water Levels Summary.

Two methods of indicating metric symbols are acceptable. The preferred symbols are the International System of Units (SI) as declared by the Canadian Standards Association. These are the symbols which are used in all publications. The second method, Form II, is acceptable for systems such as computer printouts, which have the capacity to use upper case characters only. (See Appendix C, page 36, of the "Canadian Metric Practice Guide" CAN3-Z234. 1-76).

The national symbol for metric conversion is shown on the title page (inside cover) of each publication if the use of SI units and symbols is in accordance with the Canadian Metric Practice Guide. Al manuscripts are first screened by the Canadian General Standards Board (DSS) and permission to show the national symbol is granted by the Metric Commission (ITC)

Publications are printed under a "standing offer agreement" whereby the printer has agreed to produce proofs within 5-10 working days and then to print the required number of books in 15-30 working days, depending on size. Manuals are also printed under a similar agreement.

6.1 Surface Water Data Reference Index

This publication contains descriptive information about all the gauging stations operated during the history of the Water Survey of Canada, and includes stations for which data are contributed by outside agencies. It is produced every two years from the HYDEX file using automated techniques and supersedes previous editions.

A Hydrometric Map Supplement was issued with the 1977 edition, showing the locations of active streamflow and "water level only" stations on one series of maps and discontinued stations on another series.

6.1.1 Submission and Verification of Data

Gauging Station Inventory listing (or form 067-2006) are submitted by the Region for all active and discontinued gauging stations. Changes to conditions at stations, or forms for new stations, must be submitted as soon as possible to ensure that the inventory is up to date. Descriptive information is coded at Ottawa from these forms and stored on the HYDEX file which is updated at least monthly to produce certain "management statistics", e.g. summary of gauging stations in operation by province or Region, number of stations. in various categories for cost-sharing purposes, station equipment, etc.

The coded information is initially verified at Ottawa. Printouts for verification of coding titled "HYDEX Verification of Updates", and Gauging Station Inventory listings for the new or revised stations are sent to the Regions monthly.

All revisions and additions applicable to the publication year should be submitted by October 31 so that the new Reference Index can be distributed to users in January of the following year, e.g. 1979 Reference Index distributed in January 1980.

Detailed instructions and procedures are given in the 'HYDEX System Operations Manual".

6.2 Surface Water Data

This publication contains daily discharges and daily water levels collected by the Water Survey of Canada during a particular year. These data are published annually in eight volumes y province or region. The following data files are used for the automated preparation of manuscript for printing: (a) HYDREX, (b) FLOW, (c) LEVELS and, (d) PEAKS,

6.2.1 Submission and Verification of Data

Data for the publication year are submitted annually by the Regions as soon as possible after the end or the year. It is preferable to send all the data for all the stations for a Region at the same time. Early in the new year, Ottawa will send printouts from HYDEX containing a listing for each Region showing the gauging stations for which data will be published. This retrieval is obtained shortly after the year-end for which data are to be published and therefore should reflect the conditions as applicable to the data for the publication year. An example of this retrieval is given in section 8.2.1 of the "HYDEX" System Operations Manual" and contains only the information which is required for the Surface Water Data publication. A "Publication HYDEX" file is maintained for the publication year and contains only those stations which are to be published and only the conditions applicable to the publication year, e.. the gauge may have been manual for the year of publication and a recorder installed early in the e nest year (the location might also be different). The "Remarks for Publication" apply to the publication year and therefore may change from year to year.

Regions should submit the following;

(a) Any changes, additions or deletions in red on the HYDEX listing - these will be coded and keypunched in Ottawa and the "Publication HYDEX" file then updated. Stations for which data will not e published are to be deleted from the "Publication HYDEX".

(b) Daily discharges and daily water levels as unblocked card images on an unlabelled magnetic tape in card format 71-102 obtained as card output from the STREAM or MANUAL programs or by keypunching form computation forms; 1600 bpi and 9-track should be used if possible

(c) Annual maximum instantaneous discharges and water levels on cards or form 067-2081.

(d) Identification of those station where valid annual maximum and/or minimum daily discharges or water levels exist for incomplete years or incomplete standard periods, on cards or form 067-2080.

(e) Changes to names of co-operating agencies as given in the introductory text material; the changes for the year and page number will be made at Ottawa.

At this stage, only data for the publication year are maintained on the FLOW, LEVELS and PEAKS file. After all the data have been verified and submitted for publications, the annual data are then merged with the historical data.

"Publication (FORM II) listings" of daily discharges and daily water levels, "provisional listing" of water levels for verification of totals only, and both old and new HYDEX listings containing all the data as submitted are returned to the Regions by Air Express for verification against original documents. Examples are given in sections 4.2 and 4.3 of the manual of "Publication Procedures for Surface Water Data:; these Dorm II listing are identical to the final annual publication (Alphatext) pages except that a date block is present in the upper left hand corner of each page, the station name and number are not centered as in the publications, and all metric symbols are printed in upper case letters only. Only the monthly totals need to be checked unless a discrepancy occurs, then all the daily values for that month must be checked against the original document. All maximum instantaneous discharges and water levels and valid annual extremes should be verified . Corrections may be submitted by telephone or by mail on cards or tape; these are verified again, corrected, etc. until the data are error-free. The FLOW AND LEVELS files are compared with HYDEX to ensure that all data have been submitted, This phase, from submission of data to the final verification cold take a month. After final verification, the "publication (FORM II) listings" will become the official record - one copy will be kept at Ottawa and another at the Region.

6.3 Historical Streamflow Summary

This publication contains a summary of monthly and annual mean discharges, annual maximum instantaneous discharges, annual maximum and minimum daily discharges and annual total discharges for the entire period of record for all streamflow stations (active and discontinued) operated during the history of the Water Survey of Canada. These data are published every 5 years in eight volumes by province or region, the same as for the annual Surface Water Data publications. The new editions of the Historical Streamflow Summary publications supersede previous editions. The following data files are used for the automated preparation of manuscripts for publication: (a) HYDEX, (b) FLOW, and (c) PEAKS

6.3.1 Submission and Verification of Data

The historical FLOW file is updated at least annually after the annual daily discharge data for a publication year have been verified and submitted for printing. Any corrections or revisions to previous data are also included in the updating at this time and these are verified the same way as the annual data. This also applies to the PEAKS file. A "Historical HYDEX" file is created which contains only the descriptive information required for this publication.

Very little data verification should be required by either Ottawa or the Regions unless extensive revisions have been submitted. Nevertheless, two types of listings are produced for cursory visual

examination at Ottawa and the Regions as a final check: (a) monthly and annual means, and (b) extremes and total discharge.

6.4 Historical Water Levels Summary

This publication contains a summary of monthly and annual mean water levels, annual maximum instantaneous water levels, and annual maximum and minimum daily water levels for the entire period of record for all "water level only: stations (active and discontinued) operated during the history of the Water Survey of Canada; this also includes water levels for selected stations where streamflow data are collected. These data are published every 5 years in eight volumes by province or region, the same as for the annual Surface Water Data publications. The new editions of the Historical Water Levels Summary publications supersede previous editions. The following data files are used in the automated preparation of manuscripts for publication: (a) HYDE, (b) LEVELS, and (c) PEAKS.

6.4.1 Submission and Verification of Data

The same instructions apply as for the Historical Streamflow Summary publications (see section 6.3.1).

7. RELATED HYDROMETRIC OFFICE ACTIVITIES

7.1 International Gauging Station

A uniform procedure for the operation of International Gauging Stations was adopted by the Water Survey of Canada and the United States Geological Survey on October 1, 1962 and amended on November 4, 1969. The Procedural Guide as agreed upon is given section 7.1.1.

The following office procedures should be used as a guide

(a) For a station in Canada follow the same procedure as outlined in the preceding sections. Treating discharge measurements and level checks, if any made by U.S.G.S. personnel as if done by Regional staff. The R.S.G.S. will prepare records for stations in the United States in a similar manner.

(b) When the records for the year have been computed the two District Offices on either side of the International Boundary will review and approve jointly the following: (I) stage-discharge curve or curves, (ii)stage-discharge table, (iii) computation of records, and (iv) station analysis.

(c) On completion of the above review, copies of the agreed data will be provided to the District Offices on the other side of the International Boundary for inclusion in their manuscripts for publication.

7.1.1 Procedural Guise for Operation of International Gauging Stations

This procedural guide has been prepared for the guidance of District Engineers (District Chiefs of the Water Resources Division, U.S. Geological Survey and Regional Chiefs of the Water Survey of Canada are hereafter referred to as District Engineers in this guide) of the Water Resources Division, United States Geological Survey, and of the Water Survey of Canada, to encourage a greater degree of uniformity in the operation of International Gauging Stations. It is not designed to provide a series of rigid rules, but rather to

serve as a framework within which District Engineers of both organizations can exercise their experience and judgment in making mutually acceptable arrangements for the operation of these Stations. This procedural guide dated November 4, 1969 supersedes the previous one dated October 1, 1962.

The elements of this guide are as follows:

A. Responsibility for installation, operation and maintenance

Each District Engineer will be responsible for the installation, operation and maintenance of International Gauging Stations located in his District. Should a representative of the appropriate District Office of the other country visit a station and find that it requires minor adjustments or repairs which can be made during the visit, he should make these without waiting to inform the responsible District Engineer but should make such report later. If major repairs are required, he should notify the responsible District Engineer immediately

B. Scheduling of proposed visits

It is desired that wherever possible representatives of the appropriate District Office of the other country visit International Gauging Stations several times annually. Where the respective District Engineers consider it feasible, the establishment of schedules of proposed visits for each water year is a useful practice and may offer some economies in operation by eliminating duplication of visits at shot intervals. Where possible the appropriate District Engineers of both agencies should arrange for a minimum of there visits annually to each International Gauging Station by field officers from the agency of the other country. Streamflow measurements should be made on each visit by field officers of either agency unless conditions or other commitments preclude such measurements.

C. Distribution of checked original notes

The checked original notes for any flow measurement at, or visit made to, an International Gauging Station will be forwarded to the District Office responsible for the Station. When the original notes are to be sent to a District Office in the other country, a copy of the cover sheet of the notes will be retained in the District Office of the field officer who made the measurement.

D. Initial computation of records

In general it is desirable that each District Office complete the initial office computation of the records for each International Gauging Station in its District in accordance with the standard procedure established for its regular stations, making appropriate use of the data provided by the other District Office involved in the field activities at the Station. In areas where this procedure may not be convenient, the appropriate District Engineers are free to make mutually acceptable adjustments.

E. Joint review and approval of records

After completion of the initial computations, joint review and approval of records is to be made by the two appropriate District Engineers or by their representatives. There are definite advantages to having this joint review made by visits of representatives of one District Office; however, when such visits are not feasible, the joint review can be handled by correspondence.

After completion of the joint review either by visit or by correspondence, the two appropriate District Engineers or their representative should give their joint approval to the record computations.

F. Exchange of records for publication

Following the joint review and approval, copies of the agreed records for an International Gauging Station will be provided to the appropriate District Office in the other country for inclusion in its manuscript for publication. (District Office in Canada will attempt to provide these records on a preliminary basis where necessary to meet deadlines resulting from the recent adoption by the USGS of advance publication on a State basis).

G. Publication of furnished records

records of daily discharge, summary tables, and the manuscript provided by the District Office of one agency will be edited for publication according to the standards of the agency publishing them.

H. Storage and retrieval of data on magnetic tape

Data stored on magnetic tape may be processed according to the standards of either country. This refers specifically to the rule for significant figures and includes both historical and current data. The number of significant figures may be changed in accordance with the rule in effect in either country.

E.R. Peterson,
Acting Chief,
Water Survey of Canada,
Inland Water Branch,
Department of Energy, Mines and Resources.

E.L. Hendricks,
Chief Hydrologist,
Water Resources Division,
United States Geological Survey.

7.2 Records Provided by Outside Organizations

The majority of the records published in the Surface Water Data publications are compiled solely through efforts of the Water Survey of Canada; both the collection of field data and the office computations being carried out by the Regional Offices. The remainder of the records published are obtained for stations operated In co-operation with other organizations. The degree of participation by the Branch in the collection and compilation of records for these stations varies from the complete conduct of both field and office procedures by the Branch to the compete conduct of both procedures by the co-operating agencies. In 1969, co-operation agencies agreed that data computed by them and submitted to the Water Survey may be published according to the rule for significant figure as given in section 2.6. The procedure to be followed in preparing records obtained in co-operation with other organizations for publication will therefore be the same as for those collected entirely by the Branch.

7.3 Legal Status of Microfilm (Microfiche) Records

On April 1, 1964, the Quebec Department of Natural Resources assumed responsibility for the hydrometric survey i. investigations covering most of Quebec rivers and lakes. Legal advice was sought on the proposal to transfer to Quebec all original documents pertaining to the stations in question, and on the status of microfilmed copies of these records. The following is a quotation from a memorandum dated December 2, 1968 by Mr. C.T. Mullane, Director of Legal Services for the Department of Energy, Mines and Resources:

"I am of the opinion that there is no legal barrier in using microfilms of lost or destroyed records. Photographic copies of original material have been accepted by the courts. When original documents have been lost or destroyed, photocopies are accepted under the second best evidence rule by the courts. Records should be kept evidencing that destruction of the data had taken place and microfilms substituted therefor."

Upon receipt of this assurance that there was no legal barrier to using microfilms of these records and that there was no legal objection to transferring the original document to the Province of Quebec, all relevant documents were microfilmed. Details of this are given in the "Report on the Transfer of Hydrometric Data to Quebec" by the Data Control Section dated March 31, 1970.

Further details are given in the Canadian General Standards Board (formerly Canadian Government Specifications Board) publication “Microfilm as Documentary Evidence”, National Standard of Canada CAN2-72. 11-79.

7.4 Certification of Records

Occasionally the Water Survey of Canada is required to provide certified copies of records for filing of records for filing as evidence in Courts of Law. Such certification hitherto has required the signature of the Deputy Minister on each sheet of records. However on November 27, 1969, Mr. C.T. Mullane, Director of Legal Services for the Department of Energy, Mines and Resources, gave the opinion that Regional Chiefs of the Water Survey of Canada are custodians and therefore should be responsible for certification of these records.

The signing certificate should read as follows:

I, _____ of _____, in the Province of _____, officer of the Department of the Environment of the Government of Canada, officially entrusted with keeping and guarding Hydrometric Records do hereby certify these Hydrometric Records to be a true copy of official and public documents belonging to the said Department of the Environment which are in my custody at _____ .

_____ _____ .
Date Signature

This signing certificate is to form a contiguous part of the data sheet which includes the station name. A copy of the request made of your office, your reply and of the records supplied should be forwarded to the Chief of the Water Survey of Canada at Ottawa for information in each case.

7.5 Procedure for Revising and Ordering Forms

Suggestions for new forms or revisions to present forms are to be submitted to Ottawa for approval to ensure that national standards are maintained.

The Departmental Forms Management Branch of the Planning and Finance Service has been given the responsibility for assigning form numbers and drafting (for printing) of all new or revised forms excepts “snap set” or “graph-type” forms. Form numbers used within the Inland Waters Directorate that now begin with “R” or at “IW-2000” will be changed to “067” to conform to bilingual requirements.

All forms are to be bilingual. Three choices are available: (a) bilingual on one side, (b) English on one side, French on the other, or (c) separate forms. Another factor is whether the form is for “public” use.

The desired quantities of bond-type forms as listed in sections 8.5.1 (a), (b) and (c) are now obtained by the Regions from local printers. Initial supplies of new or revised bond-type forms will be sent to Regions and negatives forwarded to local printers; Regions will thereafter obtain their own supplies as required.

Supplies of the 8 graph-type forms listed in section 8.5.1 (d) and (e) will be provided to the Region by Ottawa; most local printers do not have the facilities to produce these forms.

7.5.1 List of Forms

(a) Bond-type, size 215 x 280 mm (white with black printing)

Form No.	067-2006M	(02/80)	Gauging Station Inventory Updating
Form No.	067-2006M	(02/80)	Mise ‘a Jour de l’Inventaire de Stations Hydrométriques
Form No.	067-2080M	(09/79) R296	Daily Data Files Updating
Form No.	067-2081M	(09/79) R295	PEAKS Files Updating
Form No.	067-2087M	(09/79) R301	Request for Comparison Hydrographs
Form No.	067-2100M	(01/80) R213	Water Resources Review
Form No.	067-2119	(11/78) R42	Stage-Discharge Table
Form No.	067-2119M	(05/80) R42	Stage-Discharge Table
Form No.	067-2120	(11/78) R42A	Stage-Discharge Table (expanded)
Form No.	067-2120M	(11/78) R42A	Stage-Discharge Table (expanded)
Form No.	067-2121	(11/78) R43	Daily Gauge Heights
Form No.	067-2121M	(11/78) R43	Daily Gauge Heights
Form No.	067-2122	(05/80) R56	Discharge Measurements
Form No.	067-2122M	(11/78) R56	Discharge Measurements
Form No.	067-2123	(11/78) R56A	Miscellaneous Discharge Measurements
Form No.	067-2123M	(11/78) R56A	Miscellaneous Discharge Measurements
Form No.	067-2125	(11/78) R113	Record of Station Numbers
Form No.	067-2126	(11/78) R205	Backwater Computations
Form No.	067-2126M	(11/78) R205	Backwater Computations
Form No.	067-2127	(11/78) R237	Gauge History
Form No.	067-2128	(11/78) R238A	Gauge Corrections
Form No.	067-2130	(11/78) R242	Station Analysis
Form No.	067-2131	(11/78) R243	Stage and Contents
Form No.	067-2131M	(11/78) R243A	Stage and Contents
Form No.	067-2132M	(01/80) R256	Review Progress
Form No.	067-2140M	(01/80)	Summary of Revisions

(b) Bond-type, size 280 x 430 mm

Form No.	067-2124	(11/78) R79	Daily Discharges
Form No.	067-2124M	(11/78) R79	Débits Quotidiens
Form No.	067-2124M	(11/78) R79	Daily Discharges
Form No.	067-2124FM	(11/78) R79	Débits Quotidiens

(c) Bond-type, size 215 x 330 mm (coloured)

Form No.	067-2137	(11/78) R292	Coding Sheet for Stage-Discharge Table (bleu)
Form No.	067-2138	(11/78) R293	Coding Sheet for Stage-Gauge/Shift Correction (green)
Form No.	067-2139	(11/78) R297	Coding Sheet for Updating Correction (pink)
Form No.	067-2141	(12/77)	Coding Sheet for Miscellaneous Discharge Measurements (green)

(d) Graph-type, size 280 x 430 mm (orange, tracing paper)

Form No.	067-2001	(05/77)	Hydrograph (arithmetic scale)
Form No.	067-2002	(05/77)	Hydrograph (semi-log scale)
Form No.	067-2004	(05/77)	Stage-discharge Curve
Form No.	067-2004M	(05/77)	Stage-discharge Curve

Form No.	067-2005	(05/77)	Stage-discharge Curve
Form No.	067-2035	(03/80)	Winter Hydrograph
Form No.	067-2036	(03/80)	Winter Hydrograph (two-cycle)

(e) Graph-type, size 430 x 560 mm (orange, tracing paper)

Form No.	067-2003	(05/77)	Stage-Discharge Curve
Form No.	067-2003M	(05/77)	Stage-Discharge Curve