WALDAPS
USER'S MANUAL

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WATER LEVELS DATA PROCESSING SYSTEM

(WALDAPS) USER'S MANUAL

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January 1975

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INTRODUCTION

WALDAPS, a WAter Level DAta Processing System which was developed in 1973 at Marine Sciences, Central Region, was successfully used to process water level chart rolls produced by temporary gauges during the 1973 field season.

Other water level digitizing and processing systems were known to exist at that time, but they were considered unsuitable for implementation here. In order to meet the demands of local users, it was necessary to create a system which would continuously digitize a water level trace produced by a gauge recorder, convert it into water levels at five-minute intervals, store them on a master file, and provide a means of accessing selected portions of the data. These requirements necessitated the development of a unique system.

The original system used a D-MAC digitizer to convert the trace to computer-readable form on magnetic tape. All subsequent processing was carried out on the CDC 3170 computer at Canada Centre for Inland Waters (C.C.I.W.). A general lack of reliability of the digitizing hardware led to recent changes in the system.

In the fall of 1974, a Hewlett-Packard calculator (Model 9100A) based digitizing system already in use at the Centre was found to be suitable (with one modification) for this application. The change consisted of replacing the existing digitizing table by a larger Bendix Datagrid table.

These hardware changes resulted in several alterations to WALDAPS. The use of a different digitizing scheme made it possible to digitize data under program control, thereby giving the user greater flexibility in the manner in which his data was collected. The format of digitized data output to magnetic tape by the calculator was sufficiently different to require extensive modifications to the program which converts this data to 5-minute interval water level data. In addition, several changes and enhancements to this program were implemented.

This report consists primarily of user-oriented information such as specific ditizing instructions and program input and output information (i.e. a User's Manual). A second report will contain system and programming documentation and will describe the theory and techniques used. The former is designed to meet the needs of the everyday user while the latter is aimed at potential users of the system and at programmers making future changes.

WALDAPS SYSTEM DESCRIPTION

WALDAPS was developed because a demand existed for water level information in computer-readable form. Its primary function is the conversion (digitizing), storage and retrieval of data recorded by water level gauges operated by the Canadian Hydrographic Service, Central Region. A secondary function is to archive this same data in an organized, computer-usable form which is more practical from both storage and retrieval standpoints than storing a water level roll.

To meet these requirements, water level gauge chart rolls are digitized, converted to water levels at five-minute intervals, and added to a water levels master file. Each master file contains all the data from all temporary gauges operated in a given year.

Data on the file is ordered by station number, month, day of the month, and hour of day. Each record contains water levels for a one hour period (12 values), beginning at five minutes after the hour and ending on the following hour.

Figure 1 illustrates the procedural steps required to add a water level roll to the WALDAPS master file. Three computer routines are used in the process. Digitizing occurs under the control of a program written for the HP-9100A calculator which is part of the digitizing system. This program is referred to in other parts of the manual as "the digitizing program". Digitized data is converted to 5-minute interval water level data by a program (WLDPS01) written in FORTRAN for the CDC 3170 computer. The SORT/MERGE software package on the same computer is used to add data to the master file.

Other processes in the system are shown in Figure 2. These are initiallize a master file, extract 5-minute interval water level data, and extract instantaneous hourly water level data from a master file. The routines used to perform these processes are the SORT/MERGE package to initiallize the master file, WLDPS03

to extract 5 minute data, and WLDPSO4 to extract hourly data. These last two are written in FORTRAN for the CDC 3170.

Figure 3 shows another part of the system. WLDPSO2 is a routine used to edit the WALDAPS master file. Since work on this program is not yet completed, its function and current status are discussed in the section titled "Future Plans".

WALDAPS SYSTEM

WALDAPS.01 : Add a roll to the water levels master file.

Dec. 20 1974.

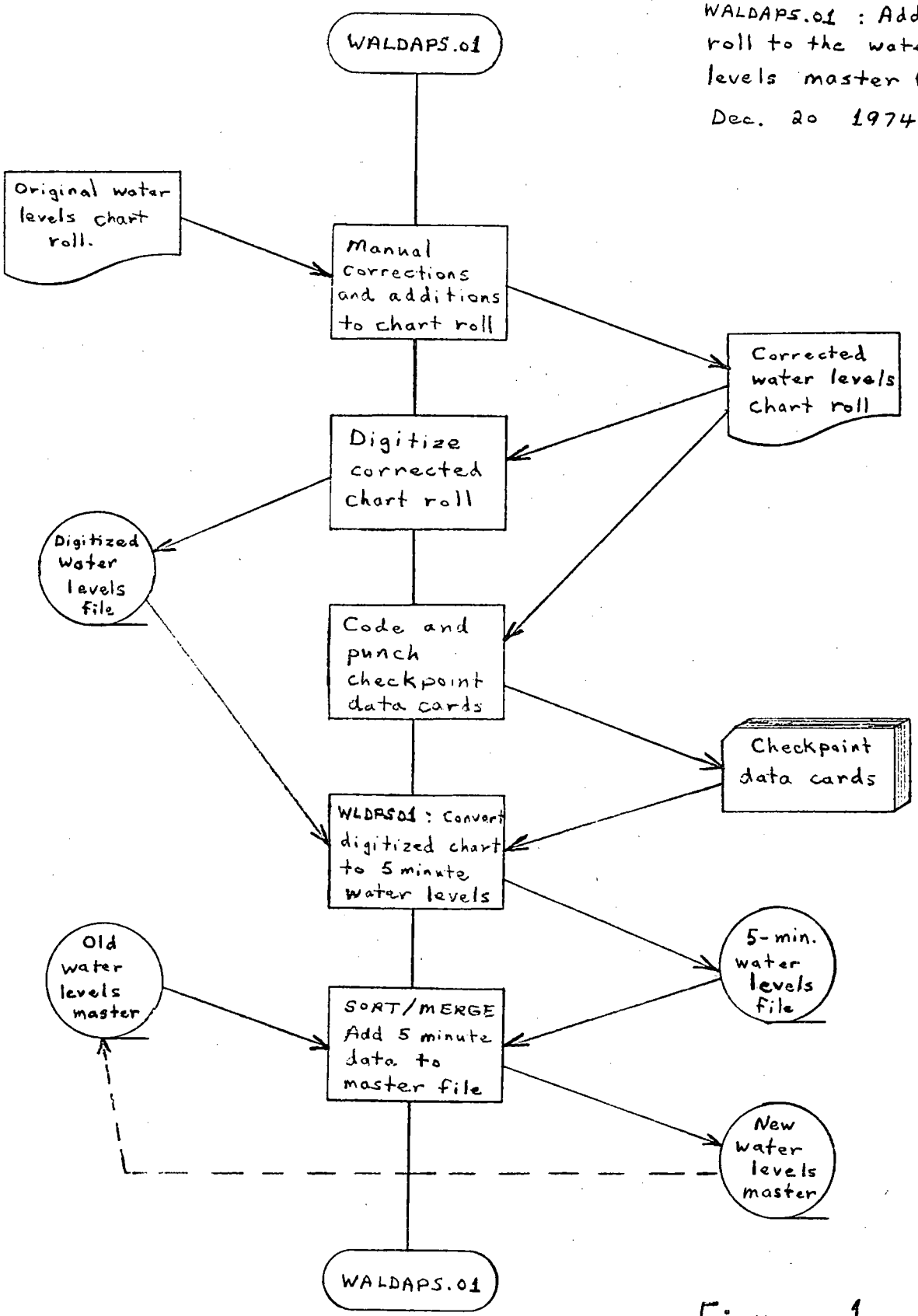


Figure 1

WALDAPS SYSTEM

WALDAPS.02 : Initiallise water levels master file.
WALDAPS.03 : Extract 5-minute interval water level data from file
WALDAPS.04 : Extract hourly interval water level data from master file

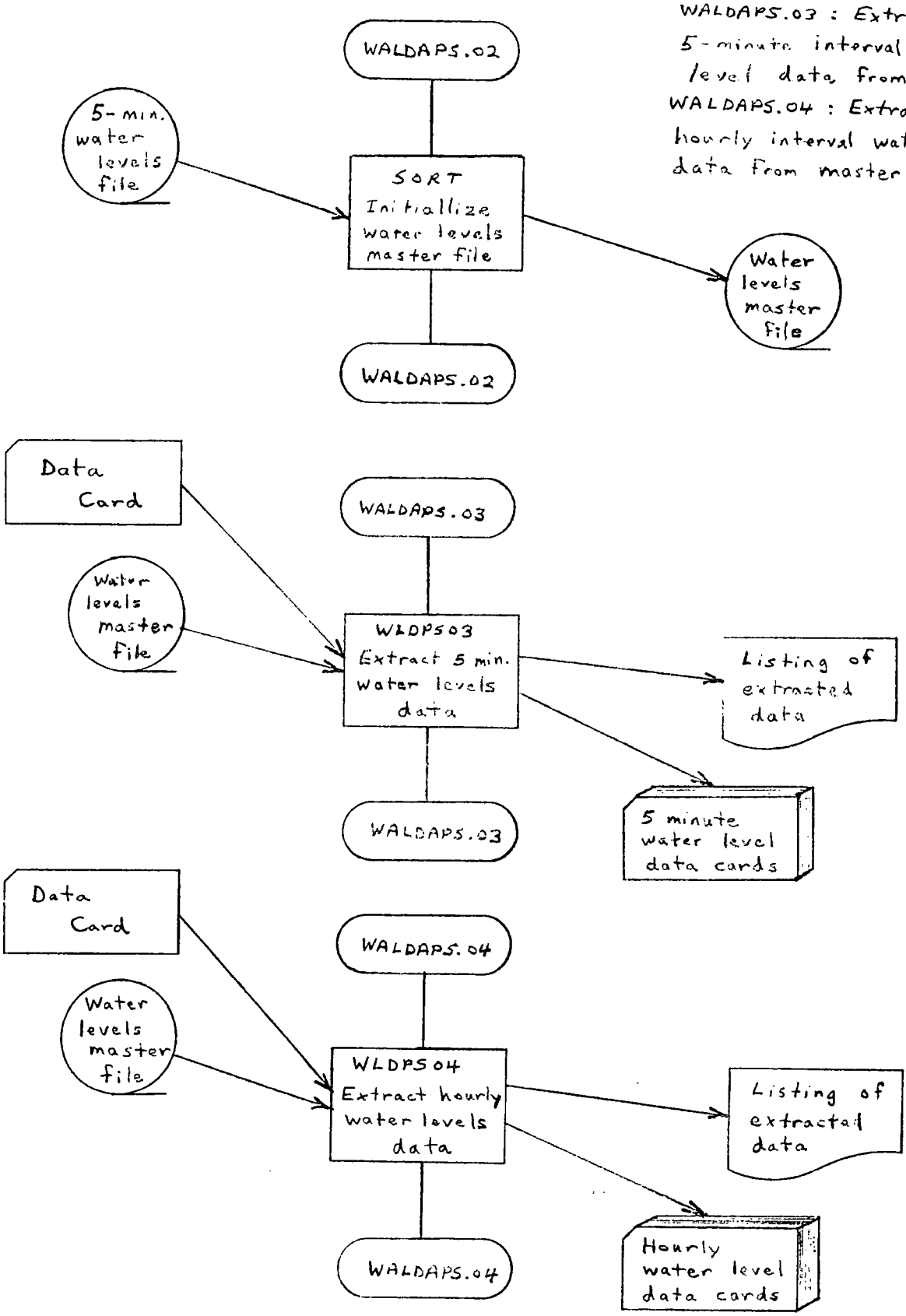


Figure 2

WALDAPS SYSTEM

WALDAPS.05 Edit a water levels master file

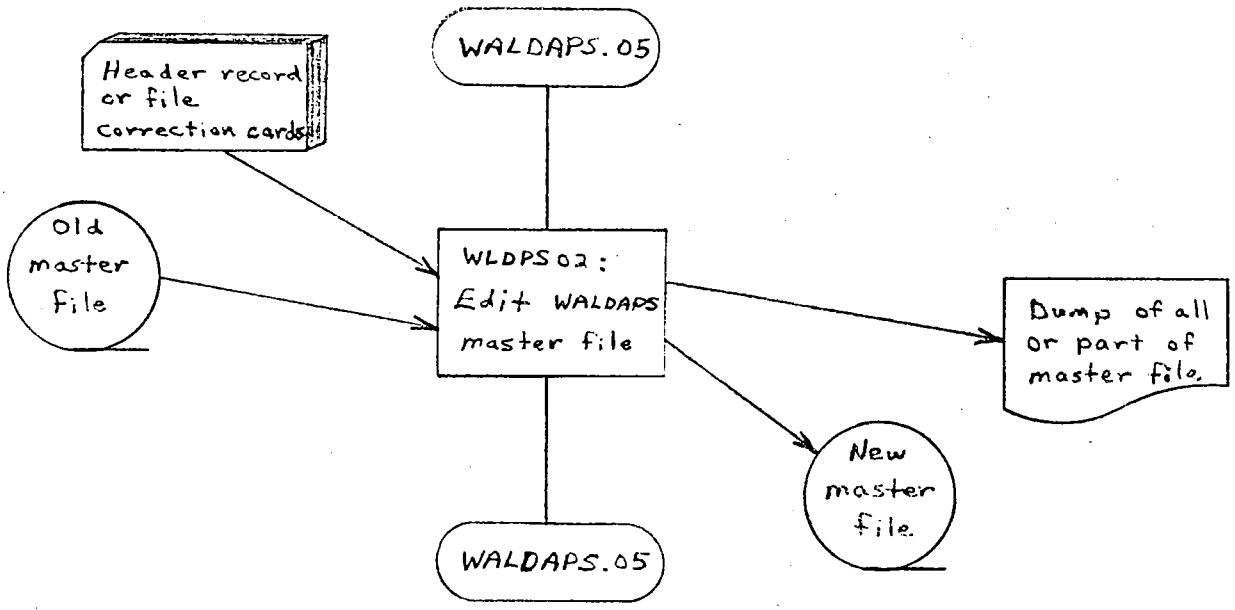


Figure 3

MANUAL CORRECTIONS AND ADDITIONS TO WATER LEVEL ROLLS

Normally, water level rolls received from the field must be checked before processing can begin to ensure that the data on them is complete and valid. Rolls should be prepared and "coded" so no interpretation on the part of the operator is required at digitizing time. This is especially important in those parts of the roll where unusual features are found.

Parts of a water level chart roll (actual size), as received from the field, is shown in Figure 4. Several important features such as the Graph Zero Line and Clock Time, for example, have been labelled. Figures 4A, 5, and 6, which represent several parts of water level rolls, are used to illustrate various correction and digitizing situations encountered.

Specific terms or words used in this discussion are defined as follows:

Field check: A point on the trace for which the true time and true water level have been verified and noted (marked on the roll) in the field. These appear at varying intervals on the roll as illustrated in Figures 4 and 4A.

Checkpoint: Any point on the trace for which the true time and water level are known. This point may be a field check or a point on the trace interpolated from existing field checks.

Clock Stoppage: The roll driving mechanism of a water level gauge is a spring-driven clockwork motor. If the mechanism "runs down", the roll stops advancing (until the clock is rewound) and a "clock stoppage" has occurred (See Figure 5).

Clock adjust: If time marked on the chart roll does not agree with the current time, the roll can be moved forward or backward until they do. This is a field adjustment made by a gauge attendant and should be indicated on the roll by a field check. Examples of clock adjusts are shown in Figures 5 and 6.

Pen Shift: If true water level and the level marked on the roll do not agree, the pen can be adjusted (in the field) until they do. This appears as a "pen shift" on the roll and is illustrated in Figure 6. The adjustment should be marked by a field check immediately after the point at which it was made.

Trace reversal: Some water level gauges will reverse the direction of pen motion when scale maximum has been reached and the water level increases beyond it. This "trace reversal" (illustrated in Figure 6) continues until the water level once again reaches and falls below chart maximum.

Digitizing Codes: Codes of the form 99.nn where nn is a number entered via the calculator during the digitizing process. These codes are used to identify specific points to the computer program processing the digitizer output tape. A list of codes and their meaning is given in the section dealing with the digitizing of water level rolls.

Record: A portion of the water level trace (from one checkpoint to the next) which will constitute one physical record on magnetic tape when digitized.

Zero Shift Correction: Under some conditions, gauge zero is different from graph zero resulting in an incorrect indication of water level. This does not mean that there is a change in gauge calibration or in recorder scale, but that an amount equal to the difference between the two zeros must be added to or subtracted from the water level indicated by the trace. This difference is called a zero shift correction. Often, a zero shift is not constant and will be different at opposite ends of a record. When this occurs, the change in zero shift is assumed to have taken place linearly over the duration of the record.

Figure 4A shows the situation most commonly encountered on water level rolls. Each point significant to the digitizing process is marked by an X and identified with an appropriate digitizing code. As shown, the roll is divided into records, each one spanning from one checkpoint to the next along the trace. Field checks are indicated by rectangular stamps with true time, date, and water level marked in them (See also Figure 4). The limits of pen excursion (maximum and minimum or zero line), indicated by lines on the roll, are labelled.

Figures 5 and 6 illustrate many of the problems encountered on water level rolls and the solution and digitizing codes used in each case.

Specific corrections and changes to be made and other relevant information are as follows:

1. Field checks should be examined to ensure that the information supplied is reasonable and correct and that the location of the field checkpoint is indicated exactly.

2. To minimize the need for interpretation on the part of the digitizer operator, all unusual portions of the trace should be labelled clearly and all digitizing codes should be specified.

3. In order to digitize a record, two contiguous checkpoints must be within table limits. These checkpoints specify the beginning and end of a record and are labelled 99.03 and 99.04 respectively (See Figure 4A, for example). The trace is digitized, continuously in most cases, from one checkpoint to the next (left to right) producing one physical record on magnetic tape.

   The size of the digitizer table limits the record to a length of 115 cm. (corresponds to 115 hours). In order to have two checkpoints on the table at one time, it is sometimes necessary to calculate (by interpolation) additional checkpoints between existing field checks.

Note that a given checkpoint can be the second one (99.04) in one record and the first (99.03) in the next.

4. Since different water level gauges record data in different ways, the zero water level line should be labelled. Digitizing points to be used in defining the zero line are labelled 99.01 and 99.02, respectively.

5. True times at checkpoints should be converted to standard time, if necessary.

6. A special case occurs if a checkpoint falls exactly at midnight. When used as a R.H.S. checkpoint (99.04), the time used should be 24:00 and the date should be that of the day just finished. When used as a L.H.S. checkpoint (99.03), the time used should be 0:00 and the date should be the one just beginning.

7. At each checkpoint on the trace, the following information (needed by the program which converts digitized data to water levels at five minute intervals) should be indicated: The day, month, hour, minute, and "true" water level which apply to the current checkpoint, and, in addition, the zero shift correction to be used.

   Since a zero shift can occur in either direction (i.e. gauge zero can be greater than or less than graph zero), two corrections are possible: If true water level is greater than the value indicated by the trace, the zero shift correction to be applied is negative. If true water level is less than the value indicated by the trace, a positive correction is applied. Figures 7 and 8 illustrate these two cases.

8. If part of the trace is missing or unusable, one of several possible corrections and/or additions can be made. If interpolation is possible, the trace should be drawn in and beginning and ending points marked and labelled (99.05 and 99.06; See Figure 5). If the trace cannot be interpolated

and the missing part is short (e.g. several hours), the limits of the region should be marked and labelled (99.07 and 99.08 as illustrated in Figure 5). If the missing part is longer, on the order of several days, checkpoints should be calculated for the beginning (99.04) and the end (99.03) of the missing region. This means that the previously existing record will now be divided into two.

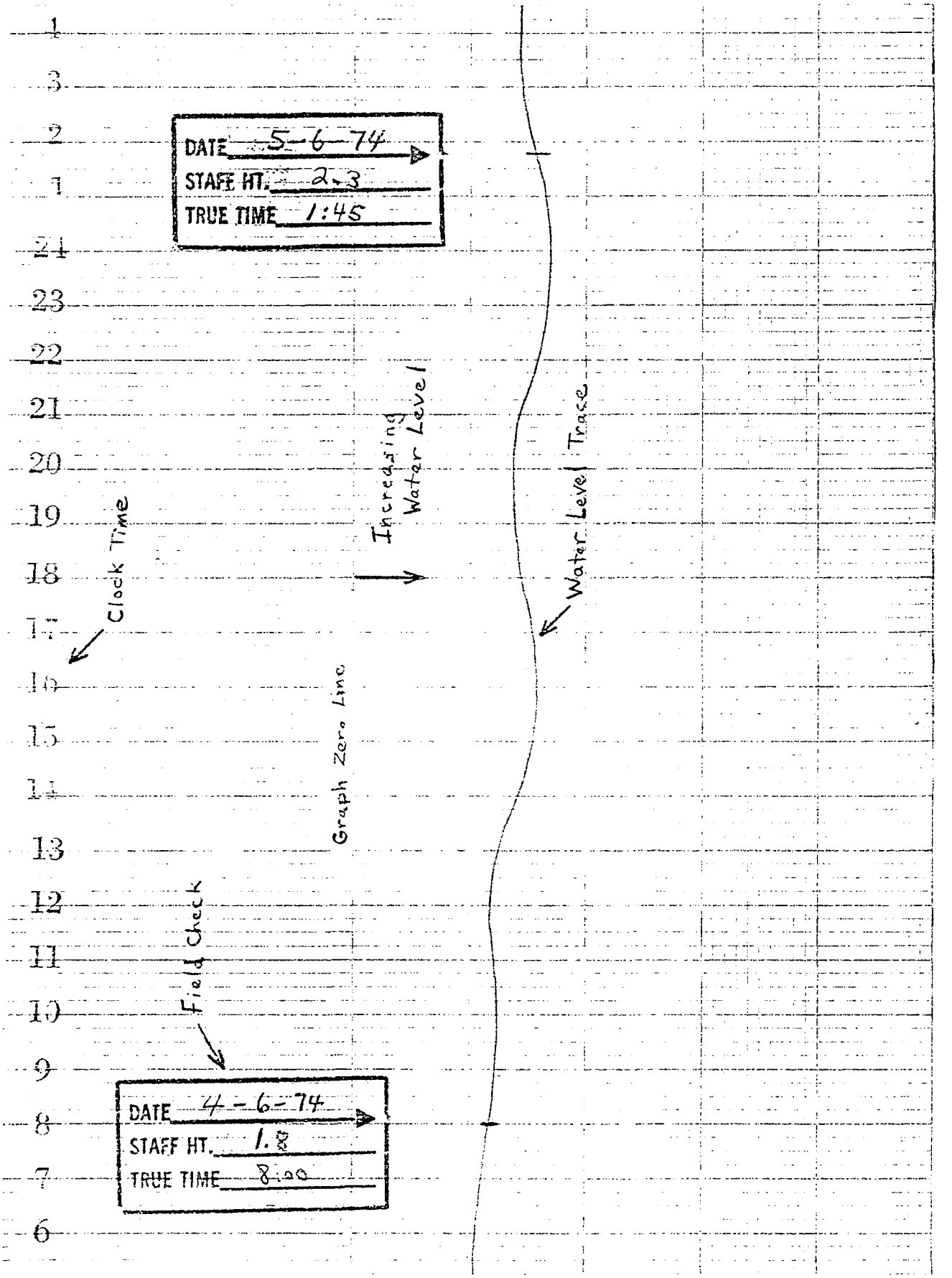
9. If a clock adjustment was made, the beginning and end of records on either side of the adjustment must be marked by checkpoints. Usually, a clock adjust is followed immediately by a field check so this point becomes the beginning of a record (99.03). However, a checkpoint to define the end of the previous record (99.04) must be calculated for a point immediately preceding the clock adjustment region. This is illustrated in Figures 5 and 6.

10. If a clock stoppage occurs, checkpoints must be defined immediately before and immediately after the stoppage region. Normally, an existing field check (immediately after the stoppage region) is used to define the beginning (99.03) of the record following, but a checkpoint must be calculated (by extrapolation) to define the end (99.04) of the record immediately preceding this region (see Figure 5).

11. If a pen shift or adjustment is made, as illustrated in Figure 6, checkpoints are defined immediately preceding (99.04) the shift region and immediately following it (99.03). Usually, the latter is a field check while the former must be calculated by extrapolation from previous field checks.

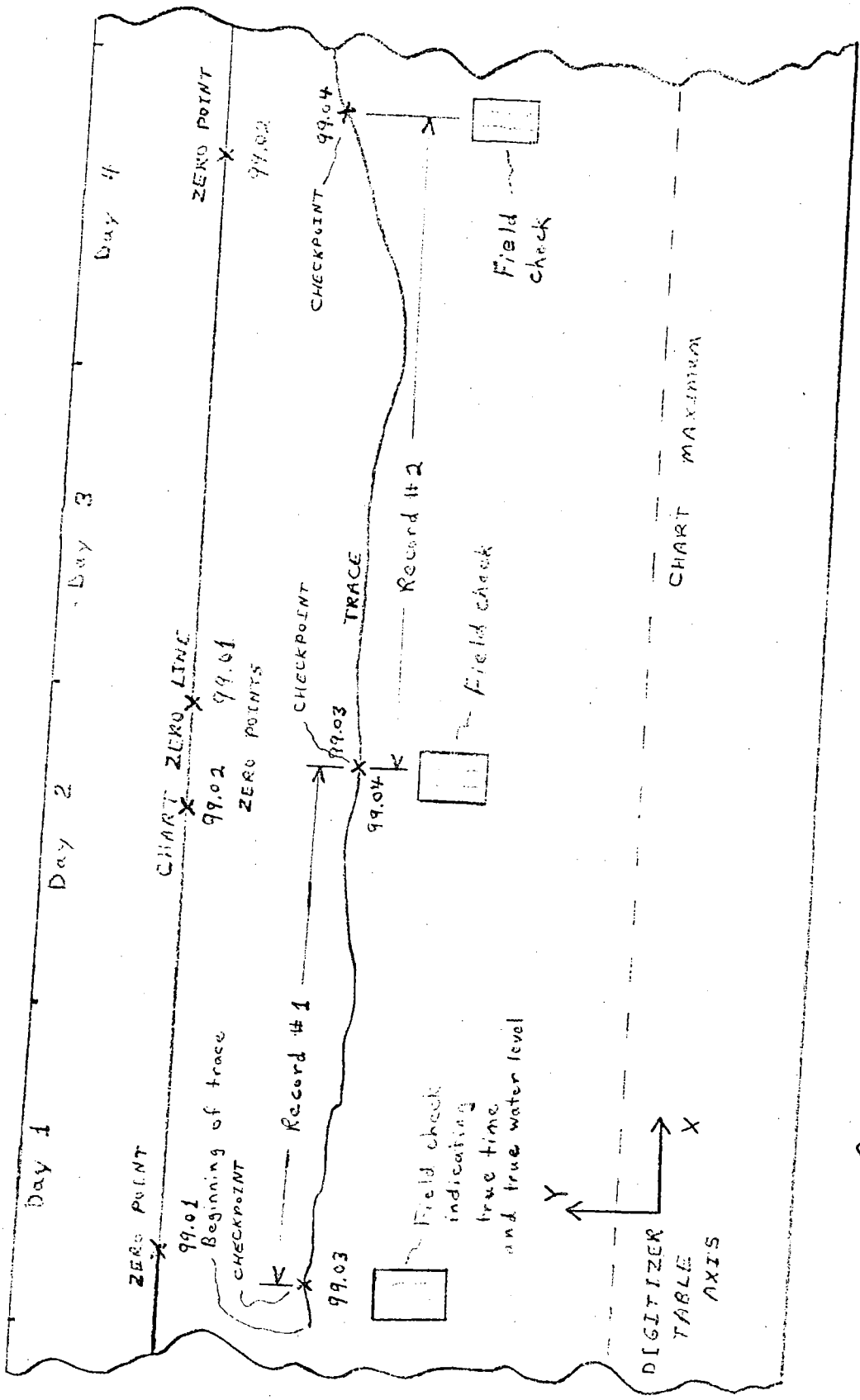
12. If a trace reversal occurs (see Figure 6), the beginning and end of the reversal region should be labelled 99.09 and 99.10, respectively.

13. Any other instructions to the digitizer operator (e.g. how to digitize parts of the trace where the water level changes rapidly) should be included with (or marked on) the roll.



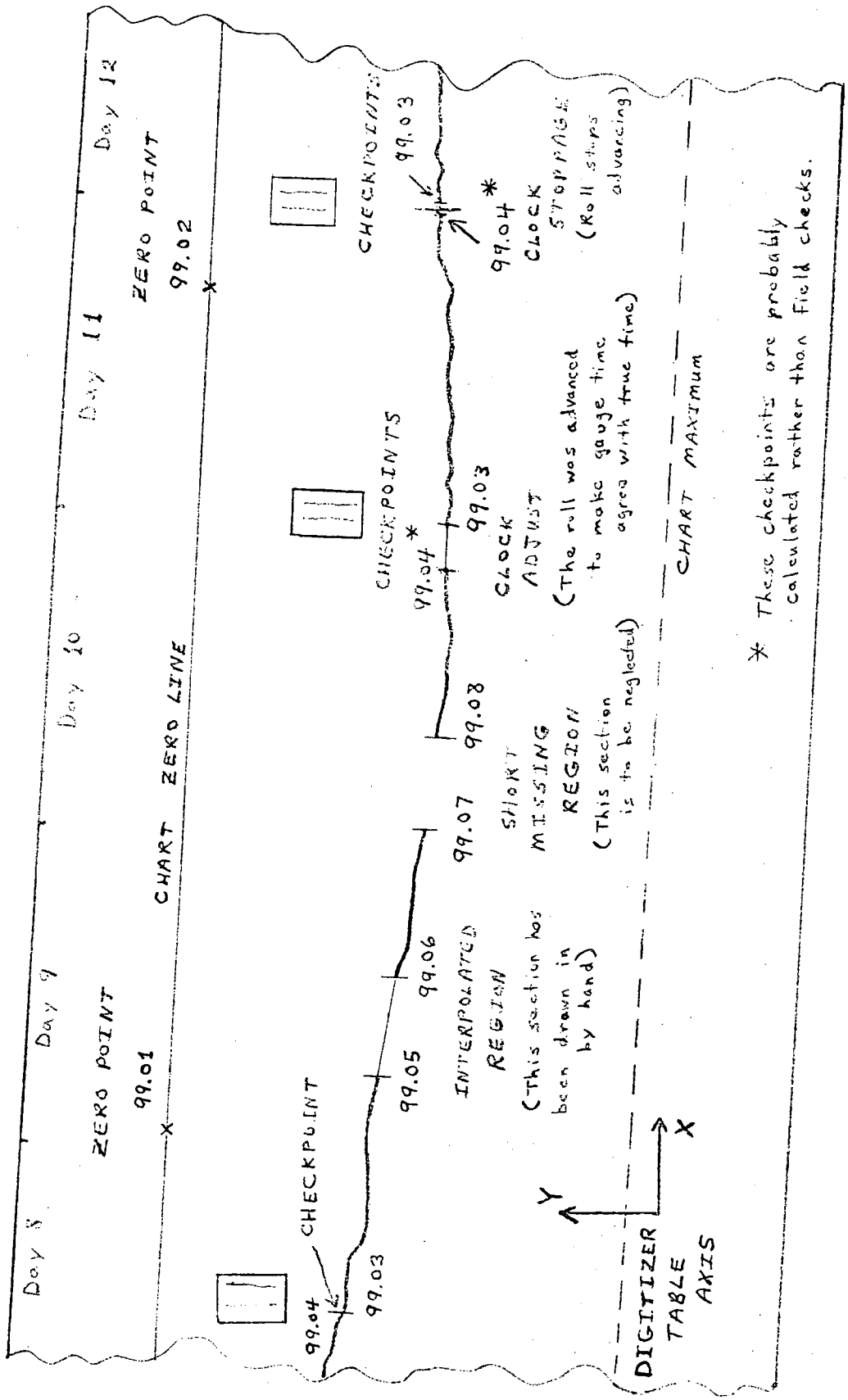
PART OF A
WATER LEVELS CHART ROLL

Figure 4



APPEARANCE OF CHART ROLLS CONTAINING NO PROBLEM AREAS

Figure 4A



SOME PROBLEMS AND
DISCONTINUITIES APPEARING
ON WATER LEVEL CHART ROLLS

Figure 5

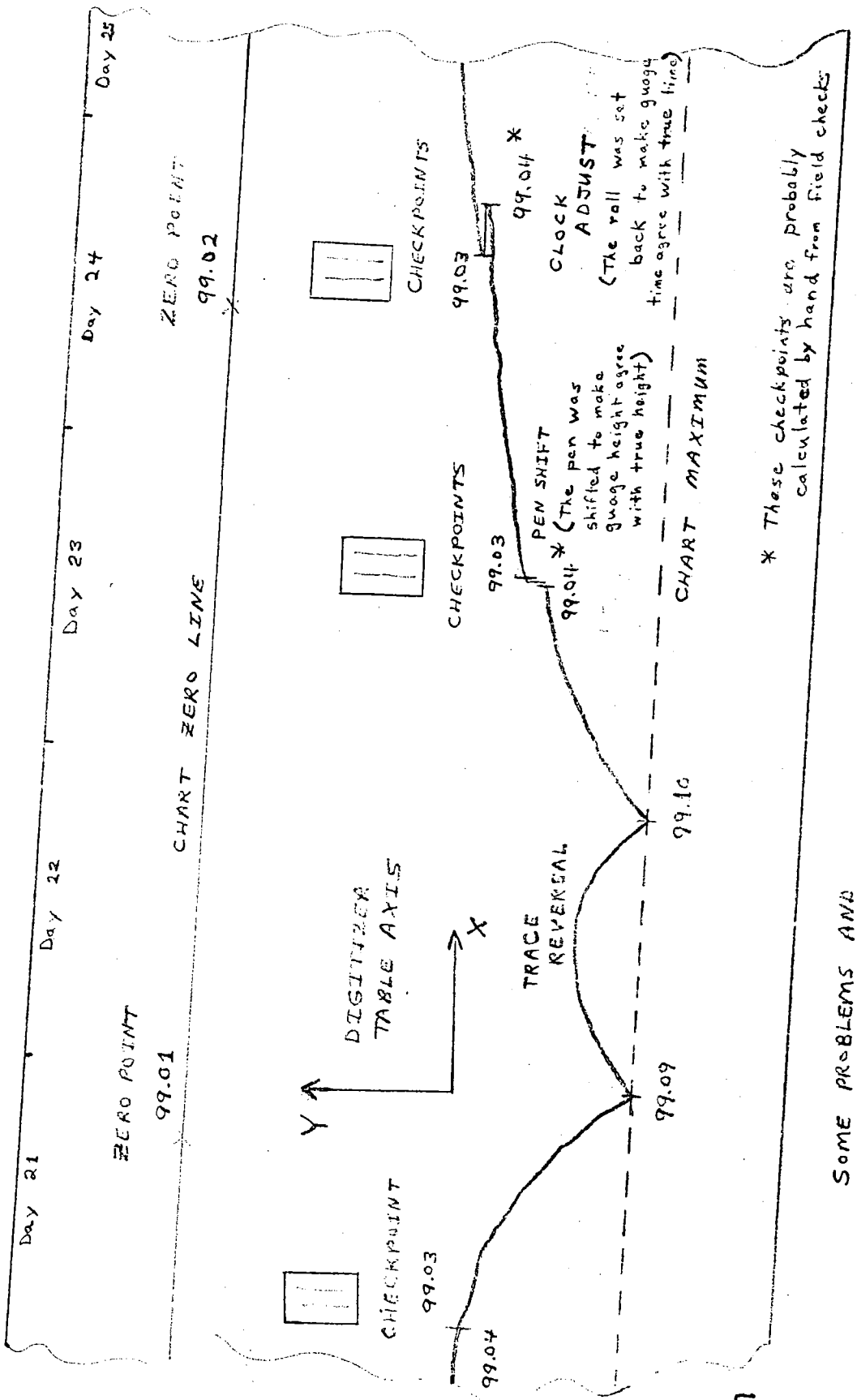
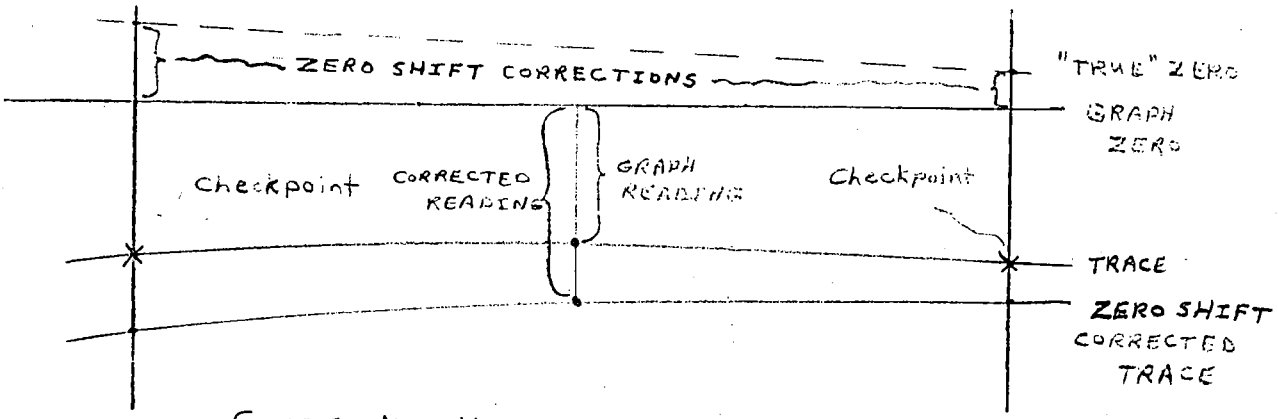


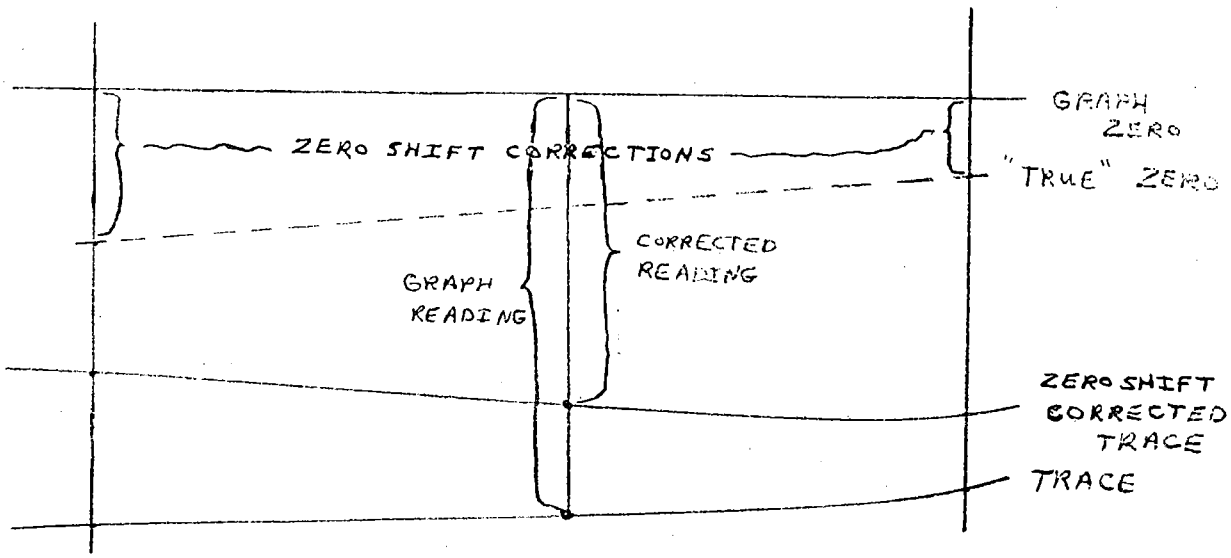
Figure 6

SOME PROBLEMS AND DISCONTINUITIES APPEARING ON WATER LEVEL CHART ROLLS



Case: Negative zero shift corrections

Figure 7



Positive zero shift corrections

Figure 8

DIGITIZING WATER LEVEL ROLLS USING THE HP-9100A

Equipment used:

Figure 9 shows the hardware used in digitizing water level chart rolls. Each block corresponds to a physically different piece of equipment. The diagram does not show the complete hardware configuration associated with the calculator but only those items used by this system. The digitizer, data coupler, and magnetic tape drive are mounted in a rack, one above the other, while the printer is mounted on top of the calculator. Each unit except the digitizing table has its own ON/OFF power switch.

The digitizing table, 3.5' x 4.5' in size, is supported on a Hamilton base permitting the surface to be lowered or raised and tilted to any angle convenient to the operator. A cursor or "bug" is used to define the point currently being or about to be digitized.

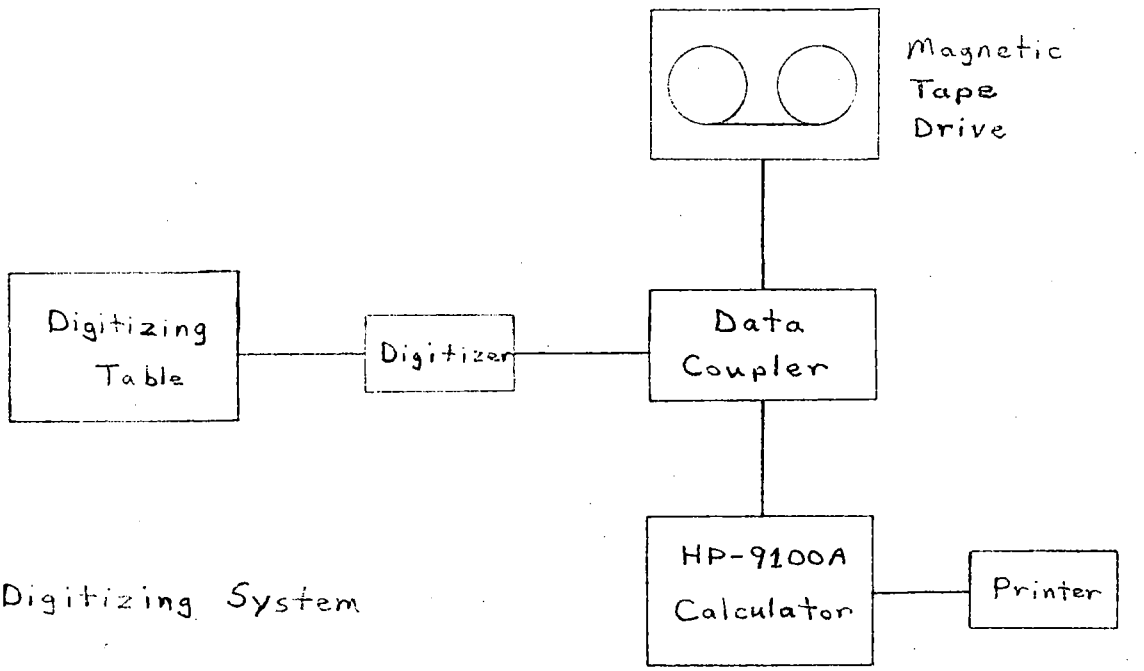
Magnetic tapes are written by the drive at 556 bpi (bits per inch) in BCD code.

The calculator has a display which shows the current contents of the 3 display registers when the calculator is in a STOP or PAUSE condition. The numbers displayed are ordered from bottom to top as X, Y and Z register contents.

The printer writes one number (i.e. the contents of 1 register) per line on 2-1/2 inch wide paper.

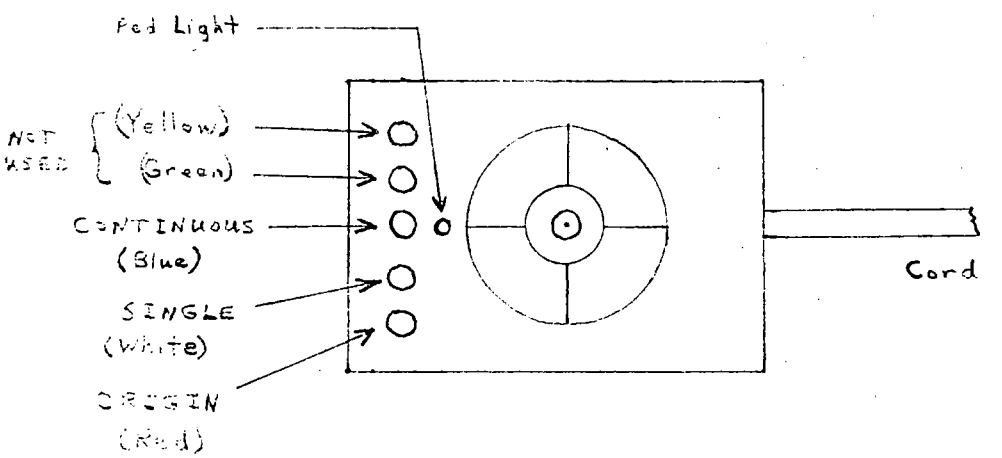
The Digitizing Process:

Digitizing on this system is a combination of operator action and program action. A data point can be digitized only if the program in the calculator requests a digitized point (X and Y co-ordinates) but this alone is not sufficient. Either the operator must "tell" the digitizer to digitize a point or he must enable the digitizer to digitize when requested to by the program. A more detailed explanation can be found in the digitizer reference manual.



Digitizing System

Figure 9



Digitizer Cursor or "Bug"

Figure 10

The digitizer "bug" is shown in Figure 10. The dot in the centre of the two concentric circles defines the current position of the bug, i.e. if a point where digitized now, it would correspond to the position of the dot.

Three buttons are used by the operator, the red, the white and the blue. The digitizer returns X and Y co-ordinates relative to a floating origin which must be defined each time the digitizing table is used. This origin could be defined at any point on the table, but, by convention, it is defined to be at the lower left hand corner. Pressing the ORIGIN (red) button defines the current position of the bug to be the origin with co-ordinates (0,0). All other digitized points will have X and Y co-ordinates relative to this origin. (Note that the digitizer can return negative co-ordinate values). This button can be pressed at any time since it is purely a function of the digitizer and not the calculator. If the origin is "lost" at some time during digitization it must be defined again. An extended "beep" indicates that the digitizer has lost its origin.

Individual points are usually digitized using single mode. Pressing the SINGLE (white) button will cause one point (one set of X, Y) to be digitized assuming that a calculator program was requesting a point.

A continuous trace is usually digitized in continuous mode. This means that co-ordinates defining the current position of the bug are returned each time the program requests them. This means, in effect, that the digitizing rate is under program control. Pressing and releasing (there is no need to hold the button down) the CONTINUOUS (blue) button places the digitizer in continuous mode. Pressing and releasing the blue button at some later time clears the continuous mode. It is important that the continuous mode be cleared when no longer needed since failure to do so can cause uncertain and uncontrollable effects depending on program and operator action.

Usually, it is difficult to determine which mode the digitizer is in. However, if the red light on the cursor (see Figure 10) is blinking while it is held stationary, it is known that the digitizer is in continuous mode and the program is requesting coordinates.

General Procedure

Digitizing occurs on a record by record basis, where a record is defined as being the trace from one checkpoint to another (usually the next). These two checkpoints must fall within table limits when the roll is in position ready to be digitized. Also, the roll must be positioned with the LHS checkpoint to the right of the origin and the trace above the origin since negative co-ordinates can cause problems later (in WLDPS01).

In general, digitization occurs from left to right. Zero points, checkpoints and anomaly-defining points must be digitized left hand side followed by right hand side (in single mode). Similarly, the trace is digitized from left to right (in continuous mode).

A minimum of two points must be digitized in each record before trace digitization can begin although, more usually, four points are digitized. These are LHS and RHS checkpoints (required) and LHS and RHS zero points (usually needed). If zero points are not defined for this record they must have been defined previously for another record and the roll must not have been moved in the interim.

Other points to be digitized are beginning and end of anomalous regions. These are areas where the trace is interpolated, where a short section is skipped or where a trace reversal occurs. These are treated from left to right as they occur in the record and, in each case, the left hand point is digitized before the right hand point.

The order of digitizing coded points is as follows: Zero points (usually needed but not always) first left hand side then right, checkpoints (always required) left and then right, and finally, anomalous points as they occur from left to right. A list of digitizing codes and their meaning is given below. A further discussion of digitizing in anomalous regions is given after the specific procedure to follow has been described.

Digitizing codes

Code	Explanation
99.01	L.H.S. zero point
99.02	R.H.S. zero point
99.03	L.H.S. checkpoint
99.04	R.H.S. checkpoint
99.05	L.H.S. trace interpolated
99.06	R.H.S. trace interpolated
99.07	L.H.S. part of trace to be skipped
99.08	R.H.S. part of trace to be skipped
99.09	L.H.S. trace reversal
99.10	R.H.S. trace reversal
99.99	Data record to be skipped

Detailed Digitizing Procedure

1. Turn power on to the Calculator, Printer, Digitizer, Data Coupler, and Magnetic Tape Drive.
2. Mount a magnetic tape (No write ring needed) on the tape drive and thread it according to instructions on the inside of the drive cover. Push "LOAD FORWARD". The tape should tension and move forward (slowly) to load point at which time the "READY" light should come on.
3. Set the calculator switches as follows:

FIXED/FLOAT	to	FIXED
DEGREES/RADIANS		Don't care
DECIMAL WHEEL	to	2
PROGRAM/RUN		Don't care

4. Press the X switch on the printer. This leaves it in the depressed (in) position. Be sure that the Y and Z buttons are not depressed.
5. On the data coupler, press START, STOP, RESET, STOP. This should leave the STOP switch in the out (not depressed) position.
6. Mount the chart roll under the clear plastic sheeting on the digitizer table with the graph zero line away from the operator (i.e. toward the top of the table).
7. Load the digitizing program into the calculator from the magnetic program card. The procedure is as follows:

   Set PROGRAM/RUN switch to RUN
   Press "GO TO () ()
   "0"
   "0"

   Insert the program card (with dark surface away from the keyboard) as far as possible into the slot on the calculator (either A or B program). Press "ENTER". The program is read into the machine and the card is ejected.
8. Move the digitizer "bug" to the LLH corner of the table and press "ORIGIN" (red button).
9. On the calculator, press "GO TO () ()"
   "0"
   "0"
   "CONTINUE"

   This starts program execution.
10. Data entry point 1

    The display should show: Z: 0
    Y: 0
    X: 1

    Enter the data recording interval in inches.
    (Format 0.nn)
    Press "CONTINUE"

The data recording interval is printed

Note: Recommended recording interval is 0.03 inches.

11. Data entry point 2

The display should show: Z: ?
Y: 2
X: 2

Enter day and month of the beginning of the record to be digitized (Format dd.mm).

Press "CONTINUE". The day and month are printed and written on magnetic tape.

12. Data entry point 3

The display should show: Z: ?
Y: 3
X: 3

Enter a code of format 99.nn, where nn is a number from 1-10 (see list of Digitizing codes).

Press "CONTINUE". The code entered is printed and written on magnetic tape.

13. Digitize the point described by the code entered in step 12 using the "SINGLE" button (white). The X and Y co-ordinates of this point are written on magnetic tape and a single "beep" is heard.

14. At this point, the display should show:

Z: ?
Y: 3
X: 3

If there are more "coded" points to be digitized repeat steps 12 and 13 for the next one. If not, press "SET FLAG" and "CONTINUE".

The display should then show:

Z: ?
Y: 4
X: 4

Digitization in continuous mode can now begin.

15. Digitization of the trace is started by centering the "bug" on the trace immediately to the left of the L.H.S. checkpoint and pressing the "CONTINUOUS" button (blue). The digitizer "beeps" at this point. To digitize the trace, move the bug towards the right along the trace. Each time a data point is recorded, the digitizer beeps. (Note that the data sampling rate is normally greater than the data recording rate). Continue digitizing until the R.H.S. checkpoint has been crossed. The digitizer will stop recording (and beeping) automatically after one point to the right of the R.H.S. checkpoint has been recorded. An IRG is written on tape automatically. Now, press the "CONTINUOUS" button to clear the continuous mode. This step must be taken before continuing or digitizing problems will occur in the next record when attempting to digitize "coded" points.

16. The display should show:

    Z: ?
    Y: 2
    X: 2

    If another record is to be digitized return to step 11 and continue.
    If not, press "SET FLAG" and "CONTINUE".
    A 0. is printed and the display will show:

    Z: 0
    Y: 0
    X: 0

17. Program execution has now stopped. Press "FILE GAP" on the tape drive. This writes an end of file (EOF) on the tape. Rewind and de-mount the tape.

18. Turn off power to all units in the system.

The specific procedure to follow is illustrated in flowchart form in Figures 11 and 11A.

WALDAPS
Water Level Roll
Digitizing Procedure
Page 1

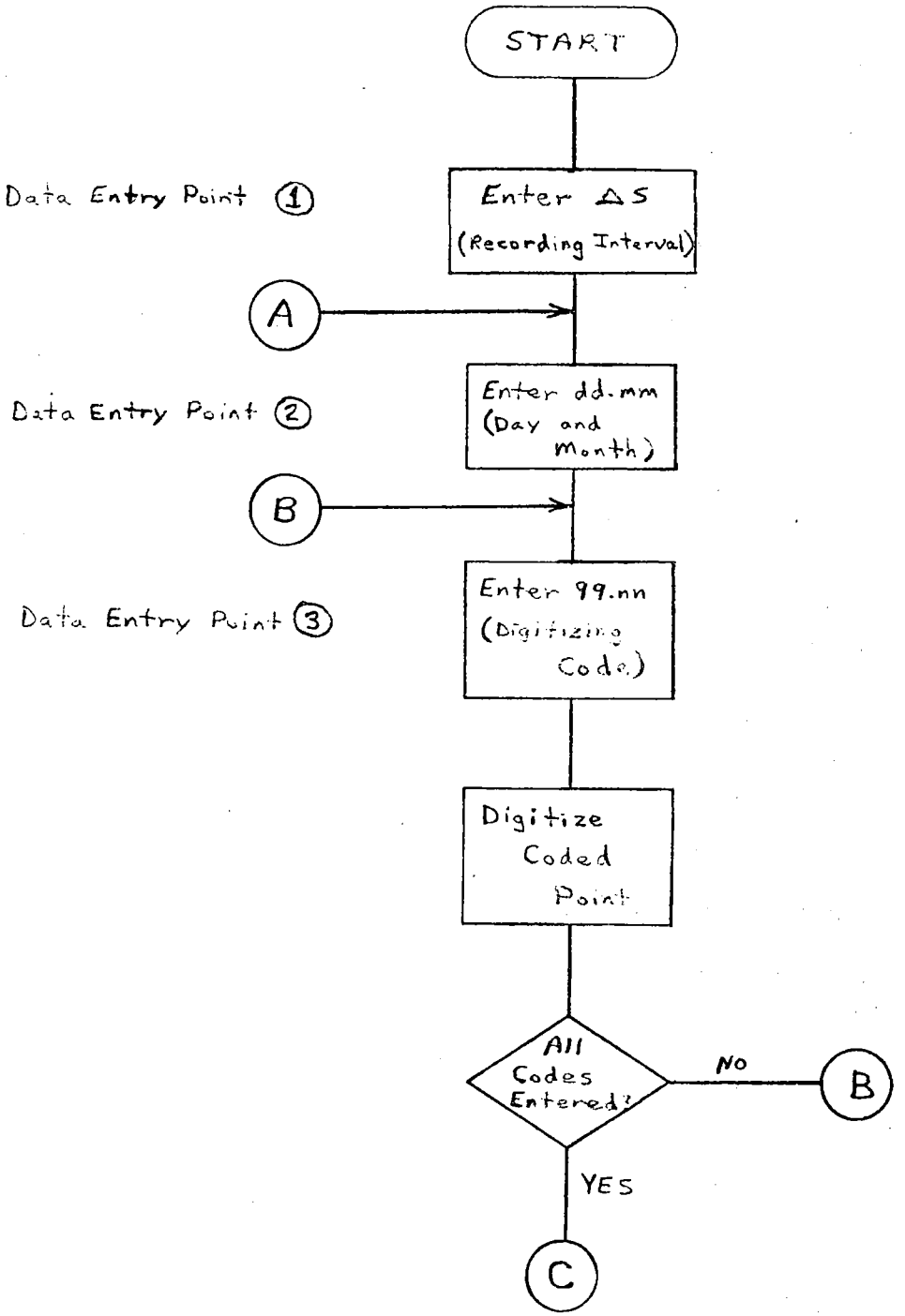


Figure 11

WALDAPS

Water Level Roll
Digitizing Procedure

Page 2

Data Entry Point (4)

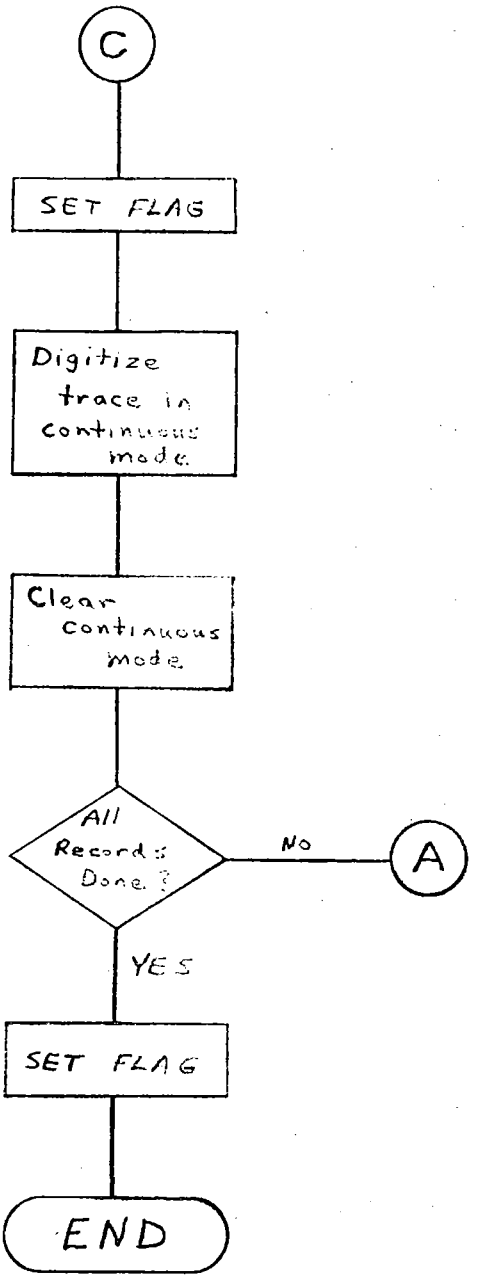


Figure 11A

Special cases

1. Errors in data entry or in digitizing

If an error is made in entering data at entry points 2 or 3, or if an error is made in digitizing "coded" points or in digitizing the trace, the record being created must be terminated and flagged with a 99.99 code indicating that it is to be ignored during further processing. A record can be cut short only during the trace digitizing phase.

To terminate a record, stop moving the bug (beeping stops) and press "STOP", "SET FLAG", and "CONTINUE" on the calculator. The program now writes 99.99 to tape, prints it, writes an IRG on tape, and returns to data entry point 2. Note that this termination sequence also clears the continuous mode in the digitizer.

If an error is made in entering the day and month or at some point in the enter digitizing codes loop, the continuous mode must be entered before the record can be terminated. This is done by pressing "SET FLAG" and "CONTINUE" on the calculator followed by pressing "CONTINUOUS" on the digitizer cursor. Before terminating the record in the fashion described above, a few points should be digitized in continuous mode to ensure that the output record is at least 18 characters in length.

Since no facility to correct a record is provided, any record terminated prematurely must be recreated.

2. A portion of the trace is interpolated

If part of the trace within a record is interpolated, the starting and finishing points of the interpolated region are specified after the checkpoints have been digitized. The first point (L.H.S. of the region) is preceded by code 99.05 and the second one by code 99.06. The trace is digitized through the interpolated region without interruption.

3. Part of the trace is missing or is to be skipped

If a small part of the trace is missing or is to be skipped, the points corresponding to the beginning and end of it are specified after the checkpoints have been digitized. The first point is preceded by code 99.07 and the second by code 99.08.

While digitizing the trace, stop digitizing from immediately to the right of the point defining the beginning (L.H.S.) of the region to be skipped, to immediately to the left of the point defining the end (R.H.S.) of the region. This is accomplished by clearing the continuous mode (press the "CONTINUOUS" button) as soon as one data point beyond the beginning point has been recorded, moving the bug to immediately to the left of the ending point and pressing the "CONTINUOUS" button to resume digitizing. This ensures that at least one point beyond the beginning point and one point before the ending point are recorded.

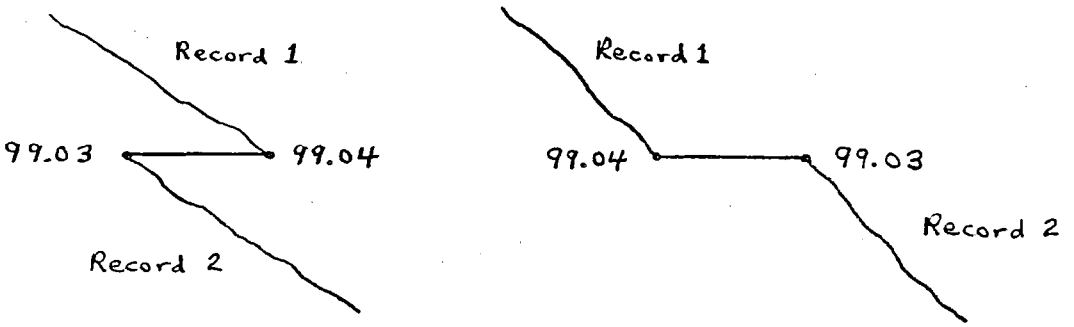
4. Trace reversals

If a trace reversal occurs (this happens if the water level becomes higher than chart maximum) the beginning and end points of the reversal region must be specified. The beginning (L.H.S.) point is preceded by code 99.09 and the end point by code 99.10. The trace is digitized through this region without interruption.

Notes

1. Records are processed (i.e. digitized) in ascending order of date and time within a water levels roll. If two or more rolls are to be digitized in one sitting, there are no restrictions on which rolls are selected (i.e. rolls do not need to be contiguous nor do they need to be of the same station). Special processing is required for a roll which continues from one year to the next.

2. An ambiguity can occur if time is moved as shown below. In each case, record 1 ends at the point labelled 99.04 and record 2 begins at the point labelled 99.03.



3. A given checkpoint can be the second one (99.04) in one record and the first (99.03) in the next record.

4. A field check occurring within a reversal region can not be used as a checkpoint. Checkpoints which lie outside this region will need to be calculated, if checkpoints are needed in this part of the roll.

DIGITIZING PROGRAM FOR THE HP-9100A CALCULATOR

The digitizing program used in WALDAPS accepts data (and some "commands") entered via the calculator, requests digitized points (X and Y co-ordinates) as necessary, decides when data should be recorded, and decides when to stop requesting data. Various other functions such as printing of the data entered, flagging a record which needs to be skipped, and writing an inter-record gap also are performed by the program.

The first data entered by the operator is a graph or chart distance which defines the interval at which data is to be recorded. The interval specified is applied to the X axis in a positive direction only, and to the Y axis in both directions. In practice, this means that if the "bug" is moved such that the distance travelled along the +X or +Y or -Y axis relative to the data point last recorded (which is the current origin of these axis) is equal to or greater than the specified interval, another data point will be recorded.

Data is entered into the program at three specific points each indicated on the display by the contents of the X, Y and Z registers. At data entry point 1 (indicated by 1., 0., 0. on the display), the recording interval to be used is entered. The day and month of the current record are entered at point 2 (indicated by 2., 2., ?). At entry point 3 (indicated by 3., 3., ?), digitizing codes are entered. One further so-called data entry point (displayed as 4., 4., ?) is used to indicate to the operator that continuous-mode digitization can begin.

The water level digitizing process occurs in two stages. Zero points, checkpoints, and anomaly-defining points are digitized first in point (single) mode. Then, the trace is digitized in continuous mode. In both cases, each point recorded on magnetic tape is signalled by a "beep" from the digitizer.

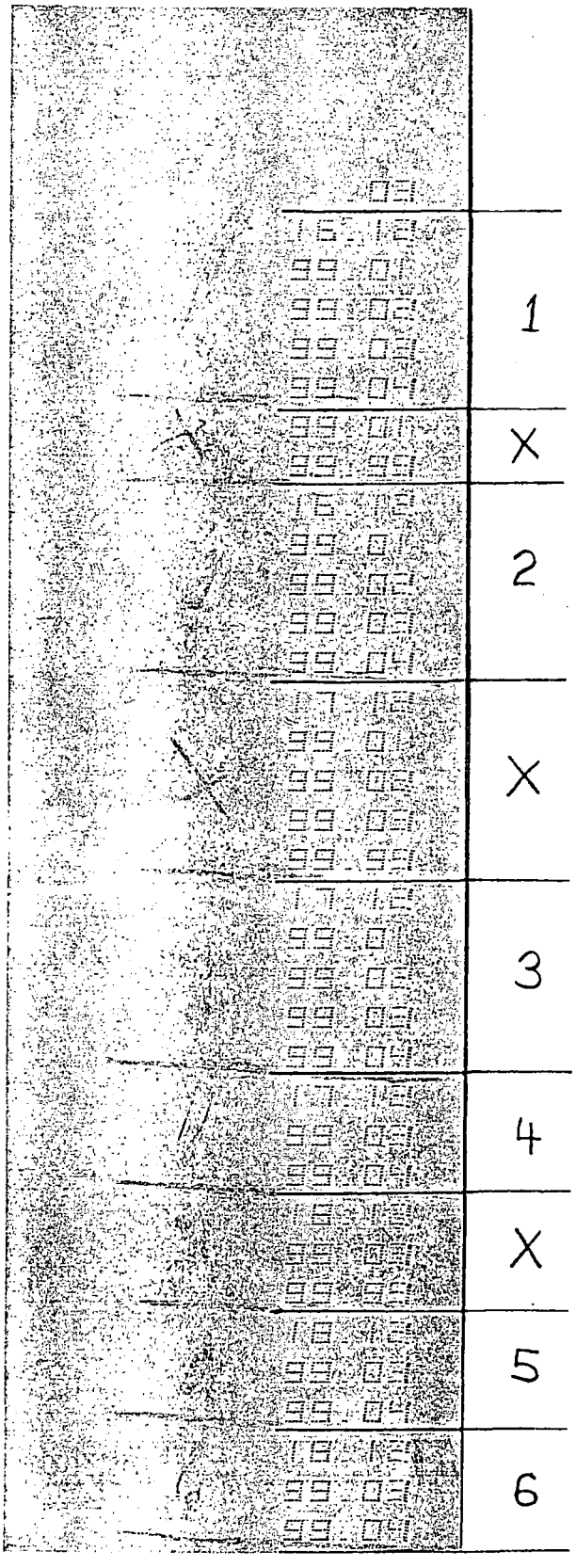
Output from the program (other than display) is a magnetic tape file and a printed list of data entered via the keyboard. File records are variable-length with an estimated maximum of 34,000 characters. Since each data point or set of X, Y coordinates occupies 16 characters, this corresponds to about 2100 points. These estimates are based on the length of the digitizing table with a small buffer factor added. Part of an output file dumped on the CDC 3170 is shown in Figure 12.

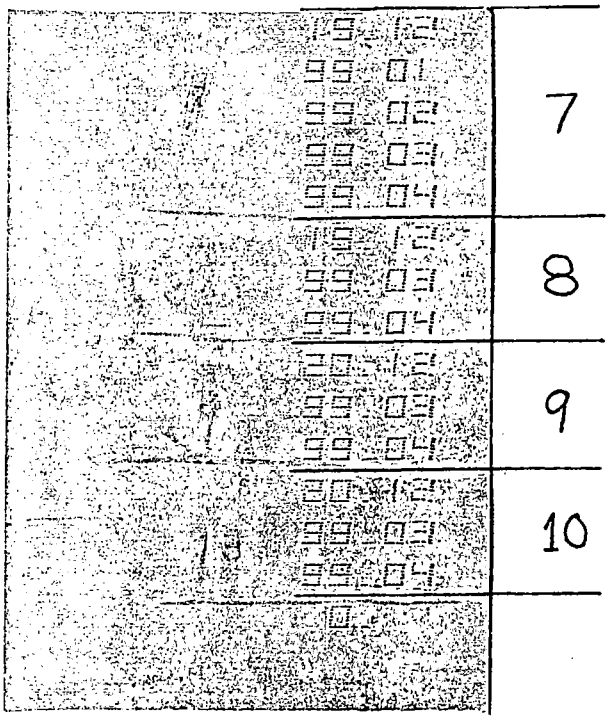
A sample of printed output from the calculator is illustrated in Figure 13. Each record digitized is identified by a day and a month (dd.mm) followed by a list of the digitizing codes used. A 99.99 as the last digitizing code indicates that the record in question was terminated prematurely and will be ignored in subsequent processing. A 0. signifies end of digitizing session.

SAMPLE OF DIGITIZER OUTPUT FILE ILLUSTRATING FORMAT

```
JOB,556,0360MP,1,2000,,,,, C DOEKES 0AA
SCHED,CORE=16,CLASS=I,TIME=1,607=2
*DEF(T,,1,607,PD092,0,,,,,,,M,,I)
*DEF(O,W,XQT,001/012,UTIL-ABS,01)
UTIL,XQT
I UTIL 000 BEGIN UTILITY
COPYT,1,,61,1F
I UTIL 100 MAX REC SIZE 07776B
  1.37,  99.01,  4.00,  8.69,  99.02,  19.98,  8.99,  99.03,  3.35,  8.06,  99.04,
07,  7.37,  8.07,  3.40,  8.06,  3.43,  8.05,  3.46,  8.03,  3.49,  8.02,
  3.61,  7.95,  3.64,  7.93,  3.65,  7.90,  3.68,  7.89,  3.71,  7.86,  3.74,
83,  7.80,  3.86,  7.78,  3.88,  7.75,  3.91,  7.73,  3.93,  7.70,  3.96,
  7.60,  4.06,  7.58,  4.09,  7.56,  4.11,  7.53,  4.13,  7.50,  4.15,  7.47,
38,  4.23,  7.35,  4.25,  7.32,  4.28,  7.30,  4.30,  7.27,  4.32,  7.24,
  4.41,  7.14,  4.43,  7.11,  4.46,  7.09,  4.48,  7.06,  4.51,  7.04,  4.53,
61,  6.94,  4.63,  6.91,  4.66,  6.89,  4.69,  6.87,  4.72,  6.86,  4.75,
  6.83,  4.97,  6.82,  4.90,  6.80,  4.93,  6.80,  4.96,  6.80,  4.99,  6.80,
81,  5.11,  6.82,  5.14,  6.84,  5.17,  6.85,  5.20,  6.86,  5.22,  6.89,
  5.31,  6.99,  5.33,  7.02,  5.35,  7.05,  5.38,  7.07,  5.39,  7.10,  5.42,
46,  7.21,  5.48,  7.24,  5.50,  7.27,  5.52,  7.30,  5.55,  7.33,  5.57,
  7.45,  5.62,  7.48,  5.63,  7.51,  5.64,  7.54,  5.65,  7.57,  5.66,  7.60,
69,  5.70,  7.72,  5.71,  7.75,  5.71,  7.78,  5.72,  7.81,  5.73,  7.84,
  5.75,  7.96,  5.76,  7.99,  5.77,  8.02,  5.77,  8.05,  5.78,  8.08,  5.79,
82,  8.20,  5.82,  8.23,  5.82,  8.26,  5.83,  8.29,  5.84,  8.32,  5.86,
  8.44,  5.94,  8.47,  5.97,  8.48,  6.00,  8.50,  6.03,  8.52,  6.06,  8.53,
56,  6.18,  8.57,  6.21,  8.58,  6.24,  8.58,  6.27,  8.59,  6.30,  8.60,
  6.42,  8.63,  6.45,  8.64,  6.48,  8.64,  6.51,  8.65,  6.54,  8.65,  6.57,
66,  8.62,  6.69,  8.61,  6.72,  8.60,  6.75,  8.59,  6.78,  8.58,  6.81,
  8.48,  6.90,  8.45,  6.91,  8.42,  6.92,  8.39,  6.93,  8.36,  6.94,  8.33,
24,  6.99,  8.21,  7.00,  8.18,  7.02,  8.15,  7.04,  8.12,  7.07,  8.10,
  7.15,  7.98,  7.17,  7.95,  7.19,  7.92,  7.22,  7.91,  7.25,  7.91,  7.27,
31,  8.03,  7.34,  8.04,  7.35,  8.01,  7.36,  7.98,  7.36,  7.95,  7.37,
  7.83,  7.40,  7.80,  7.42,  7.77,  7.43,  7.74,  7.45,  7.71,  7.46,  7.68,
69,  7.54,  7.72,  7.55,  7.75,  7.56,  7.78,  7.57,  7.81,  7.58,  7.84,
  7.64,  7.79,  7.66,  7.76,  7.67,  7.73,  7.68,  7.70,  7.69,  7.67,  7.69,
74,  7.55,  7.75,  7.52,  7.77,  7.49,  7.78,  7.46,  7.80,  7.43,  7.82,
  7.39,  7.91,  7.42,  7.92,  7.45,  7.93,  7.48,  7.94,  7.51,  7.96,  7.54,
45,  8.01,  7.42,  8.02,  7.39,  8.04,  7.36,  8.06,  7.33,  8.08,  7.30,
```

Figure 12





Sample of printed output from the digitizer program. (X = Record to be skipped)

Figure 13

WLDPS01 (V2) Dec. 1974

CONVERT DIGITIZED WATER LEVELS TO 5-MINUTE INTERVAL WATER LEVELS

System:	Water level data processing system (WALDAPS)
Author:	C. Doekes
Purpose:	Program to accept, as input, a digitized water level chart roll file and to produce a file containing water levels at 5-minute intervals, as output.
Source Language:	FORTRAN IV
Computer:	CDC 3170 (MASTER)
Status:	Production
Input:	Digitized water level file and data cards
Output:	5-minute interval water levels file, a printed listing of the file contents, and control totals.
Subroutines:	Briefly, the program reads digitized water level chart segments (records) from the input file, reads "true" water levels, times and zero shift corrections, as defined at checkpoints, from cards and creates an output file containing "true" water levels at five minute intervals. Each record on the output file contains one hour of data (12 water level values) from 5 minutes after the hour to 60 minutes after the hour.

The program operates in two stages. During the first, all digitized points between the specified checkpoints (including the checkpoints) are defined in terms of real time and "true" or corrected water level, that is, digitizer X and Y co-ordinates are converted to corrected time and water level, respectively.

In the second stage, water levels are derived at five-minute intervals from the time and water level arrays defined in stage one. Linear interpolation is used to calculate water levels at points falling between successive array elements. The values so obtained are written on the output file in one hour records. If there is no data for a given 5-minute point in time, 9999 is entered in the record in its corresponding position. If the data gap is sufficiently large (i.e. it would result in a record which contained 9999 entries only) data for certain hours will be missing in the output file, because records containing 9999's only will not be written. Similarly, if an hour of data is incomplete such as at the beginning or end of a chart roll, the remainder of the record (first part or last part) is padded with 9999's.

The input data (cards) defines station number for each record; day, month, real time, "true" water level, and zero shift correction for each checkpoint and other parameters such as units used (metric (M) or British (B)) and the year in which the data was taken. A leap year is automatically corrected for by adding one to the array element containing the number of days in February. Data continuing from one month to the next (i.e. the roll contains data from more than one month) is handled automatically. However, data continuing from one year to another is not dealt with. Special procedures to be followed for a roll in which a year ends are described in the system documentation.

Printed output from the program includes a list of all output records and a list of job statistics such as the number of cards read, the number of input records read, and the number of records written on the output file. The number of cards read should equal the number of records read in any given successful job run.

A sample of the printed output is given following this documentation (Figure 14).

Use: Assign logical unit 1 to the input file and unit 2 to the output file.

Data Cards: There are three data card formats. Card 1 is the first card in the data deck and is included once only. Card 2 is included once for each different station on the digitizer output file. Card 3 is included once for each record on the digitizer output file. Therefore, for a digitizer output file containing n records from station A and m records from station B, the order of cards is as follows: Card 1, Card 2 for station A, n card 3's, Card 2 for station B and m Card 3's. Note that the n records for station A must be contiguous as must the m records for station B.

Data Card Format:

Card 1:	Cols 1-4	Year in which the data was collected	(I4)
Card 2:	Col 1	'1' (Card type)	(I1)
	Cols 2-6	Station number	(I5)
	Col 7	Units used (M or B)	(A1)
	Cols 8-13	Zero correction	(F6.2)
Card 3:	Col 1	'2' (Card type)	(I1)
	Cols 2-3	Day of the month at checkpoint 1	(I2)
	Cols 4-5	Month at checkpoint 1	(I2)
	Cols 6-7	Hour at checkpoint 1	(I2)
	Cols 8-9	Minutes at checkpoint 1	(I2)
	Cols 10-14	"True" water level at checkpoint 1	(F5.2)
	Cols 15-19	Zero shift correction at checkpoint 1	(F5.2)
	Cols 20-21	Day of the month at checkpoint 2	(I2)
	Cols 22-23	Month at checkpoint 2	(I2)
	Cols 24-25	Hour at checkpoint 2	(I2)
	Cols 26-27	Minutes at checkpoint 2	(I2)
	Cols 28-32	"True water level at checkpoint 2	(F5.2)
	Cols 33-37	Zero shift correction at checkpoint 2	(F5.2)

Example:

1) 1973
2) 154321B 1.15
3) 210 516 4 5.20 0.1 11 5 64211.00-0.5

The year is 1973, station number is 54321, units are British, the zero correction is 1.15 units. The record described is from 16:04 on May 10 to 6:42 on May 11. Water levels at checkpoints 1 and 2 are 5.2 feet and 11.0 feet, and zero shift corrections are 0.1 and -0.5 feet, respectively.

Possible Errors:

1) A record read from the input file and a data card of type 3 do not match with respect to day and month. Either the data is wrong or out of sequence or the incorrect date was entered at digitizing time. To correct this deficiency, either change the data card (or its position) or re-digitize and replace the faulty record.

2) Other errors can occur because the appropriate digitizing codes were not entered at digitizing time. To correct this, the record should be re-digitized and replaced in the file.

3) Another error condition arises if there are insufficient data cards submitted to the program. These cards should be checked against the printed output from the calculator.

4) The condition of insufficient records on the input file is detected only if the program is searching the file for a particular record to match the data card which it has last read. Normally, if an end of file is read on the input file, the job run is complete and termination occurs. If, at this time, some data cards are not yet read, they will be ignored.

Subroutines:

CONVER: Given the Digitizer X and Y co-ordinates of a point, this routine determines the real time and "true" water level at that point. Conversion and correction factors required for the process are defined externally and are stored in labelled COMMON. Variables passed into the routine are digitizer X and Y co-ordinates. Returned variables are true time and water level.

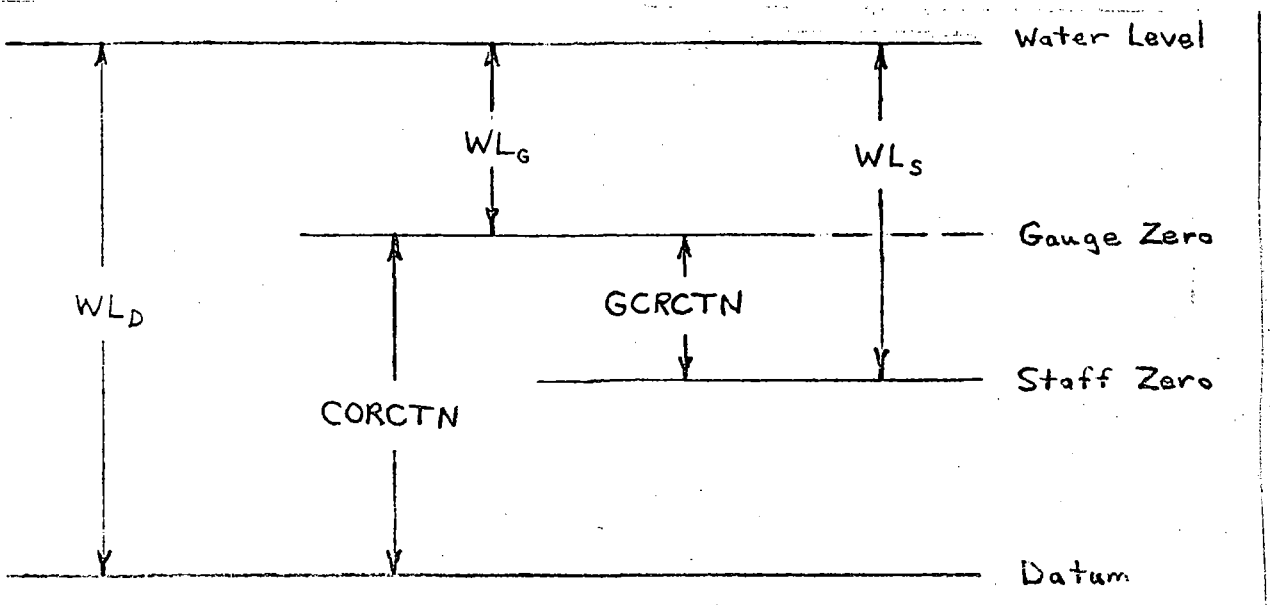
OUTPWLR: Routine to complete the formation of a water levels file record, to write the record on the output file, and to list the record in edited (i.e. spaced out) format on the line printer. All data with the exception of the hour corresponding to the record are passed through labelled COMMON.

321	1612	10	80	101	101	107	109	105	105	106	106	107	108	108	108
321	1612	11	80	109	110	111	111	113	113	113	114	115	116	117	118
321	1612	12	80	119	120	120	121	122	123	125	125	126	126	127	127
321	1612	13	80	127	128	129	129	130	131	131	133	134	135	135	137
321	1612	14	80	137	138	139	140	140	141	142	142	143	144	144	145
321	1612	15	80	146	146	147	148	148	149	151	151	152	154	155	155
321	1612	16	80	156	157	157	159	159	159	160	161	161	162	163	163
321	1612	17	80	164	165	165	166	167	168	169	170	170	171	173	174
321	1612	18	80	175	175	176	176	177	177	177	178	179	180	180	181
321	1612	19	80	181	182	183	184	185	186	186	188	189	189	190	191
321	1612	20	80	192	192	192	194	194	196	196	196	197	198	198	300
321	1612	21	80	300	299	299	298	297	296	296	296	296	294	294	294
321	1612	22	80	293	293	292	291	291	291	290	290	288	288	288	287
321	1612	23	80	287	286	285	284	284	282	282	281	281	281	279	279
321	1712	0	80	278	277	276	275	275	275	273	272	272	270	270	270
321	1712	1	80	269	268	267	267	265	265	264	263	262	262	262	260
321	1712	2	80	260	259	258	258	257	256	256	255	254	253	254	252
321	1712	3	80	252	251	250	249	249	248	247	247	246	245	244	243
321	1712	4	80	242	241	241	241	239	238	238	236	235	234	232	232
321	1712	5	80	232	230	230	228	228	226	226	224	224	222	222	221
321	1712	6	80	219	219	218	217	216	215	214	213	212	212	211	210
321	1712	7	80	209	209	207	207	206	205	205	203	202	201	200	9999
321	1712	10	80	101	104	103	105	107	106	109	110	111	110	112	112
321	1712	11	80	114	114	115	116	117	118	119	119	121	123	124	124
321	1712	12	80	127	126	129	130	130	132	132	133	134	135	136	136
321	1712	13	80	137	137	138	138	140	141	143	144	144	144	147	147
321	1712	14	80	148	150	151	152	152	153	154	154	154	155	155	156
321	1712	15	80	157	158	158	160	161	163	162	163	164	166	167	168
321	1712	16	80	168	168	170	171	171	172	172	173	173	173	175	174
321	1712	17	80	175	176	177	177	178	178	179	181	181	182	182	182
321	1712	18	80	184	185	185	185	185	186	186	187	187	188	188	189
321	1712	19	80	189	189	190	191	191	192	192	194	195	195	195	195
321	1712	20	80	196	197	197	198	198	198	198	199	199	199	200	300
321	1712	21	80	298	298	296	296	295	294	294	293	292	292	291	290
321	1712	22	80	289	289	288	287	285	285	285	283	283	281	281	280
321	1712	23	80	279	279	278	277	277	275	274	273	272	270	271	271
321	1812	0	80	269	268	268	267	266	265	263	263	262	261	259	259
321	1812	1	80	259	258	257	257	255	255	253	253	252	251	250	249
321	1812	2	80	248	248	247	246	246	245	244	244	244	242	242	242
321	1812	3	80	242	240	240	240	238	238	237	236	235	235	233	233

Figure 14

GAUGE AND ZERO CORRECTIONS

The diagram below shows the relationship between gauge zero, staff zero, water level, and datum and several correction factors which may be applied.



WL_S, WL_G, and WL_D are water levels relative to staff zero, gauge zero, and datum, respectively.

If staff and gauge zero are not the same, a correction factor, GCRCTN, must be applied to all staff readings. This is done either when field checks are made or at the time that manual corrections are made to the water level roll.

WLDPS01 can apply one correction to all water levels which it processes. This factor (CORCTN in the diagram) is used to convert water levels measured relative to gauge zero to water levels relative to datum or to mean sea level. Since the correction is added to the measured water level, it must be entered (into the program) as negative if gauge zero is below datum and vice-versa.

CREATION OF THE WATER LEVELS MASTER FILE

The water levels master file is created, initially, using MSS, the mass storage SORT/MERGE package operating under MASTER on the CDC 3170. The file created by WLDPS01 is sorted, blocked into fixed-length records and output on magnetic tape. This magnetic tape constitutes the initial water levels master file. Header records can be added at a later date using WLDPS02.

The input file (created by WLDPS01) is sorted in ascending order of station number, ascending order of month, ascending order of day, and ascending order of hour. The input file has a blocking factor of 1 and a logical record length of 64 characters. The output file (master file) has a blocking factor of 24 and a logical record length of 64.

Two mass storage files are used by MSS to store intermediate data. These files should be defined by the user with the appropriate control cards. Typically, only those cards defining the input and output (new master) files need to be changed for a given job run although occasionally the amount of disk space allocated to intermediate files will have to be increased. In general, the amount of space defined for each file should be slightly in excess (by about 20%) of the amount of space required to store the input file. This intermediate file mass storage space should be released after the sort is complete.

A typical job run is shown on the following page. The input file is assigned to logical unit 1, the output file to unit 2. Intermediate files are assigned to logical units 10 and 11 respectively. The sort control cards define, respectively, the operation to be performed, the input file, the output (master) file, two logical unit numbers assigned to intermediate files, action to be taken when various error conditions arise, and the four sort keys used. Mass storage space is released after the SORT is complete. The file can be dumped (for checking) if necessary using one of the UTILITY programs.

```
JOE,580,040WSORT,1,600,,,,      J GERVAIS
SCHED,TIME=1,CORE=50,CLASS=1,607=2                    INITIALISE MASTER FILE.
*DEF(T,,1,607,TCW014,O,,,,,,M,,I)
*DEF(T,,2,607,TCW027,O,,,,,,M,,O)
*DEF(R,W,040/580,INT1,01,040,040,ALL)
*DEF(R,W,040/580,INT2,01,040,040,ALL)
*DEF(A,W,040/580,INT1,01,040,040,1224,80,,,,841)
*DEF(O,W,10,040/580,INT1,01,040,O)
*DEF(A,W,040/580,INT2,01,040,040,1224,80,,,,841)
*DEF(O,W,11,040/580,INT2,01,040,O)
SORT(SDL=80)
    SORT=(,,F,64)
    INPUT=(1,64,,C,M,X,R,1)
    OUTPUT=(2,1536,,C,M,X,R)
    WORK=((10,11),D)
    ERRCPT=((B,F),(B,E,P),(A,P),S)
    KEY1=(I,A,5,1)
    KEY2=(I,A,2,9)
    KEY3=(I,A,2,7)
    KEY4=(I,A,2,12)
    ENDSORT

   TOURNAMENT SIZE =      796
   MERGE ORDER :    INT =    2 ;   FINAL =    2
   SORT PHASE :  IN=09/23/48     OUT=09/24/13
   SEQUENCES GENERATED =         1
   ALPHA   =     1.00

   INPUT  COUNTS  :       779 IN ;          0 INS ;          0 DEL ;        779 OUT

   FINAL RESTART DUMP
   DSI (2    ) : OUTPUT REEL     1
   OUTPUT COUNTS  :       779 IN ;          0 INS ;          0 DEL ;        779 OUT

   FINAL MERGE : IN=09/24/15     OUT=09/24/17
*DEF(R,W,040/580,INT1,01,040,040,ALL)
*DEF(R,W,040/580,INT2,01,040,040,ALL)
```

UPDATING THE WATER LEVELS MASTER FILE

The water levels master file is updated using MSS, the mass storage SORT/MERGE package operating under MASTER on the CDC 3170. The file created by WLDPS01 is sorted, merged with the old master file, and output on magnetic tape in fixed-length records. This magnetic tape is the new or updated master file.

The input file (created by WLDPS01) is sorted in ascending order of station number, ascending order of month, ascending order of day, and ascending order of hour. This sequence defines the sort keys from major to minor. This file is then merged with the old water levels master file using these same keys. The input file has a blocking factor of 1 and a logical record length of 64 characters. The old and new master files each have a blocking factor of 24 and a logical record length of 64.

Two mass storage files are used by MSS to store intermediate data during the sort phase. These files are defined by the user with the appropriate control cards. The space allocated to each of them must be slightly (by about 20%) in excess of the amount of space required to store the input file (i.e. the file to be sorted). Typically, only those cards defining the input, old master, and new master files will need to be changed for a given job run although occasionally the amount of disk space needed for intermediate files may have to be increased. The mass storage space allocated to these files should be released after the merge phase.

A typical job run is shown in the figure following this narrative. The file to be added is assigned to logical unit 1, the old master file to 3, and the new master file to unit 2. Intermediate mass storage files are assigned to units 10 and 11, respectively. The sort control cards specify the operation to be performed (SORT), the file to be added (INPUT), the file being added to (MERGE), the new master file (OUTPUT),

two intermediate files (WORK), four sort keys (Key 1 - Key 4), and action to be taken when various error conditions arise (ERROPT). Intermediate file storage space is released immediately before job termination.

At periodic intervals, the master file should be dumped for checking purposes using one of the UTILITY programs.

```
JOB,590,099WLUPD,3,7000,,,,          A. ZINGARO
SCHED,TIME=3,CORE=99,CLASS=I,607=3
*DEF(T,,2,607,TCW028,O,,,,,,,M,,W)
*DEF(I,,1,607,TCW001,O,,,,,,,M,,I)
*DEF(T,,3,607,TCW018,O,,,,,,,M,,I)
*DEF(R,W,058/590,INT1,01,058,058,ALL)
*DEF(R,W,058/590,INT2,01,058,058,ALL)
*DEF(A,W,058/590,INT1,01,058,058,1224,80,,,,,841)
*DEF(O,W,10,058/590,INT1,01,058,O)
*DEF(A,W,058/590,INT2,01,058,058,1224,80,,,,,841)
*DEF(O,W,11,058/590,INT2,01,058,O)
SORT(SOL=80)
    SORT=(,,F,64)
    INPUT=(1,64,N,C,M,X,R,1)
    MERGE=(3,,1536,N,,C,M,X,R,1)
    OUTPUT=(2,1536,(N,D),C,M,X,R)
    WORK=((10,11),D)
    KEY1=(I,A,5,1)
    KEY2=(I,A,2,9)
    KEY3=(I,A,2,7)
    KEY4=(I,A,2,12)
    ERROPT=((B,P),(8,E,P),(A,P),D)
    ENDSORT

    SORT TOURNAMENT SIZE  =      1655

  SORT PHASE IN-11/57/33    OUT-11/57/53

   MERGE ORDER:  INT =          32 ,  FINAL =         32

            1 SEQUENCES.

 ALPHA =         0.63
  I  SORT         1044 IN
  I  SORT         1044 OUT
 FINAL RESTART DUMP
  I   SORT  MERGE INPUT 3
  I   SORT  O/P REEL  01     2
  I   SORT      11002 RECORDS IN
  I   SORT      11002 RECORDS OUT
 *DEF(C,W,10)
 *DEF(C,W,11)
 *DEF(R,W,058/590,INT1,01,058,058,ALL)
 *DEF(R,W,058/590,INT2,01,058,058,ALL)
```

UPDATE MASTER FILE

Figure 16

WLDPS03 June 1973

EXTRACT 5-MINUTE INTERVAL WATER LEVELS DATA FROM THE MASTER FILE

System: Water level data processing system(WALDAPS).

Author: C. Doekes

Purpose: Program to extract 5-minute interval water levels data from the water levels master file. Options are: extract all data on the file for a given station, all data for a given station and month, all data for a given station, month and day. Only one request is processed in a single job run.

Source Language: FORTRAN IV

Computer: CDC 3170 (MASTER)

Status: Production

Input: Water levels master file and a data card.

Output: 5-minute interval water levels on cards and a listing of same.

Subroutines: LOCSTN, DMPSTN, LOCMON, DMPMON, LOCDAY, DMPDAY, DEBLOCK, READREC.

Description: A maximum of three subroutines are used to locate the data (if present) in the water levels master file and one is used to output the desired data on cards and to produce a listing of it. The station number, month, and day for which data is required is read from a data card. All three are read in all cases. If all available data for a given station is required, the month field and day field are left blank and each is read as zero. Similarly, the day field is left blank if all available data for a given station and month is required.

Data is located in the following manner: The beginning of data for a given station is located first. If the specified month is non-zero, the beginning of data for the desired month will be located. If not, extraction of data for the required station starts and continues until the station number changes or until an end of file is read at which time the job ends. When the desired month has been located, the value of the specified day is tested. If zero, extraction of data for the desired station and month begins and continues until either the station number changes or the month number changes or an end of file is read at which time the job ends. If the specified day is non-zero, data for the desired day is located, extraction begins, and continues until the station number changes or until month number changes or until the day number changes or until an end of file is read.

The 5-minute interval water levels data output by the program has the same format as logical records on the master file i.e. 64 characters per record and one hour of data (12 entries from 5 minutes after the hour to the next hour) per record.

A tally of the number of records extracted is maintained and printed at end of job.

A sample of the printed output from this program is shown in Figure 17.

Use: Assign logical unit 1 to the WALDAPS master file tape.

Data Cards: Only one data card is included for a given job run. The data included on the card depends on the option selected.

1. Extract all data for a given station:

   Card format: Cols 1-5 station number (I5)

2. Extract all data for a given station and month:

   Card format: Cols 1-5 station number (I5)
   Cols 6-7 month number (I2)

3. Extract all data for a given station, month and day:

   Card format: Cols 1-5 station number (I5
   Cols 6-7 month number (I2)
   Cols 8-9 day number (I2)

Example: 54324 216
Extract all data from the file for station number 54324 for February 16.

Possible Error: Data requested is not on the master file. Either the data card was mispunched or the data is not present on the file. An error message is printed and the job terminates.

Subroutines:

LOCSTN: A routine to locate data for a given station on the master file. The routine returns (via labelled COMMON) a pointer indicating where in the block currently in core the first logical record of the desired station begins. A variable indicating whether the data was found (FLAG=1) or not found (FLAG=0) is returned, also.

DMPSTN: Routine to output 5-minute interval water levels data (logical records on the master file) for a given station on cards and to the line printer. Dumping of records continues until the station number changes or until an end of file is read. A count of the number of records extracted is maintained. The data must have been found on the file (e.g. using LOCSTN) before executing this routine.

LOCMON: A routine to locate data for a given station and month on the master file. The routine returns (in labelled COMMON) a pointer which indicates the beginning of the desired data in the block currently in core. Another variable is returned which indicates if the data was found (FLAG=1) or not found (FLAG=0). LOCSTN must be used to find the beginning of data for the desired station before LOCMON can be called.

DMPMON: Routine to output 5-minute interval water levels data for a given station and month on cards and to the line printer. The data must be found on the file (e.g. using LOCSTN and LOCMON) before executing this routine. Dumping of records continues until the station number changes or until the month changes or until an end of file is read, whichever occurs first. A count of the number of records extracted is maintained.

LOCDAY: Routine to locate data for a given station, month, and day on the master file. LOCSTN and LOCMON must have been used to locate the desired station and month before executing this routine. A pointer indicating the location in the block currently in core where the desired data starts is returned via labelled COMMON. A flag variable indicating whether the data was found (FLAG=1) or not found (FLAG=0) is returned, also.

DMPDAY: Routine to output 5-minute interval water levels data (logical records on the master file) for a given station, month, and day on cards and to the line printer. The data must be located on the master file (e.g. using LOCSTN, LOCMON and LOCDAY) before execution of this routine can begin. Dumping continues until the station number changes or until the month number changes or until the day number changes or until an end of file is read, whichever occurs first. A count of the number of records extracted is maintained.

DEBLOCK: A routine to read logical records from the master file. Physical records or blocks are read in as required. The logical record is returned in its own buffer area. A flag variable is returned which indicates if the logical record read was successful (FLAG=1) or unsuccessful (FLAG=0).

READREC: Routine to read (buffer in) a physical record or block from the master file. A flag variable is returned which indicates whether the read was successful (FLAG=1) or unsuccessful (FLAG=0).

WLDPS03

WATER LEVELS AT 5-MINUTE INTERVALS — SAMPLE OUTPUT

1	9	6	[illegible]	BO	562	562	561	560	560	560	561	561	560	559	558	558
1	9	6	1	BO	558	558	558	558	556	556	556	556	556	554	554	552
1	9	6	2	BO	552	552	551	550	551	552	552	552	552	552	552	552
1	9	6	3	BO	552	552	552	552	551	550	550	552	552	552	552	554
1	9	6	4	BO	554	554	554	554	554	554	554	554	554	553	552	552
1	9	6	5	BO	552	552	552	552	552	554	552	552	552	551	550	550
1	9	6	6	BO	550	550	548	548	548	548	547	546	546	546	546	547
1	9	6	7	BO	548	548	548	548	550	550	549	548	549	550	550	548
1	9	6	8	BO	548	548	548	548	548	548	549	549	549	549	549	551
1	9	6	9	BO	551	551	551	551	551	551	551	551	551	551	551	551
1	9	6	10	BO	551	551	551	551	550	549	549	548	549	549	549	549
1	9	6	11	BO	549	547	546	545	544	543	543	543	543	541	541	541
1	9	6	12	BO	540	539	539	541	541	541	539	541	541	541	541	541
1	9	6	13	BO	542	542	541	543	543	543	543	543	545	544	544	545
1	9	6	14	BO	545	545	547	549	549	551	551	552	553	554	555	555
1	9	6	15	BO	555	555	555	555	555	557	557	557	558	559	559	560
1	9	6	16	BO	561	563	563	563	563	563	563	563	563	563	564	565
1	9	6	17	BO	565	565	565	565	567	567	567	567	567	568	569	569
1	9	6	18	BO	569	569	571	571	573	573	574	574	574	576	576	577
1	9	6	19	BO	579	580	580	582	582	582	582	582	582	584	584	584
1	9	6	20	BO	585	586	586	586	586	586	586	586	586	586	586	587
1	9	6	21	BO	588	588	588	588	588	588	588	588	588	588	587	586
1	9	6	22	BO	586	586	586	588	588	588	586	586	586	587	588	588
1	9	6	23	BO	588	588	588	588	588	590	590	590	590	590	590	592

24 RECORDS EXTRACTED

EOJ

Figure 17

WLDPS04 June 1973

EXTRACT HOURLY WATER LEVELS FROM MASTER FILE

System:	Water level data processing system (WALDAPS)
Author:	C. Doekes
Purpose:	Program to extract water level data at one-hour intervals, for a given station and month, from the water levels master file and output it to the line printer and on cards at two records per day (i.e. each record has 12 hours of data on it). All available data for a given month is extracted.
Source Language:	FORTRAN IV
Computer:	CDC 3170 (MASTER)
Status:	Production
Input:	Water levels master file and a data card
Output:	Hourly water level records on cards and a listing of same.
Subroutine:	OHWLR
Description:	For a given station number and month the program creates, punches (on cards) and lists, data records containing instantaneous hourly water levels (i.e. the water level on the hour). Each record contains data for twelve hours, either from 1 to 12 or from 13 to 24. Padding with 9999's occurs if data is missing. If more than 12 hours of data are missing, thereby resulting in a record containing 9999 padding only, that record is not output.

The station and month, for which the data is desired, gauge zero and the year in which the data was collected are entered on a data card. The master file is searched by physical record until the desired part of the file has been reached. This is followed by a logical record search until the beginning of the desired data is found. If the record data is not on the

file an error message is printed and the job terminates. When the desired data is found extraction of hourly water levels and creation of output records begins. This extraction process continues until the station number changes or until the month changes or until an end of file is reached, whichever occurs first. At this time the number of output records created is printed and the job terminates normally.

A sample of the printed output is given following this documentation, in Figure 18.

Use: Assign logical unit 1 to the WALDAPS master file tape.

Data Cards: In a given job run, no more than one month of data can be extracted. Just one data card is needed.

Format:

Card 1:	Cols 1-5	Station number for desired data	(I5)
	Cols 6-7	Month number for desired data	(I2)
	Cols 8-12	Gauge zero	(I5)
	Cols 13-16	Year in which data was collected	(I4)

Example: 5432107 1051973

Data is desired for station number 54321 and month 7. The gauge zero is 1.05 units (feet or metres) and the year in which the data was collected is 1973.

Possible Error:

1) Data is not on the master file. Either the data card was improperly punched or the data is not actually on the file. A dump of the file (or of part of the file) should be consulted to determine if the data is actually present.

Subroutine:

OHWLR: Output hourly water level record. This routine completes the hourly water levels record (i.e. it adds the record type, station number, gauge zero, day, month, and year) and outputs the record to the line printer and the card punch. A count of the number of records output is maintained.

WLDP504

SAMPLE OUTPUT

UPLY WATER LEVELS FROM WALDAPS MASTER FILE

```
 3 674999999999999999999999999999999 630 632 632 634 631-
 3 674 599 611 599 595 589 585 579 577 572 569 568 563-
 9 674 558 552 552 554 552 55. 547 548 551 551 549 541-
 9 674 541 545 555 56  565 569 577 584 587 586 588 592-
 1 674 592 588 582 581 577 573 571 567 567 569 569 567-
 1 674 567 570 578 586 596 6.4 615 6.6 638 610 612 610-
11 674 615 615 613 597 593 595 595 599 6 1 61 6 1 594-
11 674 593 594 590 59  590 59. 589 588 585 583 580 578-
12 674 573 568 566 561 561 557 557 557 557 560 562 550-
12 674 560 559 559 56  561 567 571 573 573 572 572 571-
13 674 568 566 565 563 558 555 551 546 544 541 539 538-
13 674 533 531 526 526 525 524 524 523 534 536 530 546-
14 674 560 555 563 574 565 564 588 590 574 598 581 598-
14 674 636 597 575 576 598 588 596 597 591 595 596 600-
15 674 604 617 617 613 6.9 6 7 611 611 621 622 630 640-
15 674 638 642 644 644 648 647 646 648 644 636 630 620-
16 674 604 598 590 584 584 582 580 576 574 574 578 584-
16 674 590 592 602 606 6 4 6.3 602 6 2 606 610 608 618-
17 674 608 606 602 598 590 587 585 586 582 582 580 580-
17 674 578 576 579 582 586 59. 588 588 584 580 582 592-
18 674 584 582 582 581 580 578 58 999999999999999999999-
19 674999999999999999999999999999999 57  567 576 569 571-
19 674 577 570 576 573 574 571 572 569 573 574 574 576-
20 674 579 58 581 584 583 582 581 583 580 583 584 585-
20 674 592 593 594 598 596 599 6 3 614 601 602 603 605-
21 674 602 603 600 599 60 601 596 593 593 594 591 586-
21 674 589 592 599 602 610 612 619 627 626 625 620 617-
22 674 615 612 613 61  606 608 609 610 611 608 603 596-
22 674 588 59 594 601 604 601 594 591 589 588 589 590-
23 674 587 586 583 578 576 573 574 575 576 577 575 574-
23 674 577 576 577 578 575 570 564 559 552 553 556 561-
24 674 561 562 561 56  559 562 561 558 557 555 554 553-
24 674 553 554 554 553 555 550 551 546 545 546 543 544-
25 674 551 555 555 558 560 559 556 554 553 553 552 549-
25 674 553 556 558 563 567 570 569 565 562 556 553 554-
26 674 554 547 545 548 550 549 552 556 555 555 547 546-
26 674 543 538 532 527 525 519 518 519 514 516 519 525-
27 674 527 533 537 544 556 569 572 574 573 575 574 576-
27 674 578 579 582 584 593 598 607 613 615 616 615 617-
28 674 616 613 611 607 6 4 6.1 600 603 605 602 597 596-
28 674 593 593 589 588 585 583 577 590 585 594 620 620-
29 674 619 628 625 616 617 6.6 593 602 604 607 624 620-
29 674 613 630 619 62  633 629 631 651 644 649 639 636-
30 674 637 631 632 631 636 641 642 643 638 635 634 627-
31 674 621 606 598 6.3 601 598 606 601 606 602 594 592-
```

E RECORDS

OF JOB

Figure 18

PROGRAM EXECUTION UNDER THE MASTER OPERATING SYSTEM

Control cards required to execute WALDAPS programs under MASTER on the CDC 3170 are illustrated in Figure 19.

The first listing shows execution of the WLDPS01 program from a FORTRAN source card deck. Two data tapes are defined: the first, a digitizer output tape (HWL008), is assigned to logical unit 1, and the second, a five-minute interval water levels tape (HWL009), is assigned to logical unit 2.

Execution of the same program from an object file on disk is illustrated in the second listing. In addition to defining input and output magnetic tape files, the binary program file on disk must be defined using another *DEF control card.

An explanation of individual control cards and their use may be found in the MASTER User's Guide published by Control Data Corporation.

PROGRAM EXECUTION UNDER MASTER

Control Cards for Program Execution under MASTER

STATEMENT NUMBER / NUMÉRO DE L'ÉNONCÉ	COST	FORTRAN STATEMENT / ÉNONCÉ FORTRAN
$	J	JØB,556,036WO1,3,3000,,,,,C DØEKES ØAA
$	S	SCHED,CØRE=72,CLASS=I,TIME=3,607=2
$	*	*DEF(T,,1,607,HWL008,Ø,,,,,,M,,I)
$	*	*DEF(T,,2,607,HWL009,Ø,,,,,,M,,Ø)
$	F	FTNU(I,L,X,S)
		FØRTRAN SØURCE DECK
		FINIS
$	D	DTSK,LGØ
		DATA CARDS
78	78	(EØF CARD)
$	J	JØB,556,036WO1,3,3000,,,,,C DØEKES ØAA
$	S	SCHED,CØRE=72,CLASS=I,TIME=3,607=2
$	*	*DEF(T,,1,607,HWL008,Ø,,,,,,M,,I)
$	*	*DEF(T,,2,607,HWL009,Ø,,,,,,M,,Ø)
$	*	*DEF(Ø,W,11,036/556,WALDAPS01,01,036,Ø)
$	D	DTSK,11
		DATA CARDS
78	78	(EØF CARD)

Execution From FØRTRAN DECK

Execution From Disk

Figure 19

FUTURE PLANS

Two computer programs are planned for implementation in the system at some time in the future. These are a master file editing program and a program to extract averaged hourly water level data.

Some work has already been done on an editing program (WLDPSO2), but, since all needed functions have not been incorporated yet, no formal documentation exists. The following functions are enabled and tested: Dump file header records; Dump the entire file; Dump selected portions of the file (all data for a specified station or all data for a specified station and month or all data for a specified station, month, and day); Copy the entire file onto another magnetic tape; Add header records to the file. Further work on this program will include the ability to add, delete or change records.