COMPUTER REDUCTION OF WATER RECORDS

By

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Introduction

The last ten years have been aptly called the "Computer Decade" and we have witnessed a tremendous increase in the use of computers to process data. Since hydrographic records are the result of extensive and time consuming analysis and manual handling of raw data, it was logical that the reduction to permanent records should be done by computers. Pacific Gas and Electric Company now operates over 600 water gages, ranging from staff gages to power plant differential pressure flow meters. Ten years ago, foreseeing this volume of data to process, a start was made by P.G. and E. to produce ultimate water records by computer. This was not pioneering, because others were already doing this. Since that time, significant changes have occurred in both recorders and computers, which now allow completely automated reduction of water records.

In order to illustrate the use of some of the techniques, which P.G. and E. has adopted for handling such records, I have selected a "typical" hydrographic station and we will follow the various steps taken to produce the final record.

Correlation Analysis

The first step required is to establish a rating, i.e. stage-discharge relationship. To do this, measurements of flow at many stages are made. We have not yet found a way of sending a computer into the field. We must still send a hydrographer armed with a Price current meter, which has changed little in the past 100 years, to make the measurements. Once his measurements reach the office, however, the machines can take over.

In our example we used 26 actual measurements which were taken in the last two years at our Philadelphia Canal near Strawberry Station. No attempt was made to weight the measurements and none were discarded.

Gage height and discharge were punched into cards as well as the name of the station. An IBM 1800 computer was used to fit the data to six different types of curves, which are used as models, by the method of least squares using gage height as the independent variable X and discharge as the dependent variable Y. The types of curves are linear, exponential, power function, and three hyperbolic functions. See bottom of Fig. 1. The values of A and B and an index value were calculated for each type of curve. The computer then selected the best fit as indicated by the index and printed out the results, as shown, indicating the departure of each measurement from the computed curve. We have found that both storage and discharge curves can be best expressed by equations of the power function type $Q=A(H+C)^B$, where "C" is a positive or negative constant which shifts the datum. For example, if the shape of a plot, when plotted on logarithmic paper, is curvilinear, a "C" can be used to obtain a straight plot. To determine conformity we indicate percent difference of the actual discharge from the theoretical discharge. In our analysis of the curve other values, such as the correlation coefficient, standard deviation, and standard error, are also used.

Figure II shows the results of a different program run on an IBM 360 computer using the same data, but selecting the type of curve beforehand as a power function. The computer performed a regression analysis of the relation between the logarithms of the variables. The following results were shown:

Observation Number	log Actual	log Predicted	Deviation	Standard Error from Curve
t	Yt	Yt^1	$Yt - Yt^1$	$\frac{Yt - Yt^1}{sy : x}$

1/ Hydrographer, Pacific Gas and Electric Company, San Francisco, California.

FIG. I

PHILADELPHIA CANAL NEAR STRAWBERRY
PACIFIC GAS AND ELECTRIC COMPANY

CLB, SURFT LD XQ

LEAST SQUARES CURVE FIT

CURVE TYPE	INDEX	A	B
1. Y=A+(B*X)	0.97586E 00	-0.11761E 02	0.39593E 02
2. Y=A*EXP(B*X)	0.88381E 00	0.18462E 01	0.20890E 01
3. Y=A*(X**B)	0.99937E 00	0.23479E 02	0.16731E 01
4. Y=A+(B/X)	0.46963E 00	0.51953E 02	-0.82625E 01
5. Y=1/(A+**X)	0.43328E 00	0.67580E 00	-0.42116E 00
6. Y=X/(A*X+)	0.96495E 00	-0.11708E 00	0.18907E 00

$Q=23.479(H)^{1.6731}$

3. Y=A*(X**B) IS A POWER FUNCTION. THE RESULTS OF A LEAST SQUARES FIT OF ITS LINEAR TRANSFORM ARE AS FOLLOWS

X-ACTUAL	Y-ACTUAL	Y-CALC	PCT DIFFER
0.61500	11.10000	10.40968	6.6
1.41000	42.90000	41.72192	2.8
1.60000	50.70001	51.54948	-1.6
1.60000	51.60000	51.54948	0.0
1.77000	59.90000	61.03785	-1.8
1.76000	58.20001	60.46196	-3.7
1.16000	29.30000	30.09831	-2.6
1.22000	32.30000	32.74827	-1.3
1.75000	58.40000	59.88827	-2.4
0.29000	3.06000	2.95922	3.4
1.68000	53.90000	55.93429	-3.6
1.68000	54.70001	55.93429	-2.2
1.75000	59.40000	59.88827	-0.8
1.68000	56.20001	55.93429	0.4
1.16000	30.00000	30.09831	-0.3
1.17000	31.30000	30.53371	2.5
1.59000	50.70001	51.01154	-0.6
1.29000	36.60000	35.95255	1.8
0.12000	0.64000	0.67605	-5.3
1.62000	53.30000	52.63216	1.2
1.74000	60.20001	59.31673	1.4
1.72000	59.00000	58.18037	1.4
1.72000	58.50000	58.18037	0.5
1.76000	62.20001	60.46196	2.8
1.18000	31.20000	30.97163	0.7
0.63000	11.00000	10.83798	1.4

1. $Y=A+BX$
2. $Y=A+e^{BX}$
3. $Y=A(X^{B})$
4. $Y=A+\frac{B}{X}$
5. $Y=\frac{1}{A+BX}$
6. $Y=\frac{X}{AX+B}$

FIG. II

E. HORCIZA HYDRO GENERATION-ELECTRIC OPERATIONS PACIFIC GAS AND ELECTRIC COMPANY

TRANSFORMED VARIABLES STEPWISE REGRESSION ANALYSIS

1 -0.21112E 00
Y 0.10453E 01

1 JOBS THIS RUN
PHILADELPHIA CANAL NEAR STRAWBERRY

NO OF OBSERVATIONS # 26
NO OF VARIABLES # 2
WEIGHTED DEGREES OF FREEDOM # 26.00
F LEVEL TO ENTER VARIABLE # 0.0
F LEVEL TO REMOVE VARIABLE # 0.0

STEP NO. 1

VARIABLE ENTERING	1
F LEVEL	35808.7852
CORRELATION COEFFICIENT	0.9997
CORR COEF CORRECTED FOR BIAS	0.9997
STANDARD ERROR OF Y	0.11906099E-01
STD. ERR. CORRECTED FOR BIAS	0.12151610E-01
CONSTANT (LOG A)	0.13706865E 01
A	23.479

VARIABLE	COEFFICIENT	STD ERR OF COEF	COEF X MEAN
1	B=0.16732E 01	0.88421E-02	0.14008E 00

$Q=23.479(H)^{1.6732}$

PREDICTED VS ACTUAL RESULTS

OBS NO.	ACTUAL	PREDICTED	DEVIATION	STANDARD ERROR FROM CURVE
1.	1.04532	1.01743	0.02789	2.3
2.	1.63246	1.62036	0.01210	1.0
3.	1.70501	1.71222	-0.00721	0.6
4.	1.71265	1.71222	0.00043	0.0
5.	1.77743	1.78560	-0.00817	0.7
6.	1.76492	1.78148	-0.01656	1.4
7.	1.46687	1.47854	-0.01167	1.0
8.	1.50920	1.51518	-0.00598	0.5
9.	1.76641	1.77734	-0.01093	0.9
10.	0.48572	0.47117	0.01455	1.2
11.	1.73159	1.74767	-0.01609	1.3
12.	1.73799	1.74767	-0.00969	0.8
13.	1.77379	1.77734	-0.00355	0.3
14.	1.74974	1.74767	0.00206	0.2
15.	1.47712	1.47854	-0.00142	0.1
16.	1.49554	1.48477	0.01077	0.9
17.	1.70501	1.70767	-0.00266	0.2
18.	1.56348	1.55573	0.00775	0.6
19.	-0.19382	-0.17004	-0.02378	2.0
20.	1.72673	1.72125	0.00548	0.5
21.	1.77960	1.77318	0.00642	0.5
22.	1.77085	1.76477	0.00608	0.5
23.	1.76716	1.76477	0.00238	0.2
24.	1.79379	1.78148	0.01231	1.0
25.	1.49415	1.49096	0.00319	0.3
26.	1.04139	1.03494	0.00645	0.5

CORRELATION COEFFICIENT 0.9997
STANDARD DEVIATION OF Y # 0.460033

Also, the correlation coefficient

$$r = 1 - \frac{\sum_{t=1}^{m} (Yt - Yt^1)^2}{\sum_{t=1}^{m} (Yt - \overline{Y}t)^2}$$

and the standard deviation

$$\sigma = \sqrt{\left[\frac{\sum (x - \overline{x})^2}{n - 1}\right]}$$

where
Sy:x = Standard error of Y
m = number of observations
n = number of variables

The accuracy of the different parts of the curve can be determined by considering the standard error of the scatter of measurements from the curve. Although many discharge curves can be expressed as one equation, many others require more than one equation. Our program allows for 25 equations. We found that we were able to express all of our capacity tables or discharge tables by that number of equations without significant error.

Graphic Methods

In many cases a graphical method provides a satisfactory line of relation without using the analytical method of least squares. If measurements are plotted on log log graph paper, the plot may indicate that "C" is positive or negative. Figure III shows such a plot. The straight line is a plot of the discharge over a 90^{o} V-notch weir with the head measured from the bottom of the notch. The two curved lines indicate the result of the measurement being made from a datum .1 foot above and .1 foot below the bottom of the notch. In other words, "C" is +.1 in one case and -.1 in the other. After a line is drawn through the scatter diagram of measurements, any possible ranges can be determined by selecting apparent breaking points in the slope of the curve.

In a power function curve, the relationship of X to Y is fixed. A true curve of this type will always plot as a straight line on a log log graph. In order to derive an equation of the type $Q=A(H+C)^B$ for each of the ranges, we consider that since

$$\frac{Q_3}{Q_2} = \frac{Q_2}{Q_1}$$

or

$$Q_2^2 = Q_1 \ Q_3$$

$$Q_2 = \sqrt{Q_1 \ Q_3}$$

The equivalent gage height H_2 can be determined from the plotted curve. Now, in order to obtain the correction for deviation from a theoretical curve "C", it is obvious that

$$\frac{H_3+C}{H_2+C} = \frac{H_2+C}{H_1+C}$$

and solving for C

$$C = \frac{H_2^2 - H_1H_3}{H_1 + H_3 - 2H_2}$$

also, exponent

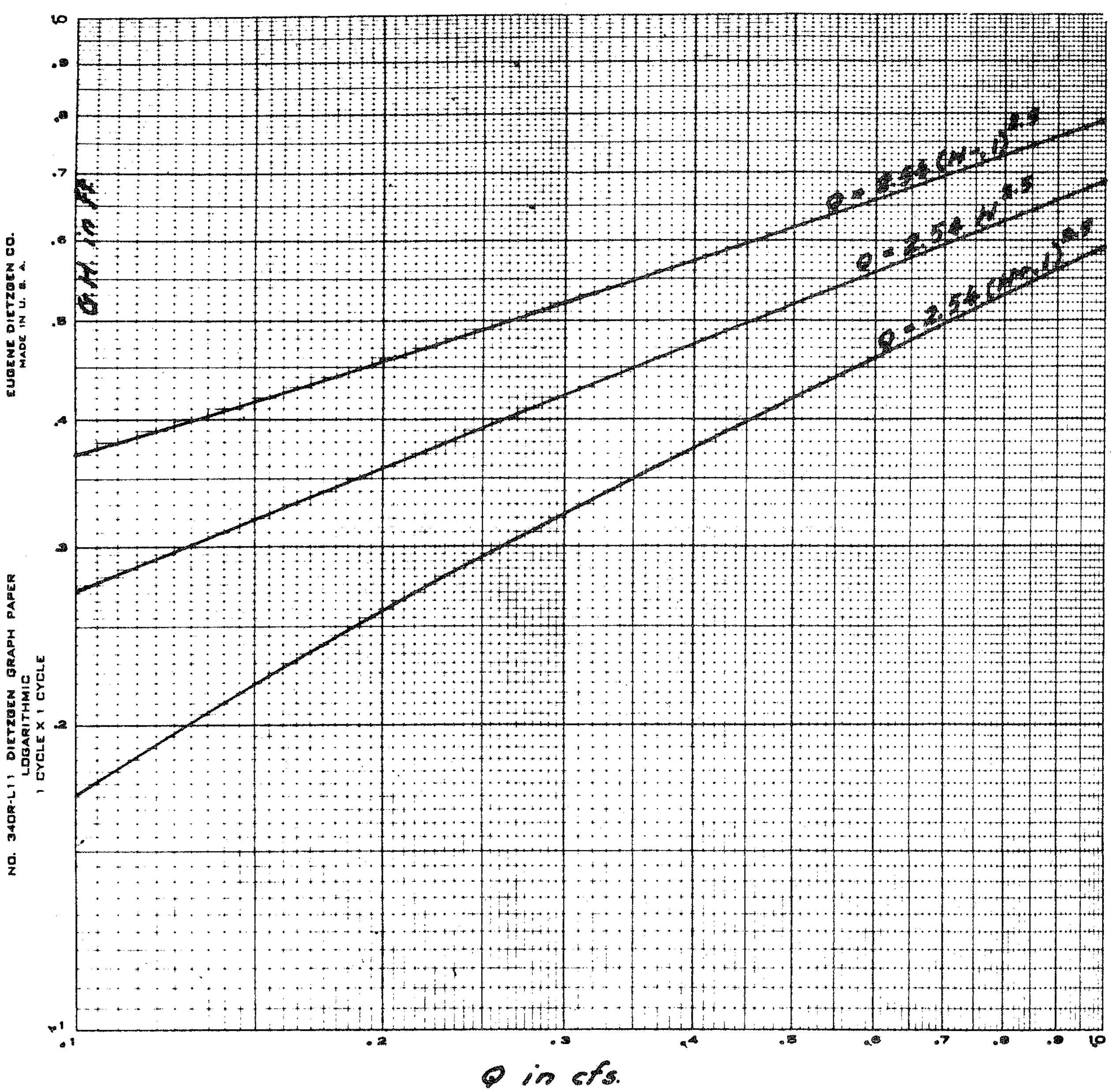
$$B = \frac{\frac{\ln Q_3}{\ln Q_2}}{\frac{\ln H_3}{\ln H_2}}$$

and coefficient

$$A = \frac{Q}{(H+C)^B}$$

A simple Basic Program was written for the GE235 Computer to make the above calculations. Fig. IV.

FIG. III



EUGENE DIETZGEN CO.
MADE IN U. S. A.
NO. 340R-L11 DIETZGEN GRAPH PAPER
LOGARITHMIC
1 CYCLE X 1 CYCLE
G.H. in ft.
Q = 2.54 H 2.5
Q in cfs.

FIG. IV

PACIFIC GAS AND ELECTRIC COMPANY
CURVE EQUATION PROGRAM

```
10 READ G1,G2,G3
30 LET C=(G2'2-G1*G3)/(G1+G3-G2*2.)
50 READ Q1,Q3
70 LET D=LOG(Q3)
90 LET E=LOG(Q1)
110 LET F=LOG(G3+C)
130 LET G=LOG(G1+C)
150 LET B=(D-E)/(F-G)
170 LET A=Q3/(G3+C)'B
190 PRINT "G1",G1
210 PRINT "G2", G2
230 PRINT "G3",G3
250 PRINT "Q1",Q1
270 PRINT "Q3",Q3
290 PRINT "A",A
310 PRINT "B",B
330 PRINT "C",C
350 PRINT "H","Q=A*(H+C)'B"
370 FOR H=G1 TO G3 STEP .1
390 PRINT H,A*(H+C)'B
410 NEXT H
430 GO TO 10
450 DATA .1,.3,.7
470 DATA .0454369,1.45398
490 END
```

```
450 DATA .1,.3,.7
451 DATA .0454369,1.45398
RUN
G1   .1
G2   .3
G3   .7
Q1   .0454369
Q2   1.45398
A    2.54
B    2.5
C    .1
H  Q=A*(H+C)'B
.1   .0454369
.2   .125209
.3   .25703
.4   .449013
.5   .708291
.6   1.04131
.7   1.45398
```

```
450 DATA .3,.5,.7
451 DATA .0454369,1.45398
RUN
G1   .3
G2   .5
G3   .9
Q1   .0454369
Q2   1.45398
A    2.54
B    2.5
C    -.1
H  Q=A*(H+C)'B
.3   .0454369
.4   .125209
.5   .25703
.6   .449013
.7   .708291
.8   1.04131
.9   1.45398
```

```
10 PRINT "H","CFS"
20 FOR H=.1 TO 1. STEP .1
30 PRINT H,2.54*( H )'2.5
40 NEXT H
50 END
RUN
.1    .0083212
.2    .045469
.3    .125209
.4    .25703
.5    .449013
.6    .708291
.7    1.04131
.8    1.45398
.9    1.95182
1.    2.54
```

The equation which was calculated by the computer and is shown on Fig. I and Fig. II is exactly the same as one which we derived by hand using the graphic method. We found that we were able to derive most of the equations by using the graphical method, which is less time consuming than to derive them by correlation analysis.

The Plot Program

Once the equations for all the ranges in a discharge or storage curve have been derived, an IBM 1800 Plotter is used to obtain a plot. Fig. V.

A 10-inch wide, strip graph paper is used for the plot and points are calculated and plotted each 0.01 inch along the vertical axis. The plotter pen connects the points only horizontally and vertically, so that distinct steps result. Since the steps are, however, small, a fairly smooth curve is obtained. In order to obtain usable scales along the X and Y axis, the maximum and minimum values and the length of the plot should be determined and fed into the computer.

Discharge and Area-Capacity Tables

After the discharge curve was plotted, the same input cards were used in the IBM 1800 computer to obtain a Gage Height-Discharge Table. Fig. VI. The computer used the curve equations in order to calculate the discharge in c.f.s. for each increment of 0.01 ft. gage height. In the print-out all the values were rounded off to 3 to 4 significant figures. The size and format of the output is suitable for reproduction.

Because a higher accuracy is required for computing the surface areas and capacities of some reservoirs, we use a 360 Fortran Program where areas for given elevations are read into the program and the intervening areas are calculated as a straight line between these given areas. The capacities are then computed based on these areas.

Analog to Digital Recorders

Several years ago the U. S. Geological Survey requested from suppliers an automatic data recording device which would convert stage to digital form. There was an obvious need for a recorder which produced data that could be easily used and processed by a computer to derive flows. The Fisher and Porter Company adapted their traffic counter to this use, and the ADR was born.

We have followed the development and application of the ADR since its inception, realizing its value to us.

We now own over 60 ADR's and hope to have over 90 ADR's installed by the summer of 1969. Recently, we also purchased a translator which reduces the 16-channel ADR tapes to computer paper tapes. This allows a complete machine produced record, which will reduce the cost of compiling records and eliminate human errors.

Differential-Pressure Meters

At locations where differential-pressure meters are in use, for example, to measure flow through hydro-electric plants, we record the output of the integrator on magnetic tapes. In all cases, so far, we used a Westinghouse WR4 Tape Recorder with our Baily Differential-Pressure Meters. The recorder receives and records the pulses from the meter integrator cam mechanism. The tapes are removed monthly and run through an IBM 360 Computer, which prints out half-hourly readings, the average, maximum and minimum flow for each day, and the total acre feet for the month.

The Annual Record

Although the ultimate result of processing hydrographic data is the annual record, it takes a continuous collection, processing, updating, checking, and correction of data, throughout the water year, to obtain a good final record. Daily gage readings from graphic charts or reports are periodically punched on input cards, the cards are sorted, the data transferred from card to magnetic tape, and the tape is run, along with the calibration tape, through a computer. The computer then computes flows or storage by equation $A(H+C)^B$

FIG. V

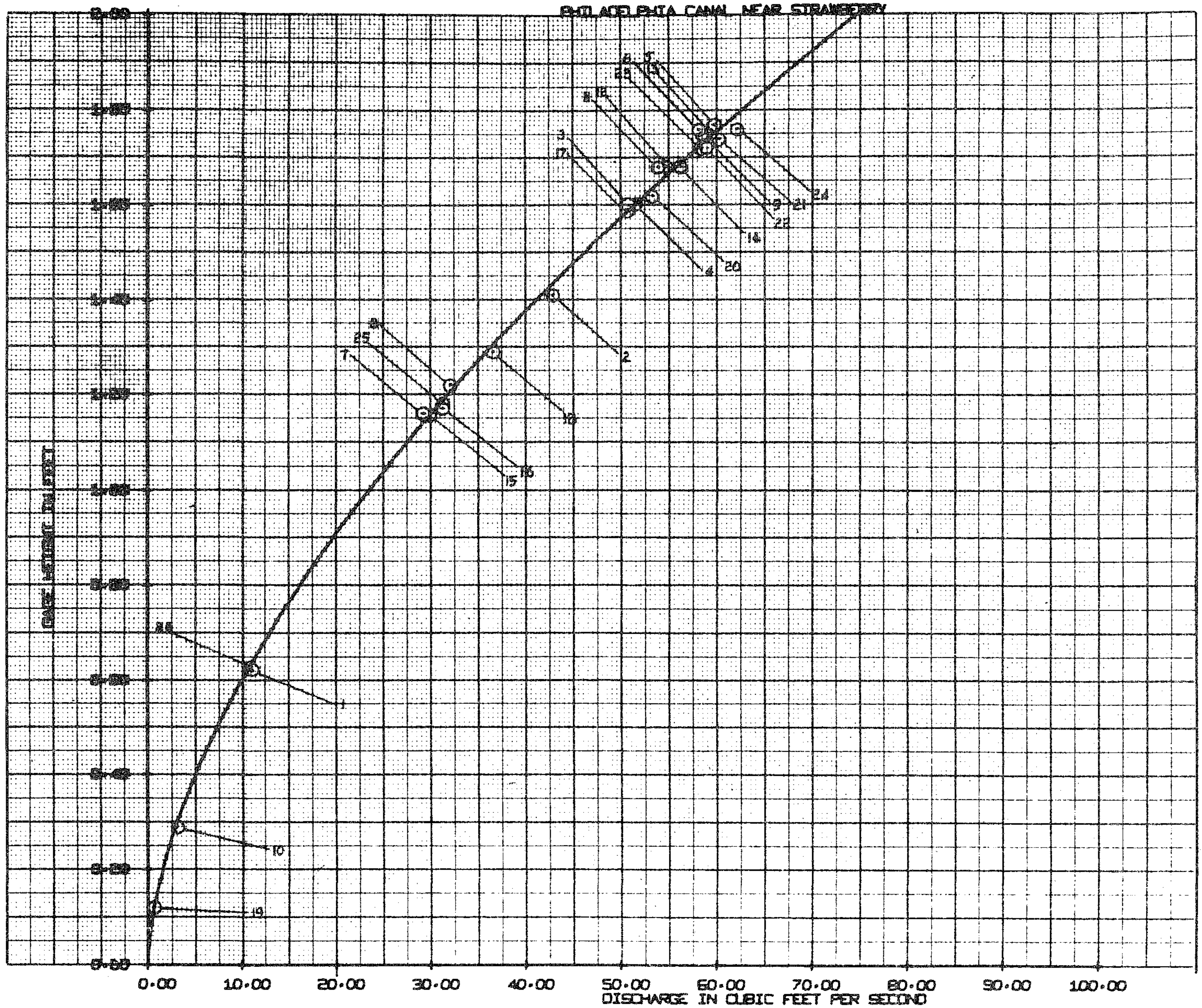

PHILADELPHIA CANAL NEAR STRAWBERRY
GAGE HEIGHT IN FEET
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
DISCHARGE IN CUBIC FEET PER SECOND

FIG. VI

SHEET 1

PACIFIC GAS AND ELECTRIC CO.
HYDRO GENERATION DEPARTMENT - ELECTRIC OPERATIONS

DISCHARGE TABLE FOR GAGE 59 PHILADELPHIA CANAL NEAR STRAWBERRY
RATED BY R.A.D.
USED FROM JAN. 1,1968

$Q=A(H\pm C)^B$

RANGE 0.00 TO 1.90

FROM 0.00 TO 1.90 A= 23.5000 B= 1.670000 C= 0.0000

GAGE HEIGHT FEET	DISCHG SEC FT	GAGE HEIGHT FEET	DISCHG SEC FT	GAGE HEIGHT FEET	DISCHG SEC FT	GAGE HEIGHT FEET	DISCHG SEC FT	GAGE HEIGHT FEET	DISCHG SEC FT
0.00	0.0	0.35	4.0	0.70	12.9	1.05	25.4	1.40	41.2
0.01	0.0	0.36	4.2	0.71	13.2	1.06	25.9	1.41	41.7
0.02	0.0	0.37	4.4	0.72	13.5	1.07	26.3	1.42	42.2
0.03	0.0	0.38	4.6	0.73	13.8	1.08	26.7	1.43	42.7
0.04	0.1	0.39	4.8	0.74	14.2	1.09	27.1	1.44	43.2
0.05	0.1	0.40	5.0	0.75	14.5	1.10	27.5	1.45	43.7
0.06	0.2	0.41	5.3	0.76	14.8	1.11	27.9	1.46	44.2
0.07	0.2	0.42	5.5	0.77	15.1	1.12	28.3	1.47	44.7
0.08	0.3	0.43	5.7	0.78	15.5	1.13	28.8	1.48	45.2
0.09	0.4	0.44	5.9	0.79	15.8	1.14	29.2	1.49	45.7
0.10	0.5	0.45	6.1	0.80	16.1	1.15	29.6	1.50	46.2
0.11	0.5	0.46	6.4	0.81	16.5	1.16	30.1	1.51	46.7
0.12	0.6	0.47	6.6	0.82	16.8	1.17	30.5	1.52	47.2
0.13	0.7	0.48	6.8	0.83	17.2	1.18	30.9	1.53	47.8
0.14	0.8	0.49	7.1	0.84	17.5	1.19	31.4	1.54	48.3
0.15	0.9	0.50	7.3	0.85	17.9	1.20	31.8	1.55	48.8
0.16	1.1	0.51	7.6	0.86	18.2	1.21	32.3	1.56	49.3
0.17	1.2	0.52	7.8	0.87	18.6	1.22	32.7	1.57	49.9
0.18	1.3	0.53	8.1	0.88	18.9	1.23	33.2	1.58	50.0
0.19	1.4	0.54	8.3	0.89	19.3	1.24	33.6	1.59	51.0
0.20	1.5	0.55	8.6	0.90	19.7	1.25	34.1	1.60	52.0
0.21	1.7	0.56	8.9	0.91	20.0	1.26	34.5	1.61	52.0
0.22	1.8	0.57	9.1	0.92	20.4	1.27	35.0	1.62	53.0
0.23	2.0	0.58	9.4	0.93	20.8	1.28	35.4	1.63	53.0
0.24	2.1	0.59	9.7	0.94	21.1	1.29	35.9	1.64	54.0
0.25	2.3	0.60	10.0	0.95	21.5	1.30	36.4	1.65	54.0
0.26	2.4	0.61	10.2	0.96	21.9	1.31	36.8	1.66	55.0
0.27	2.6	0.62	10.5	0.97	22.3	1.32	37.3	1.67	55.0
0.28	2.8	0.63	10.8	0.98	22.7	1.33	37.8	1.68	56.0
0.29	2.9	0.64	11.1	0.99	23.1	1.34	38.3	1.69	56.0
0.30	3.1	0.65	11.4	1.00	23.4	1.35	38.7	1.70	57.0
0.31	3.3	0.66	11.7	1.01	23.8	1.36	39.2	1.71	58.0
0.32	3.5	0.67	12.0	1.02	24.2	1.37	39.7	1.72	58.0
0.33	3.6	0.68	12.3	1.03	24.6	1.38	40.2	1.73	59.0
0.34	3.8	0.69	12.6	1.04	25.0	1.39	40.7	1.74	59.0
								1.75	60.0
								1.76	60.0
								1.77	61.0
								1.78	62.0
								1.79	62.0
								1.80	63.0
								1.81	63.0
								1.82	64.0
								1.83	64.0
								1.84	65.0
								1.85	66.0
								1.86	66.0
								1.87	67.0

and prints out daily discharges, or daily storage, changes in daily storages, maximum and minimum readings, and total acre feet for each month. The print-out is next checked for accuracy and completeness and any necessary corrections made. We are using a Julien Date System by which any day can be easily identified and when corrections are made, only data which is in error need to be punched on cards again. In our present program, we can apply shifts to the rating for any given period, or if there is a decided change in rating, we can use the old equation up to that date and a new one from that date on. The data from each run is added and stored on magnetic tape and it appears on each print-out, throughout the water year, on an accumulative basis. The repeated checking and analysis of data reduces the number of errors considerably. After the water year is completed, all the final data is printed out on a convenient 8-1/2 x 11 inch form. Fig. VII. The data is also transferred back to cards again which may be used for water studies in the future.

The advent of computers has made it possible for us to stay abreast of the ever increasing volume of hydrographic data and to produce more accurate records in less time. The day of fully automated watersheds is coming closer and the use of computers to process hydrographic data may become absolutely essential.

REFERENCES

1. Ralston and Wilf, Mathematical Methods for Digital Computers, John Wiley & Sons, New York, 1960

2. A. Hald, Statistical Theory with Engineering Applications, John Wiley & Sons, New York, 1952

FIG. VII

GAGE NO. S

DEPARTMENT OF WATER SYSTEMS -- PG&E
DAILY WATER DISCHARGE OR STORAGE

Daily Discharge in second feet, or Storage in Acre Feet of PHILADELPHIA CANAL for the year Ending Sept. 30, 1967

Day	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
1	46	0.7	55	55	59	56	55	55	0.0	61	55	61
2	46	0.7	55	55	59	56	55	55	0.0	61	55	61
3	46	12	55	55	59	57	54	55	0.0	61	55	61
4	46	1.1	53	55	57	57	54	55	0.0	61	61	61
5	46	1.1	56	54	57	57	55	56	0.0	61	61	61
6	26	1.1	42	55	57	58	55	57	0.0	61	61	61
7	26	1.1	42	55	57	58	55	61	0.0	61	61	61
8	26	1.1	42	55	57	59	55	61	43	61	61	61
9	26	1.1	53	55	57	60	55	59	63	61	61	61
10	26	8.1	53	55	56	60	54	58	61	61	61	61
11	26	20	53	55	56	61	55	58	61	61	61	61
12	26	20	53	56	56	60	55	58	61	61	61	61
13	26	1.3	53	56	57	61	55	60	61	61	61	61
14	25	0.8	53	56	57	53	55	60	60	61	61	61
15	10	0.8	53	57	56	55	55	60	60	61	61	61
16	10	52	53	57	56	63	54	60	60	61	61	61
17	10	33	53	57	56	57	55	60	61	61	61	61
18	10	6.8	53	56	56	56	55	60	60	61	61	61
19	0.9	6.8	53	56	56	56	55	60	60	61	61	61
20	0.9	6.7	53	57	56	55	55	60	60	61	61	61
21	0.9	35	53	56	56	56	55	60	60	61	61	61
22	4.8	55	55	55	56	56	55	0.0	61	61	61	61
23	4.8	55	55	55	56	56	55	0.0	61	61	61	61
24	4.8	55	55	55	56	56	55	0.0	61	61	61	61
25	0.7	55	55	55	57	56	54	0.0	61	61	61	61
26	0.7	55	55	55	56	56	54	0.0	60	61	61	61
27	0.7	55	55	56	56	56	54	0.0	60	61	61	61
28	0.7	55	55	56	56	55	54	0.0	60	61	61	61
29	0.7	55	55	58	*******	55	54	0.0	60	61	61	61
30	0.7	55	55	61	*******	54	54	0.0	61	22	61	61
31	0.7	*******	55	61	*******	55	*******	0.0	*******	60	61	*******
TOTAL:	525.0	706.3	1639.0	1735.0	1586.0	1766.0	1640.0	1228.0	1376.0	1851.0	1873.0	1830.0
MEAN	16.9	23.5	52.9	56.0	56.6	57.0	54.7	39.6	45.9	59.7	60.4	61.0
MAXIMUM	46.0	55.0	56.0	61.0	59.0	63.0	55.0	61.0	63.0	61.0	61.0	61.0
MINIMUM	0.7	0.7	42.0	54.0	56.0	53.0	54.0	0.0	0.0	22.0	55.0	61.0
ACRE FEET	1041.3	1400.9	3251.0	3441.4	3145.8	3502.9	3252.9	2435.7	2729.3	3671.5	3715.1	3629.8

MEAN 48.7 MAXIMUM 63.0 MINIMUM 0.0 TOTAL C.F.S.D. 17755.3 ACRE FEET 35217.6