RATING CURVE EXTENSION
CHAPMAN CREEK ABOVE SECHELT DIVERSION

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CHAPMAN CREEK ABOVE SECHELT DIVERSION
(08GA060)

BY

A.G. SMITH
I.J. NEUFELD

Planning and Studies Section
Water Resources Branch
Vancouver, B.C.

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ABSTRACT

On November 15, 1983 runoff from heavy precipitation caused considerable erosion of the stream channel at the stream gauging station on Chapman Creek above Sechelt Diversion. This high flow changed the stage-discharge relationship developed to that date. The lack of present high stage-discharge measurements had created a problem in developing a new relationship.

The problem has been solved with the guidance of channel conveyance computed from discharge measurements taken at medium stage and the rating curve extension has been computed by use of a stage-discharge equation.

An indirect measurement program is required to verify the value of Manning's "n" used in this study.

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1. INTRODUCTION

The Chapman Creek channel at station 08GA060 underwent considerable erosion during the high water of November 15, 1983. Rating Curve #17 was well defined throughout the range of stage to 2.545 metres prior to the channel change. The current stage-discharge Curve #21 has not been adequately defined above a stage of 1.677 metres.

Two high water measurements were made on February 26, 1986 at stages of 2.255 and 2.230 metres. There has been some concern as to their accuracy because of the large boulders that are present in the stream channel under the cableway. This condition makes accurate metering difficult. It is felt that these two measurements would draw a new rating curve too far to the right.

2. PURPOSE

The purpose of this report is to describe the investigation into extending Rating Curves #17, #21, #23 and verify the location of Rating Curve #23. It is also to help provide an understanding of the effect of the changing conditions that have taken place in the stream channel.

3. CHANNEL DESCRIPTION

The stream channel at the gauging site consists of sharp rock, boulders to one metre in diameter, and coarse gravel. The high water of November 15, 1983 removed much of the sharp rock in the channel and left some large boulders in the metering section. The change in cross section at the cableway is shown in Figure 1 for measurements taken before and after the above-mentioned high water. Measurement data and hydraulic parameters are listed in Table 1. The effect of the change in the control is shown in Figure 2 for the stage-discharge relationship. The photographs in Figure 3 show the creek channel upstream and downstream of the cableway and the recorder well.

TABLE 1

Measurement Data and Hydraulic Parameters Prior to the Flood of November 15, 1983

Imperial Units
Manning's n=0.06

Date of Measurement	Flow	Stage	A	W	V Mean	Dm Mean	R	S	K
Nov 1, 1977	2380	8.35	279.0	56.0	8.53	4.98	4.52	0.0158	18900
Nov 1, 1977	1370	7.54	193.0	53.0	7.10	3.64	3.45	0.0158	10900
Dec 14, 1977	907	7.07	148.0	53.0	6.13	2.79	2.69	0.0164	7090
May 22, 1980	135	5.46	59.4	43.0	2.28	1.38	1.29	0.0060	1750
Jul 6, 1982	166	5.52	66.2	46.0	2.51	1.44	1.39	0.0066	2040
Jan 11, 1983	424	6.35	105.0	49.9	4.04	2.10	2.01	0.0104	4150
Jan 13, 1983	335	6.06	93.1	47.9	3.60	1.94	1.86	0.0092	3490

Measurement Data and Hydraulic Parameters After the Flood of November 15, 1983

Imperial Units
Manning's n=0.06

Date of Measurement	Flow	Stage	A	W	V Mean	Dm Mean	R	S	K
Jan 29, 1986	494	5.86	122.7	51.0	4.03	2.40	2.34	0.0085	5350
Feb 24, 1986	1903	7.32	226.0	55.0	8.42	4.10	3.86	0.0191	13800
Feb 24, 1986	1797	7.40	228.0	55.0	7.88	4.15	3.99	0.0165	14000
May 20, 1986	636	6.21	144.0	50.9	4.41	2.84	2.72	0.0084	6960
Nov 25, 1986	150	4.93	72.3	46.6	2.07	1.54	1.46	0.0042	2310
Jan 12, 1987	455	5.94	122.0	50.9	3.75	2.36	2.33	0.0073	5320

4. METHOD OF ANALYSIS

(a) Extension of Rating Curves by the stage-discharge Equation $Q = a + b\ (G - g)^{3/2}$; where Q is in m^3/s and G is in metres. The coefficients "a" and "b" are derived from the rating curves drawn by judgement through the measured stage-discharge data. R^2, the coefficient of determination, indicates the accuracy of the equation for predicting flow from gauge heights. To be meaningful R^2 must be greater than or equal to 0.999. As the equation is theoretically sound, it can be extended beyond the measured range to a reasonable limit; twice the highest measured flow used to develop the rating but not beyond bankful flow.

(b) Rating Curve Development by Conveyance

Conveyance rating curves were developed for two sets of data using Manning's "n" = 0.06. One rating curve was developed using cross sectional data before the flood of November 15, 1983 and another rating curve developed from measurement data taken after the flood. Figure 4 shows the conveyance curves developed for the sections. Figures 5, 6 and 7 show the conveyance rating curves in comparision to measurement Rating Curves #17, #21 and #23 respectively. Figure 8 shows the energy slope curve as developed from all of the measurement data. One common curve indicates that the energy slope remained constant throughout the channel changes.

(c) Extension of Rating Curve #23

Rating Curve #23 has been developed by judgement using the two high flow measurements of February 26, 1986. This curve has been extended by use of the stage-discharge equation as shown in Figure 9. The extension pulls the curve slightly farther to the right at the top end whereas Rating Curves #19 and #21 converge at the higher stages.

5. COMPARISON OF PEAK FLOWS AS ESTIMATED FROM EXTENDED RATING CURVES

(a) October 31, 1981 Stage = 3.192 m
Table #16 Discharge = 148 m^3/s

Rating Curve #16 as Extended by Stage-Discharge Equation
$Q = 10.649 + 96.378 (G - 1.85)^{3/2}$
$R^2 = .999$ Discharge = 160 m^3/s

(b) November 15, 1983 Stage = 3.075m
Table #18 Discharge = 133 m^3/s

Rating Curve #18 as Extended by Stage-Discharge Equation
$Q = 8.99 + 98.992 (G - 1.85)^{3/2}$
$R^2 = .999$ Discharge = 143 m^3/s

6. CONCLUSIONS AND RECOMMENDATIONS

The location of rating curves #17 and #21 has been confirmed by conveyance developed rating curves that show the curves are coincident in the low and medium stage range. The coefficients "a" and "b" can be developed with good accuracy to relate the top portion of the rating curves to the stage-discharge equation.

The value of Manning's "n" should be confirmed by several slope measurements.

Both extended rating curves (#17 and #21) converge, which is expected provided the channel controls the flow and the channel has not been significantly changed for the time period covered by the curves. Rating Curve #23 is shown to diverge from the other two curves. This condition cannot be explained and should be verified with more high water measurements either by direct or indirect methods.

It is recommended that the stage-discharge equation be used to extend rating curves wherever applicable.

It is recommended the high flow of October 31, 1981 and the high flow of November 15, 1983 be revised to be conservative for design purposes although revision is not required by present criteria.

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Sangal Dr., B.P. Extending a Rating Curve Internal Report. Water Resources Branch, Vancouver, B.C. 1987.

FIGURES 1 - 9

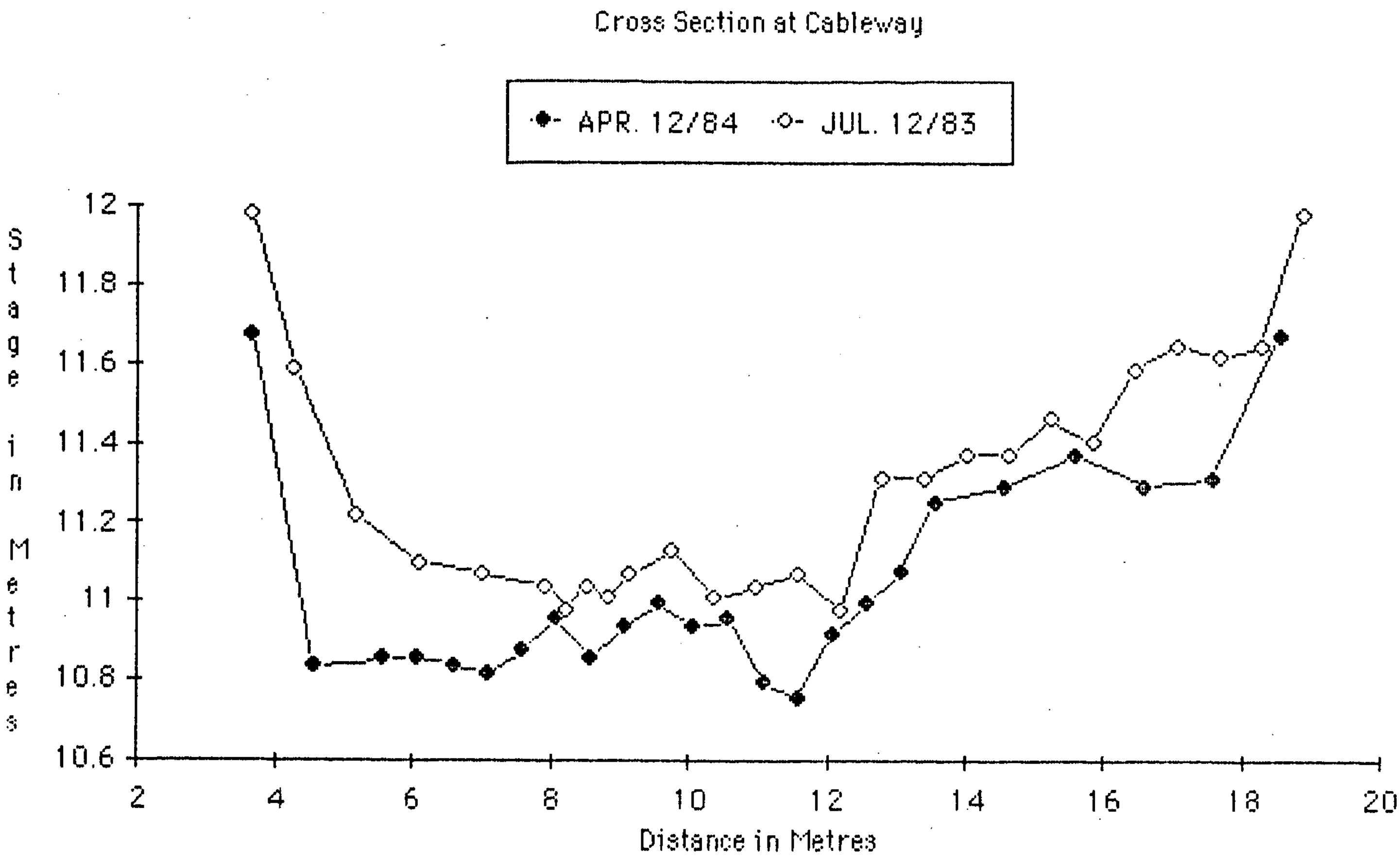

Figure 1 Cross Section at Cableway

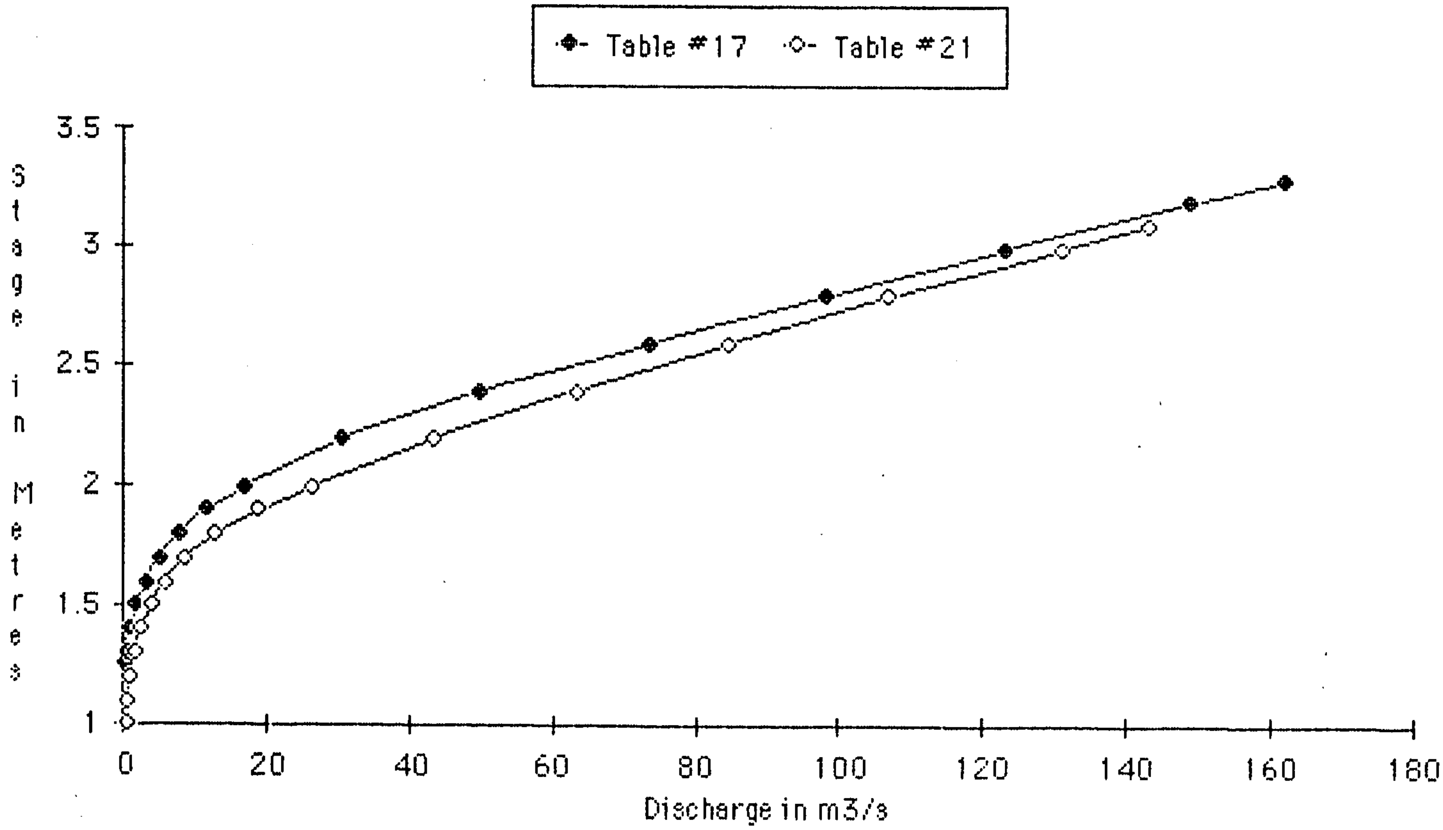

Figure 2 Rating Curves #17 and #21

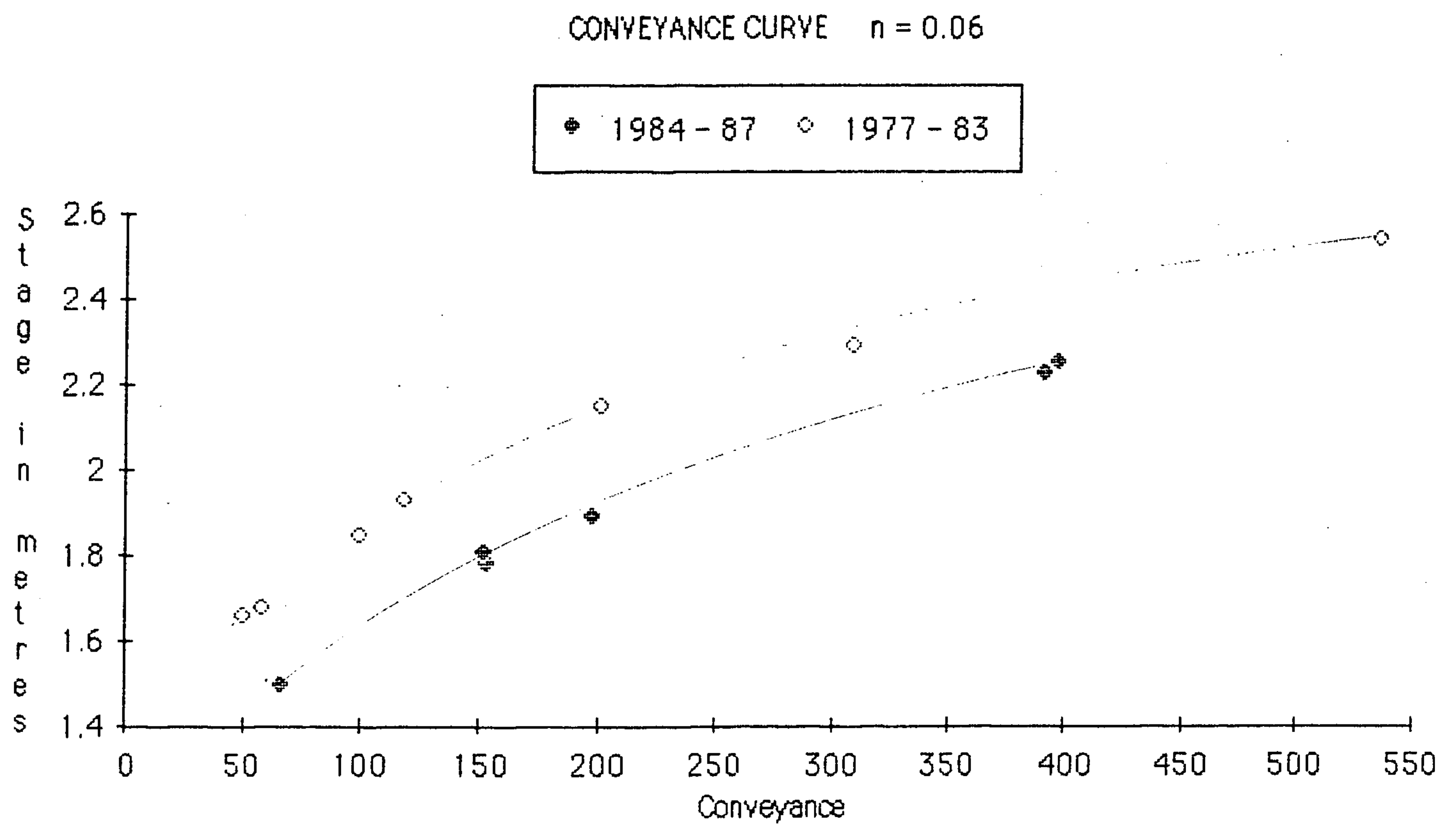

Figure 4 Conveyance Curves Developed From Channel Characteristics

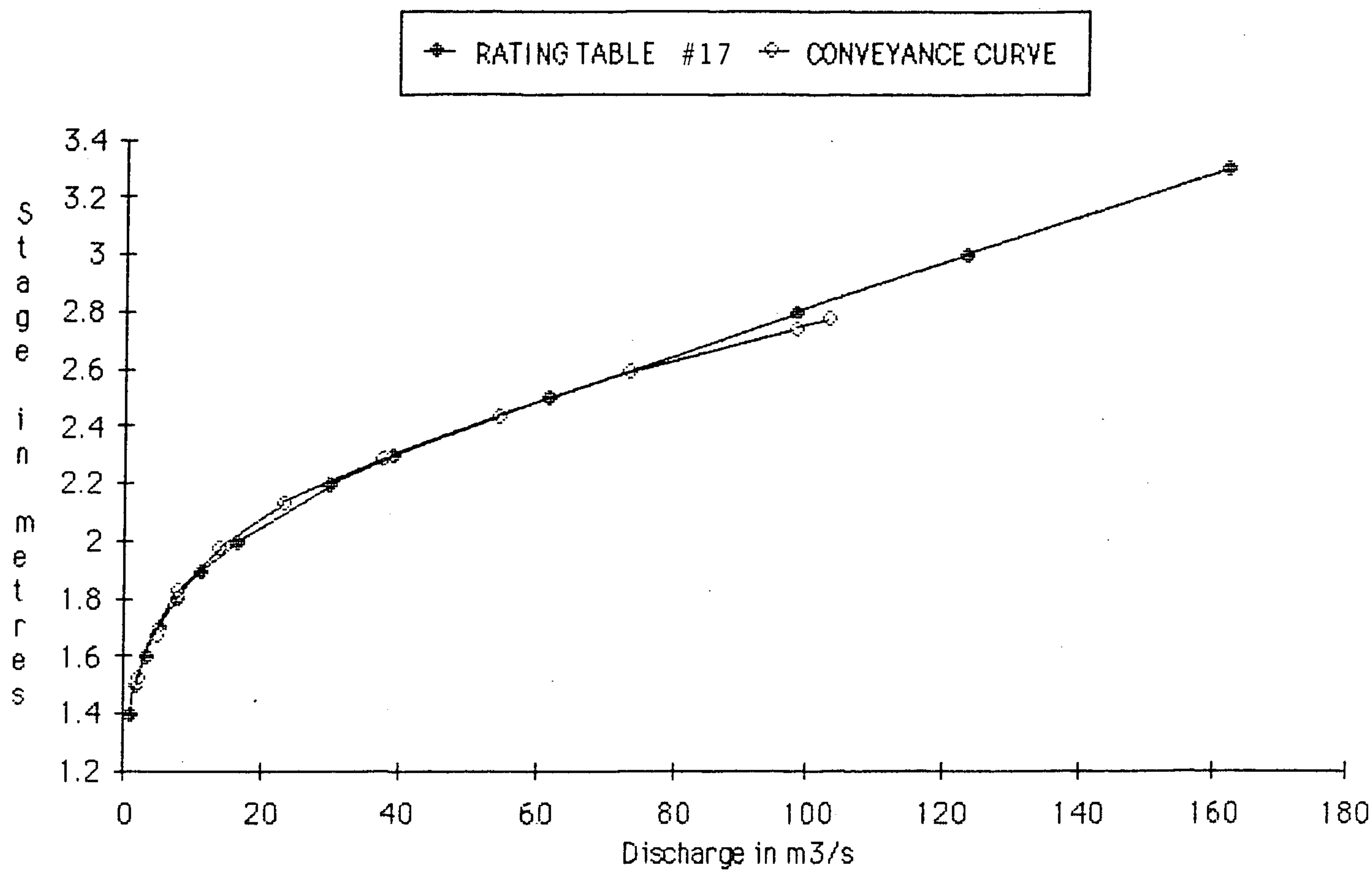

Figure 5. Conveyance Rating Curve and Rating Curve #17

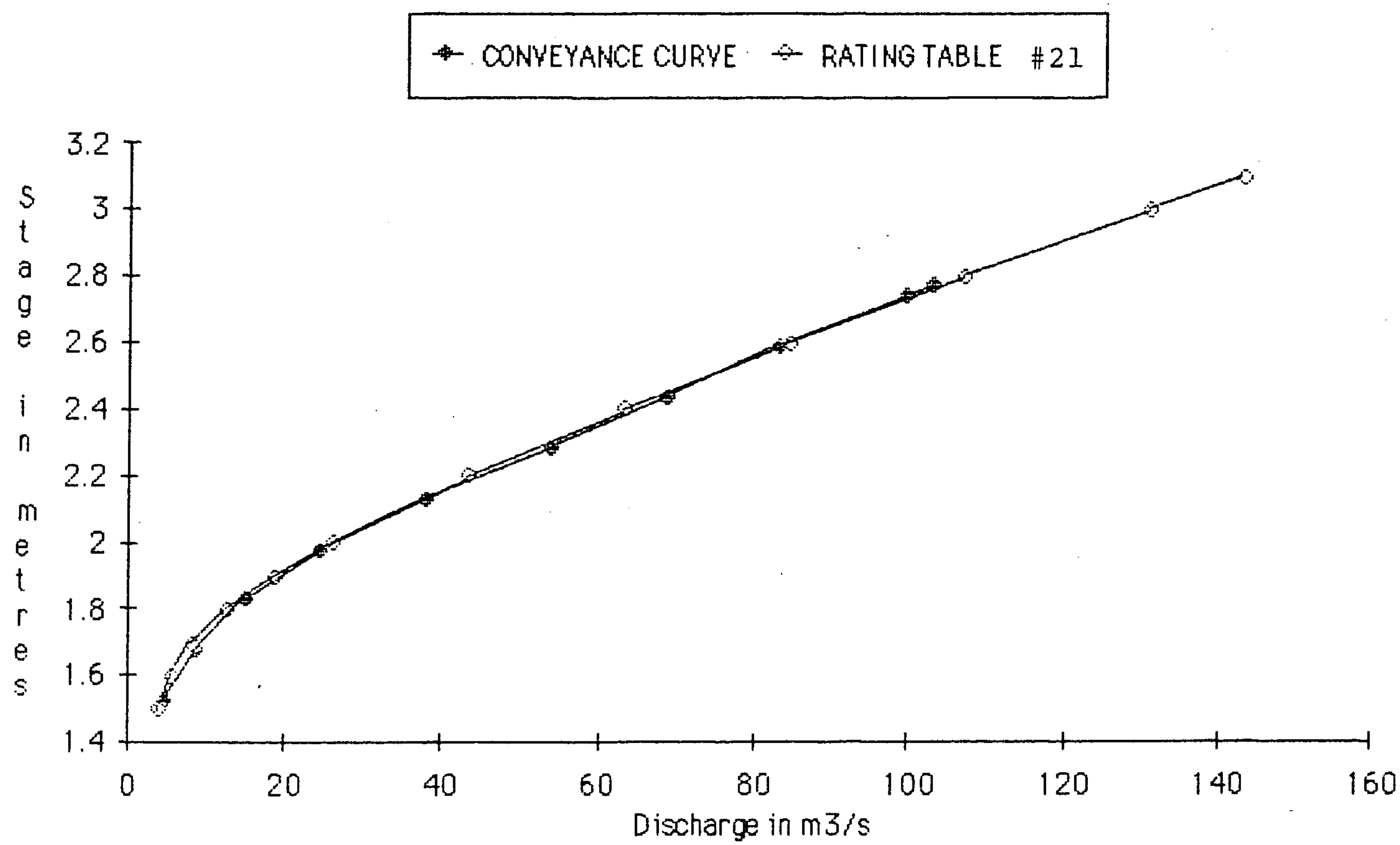

Figure 6 Conveyance Rating Curve and Rating Curve #21

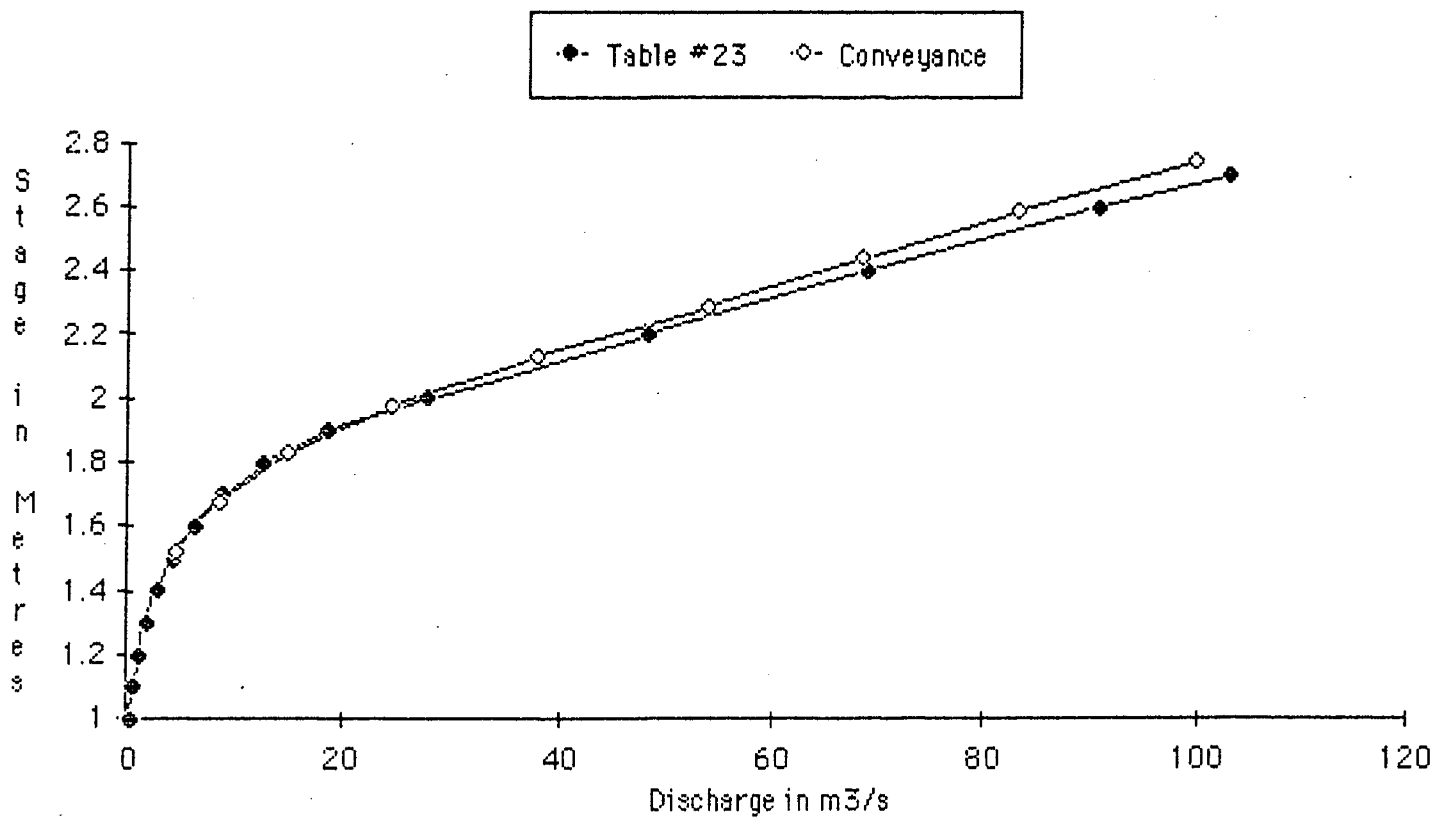

Figure 7 Conveyance Rating Curve and Rating Curve #23

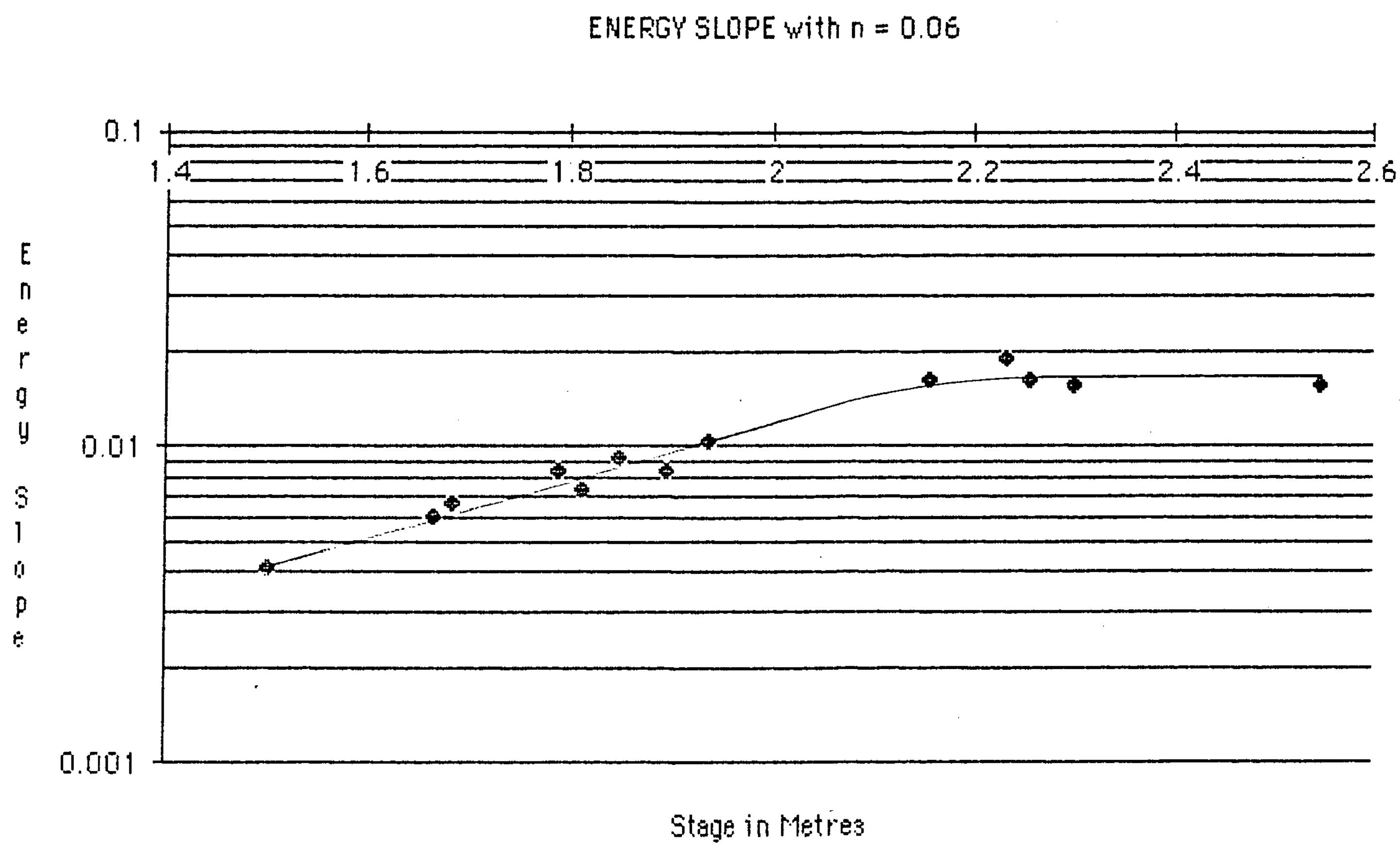

Figure 8 Slope Energy Curve

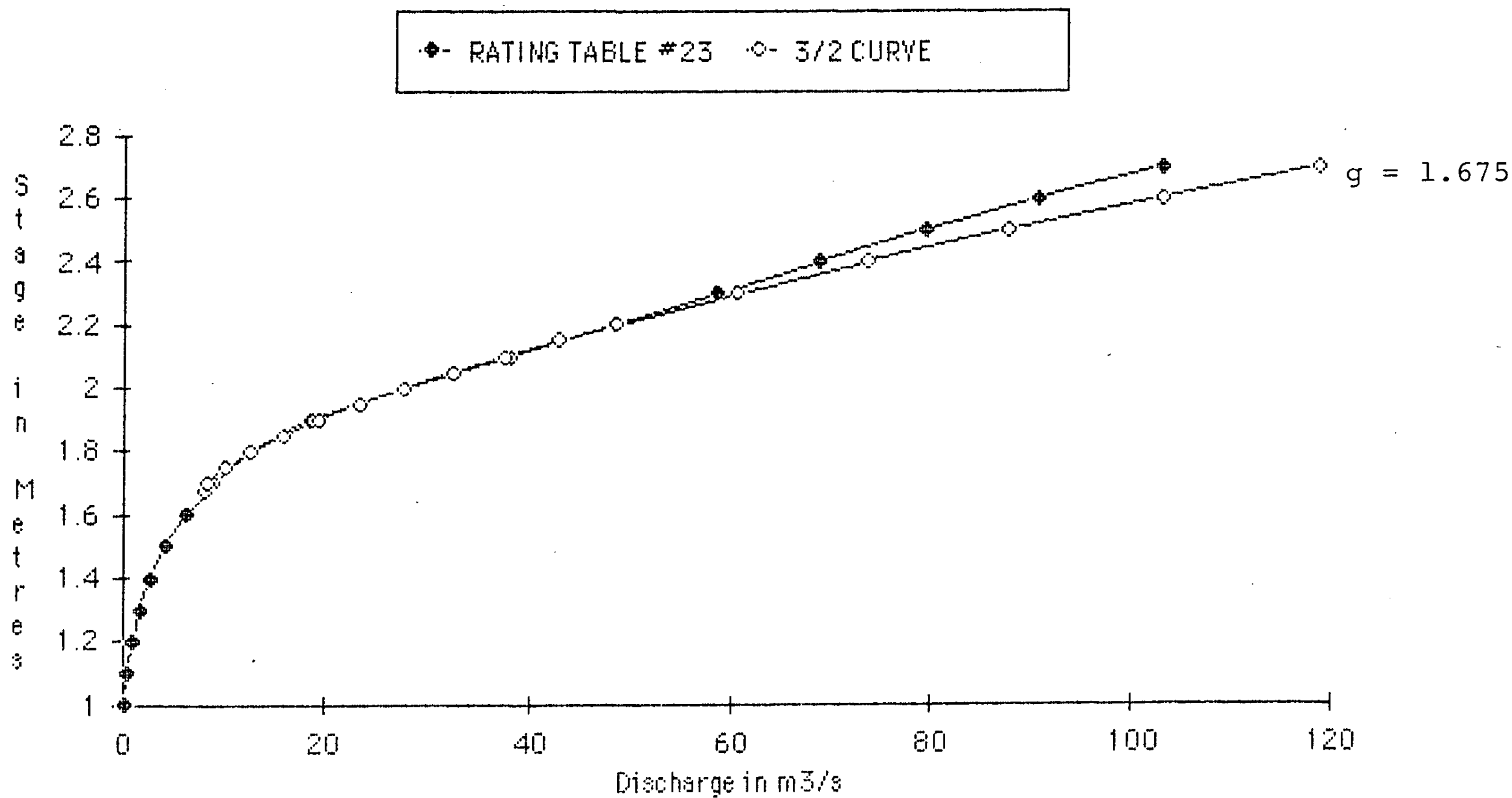

Figure 9 Extension of Rating Curve #23