RUSHOON HYDROTECHNICAL STUDY

FIELD REPORT

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FIELD REPORT

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1.0 INTRODUCTION

1.1 Statement of Objectives

The objectives of the field program were to gather information from residents pertaining to flood levels and flood damage, to collect topographical data, and to measure flows. These data will be used in computer modelling of floods on the lower Rushoon Brook. Additional data on ice conditions during the winter of 1984/85 were also collected via an ice observation program. These results are available in a separate document - the "Ice Observer's Scrapbook" filed with the Newfoundland Department of Environment - Water Resources Division, St. John's, Newfoundland.

1.2 Description of Phase I Field Program

Phase I of the Field Program was carried out from March 18, 1985 to March 22, 1985. This phase comprised the following elements.

(i) Meeting with Town Council, to make council aware of the project scope of work and to solicit help from senior residents of the community in compiling data related to past flooding events.

(ii) Installation of Staff Gauges, to facilitate in obtaining an accurate picture of what happens to the river at the time of ice break-up.

(iii) Level Survey, of houses that were affected by past floods and houses that may be affected in the event of an extreme flood in the future.

(iv) Assessment of Previous Flood Damage

An interview survey was administered to householders whose homes had been damaged in either of the 1973 or 1983 flood. A complimentary building classification survey was also carried out in adjacent areas which may be affected by a more severe 1 in 20 year or 1 in 100 year flood in the future.

(v) A Flow Gauging, program was set up to develop a head discharge relationship for estimating flows in Rushoon Brook.

1.3 Description of Phase II Field Program

Phase II of the field program was carried out from May 27, 1985 to May 30, 1985. This phase comprised the following elements.

(vi) Topographical And Water Level Survey, of the river channel to supply the physiographic data required for La Salle Hydraulic Laboratory's river ice model.

2.0 MEETING WITH TOWN COUNCIL

A meeting with the Town Council was held upon arrival at the site to inform council and residents of the study program. ShawMont also requested that senior members of the community be invited to give the study group as much insight into past flooding events as possible.

Observations by F.E. Parkinson - La Salle Hydraulic Laboratory

These observations were made during a site visit to Rushoon - March 18 and 19, 1985.

(i) Portion of River Contributing Ice to Jam

Information Sources:

- Discussions with Frank Murphy,Mayor of Rushoon, on site (he has observed the last three break-ups)

- Personal observations

The large pond on the upstream side of the highway bridge retains its cover, so it melts in place. Within about one kilometre along the river downstream of the highway, there are three steadies (wide, slow flow reaches) which apparently hold their covers longer as well. Mr. Murphy had identified the ice coming out of these steadies 10 to 12 hours after the main rush of ice had come through the Community during previous break-ups.

At a point about 1.5 km downstream of the highway bridge, and 3 km upstream of the Bailey Bridge in the Community, there is about a 3 m waterfall. It appears likely that the ridge creating the falls retains the ice upstream during the early part of break-up, so that only when the covers come out of the steadies is there enough flow to get the ice past the falls.

(i) <u>Portion of River Contributing Ice to Jam (Cont'd.)</u>

It therefore appears that the only part of the river contributing ice to the jam that forms in the Community with the first flow rise during a break-up is the reach from the falls down to the Community. A rough calculation of a possible jam keyed at Salmon Hole Point, assuming it is 3 m thick at its deepest point, 500 m long and an average of 50 m wide gives an ice volume of about 25,000 m^3. The four kilometre reach from the Point to the falls would require an ice thickness of only 30 cm to provide this volume of ice. Therefore, the reach below the falls could easily supply enough ice to cause the jam in the Community without any contribution from further upstream.

(ii) <u>Rough Rocks</u>

Information Sources: - Frank Murphy, Sr.

- Discussion during town council meeting
- Personal observations

This feature of the river is about 460 m upstream of the Bailey Bridge, and takes the form of a narrow restriction, with a very rough, rocky bed, ending in about a 2 m fall. During the site visit, there were the remains of a jam key right at the narrowest point just before the falls. Individual broken sheets in the jam measured up to 15 cm thick, but more generally 10-12 cm, and the broken rubble rose about 2 m above the channel bed. The jam was likely caused by a mid-winter discharge rise that was able to break up the ice upstream and cause the jam at Rough Rocks, but not great enough to break the key to carry the ice further downstream.

Photographs taken during the summer show that this short reach, about 50 m, has jagged rock ridges running across it. This is already the narrowest spot in the river, and when the highway was widened in 1963, it encroached on the river, restricting it even more. During the 1973 flood, a jam formed at Rough Rocks, rising to flood the road for 2 or 3 days.

(iii) Rate of Break-up Progress

Frank Murphy, Sr. described how he was coming along the road toward the Community, as the water began rising before the 1983 flood. When he saw that the level had risen enough to start breaking the ice out at the Rough Rocks, he immediately drove to the Community to warn the people. The broken ice and flood wave reached the Community within minutes of Frank's arrival, suggesting it was moving about 20-30 km/hr.

(iv) Flood at Bailey Bridge

The Bailey Bridge replaces an old concrete bridge which was collapsed in 1971.

During the early stages of the 1973 flood, ice jammed against the old bridge pier(?) and abutments. The water level built up high enough to flood the nearest house on the left bank, about 50 m upstream. (Following the 1973 flood the offending abutments and pier(?) were removed).

Brief hand level sights in the reach upstream of the bridge showed a very steep riverbed slope, about 1%.

The central pier is a ballasted timber structure with a steel plate on the upstream nose for ice protection. During the site visit it was observed that the bottom of the plate was about 1 m above the ice level, and the timber on the nose over the exposed section had been severely gouged by previous floods.

(v) Reach from the Bailey Bridge to Salmon Hole Point

The ice cover over the reach was of fairly uniform width, about 25 to 30 m. First ice along the shores was about 60-80 cm above the present water level. This first ice indicates the water level during freeze-up last fall. The thickness of the solid blue ice at this level was noted at several places to be 10-12 cm, suggesting that the discharge must have stayed relatively steady long enough for ice this thick to form (several days at sub zero temperature occured during this period.)

The total ice build-up noted along several open leads and a hole cut through the ice was about 60-80 cm. There were two or three layers of competent blue ice 10-12 cm thick, but most of the thickness was made up of white snow-ice; snow that had been

(v) Reach from the Bailey Bridge to Salmon Hole Point (Cont'd.)

soaked, then frozen. It was a very complex composition, different at each observation point. As the water level dropped following freeze-up, parts of the original cover may have broken and followed the water down. Other parts probably retained the original cover, then froze underneath. There was also evidence of successive icing phenomena caused either by temporary flow blockages or mid-winter higher flows. In either case, the water rose to flood the snow or existing ice sheets, then froze in place on top before the level dropped again.

Such an occurrence was noted at a point about 100 m downstream of the Bailey Bridge on March 19, 1985. There was fresh ice in the centre of the river, with water-soaked snow all around it. The cover had likely frozen to the bottom further downstream, forcing the water up to the surface.

Such a complex cover would not be very strong, so the first flow should dislodge it fairly easily. Also, once a jam has formed, the lack of internal strength in the individual blocks would likely mean that the jam could not last very long.

Over most of the reach, the ice cover was at a fairly uniform level. However, at various locations, there was an obvious sag from the first ice along the shores down to the centre of the river; hand level sights gave 25-30 cm. Snow on the cover varied from 0 to 25 cm in depth.

The flow channel under the cover meandered from side to side across the riverbed, opening up leads where it impinged on the shores. Between two successive leads, the stream crossed from one shore to the other under the ice, and the cover remained solid in between, being strong enough to support ski-doos. Where the flow could be observed in the leads, the discharge was estimated at 0.5 m^3/s, and the alluvial material making up the riverbed was noted as being large gravel, stones and boulders with gravel sizes between 10-15 cm, regular stones 30 cm and occasionally large boulders up to 80 cm. Manning's "n" is estimated to be 0.040.

There were a few large bumps in the cover that were found to be large boulders over which the cover had

(v) Reach from the Bailey Bridge to Salmon Hole Point (Cont'd.)

formed, then descended, remaining suspended. Where the ice had broken, it was possible to see the complex layers over and around the boulders. The main cover over the tops of the boulders was 12-15 cm thick, of blue ice, and sometimes up to 30 cm, but with snow-ice included. Much of the cover around the boulders was resting on the gravel riverbed, so it is likely that most of the cover is grounded with only the small channel open underneath in which the water was flowing.

(vi) Timber Crib Fender Wall

The crib running along the left shore in front of the most exposed houses appeared to be in good condition. The timber was all solid, not broken, and the rock fill was still right up to the top. Timber in the upstream portion that had been added more recently still had the characteristic light green colour from the pressure preservative treatment. (See Figure 1, in Appendix IV).

The level of the first ice appeared to be up to the foundation of the crib, but it was difficult to accurately determine the level due to the ice and snow cover.

(vii) Salmon Hole Point

The hard rock dyke sticking out from the right bank creates an obvious obstruction for ice movement. However, Mr. Murphy maintained that open water flow goes by without any apparent restriction - suggesting that the channel must be very deep right at the narrowest point. Although the ice level was a bit lower on the upstream side of the rock, there was no open water, again suggesting that there is ample depth for the flow to get by underneath without a flow concentration that could melt the ice.

The right shore just upstream extends back from the river in a low, swampy area. This should provide a good ice storage area once a jam forms, and the level starts rising.

Although it was difficult to be sure with the snow-covered ice in place during the visit, this restriction likely corresponds to the upstream limit of the tidal influence. No cracks along the shores that might suggest tidal movements were found. However, later surveys should be directed to defining the extent that the tides do enter the river.

(vii) Salmon Hole Point (Cont'd.)

The fractured gneiss island (Pete Moore's Island) just downstream of the narrows used to be much larger, but was reduced by bulldozer* to stop ice jamming. Apparently before it was removed, it used to divert the ice cover onto the left shore where it rafted up onto the grass. Several of the older people at the council meeting told of recovering this ice to put in their ice houses to keep fish fresh over the summer.

(viii) Downstream Pond

Practically the whole length of this wide reach running from Salmon Hole Point down to the Seaward Bridge can be considered as being under tidal influence. The morning of March 19, 1985, 120 m downstream of Salmon Hole Point, cracks in the cover along the right shore were noted where water had come up and soaked the snow at high tide earlier that morning. Dry cracks in the snow were found up to 100 m from the Point, at 14:00 hrs that afternoon, near low tide, and they were interpreted as having been caused by the descent of the ice as the tide went down.

At low tide, most of the cover in the pond was resting on the ground. Where there were large boulders, say up to 80 cm, the cover was suspended and broken in some places. Once again the complex build-up appeared, with the heaviest blue ice about 12-15 cm thick, and various other thinner sheets of snow ice and frozen slush.

While discussing possible solutions to the jamming problem at Salmon Hole Point, the suggestion came up to remove the natural rock dyke widening the restriction. It did not appear that this would be all that effective, because the cover in the pond would still remain solid. Therefore, even if the keying point were removed at Salmon Hole Point, it is likely that the jam could still key a little further downstream, against the pond cover.

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* This operation was carried out in several phases during the period 1969 - 1973.

(ix) Seaward Bridge

The central pier of the bridge was lost during the 1973 spring flood, but not due to ice. There was still some ice in the pond, but the pier footings were scoured out by high velocity flows at low tide. At high tide, the water level rose to within about 0.5 m of the jetty deck just to the right and upstream of the bridge.

(x) Additional Comments by P.C. Helwig

The area upstream of the Town Hall and lying between the main road and the river has been occupied only since 1970 when families from Oderin and Flat Islands in Placentia Bay were resettled in Rushoon.

During earlier floods, notably in 1973 the main risks to houses in this area came from rafting ice, as was dramatically shown in a series of photographs taken by Mr. Joe Hayden. Senior members of the community were unable to specifically identify any floods prior to 1973 as to year and date, but noted that it was not uncommon for ice to be carried by winter and spring floods into the area of concern. The construction of the fender wall along the bank of the river has so far been effective in preventing ice coming into this area with flood waters in recent ice jam floods.

Following the 1983 flood the river channel opposite Salmon Hole Point was widened by excavating the left bank (looking downstream).

3.0 INSTALLATION OF STAFF GAUGES

A complete tour of the river was conducted by the study group upon arrival at the site. After this inspection of the site and discussions with the Town Council a total of ten river sections were identified.* It was intended that staff gauges be erected at each of these locations to allow the ice observer to make direct readings of water levels. Unfortunately, the ground was found to be frozen and it was impossible to install the staff gauges. The staff gauges were left on the river banks instead to serve as markers. See Figure 1, Appendix IV. The observer has been instructed to identify the maximum river levels associated with ice jams (if any occur) and also to mark the high water levels associated with the maximum flood occurring during the study period (up to May 31, 1985).

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* The Technical Committee has asked that two additional cross-sections be included in the topographical survey.

3.0 INSTALLATION OF STAFF GAUGES (Cont'd.)

During Phase II of the Field Program the elevation and location of these high water level marks were measured to establish flood water profiles (Sub-section 7).

4.0 LEVEL SURVEY

A level survey was performed to obtain the door sill elevations of houses that are at risk to flooding. Vertical control for the field survey program was taken from vertical control points established for flood risk mapping provided by Newfoundland Department of Environment. An elevation of 12.0 m (North American Datum 1927) was established at the intersection of the main road into Rushoon and the old Burin Peninsula Highway and by means of differential levelling this datum was then carried along the main road in Rushoon to a point on the Seaward Bridge where it was then verified with the mapping provided. All levelling loops were completed back to the original bench mark. A number of temporary bench marks were also established at several locations within the study area.

5.0 FLOOD DAMAGE ASSESSMENT

5.1 Introduction

As an integral part of the field program a flood damage assessment was undertaken. This investigation was designed to provide both quantitive and qualitative information on the magnitude of damages in the flood prone area of Rushoon. During the planning stages three important objectives were identified to guide the data collection process:

(i) To provide detailed information on the tangible costs associated with previous flood events; this was defined to include residential, commercial, recreational, and utility damages;

(ii) To provide information on the intangible flood damages; this was to include such elements as: safety, inconvenience and health, and

(iii) To obtain community input into the severity of the situation in terms of the attitudes and perceptions of local residents to the flooding condition.

5.2 Flood Damage Assessment Procedures

There were two primary components involved in the damage assessment: (i) interviews with municipal authorities and influential members of the community and (ii) a residential questionnaire to assist in obtaining information on past flooding events, for which no documentation is available. The Mayor of Rushoon was asked to contact senior members of the community and invite them to the Council Meeting that was held in the Municipal Hall - Rushoon on March 18, 1985. Three senior citizens were able to attend this meeting, together with seven council members and the Mayor, Frank Murphy, Sr.

The seniors, most of whom were between 65 and 76 years old, advised that in early years (prior to 1960) the area subject to floods was unoccupied and therefore no one took particular notice of what happened there. There was general agreement, however, that the area was frequently invaded by rafting ice associated with break-up floods. It would appear that portions of the ice sheet have, on a few occasions, been pushed inland above and beyond flood water levels and in one year possibly - 1969, ice was even pushed across the main road, as shown in Figure 1, Appendix IV.

Following this event, Pete Moore's Island, just downstream of Salmon Point was reduced by bulldozer, in several operations during 1969 - 1973, since it seemed that the Island was deflecting the ice into the community.

Unfortunately, none of the elders of the community were able to identify dates of significant events in the past, not even the year of occurrence. There was a concensus however, that ice jamming was a frequent occurrence often obstructing access to the community, notably in the Rough Rocks section of the river upstream of the Town. In years when no significent ice jams occurred on Rushoon Brook no flooding was reported; hence, it was concluded that peak open water flows do not result in flooding.

The second component of the damage assessment was designed to provide a comprehensive assessment of individual tangible and intangible damages experienced by the residents. To do this, a questionnaire was developed and presented in a face to face interview format, to residents who are located in the flood prone area (Figure 1). To collect as much information as possible, within the time frame of the field visit, the questionnaire was designed to provide information under four major headings: housing stock characteristics, occupancy characteristics, damage information, and resident attitudes and perceptions. A copy of the questionnaire used is contained in Appendix I.

5.2 Flood Damage Assessment Procedures (Cont'd.)

To complement the information collected on previous damages, data was also collected in adjacent areas of the community hitherto uneffected by flooding. This was done in order to project damages for the 1 in 20 year and 1 in 100 year flood events. This assumes that previous damages did not reflect these water levels. This information included house type, business location, community facilities (schools, churches, recreation facilities, etc) and utilities. Concerning house types, all houses were classified according to their architectural structure. The classifications used were based on a report by Acres Consulting Services Limited.*

A - Architect designed, high quality homes, often large and expensive;

B - Typical homes, well maintained and intermediate in size and value;

C - Small homes of thin walled construction of low quality and low value.

5.3 Results and Discussion

Based on the meetings with community leaders and senior residents, the most significant damages are restricted to the area of the community upstream of Salmon Hole Point (Figure 1). No significant damages have been identified related to businesses, recreation facilities, community services or public utilities.

Nine residential buildings and one small store were identified as having experienced damages in previous flood events. A detailed summary of the responses from those interviewed is included in Table 5.1. Based on this summary the following synopsis representing each of the main questionnaire components is presented:

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* "Guidelines for Analysis: Stream Flows, Flood Damages Secondary Flood Control Benefits" Acres Consulting Services Limited, 1968.

TABLE 5.1 - SUMMARY OF FLOOD DAMAGES IN RUSHOON, NEWFOUNDLAND

RESPONDENT	1	2	3	4	5	6	7	8	9	10	Totals
House Characteristics:											
Age Heating System (Age)	11 yrs Electric (5)	? Electric (6)	50 yrs Electric (10)	60 yrs Woodstove (15)	30 yrs Oil & Wood Furn. (15)	45 Oil & Wood (45)	18 Oil Furnace (16)	23 Woodstove (23)	65 Woodstove (4)	21 Woodstove (4)	
Basement (Height) Number of Stories	No 1	No 2	No 2	No 2	No 1	No 2	Yes (8') 1	No 2	No 2	No 1	1
Occupancy Characteristics:											
Length of Occupancy (years)	1 1/2	6	15	15	30	?	16	14	5	14	
Number of Occupants	4	3	1	Store	4	2	4	11	5	7	41
Damage Information:											
Occurrence	1983	1983	1973?	1973?	1973	No	1968,71 (72),1983	1979,1983	1983	1973,1983	
Type of Damage (Tangible)	Floor Insul.	Damp Flooring	None	None	Replace Floor, Clapboard	- -	Furnace Insul. Mattress Plumbing Car	Damage to Fence	Underlay, Deep Freeze	Flooring, Insul. Fence	
Approx. Value Intangible Damage	Minimal Inconven.	Minimal Inconven.	N/A Inconven.	N/A	$1,500 Safety	- -	$1,200 -	Minor Inconven.	$500 Safety, Inconven.	$1,400 Safety, Inconven.	$4,600
Evacuation (Duration/ Cost)	2 days/$0	3 days/$0	-		3 days/$0	-	-	1 1/2 days /$0	2 days/$0	2 days/$0	$0
Resident Perceptions and Attitudes											
Flood Cause	Unknown	Unknown	Salmon Hole Point Ice Jams	-	Ice Jam	-	Nature	Salmon Hole Point Ice Jams	Salmon Hole Point Ice Jams	Unknown	
Solution	Raise houses, backfill land, retaining wall	"	Unknown	-	Wall along brook - increase height	-	Make cribbing watertight	Raise houses & build up land	Backfill, raise houses & retaining wall	Backill, raise houses	
Community Problems (Rating)	Poor roads (10), Flooding (6), Unemploy. (6), Pollut. (2)	Flooding (9), Poor roads (8), Unemploy. (2), Pollut. (1)	Flooding (9), Poor roads (7), Pollut. (5), Unemploy. (2)	-	Flooding (8), Poor roads (6), Unemploy. (5) Social (4)	-	Flooding (8), Poor roads (5), Pollut. (2)	Flooding (8), Poor roads (7), Unemploy. (7)	Flooding (10), Poor roads (10), Pollut. (8), Unemploy. (4)	Flooding (10), Poor roads (10), Pollut. (10), Unemploy. (8)	
Added Benefits	None	None	None	-	None	-	None	None	None	None	
Comments	No water entered house Mobile Home	No water entered house	No water entered house Water around property creates nuisance	No water entered	3 hrs duration Tel. & Elec. out for 2 days	-	Basement flooding approx. 5' water	No water entered house	6" water $198 Fed. Govt. Compen. 2 days duration	Raised House, 1984 $150 Compen.	

5.3 Results and Discussion (Cont'd.)

(a) House Characteristics

The houses are generally older homes with an average age of 36 years and a range of 11-65 years. Seven of the ten houses were reported to haved been relocated as part of the resettlement program in the 1960's. There is a relatively equal split between the number of houses with 1 and 2 stories and only one house has a basement. Heating systems are divided between one of three types: electricity (3), wood (4) and wood/oil (3).

(b) Occupancy

The number of occupants per residence ranged from 1 to 11 individuals with a total of 41 for all houses involved. The length of occupancy ranged from 1 1/2 years to 30 years with an average of 13 years.

(c) Damage Assessment

The most severe flood damage years were 1973 and 1983. As would be expected, the house with the basement had the greatest incidence of damage associated with water entering the house; only two other homes reported water entering the house.

The tangible damages were mainly related to flooring and floor insulation, although there were a few incidences of damage to furniture, clapboard, fences, a furnace and an automobile. The total tangible damages for both events was calculated to be approximately $4,600. Damages were generally equal for both events with amounts of $2,000 for the 1973 event and $2,600 for the 1983 event.

Concerning the intangible damages most residents indicated that their major concern was that of inconvenience and potential safety hazards associated with water around their homes. In total, 34 people were forced to evacuate their homes during flooding. Evacuation was normally for 2-3 days until the flood water abated; no costs resulted from these dislocations as residents stayed with friends and relatives.

5.3 Results and Discussion (Cont'd.)

Resident Attitudes and Perceptions

Most residents interviewed perceived the flooding was the result of ice jams at Salmon Hole Point. The common solutions suggested for the problem included: raising houses, backfilling the land surrounding the houses and raising or water tightening of the retaining wall.

In order to ascertain the relative importance of the flooding problem in relation to other community problems, which may or may not exist, the respondents were asked to rank on a scale of 1 to 10 the seriousness of the following potential problems: pollution, unemployment, social problems (e.g. alcoholism, marriage breakdown, etc), poor roads, crime and flood hazard.

Taking the average of the ratings, the rating in terms of seriousness, for each problem was found to be: flood hazard - 6.8; poor roads - 6.3; unemployment - 3.5; pollution - 3.0; social problems - 0.8 and crime - 0.8.

As a result of the interviews carried out and data collected it was found that the amount of tangible damages which have resulted from flood events in Rushoon has been relatively small. Additional evidence for this lies in the fact that the house experiencing the most damage in 1983 has since been raised. This would suggest that the $2,600 damage estimate for the 1983 flood level would be reduced to approximately $1,200 in a future flood at that level. It can be seen however, that the intangible damages associated with inconvenience, potential safety hazards and resident dislocation are significant. During the 1983 flood for example, 34 people were forced to evacuate their homes for 2-3 days.

It is impossible without knowing the frequency of water level occurrence to determine the average annual damages. Once these frequences are known it will be possible to indicate whether or not the water levels experienced in the 1973 and 1983 events reflect the 1 in 20 or 1 in 100 year event. These calculations will be made in the analytical phase of the study. This in turn will permit a detailed socio-economic analysis to be performed.

5.3 Results and Discussion (Cont'd.)

Resident Attitudes and Perceptions (Cont'd.)

Relatively speaking, the residents interviewed rated the flooding as the most serious problem facing the community, however, poor road conditions were considered almost as serious. It should be noted that given the respondent's awareness of the nature of the questionnaire there may have been a tendency to over-estimate the seriousness of the problem, nevertheless, flooding was perceived as serious. Related to the significance of the possible flood control measures the respondents did not perceive any added benefits which would accrue from the implementation of such projects.

5.4 Conclusion

In conclusion, although it is apparent that past tangible damages associated with flooding in Rushoon have been minimal, it is impossible to indicate, at this time, the potential damages associated with the 1:20 year and 1:100 year water levels. These potential damages along with the socio-economic viability of project alternatives will be assessed in the analytical phases of the study once data are available on the potential magnitude, extent, duration of flooding and alternative flood control measures available.

6.0 FLOW GAUGING

A site just above a natural constriction in the river, locally known as the Rough Rocks, was chosen to be the best site for purposes of this study.

The area tributary to the gauge is 55.5 km^2 or 94% of the total drainage area of the Rushoon River. It is located immediately upstream of the study area. An alternative site at the Burin Peninsula Highway Bridge was also considered, although a better site from the hydraulic point of view, it was rejected because:

(i) it measured flow from only 81% of the Rushoon River basin,

(ii) it was located on the plateau above the steep valley portion of the watershed from which very rapid runoff rates can be expected.

Because of these factors it was concluded that this upper gauge site would be unrepresentative of conditions actually observed on the river.

6.0 FLOW GAUGING (Cont'd.)

During the Phase I of this Field Program the ice observer (Frank Murphy, Jr.) was instructed in use of a flow gauge. He was instructed to carry out a series flow measurements over a range of flows, and to make a special effort to obtain measurements when the river was in flood.

Flow gauging was carried out at the gauge site by wading into the river when flows are relatively low. When flows were too high for wading, measurements were taken by suspending the flow gauge from the Bailey Bridge.

A total of five flows were gauged covering a range from a low of 0.21 m^3/s to a high of 24.5 m^3/s. Only one measurement was taken with ice in the brook - all others were taken for open water condition. Sufficient data was collected to establish a head - discharge curve for open water conditions, see Figure II-I, (Appendix II).

Appendix II also contains a summary of data, and a copy of the notes prepared for the Observer.

7.0 TOPOGRAPHIC AND WATER LEVEL SURVEYS

The overall objective of the field program was to gather the information necessary to calibrate the computer models that will be used to mathematically represent ice jam formation and flooding in Rushoon Brook. A topographic survey of the river channel is required to provide geometric data for the ice model; unfortunately, the snow and ice cover on the brook channel was too thick to economically perform such a survey during Phase I of the Field Program. Hence, cross-sectioning of the brook channel had to be deferred to a later date and was carried out during Phase II of the field program.

Phase II of the Field Program commenced on May 27, 1985. Locations of the cross-section sites were established during Phase I of the Field Program (see Figure I). Cross-sections in the flood prone area were extended to take in the main road into Rushoon to allow for the modeling of the 1:100 year. Flood Field notes taken during the survey have been tabulated in a co-ordinate form (see Appendix III). A computerized graph of each section has been generated from the field notes (Appendix III).

During Phase I of the Field Program the ice observer (Frank Murphy Jr.) was instructed to monitor high water levels in the brook by marking these levels on the river bank with spray paint. These paint marks were found during the cross-section survey, their elevations determined by differential leveling and their locations referenced to chainage distances along the river profile - as summarized in Table III.3. These water levels were produced by a peak flow, estimated to be 16.5 m^3/s, which occurred on April 28, 1985. This flow condition was just marginally below the "bankfull" condition (water levels for 100% bankfull flow would be about 0.2 to 0.3 m higher than observed in this event).

Two sets of tidal observations (Tables III - 1 and 2) were made in order to investigate the extent of Rushoon Brook subject to tidal effects, as well as to relate the characteristics of the tidal cycle at Rushoon with the published tidal characteristics at the nearest Reference Port - Argentia (Nfld.). During the exercise of 1985-05-18 water levels at Salmon Hole Point were also monitored to verify whether the water level at this location was tidal. No water changes were noted, hence it is concluded that Salmon Hole Point lies above the tidal range for ordinary tides.

APPENDIX I

RESIDENTIAL FLOOD DAMAGE QUESTIONNAIRE

CONFIDENTIAL

RUSHOON FLOOD STUDY

RESIDENTIAL FLOOD DAMAGE QUESTIONNAIRE

PART 1 - IDENTIFICATION

1. Respondents Name: ______________________

   Mailing Address: ______________________

   ____

   Telephone Number: ______________________

2. Position in Household: Head of Household ____________

   Other (Specify) ____________

   No. of Occupants ____________

3. How long have you been living at this address? ____ years

4. During this time has you house ever been damaged by flooding or ice? __________. Specify ______________________

   (Note: This does not refer to internal flooding) ____________

   If yes, how many times ________. If no, terminate interview.

5. House Description: Number of Stories ____________

   Basement present ___ (yes or no)

   If "Yes" - Give Height ___(Specify ft.or m)

   Is it developed? ___ (yes or no)

   If "Yes" - How is it developed ____________

   ____

   ____

   Age of House __________years

   Heating System Type & Age ____________

   ________years

* Photograph house and identify its location on the attached map.

PART 2 - FLOOD DAMAGE

6. During flooding events has water ever entered your house?

    ____________(yes or no)

    If "yes" record the date (as close as possible) and the water depth.

Event Date	Water Depth (Metric or imperial but specify)
____________	____________________
____________	____________________
____________	____________________
____________	____________________

* Use back of paper for additional recordings.
* If this refers to the basement specify.

7. Could you give an indication of the types of physical damages experienced. Do not give examples but check them as the respondent mentions them; as they mention them have them give some details and cost of repair/replacement. This refers to each event; give date ________________________

Item	Details	Total Costs
Furniture	____________________) ____________________) ____________________)	____________ ____________
Appliances (Major)	____________________) ____________________)	____________
Appliances (Minor)	____________________) ____________________)	____________
Floor Covering	____________________) ____________________)	____________
Foundation	____________________) ____________________)	____________
Heating System	____________________) ____________________)	____________

7. (Cont'd.)

Item	Details	Total Costs
Walls	________) ________) ________)	________
Plumbing	________) ________) ________)	________
Electrical	________) ________) ________)	________
Exterior (i.e. to the yard)	________ ________ ________	________ ________ ________ Specify individual costs
Other (e.g. Sheds, cars, food stuffs etc)	________ ________	________ ________ Specify individual costs

8. Where did the water first enter (i.e. foundation, window, door etc.)? ____________________

* Get above grade elevation and photograph.

10. How long did this water remain inside the House? ________ hrs

11. Were you forced to leave your house during any of the flood events? ________. If "yes" during what event did you have to leave and for how long?

Event Date	Length of Time	Where did you stay?
________	________ hrs	________
________	________ hrs	________
________	________ hrs	________

12. During the flooding did you have any utilities cut off? ________. If yes, give details?

PART 2 - FLOOD DAMAGE (Cont'd.)

12. (Cont'd.)

Utility	Period of Outage
Electricity	______ hours
Water	______ hours
Telephone	______ hours
Other (Specify)	
______	______ hours
______	______ hours

13. Are there any non physical damages or hazards experienced during these flood events?* NB. Do not read list, check as respondent answers:

Safety ______

Inconvenience ______

Isolation ______

Depression ______

Loss of Work ______ (Amount of Time) ______

Other (Specify) ______

______

* Was insurance carried? If so, did it pay for damages?

______

PART 3 - FLOOD CAUSES, SOLUTIONS, PERCEPTIONS & ATTITUDES

14. What in your opinion is the cause of the flooding?

    ____

    If unknown, check here ______________________________

15. As a resident can you recommend any possible measures to reduce or eliminate the problem?

    ____

    ____

    ____

16. On a scale of 1 to 10, how serious do you rate the following problems which may or may not be facing your community? 1 is least serious and 10 is most serious

Problem	Rating (1-10)
Pollution	________
Unemployment	________
Social Problems	________
Poor Roads	________
Crime	________
Flooding Hazard	________
Other (Specify)	________

17. In what ways, other than damage reduction, would you see the implementation of flood control measures would benefit your community? Specify:

    If None check here ________

    ____

    ____

18. Are there any other comments you would like to make concerning the flooding events within your community? *If yes, use back of sheet for details.

APPENDIX II

FLOW GAUGING

- Notes
- Data
- Figures

SHAWMONT NEWFOUNDLAND LIMITED

Subject: RUSHOON HYDROTECHNICAL STUDY
NOTES ON FLOW GAUGING
Work Order No.

Made by: D.C.H. Checked by: Date: March 16, 1985

PURPOSE:

Flow gauging is a means of measuring the flow in a river directly and is carried out for a series of flow events ranging from low the high flows in order to establish a head discharge relationship at an appropriate location on the river. These flow measurements allow us to establish the relationship between head (or water level) and flow (discharge). This relationship is called a head-discharge curve. Once this relationship has been established by flow gauging, it is possible to estimate other flows indirectly, from a known water level.

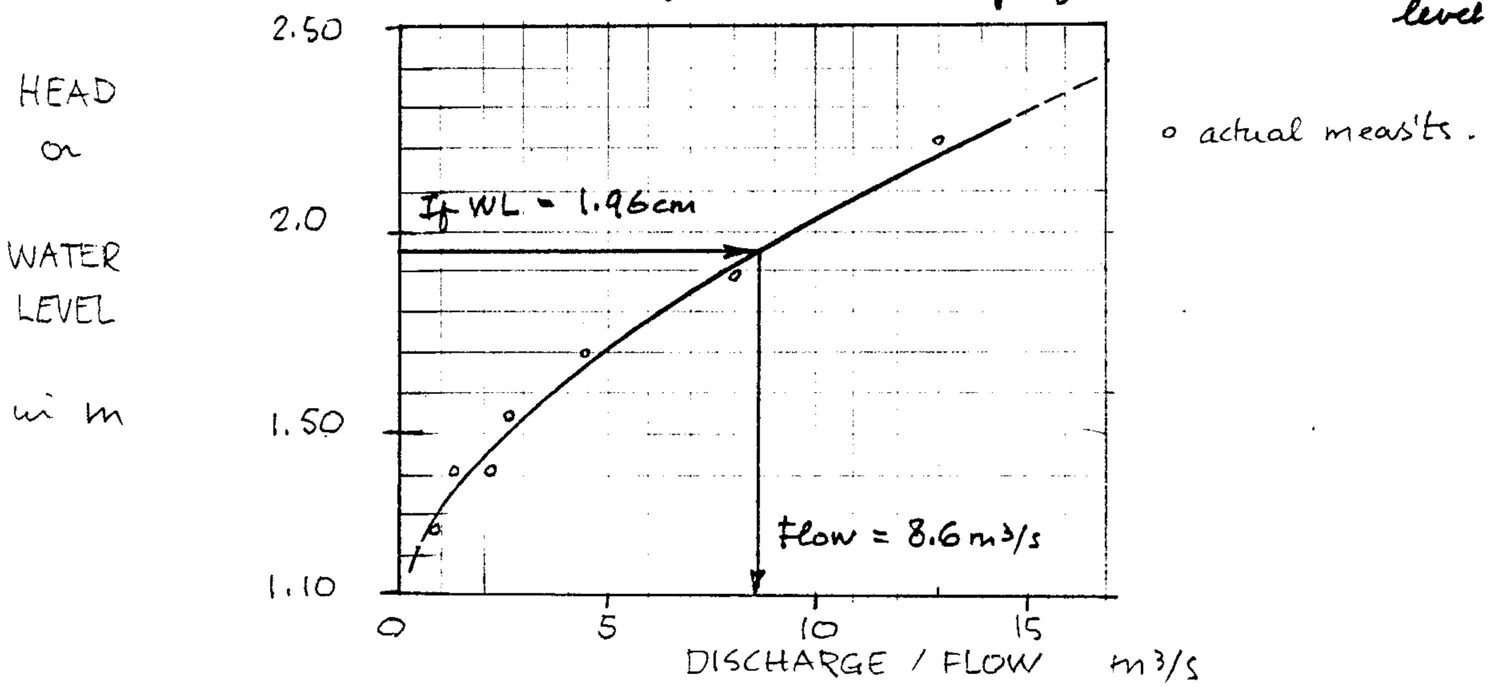


Figure 1: HEAD DISCHARGE CURVE

SHAWMONT NEWFOUNDLAND LIMITED

Subject: RUSHOON HYDROTECHNICAL STUDY
NOTES ON FLOW GAUGING
Work Order No.
Made by: D. C. H. Checked by: Date: March 16, 1985

CHOICE OF GAUGING SECTION:

The best choice for a gauging section is just above a constriction in the river, typically above a set of rapids or waterfalls. At such sections the changes in water level will be greater than at wide sections in the river, for the same change in flow. The actual choice of a gauging section must take into consideration such practical considerations as ease of access, suitability of ground for installation of staff / float gauge etc. The site will be chosen by ShawMont's engineer

CHOICE OF MEASUREMENT SECTIONS:

The section where flow is gauged need not be exactly at the section where the staff gauge has been erected. However it should be close enough that no significant inflows from tributary streams occur between the gauge site and measuring section.

For low flows (depth less than 1m) measurements will be made by wading. The ideal gauging

SHAWMONT NEWFOUNDLAND LIMITED

Subject: RUSHOON HYDROTECHNICAL STUDY
NOTES ON FLOW GAUGING Work Order No.
Made by: D.C.H. Checked by: Date:

section would be located on a straight section of the river having a smooth and regular bottom (as far as possible!). ShawMont's engineeer will choose section.

For high flows, when it is no longer practical or safe for wading, measurements will be made from the upstream parapet of the Bailey Bridge.

MEASUREMENT PROCEDURES:

(a) By Wading:

Two people will be required: a Gauge Reader and a Note Taker. The following steps are involved

Step I. Layout the Gauging section.

It is suggested that a rope be pegged on either bank, as shown in Figure 2. Alternatively the Note Taker can line up the Gauge Reader to a sight rod on the other bank and measure the distance to to the metering point [the meter reader should hold the "0" end of the tape].

Step II Measure depth of water to nearest 0.01 m using metre rule.

SNL-10

SHAWMONT NEWFOUNDLAND LIMITED

Subject: RUSHOON HYDROTECHNICAL STUDY
NOTES ON FLOW GAUGING — Work Order No. ______

Made by: P.C.H. — Checked by: ______ Date: ______

MEASUREMENT PROCEDURES (cont'd)

Step III — Lower flow gauge to a depth below the surface of about 0.6 × water depth measured in Step I (or 0.4 depth above the bottom)

Step IV — Read velocity from flow meter gauge and call out results to note taker. The needle will probably vibrate somewhat. Choose the average reading, by estimating the mid-point between the max. and min values on the meter. Check setting of meter and tell Note Taker [low/high]

Step V — Repeat steps I-IV for next metering point. Recommended distance between metering points is 1.0 m.

[Continued on page 6].

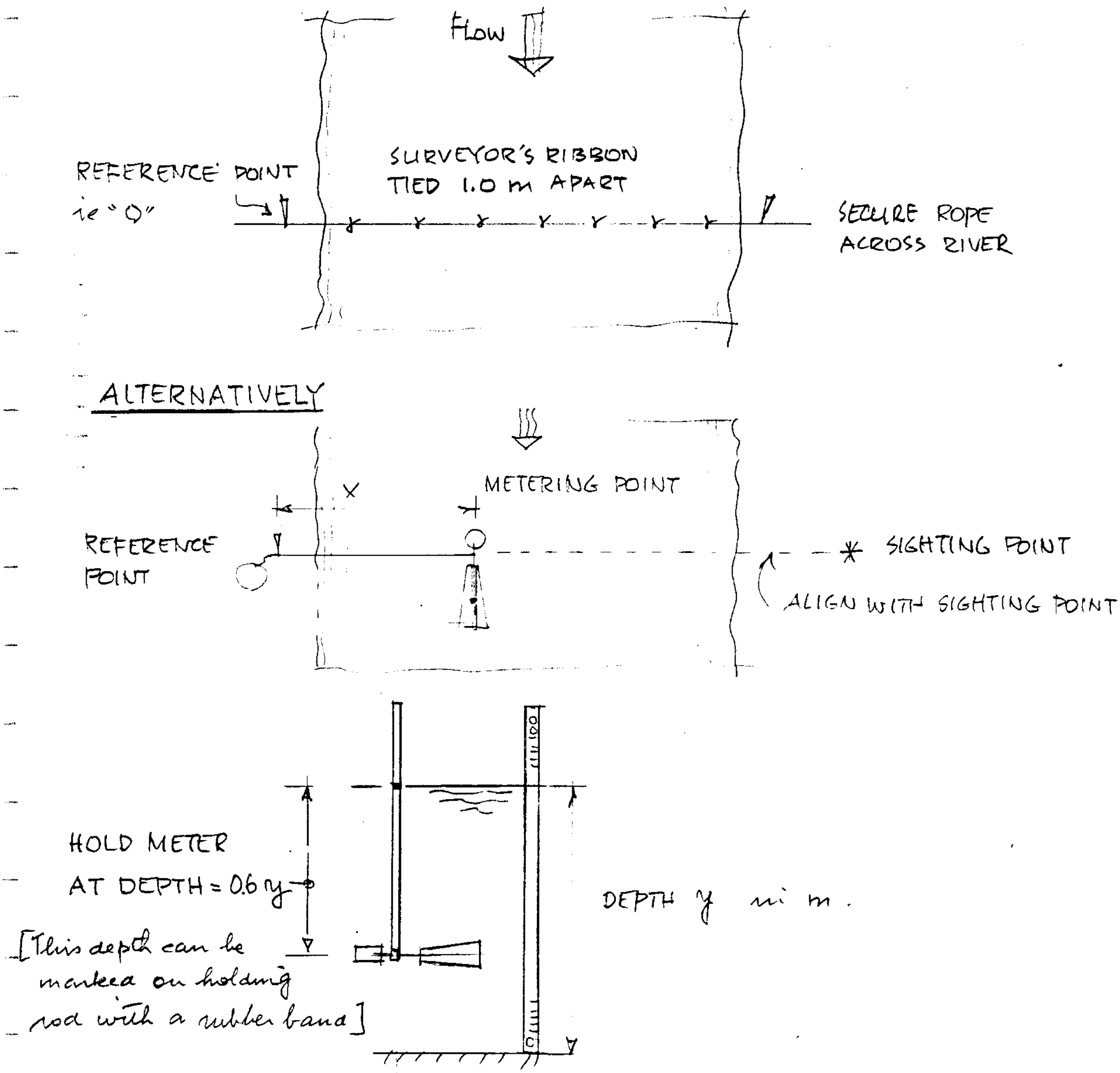
SHAWMONT NEWFOUNDLAND LIMITED

Subject RUSHOON HYDROTECHNICAL STUDY

NOTES ON FLOW GAUGING **Work Order No.**

Made by P.C.H. **Checked by** **Date**

Figure 2 LAYOUT OF METERING SECTION



SHAWMONT NEWFOUNDLAND LIMITED

Subject: RUSHOON HYDROTECHNICAL STUDY
NOTES ON FLOW GAUGING — Work Order No.
Made by: P.C.H. Checked by: Date:

MEASUREMENT PROCEDURES

(b) From Bridge. Two people will be required as before - a Gauge Reader and a Note Taker. The following steps are involved -

Step I Metering points can be laid out directly by marking bridge railing at 1.0 m intervals. Record distance to metering point.

Step II Depths must be measured by sounding. To do this, the electrical cord attached to the meter should be marked a 1.0 m intervals with adhesive tape. Note the first marker should be placed at a height 1.0 m measured above the sinker.

Heights are measured by counting the number of markers below the railing of the bridge. Depth of water will be equal to the difference between measurements to river bottom and river surface (y m). Heights should be measured to the nearest ± 0.05 m with respect to railing of bridge)

SNL-10

SHAWMONT NEWFOUNDLAND LIMITED

Subject: RUSHOON HYDROTECHNICAL STUDY

Work Order No.

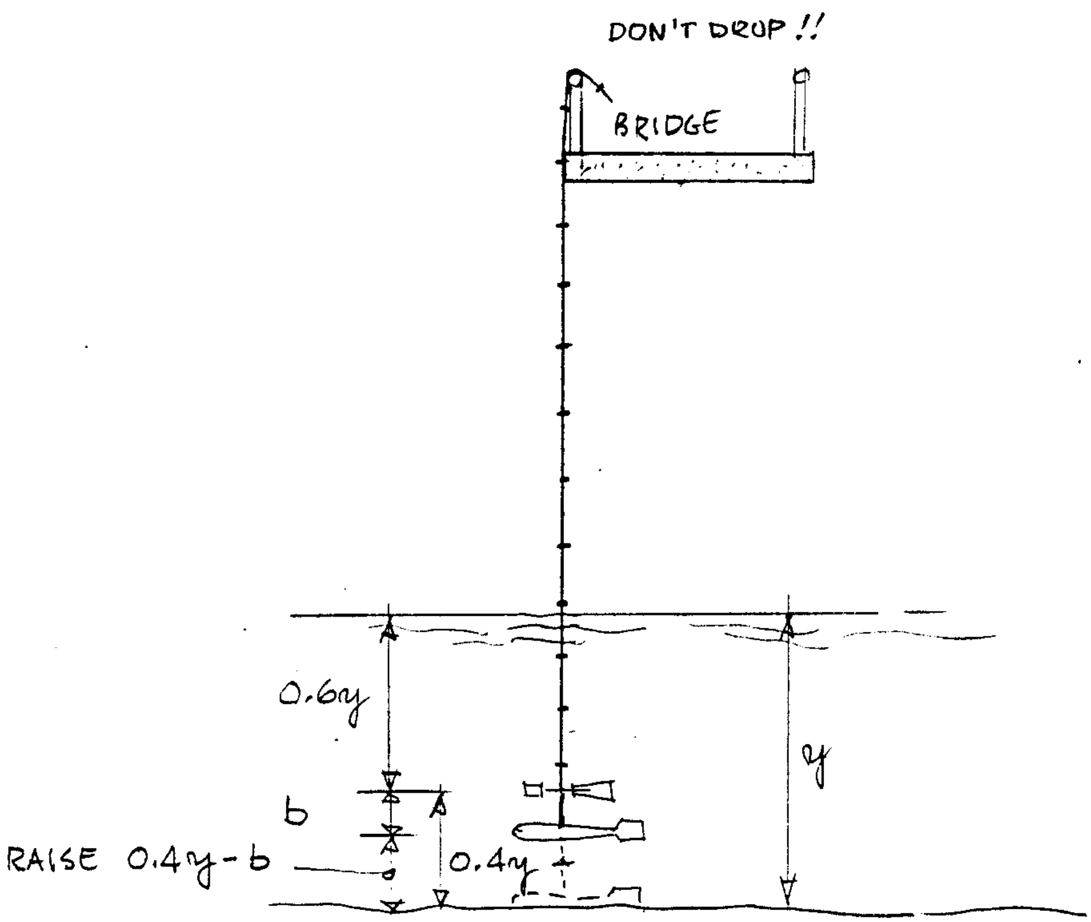
Made by: P.C.H. Checked by: Date:

MEASUREMENT PROCEDURES (cont'd)

Step III To set meter at proper level, raise meter from bottom by [0.4y − b] as shown in Figure 3.

Steps IV and V .. same as before

Figure 3 .. SETTING METER



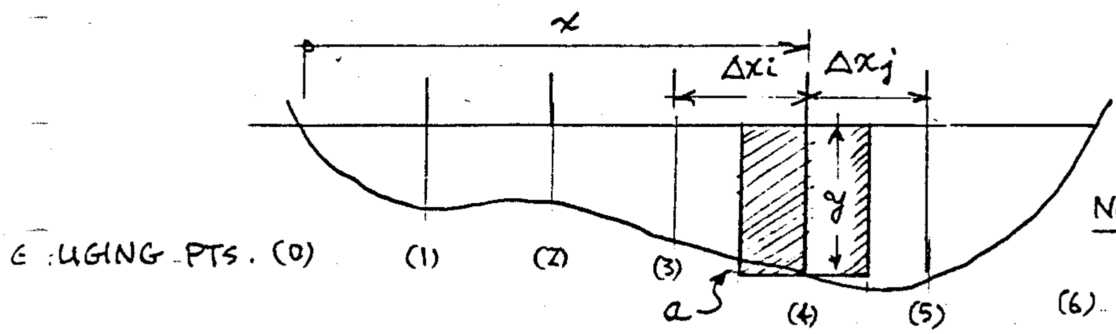
RUSHOON HYDOTECHNI .L STUDY - FLOW GAUG JG NOTES..

DATE : March 16 LOCATION : RUSHOON RIVER, METERING SECTION

TIME - AT START 3.45 pm GAUGE READING - AT START 1.265
AT FINISH 5.00 pm - AT FINISH 1.267
Mean = 1.266 m

OBSERVER JOE DOE & BILLY McGEE INSTRUMENT USED PRICE
SETTING HIGH / LOW RANGE

DEFINITION OF TERMS FOR FLOW CALCULATIONS (AS BELOW):



NOTE: INSTRUMENT SHOULD BE HELD AT ~ 0.6y ABOVE BOTTOM.

FIELD NOTES AND CALCULATIONS:

DISTANCE FROM SHORE (x) m	SECTION WIDTH (ΔX) m	DEPTH (y) m	FLOW VELOCITY (v) m/s	SUB-AREA $a = y\frac{[\Delta x_i + \Delta x_j]}{2}$	FLOW v×a m³/s
0 = water's edge		0	0	$0.0\frac{[0+1]}{2}$ = 0.0	0.000
	1				
1		0.400	0.25 (L)	$0.400\frac{[1+1]}{2}$ = 0.400	0.25×0.400 = 0.100
	1				
2		0.505	0.29 (L)	$0.505\frac{[1+1]}{2}$ = 0.505	0.29×0.505 = 0.160
	1				
3		0.615	0.31 (L)	= 0.615	= 0.191
	1				
4		0.605	0.30 (L)	= 0.605	= 0.182
	1				
5		0.550	0.27 (L)	= 0.550	= 0.149
	1				
6		0.300	0.15 (L)	$0.300\frac{[1+0.7]}{2}$ = 0.255	= 0.038
	0.70				
6.70 = water's edge		0.200	0.05 (L)	$0.200\frac{[0.7+0]}{2}$ = 0.070	= 0.004
		Total Flow			= 0.824 m³/s

TABLE II - 1

SUMMARY OF FLOW MEASUREMENTS

- RUSHOON BROOK -

FLOW GAUGING - SUMMARY OF RESULTS

W.L.	Flow	$AR^{2/3}$	Date of Measurement
m	m^3/s		
16.35	1.32	0.80	March 21/85 (ice affected)
16.38	3.81	1.10	April 08/85 (ice free)
16.57	10.08	3.10	April 30/85 (ice free)
16.96	24.30	10.60	May 5/85 (ice free)
16.25	0.21	0.23	May 29/85 (ice free)

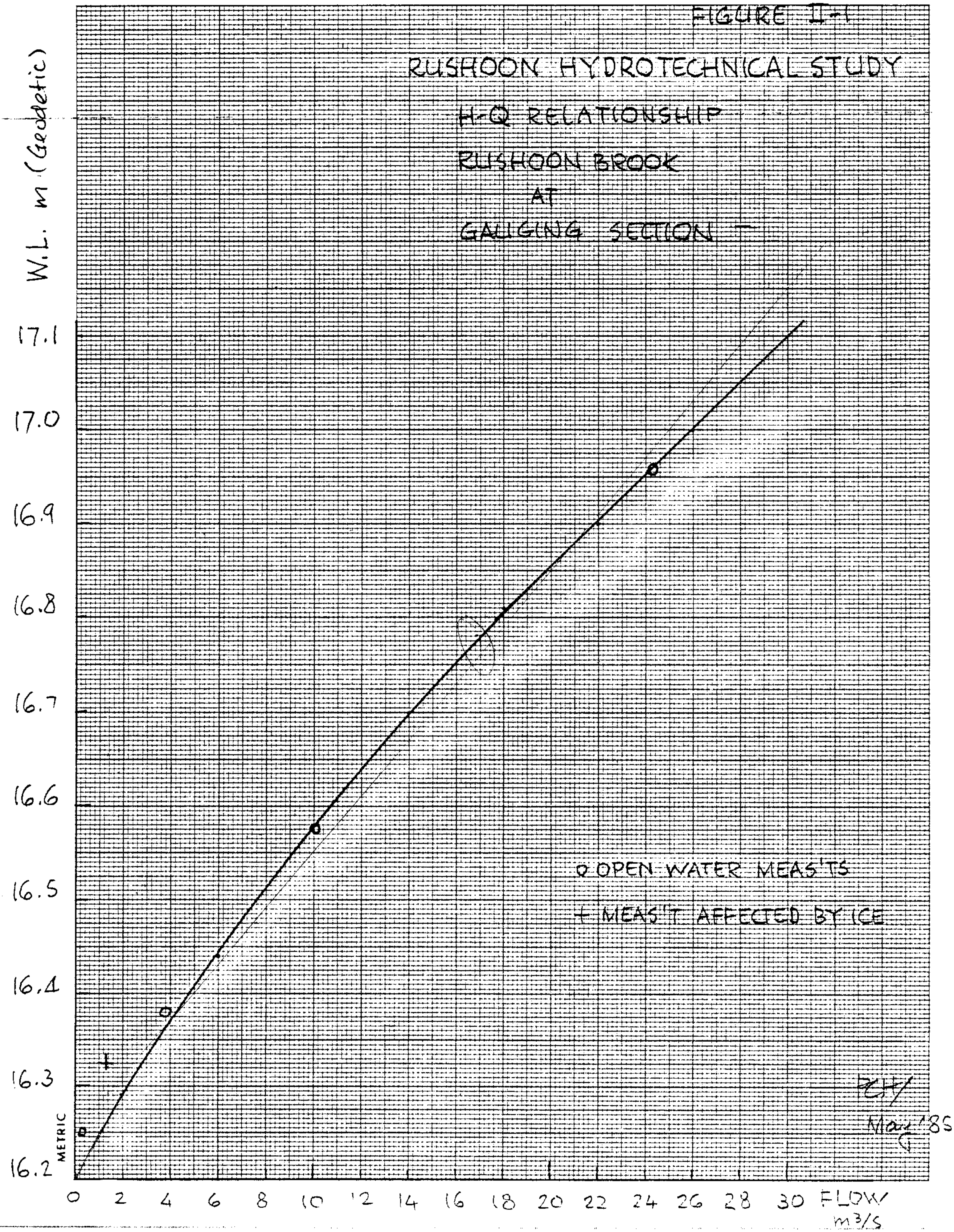
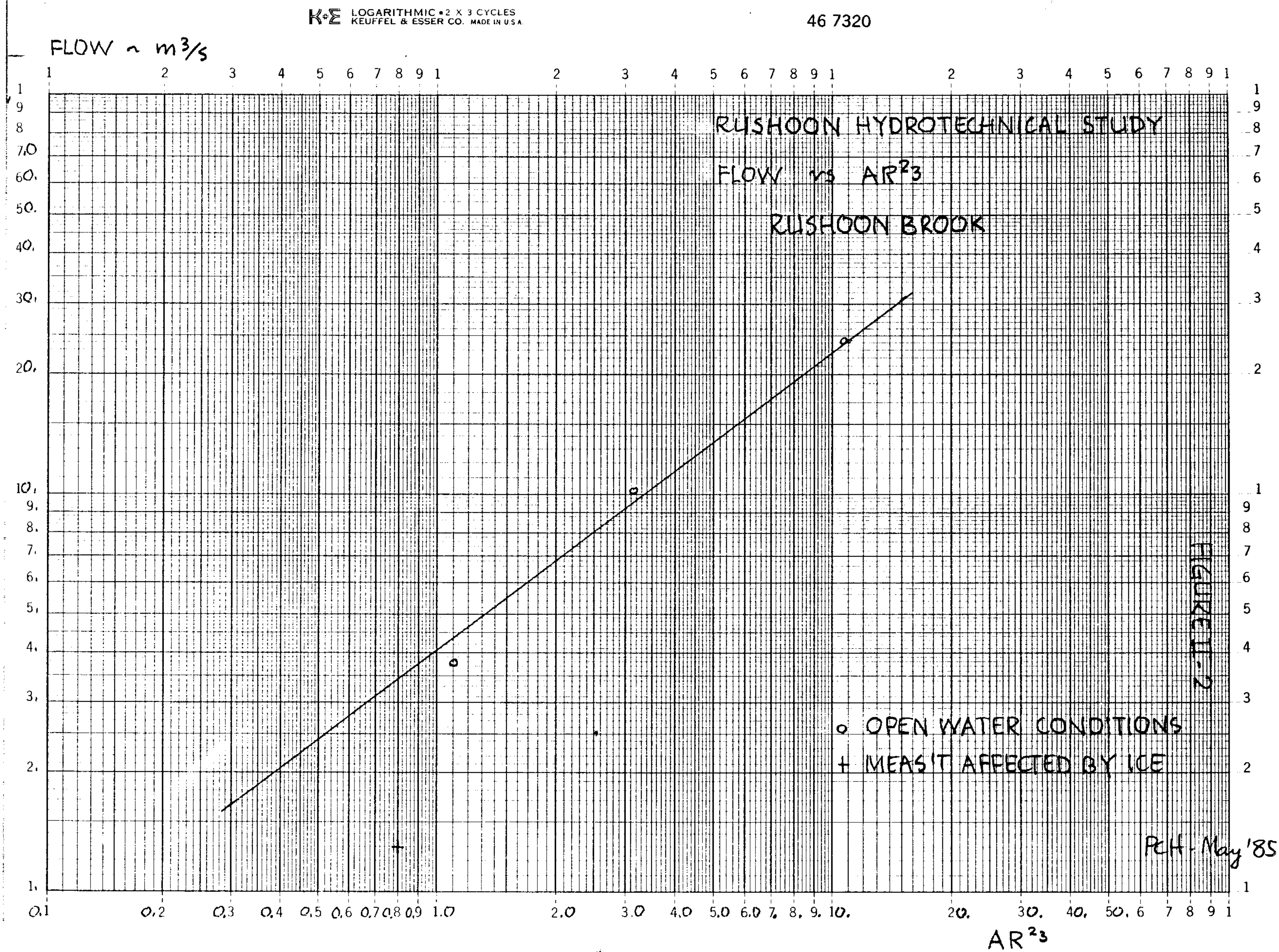


FIGURE II-1
RUSHOON HYDROTECHNICAL STUDY
H-Q RELATIONSHIP
RUSHOON BROOK
AT
GAUGING SECTION
W.L. m (Geodetic)
17.1
17.0
16.9
16.8
16.7
16.6
16.5
16.4
16.3
16.2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
FLOW m3/s
o OPEN WATER MEAS'TS
+ MEAS'T AFFECTED BY ICE
May '85
METRIC



K&E LOGARITHMIC • 2 X 3 CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.
46 7320
FLOW ~ m³/s
RUSHOON HYDROTECHNICAL STUDY
FLOW vs AR²³
RUSHOON BROOK
FIGURE II-2
o OPEN WATER CONDITIONS
+ MEAS'T AFFECTED BY ICE
PCH - May '85
AR²³

APPENDIX III

FIELD NOTES AND CROSS-SECTIONS

NOTE: All cross-sections are plotted as they would appear to an observer looking downstream.

TABLE III-1

RUSHOON HYDROTECHNICAL STUDY

OBSERVATION OF TIDAL FLUCTUATIONS

DATE: 1985-03-19 - 1985-03-21 OBSERVERS: F.Parkinson & H. Keats

LOCATION: SEWARD BRIDGE

DATE	TIME OF OBSERVATION	ELEVATION (Geodetic) m
85-03-19	10:28	- 0.05
85-03-19	11:35	- 0.38
85-03-19	11:55	- 0.53
85-03-19	13:54	- 0.62
85-03-19	17:07	- 0.08
85-03-20	8:34	0.42
85-03-20	10:00	- 0.03
85-03-20	12:11	- 0.74
85-03-20	13:35	- 0.82
85-03-20	15:04	- 0.83
85-03-20	17:10	- 0.17
85-03-21	8:42	0.76
85-03-21	10:17	0.67
85-03-21	17:54	- 0.05

TABLE III-2

RUSHOON HYDROTECHNICAL STUDY

OBSERVATION OF TIDAL FLUCTUATIONS

DATE: 1985-05-18 OBSERVER: Frank Murphy, Jr.

LOCATION: SEWARD BRIDGE

Time of Observation	Elevation (Geodetic) m
6:00 hr.	- 0.23
7:00 hr.	0.16
8:00 hr.	0.47
9:00 hr.	0.45
10:00 hr.	0.37
11:00 hr.	0.14
12:00 hr.	- 0.23
13:00 hr.	- 0.63
14:00 hr.	- 0.67
15:00 hr.	- 0.76
16:00 hr.	- 0.57
17:00 hr.	- 0.47
18:00 hr.	- 0.16

TABLE III-3

RUSHOON HYDROTECHNICAL STUDY

HIGH WATER ELEVATIONS - April 28, 1985

- APPROX. "BANKFULL CONDITION" -, $Q = 16.5\ m^3/s$

STATION	ELEVATION (Geodetic) (m)
- 0 + 015	10.42
0 + 107	9.01
0 + 315	7.97
0 + 339	7.57
0 + 370	6.94
0 + 458	6.62
0 + 501	6.38
0 + 522	5.80
0 + 591	5.05
0 + 613	4.77
0 + 749	3.61
0 + 741	3.58
0 + 881	2.69
0 + 972	1.76
1 + 023	1.25
1 + 043	0.85
1 + 063	0.94

TABLE III-4

RUSHOON HYDROTECHNICAL STUDY

WATER LEVELS OF RUSHOON BROOK ON May 29, 1985

STATION	ELEVATION (Geodetic) (m)
0 + 000	9.45
0 + 150	7.88
0 + 351	6.87
0 + 666	3.64
0 + 755	3.03
0 + 881	2.27
0 + 972	1.27
1 + 038	0.51
1 + 098	0.22

FLOW = $0.21 m^3/s$

TABLE III-5

RUSHOON HYDROTECHNICAL STUDY

CROSS-SECTIONS ACROSS RUSHOON BROOK

SECTION # 1 - STATION 1 + 500

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	2.57	
0.0	- 1.15	Abutment
2.0	- 1.38	
4.0	- 1.79	
7.0	- 2.35	Pier
7.0	2.57	
10.8	2.57	
10.8	- 2.45	Pier
12.3	- 2.60	
14.3	- 2.60	
16.3	- 1.85	
18.3	- 1.53	
19.2	- 1.40	Abutment
19.2	2.57	

SECTION # 2 - STATION 1 + 358

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	4.01	Centerline of Road
4.1	3.88	
6.6	3.01	
10.0	2.75	
15.0	2.45	
19.1	2.20	
21.7	0.63	
25.0	0.25	

SECTION # 2 - STATION 1 + 358

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
30.0	- 0.38	
35.0	- 0.75	
40.0	- 0.87	
45.0	- 0.65	
47.6	0.10	
50.0	- 0.52	
55.0	- 0.51	
60.0	- 0.52	
65.0	- 0.51	
70.0	- 0.52	
75.0	- 0.52	
80.0	- 0.54	
85.0	- 0.34	
90.0	- 0.18	
95.0	- 0.24	
100.0	- 0.33	
105.0	- 0.43	
110.0	- 0.54	
115.0	- 0.63	
120.0	- 0.71	
125.0	- 0.63	
130.0	- 0.76	
135.0	- 0.87	
140.0	- 0.85	
145.0	- 0.68	
150.0	- 0.53	

SECTION # 2 - STATION 1 + 358

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
155.0	0.06	
158.7	1.02	
160.5	2.57	

SECTION # 3 - STATION 1 + 177

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	4.62	Centerline of Road
6.8	4.04	
9.5	2.75	
15.0	2.25	
20.0	2.19	
25.0	2.05	
30.0	1.85	
49.8	1.35	
54.5	0.60	
60.0	0.20	
65.0	0.42	
70.0	0.55	
75.0	0.60	
80.0	0.59	
85.0	0.00	
90.0	- 0.05	
100.0	- 0.13	
110.0	- 0.13	
120.0	- 0.13	
130.0	- 0.16	
140.0	- 0.09	
150.0	- 0.09	

SECTION # 3 - STATION 1 + 177

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
160.0	- 0.16	
170.0	- 0.27	
180.0	- 0.71	
183.3	- 0.28	
185.0	0.72	
187.0	1.37	
192.0	3.60	

SECTION # 4 - STATION 1 + 098

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	2.55	Centerline of Road
6.0	2.42	
9.9	1.22	
13.4	1.32	
15.1	1.83	
30.0	1.87	
60.0	1.97	
71.5	1.91	
74.9	1.47	
81.1	1.50	
88.5	1.12	
90.0	0.86	
100.0	0.37	
110.0	0.22	
120.0	0.12	
130.0	0.11	
140.0	0.27	
150.0	0.19	
151.5	0.32	

SECTION # 4 - STATION 1 + 098

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
154.4	1.09	
158.0	2.14	
161.9	1.17	
164.3	0.21	
169.5	- 0.01	
176.9	0.02	
178.5	0.17	
180.0	0.79	
182.8	0.99	
185.2	1.09	
187.0	1.45	
195.0	4.10	

SECTION # 5 - STATION 1 + 038

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	2.82	Centerline of Road
5.7	2.56	
6.9	2.15	
8.9	2.68	
21.0	2.46	
30.0	2.49	
40.0	2.47	
50.0	2.39	
60.0	2.40	
70.0	2.18	
80.0	2.17	
90.0	2.03	
97.8	1.93	
102.0	3.42	

SECTION # 5 - STATION 1 + 038

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
107.2	2.61	
115.3	0.96	
120.0	0.51	Edge of River
130.0	0.47	
135.4	0.13	
136.9	- 0.07	
141.9	- 0.51	
143.9	3.24	Top of Salmon Hole Point
150.0	3.40	

SECTION # 6 - STATION 0 + 972

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	3.18	Centerline of Road
4.4	2.91	
6.1	2.06	
8.7	2.89	
10.0	2.87	
20.0	2.86	
30.0	2.86	
40.0	2.85	
50.0	2.83	
60.0	2.79	
70.0	3.01	
80.0	3.02	
90.0	2.50	
98.4	2.48	
101.9	3.61	
106.4	2.91	

SECTION # 6 - STATION 0 + 972

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
110.9	1.45	Edge of River
120.0	1.01	
125.0	1.15	
130.0	1.20	
135.0	1.12	
140.0	1.27	
145.0	1.76	
150.0	2.08	
160.0	2.42	
176.6	2.90	
180.0	3.21	
190.0	3.60	
200.0	4.06	

SECTION # 7 - STATION 0 + 881

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	4.83	Centerline of Road
4.0	4.48	
10.0	3.75	
15.0	3.73	
20.0	3.59	
25.0	3.35	
28.9	3.21	
29.2	3.01	
30.0	3.46	Edge of Road
36.5	3.71	Edge of Road
39.5	2.83	

SECTION # 7 - STATION 0 + 881

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
46.3	2.84	
51.1	3.03	
55.0	3.13	
60.0	3.28	
67.1	3.13	Timber Crib
67.1	4.30	
69.9	4.30	
69.9	3.07	Timber Crib
71.3	3.76	
73.1	3.16	
77.3	2.27	Edge of River
80.0	2.02	
85.0	1.97	
90.0	2.02	
100.0	1.97	
104.4	2.04	
105.2	2.47	
106.0	2.62	
111.5	5.02	

SECTION # 8 - STATION 0 + 755

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	4.50	Centerline of Road
4.6	4.35	
15.0	4.03	
20.5	3.81	
30.0	3.87	
31.2	3.90	Timber Crib

SECTION # 8 - STATION 0 + 755

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
31.2	5.17	
34.9	5.17	
34.9	3.99	Timber Crib
40.0	3.03	Edge of River
45.0	2.61	
50.0	2.72	
56.0	2.81	
60.0	2.82	
65.0	2.91	
69.5	3.14	
72.3	4.16	
74.7	5.59	

SECTION # 9 - STATION 0 + 666

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	6.16	
5.0	6.42	
9.6	6.35	
14.4	4.82	Timber Crib
14.4	6.21	
17.2	6.21	
17.2	4.64	Timber Crib
24.0	3.64	Edge of River
28.1	3.36	
30.0	3.41	
35.0	3.58	
40.2	3.64	
45.0	3.68	
50.0	3.77	
52.4	4.06	
55.3	4.51	
60.0	5.39	

SECTION # 10 - STATION 0 + 351

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	8.78	
5.0	8.20	
10.0	7.72	
15.0	7.21	
18.2	6.87	Edge of River
20.0	6.74	
25.0	6.67	
30.0	6.54	
35.0	6.59	
38.6	6.21	
40.0	6.62	
42.0	6.95	
43.0	7.15	
45.0	7.51	
50.0	7.82	

SECTION # 11 - STATION 0 + 150

0.0	12.67	
0.0	9.67	Abutment of Bridge
4.4	8.00	
10.2	7.88	Edge of Water
13.2	7.53	
15.4	7.53	
17.5	7.49	
19.2	7.78	Pier
19.2	12.67	
21.5	12.67	
21.5	7.78	Pier

SECTION # 11 - STATION 0 + 150

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
23.6	8.47	
25.6	8.10	
30.0	8.05	
32.4	8.60	
34.6	9.76	Abutment
34.6	12.67	

SECTION # 12 - STATION 0 + 000

DISTANCE (m)	ELEVATION (Geodetic)	REMARKS
0.0	11.35	
9.0	11.36	
12.7	9.45	Edge of Water
15.0	9.37	
20.0	9.51	
25.0	9.52	
30.0	9.56	
35.0	9.69	
39.8	9.72	
40.5	10.00	
45.0	10.33	
50.0	10.64	
55.0	11.13	
58.0	12.91	

TABLE III - 6

RUSHOON HYDROTECHNICAL STUDY

CROSS-SECTION AT GAUGING STATION - March 1985

DISTANCE (m)	ELEVATION (Geodetic)
0.0	17.50
8.5	17.07
10.8	17.27
13.2	17.22
15.1	16.94
16.7	16.47
20.0	16.27
23.0	16.14
26.0	16.12
29.0	16.14
32.0	16.17
34.2	16.42
36.4	16.87
39.0	17.52

TABLE III - 7

RUSHOON HYDROTECHNICAL STUDY

Results of Ice Thickness Survey by F. Murphy Jr., March 26 & 27, 1985

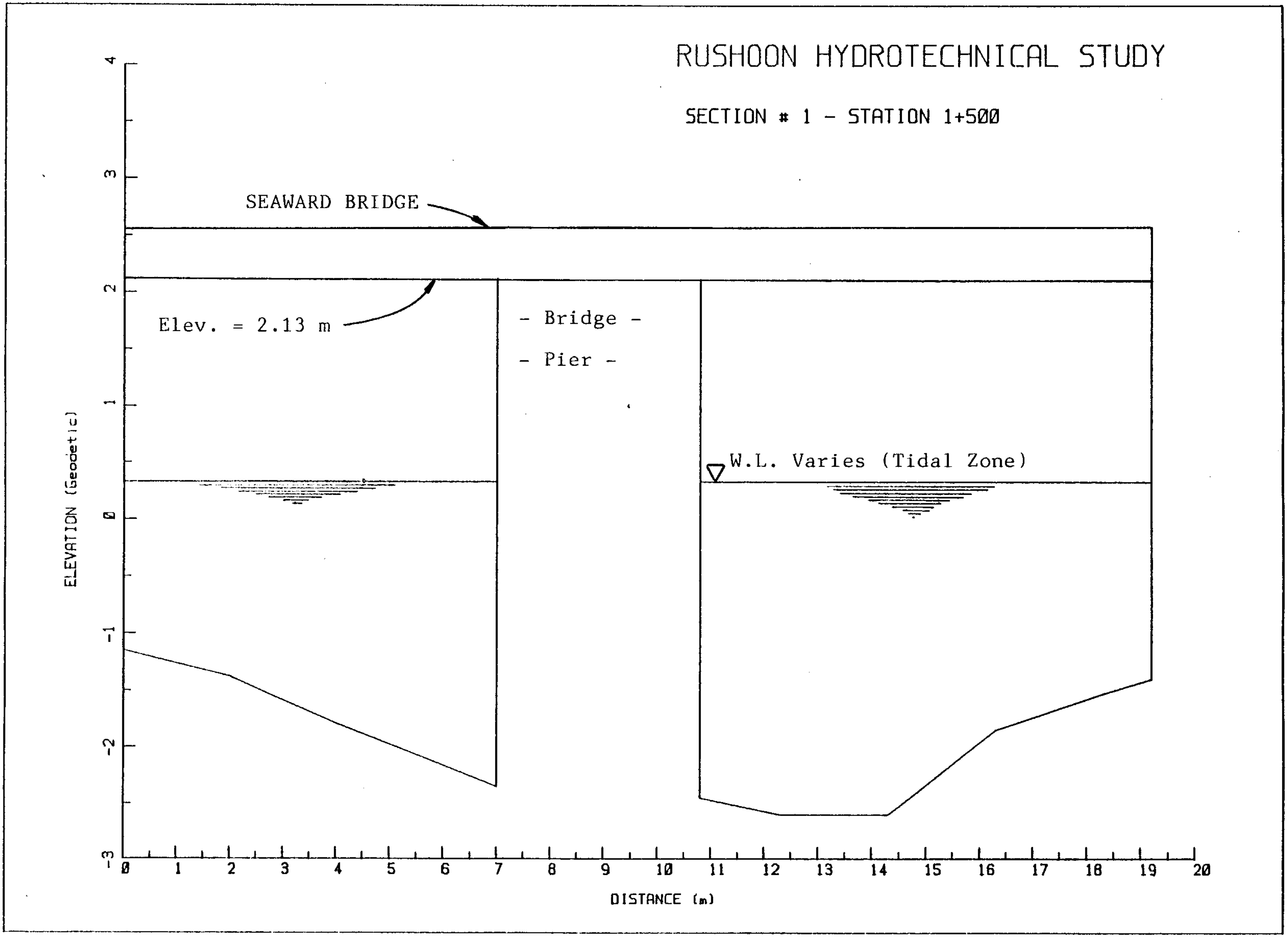
Dates of Ice Survey: March 26 & 27, 1985

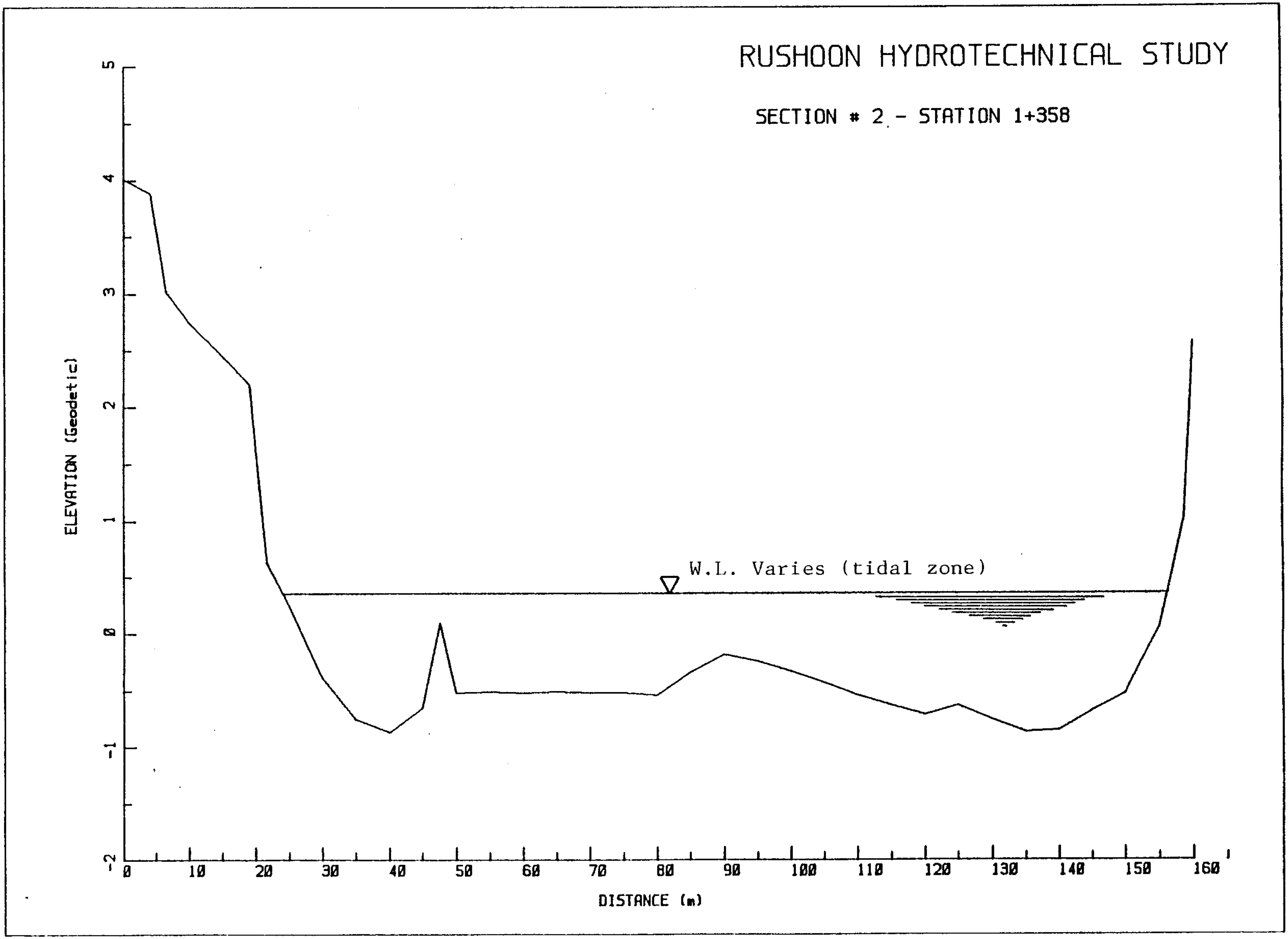
SECTION	MEAN THICKNESS m	MEAN WIDTH m	LENGTH m	ICE VOL. m^3	REMARKS
Section #1	0.46	120	350	19300	Below Expected Jam Site
Section #2	0.82	33	260	7000	
Section #3	0.76	35	400	10600	
Section #4	0.51	30	490	7500	Bailey Bridge
Section #5	2.26	20	150	6800	Rough Rocks. Extreme Thickness Are Localized to 150 m Zone
	0.70	30	150	3200	
Section #6	0.70	20	900	12600	
Section #7	0.70	18	1000	12600	

Estimate Volume of Ice in Sections #2 to #7 = 60300 m^3

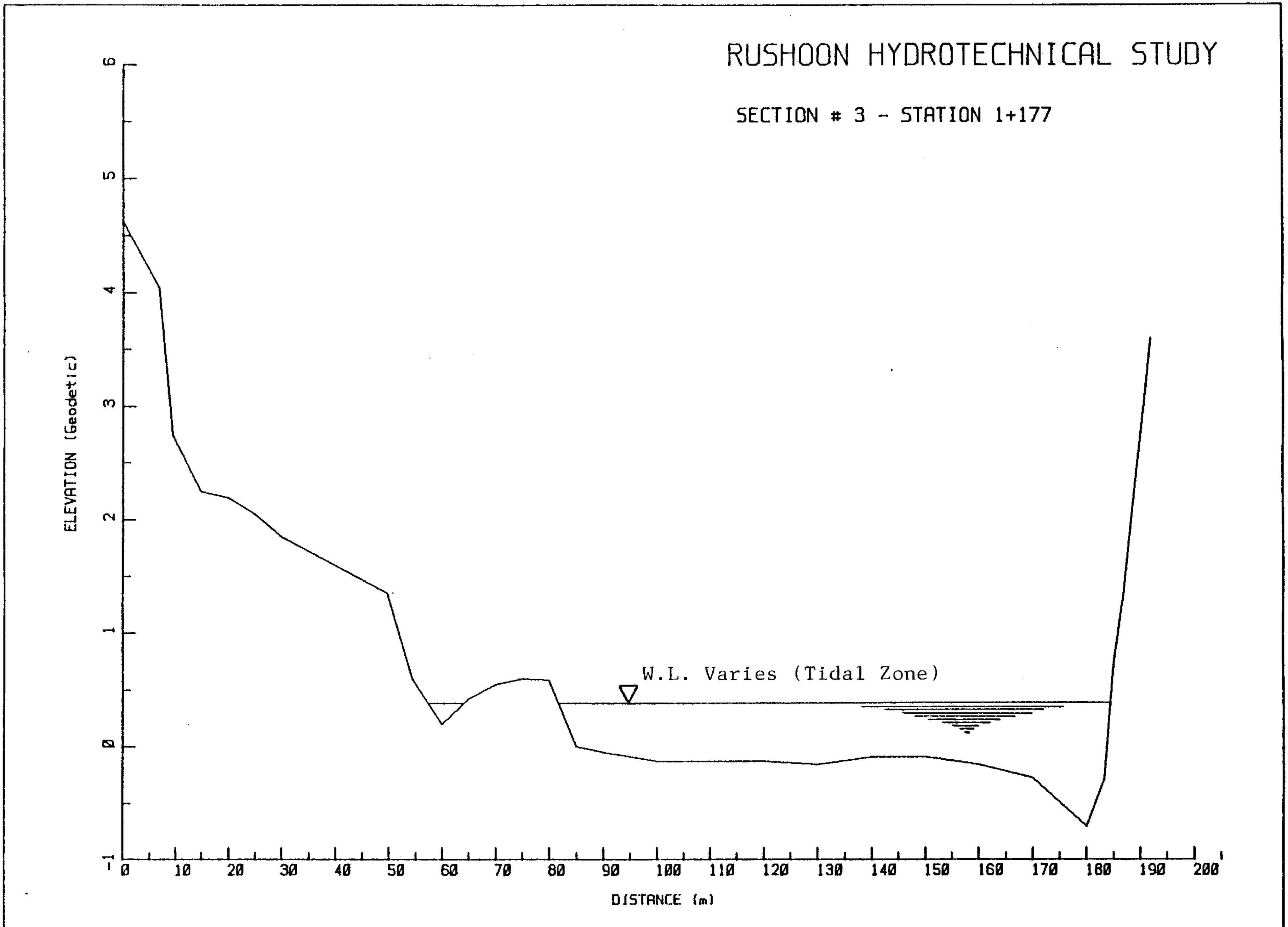
Average Ice Thickness in Section #2 to #7 = 0.69 m

Gully #3	2.40	30	250	18000	Probably Thickened by Frazil
Gully #2	0.47	30	150	2100	
Gully #1	0.48	60	120	3500	


RUSHOON HYDROTECHNICAL STUDY
SECTION # 1 - STATION 1+500
SEAWARD BRIDGE
Elev. = 2.13 m
- Bridge -
- Pier -
W.L. Varies (Tidal Zone)
ELEVATION (Geodetic)
DISTANCE (m)

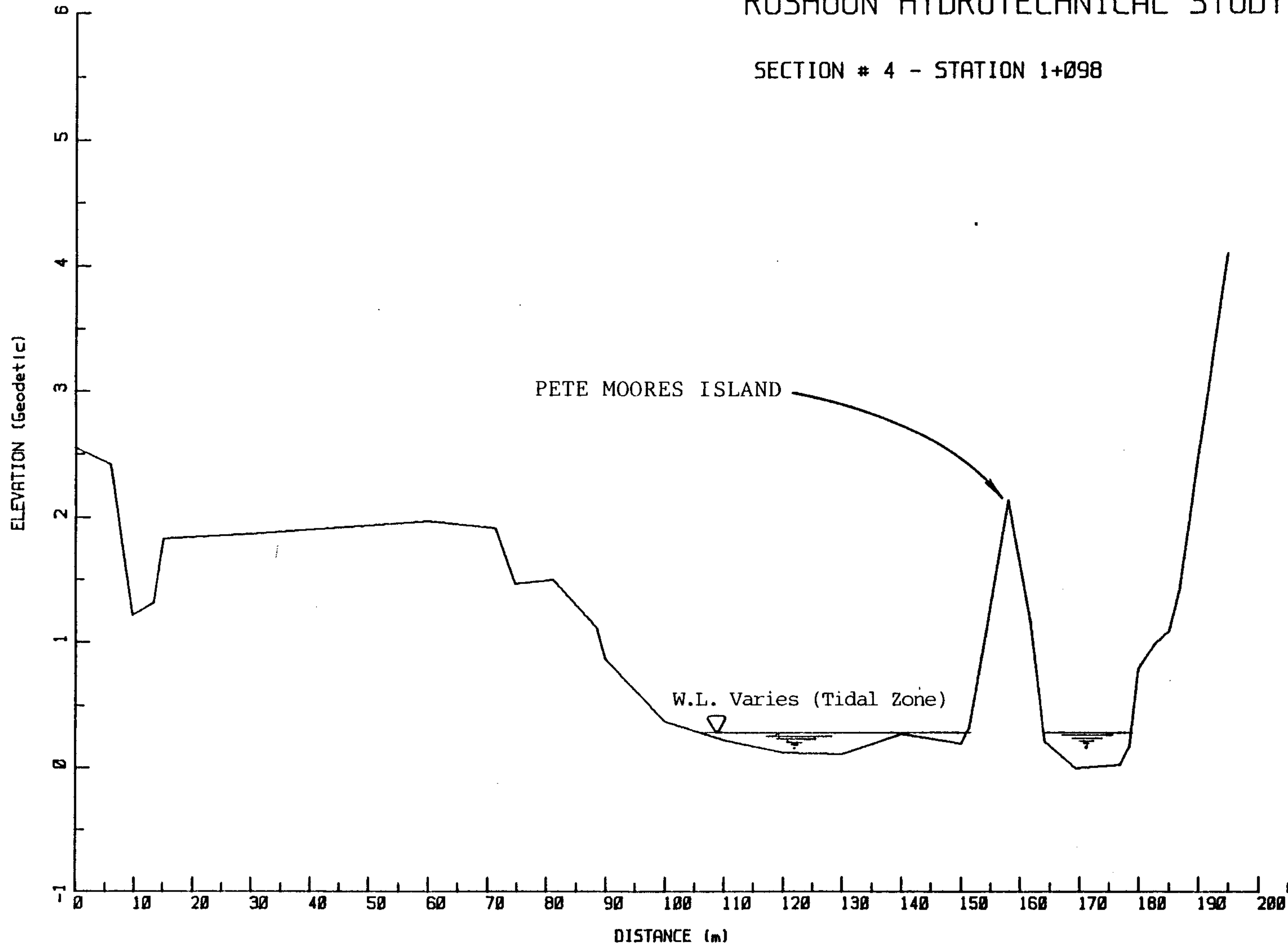


RUSHOON HYDROTECHNICAL STUDY
SECTION # 2 - STATION 1+358
W.L. Varies (tidal zone)
ELEVATION (Geodetic)
DISTANCE (m)
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160


RUSHOON HYDROTECHNICAL STUDY
SECTION # 3 - STATION 1+177
W.L. Varies (Tidal Zone)
ELEVATION (Geodetic)
DISTANCE (m)
-1
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200

RUSHOON HYDROTECHNICAL STUDY

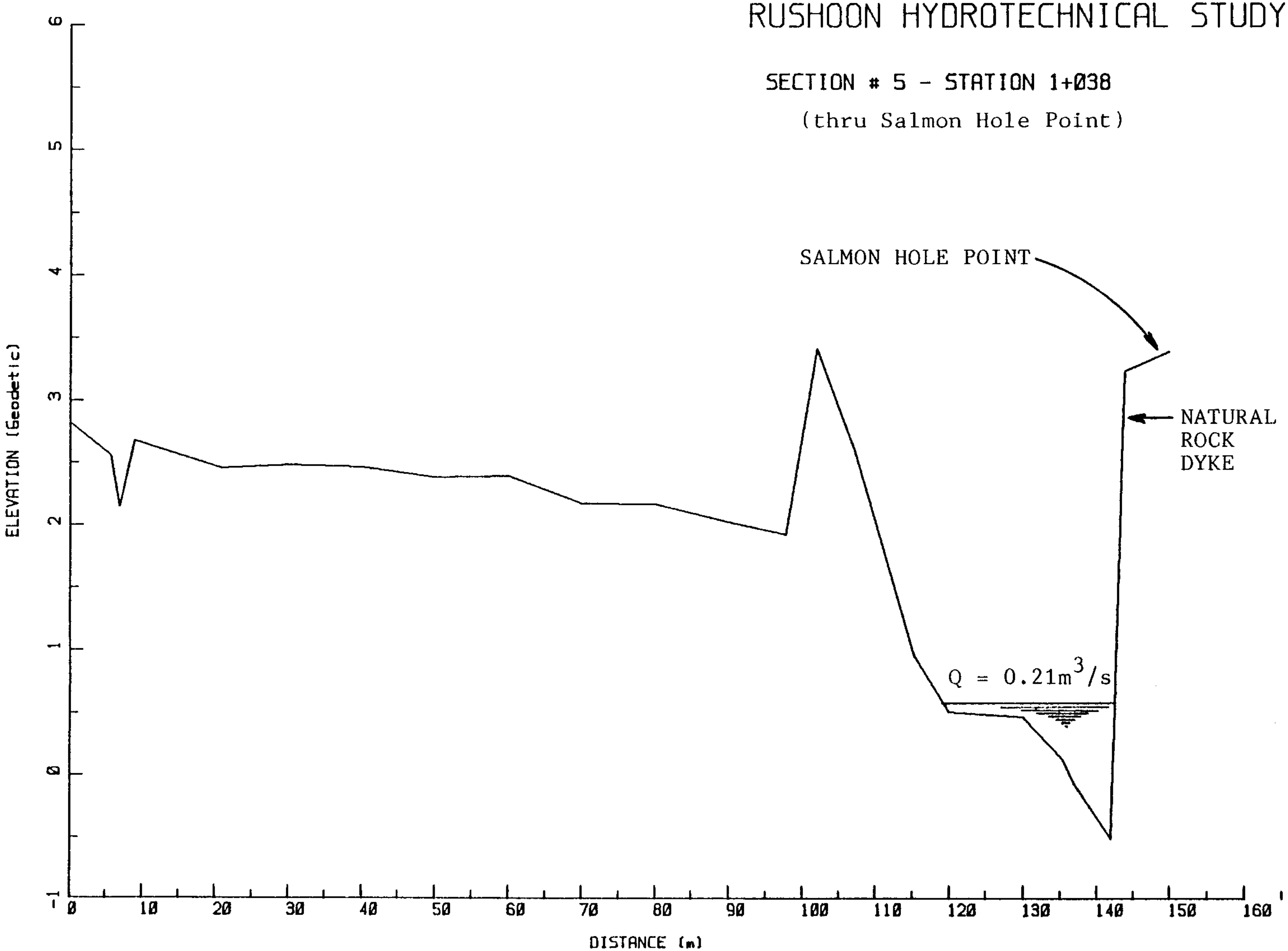
SECTION # 4 - STATION 1+Ø98

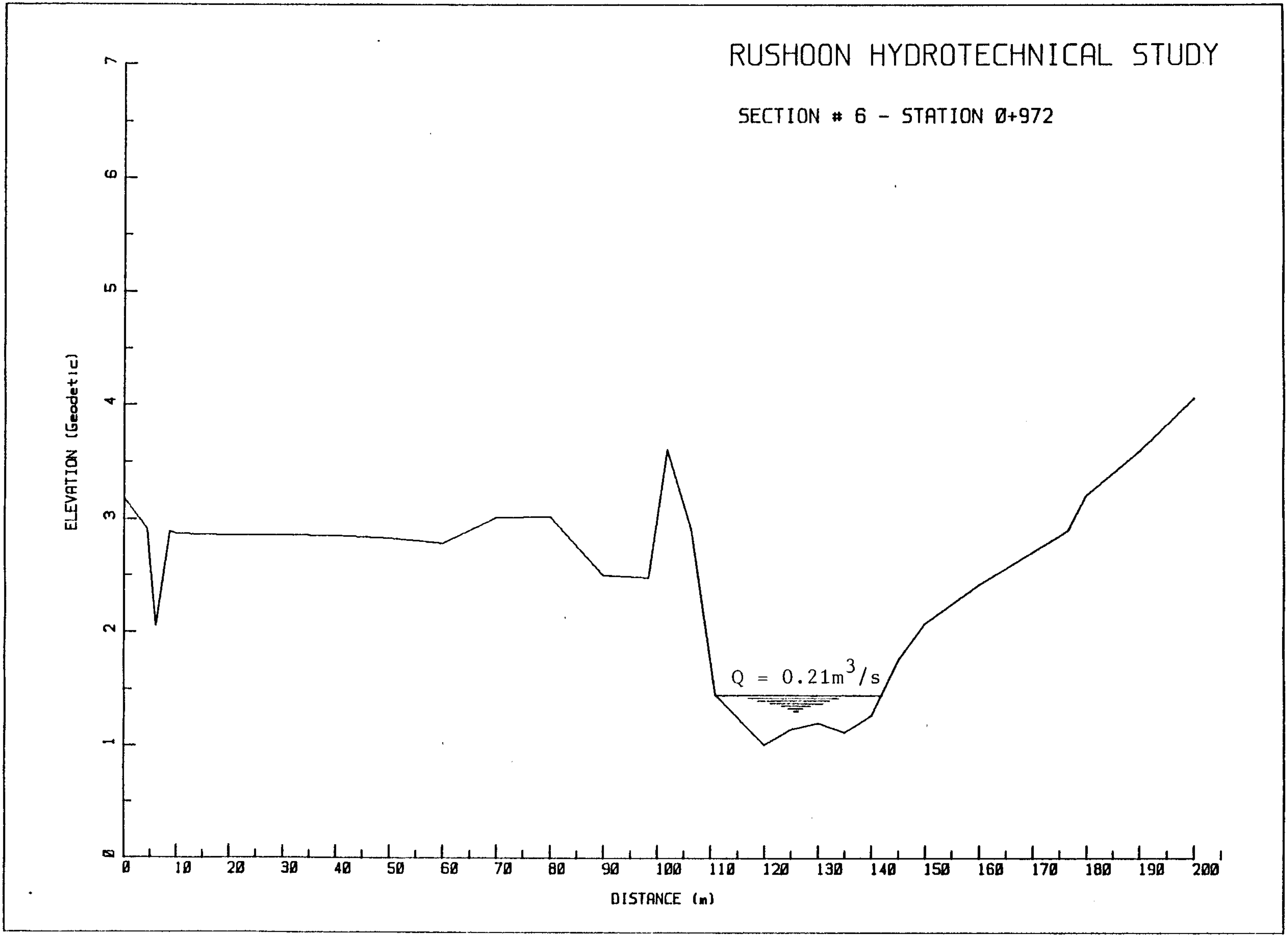


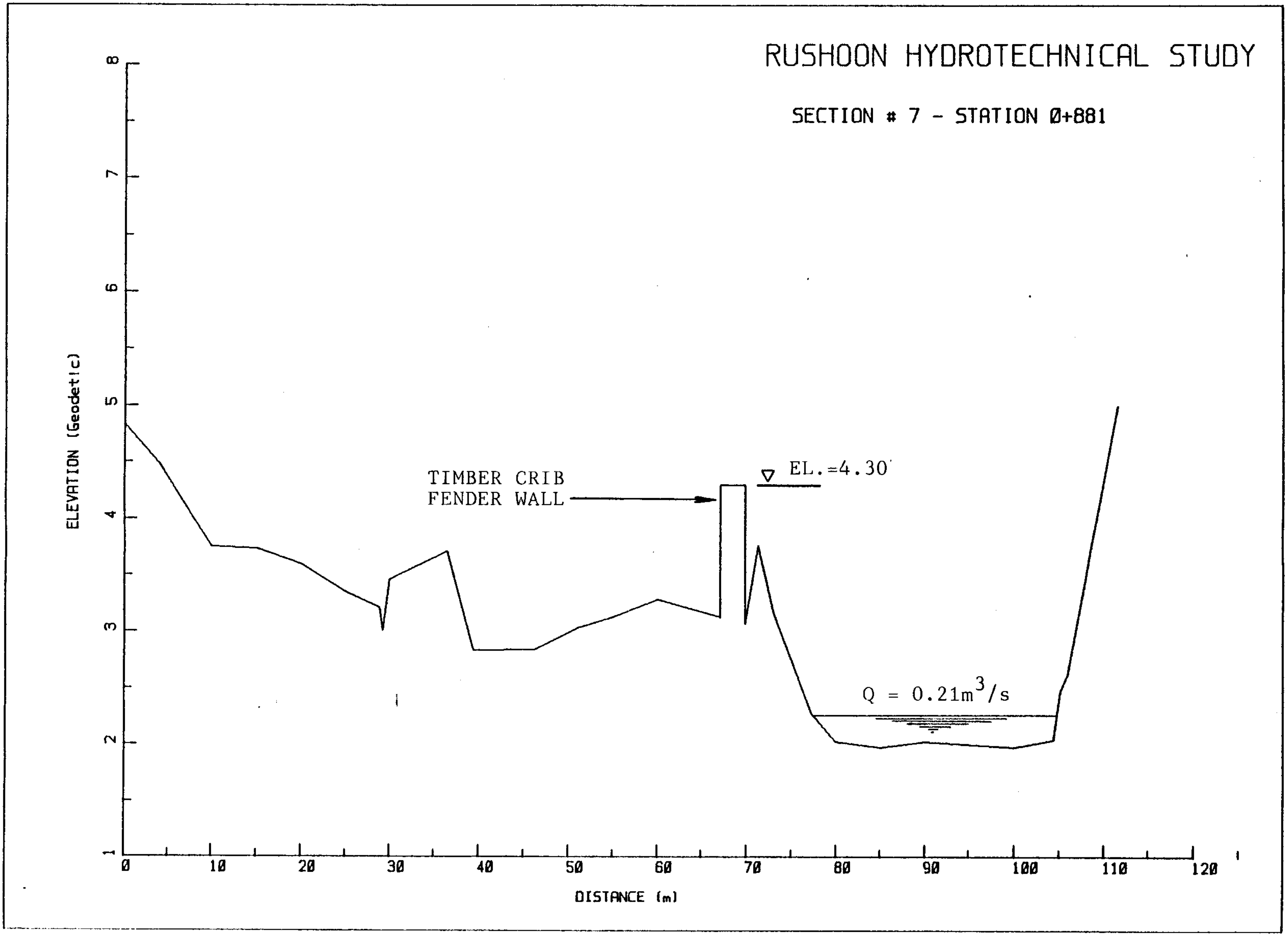
RUSHOON HYDROTECHNICAL STUDY

SECTION # 5 - STATION 1+Ø38

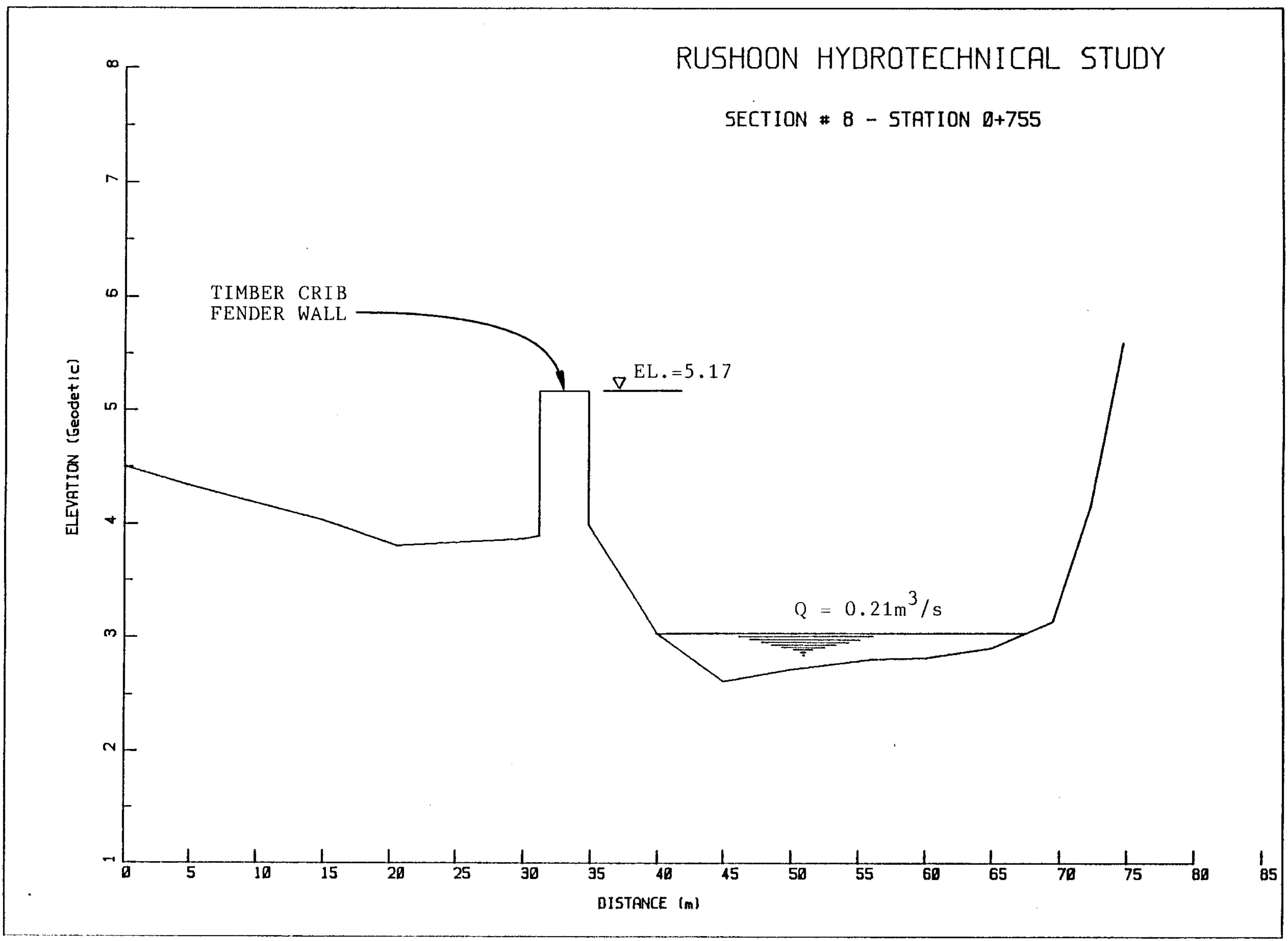
(thru Salmon Hole Point)




RUSHOON HYDROTECHNICAL STUDY
SECTION # 6 - STATION Ø+972
ELEVATION (Geodetic)
DISTANCE (m)
Q = 0.21m3/s
Ø
1
2
3
4
5
6
7
Ø
1Ø
2Ø
3Ø
4Ø
5Ø
6Ø
7Ø
8Ø
9Ø
1ØØ
11Ø
12Ø
13Ø
14Ø
15Ø
16Ø
17Ø
18Ø
19Ø
2ØØ

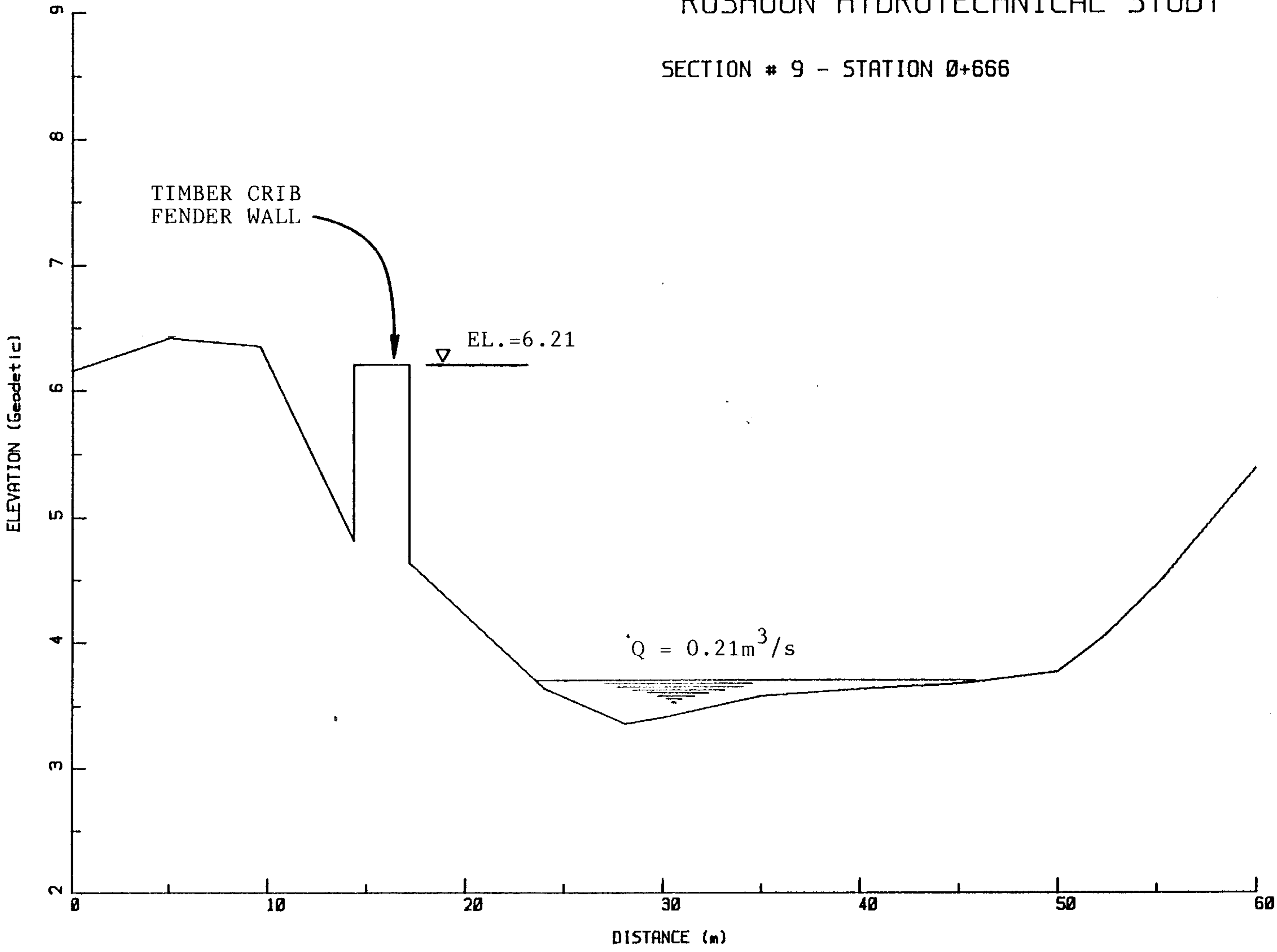


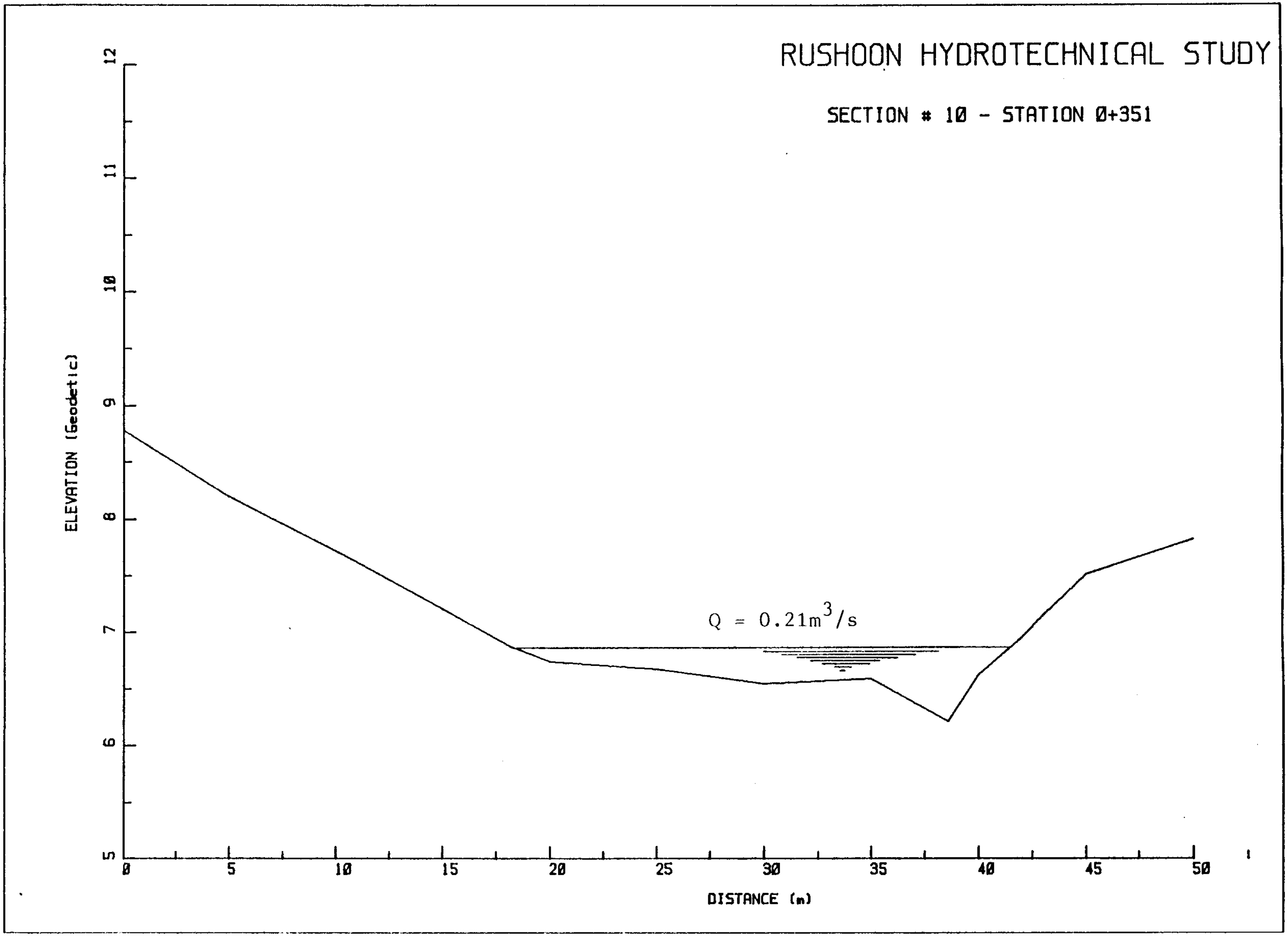
RUSHOON HYDROTECHNICAL STUDY
SECTION # 7 - STATION Ø+881
TIMBER CRIB
FENDER WALL
EL.=4.30
Q = 0.21m³/s
ELEVATION (Geodetic)
DISTANCE (m)
8
7
6
5
4
3
2
1
Ø
1Ø
2Ø
3Ø
4Ø
5Ø
6Ø
7Ø
8Ø
9Ø
1ØØ
11Ø
12Ø


RUSHOON HYDROTECHNICAL STUDY
SECTION # 8 - STATION 0+755
TIMBER CRIB
FENDER WALL
EL.=5.17
Q = 0.21m3/s
ELEVATION (Geodetic)
DISTANCE (m)
1
2
3
4
5
6
7
8
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85

RUSHOON HYDROTECHNICAL STUDY

SECTION # 9 - STATION Ø+666

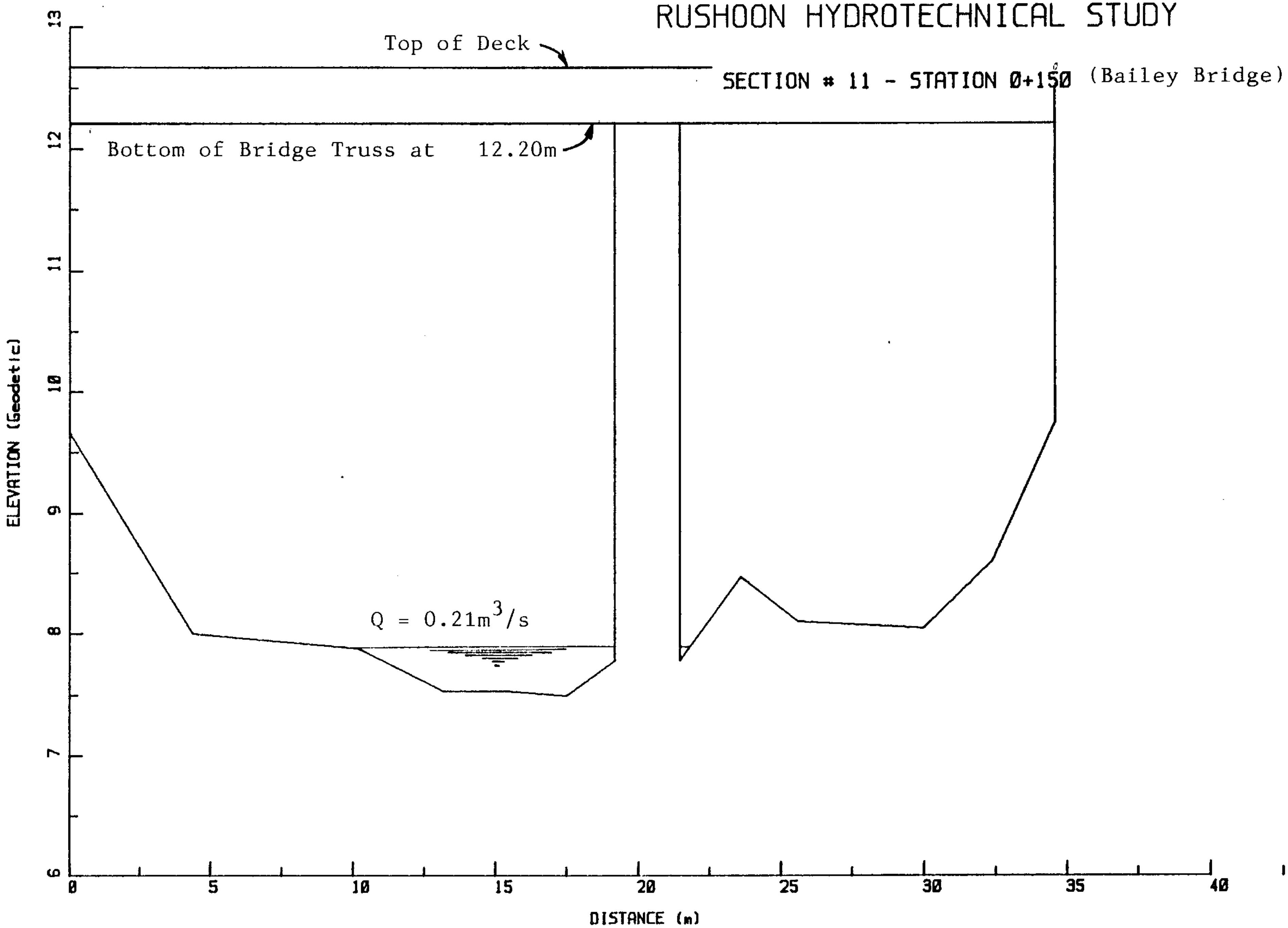


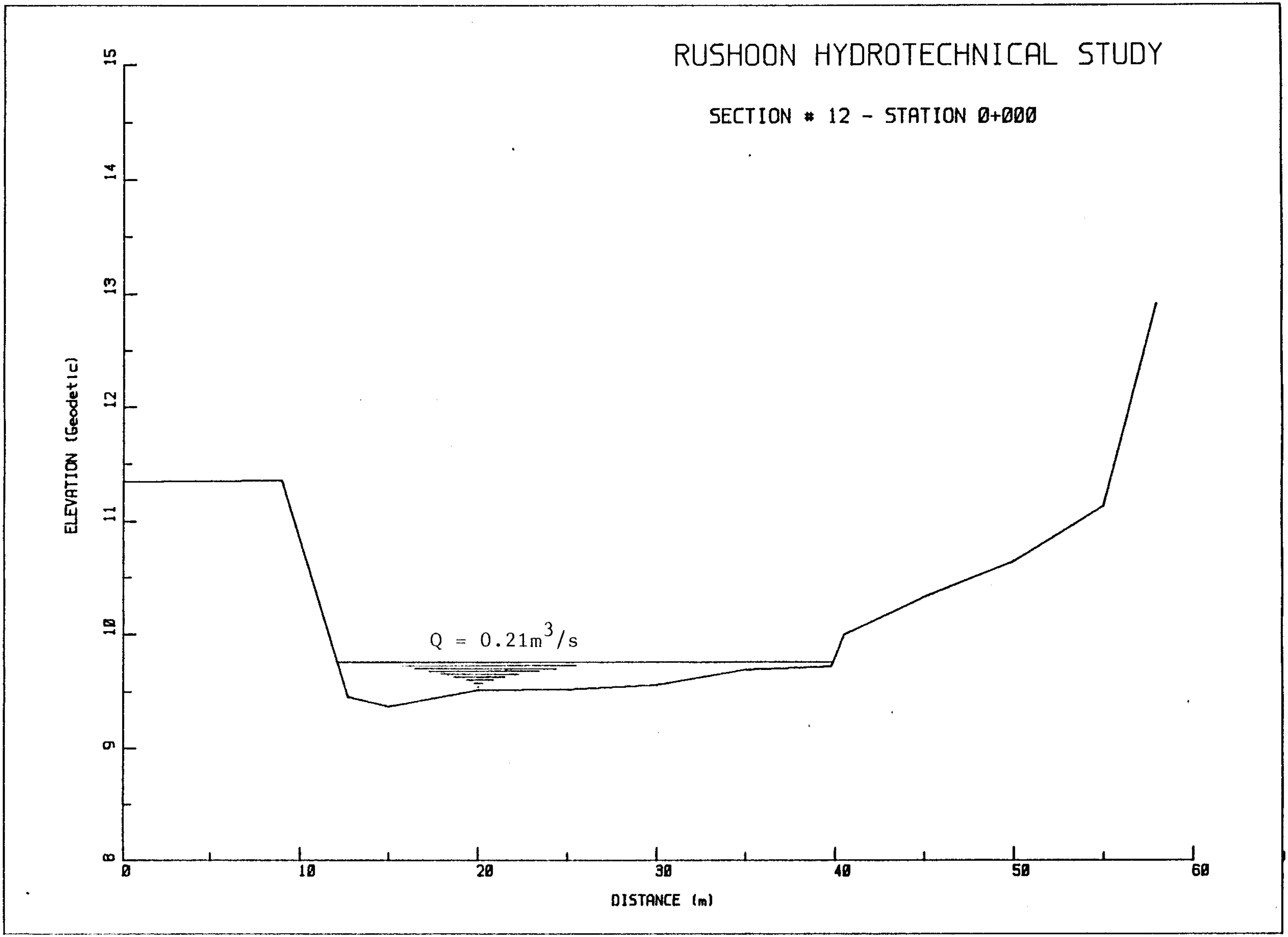


RUSHOON HYDROTECHNICAL STUDY
SECTION # 10 - STATION 0+351
Q = 0.21m3/s
ELEVATION (Geodetic)
12
11
10
9
8
7
6
5
0
5
10
15
20
25
30
35
40
45
50
DISTANCE (m)

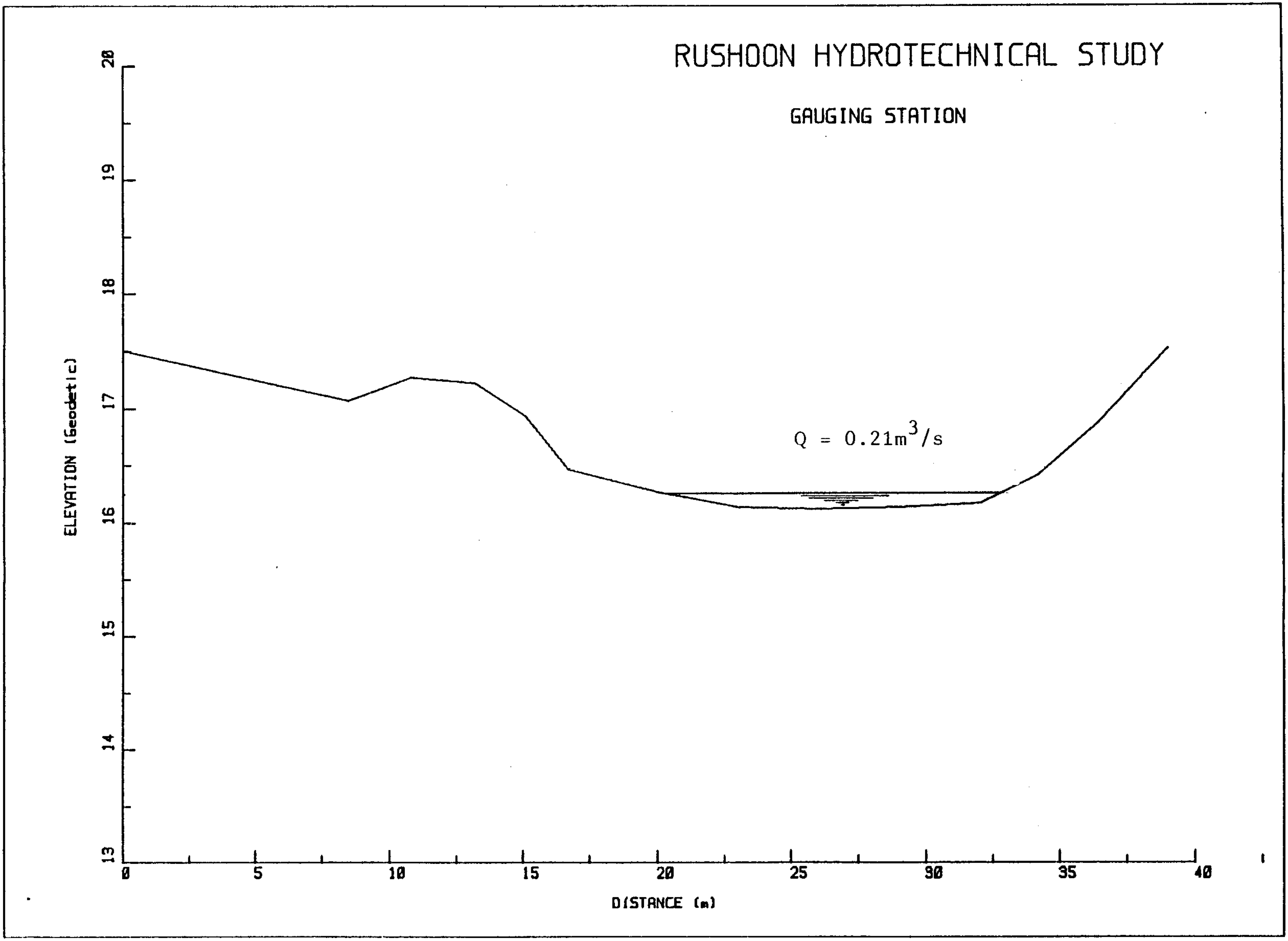
RUSHOON HYDROTECHNICAL STUDY

SECTION # 11 - STATION 0+150 (Bailey Bridge)





RUSHOON HYDROTECHNICAL STUDY
SECTION # 12 - STATION 0+000
Q = 0.21m3/s
ELEVATION (Geodetic)
15
14
13
12
11
10
9
8
0
10
20
30
40
50
60
DISTANCE (m)



RUSHOON HYDROTECHNICAL STUDY
GAUGING STATION
Q = 0.21m³/s
ELEVATION (Geodetic)
DISTANCE (m)
20
19
18
17
16
15
14
13
0
5
10
15
20
25
30
35
40

APPENDIX IV

FIGURE 1