

B.C. HYDRO

STATION PROJECTS DIVISION
THERMAL ENGINEERING DEPARTMENT

BOX 12121

555 WEST HASTINGS STREET

Vancouver, B.C. V6B 4T6

Assessment Report for the

HAT CREEK

COAL EXPLORATION PROJECT

1983

On Coal Licence Numbers

12, 144, 2753-2762, 2991-2999, 3000-3013,

3655, 7453, 7457

NTS AREA 92 1/12 and 13

Between

Latitude $50^{\circ} 36'20''$ - $50^{\circ} 48'35''$

Longitude $121^{\circ} 39'30''$ - $121^{\circ} 34' 9''$

**GEOLOGICAL BRANCH
ASSESSMENT REPORT**
APRIL 1984

00 146 ^{1/3}

~~CONFIDENTIAL~~

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INTRODUCTION

This report summarizes the site maintenance, monitoring and security programs carried out by B.C. Hydro on coal licences in Upper Hat Creek Valley from May 1983 to April 1984.

In 1982 B.C. Hydro deferred indefinitely its plans to develop the Hat Creek Coal Resource. In order to protect its investment in the exploration activities carried out to that point, a decision was made to maintain 38 of 54 coal licences held at that time. As directed by the local Inspector of Mines, a Site Maintenance and Monitoring Program, containing both mandatory and non-mandatory programs, was approved to continue data gathering in certain areas of interest e.g. groundwater conditions, environmental and reclamation programs etc. Also, the site facilities were to be maintained at a reduced level which involved disposal of some buildings and other assets, with other facilities being moved to a central location and enclosed within a fenced secure compound. All trenches and roads were to be maintained and inspected to ensure safety and security as per the Inspector of Mines Requirements.

Golder associates were consultants for the Groundwater Monitoring Program, and Klohn Leonoff were consultants for the Seismic Assessment Studies.

Mr. P. Imada provided on-site services for each of the above studies.

B.C. Hydro's Environmental Services Group provided services in the Environmental Engineering Program.

Mr. W. C. Fothergill, P. Eng. was contracted to provide site inspection services in accordance with the requirements of the local Inspector of Mines, Mr. E. Sadar, P. Eng.

Detailed exploration costs have been presented in the Application to Extend Terms of Licences. A summary is presented in Schedule B, as required under the Coal Act.

As the above programs comprise the work credit claimed for this Assessment Report, the results of the investigations, as presented by the consultants are submitted along with this assessment report.

LOCATION

Upper Hat Creek Valley, in which the coal licences are situated, is located 192 km northeast of Vancouver, B.C. midway between the towns of Lillooet and Ashcroft (Figure 1). Railheads can be reached at Pavilion, on the B.C. Railroad, 24 km to the northeast, and at Ashcroft, on the C.P. and C.N. railroads, 48 km to the east. Easiest access to the property is from the Trans-Canada Highway at Cache Creek, 37 km to the east, via the secondary highway (No. 12) between Cache Creek and Pavilion. The closest regularly serviced airport is at Kamloops, 109 km to the east.

The coal licences are situated in the broad, north-trending, grassland valley, about 24 km in length, through which flows the upstream portion of Hat Creek. From the north end of this valley Hat Creek flows northeastward through a narrow valley into the Bonaparte River, which flows south to join the Thompson River at Ashcroft.

Upper Hat Creek Valley lies within the Interior Dry Belt of British Columbia at a mean elevation of about 1067m. The valley is flanked by somewhat subdued mountains that rise to elevations of 1830-2130 m 6.5 km to the west of Hat Creek and to elevations 1525-1830 m 9.7 km to the east. The uplands are covered by thin forests and the valleys are sparsely-treed open ranges of grass and sage.

COAL LICENCES

The coal licences held by B.C. Hydro are grouped into four groups as shown in Figure 3.

Table I shows the licence numbers and areas in hectares and acres, and their locations.

HAT CREEK SITE SECURITY & MAINTENANCE

The local Inspector of Mines directed that B.C. Hydro establish a site security and maintenance program to:

- a) monitor the coal trenches and coal storage areas for fires caused by spontaneous combustion and/or other means
- b) monitor the site in general, and the coal trenches and storage areas in particular, for drainage regarding leachate control
- c) control vandalism to any site facilities such as buildings, core sheds, water walls etc.

A monthly inspection routine was established and Mr. W. C. Fothergill, P.Eng., formerly Hat Creek Site Manager was contracted to carry out the above mentioned site inspection duties. A monthly site report was prepared and submitted to the local Inspector of Mines in Kamloops.

A local contractor, Pavillion Lake Contracting Ltd. was also hired to provide assistance to carry out any repairs, modifications etc. to site fences, facilities and roads as required following the monthly inspection. Also, this local contractor was assigned certain inspection duties as required between the monthly inspections.

It was necessary at times to monitor the coal storage piles daily after several high temperatures were noted in certain of the piles; also fence repairs were frequently required, and clean-out of ditches and culverts.

At the beginning of the year, following the sale of numerous buildings in an asset disposal sale all equipment was moved to a central fenced compound for security.

GROUNDWATER MONITORING PROGRAM

This program was established to ensure the acquisition of data regarding the groundwater regime in the area of the No. 1 Coal Deposit, at the north end of Hat Creek Valley. The program consisted of the reading of selected standpipe and pneumatic piezometers on a quarterly or semi-annual basis, and the assessment and plotting of the readings onto existing hydrographs.

A local resident was hired to take the readings as required by a schedule prepared by Golder Associates, who in turn processed the readings and prepared a report which is included in the Assessment Report as an appendix.

SEISMIC MONITORING PROGRAM

For the proposed Hat Creek Project it was decided that in view of the large structures involved, i.e. water reservoir dam, mine waste embankment etc., it would be necessary to monitor the area for seismic activity. This program was commenced in October 1981 and in order to gain the maximum amount of information it was continued through until March 1984.

Klohn-Leonoff was hired as consultant to compile and analyze the data recorded on a microseismic instrument located at the entrance to the Hat Creek Valley. A local resident was hired to operate and maintain the instrument on site.

A report on the Program by Klohn-Leonoff is attached to this report for reference.

ENVIRONMENTAL MONITORING PROGRAM

As recommended by B.C. Hydro's Environmental and Socio-Economic Services Department, an environmental monitoring program was established to ensure continuity of an environmental data base. The program covered the

monitoring, a mine leachate, reclamation, fresh water quality and meteorology.

The following describes the activities, in summary, for the year.

Mine Leachate

Quarterly inspection and collection (where possible) of leachate samples from coal piles and waste dumps. Routine inspection of trenches and pits for seepage.

Reclamation

A June site inspection was conducted to determine the condition of all reclaimed areas. The results of this inspection were documented in the 1983 Hat Creek Reclamation Report submitted to the Inspector of Mines.

Fresh Water Quality

Samples of water from the Hat Creek and Bonaparte River were collected in March, June and September as part of the ongoing pre-construction water quality monitoring program. This sampling program was discontinued in December 1983 to reduce costs.

Meteorological Monitoring

Continuous monitoring of meteorological parameters at two sites in the Hat Creek area was carried out until November 1983 when the meteorological program was eliminated. In the future meteorological site buildings and structures will be maintained however no data will be collected.

OTHER STUDIES

Other activities associated with the Hat Creek Coal Resource and which were principally carried out by B.C. Hydro "in-house" were:

- a) geological review and update
- b) preparation of a mine plan for a 225MW Thermal Plant as a further alternative for the development of Hat Creek.

a) Geological Review - as an on-going update of the data which has been gathered from the various site investigation programs, a review of the geophysical logs was carried out. This resulted in some re-interpretation of the coal deposit and approval was given to re-draw the geological cross-sections of No. 1 Deposit. This work is in progress and completion is forecasted for August 1984.

b) 225MW Mine Plan - As a further alternative for the development of Hat Creek, B.C. Hydro's Thermal Engineering Department carried out a pre-feasibility study on a 225MW (gross) Thermal Plant and associated Mine.

The various mine plans, site layout and associated capital and operating costs have been developed for a mine to supply up to 930,000 tonnes of coal/annum to a powerplant located to the north-east of No. 1 Deposit.

A report is presently in preparation and will be submitted as part of this report when completed.

SCHEDULE B

Category of Work	Dimensions (where applicable)	Unit Cost (where applicable)	Cost
Geological Mapping			
Reconnaissance	_____	_____	_____
Detail—			
Surface	_____	_____	_____
Underground	_____	_____	_____
Other (specify)*	_____	_____	_____
Geophysical/Geochemical Surveys			
Method	_____	_____	_____
Grid	_____	_____	_____
Topographic	_____	_____	_____
Other (specify)*	_____	_____	_____
Road Construction			
On licenses Nos.	_____	_____	_____
Access to	_____	_____	_____
Surface Work			
Trenching	_____	_____	_____
Seam tracing	_____	_____	_____
Crosscutting	_____	_____	_____
Other (specify)*	_____	_____	_____
Underground Work			
Test adits	_____	_____	_____
Other workings*	_____	_____	_____
Drilling			
Cores—			
Diamond	_____	_____	_____
Wireline	_____	_____	_____
Rotary—			
Conventional	_____	_____	_____
Reverse circulation	_____	_____	_____
Other (specify)*	_____	_____	_____
Contractor			
Where core stored _____	_____	_____	_____
Logging	_____	_____	_____
Sampling	_____	_____	_____
Testing	_____	_____	_____
Other work: (specify details)* <u>Site Maintenance & Monitoring</u> } <u>\$17,689</u>			
Reclamation work (Permit No.) <u>(103) Inspection</u> }			
ON-PROPERTY COSTS			<u>\$ 17,689</u>
OFF-PROPERTY COSTS			<u>\$ 31,435</u>
TOTAL EXPENDITURES			<u>\$ 49,124</u>
<u>27 April 1984</u>		<u>W. F. MEEKS, Senior Mine Equip. Engineer</u>	
(Date)		(Signature and position)	

*A full explanation of "Other" work is to be included.

SCHEDULE B

Category of Work	Dimensions (where applicable)	Unit Cost (where applicable)	Cost
Geological Mapping			
Reconnaissance	_____	_____	_____
Detail—			
Surface	_____	_____	_____
Underground	_____	_____	_____
Other (specify)*	_____	_____	_____
Geophysical/Geochemical Surveys			
Method	_____	_____	_____
Grid	_____	_____	_____
Topographic	_____	_____	_____
Other (specify)*	_____	_____	_____
Road Construction			
On licences Nos.	_____	_____	_____
Access to	_____	_____	_____
Surface Work			
Trenching	_____	_____	_____
Seam tracing	_____	_____	_____
Crosscutting	_____	_____	_____
Other (specify)*	_____	_____	_____
Underground Work			
Test adits	_____	_____	_____
Other workings*	_____	_____	_____
Drilling			
Core—			
Diamond	_____	_____	_____
Wireline	_____	_____	_____
Rotary—			
Conventional	_____	_____	_____
Reverse circulation	_____	_____	_____
Other (specify)*	_____	_____	_____
Contractor _____			
Where core stored _____			
Logging	_____	_____	_____
Sampling	_____	_____	_____
Testing	_____	_____	_____
Other work: (specify details)*	Site Maintenance & Monitoring		\$13,014
Reclamation work (Permit No.)	(103) Inspection		
ON-PROPERTY COSTS	\$ 13,014		
OFF-PROPERTY COSTS	\$ 28,028		
TOTAL EXPENDITURES	\$ 41,042		

27 April 1984
(Date)

W. E. MEEKS P. Eng.
W. E. MEEKS Senior Mine Equip. Engineer
(Signature and position)

*A full explanation of "Other" work is to be included.

Reprinted from *The British Columbia Gazette*—Part II, December 31, 1979.

SCHEDULE B

Category of Work	Dimensions (where applicable)	Unit Cost (where applicable)	Cost
Geological Mapping			
Reconnaissance	_____	_____	_____
Detail—			
Surface	_____	_____	_____
Underground	_____	_____	_____
Other (specify)* . . .	_____	_____	_____
Geophysical/Geochemical Surveys			
Method	_____	_____	_____
Grid	_____	_____	_____
Topographic	_____	_____	_____
Other (specify)*	_____	_____	_____
Road Construction			
On licences Nos.	_____	_____	_____
Access to	_____	_____	_____
Surface Work			
Trenching	_____	_____	_____
Seam tracing	_____	_____	_____
Crosscutting	_____	_____	_____
Other (specify)*	_____	_____	_____
Underground Work			
Test adits	_____	_____	_____
Other workings*	_____	_____	_____
Drilling			
Cores—			
Diamond	_____	_____	_____
Wireline	_____	_____	_____
Rotary—			
Conventional	_____	_____	_____
Reverse circulation . .	_____	_____	_____
Other (specify)*	_____	_____	_____
Contractor _____			
Where core stored _____			
Logging	_____	_____	_____
Sampling	_____	_____	_____
Testing	_____	_____	_____

Other work: (specify details)* Site Maintenance & Monitoring \$13,013
 Reclamation work (Permit No.) (103) Inspection

ON-PROPERTY COSTS \$ 13,013
 OFF-PROPERTY COSTS \$ 28,029
 TOTAL EXPENDITURES \$ 41,042

27 April 1984
(Date)

W.E. MEEKS P.Eng.
W.E. MEEKS Senior Mine Equip. Engineer
(Signature and position)

*A full explanation of "Other" work is to be included.

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SCHEDULE B

Category of Work	Dimensions (where applicable)	Unit Cost (where applicable)	Cost
Geological Mapping			
Reconnaissance	_____	_____	_____
Detail—			
Surface	_____	_____	_____
Underground	_____	_____	_____
Other (specify)*	_____	_____	_____
Geophysical/Geochemical Surveys			
Method	_____	_____	_____
Grid	_____	_____	_____
Topographic	_____	_____	_____
Other (specify)*	_____	_____	_____
Road Construction			
On licences Nos.	_____	_____	_____
Access to	_____	_____	_____
Surface Work			
Trenching	_____	_____	_____
Seam tracing	_____	_____	_____
Crosscutting	_____	_____	_____
Other (specify)*	_____	_____	_____
Underground Work			
Test adits	_____	_____	_____
Other workings*	_____	_____	_____
Drilling			
Core—			
Diamond	_____	_____	_____
Wireline	_____	_____	_____
Rotary—			
Conventional	_____	_____	_____
Reverse circulation	_____	_____	_____
Other (specify)*	_____	_____	_____
Contractor _____			
Where core stored _____			
Logging	_____	_____	_____
Sampling	_____	_____	_____
Testing	_____	_____	_____
Other work: (specify details)* <u>Site Maintenance & Monitoring?</u>			<u>\$13,011</u>
Reclamation work (Permit No.) <u>(103) Inspection</u>			
ON-PROPERTY COSTS		\$ <u>13,011</u>	
OFF-PROPERTY COSTS		\$ <u>28,028</u>	
TOTAL EXPENDITURES		\$ <u>41,039</u>	
<u>27 April 1984</u>		<u>W.E. MEEKS Senior</u>	<u>W. E. Meeks P. Eng</u> Mine Equip. Engineer
(Date)		(Signature and position)	

*A full explanation of "Other" work is to be included.

Reprinted from *The British Columbia Gazette*—Part II, December 31, 1979.

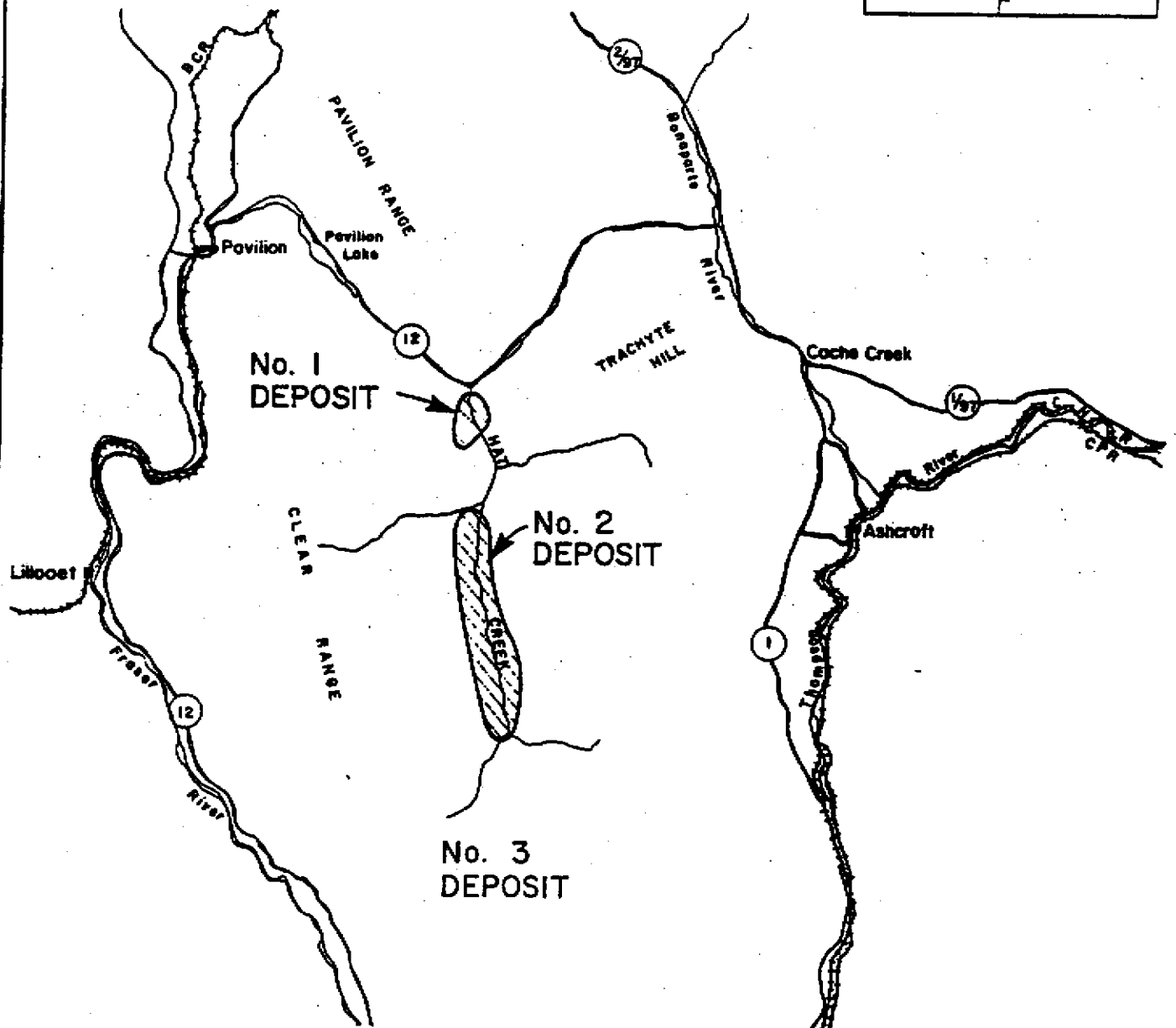
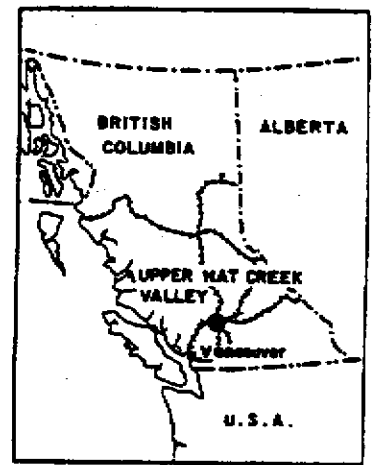
TABLE 1

	<u>LICENCE No.</u>	<u>ACRES</u>	<u>HECTARES</u>	<u>LOCATION*</u>	
	12	640	259.0	E $\frac{1}{2}$ of E $\frac{1}{2}$ of W $\frac{1}{2}$ of 1/21/27+ W $\frac{1}{2}$ of W $\frac{1}{2}$ of 6/21/26	
	144	320	129.5	E $\frac{1}{2}$ of W $\frac{1}{2}$ of 6/21/26+ E $\frac{1}{2}$ of W $\frac{1}{2}$ of 7/21/26	
<u>GREEN</u> <u>GROUP</u> <u>NO. 1</u>	2758	630	254.95	11/21/27	
	2759	588	237.95	2/21/27	
	2760	319	129.09	W $\frac{1}{2}$ of W $\frac{1}{2}$ of 12/21/27+ W $\frac{1}{2}$ of W $\frac{1}{2}$ of 1/21/27	
	2761	640	259.0	35/21/27	
	3005	320	129.5	N $\frac{1}{2}$ of 25/19/27	
	3006	640	259.0	36/19/27	
	3007	640	259.0	1/20/27	
	3008	640	259.0	12/20/27	
	3009	640	259.0	13/20/27	
	3010	320	129.5	E $\frac{1}{2}$ of 23/20/27	
	3013	640	259.0	26/20/27	
		<u>13 Licences</u>	<u>6,977</u>	<u>2823.49</u>	
	<u>YELLOW</u> <u>GROUP</u> <u>NO. 2</u>	2992	316	127.88	N $\frac{1}{2}$ of 18/19/26
2993		640	259.0	19/19/26	
2996		635	256.97	30/19/26	
2997		642	259.81	31/19/26	
3000		642	259.81	6/20/26	
3001		642	259.81	7/20/26	
3002		642	259.0	18/20/26	
3011		640	259.0	24/20/27	
3012		640	259.0	25/20/27	
2753		640	259.0	31/20/26	
2754		638	258.19	E $\frac{1}{2}$ of 6/21/26+ E $\frac{1}{2}$ of 7/21/26	
	2762	640	259.0	36/20/27	
	<u>12 Licences</u>	<u>7,355</u>	<u>2976.47</u>		
<u>RED</u> <u>GROUP</u> <u>NO. 3</u>	2991	320	129.5	W $\frac{1}{2}$ of 17/19/26	
	2994	321	129.9	W $\frac{1}{2}$ of 20/19/26	
	2995	320	129.5	W $\frac{1}{2}$ of 29/19/26	
	2998	320	129.5	W $\frac{1}{2}$ of 32/19/26	
	2999	320	129.5	W $\frac{1}{2}$ of 5/20/26	
	3003	640	259.0	19/20/26	
	3004	640	259.0	19/20/26	
	3655	641	259.4	W $\frac{1}{2}$ of 8 +17/20/26	
	<u>8 Licences</u>	<u>3,522</u>	<u>1425.3</u>		

TABLE 1 (Cont'd)

	<u>LICENCE No.</u>	<u>ACRES</u>	<u>HECTARES</u>	<u>LOCATION*</u>
	2755	636	257.4	18/21/26
	2756	639	258.6	13/21/27
<u>ORANGE</u>	2757	636	257.4	14/21/27
<u>GROUP</u>	7453	143	58.0	Fraction of S $\frac{1}{2}$ 19/21/26 W6
<u>NO. 4</u>	7457	613	248.0	24/21/27 W6
	<u>5 Licences</u>	<u>2,667</u>	<u>1079.4</u>	
Totals	<u>38 Licences</u>	<u>20,521</u>	<u>8304.66</u>	

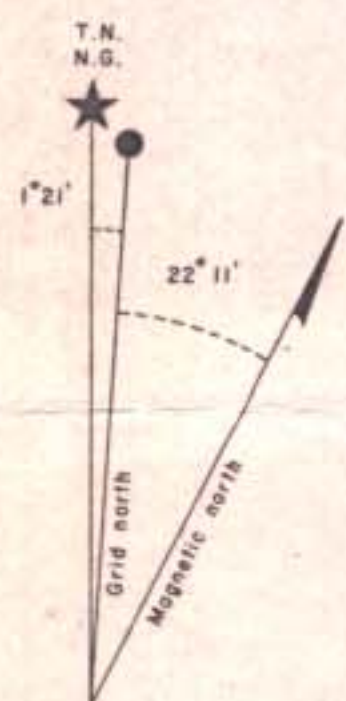
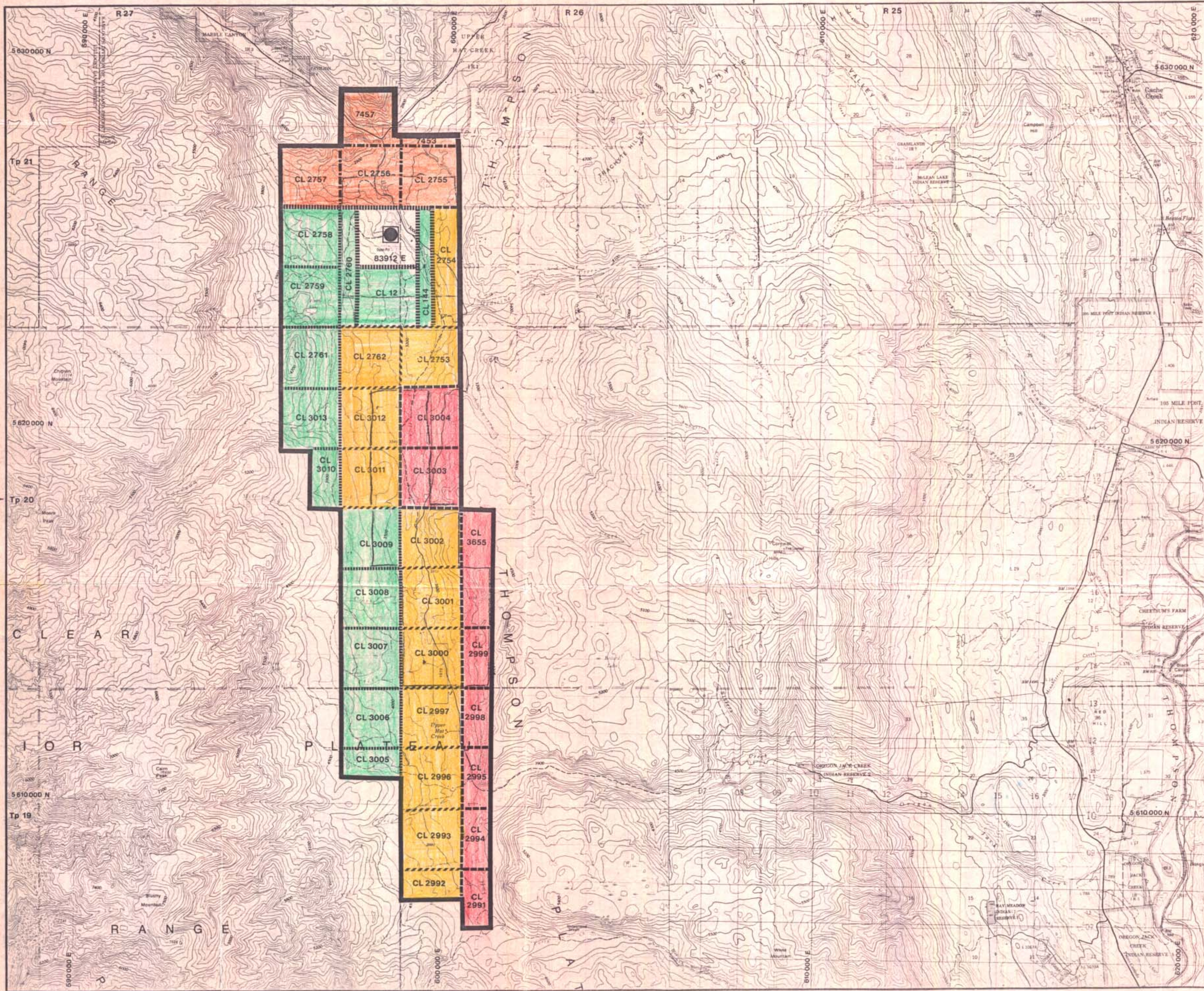
* Section/Township/Range (West of 6th Meridian, Kamloops Land District)








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BRITISH COLUMBIA HYDRO & POWER AUTHORITY	
THERMAL DIVISION · MINING DEPARTMENT	
HAT CREEK PROJECT	
LOCATION PLAN	
SEPTEMBER 1979	FIGURE 1



-  CROWN GRANT
-  GROUP 1
-  GROUP 2
-  GROUP 3
-  GROUP 4

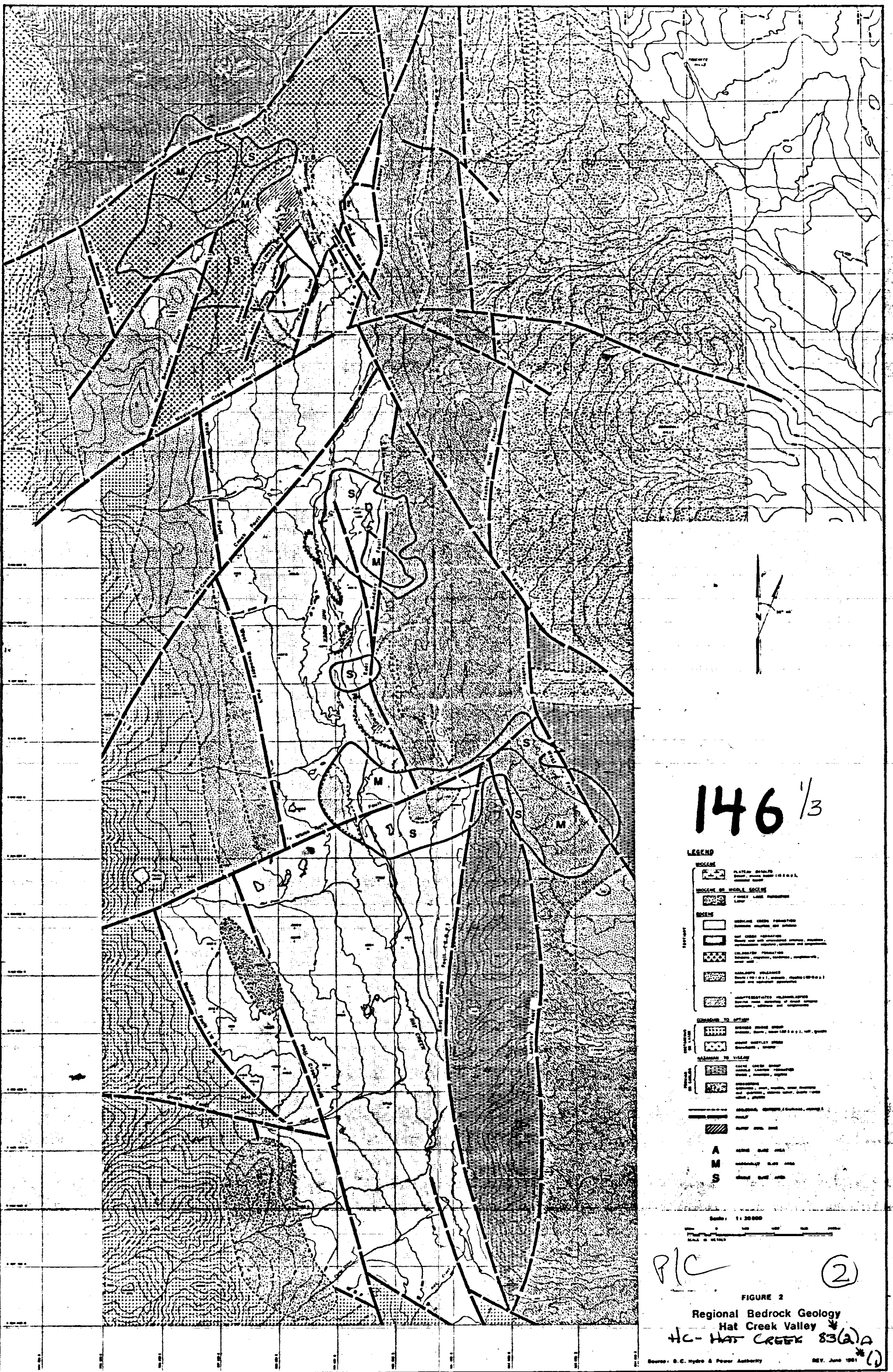
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92-1/11, 92-1/12, 92-1/13, 92-1/14

SCALE IN METRE: 1 : 50000

146 1/3

B. C. HYDRO HAT CREEK PROJECT - MINING DEPARTMENT		①
COAL LICENCES UPPER HAT CREEK VALLEY		
<i>H.C. Hat Creek 83(2)A * (1)</i>		
DATE	March 1984	R
DWN	DWG No. FIG.3	

REPORT No.



146 ¹/₃

LEGEND

MOSAIC

- PLAT. SHALE
- SANDSTONE

STRUCTURE OF MIDDLE SECTION

- FAULT LINE
- FAULT LINE

STRATIGRAPHY

- SANDSTONE
- SILTSTONE
- SHALE
- LIMESTONE
- DOLOMITE
- GNISS
- SCHIST
- QUARTZITE
- GRANITE
- DIORITE
- GABBR
- BASALT
- ANDESITE
- TUFF

STRUCTURE OF WEST

- FAULT LINE
- FAULT LINE

STRUCTURE OF EAST

- FAULT LINE
- FAULT LINE

A

M

S

Scale: 1:20000

PIC (2)

FIGURE 2
Regional Bedrock Geology
Hat Creek Valley
HC- HAT CREEK 83(2)A

~~CONFIDENTIAL~~

BRITISH COLUMBIA HYDRO AND POWER AUTHORITY
HAT CREEK PROJECT

SEISMIC OBSERVATIONS AT HAT CREEK
JANUARY 1, 1983 TO MARCH 31, 1984

GEOLOGICAL BRANCH
ASSESSMENT REPORT

Our File: PB 2834-0301

April 19, 1984

00 146



KLOHN LEONOFF
CONSULTING ENGINEERS

2/3



KLOHN LEONOFF
CONSULTING ENGINEERS

Our File: PB 2834 0301

April 19, 1984

B.C. Hydro and Power Authority
Box 12121
555 West Hastings Street
Vancouver, British Columbia
V6B 4T6

Mr. D.J. Wright, P.Eng.
Manager, Thermal Engineering Department

Seismic Observations at Hat Creek
January 1, 1983 to March 31, 1984

Dear Sirs:

We are pleased to present three (3) copies of our report on the micro-earthquake observations at Hat Creek during the period January 1, 1983 to March 31, 1984.

We have found this study very interesting and have enjoyed performing the work. Should there be any questions concerning this report, please call.

Yours very truly,

KLOHN LEONOFF LTD.

Robin G. Charlwood, Ph.D., P.Eng.
Project Manager

Encl.

RGC/tp

SEISMIC OBSERVATIONS AT HAT CREEK
JANUARY 1, 1983 TO MARCH 31, 1984

1. INTRODUCTION

In accordance with B.C. Hydro Purchase Order No. 359001, dated February 16, 1983, Klohn Leonoff Limited (KLL) operated a vertical component high gain seismograph at a site near the Hat Creek coal field during the period January 1, 1983 to March 31, 1984. The principal objectives of this experiment were:

- 1) to monitor earthquake activity within a 50 km radius of the site, and
- 2) to report epicentral distances and magnitudes of observed earthquakes.

Such data would be used in a seismic risk assessment of the area in general and the Hat Creek Thermal Project in particular.

This report summarizes and discusses the observations during the fifteen month period. Although the terms of reference in the B.C. Hydro Purchase Order refer only to the twelve month period February 1, 1983 to January 31, 1984, the observations of the other months are included for completeness (see next paragraph). The station was dismantled at the end of March 1984 and the equipment returned to B.C. Hydro. All seismograms recorded during the fifteen month period are kept in KLL offices.

The station was originally installed by the Department of Geophysics and Astronomy of the University of British Columbia. Operation began on October 2, 1982. In addition to two interim reports, a final report concerning the observations during the period October 2, 1981 to October 2, 1982 has been issued (Ellis and Meldrum, 1982a). A report on an

earthquake swarm which occurred in early October 1982 has also been issued (Ellis and Meldrum, 1982b). A report discussing observations during the months of October to December 1982 is still outstanding.

2. STATION CHARACTERISTICS

The station characteristics is as described in previous reports, but are presented here for completeness.

The recording system consists of a vertical component Mark Products L4-C 1 Hz seismometer, the output of which is recorded on a Sprengnether MLQ-800 chart recording system operated at a speed of 60 mm/min. Time calibration for this system is provided by WWV and WWVB radio time signals.

The seismometer is anchored on bedrock on the hill west of the B.C. Hydro field office at Hat Creek. A cable connects the seismometer to the chart recorder located in a heated pump-house at the base of the hill. The seismometer coordinates are 50° 47' 38" N, 121° 36' 47" W, elevation 930 m.

The magnification curve for the system is shown in Figure 1. (This curve gives the amount by which ground movement at a particular frequency is magnified before recording on the chart.) The amplifier gain is 90 db. A low cut filter is not used, but a 20 Hz high cut filter is.

3. MAGNITUDE AND DISTANCE DETERMINATION

The epicentral distance of an event was calculated by measuring the time difference, Δt , (measured in seconds) between the arrival times of the S (Shear) wave and the P (Primary or Compressional) wave. The P wave velocity of the upper layers of the earth is usually taken to be 6.1 km/sec. Assuming a Poisson's ratio of 0.25 for the earth, the S

wave velocity is then 3.52 km/sec. The epicentral distance, x , is derived as follows:

$$\begin{aligned} \Delta t &= t_s - t_p \\ &= \frac{x}{3.52} - \frac{x}{6.1} \\ \text{or } x &= 8.3 \Delta t \end{aligned}$$

where t_s and t_p are the arrival times of the S and P waves, respectively. Note that this only provides a distance from the station, not a direction. More stations would be required to give the epicentral location.

Knowing the magnification of the seismograph system and the epicentral distance, the local magnitude, M_L , of an event was determined by measuring the amplitude, in millimetres, of the largest wave motion on the seismogram of the event. The nomogram in Figure 2 was then used to determine the magnitude.

The magnitude was also determined by measuring the coda length, T , which is the time interval between the arrival of the S wave and the time that the signal to noise ratio returns to 1. Given T , the coda length magnitude, M_T , is given by:

$$M_T = -3.2 + 2.7 \log_{10} T$$

For most earthquakes of small magnitude in British Columbia, M_L should be roughly equal to M_T .

4. OBSERVED SEISMICITY

A major difficulty in detecting natural events is distinguishing them from blasts in local mines. This can usually be done by noting the time of day or week of the occurrence of the event or from blast records obtained from the mines. Also the "signature" of most blast events is quite different from that of natural events; the latter usually have a prominent S wave arrival.

During the fifteen month period, four earthquakes were recorded with an epicentral distance less than 50 km. (See Table 1) Another earthquake, Event 4, whose epicentral distance was approximately 90 km from Hat Creek, is also included. This event, whose local magnitude is 1.8, occurred near Nicola Lake and was observed at other seismograph stations in southern British Columbia. Its epicentre was located by the Pacific Geoscience Centre at 50° 16' 48" N, 120° 36' 36" (D. Weichert, pers. comm., April 12, 1984).

The other events, except Event 3, are very small earthquakes within 20 km of the station. Their local magnitudes are less than or equal to 1.0. Event 3 is possibly a blast, but occurred late at night (local time).

TABLE 1
OBSERVED SEISMICITY
January 1, 1983 to March 31, 1984

Event	Date			Time (GMT)			M_L	M_T	Distance (km)
	y	m	d	h	: m	: s			
1	83	2	18	9	: 41	: 01	0.5	0	14
2	83	2	22	7	: 47	: 34	1.0	1.0	17
3	83	4	18	6	: 06	: 55	1.3	0.7	40
4	83	5	30	11	: 03	: 46	1.8	1.7	90
5	83	10	6	4	: 25	: 17	0.9	0.4	17

5.

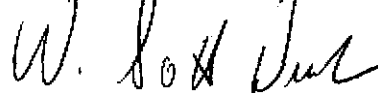
CONCLUSIONS

The level of activity observed during the fifteen month period, January 1, 1983 to March 31, 1984 is similar to that observed in this region by Ellis and Meldrum, (1982a). With one station, it is not possible to determine epicentral locations and thereby attempt to associate the activity with any of the local faults at or near the Hat Creek site. However, Events 1, 2 and 5 are located 14 to 17 km from the station, which is the approximate distance to the Fraser fault (KLL, 1982).

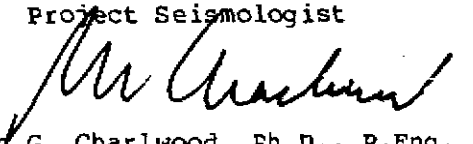
It must be noted that, by themselves, the results of this experiment should be used with caution in that

- 1) magnitudes of small events are not reliable since usually only one measurement is possible; and
- 2) significant short term increases in activity, such as the swarm of events in October, 1982, (Ellis and Meldrum, 1982b) are possible.

KLOHN LEONOFF LTD.



W. Scott Dunbar, Ph.D., P.Eng.
Project Seismologist



Robin G. Charlwood, Ph.D., P.Eng.
Project Manager

REFERENCES

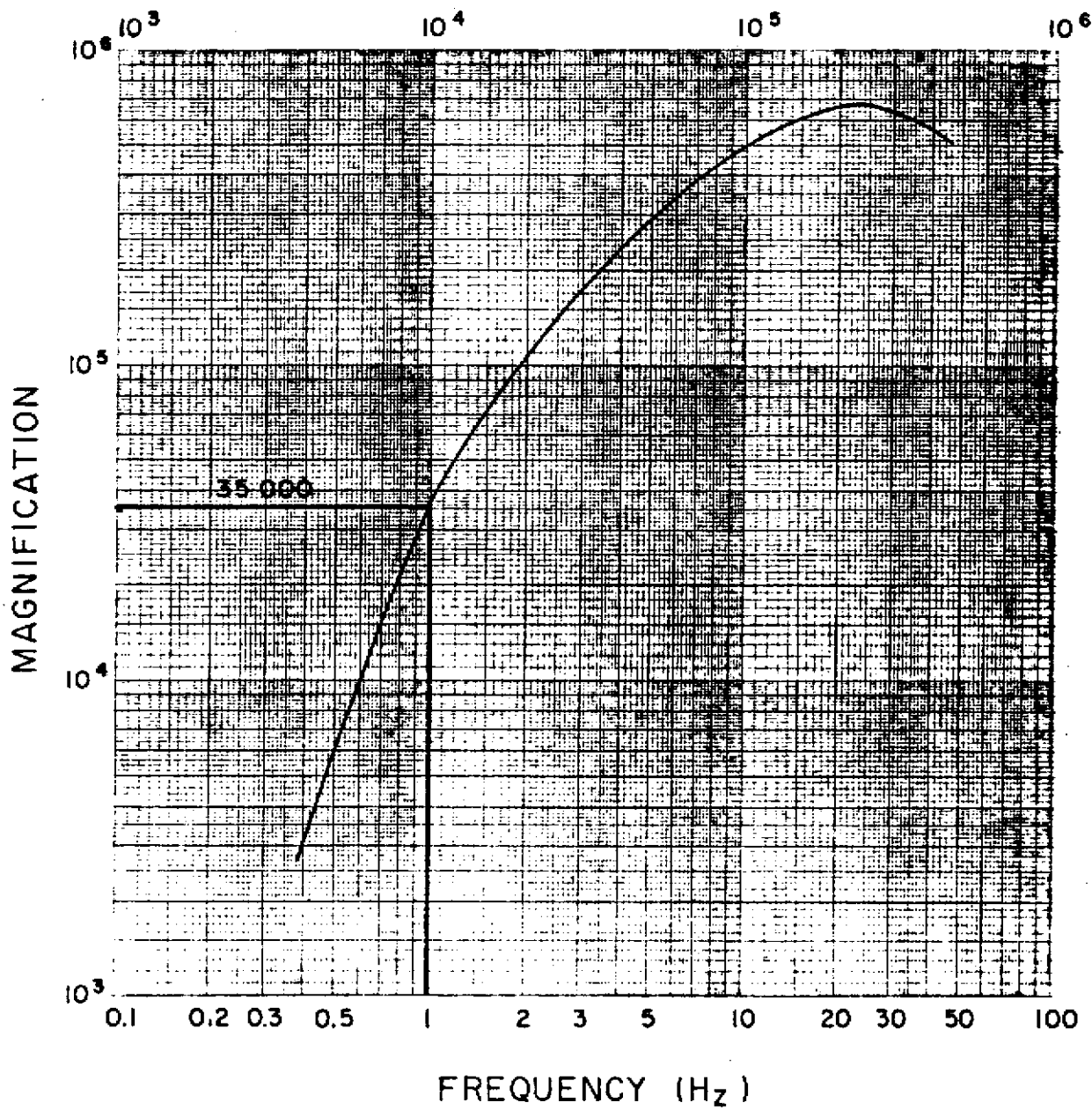
Klohn Leonoff Limited, 1982. Seismicity Assessment and Seismic Design Criteria. Report to B.C. Hydro, August 16, 1982.

Ellis, R.M. and Meldrum, R.D., 1982a. Seismic Observations at Hat Creek, October 2, 1981 to October 2, 1982. Report to Klohn Leonoff Limited, October 19, 1982.

Ellis, R.M. and Meldrum R.D., 1982b. The Hat Creek Earthquake Sequence of October 1982. Report to Klohn Leonoff Limited, November 17, 1982.


DRAWINGS

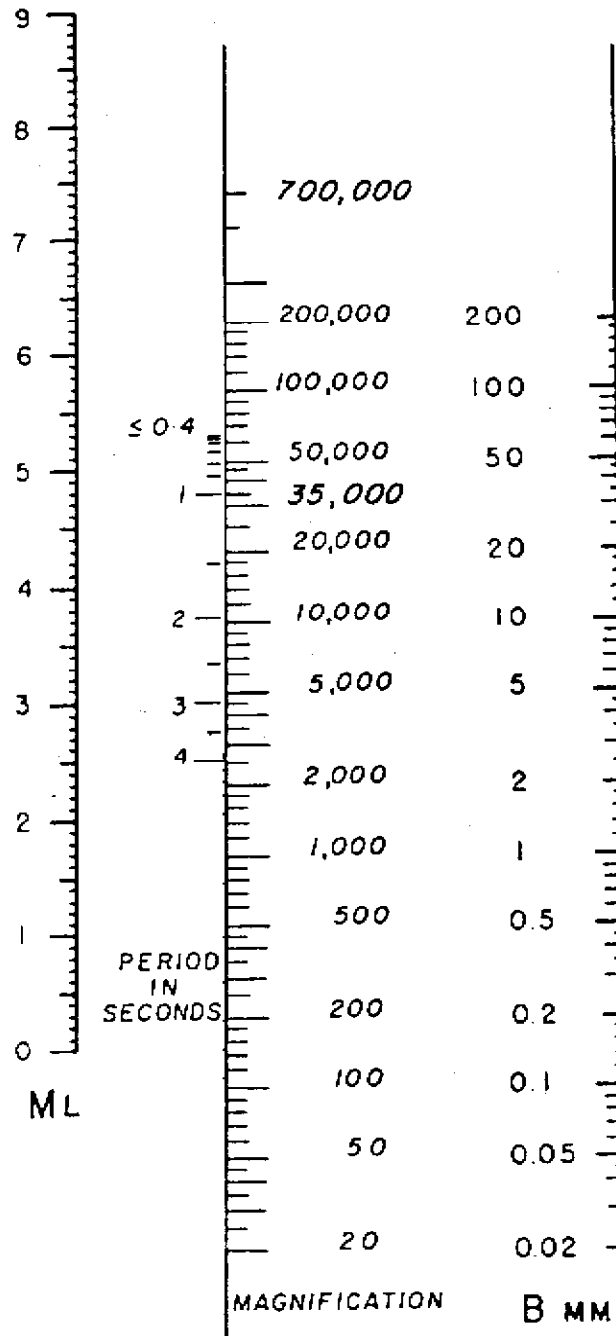
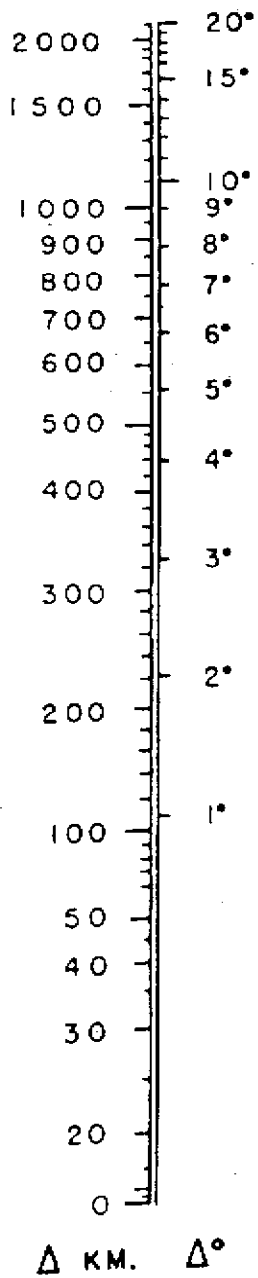
- Figure 1 Magnification Curve of
 Hat Creek Seismograph
- Figure 2 Nomogram for Magnitude
 Determination



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SCALE

 KLOHN LEONOFF LTD. CONSULTING ENGINEERS	PROJECT HAT CREEK SEISMICITY			
	TITLE MAGNIFICATION CURVE OF HAT CREEK SEISMOGRAPH			
CLIENT: BC. HYDRO & POWER AUTHORITY	DATE OF ISSUE APR. 19, 1984	PROJECT No. PB2834-03	DWG No. FIGURE - 1	REV.
APPROVED				



B = Maximum Trace Amplitude
 Δ = Epicentral Distance

AS A MUTUAL PROTECTION TO OUR CLIENT, THE PUBLIC AND OURSELVES, ALL REPORTS AND DRAWINGS ARE SUBMITTED FOR THE USE OF DIGITAL INFORMATION OF OUR CLIENT FOR A SPECIFIC PROJECT AND ALL THEIR ZONES, FORMS, AND/OR PUBLICATION OF DATA, STATEMENTS, CONCLUSIONS OR ABSTRACTS FROM OR REGARDING OUR REPORTS AND DRAWINGS IS RESERVED PENDING OUR WRITTEN APPROVAL.

SCALE



KLOHN LEONOFF LTD.
 CONSULTING ENGINEERS

PROJECT HAT CREEK SEISMICITY

TITLE NOMOGRAM FOR MAGNITUDE DETERMINATION

CLIENT: B.C. HYDRO & POWER AUTHORITY

DATE OF ISSUE APR. 19, 1984
 APPROVED

PROJECT No. PB2834-03

DWG No. FIGURE - 2

REV

NO. 144-1-KT

00

146

3/3
~~CONFIDENTIAL~~



Golder Associates

CONSULTING GEOTECHNICAL AND MINING ENGINEERS

THERMAL

E/84/445

April 12th, 1984

British Columbia Hydro
and Power Authority
555 West Hastings Street
Vancouver, B.C.
V6B 4T6

ATTENTION: Mr. W.E. Meeks, P. Eng.

Re: Hat Creek Project
Ground Water Hydrographs

FILE: 604H-90500	
THERMAL ENGINEERING DEPARTMENT	
ROUTE	INIT
DIV. MGR.	
DEPT. MGR.	
MEAGER CREEK	
PFBC	
	LEM
ACTION <u>LEM</u>	
COPIES	[diagonal line]
RETURN ORIGINAL TO CENTRAL FILES A.S.A.P.	

Dear Sir:

Further to our letter of March 14th, 1984, and subsequent telephone conversation, we have prepared a short final report summarizing the ground water level monitoring program to date at Hat Creek. The report includes an assessment of the ground water level monitoring results and attached updated computer plotted hydrographs.

1.0 INTRODUCTION

Assessment of ground water level hydrographs prepared from data gathered between 1977 and 1982 was presented in Golder Associates report entitled "Hat Creek Project Geotechnical and Hydrogeological Update, Fall 1982", submitted to B.C. Hydro. Subsequently, a reduced monitoring schedule was proposed for those piezometers located in the immediate vicinity of the pit; the proposed monitoring schedule was detailed in our letter dated February 14th, 1983, reference E/83/198. The present report is intended as an addendum to the 1982 report and covers the results of ground water level monitoring subsequently carried out by B.C. Hydro up to January 1984.

2.0 ASSESSMENT OF GROUND WATER LEVEL MONITORING (1982 - 1984)

The following assessment of ground water hydrographs is concentrated on those piezometers that have continued to show long term changes in piezometric levels. Conclusions derived from an assessment of short term ground water level fluctuations remain unchanged from the 1982 update report.

Examination of the individual ground water hydrographs indicates that there are still a number of piezometers that have not stabilized with the in situ ground water pressures. The table below details those piezometers that have recorded the greatest change in piezometric level since 1982.

Piezometer Number	Piezometric Level Change (m)	Lithology
RH 77-48-1	+1.31	Siltstone (Tcu)
RH 77-61A-2	-13.65	Claystone (Tcl)
RH 77-62-1	-14.92	Claystone (Tcl)
RH 77-63-1	+11.36	Claystone (Tcl)
RH 78-70-1	+12.07	Siltstone (Tcu)
RH 78-75-1	+1.21	Coal
DDH 76-141-1	-1.30	Siltstone/Sandstone (Tcl)
DDH 76-143-1	-1.49	Siltstone/Sandstone (Tcl)
DDH 76-150-1	-11.49	Claystone/Sandstone (Tcl)
DDH 76-161-1	-9.55	Siltstone/Sandstone (Tcl)
DDH 77-840-1	+9.13(?)	Tuffaceous Sandstone
DDH 78-867-1	-2.97	Clayey Siltstone (Tcu)

NOTE: Tcl - Coldwater Formation; Tcu - Medicine Creek Formation

These piezometers are generally installed in very low permeability bedrock (hydraulic conductivity less than 10^{-11} m/sec). Piezometer RH 77-48-1 however, appears to be completed in more permeable (10^{-7} m/sec) siltstone and may be recording higher piezometric levels due to increased precipitation during the monitoring period. The ground water level recorded in piezometer DDH 77-840-1 rose 9.13 m between July 1983 and January 1984. During the previous six years of monitoring, ground water levels in this piezometer fluctuated by approximately 1 m. The recent "rise" in ground water levels is thus attributed to reading inaccuracy rather than increased ground water levels.

The 1982 update report noted that piezometer DDH 76-150-1, completed within the siltstone, sandstone, conglomerate unit (Tcl) of the Coldwater Formation, was recording an anomalously low piezometric elevation of approximately 795 m (i.e. below the level of Hat Creek). The piezometric elevation appeared to be approaching stabilization some 4 years after carrying out a falling head permeability test. During subsequent monitoring, the ground water level in this piezometer has shown an increased rate of decline and shows no sign of stabilizing. Piezometer RH 77-61A-2, 100 m distant from DDH 76-150-1, is recording declining ground water levels similar to those recorded in DDH 76-150-1. The piezometric elevations of these two piezometers are now approximately 65 to 75 m below neighbouring piezometers completed within similar materials [siltstone, sandstone, conglomerate (Tcl)], but at different horizons. As indicated in the 1982 update report, it is considered possible that burning of the coal at outcrop within the geological past may have resulted in unloading of the underlying material leading to an expansion of the material and decrease in pore water pressure. Due to the low hydraulic conductivity of the bedrock, the reduced piezometric pressures developed on unloading have not yet come into equilibrium with the neighbouring piezometers set in more permeable parts of the rock sequence.

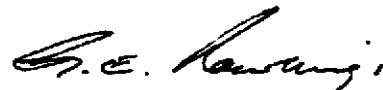
The 1982 update report indicated that a number of piezometers in the Houth Meadows area responded to the pump testing of well PW1 during July 1981. Subsequently, during autumn 1981, some piezometers in the Houth Meadows area, completed in limestone or surficial deposits, showed only a partial recovery, while others continued to decline. Subsequent monitoring during 1983 and early 1984 indicates that all of the piezometers affected by the pump test did not recover fully and have shown a continual decline in ground water levels since 1982. The decline in ground water levels in those piezometers affected (DDH 76-813-1, DDH 77-829-1, DDH 77-831-1, DDH 77-834-1, DDH 77-835-1 and DDH 77-835-2) has generally been less than 1 m. The incomplete recovery of these piezometers following pump testing reflects a slow rate of recharge to both the limestones and the surficial granular deposits. The continuing decline in ground water levels in the Houth Meadows area since 1981/82 is probably the result of removal of ground water from storage associated with the continued natural discharge of well OW4 and limited natural recharge to both the limestone and surficial deposits.

As you know, it is Golder Associates intention to continue reading some of the piezometers at Hat Creek periodically because of their unique scientific interest. We will keep you informed of any interesting changes.

We hope this report provides you with the information you require. Should you have any questions, please do not hesitate to contact me.

Yours very truly,

GOLDER ASSOCIATES



G.E. Rawlings, P. Eng.

GER/sek
832-1516

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Golder Associates

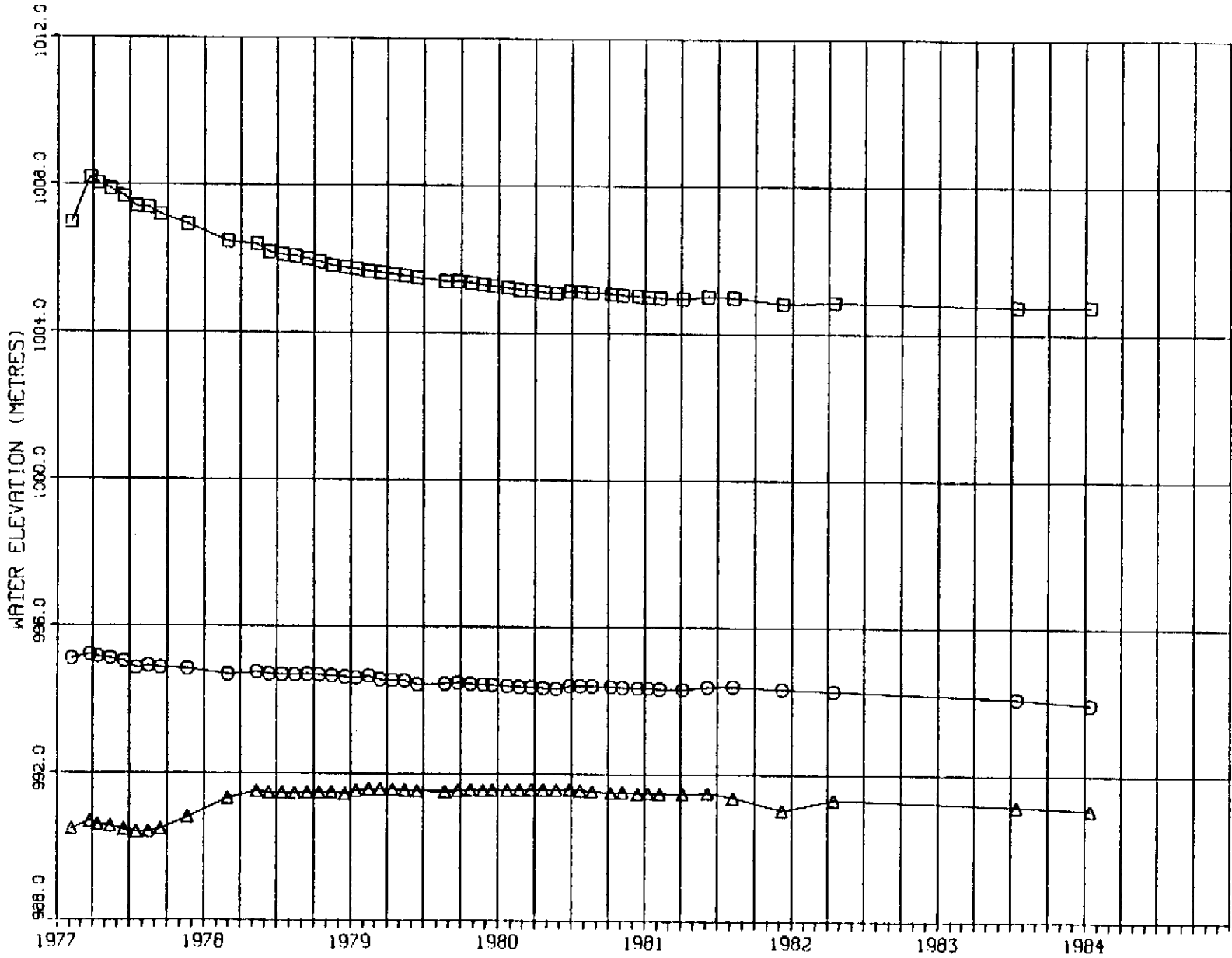
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HAT CREEK PROJECT
GROUND WATER HYDROGRAPHS
1977 - 1984

April, 1984

832-1516

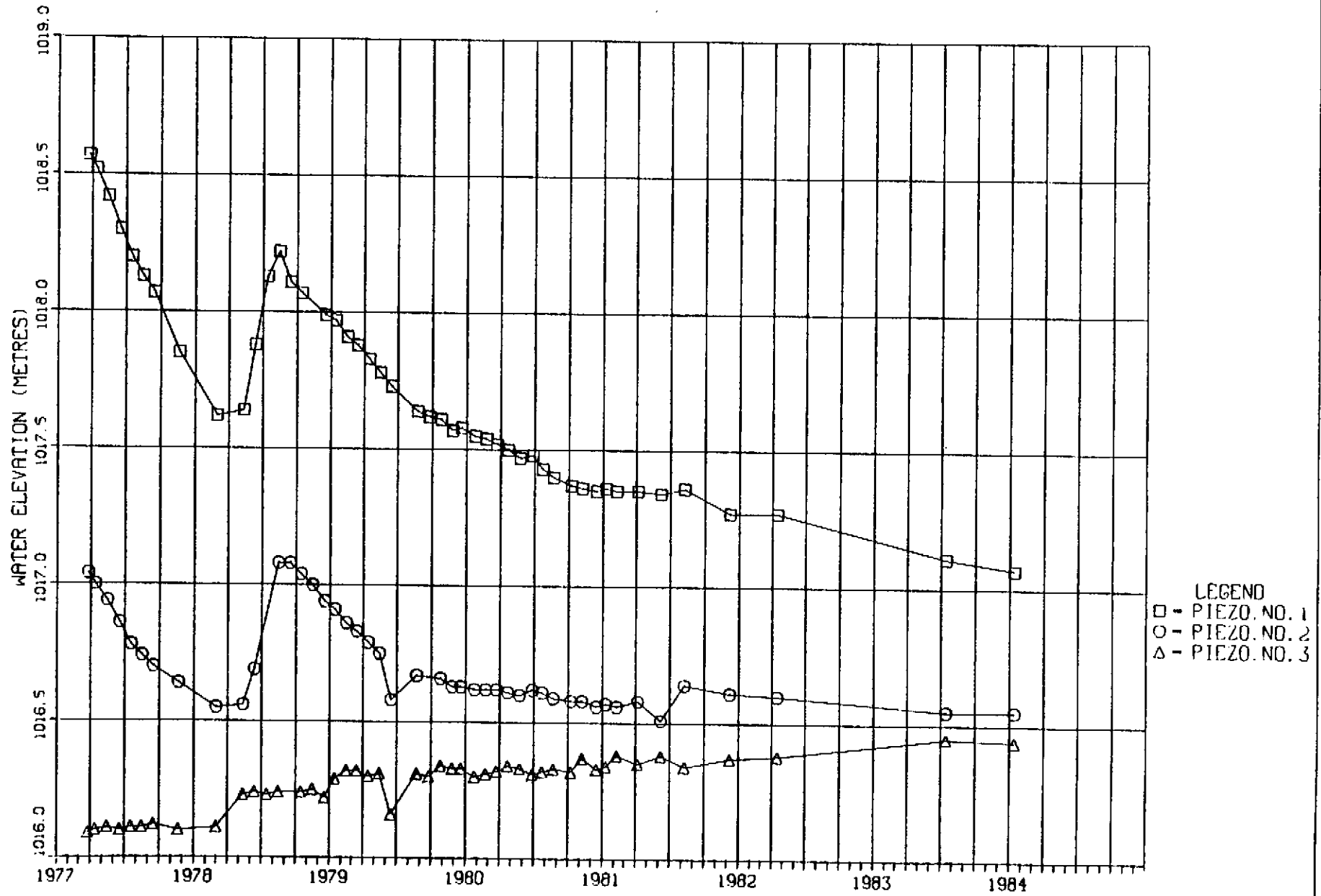
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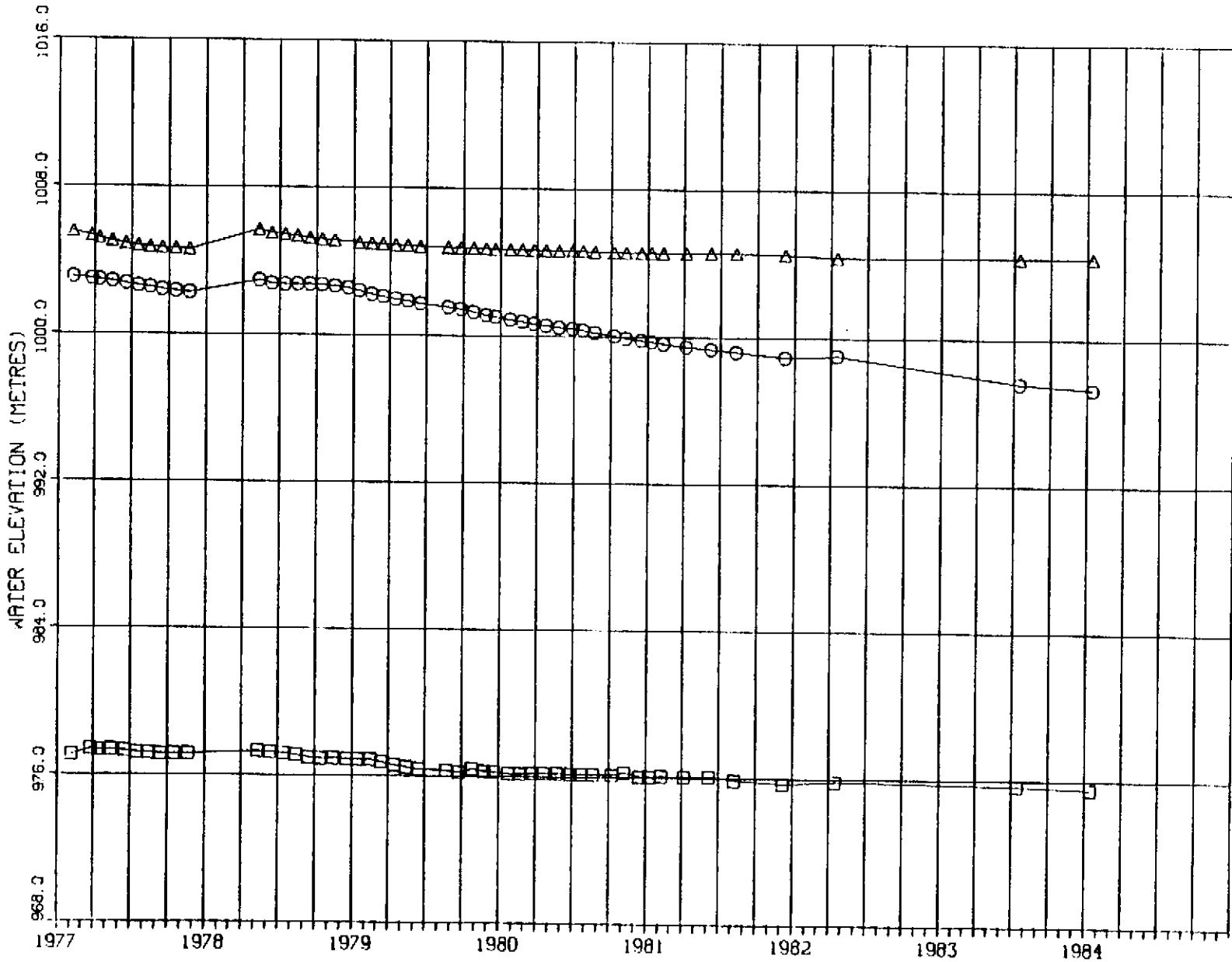
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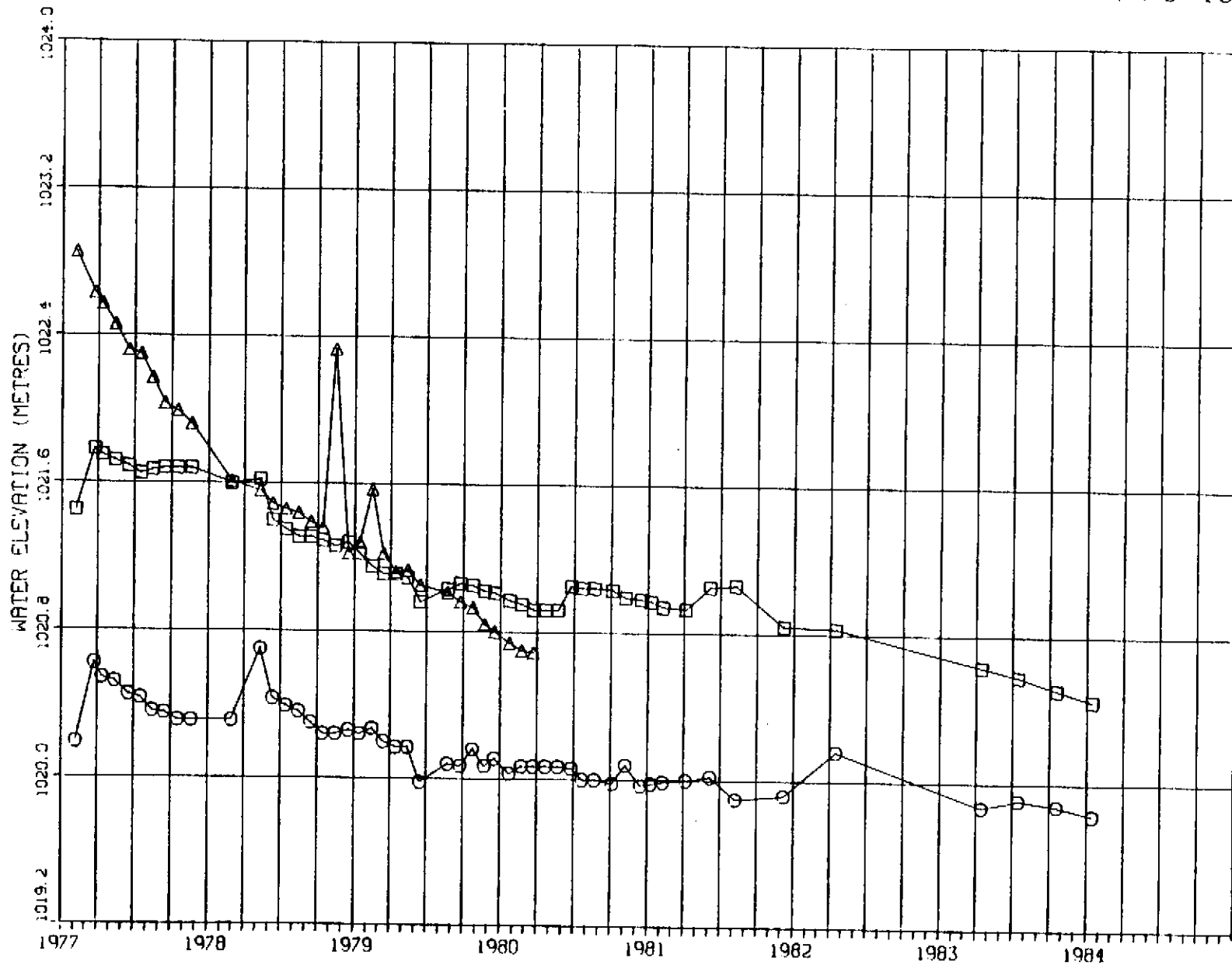


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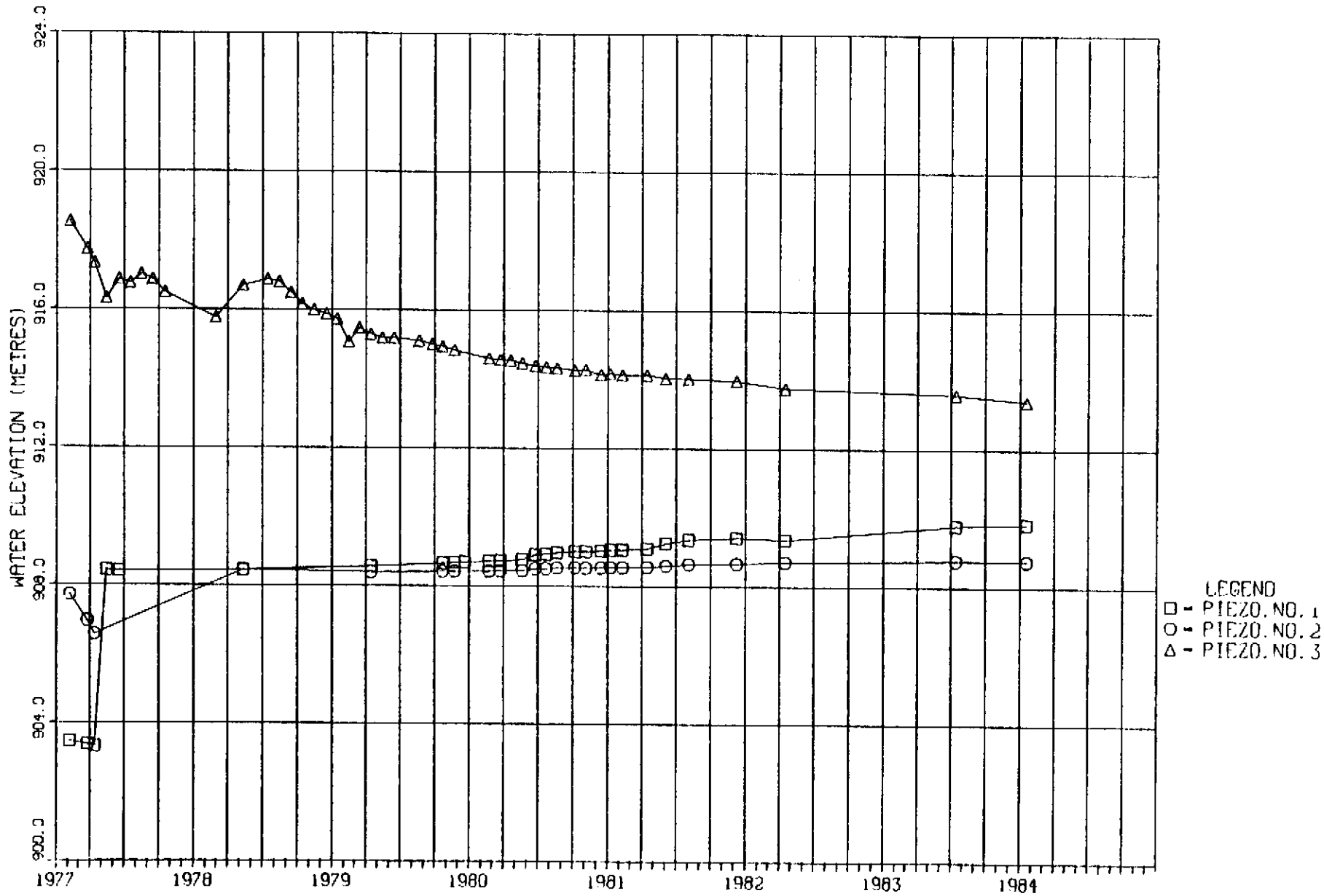
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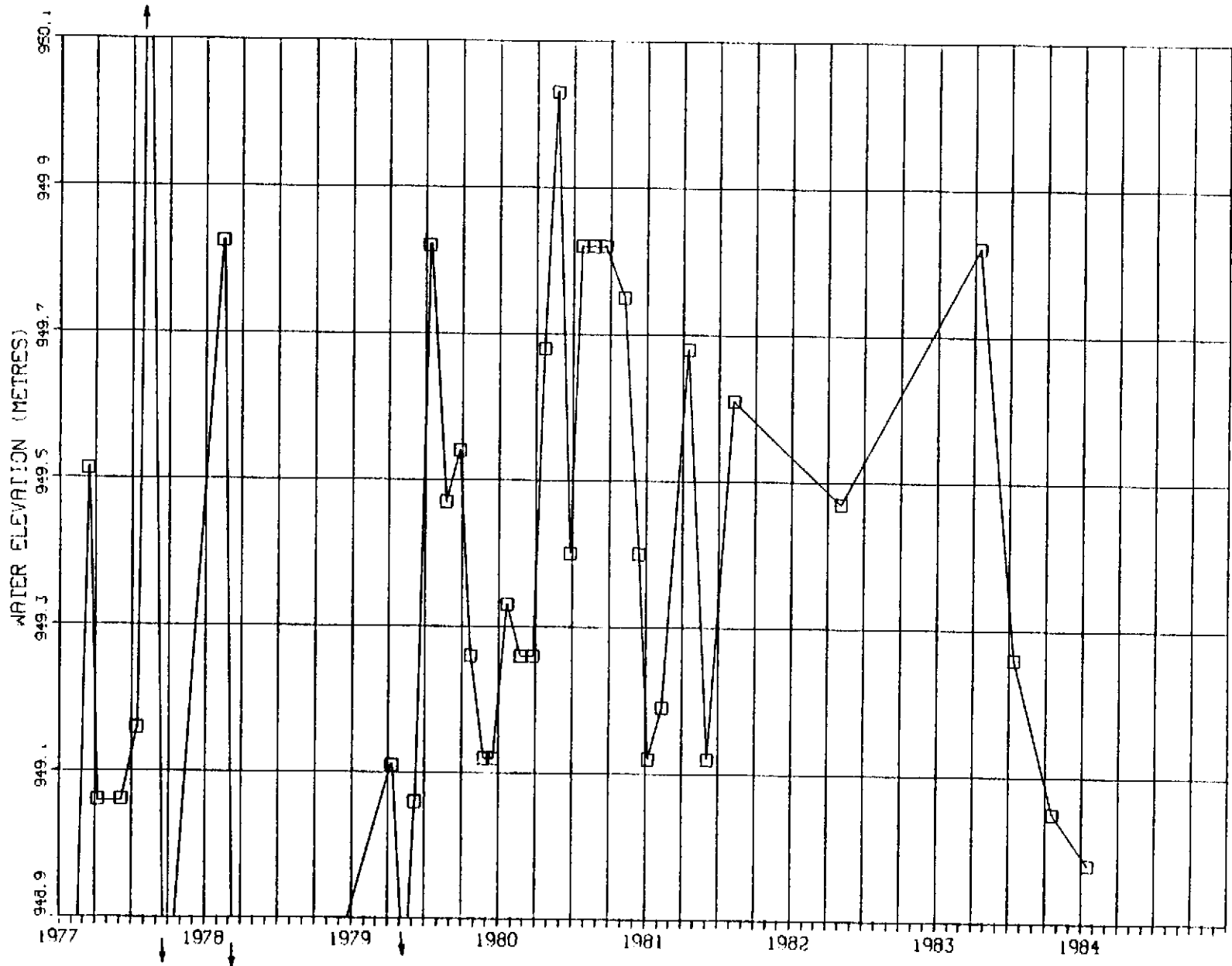
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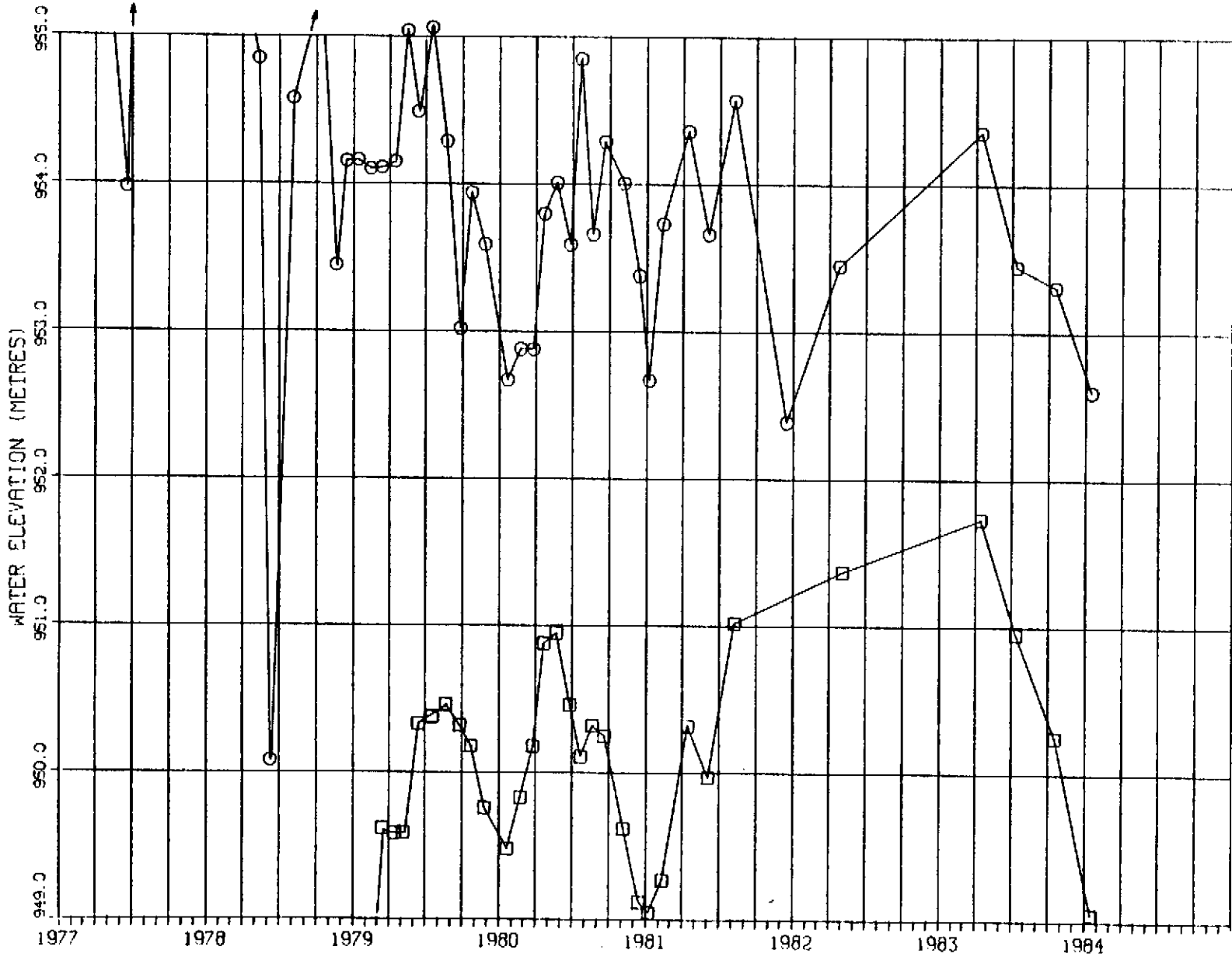


1977 1978 1979 1980 1981 1982 1983 1984
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 WATER ELEVATION (METRES)
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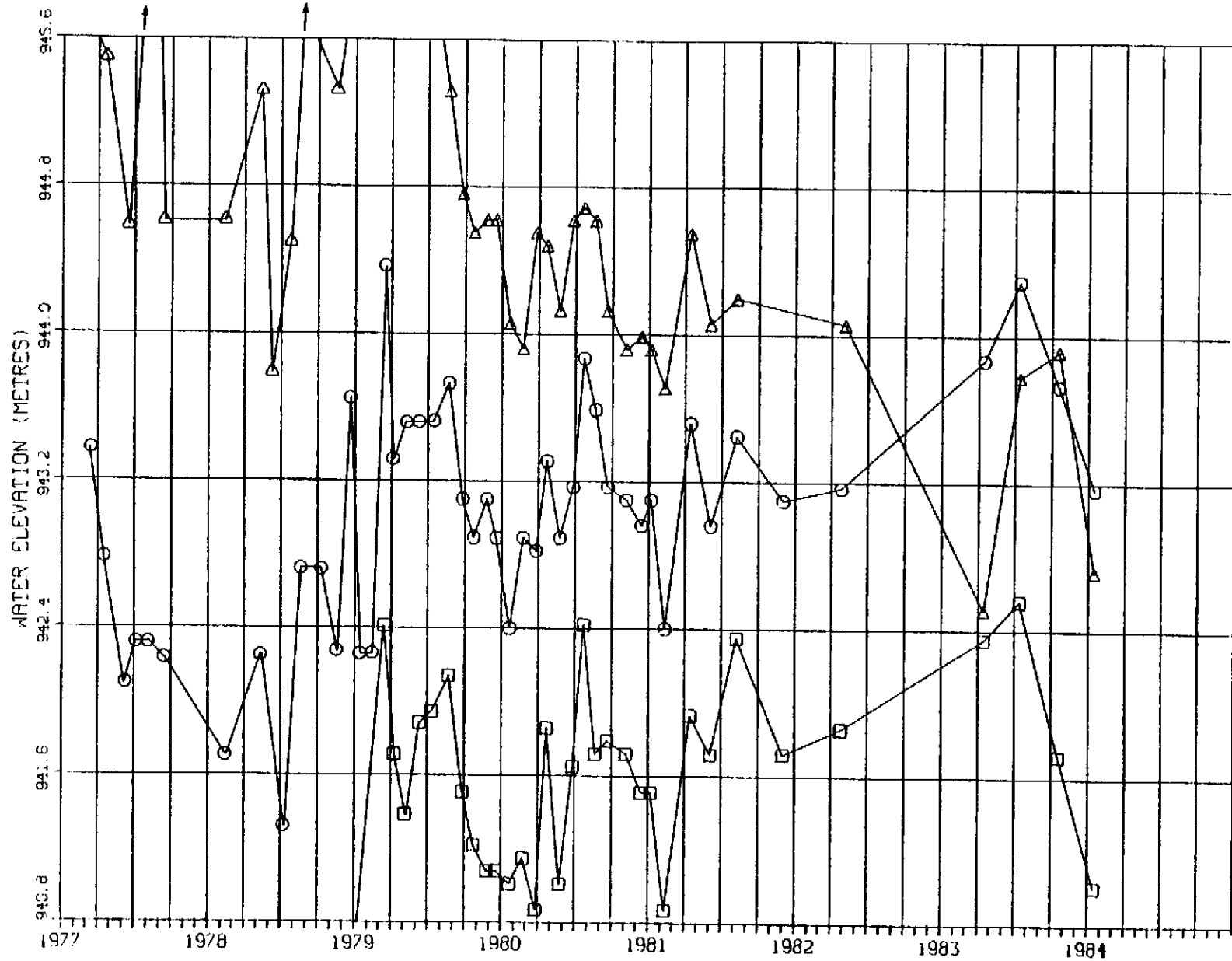


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 DATE: 1984
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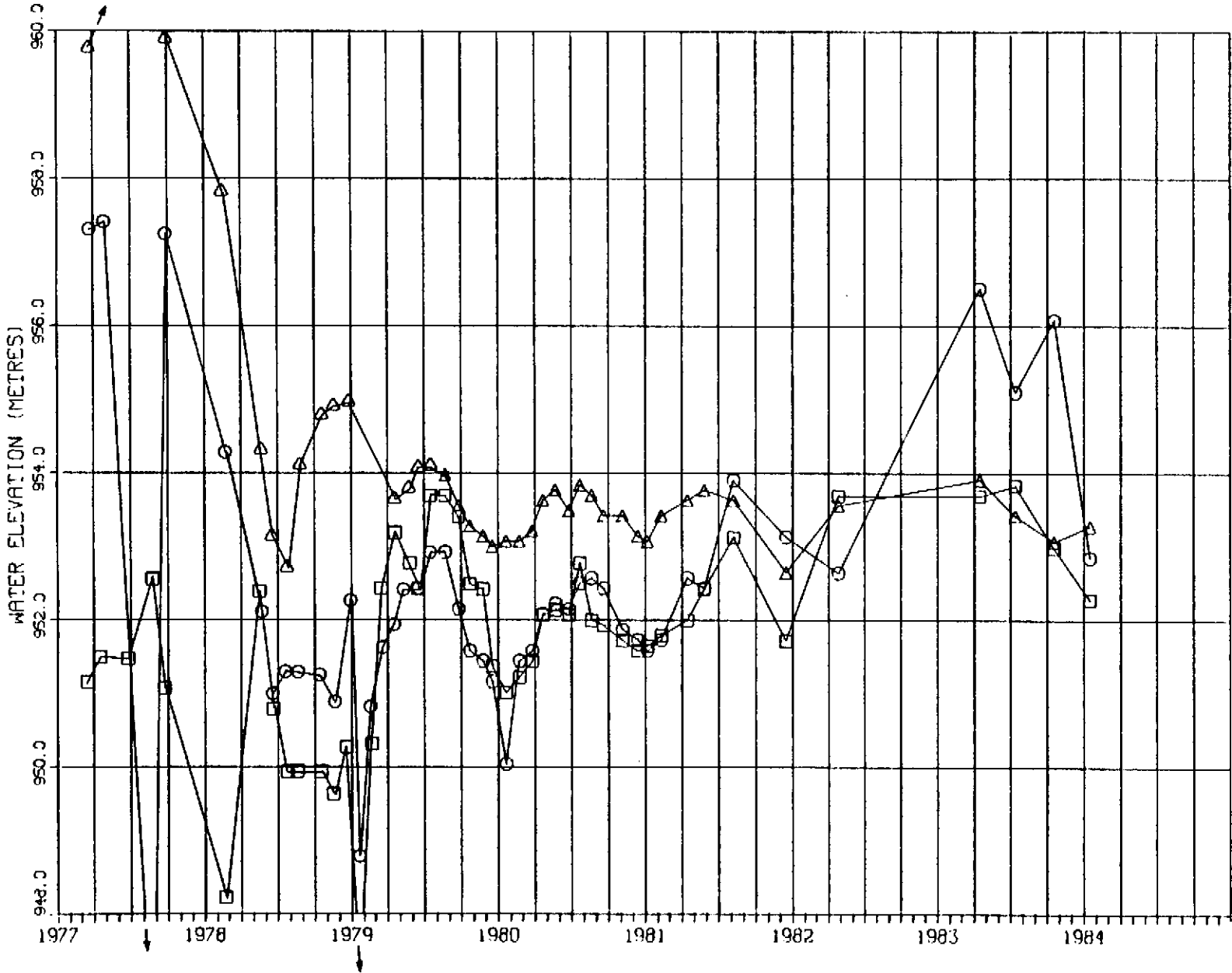
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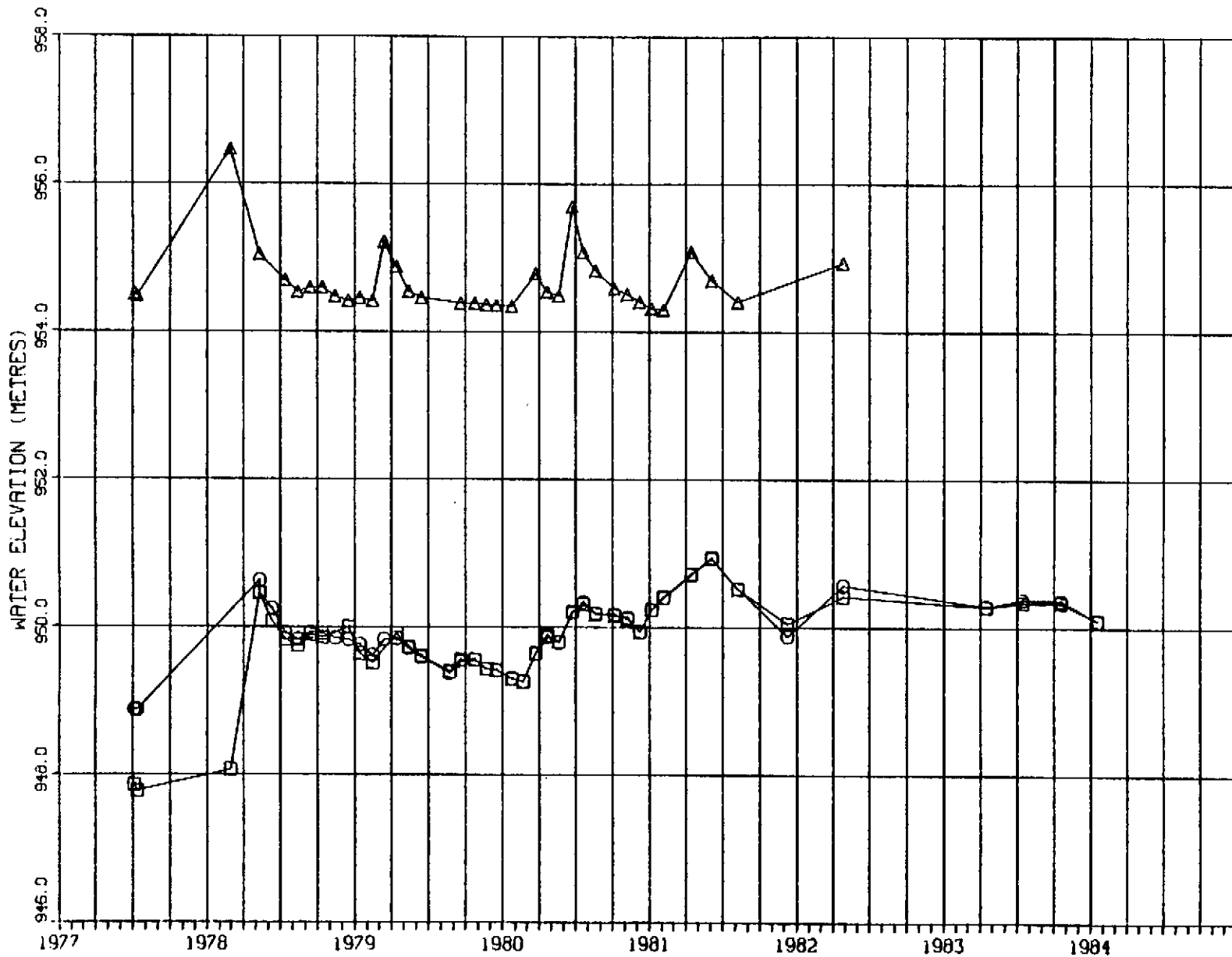
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DATE: 06 MAR 1984
OPERATOR: SCS - ENV DISTRICT 914

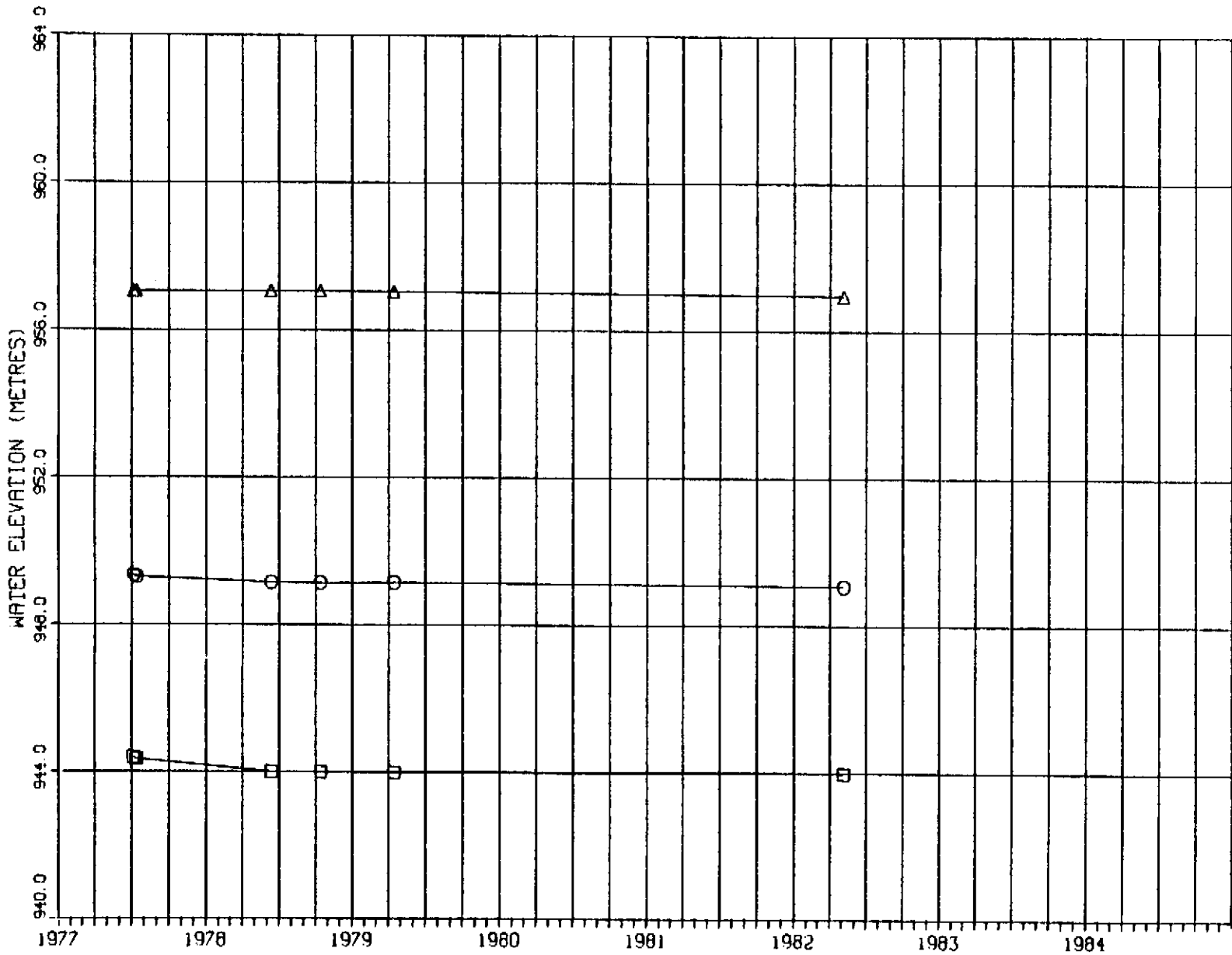
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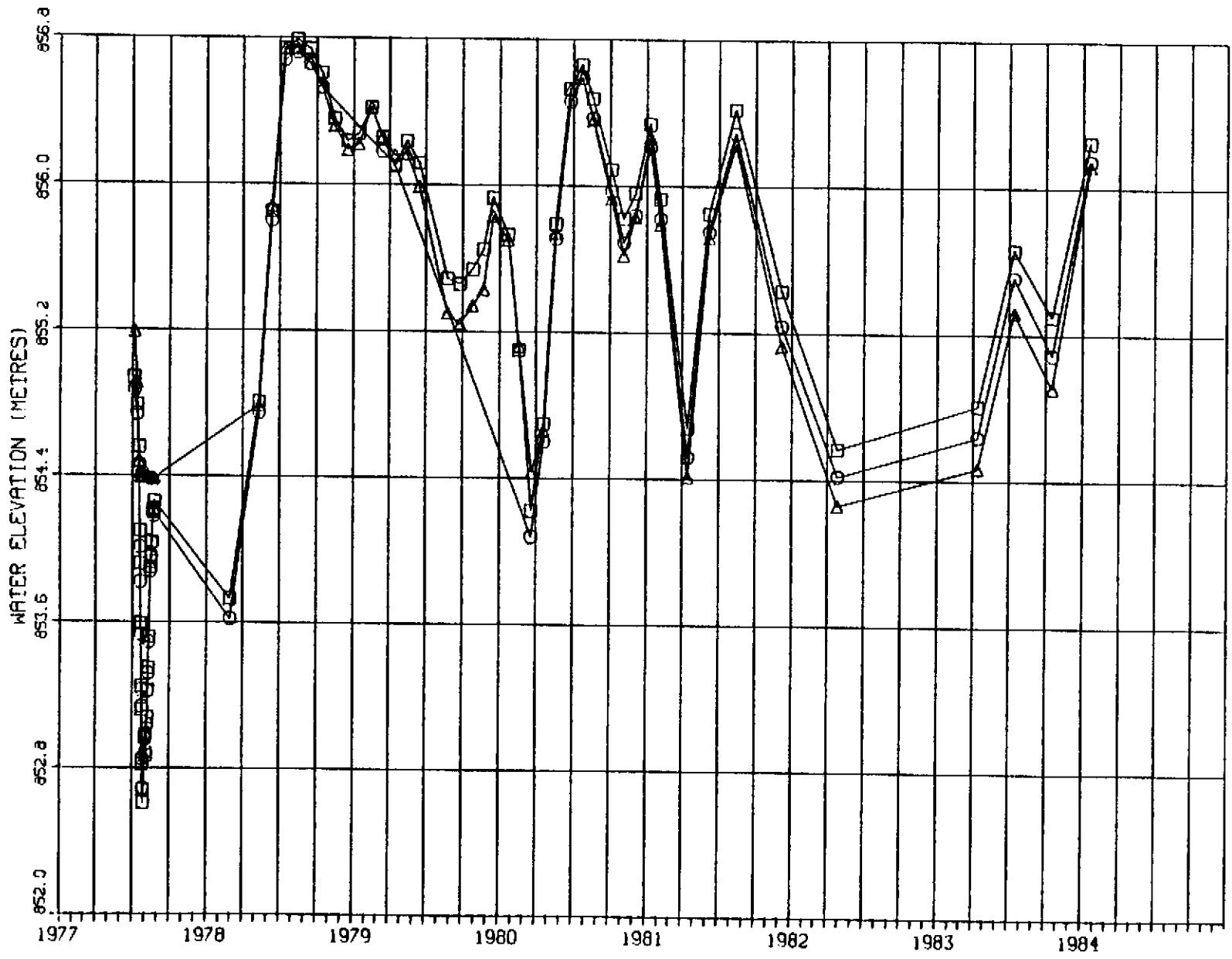
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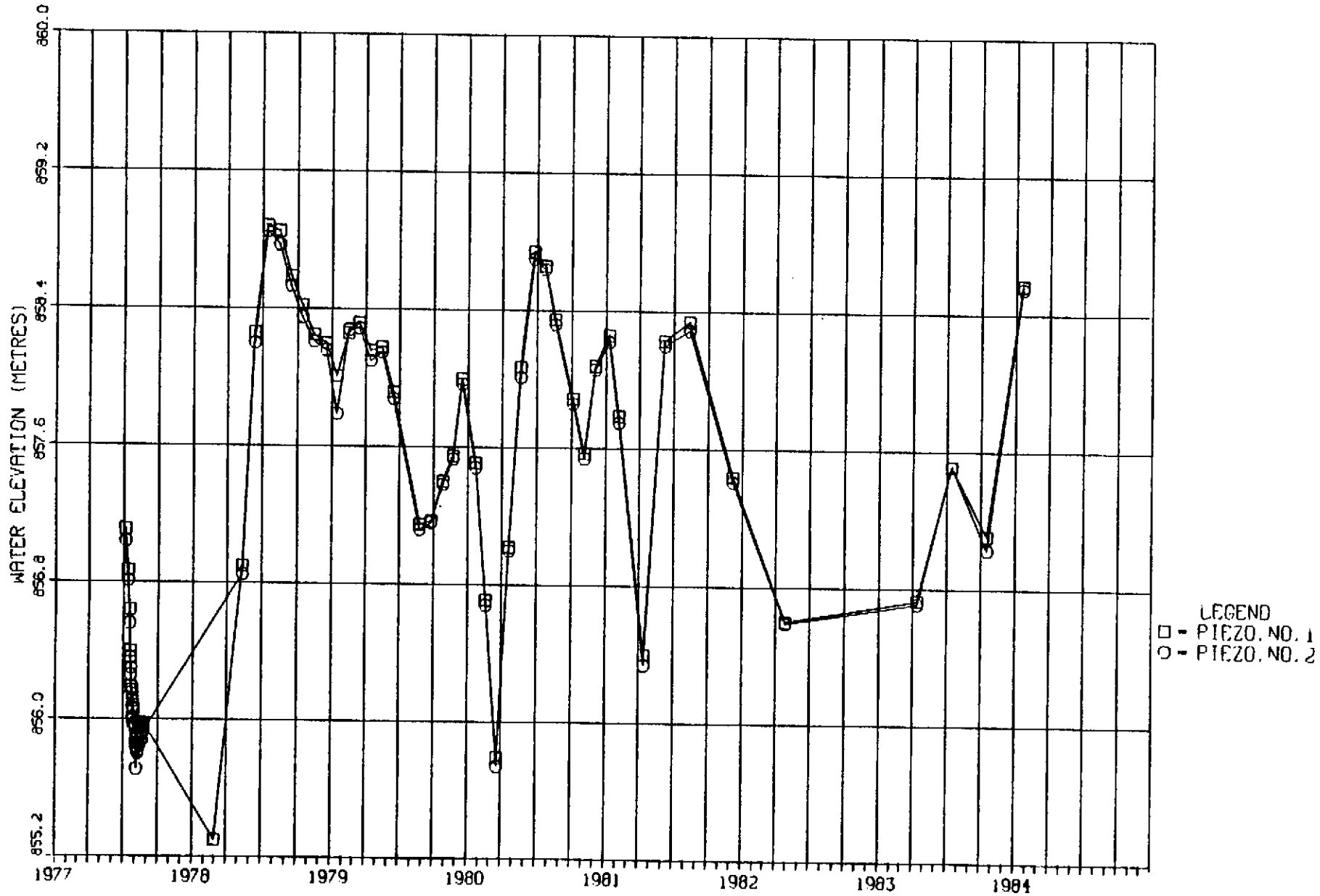
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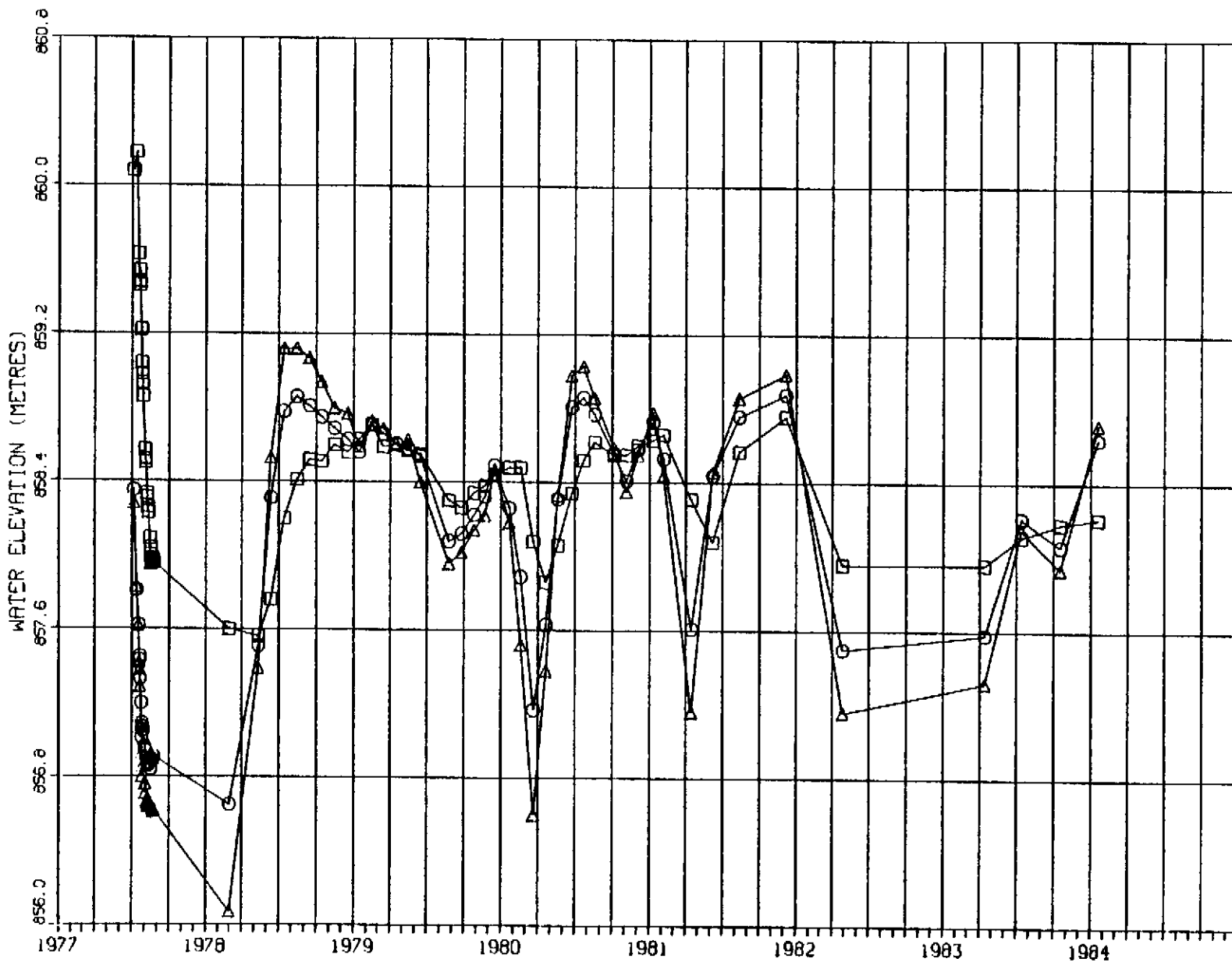
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LOT 5 14.09.89 AED 28 MAR, 1984 JOB-LR0071 805 - EXS DISSPLA VER 8.2

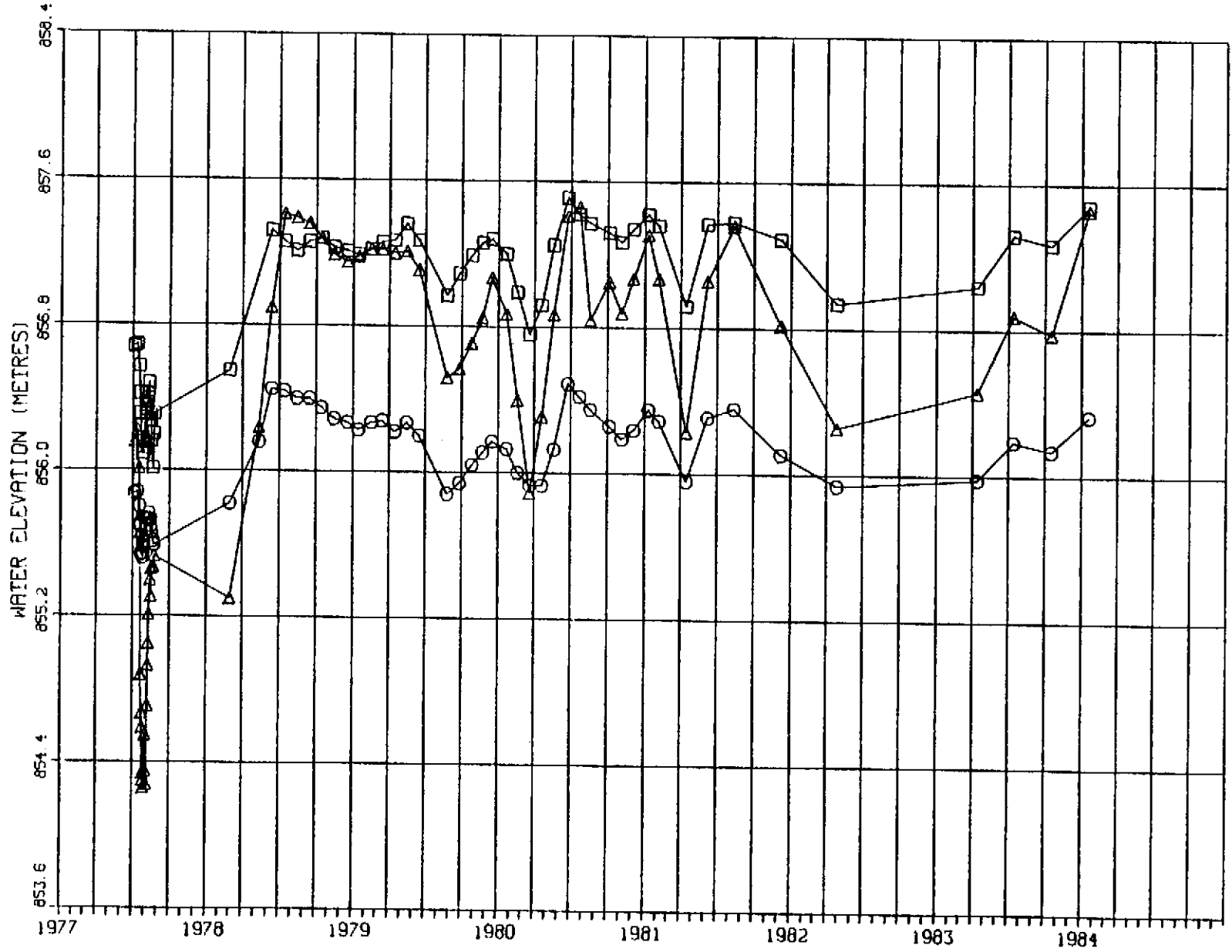
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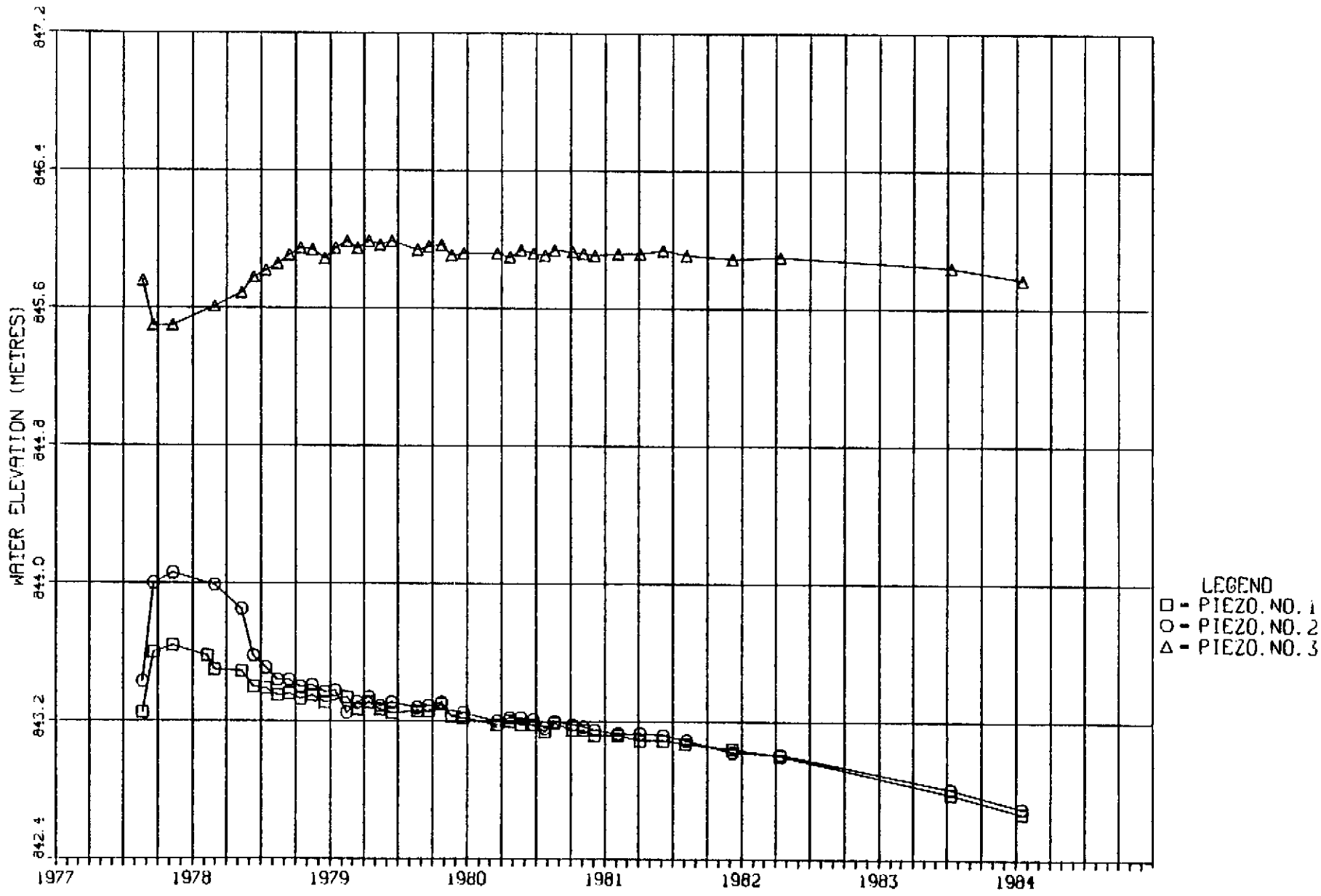
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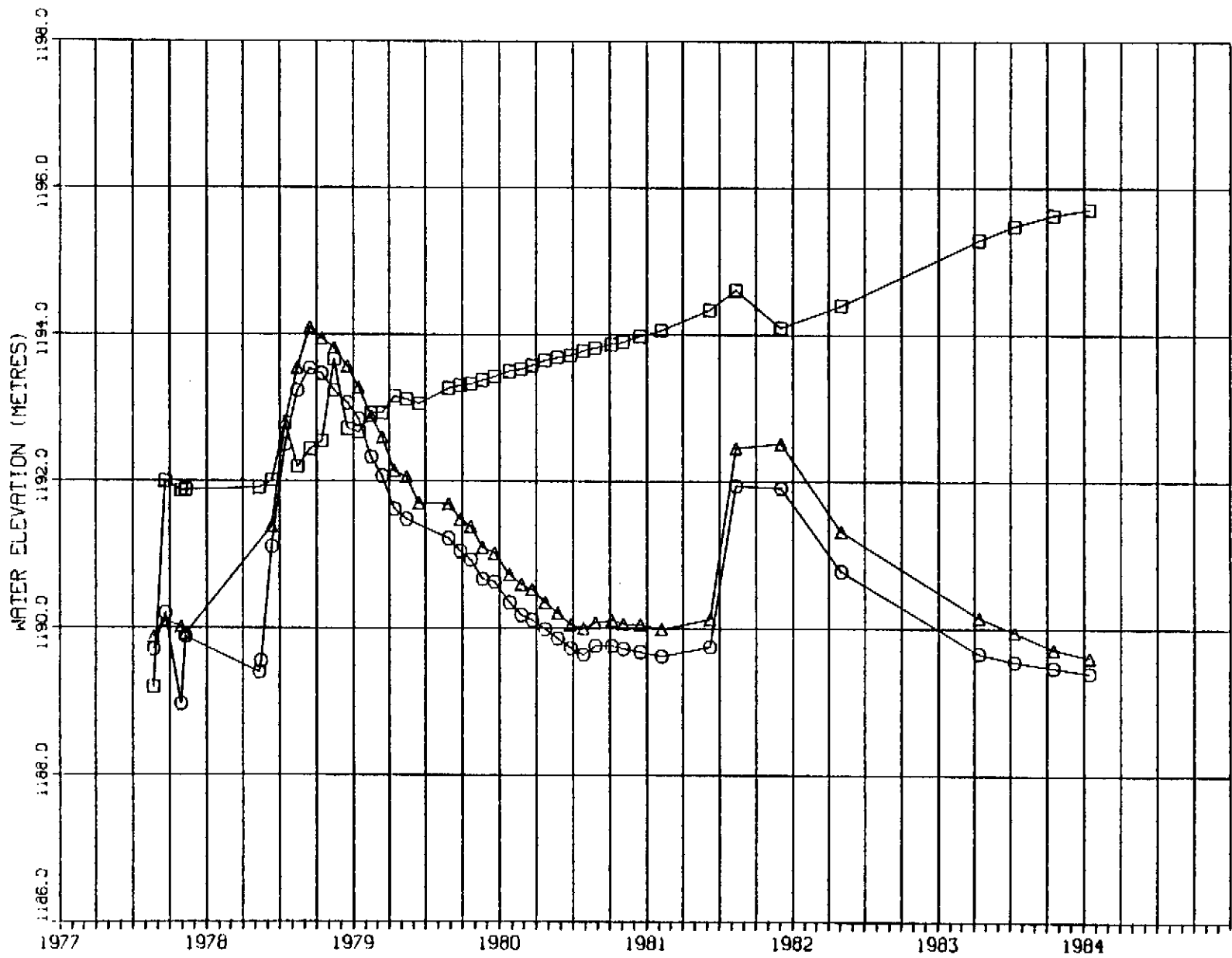
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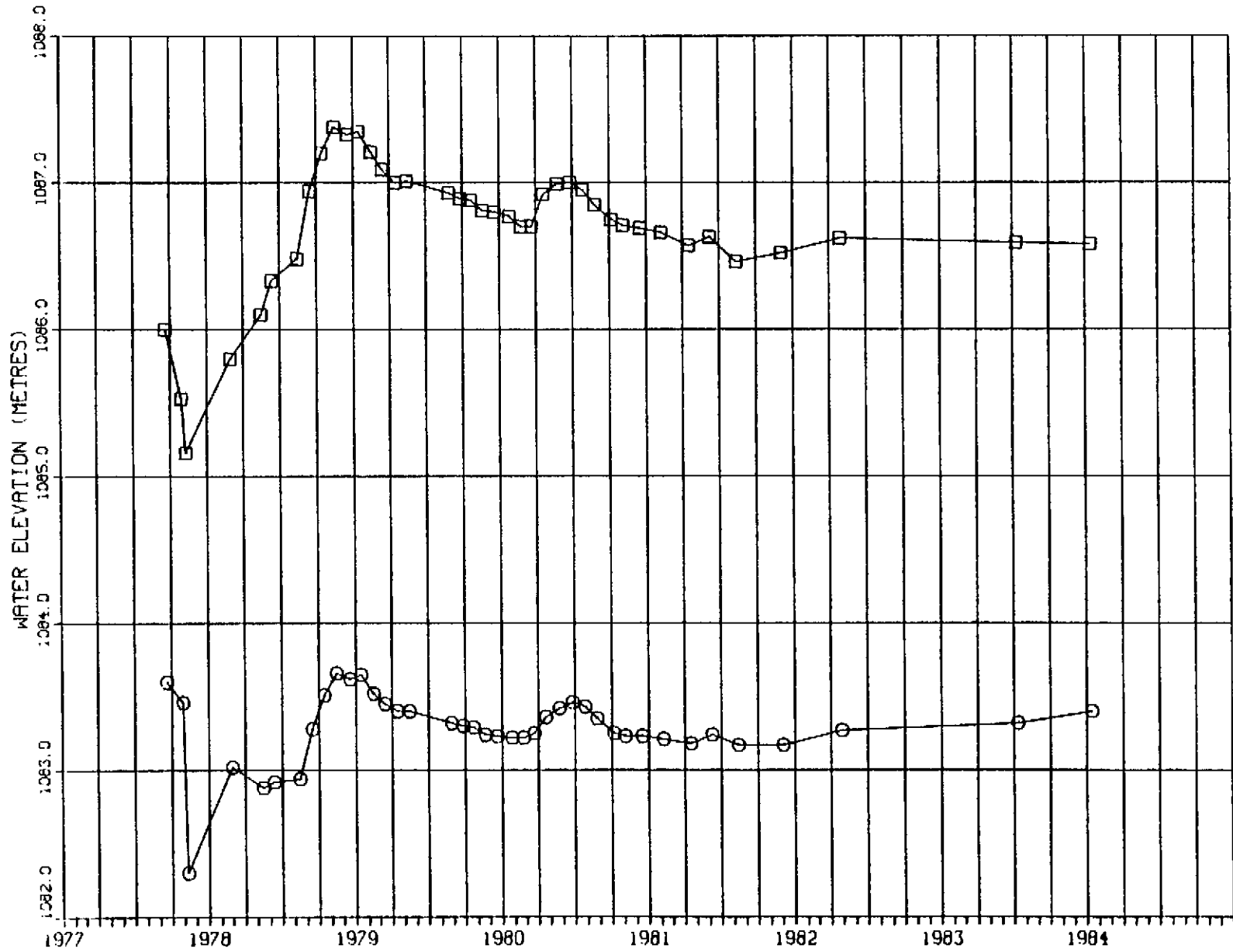
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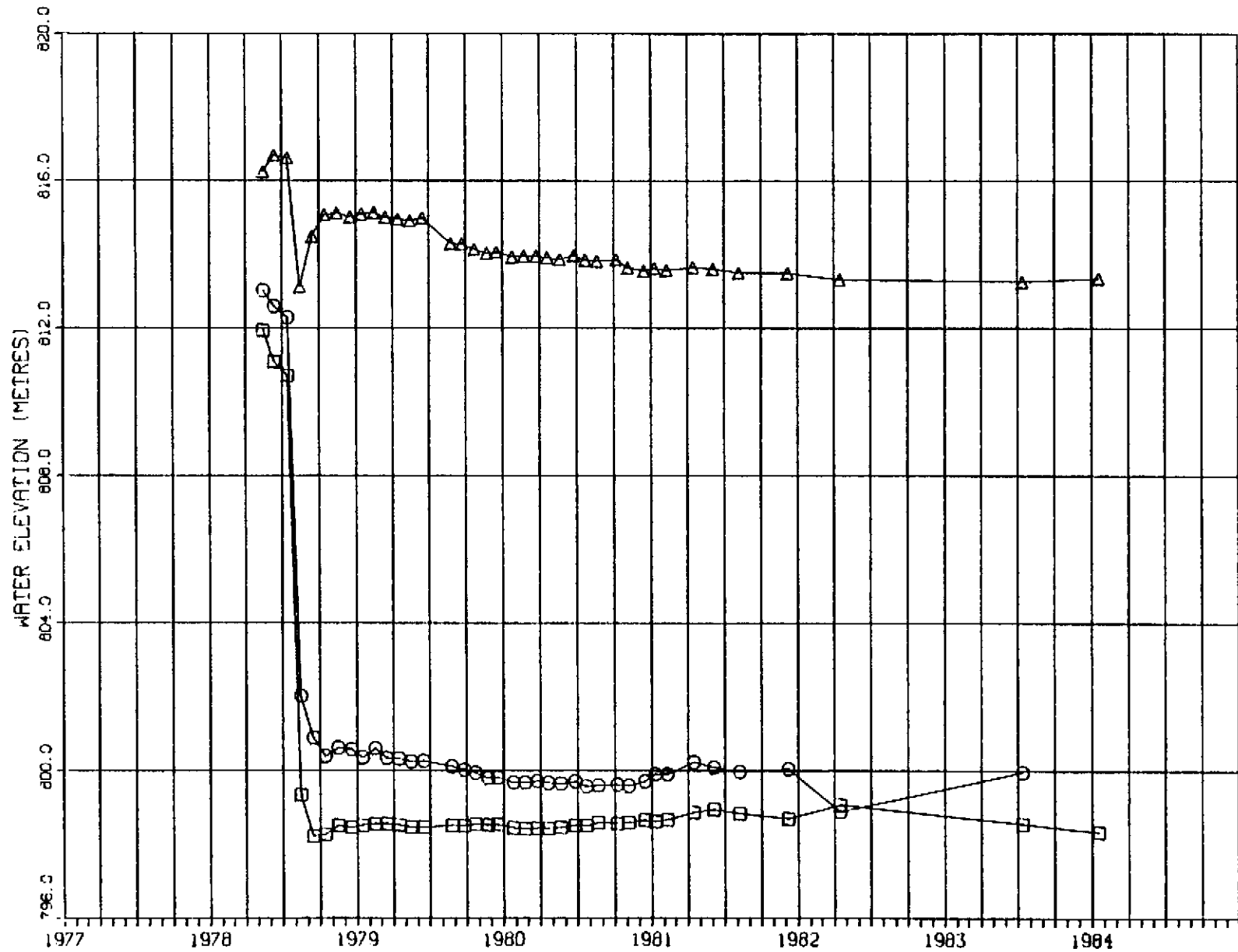
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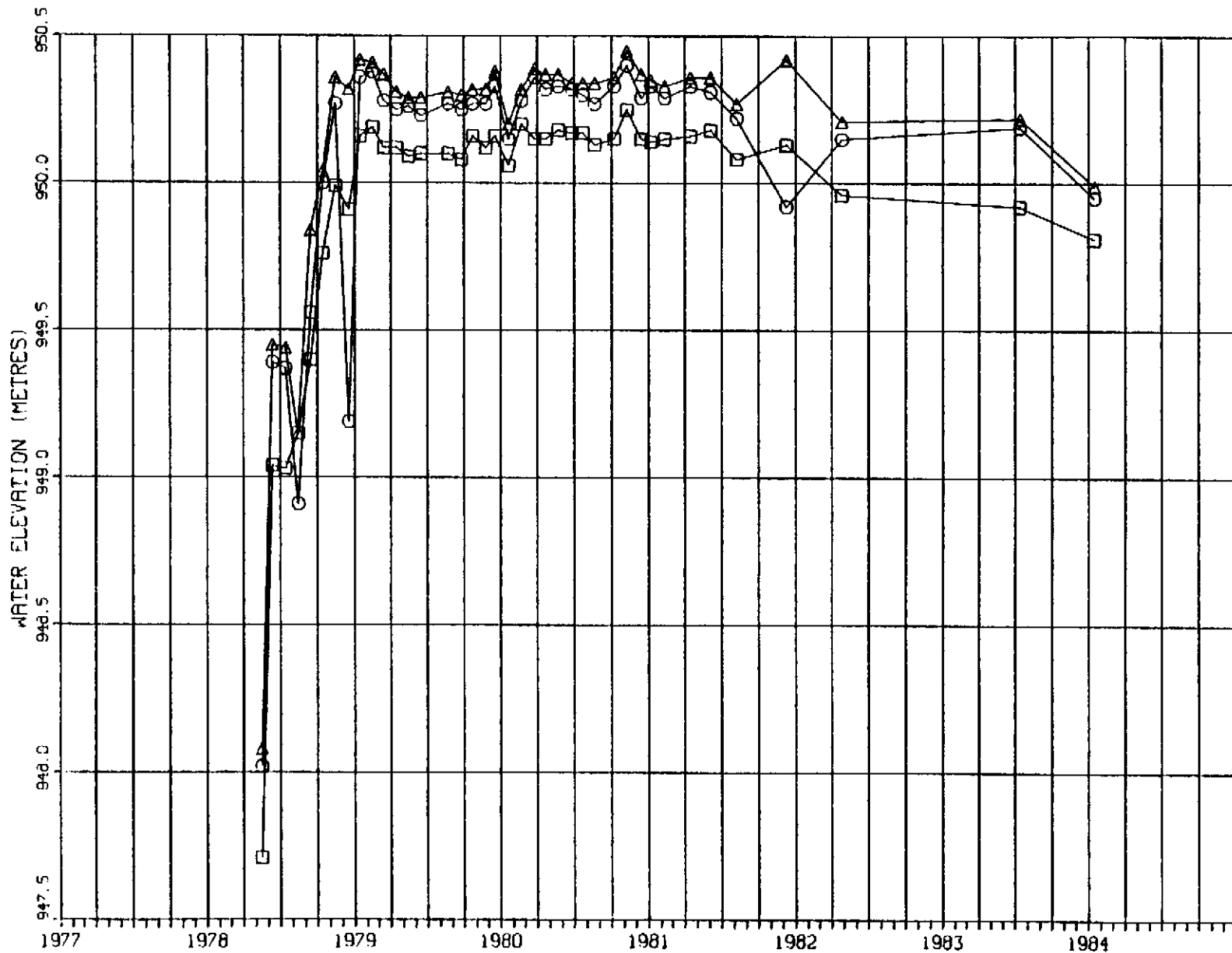


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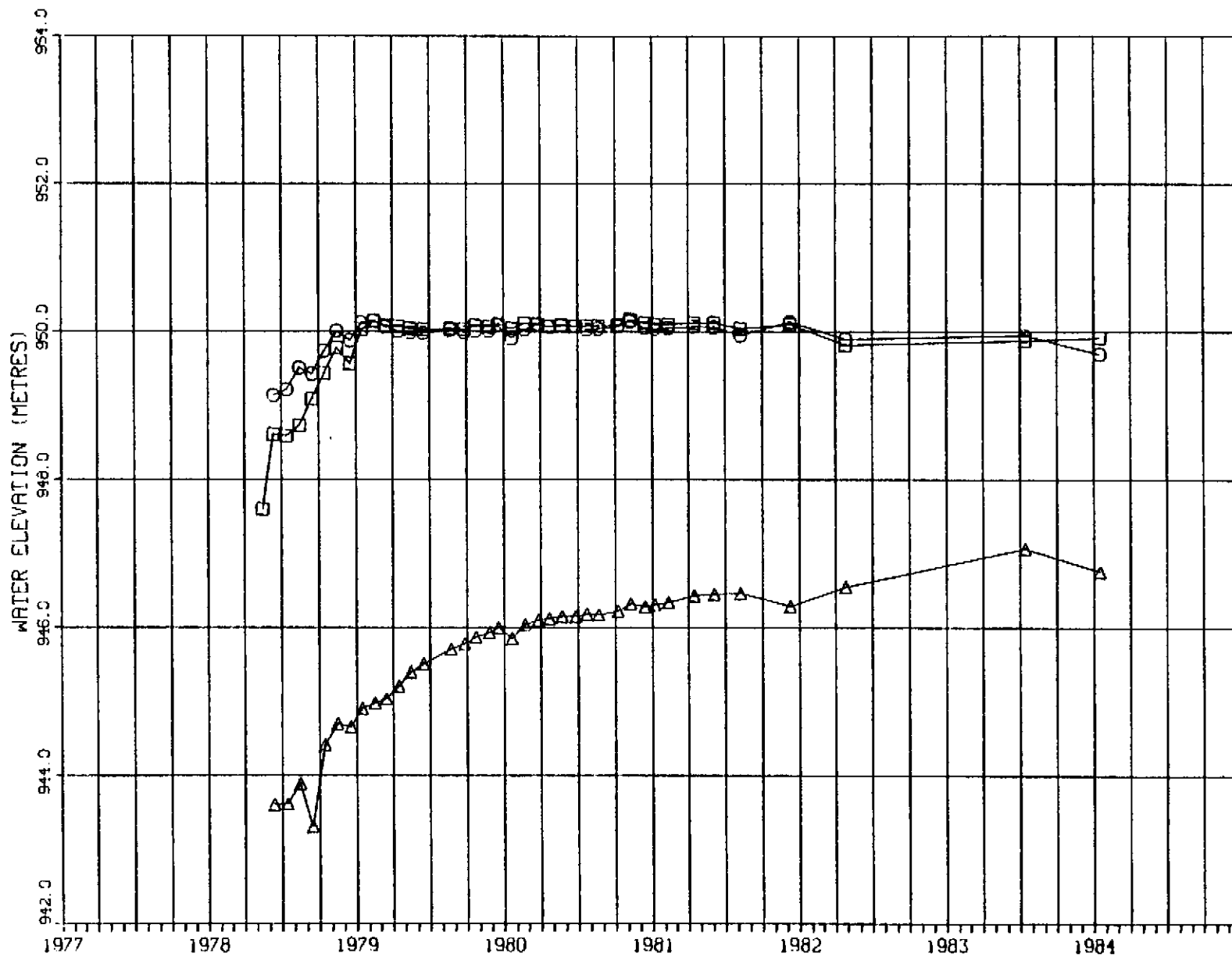
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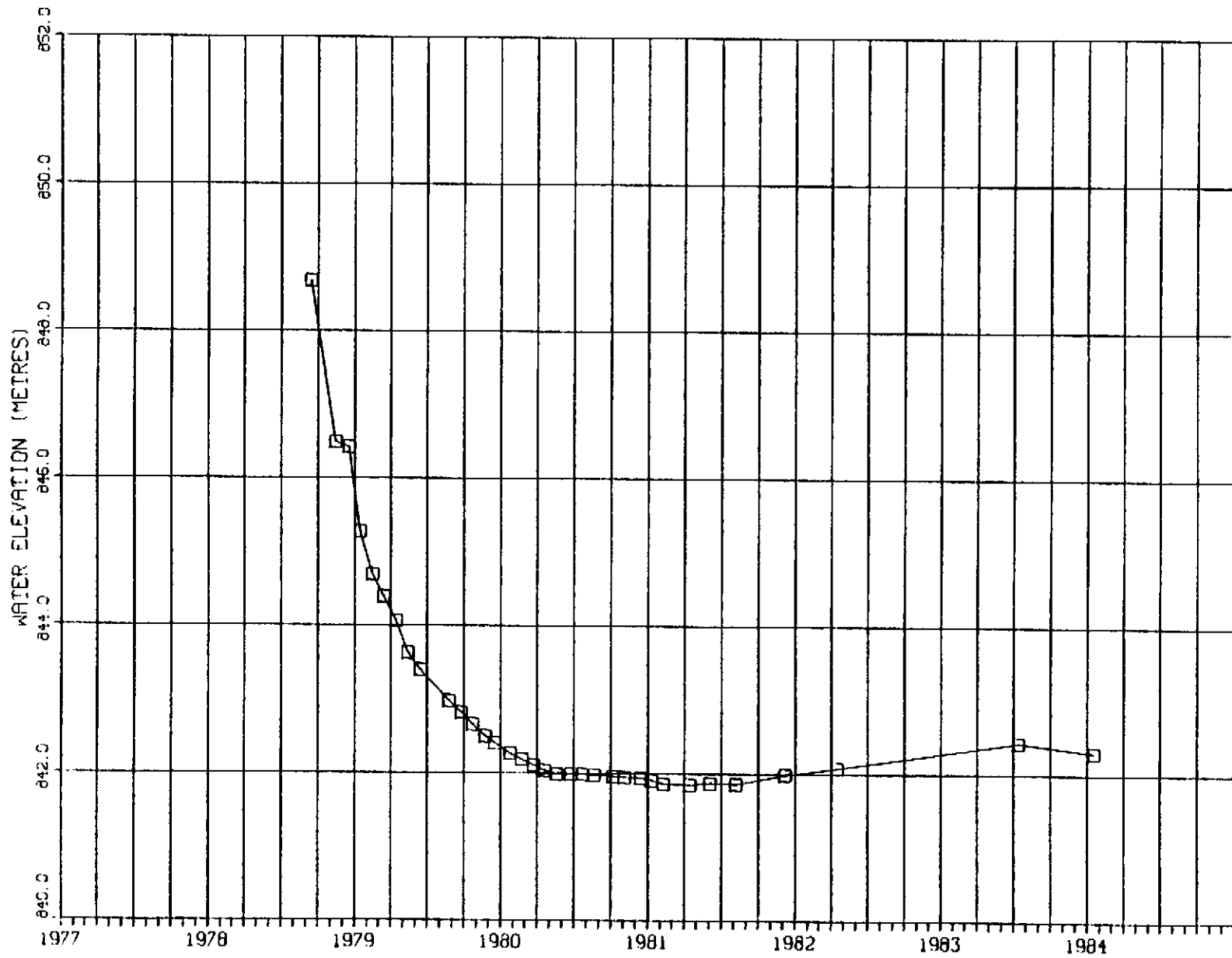
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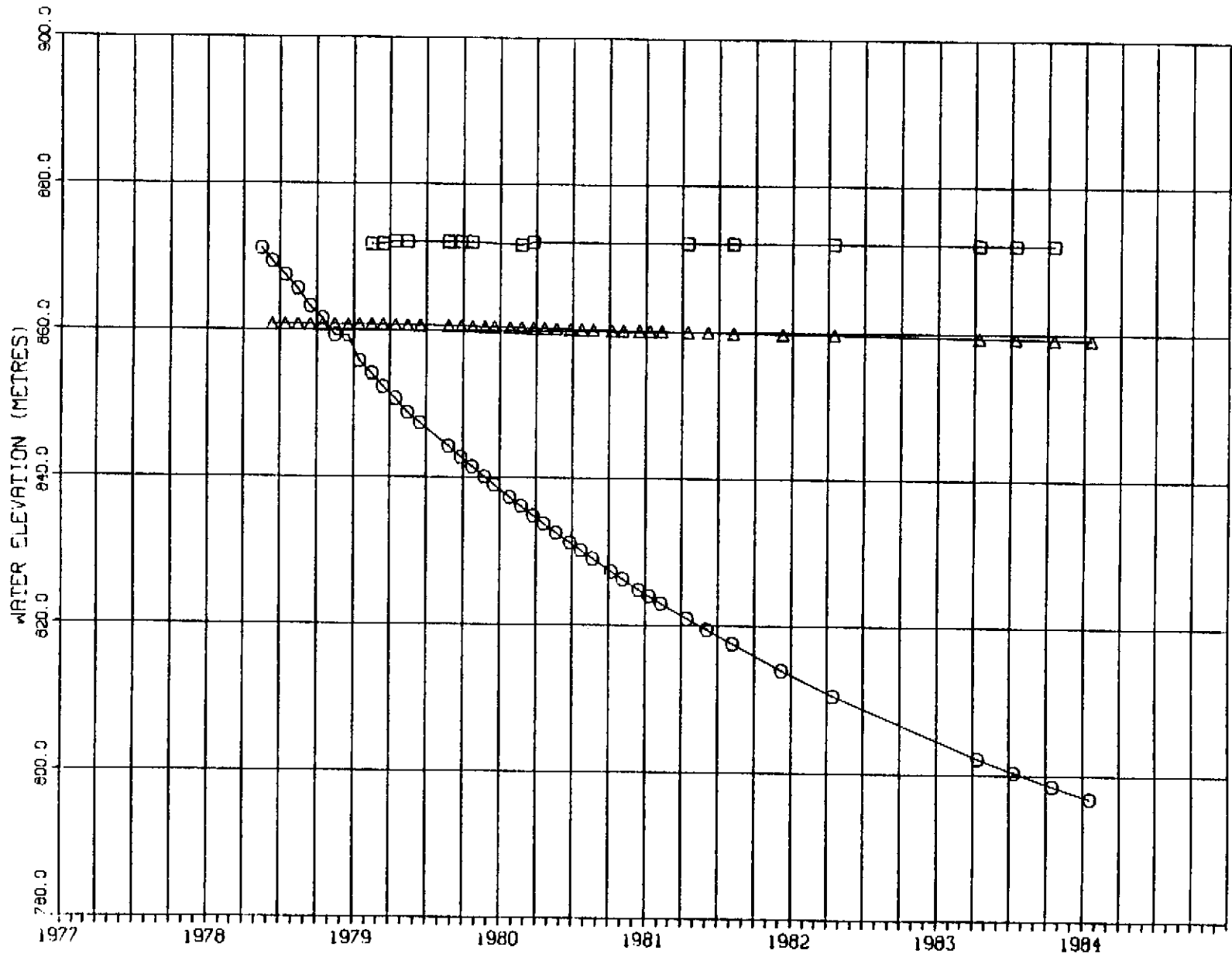
LOT 5 10.45.12 400 26 MAR. 1984 JOE-L'VECHEY : BOS - EKS DISSPLA PER 0.2

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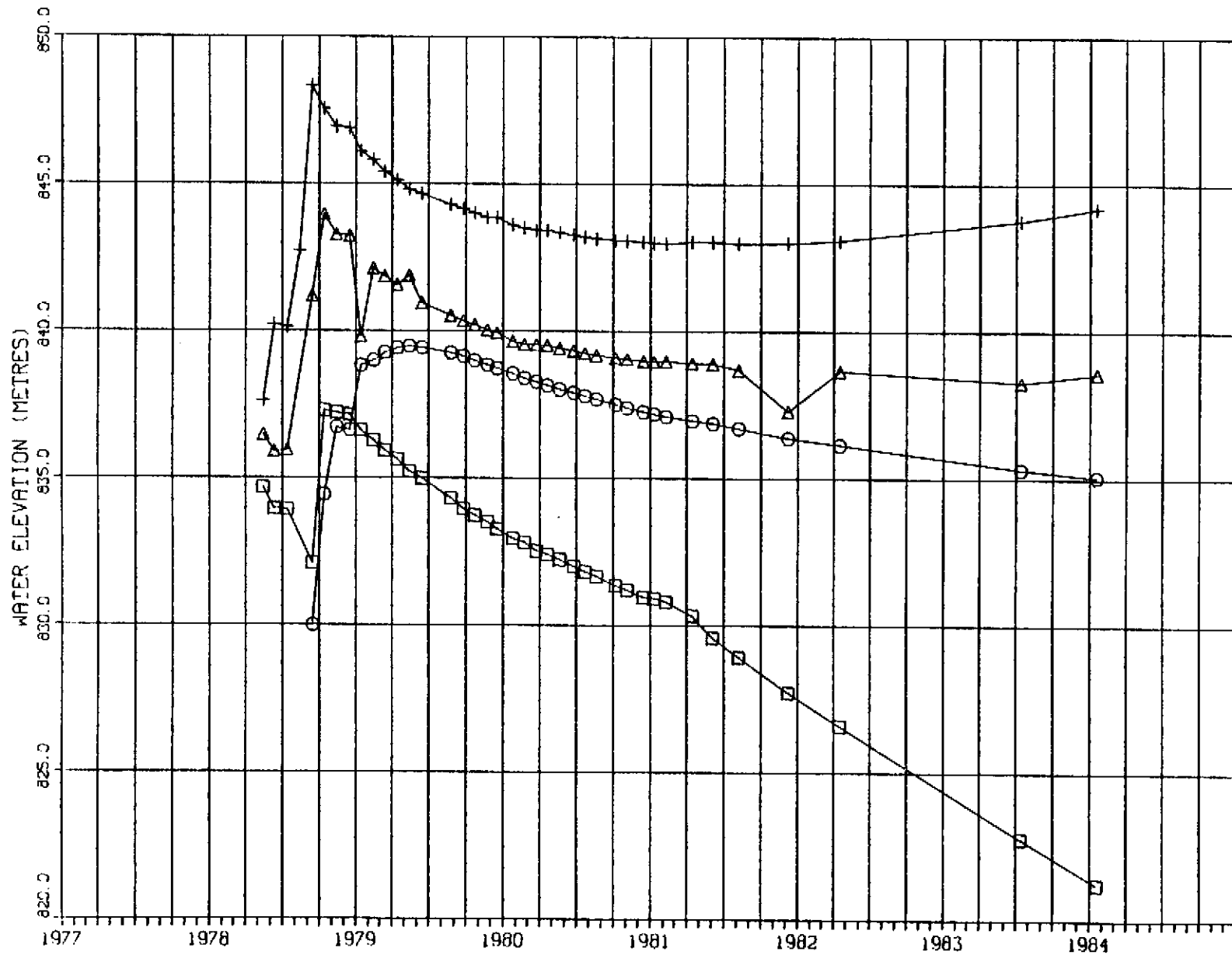
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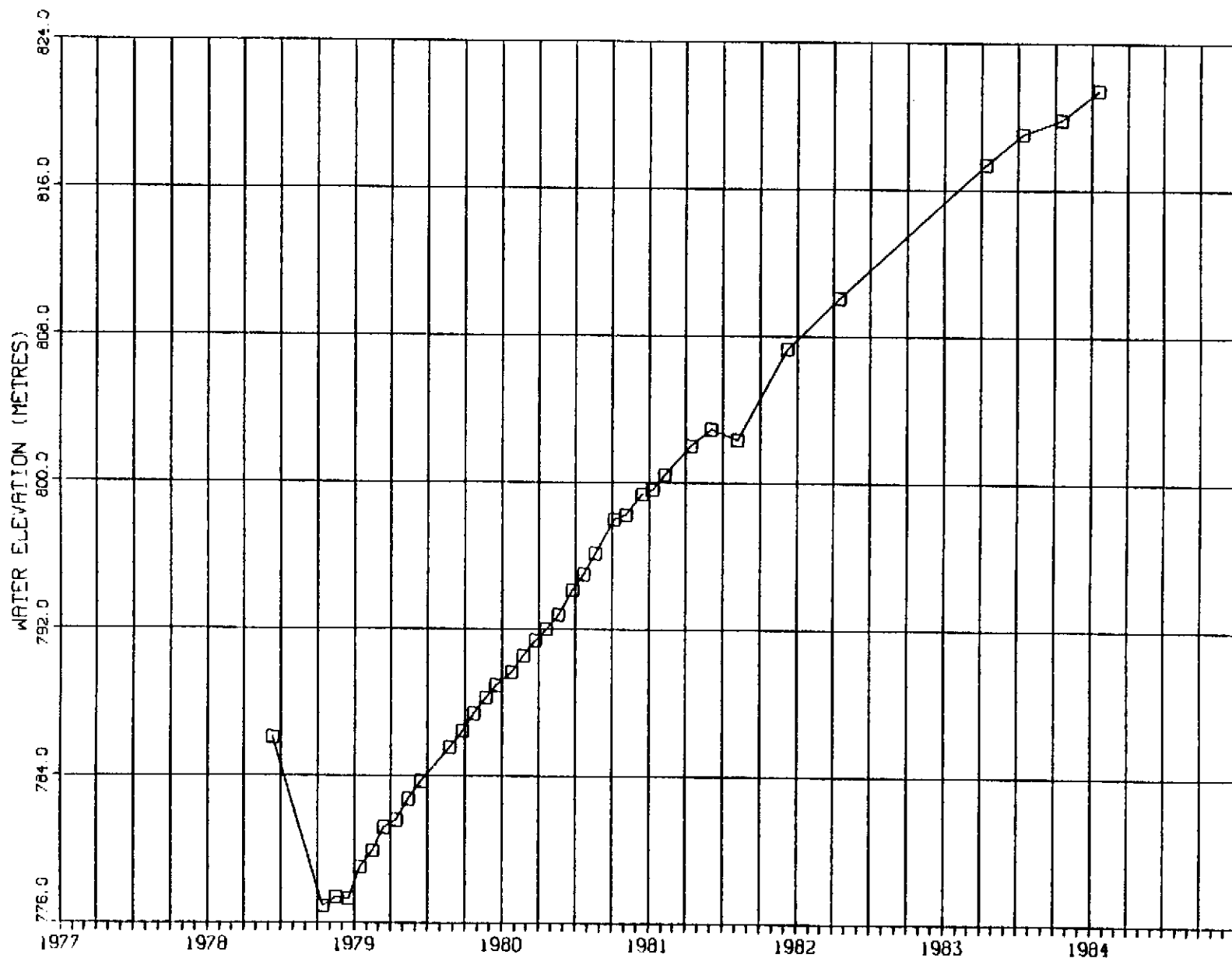
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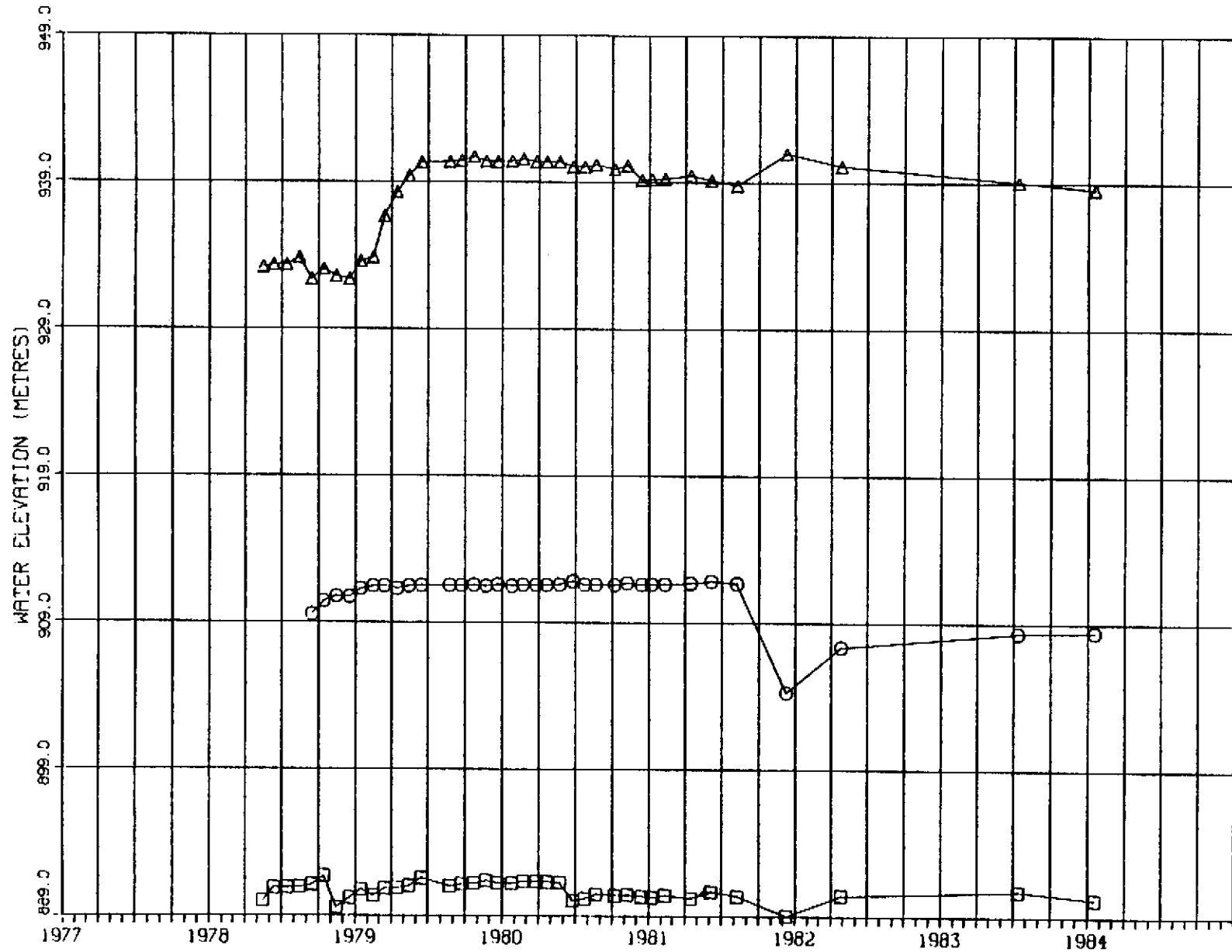
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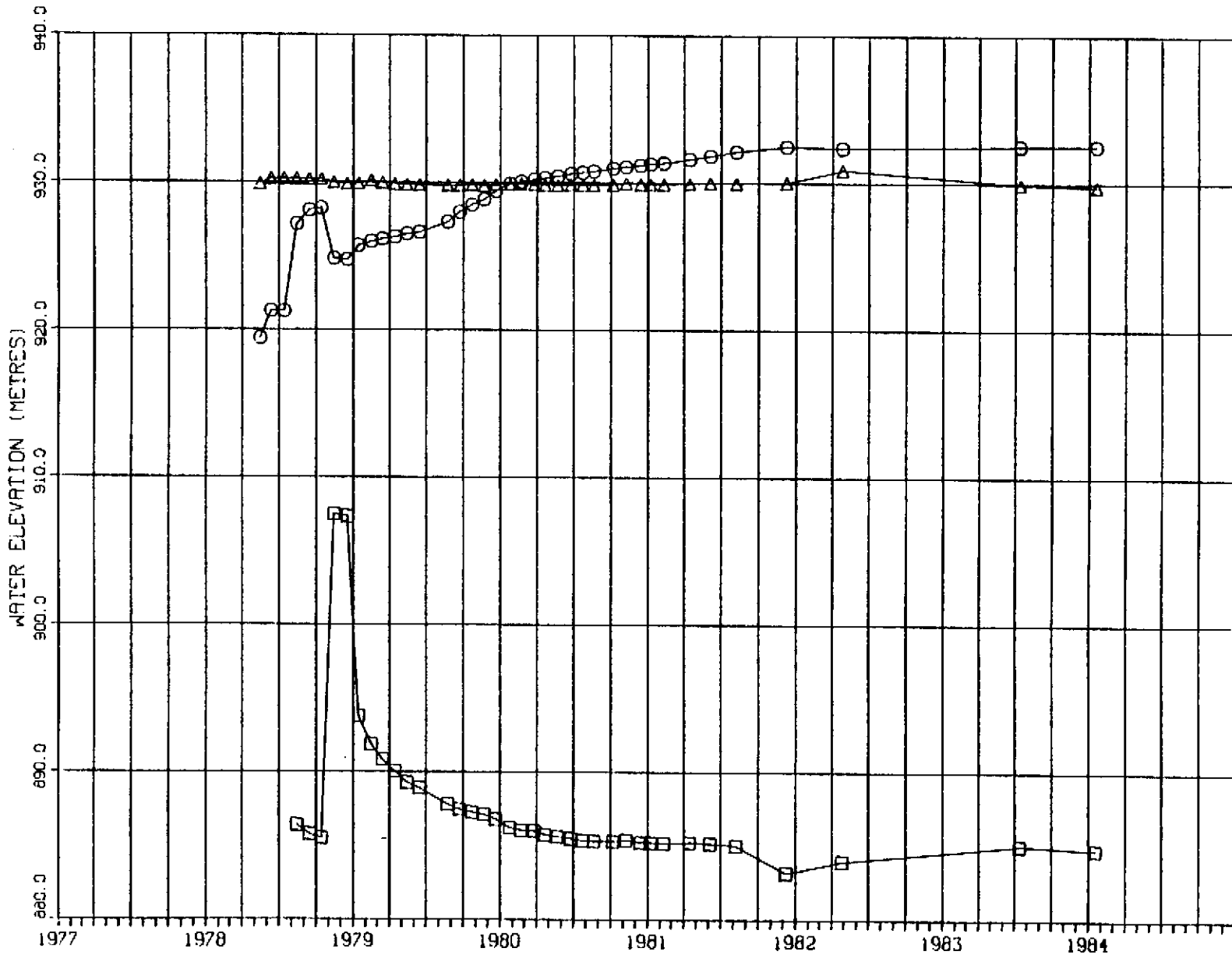
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-64



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2
△ - PIEZO. NO. 3

LOT 3 16.40.42 WED 26 MAR, 1984 JOB=LARHER: 905 - EX5 DISPLA VER 8.2

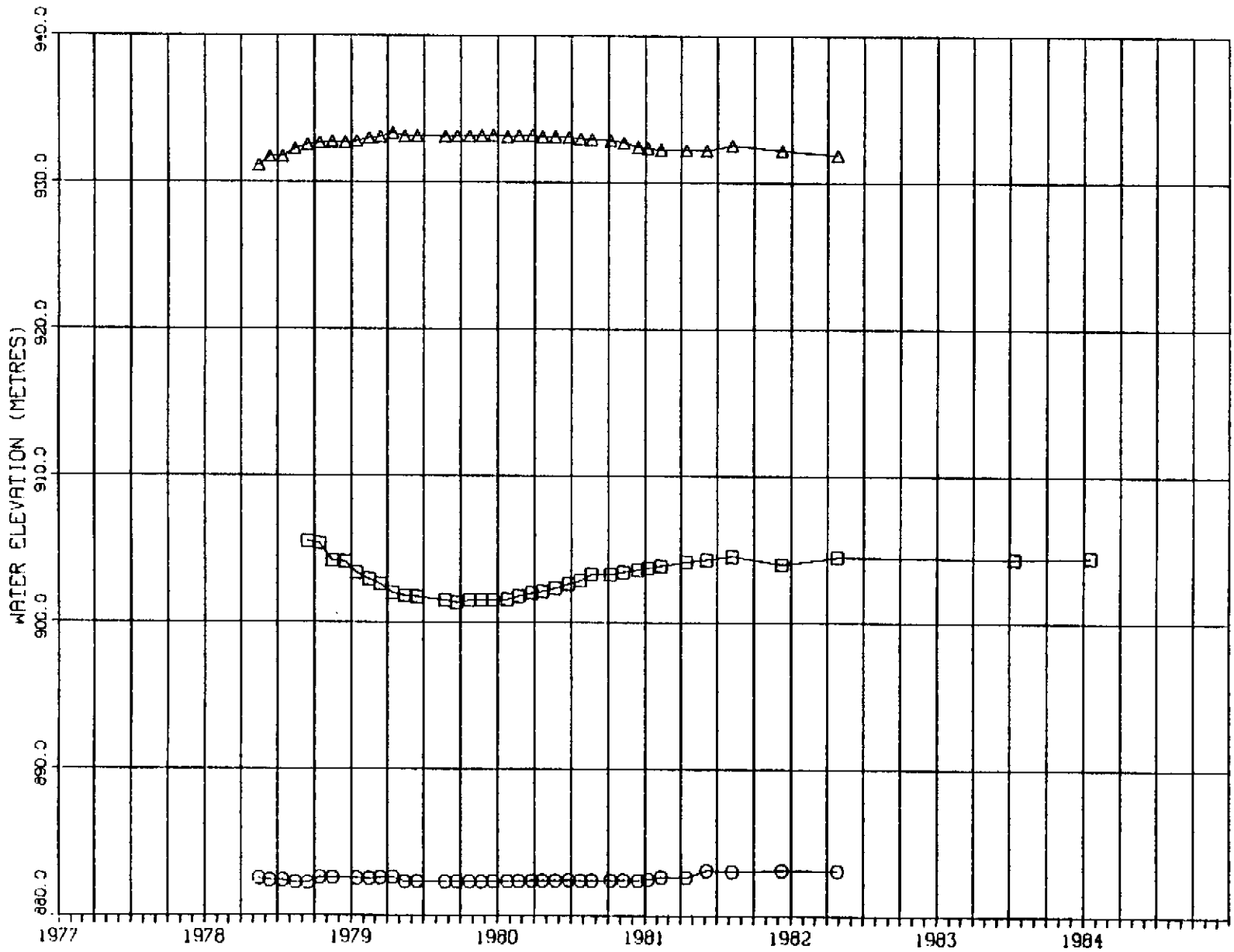
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-65



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2
△ - PIEZO. NO. 3

LOT 4 .6.43.22 .MID 28 APR. 1984 JOB-LRCHCR .905 - EXS DISPLA VER 6.2

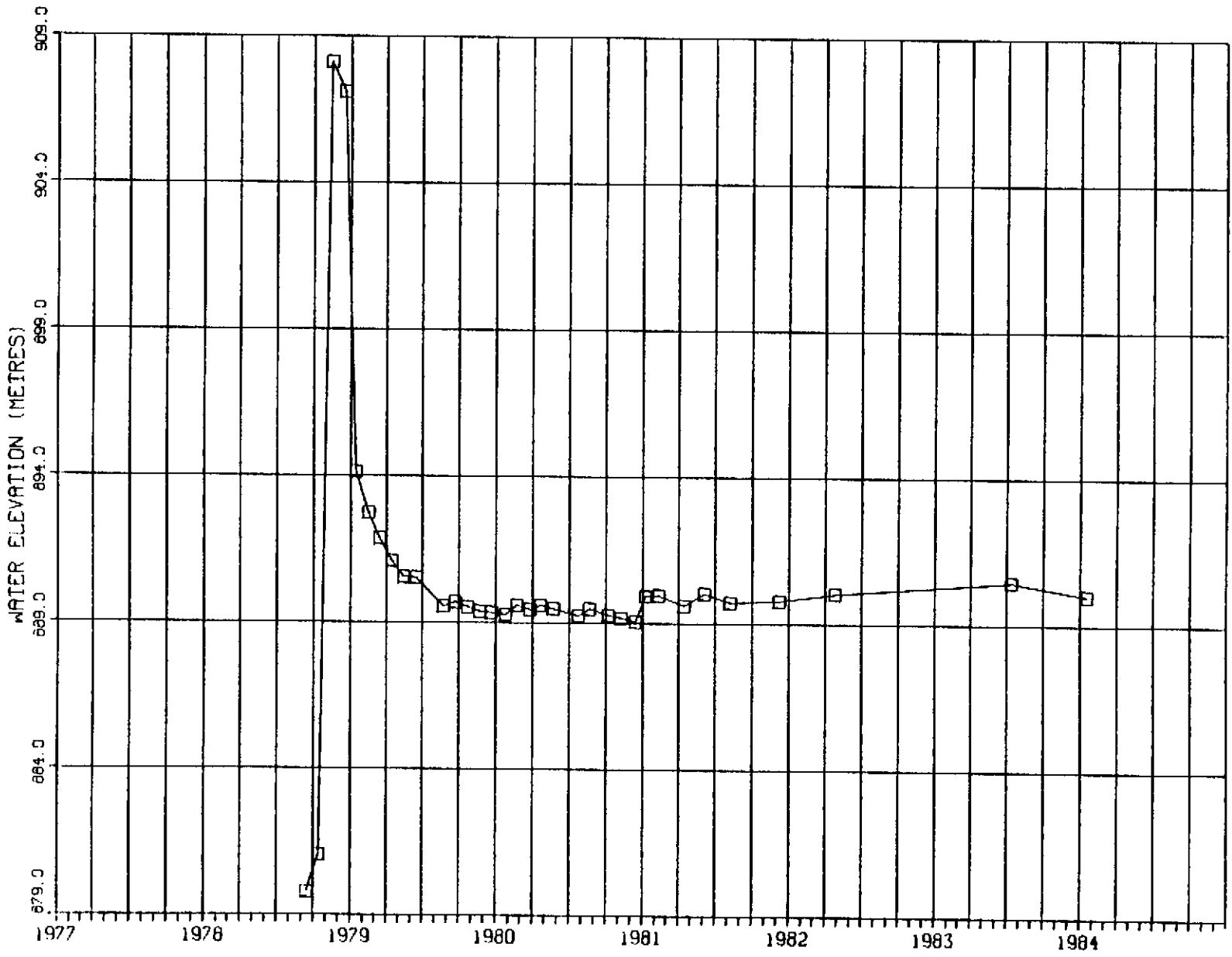
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-66



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2
△ - PIEZO. NO. 3

LOT 5 16.43.27 4ED 26 MAR, 1984 J06-LVROVER . BCS - EKS DISSPLA VER 3.2

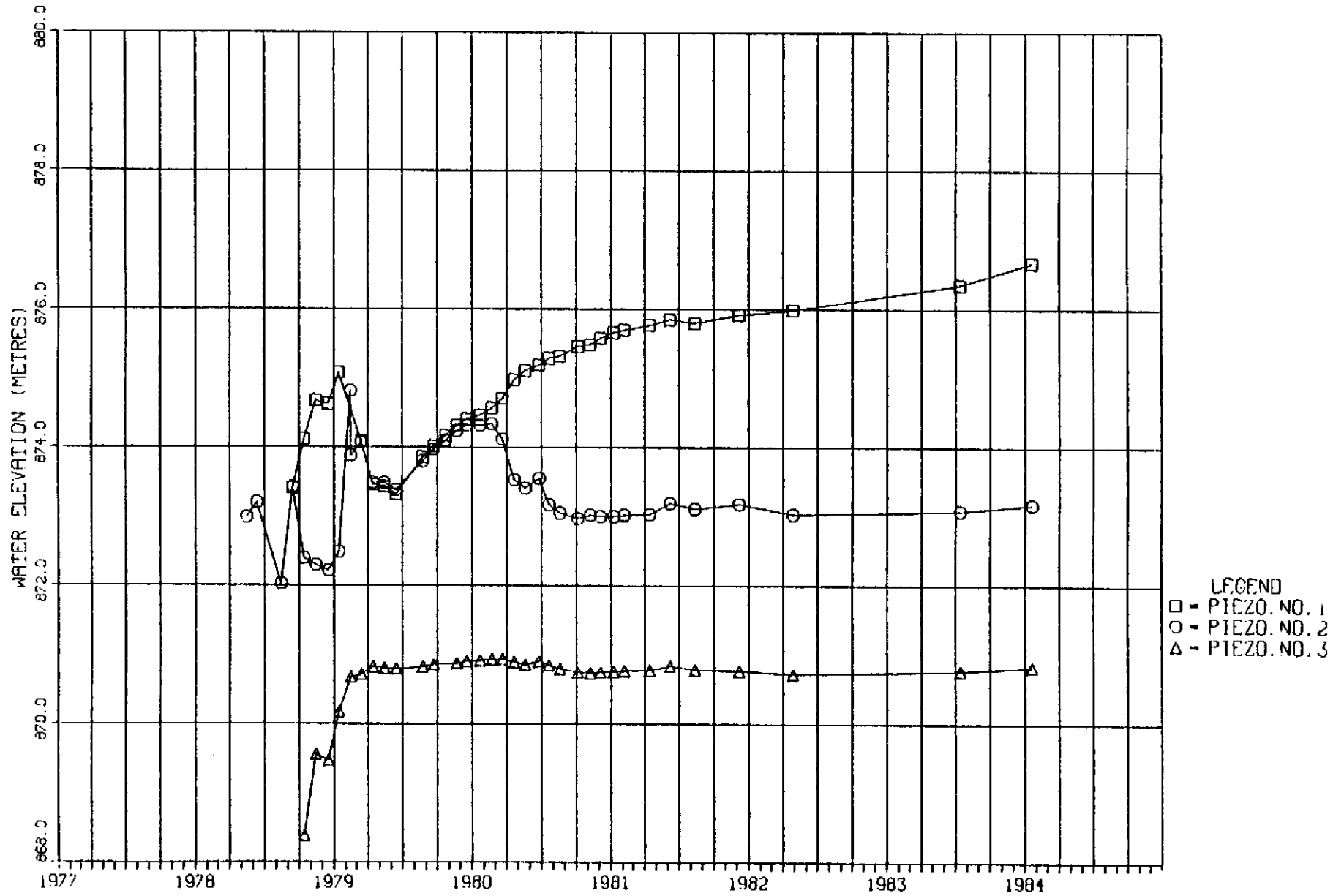
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-67



LEGEND
□ - PIEZO. NO. 1

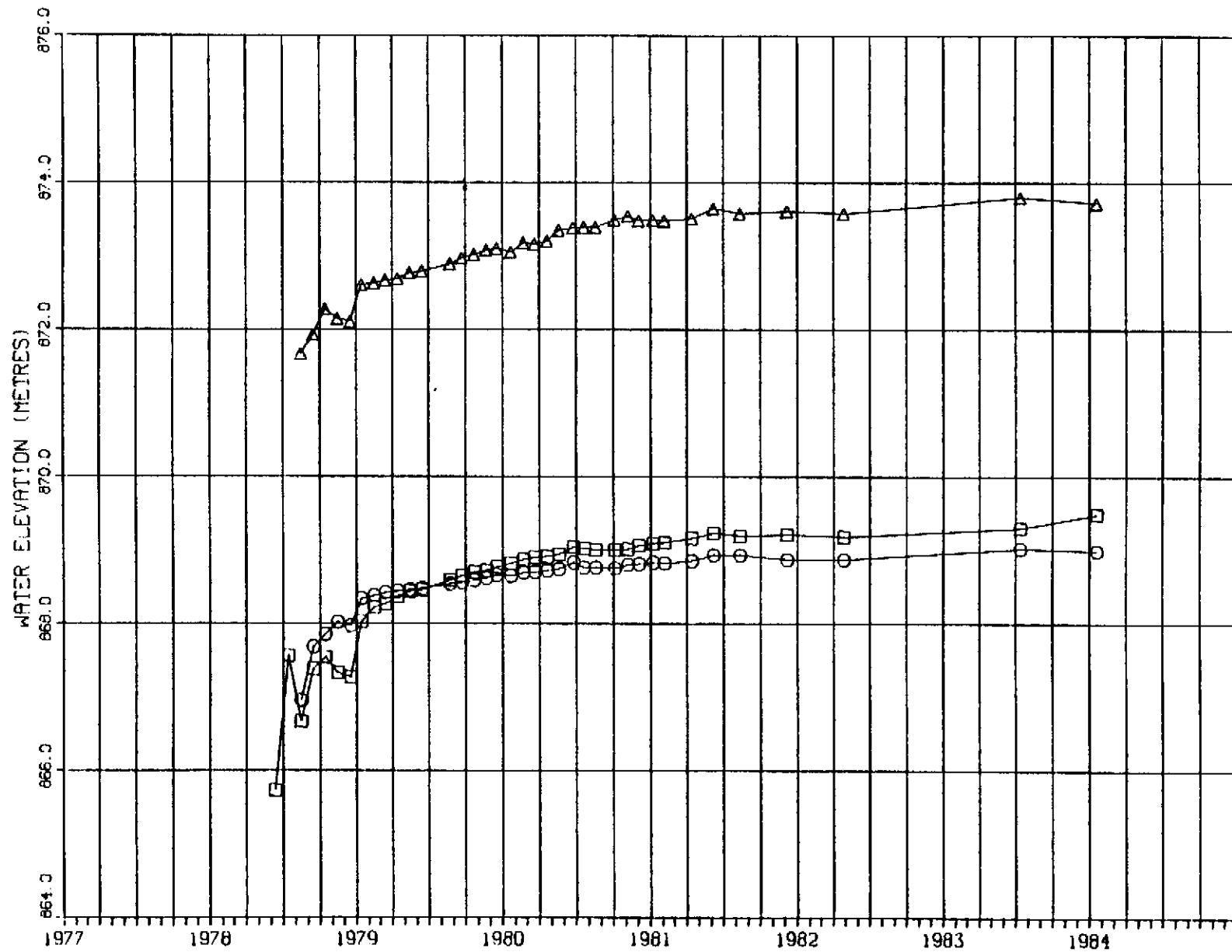
PLW: 6 18 43:00 WED 26 MAR, 1984 JOB=VADLER SCS - SXS DISSPLA VER 8.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-68A



LOT 7 13:44:00 WED 26 MAR, 1984 JOB=PROHER SCS - EXS DISPLAY VER 3.2

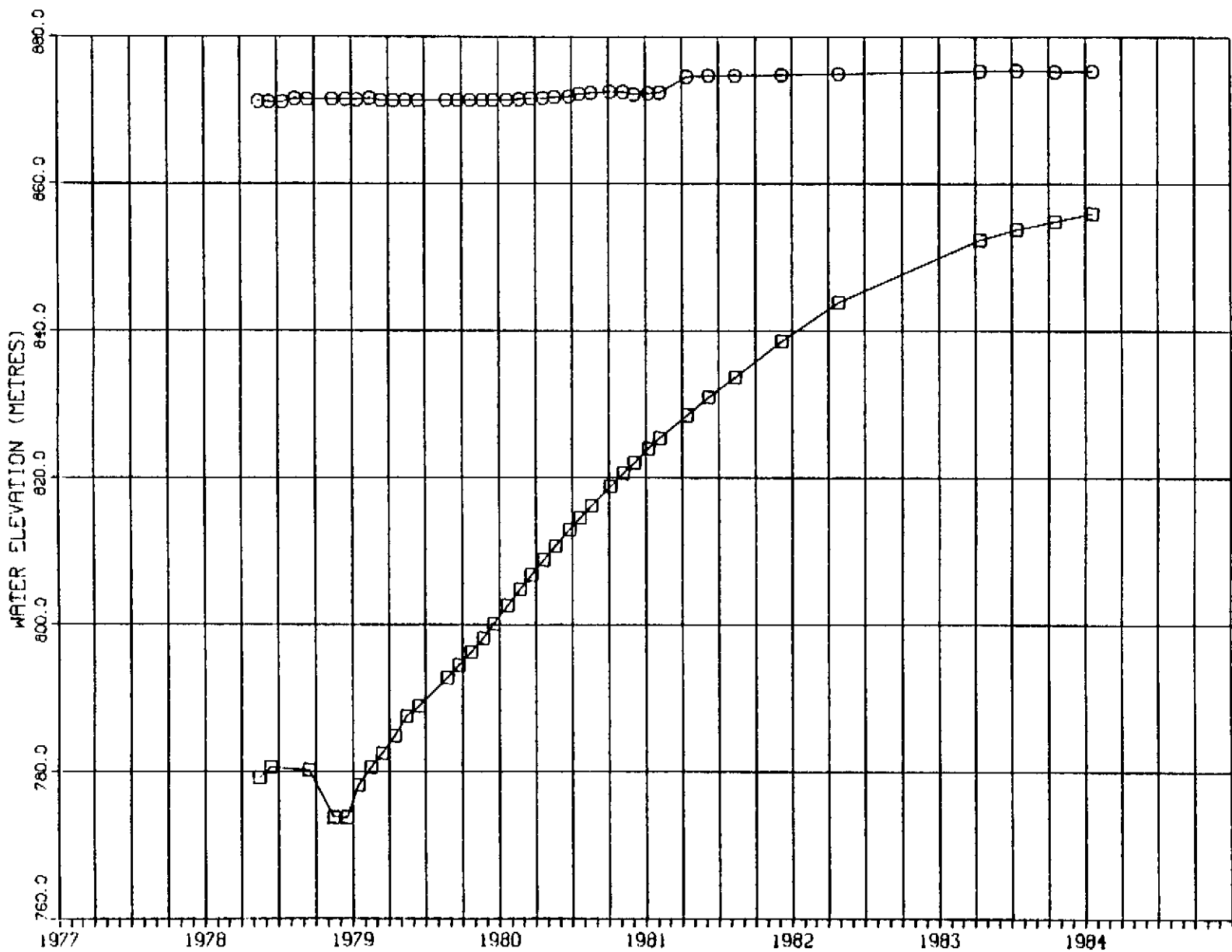
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-69A



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2
△ - PIEZO. NO. 3

LOT 8 16.11.05 WED 26 MAR, 1984 JOB NUMBER 505 - 5X5 DISPLAY VER 0.2

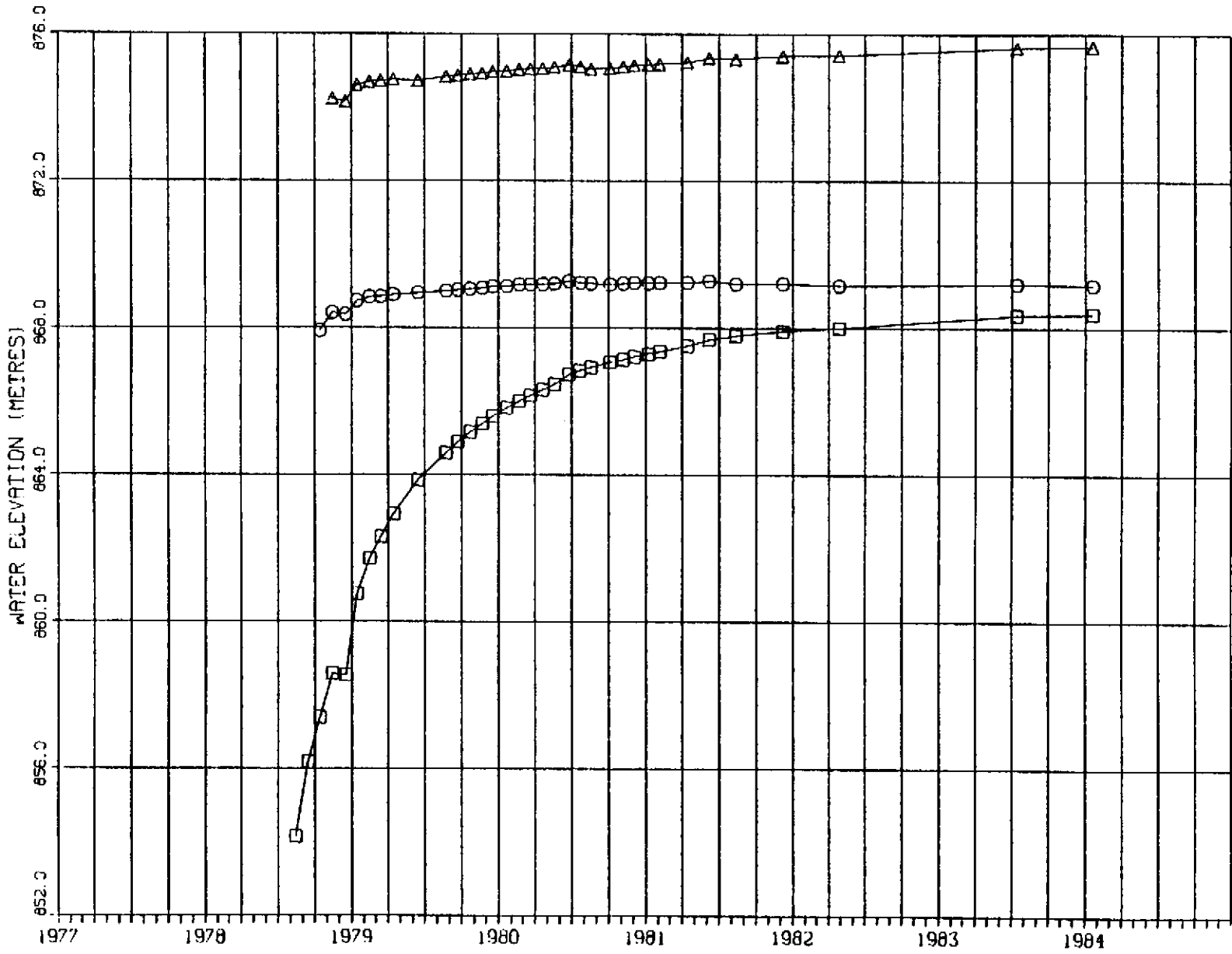
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-70



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

LOT 9 16.44.10 WED 28 MAR, 1984 JOB=C:\PACMER . BCS - EXS DISPLA VER 8.2

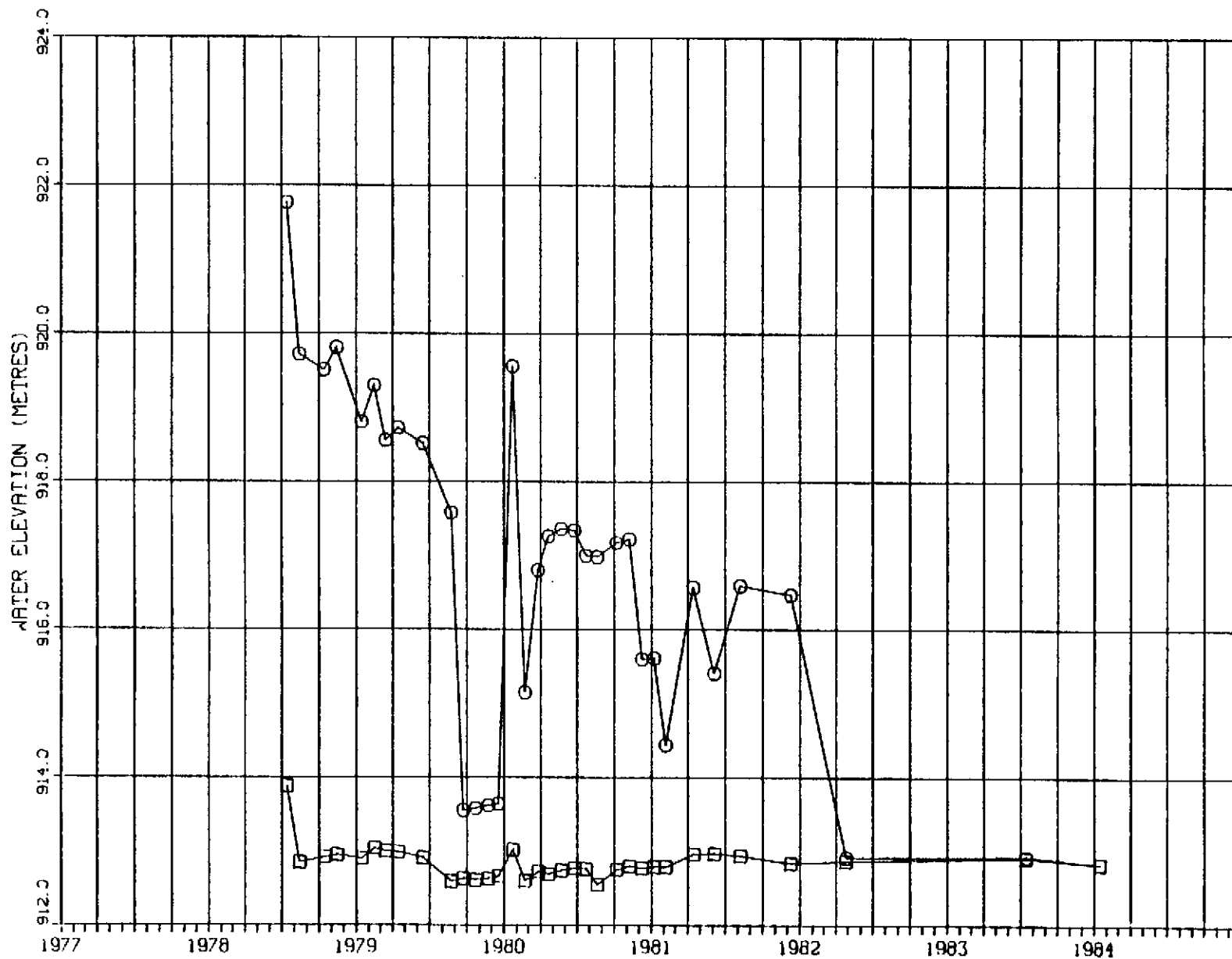
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-71



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2
△ - PIEZO. NO. 3

DATE: 10/14/84 10:40 AM, 1984 SUBPLOTTER: BUS - EKS DISOPH VEX 0.2

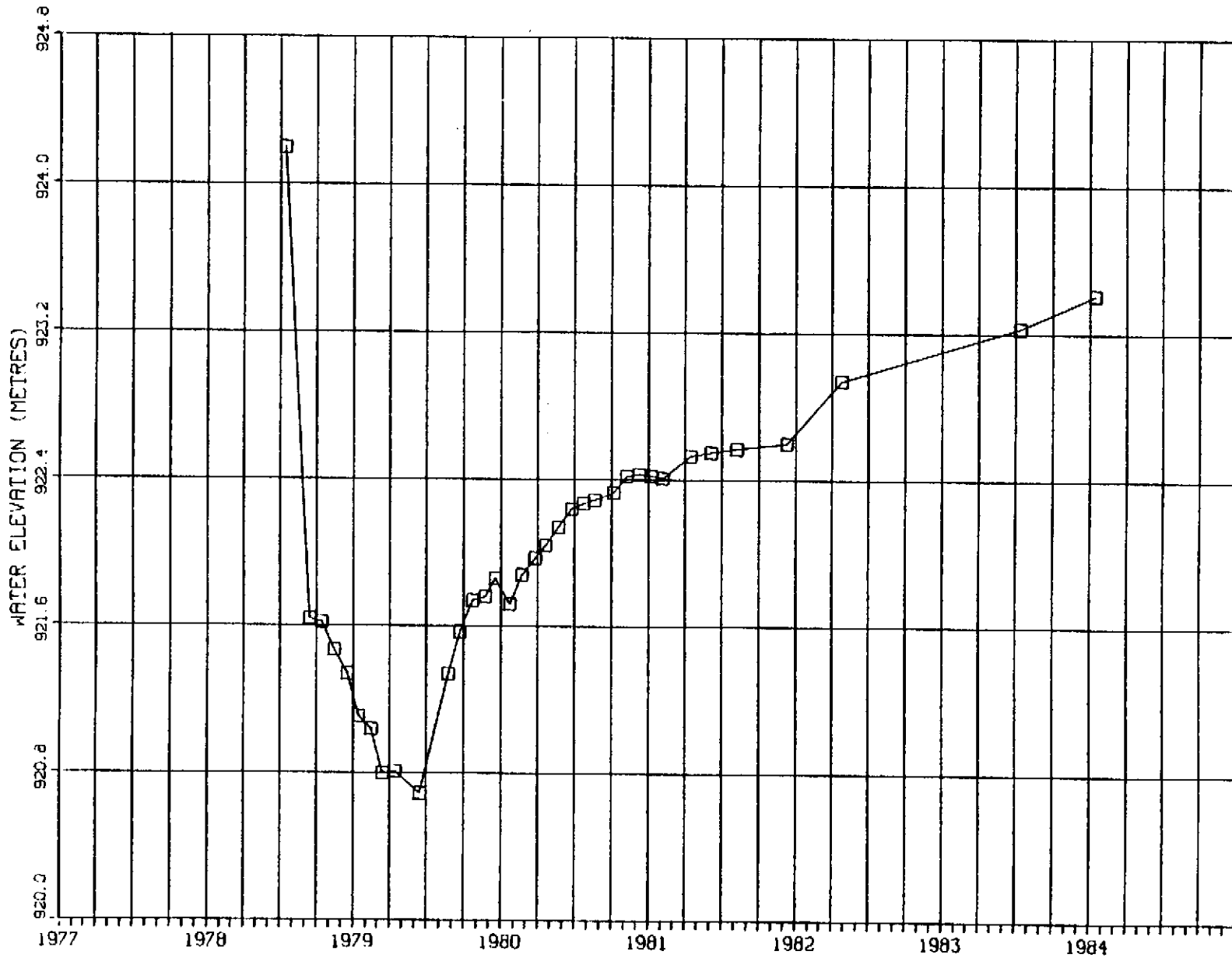
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-73



LEGEND
□ - PIEZO. NO. 2
○ - PIEZO. NO. 3

LOT 5 19.06.09 11:20 26 MAR, 1984 102-1160-66 . BCS - EXS DISPLA PER 0.2

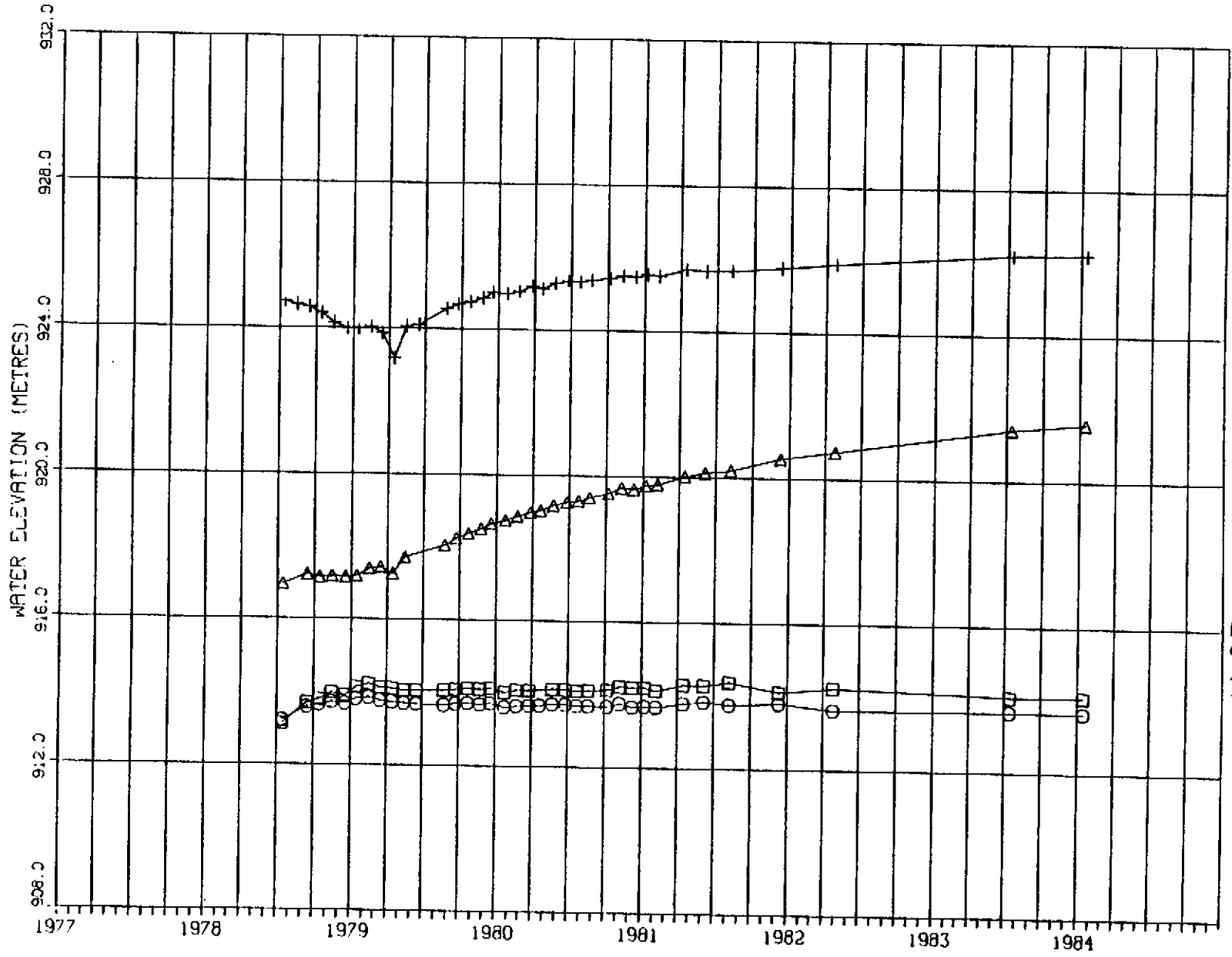
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LEGEND
□ - PIEZO. NO. 1

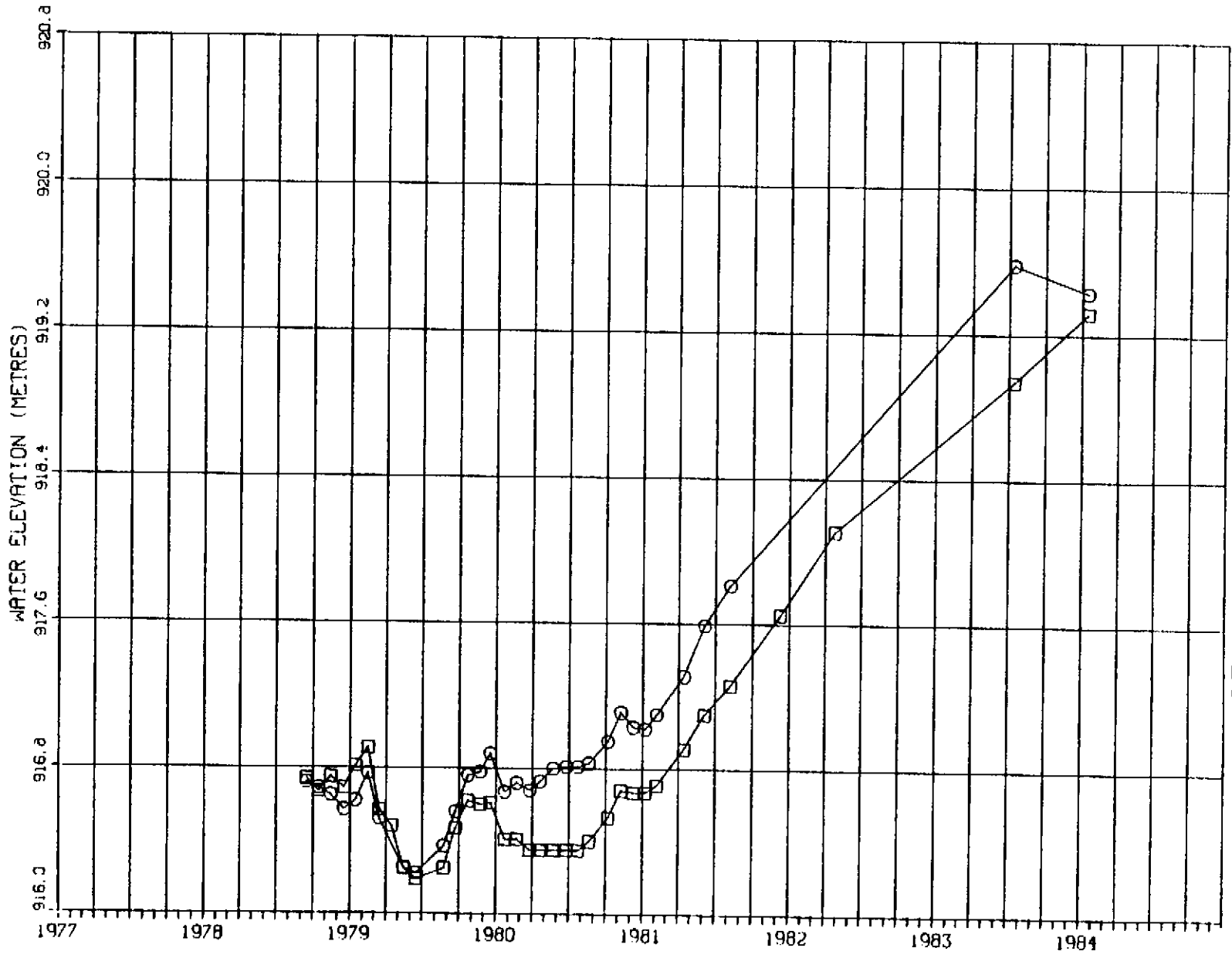
1017 9.06.15 1400 26 APR, 1984 JOB=LVRCH60 . BCS - EXS DISSPLA VER 6.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-74A



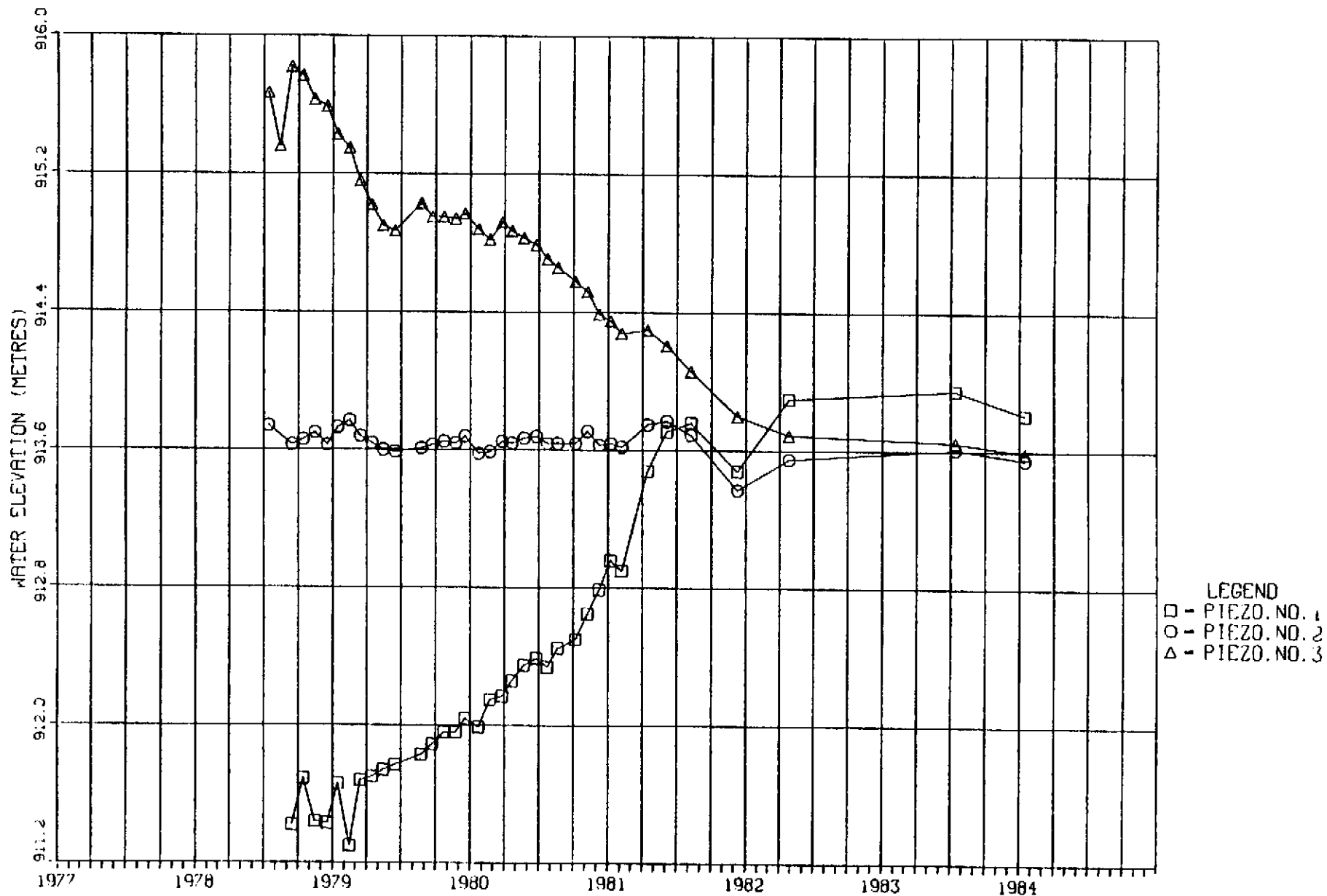
- LEGEND
- - PIEZO. NO. 2
 - - PIEZO. NO. 3
 - △ - PIEZO. NO. 4
 - + - PIEZO. NO. 5

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-75



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

HAI CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-76



DOT 9 19.06.22 AED 26 MAR, 1984 ICE-ARCH00 905 - EXS DISPLA VER 3.2

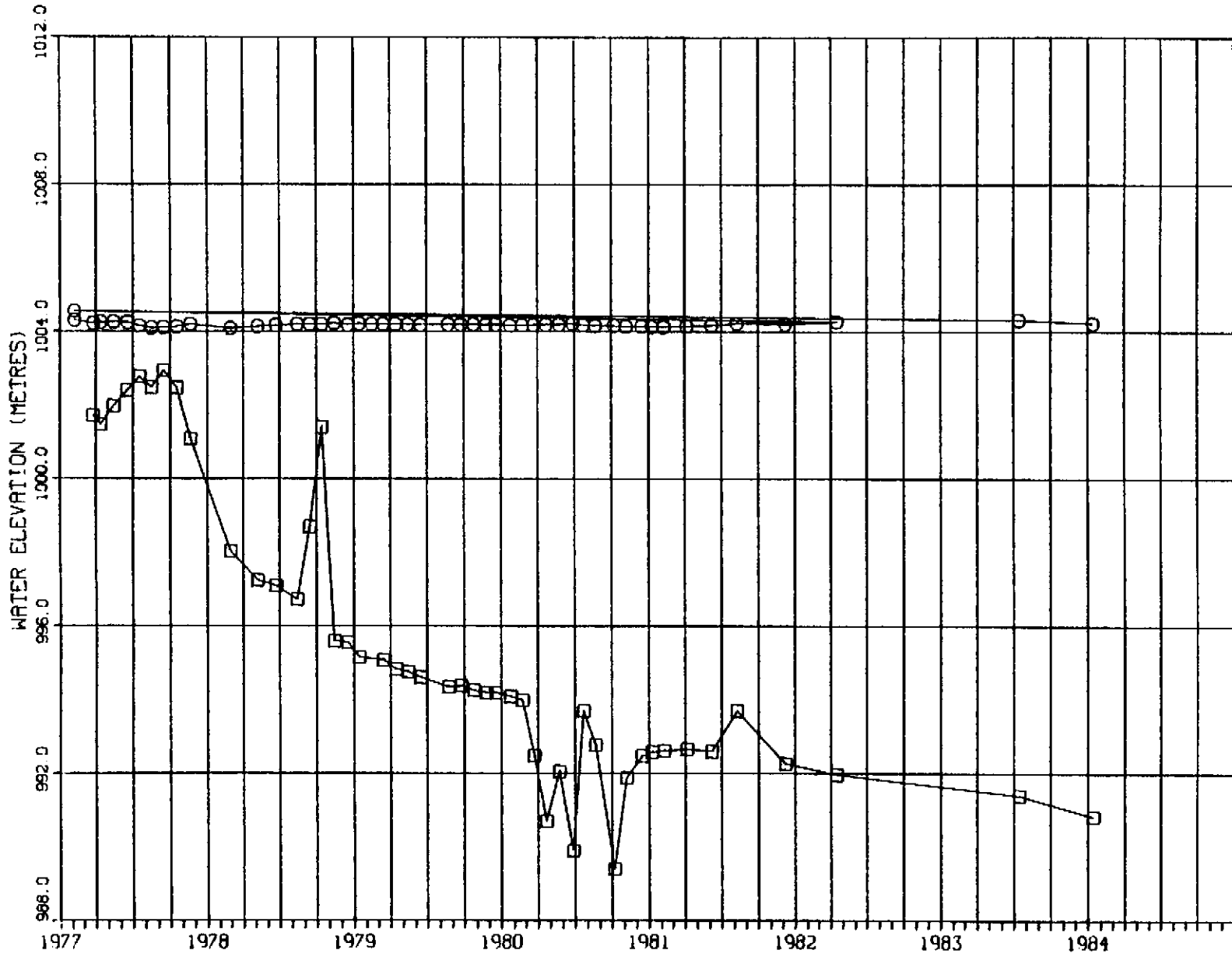
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. RH-78-77



LEGEND
□ - PIEZO. NO. 1

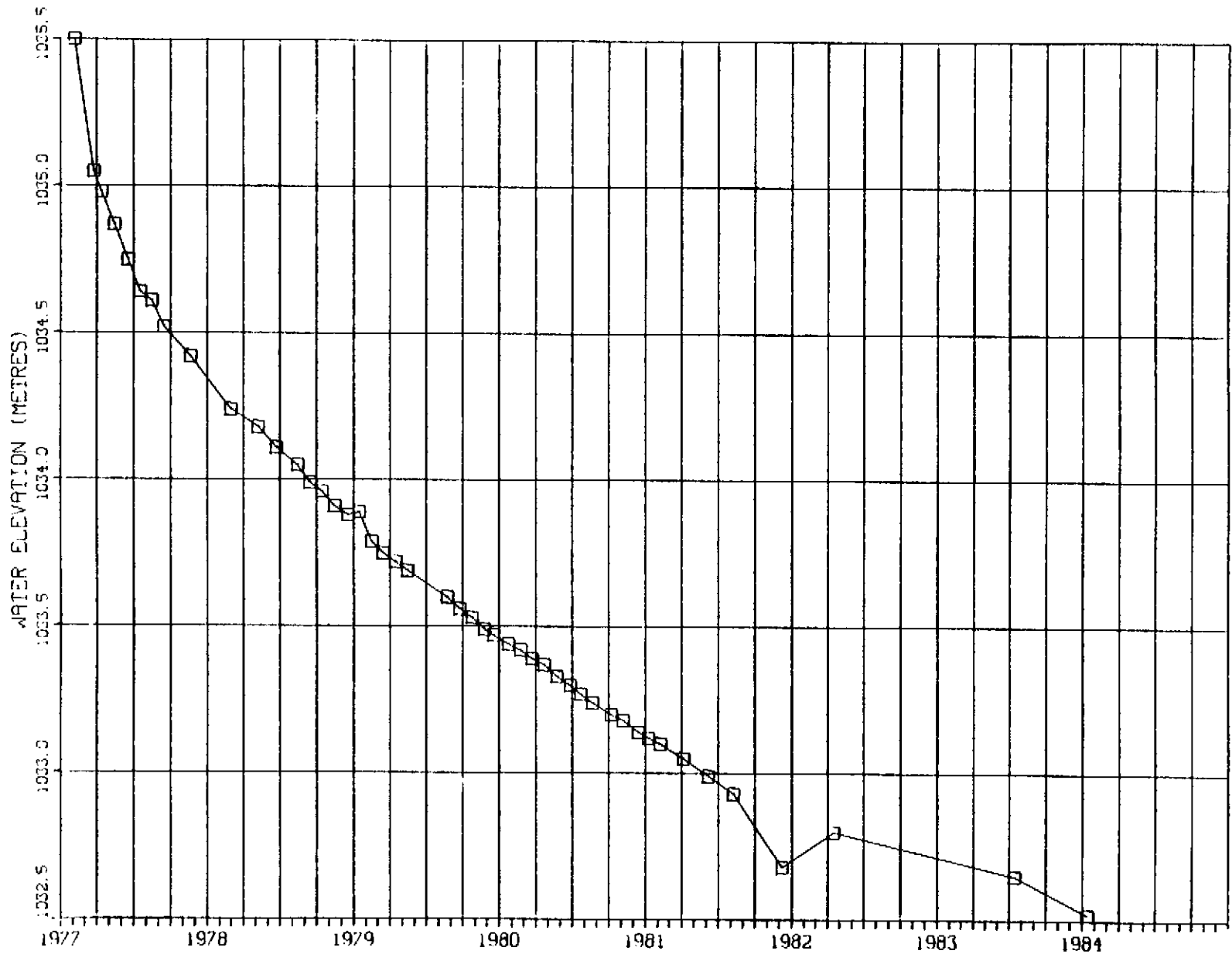
1. Date of report: 1984
2. Project: 805 - 2KS DISSEJA PER 0.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-134



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

HAI CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-137



LEGEND
 □ - PIEZO. NO. 1

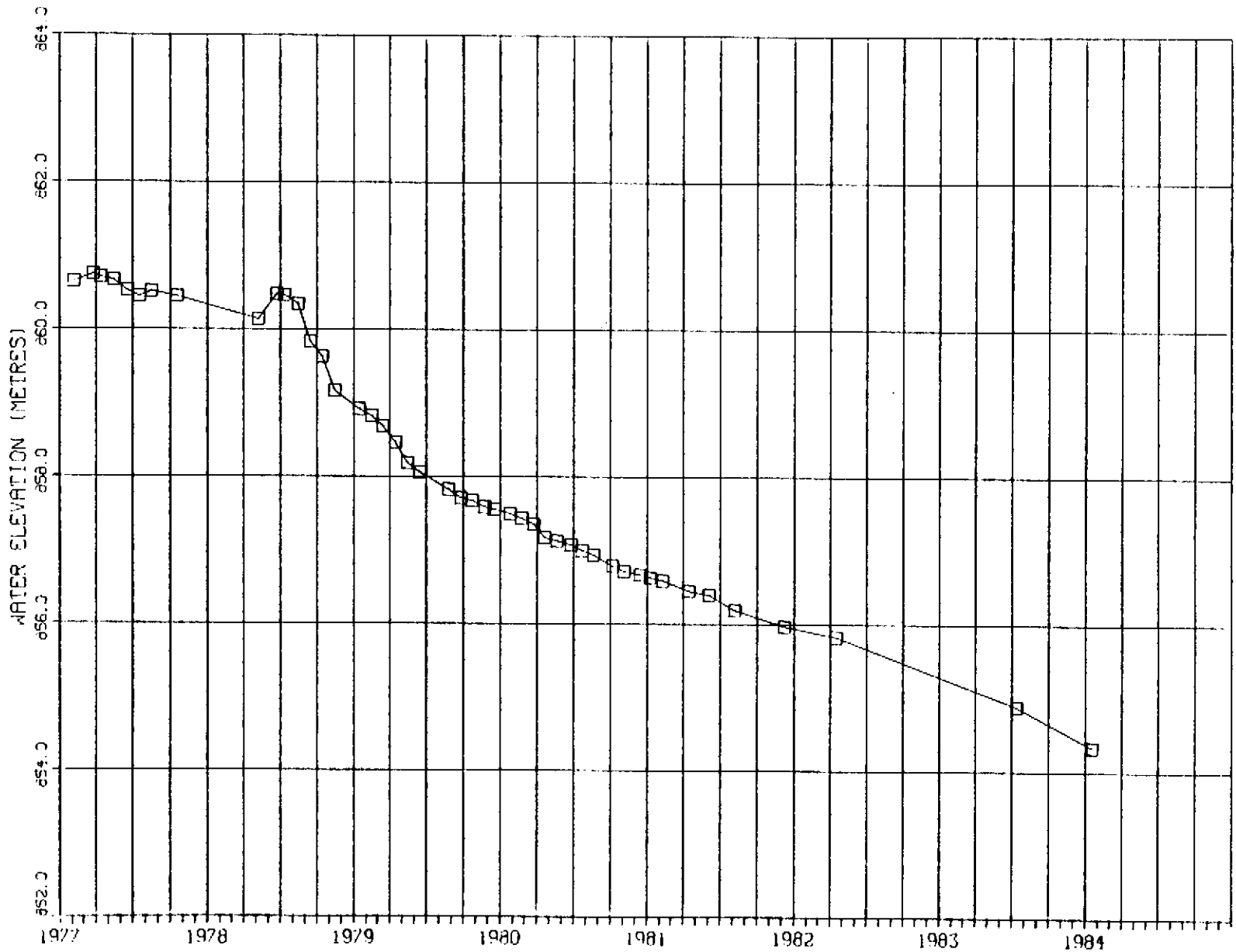
19 2 2 14 14JUN 20 1996 1804 106469596 . 903 - 515 DISPLA PER 0.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-141



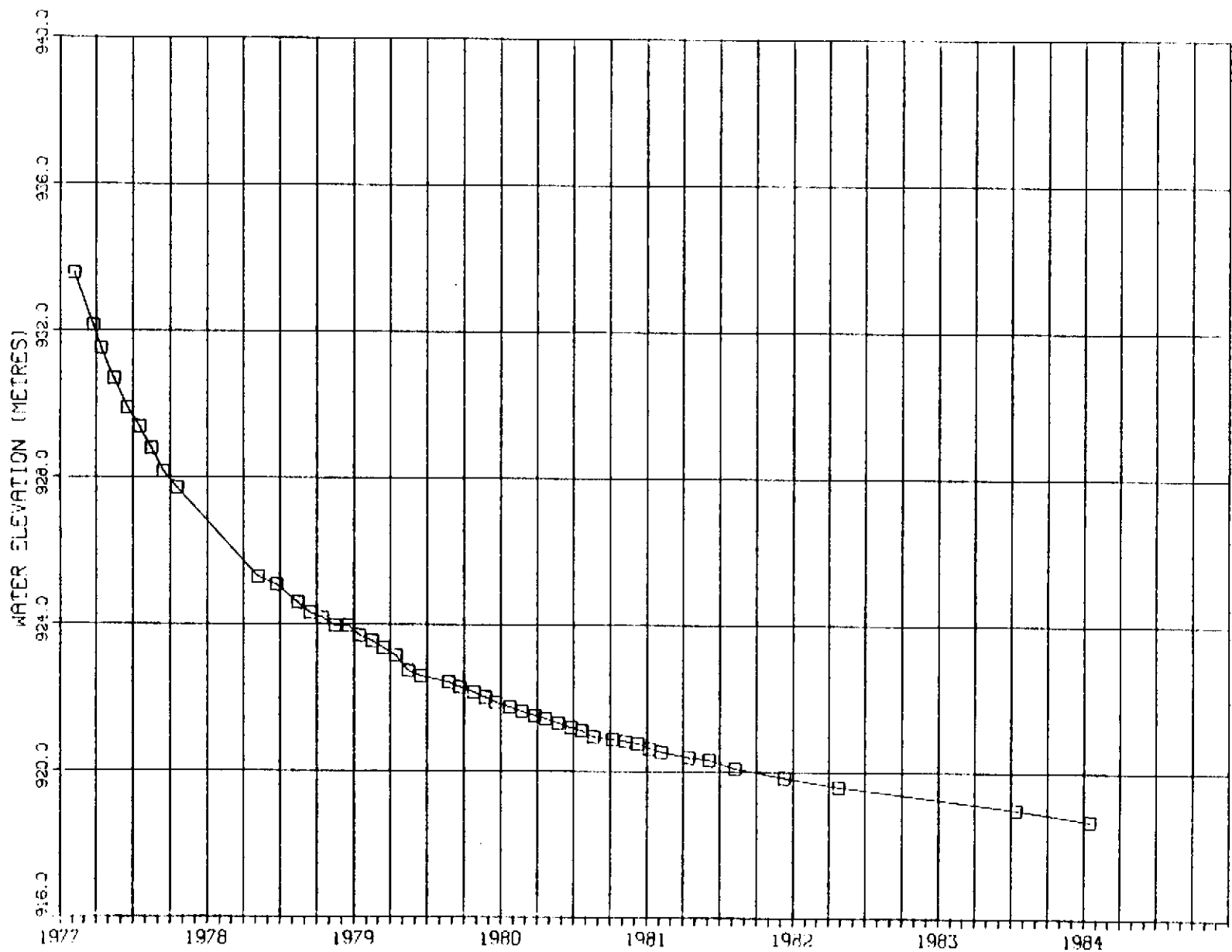
LEGEND
□ - PIEZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-143

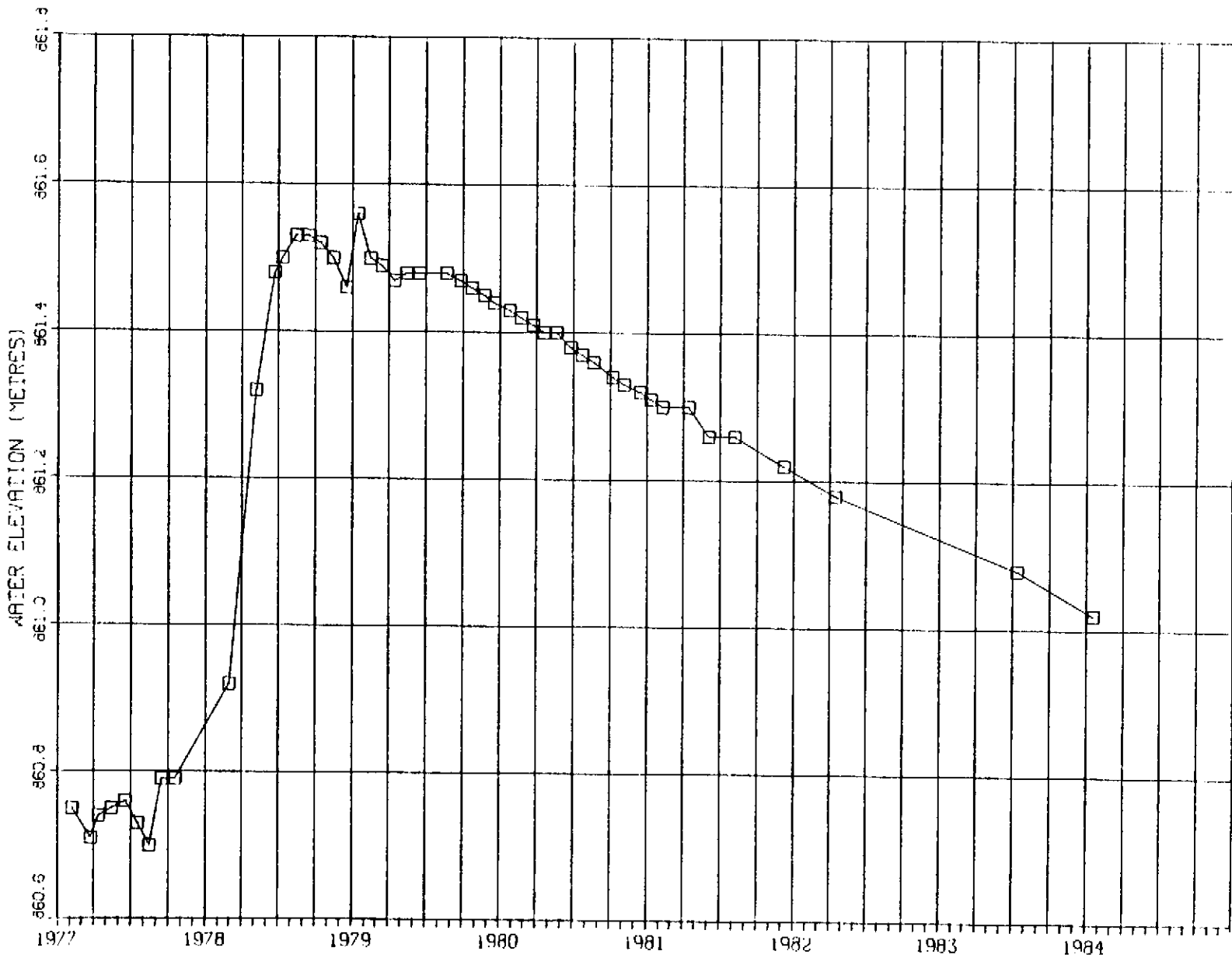


LEGEND
□ - PIEZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-144

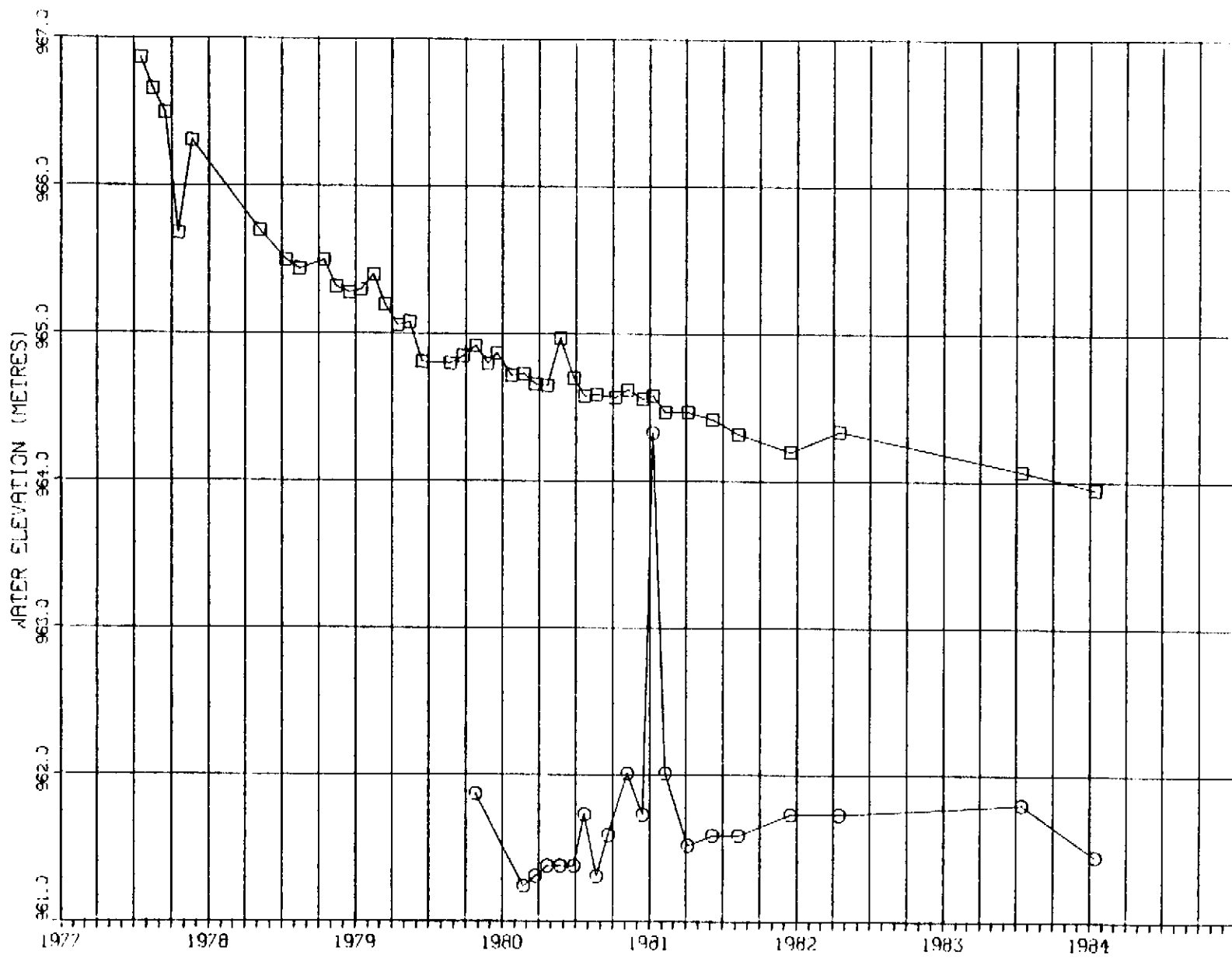


HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-148



LEGEND
□ -- PIEZO. NO. 1

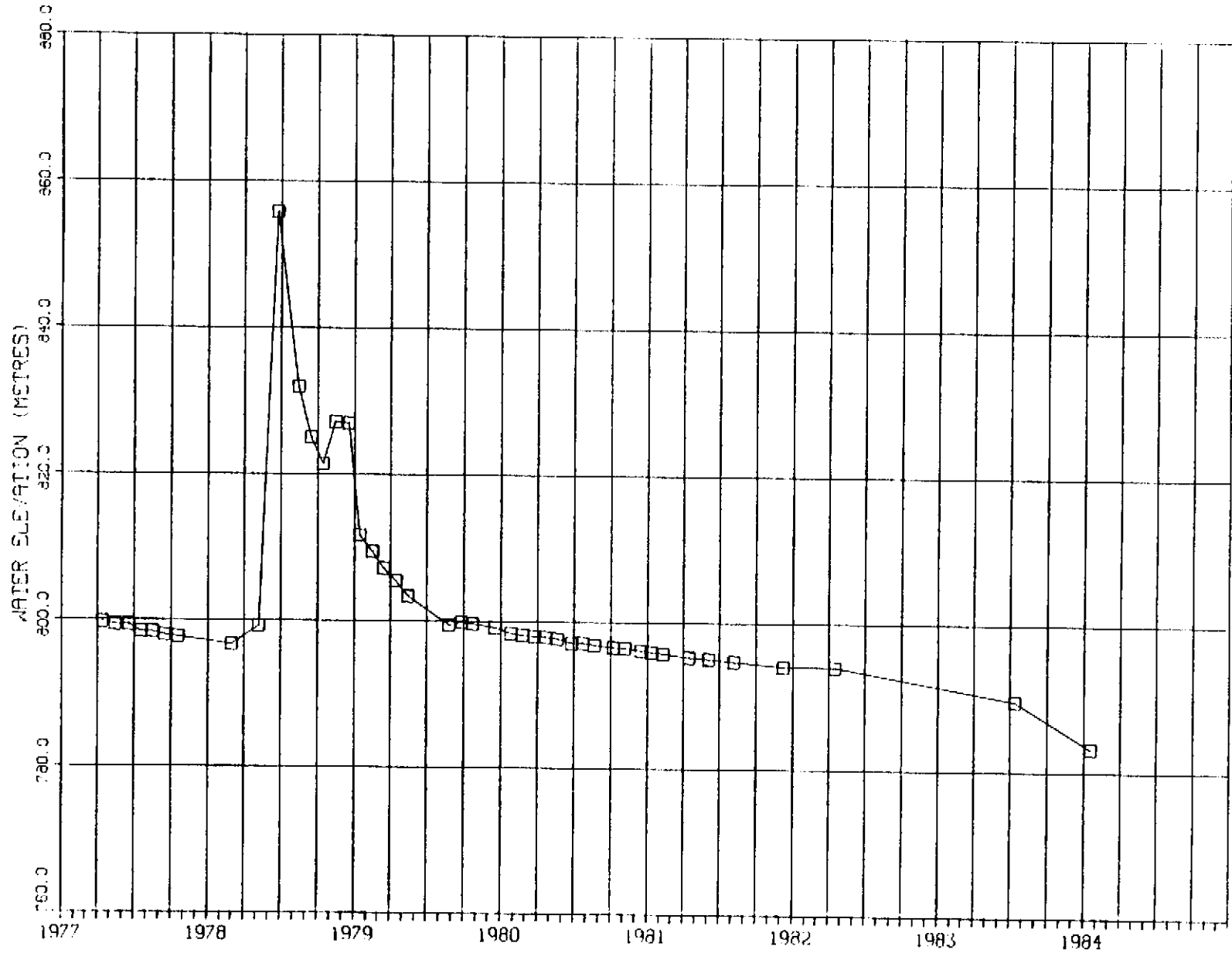
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-149



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

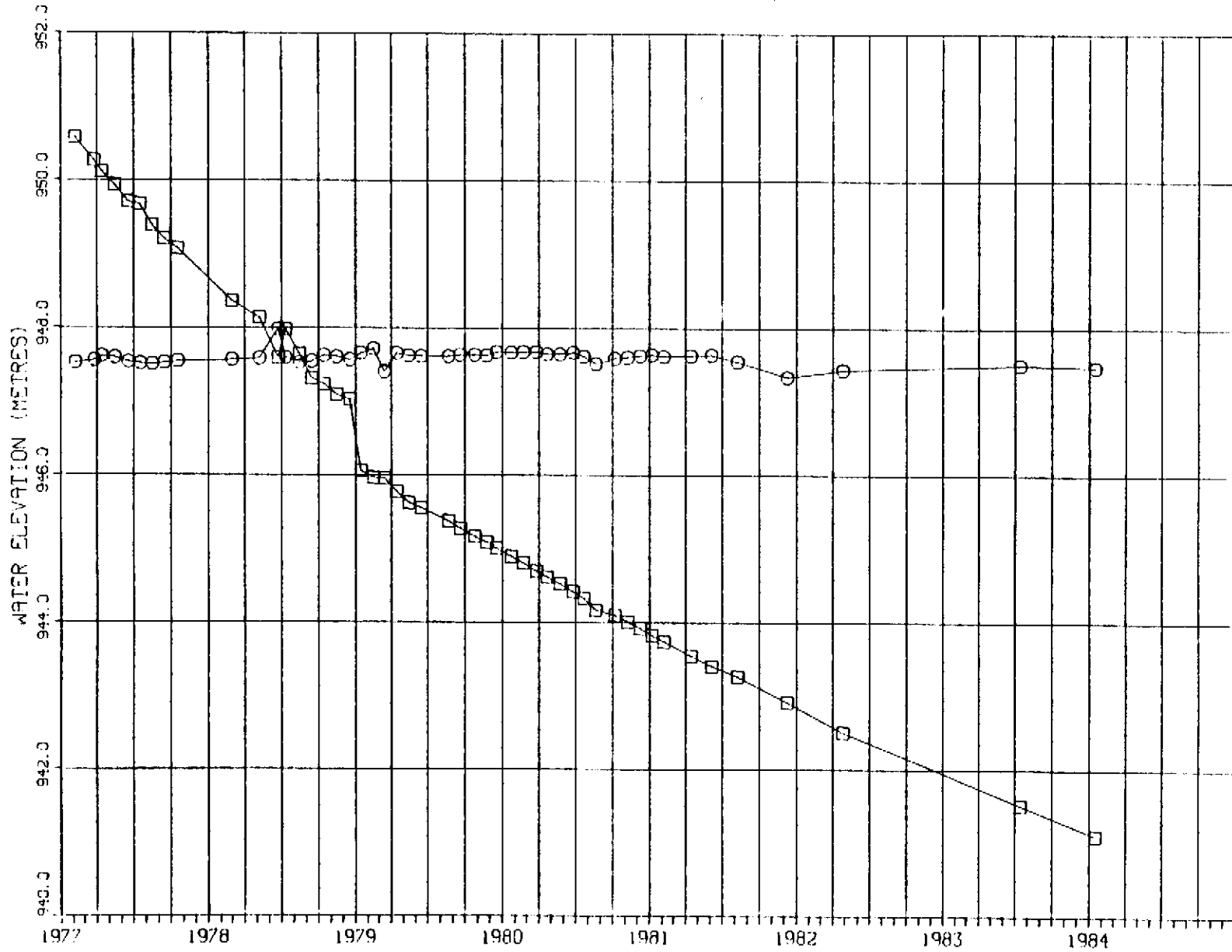
DATE: 11/15/84 TIME: 1:04 DRAWING: 803 - 215 315/315/84 614

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-150



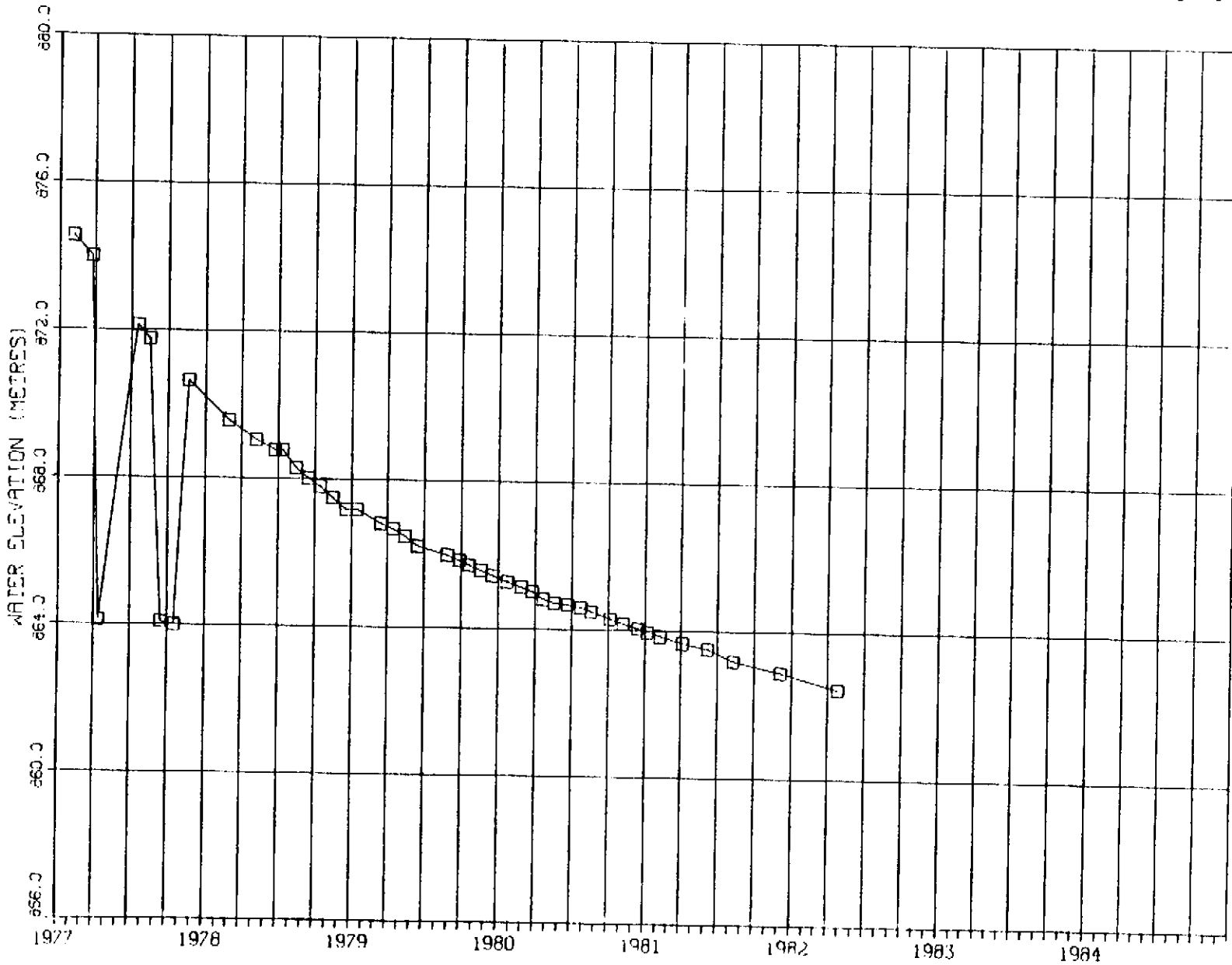
LEGEND
□ - PIEZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-155



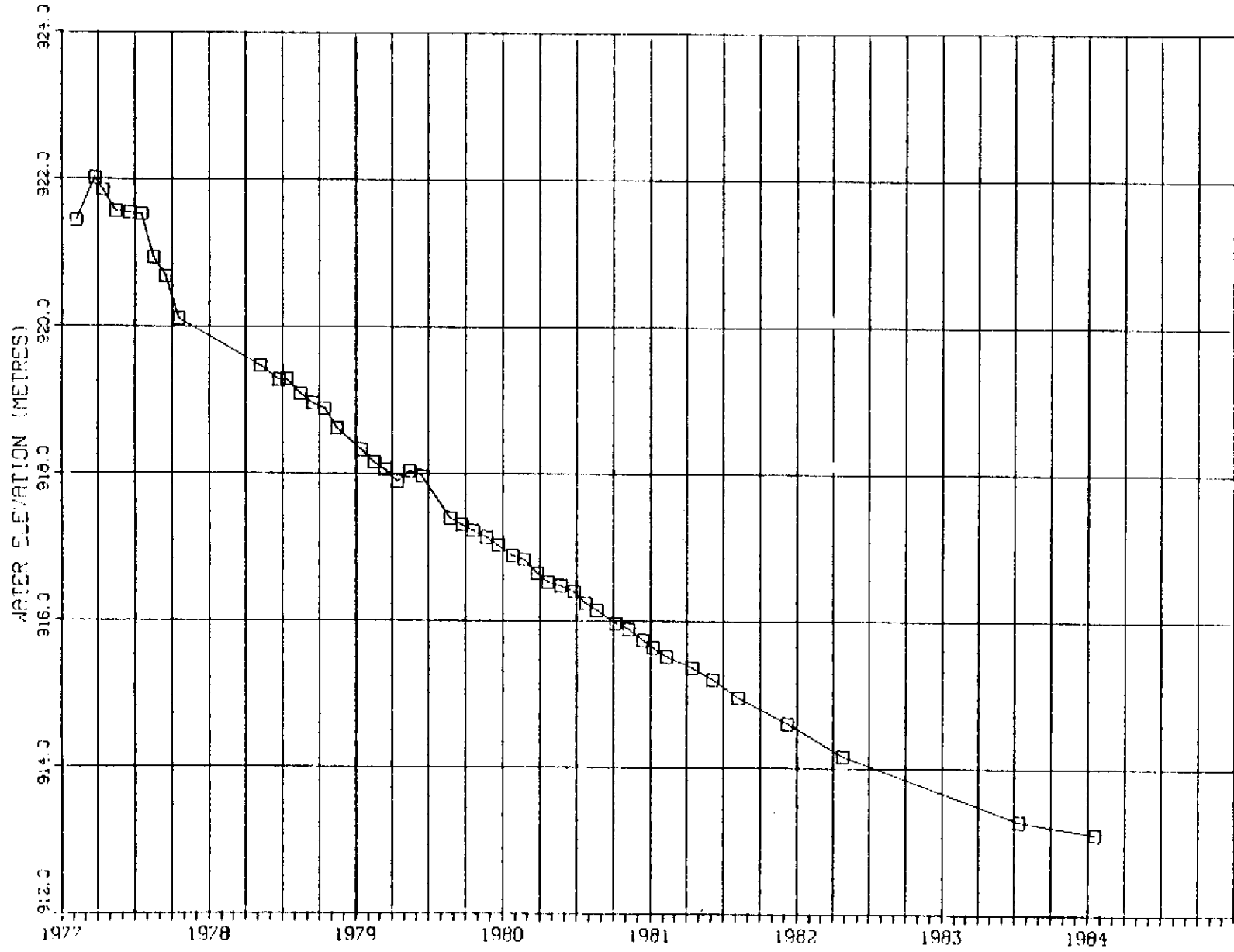
LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-15G



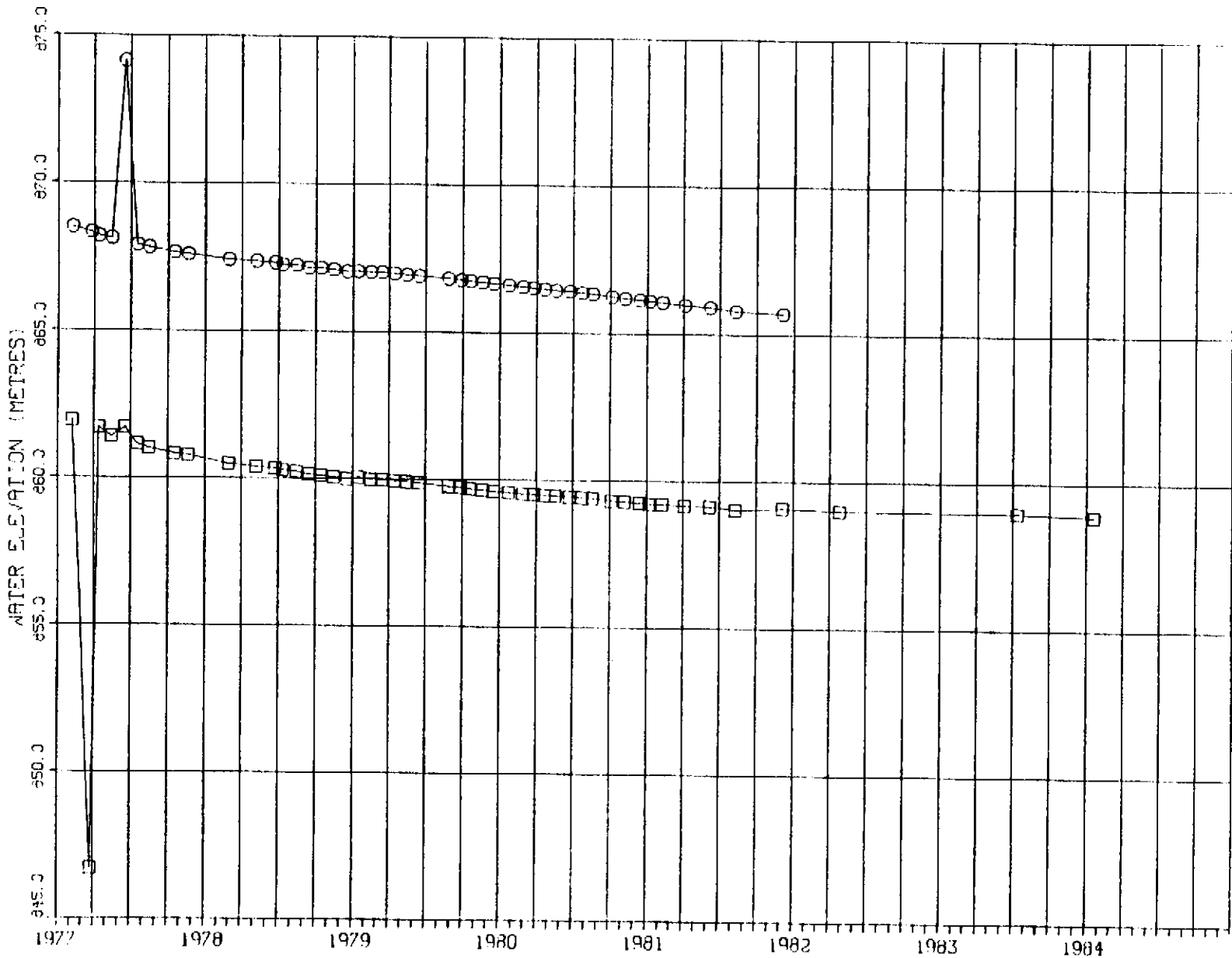
LEGEND
□ - PIEZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-158



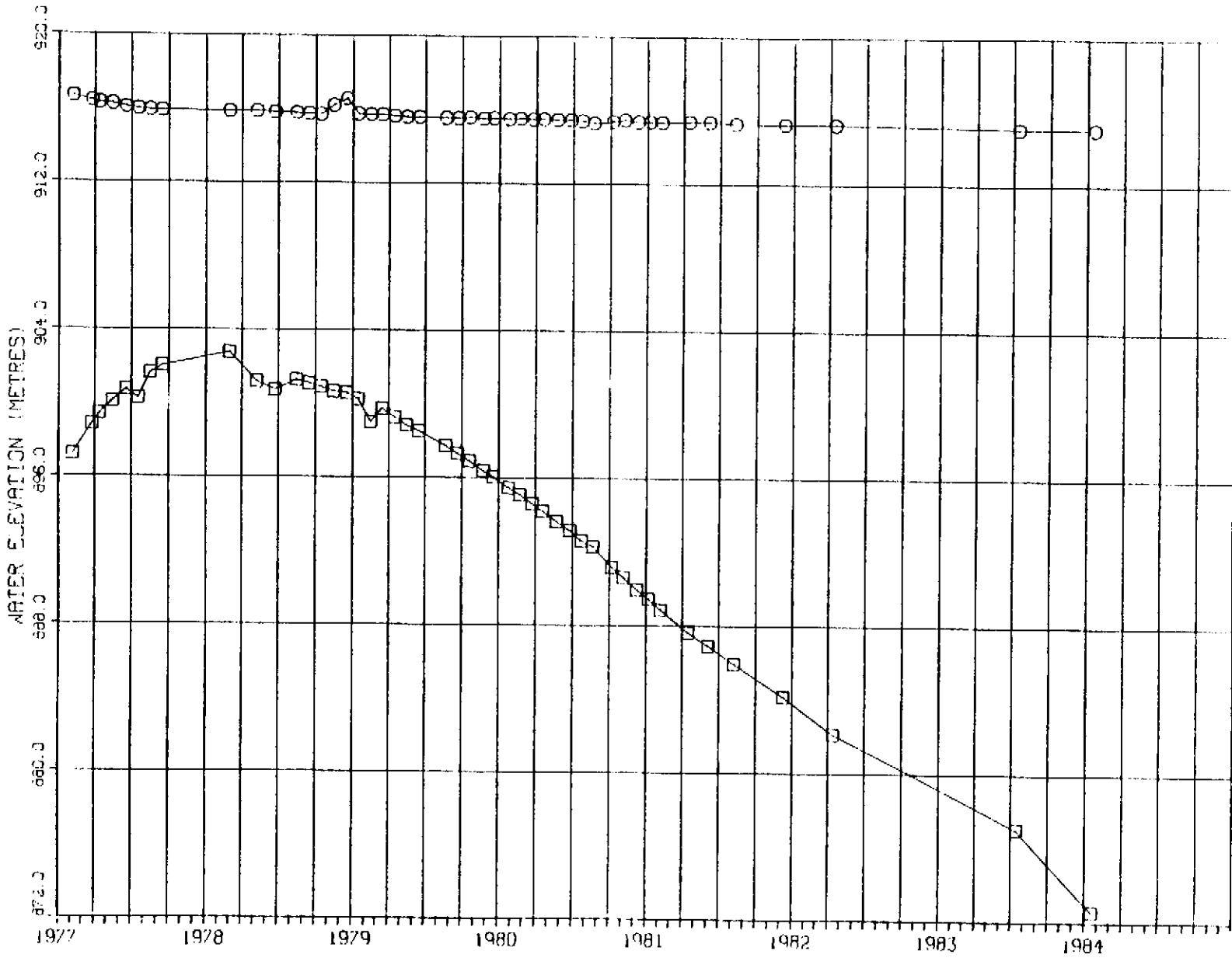
LEGEND
□ - PTCZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-160



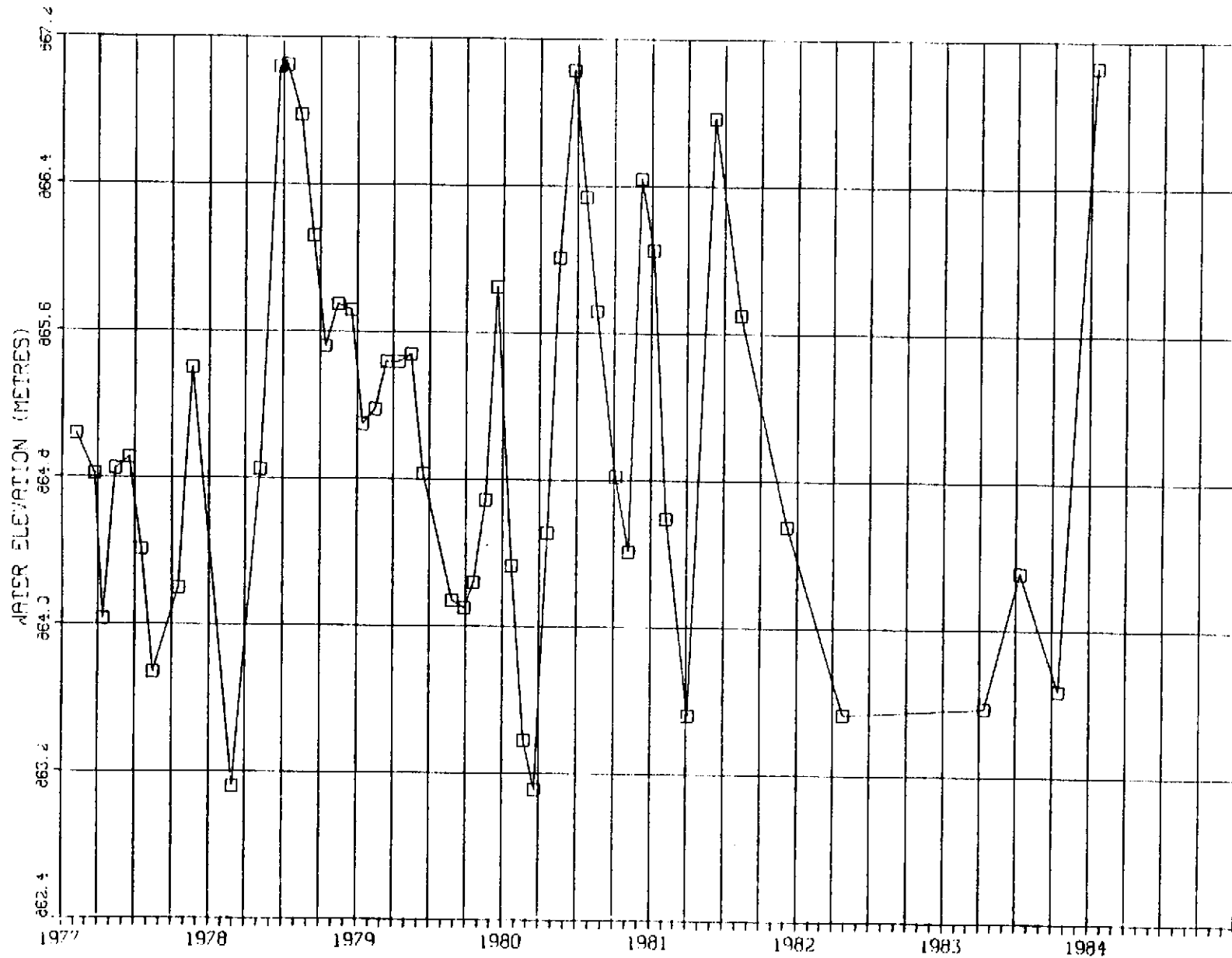
LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-161



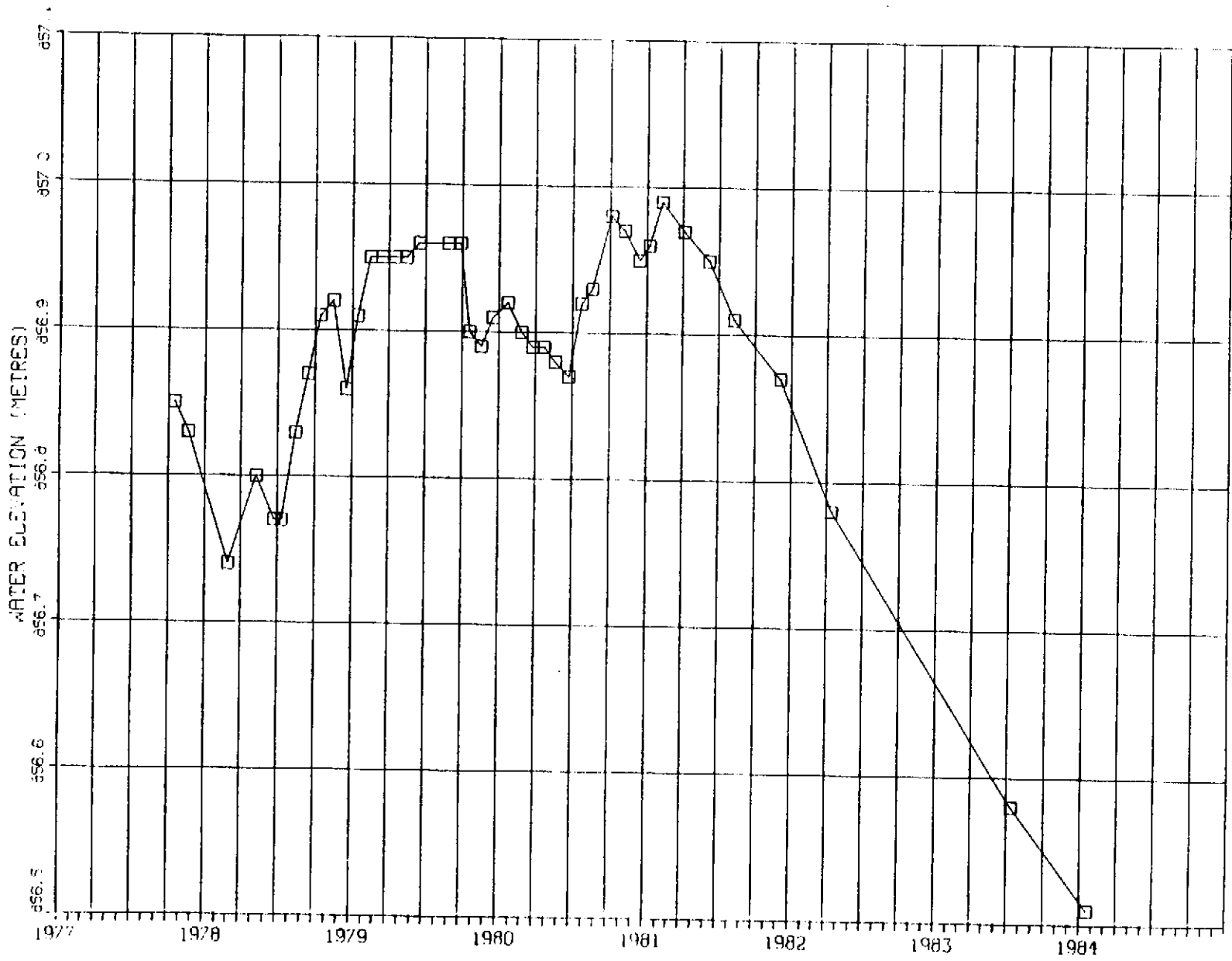
LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-168



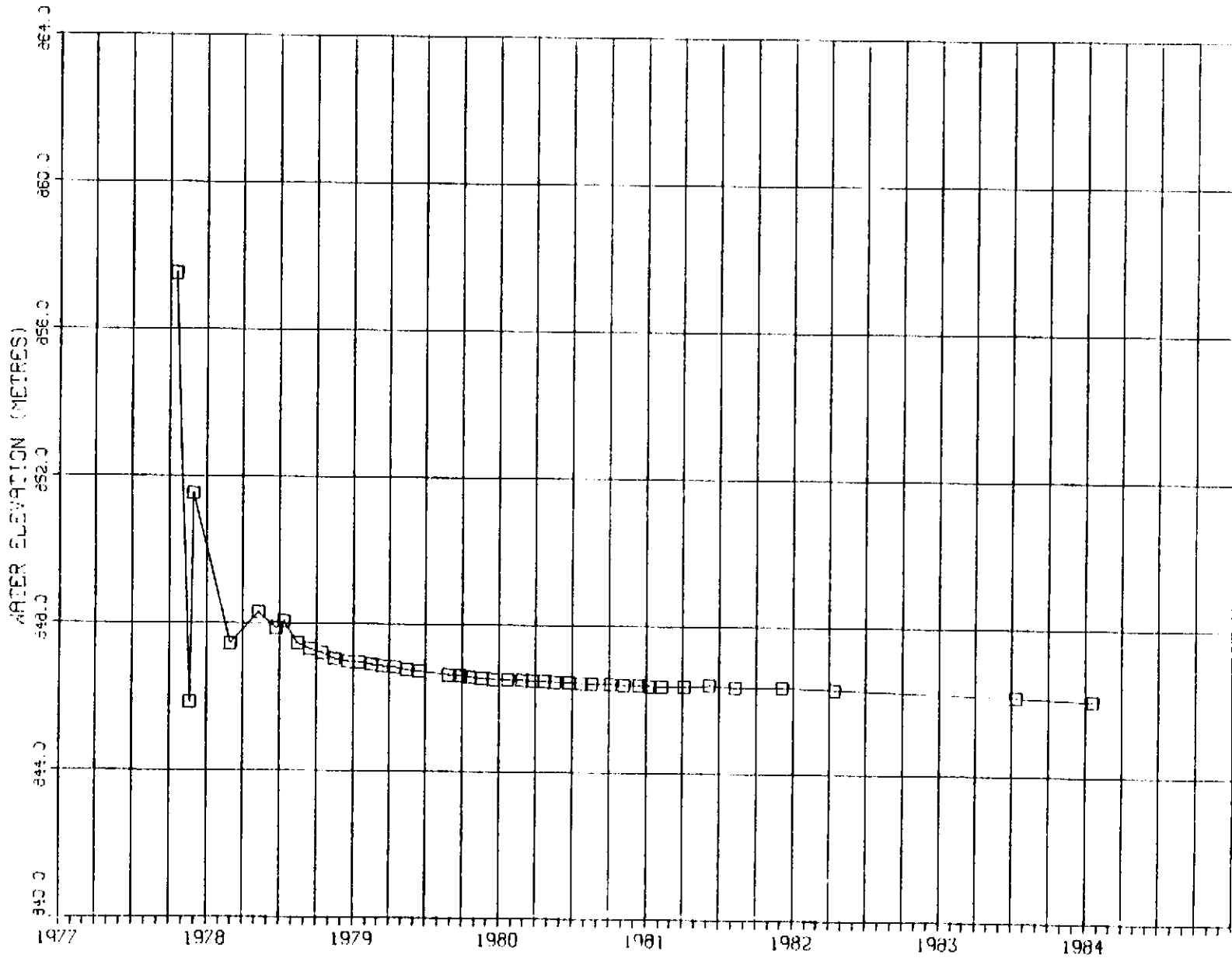
LEGEND
□ - PTCZO. NO. 1

HAI CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DOH-77-220



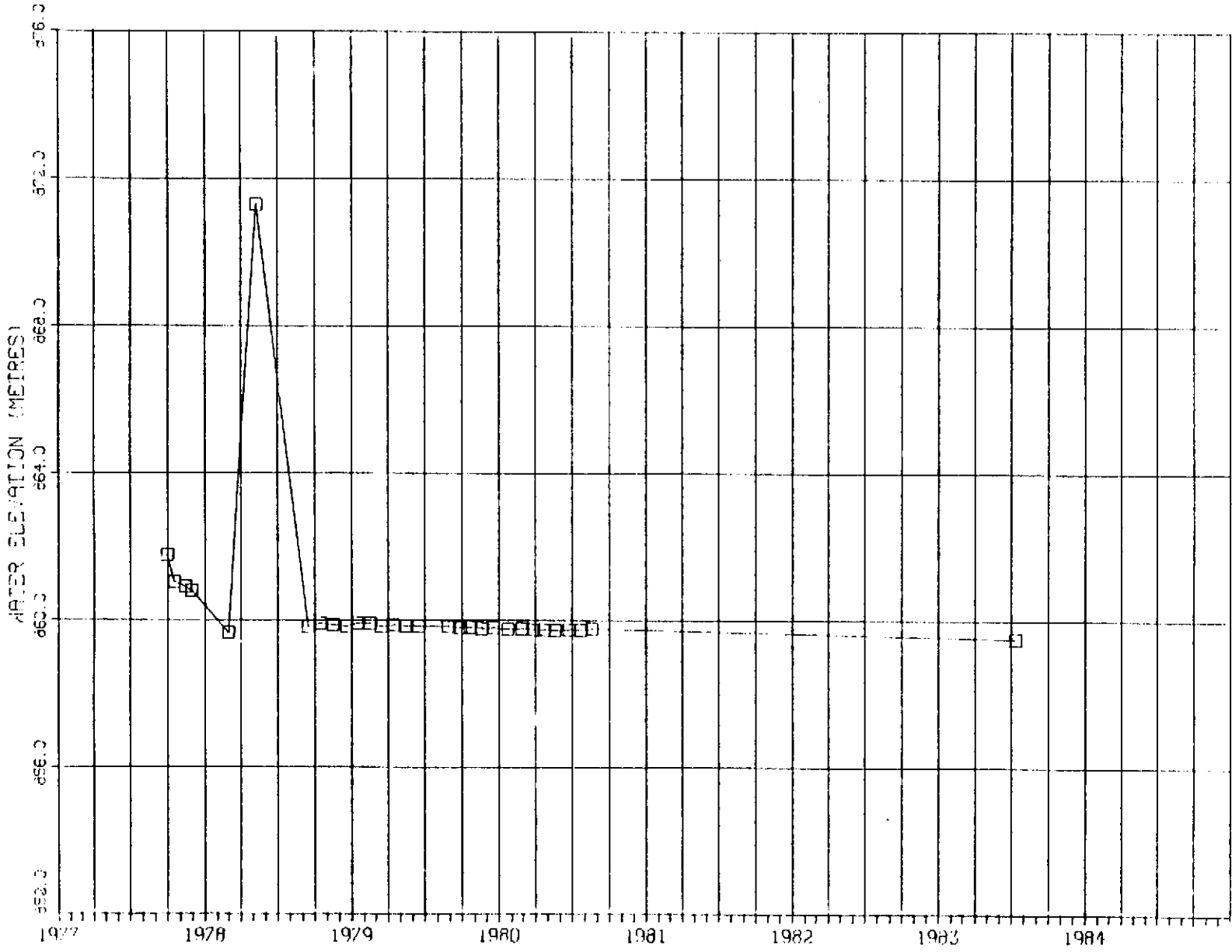
LEGEND
□ - PTCZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-224



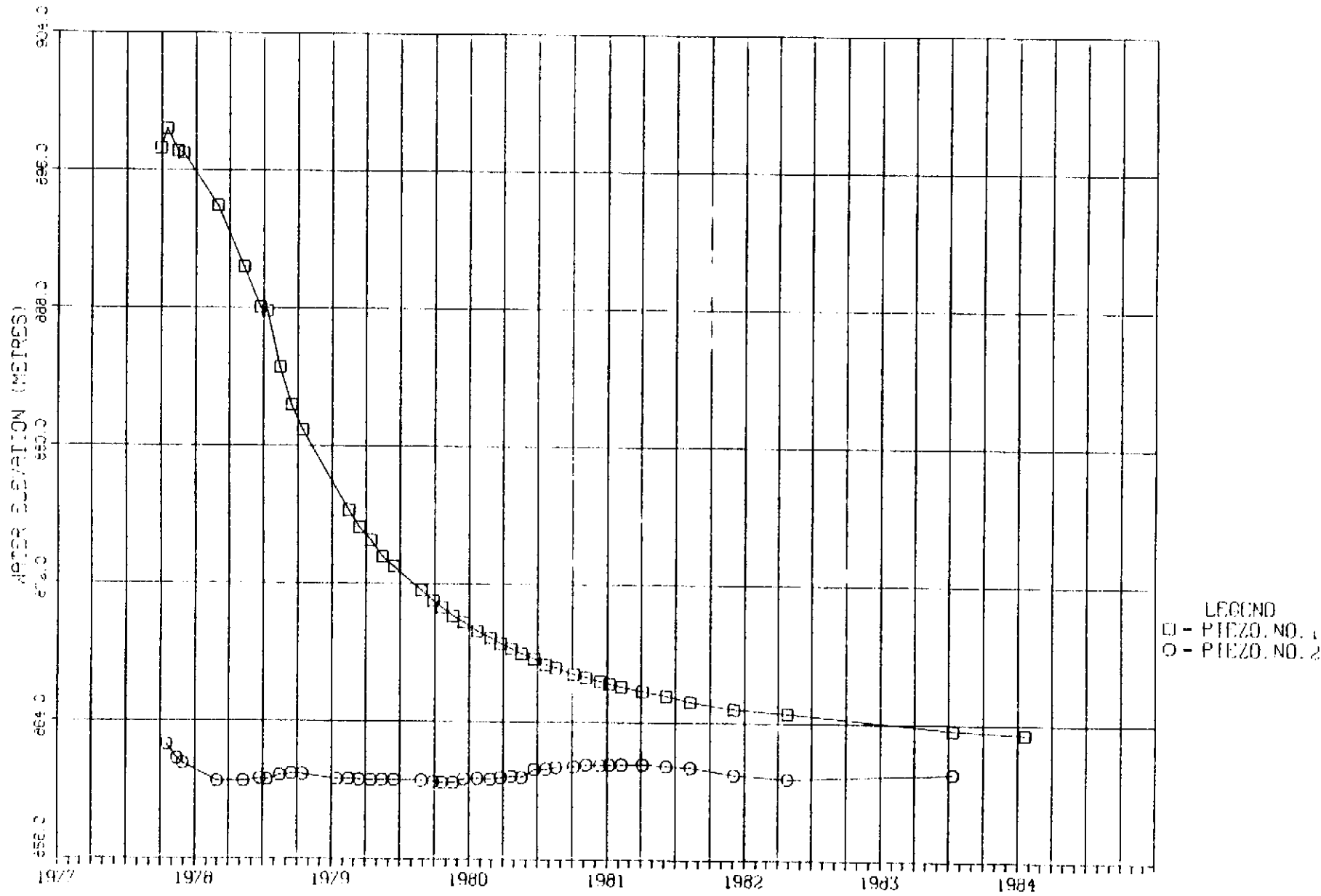
LEGEND
□ - PTCZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-225



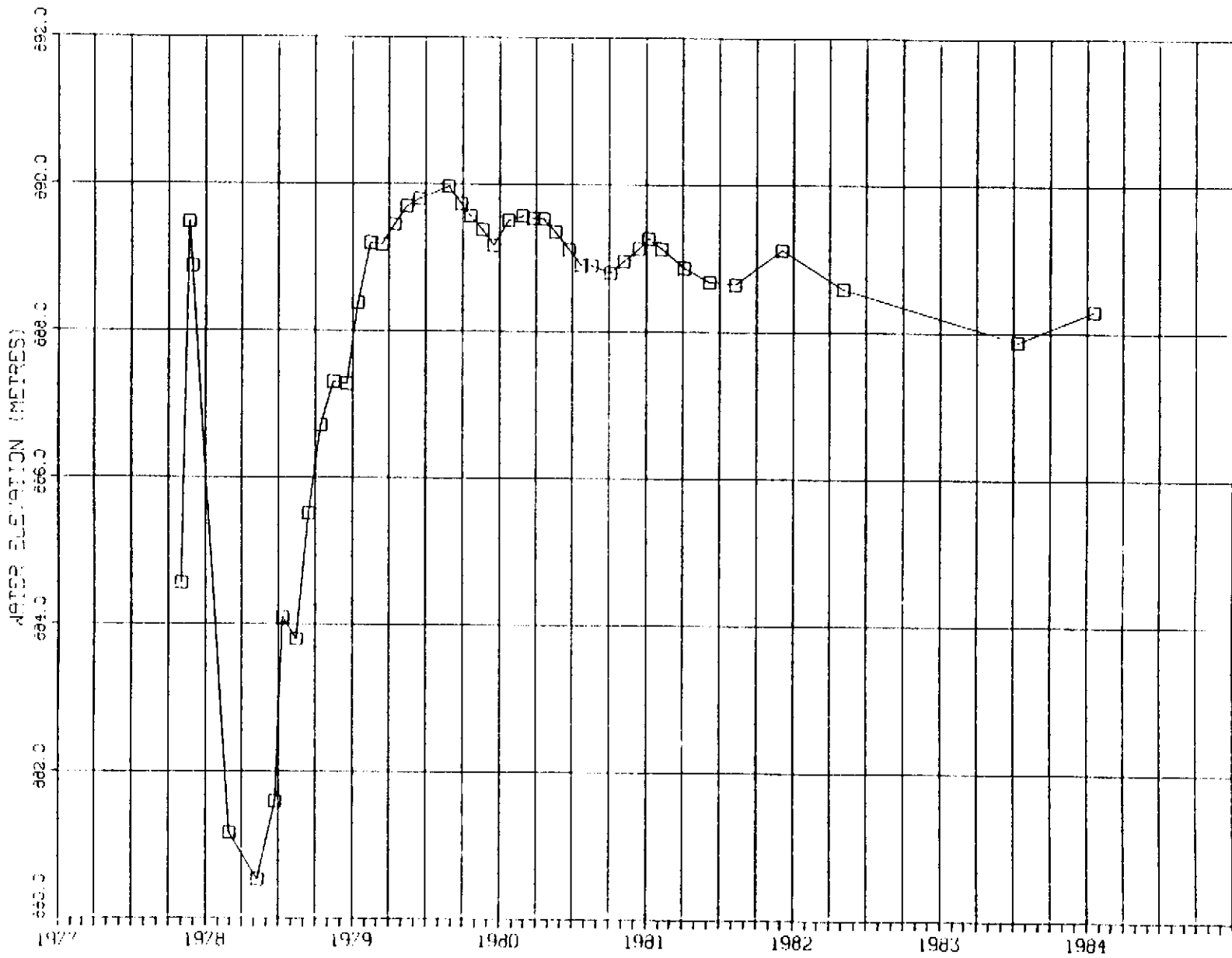
LEGEND
□ - PIEZO, NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-226



LOT 5
 DATE: 12/20/84
 TIME: 10:00 AM
 DRAWN BY: J. R. B.

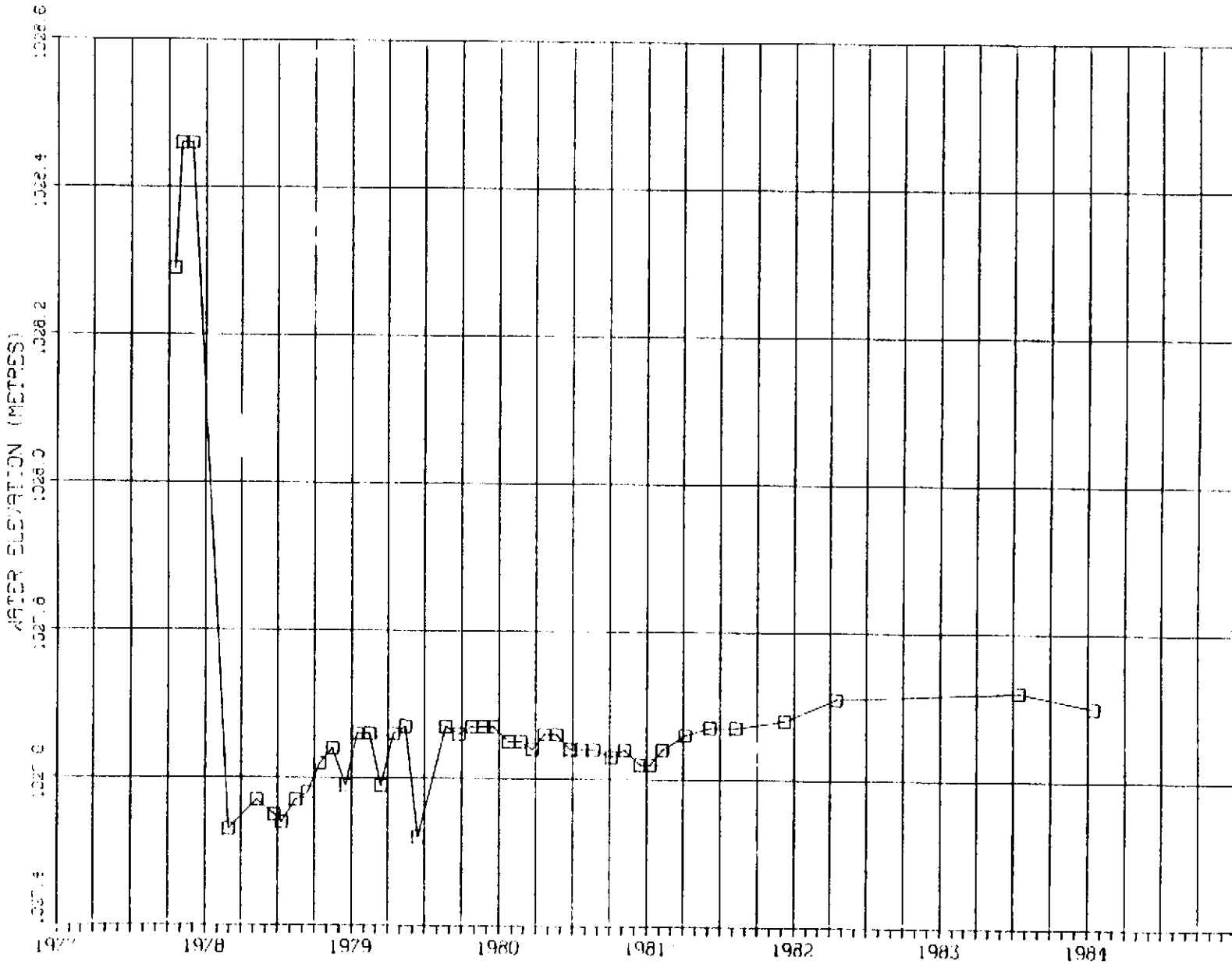
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-227



LEGEND
□ - PIEZO. NO. 2

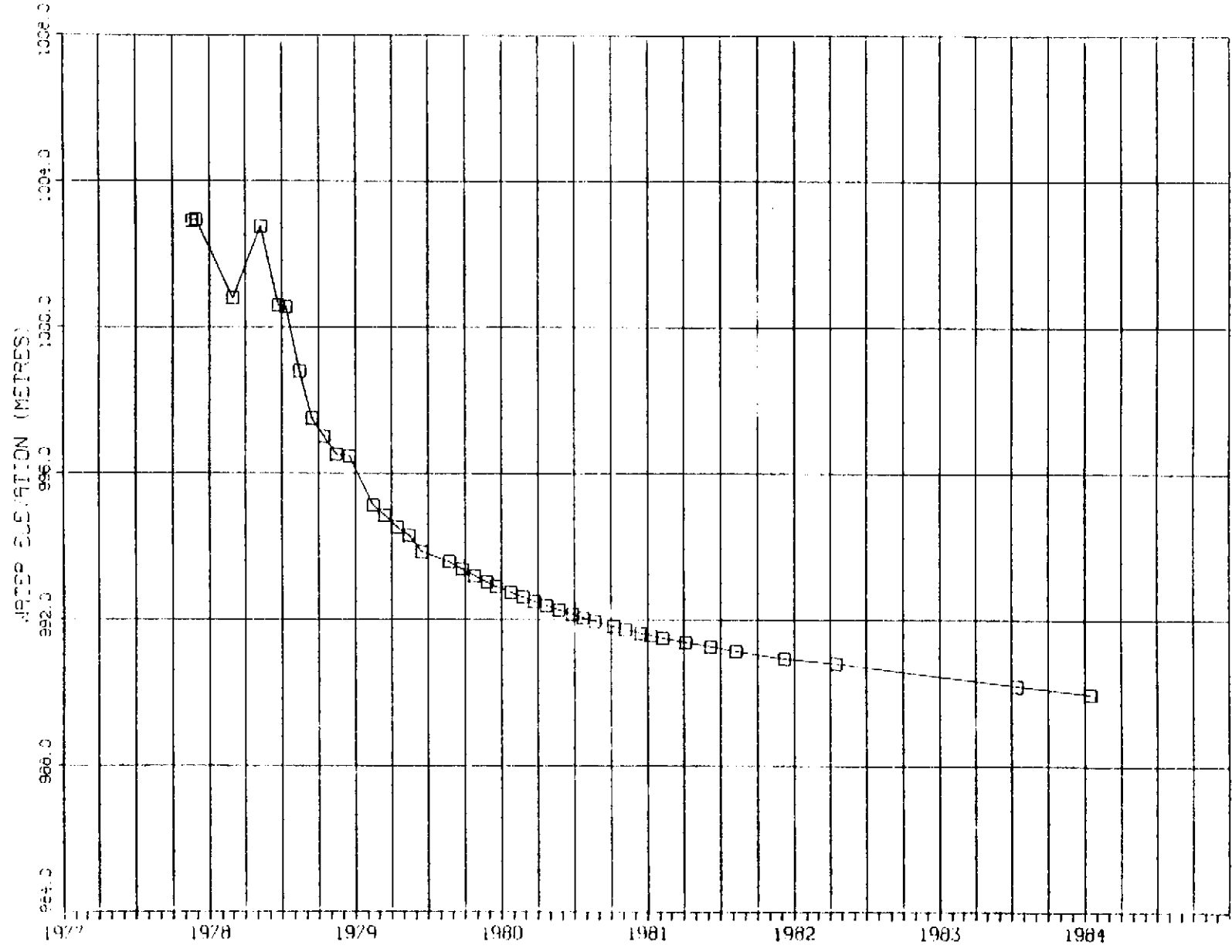
UNIT 2
DATE 01/11/2001
TIME 10:00 AM
JOB NO. 100000000
JOB - ENV. DISSEMIN. FOR 5.2

HOT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-230



LEGEND
□ - PIEZO. NO. 1

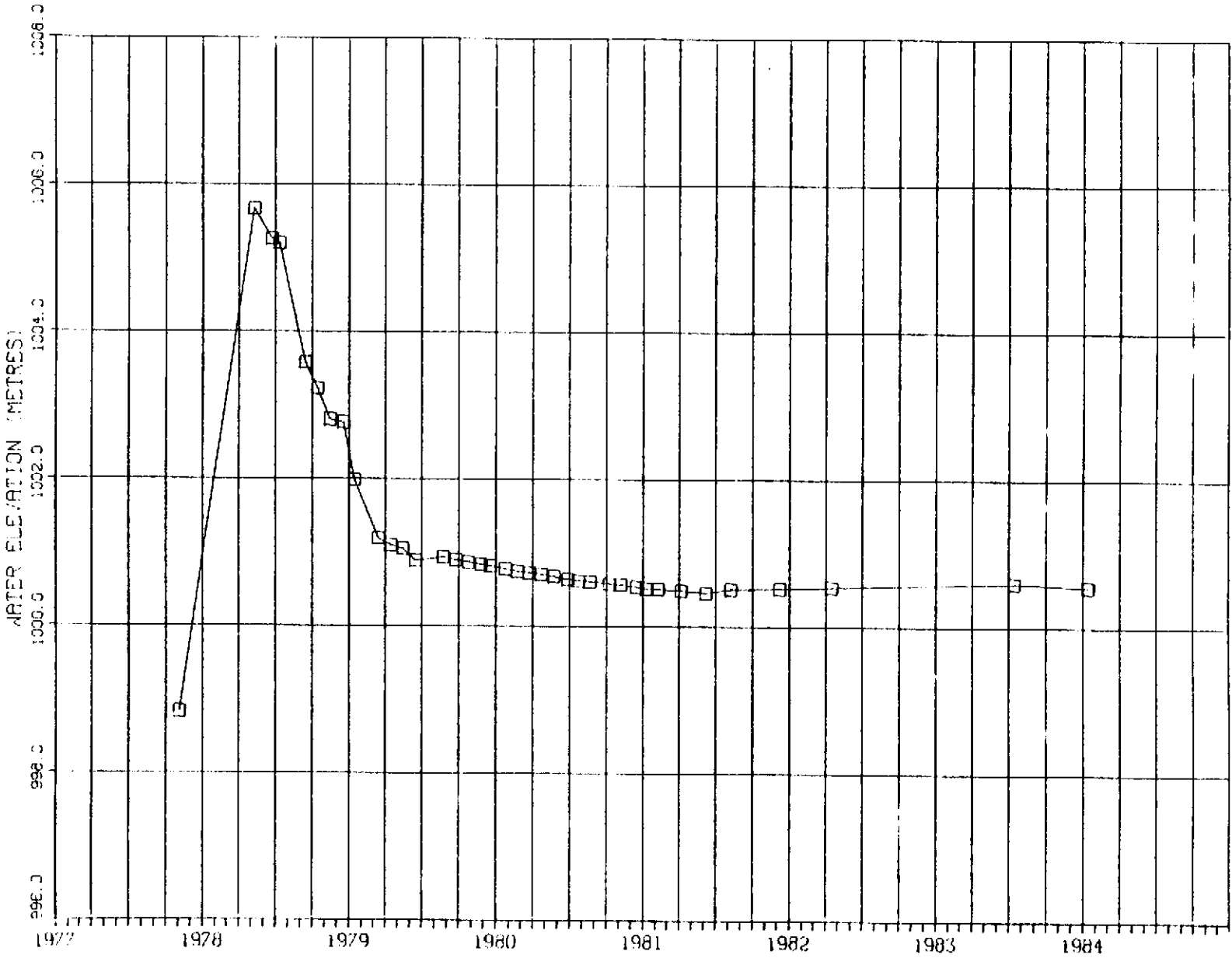
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-236



LEGEND
□ - PICZO. NO. 1

DATE: 10/10/84 TIME: 10:00 AM PAGE: 1 OF 1

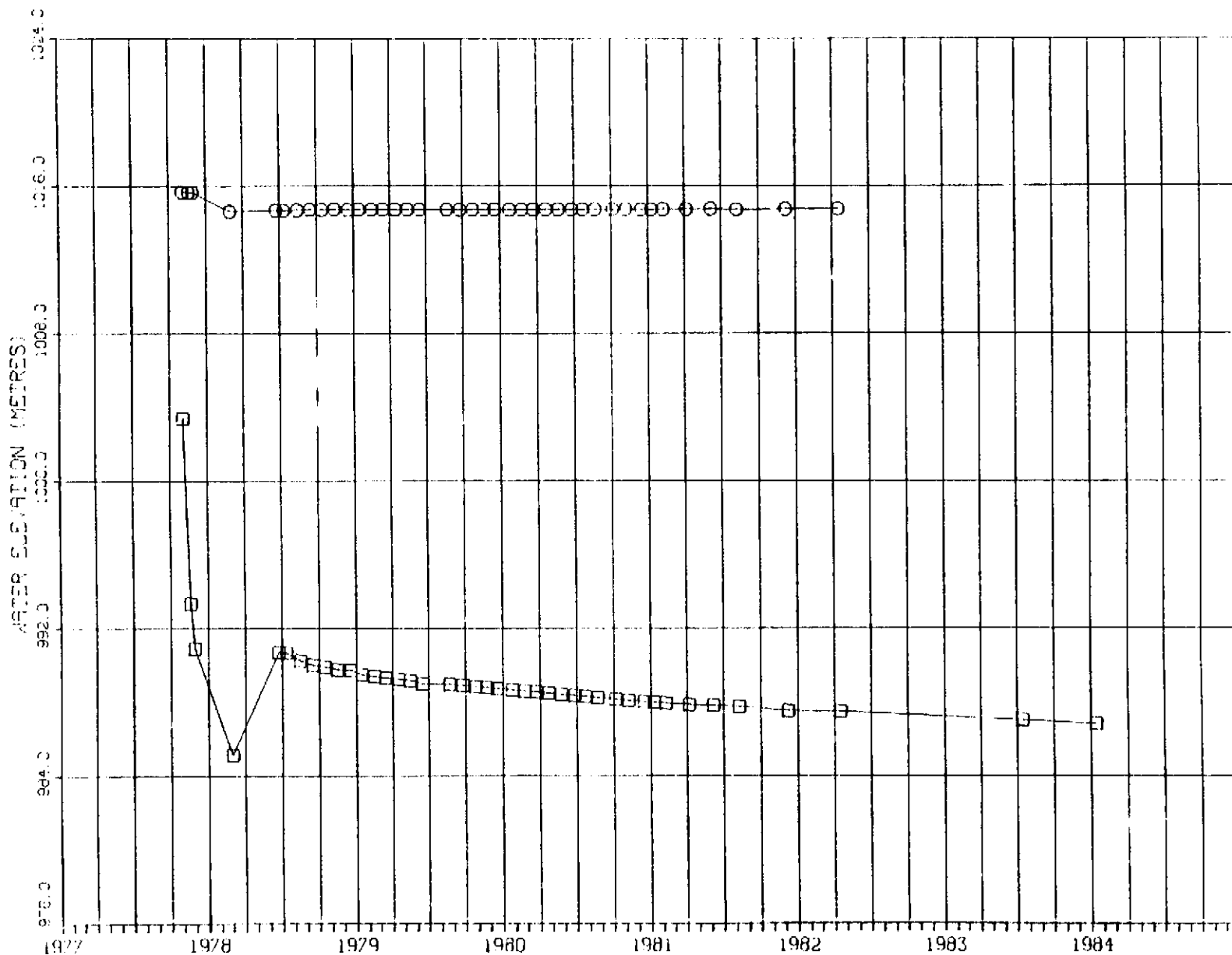
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-239



LEGEND
□ - PIEZO. NO. 1

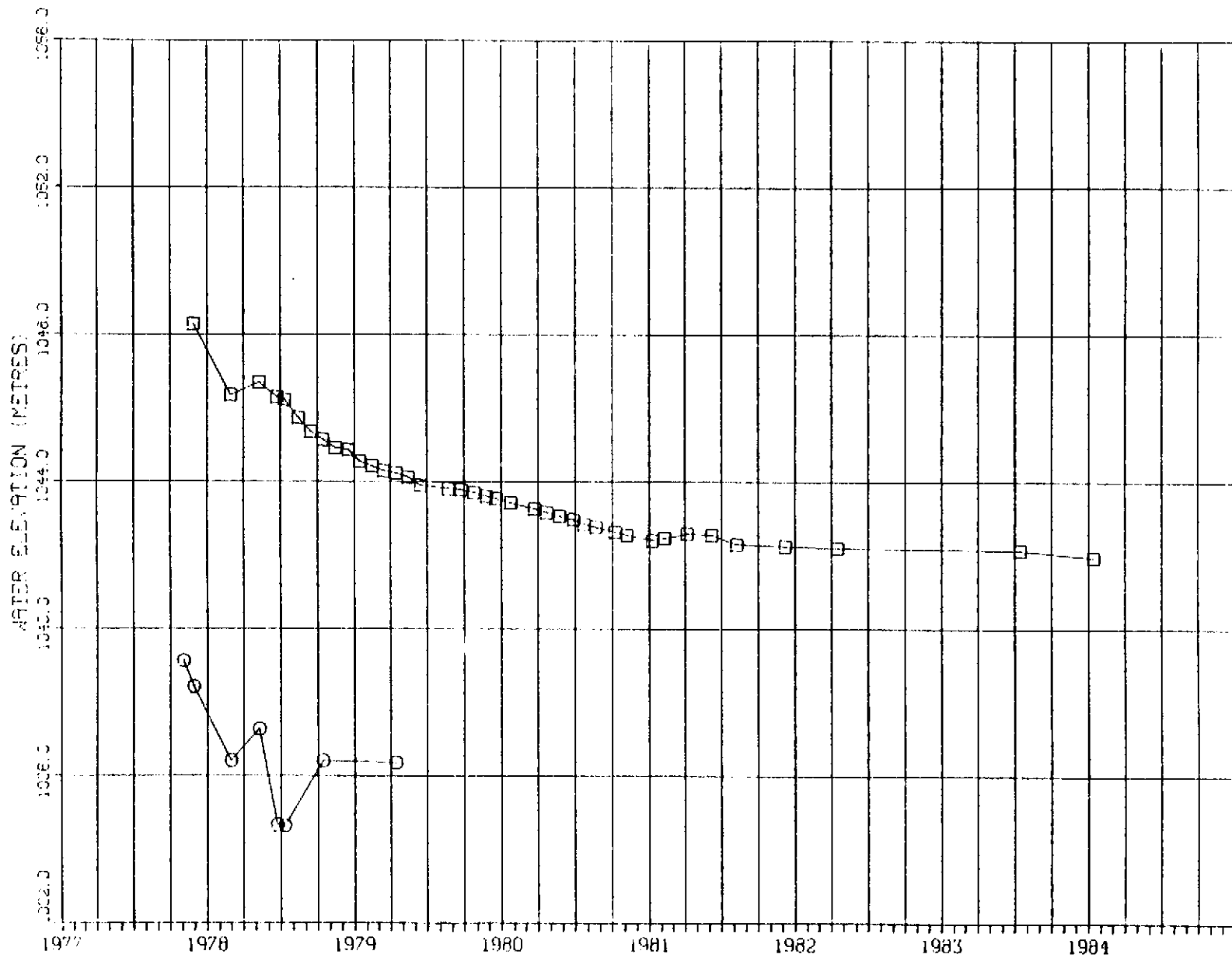
PAGE 9
DATE 29 APR 1984
JOB-ACRIF
POS - EWS
DISPLA PER 6.4

HOT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-240



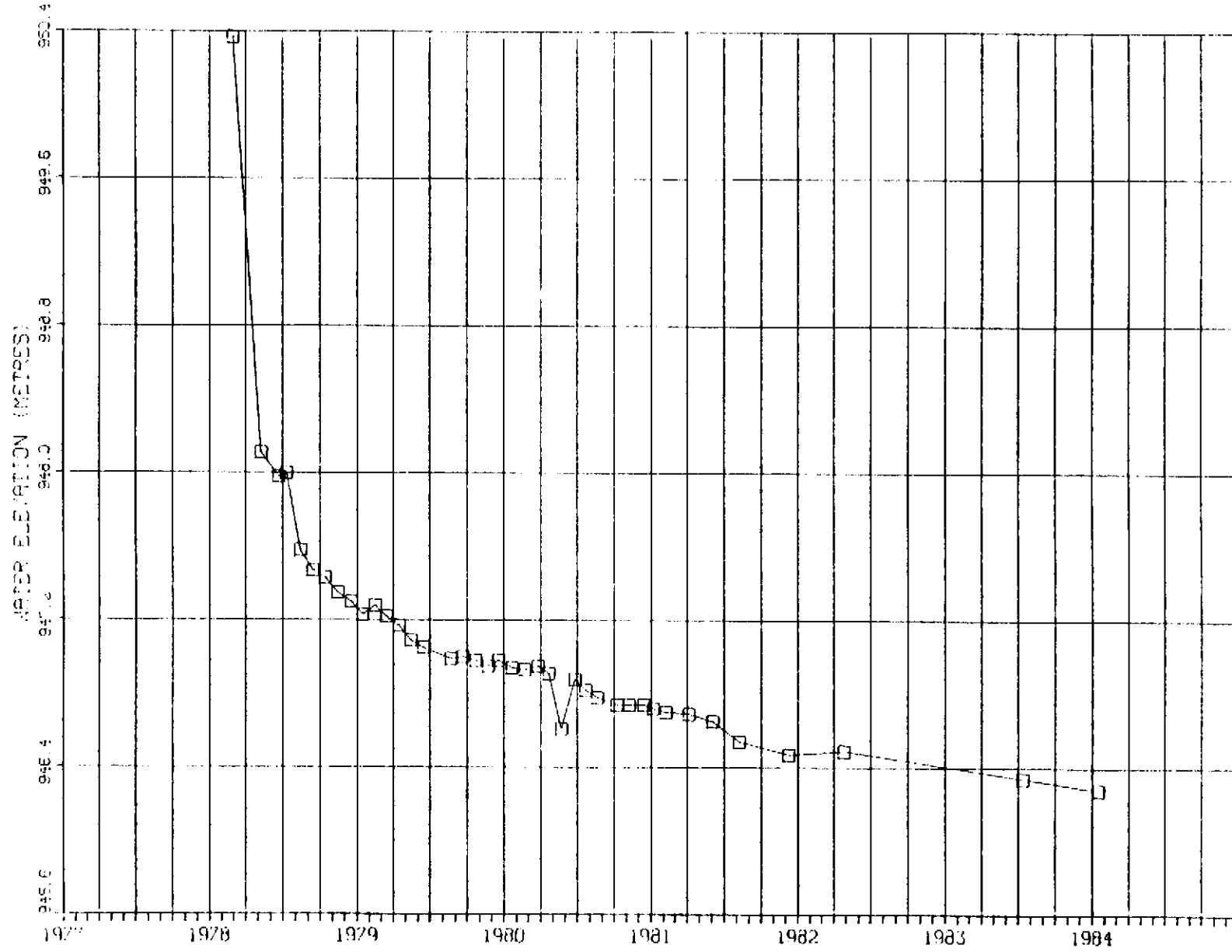
LEGEND
 □ - PTCZO. NO. 1
 ○ - PTCZO. NO. 2

HOT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-241



LEGEND
 □ - PIEZO. NO. 1
 ○ - PIEZO. NO. 2

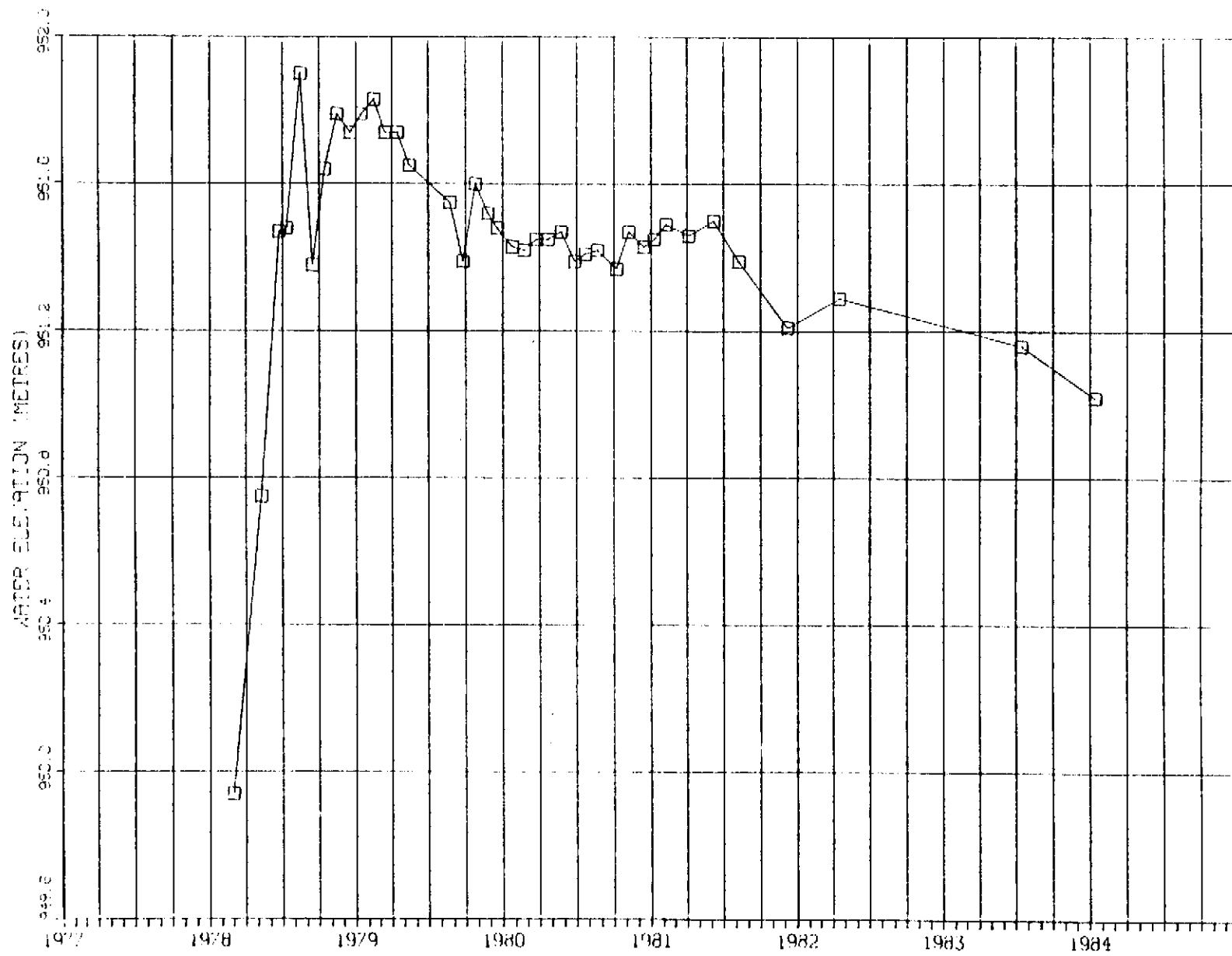
HOT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-251



LEGEND
□ - PTEZO. NO. 1

945.0 945.2 945.4 945.6 945.8 946.0 946.2 946.4 946.6 946.8 947.0 947.2 947.4 947.6 947.8 948.0 948.2 948.4 948.6 948.8 949.0 949.2 949.4 949.6 949.8 950.0 950.2 950.4

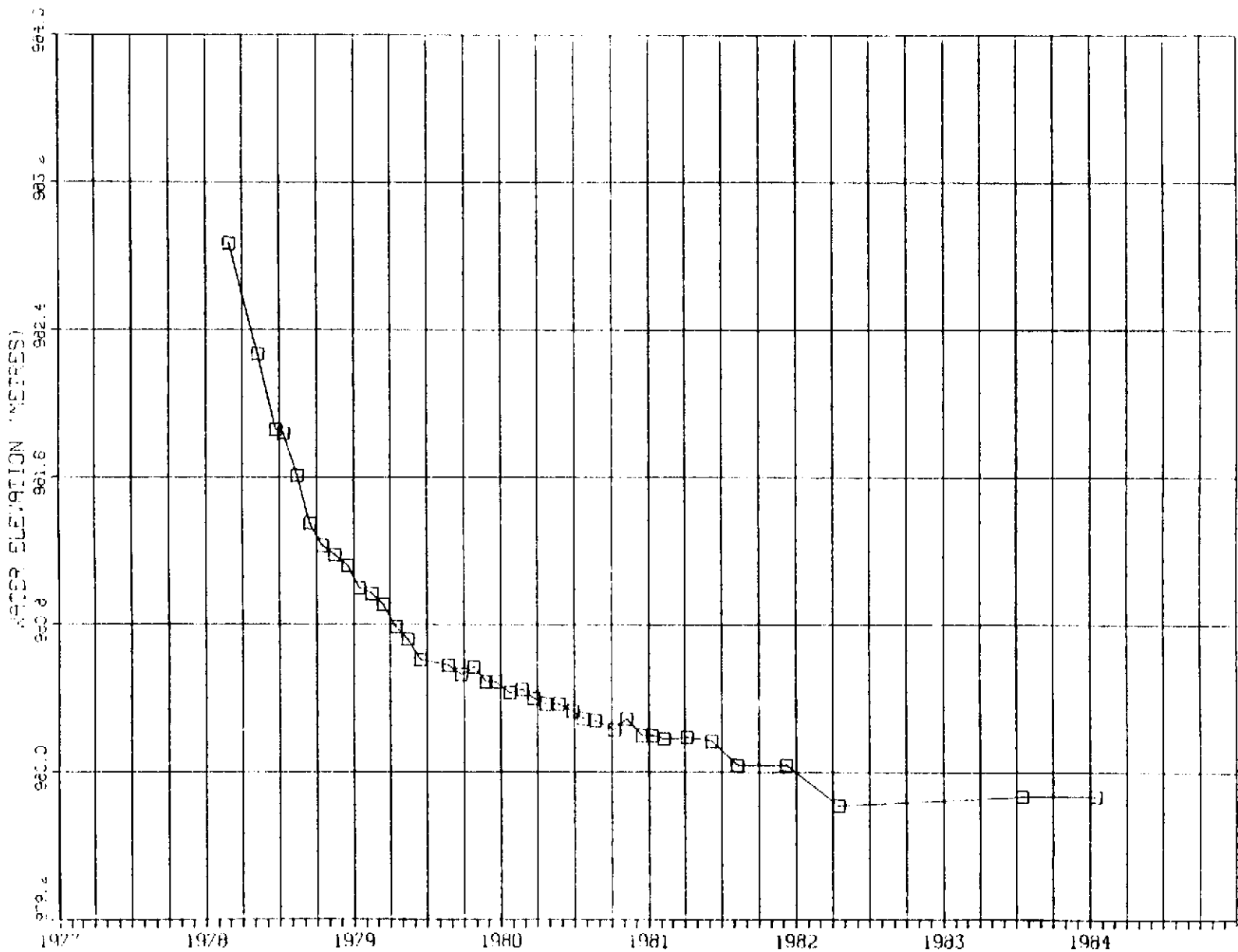
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-252



LEGEND
 □ - PIEZO. NO. 1

DATE: 04/01/85 10:00 AM 04/01/85 10:00 AM 04/01/85 10:00 AM 04/01/85 10:00 AM 04/01/85 10:00 AM 04/01/85 10:00 AM

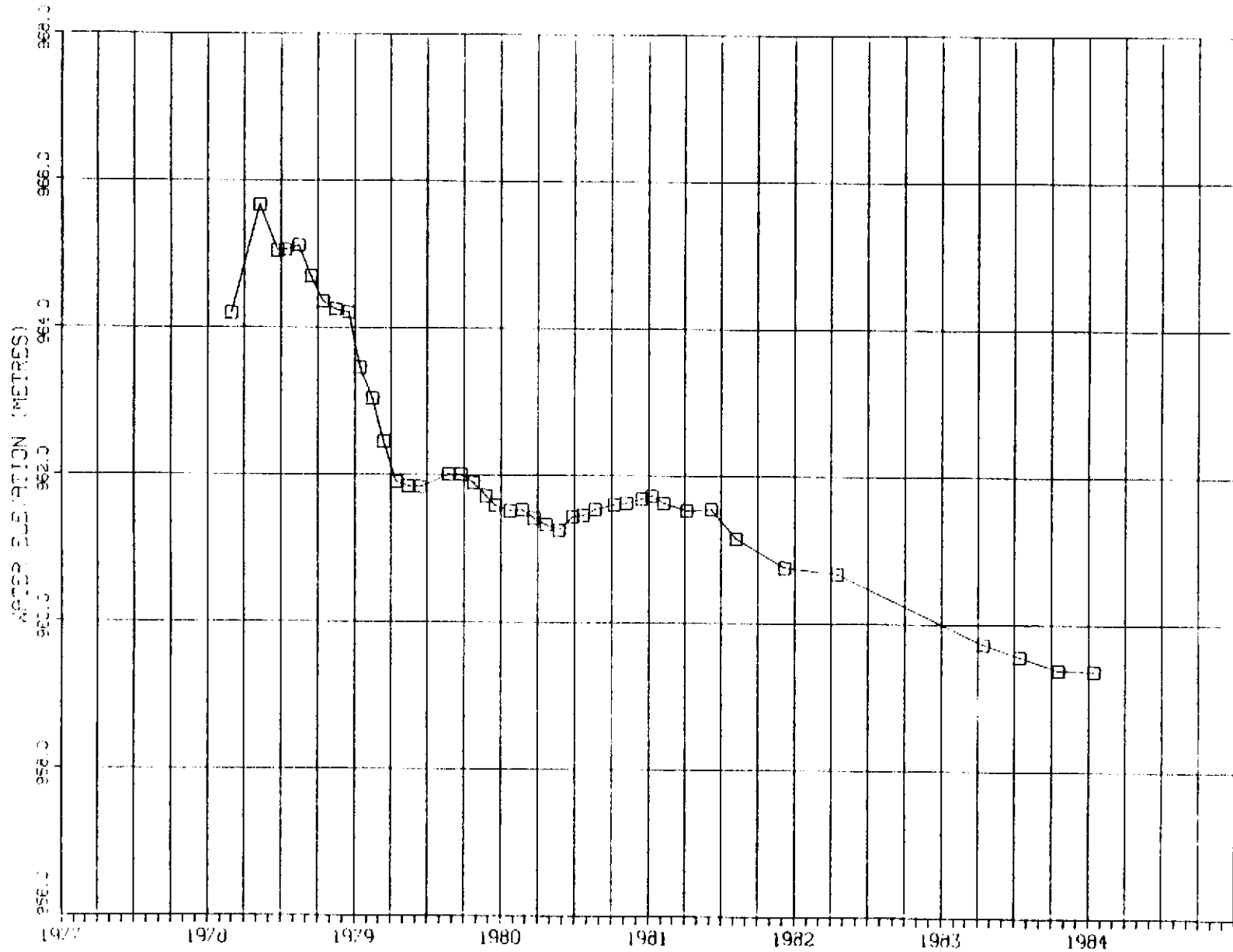
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-253



LEGEND
□ - PIZZO, NO. 1

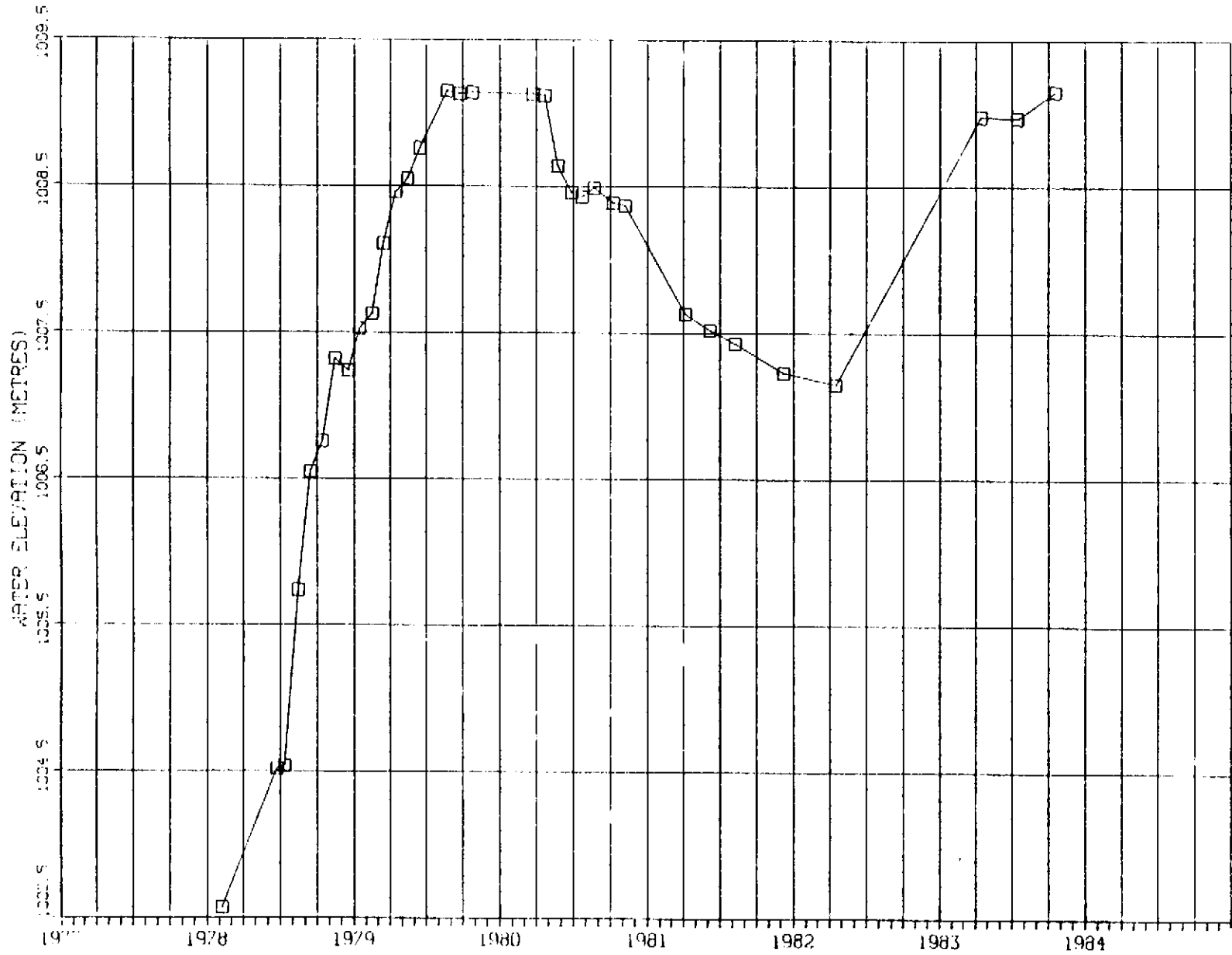
10-10-14 10:00 AM 1984 1051-10500-1-205 - 215 DISSEAL 100 0.14

HAI CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDII-77-255



LEGEND
□ - PIEZO. NO. 1

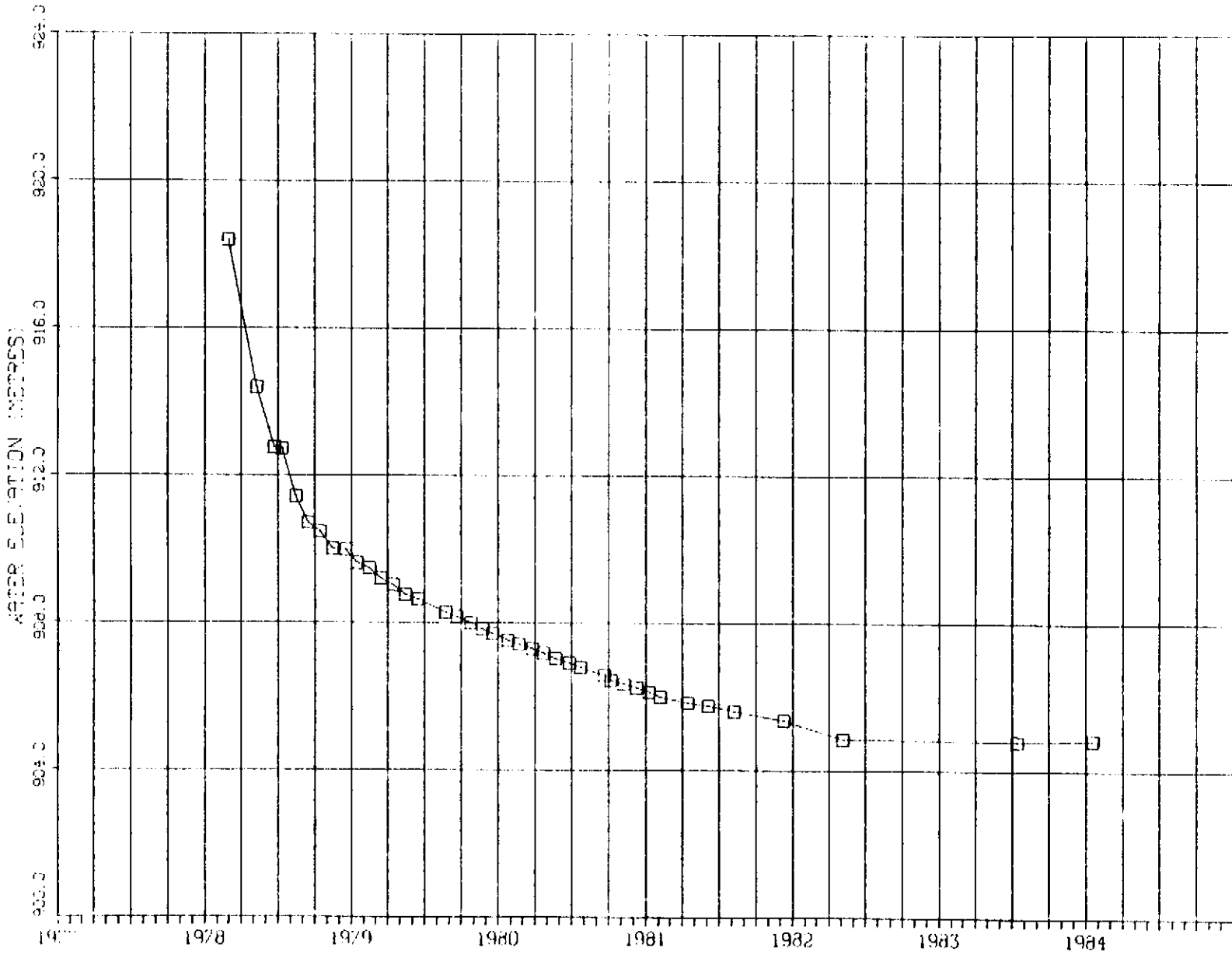
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-256



LEGEND
□ - PIEZO. NO. 1

DATE: APR 09 1984 08:55:00 AM - 08:55:00 AM - 08:55:00 AM

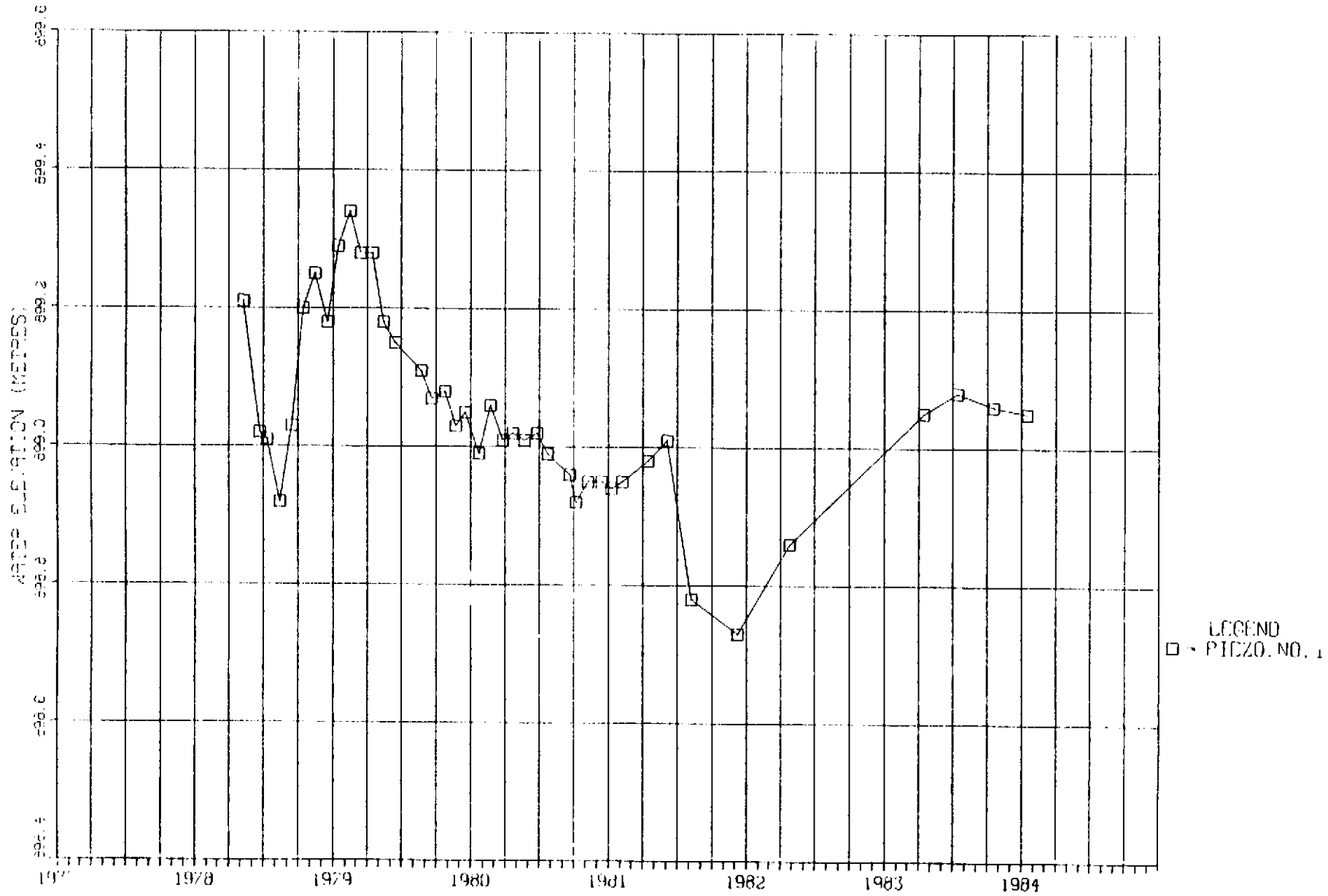
HOT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-261



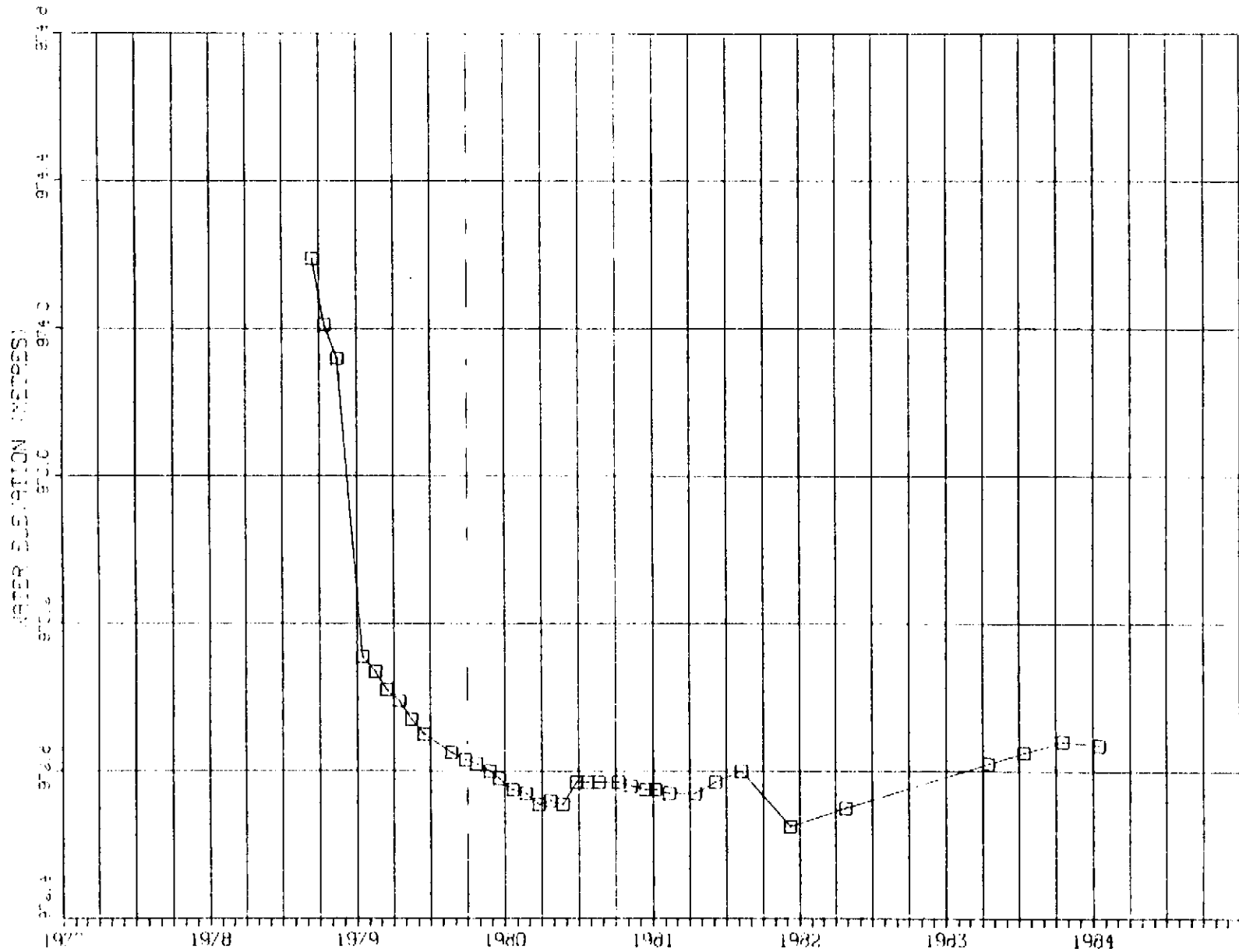
LEGEND
□ - PIEZO. NO. 1

DATE: 10/15/84 TIME: 10:00 AM DRAWN BY: J. S. BASSON PER 102

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-262



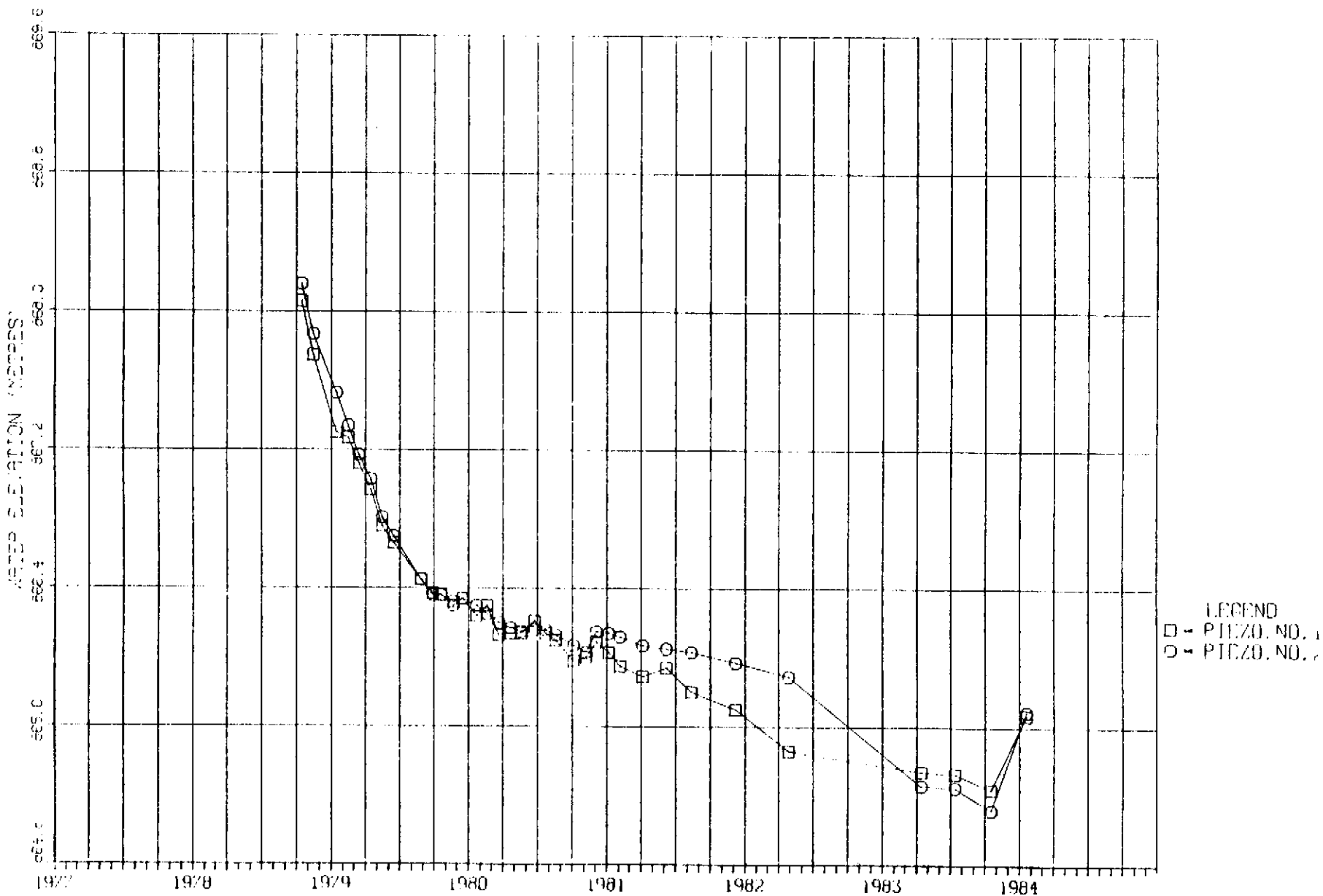
HOT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-281



LEGEND
□ - PIZZO, NO. 1

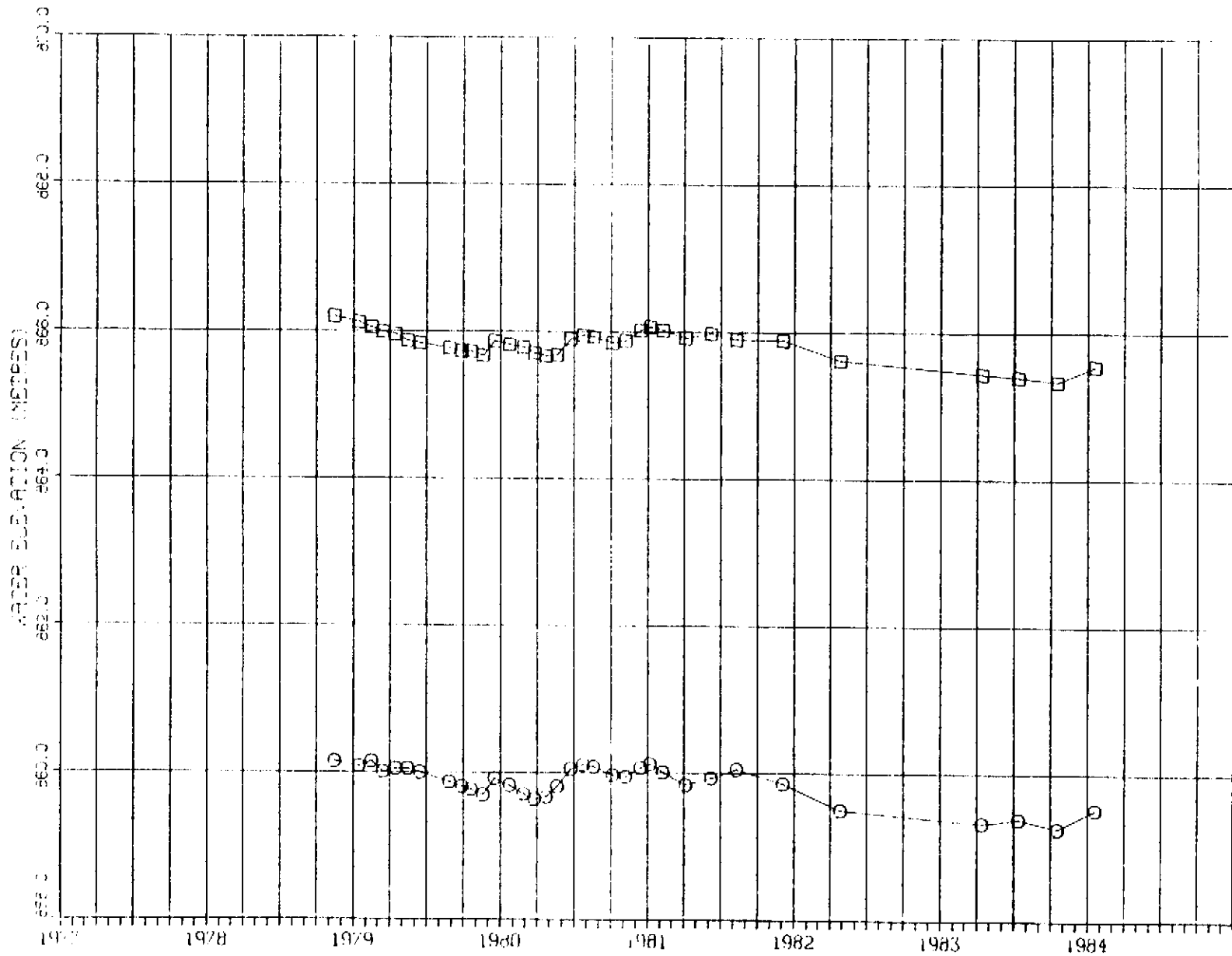
1978 1979 1980 1981 1982 1983 1984

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-282



1984-01-01 08:00:00 AM 1984-01-01 08:00:00 AM 1984-01-01 08:00:00 AM 1984-01-01 08:00:00 AM 1984-01-01 08:00:00 AM

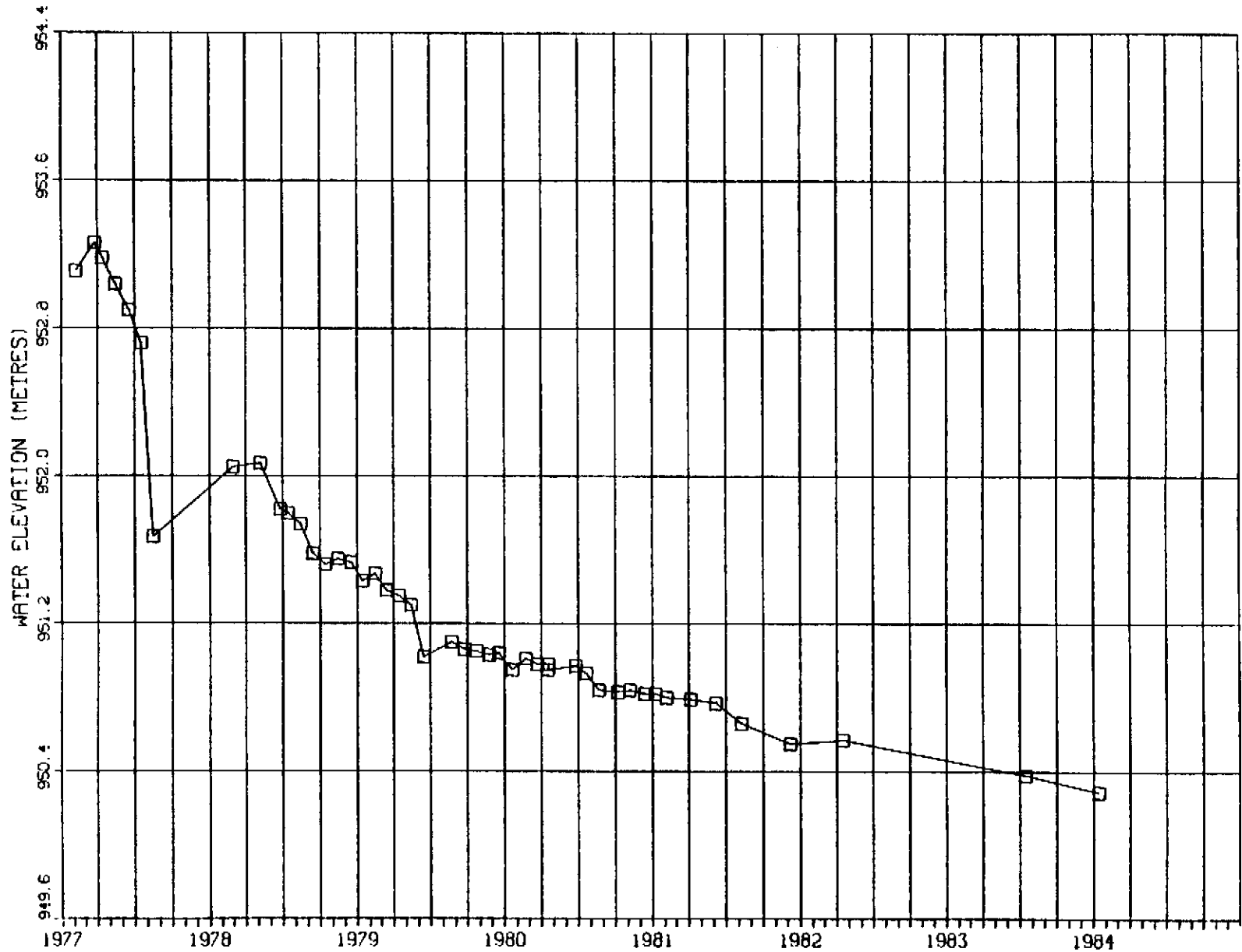
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-290



LEGEND
 □ - PTCZO. NO. 1
 ○ - PTCZO. NO. 2

DATE: 1984-09-28 09:05:10
 USER: JLM
 PLOT: HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-290

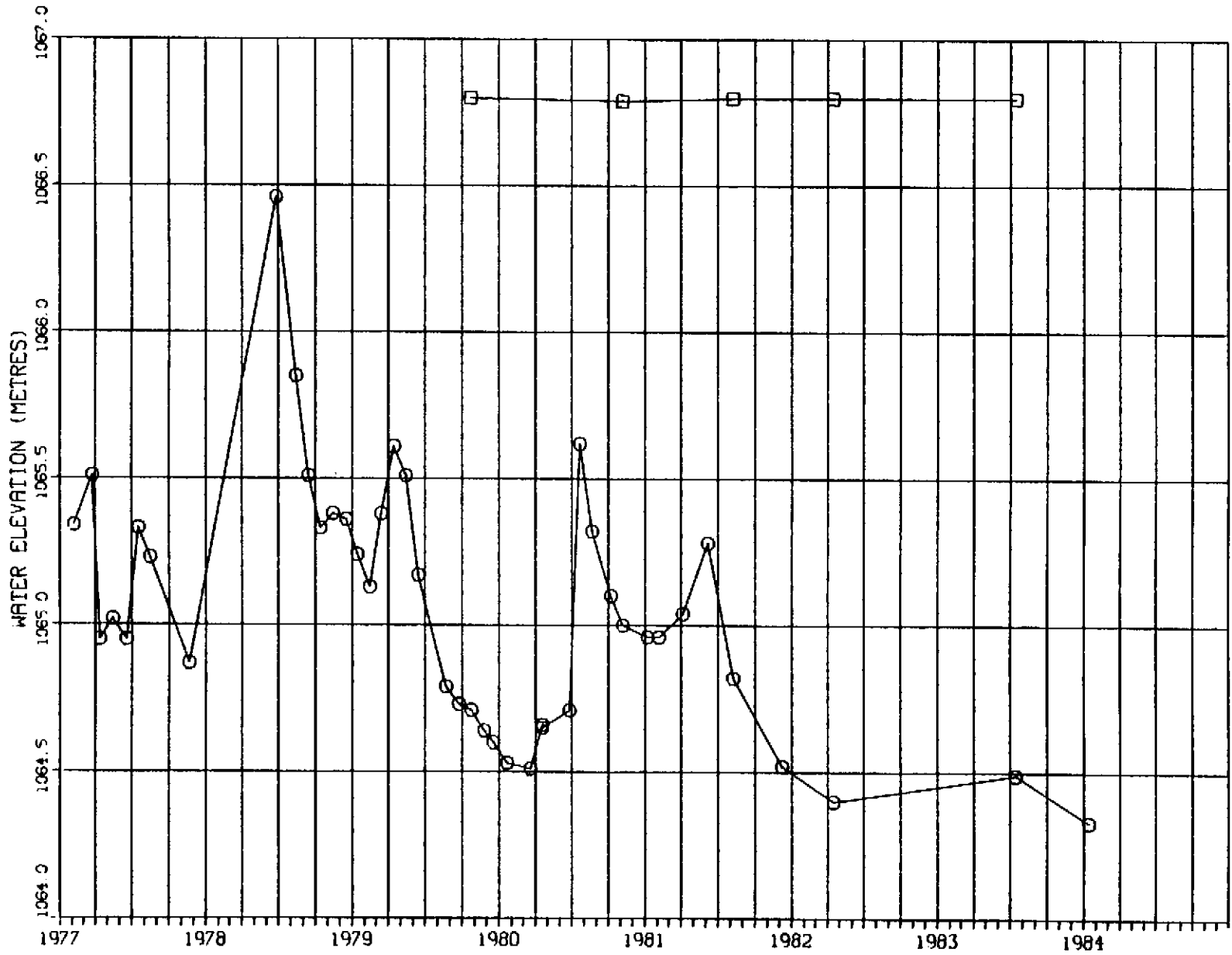
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-801



LEGEND
□ - PIEZO. NO. 1

1977/78 WLU 20 NWS, 1984 SUB-NUMBER 103 - END DISTRICT VOL 0.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-802

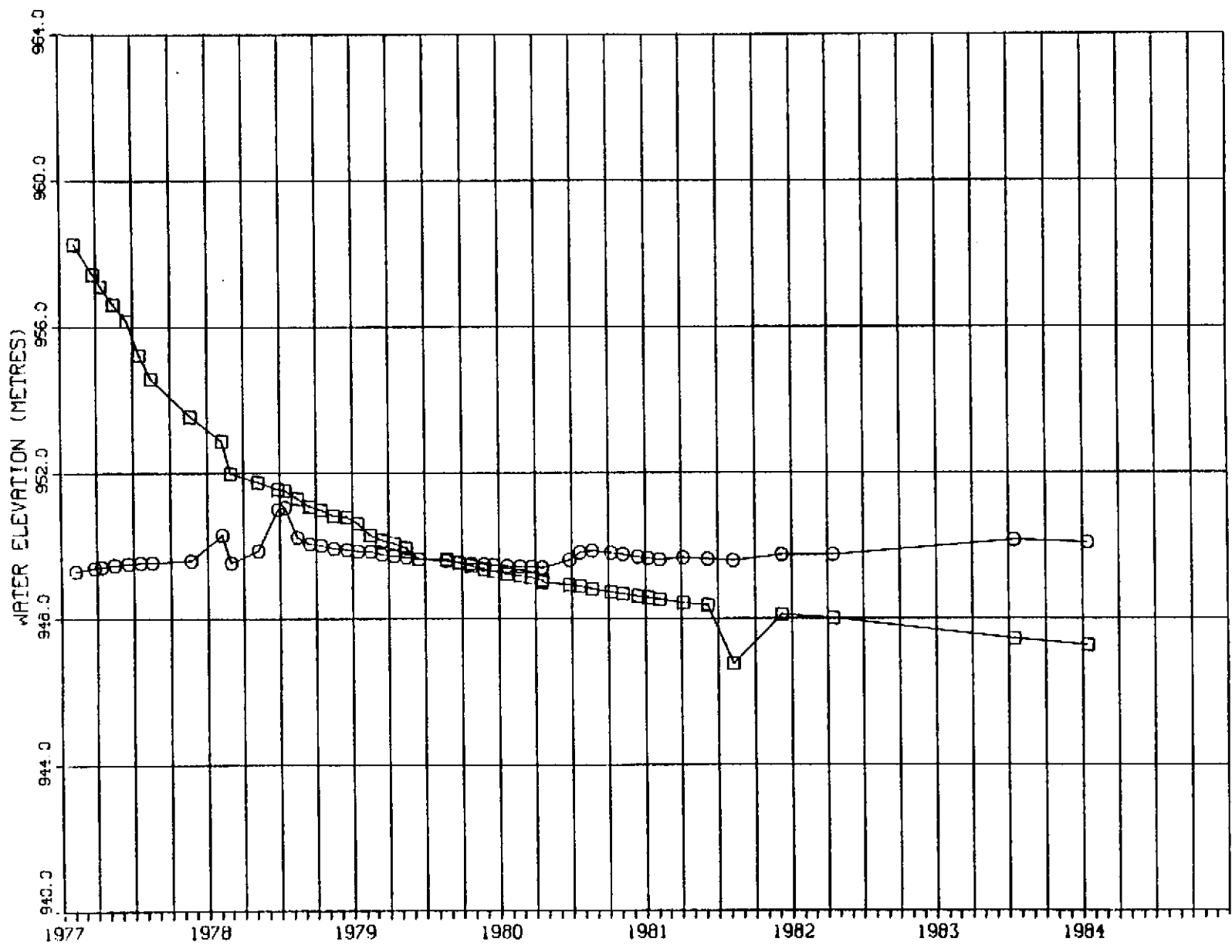


LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

LOT 2 14 00.09 FR: 6 APR. 1984 JOB-LVROCKX . BCS - EKS DISPLAY VER 8.2

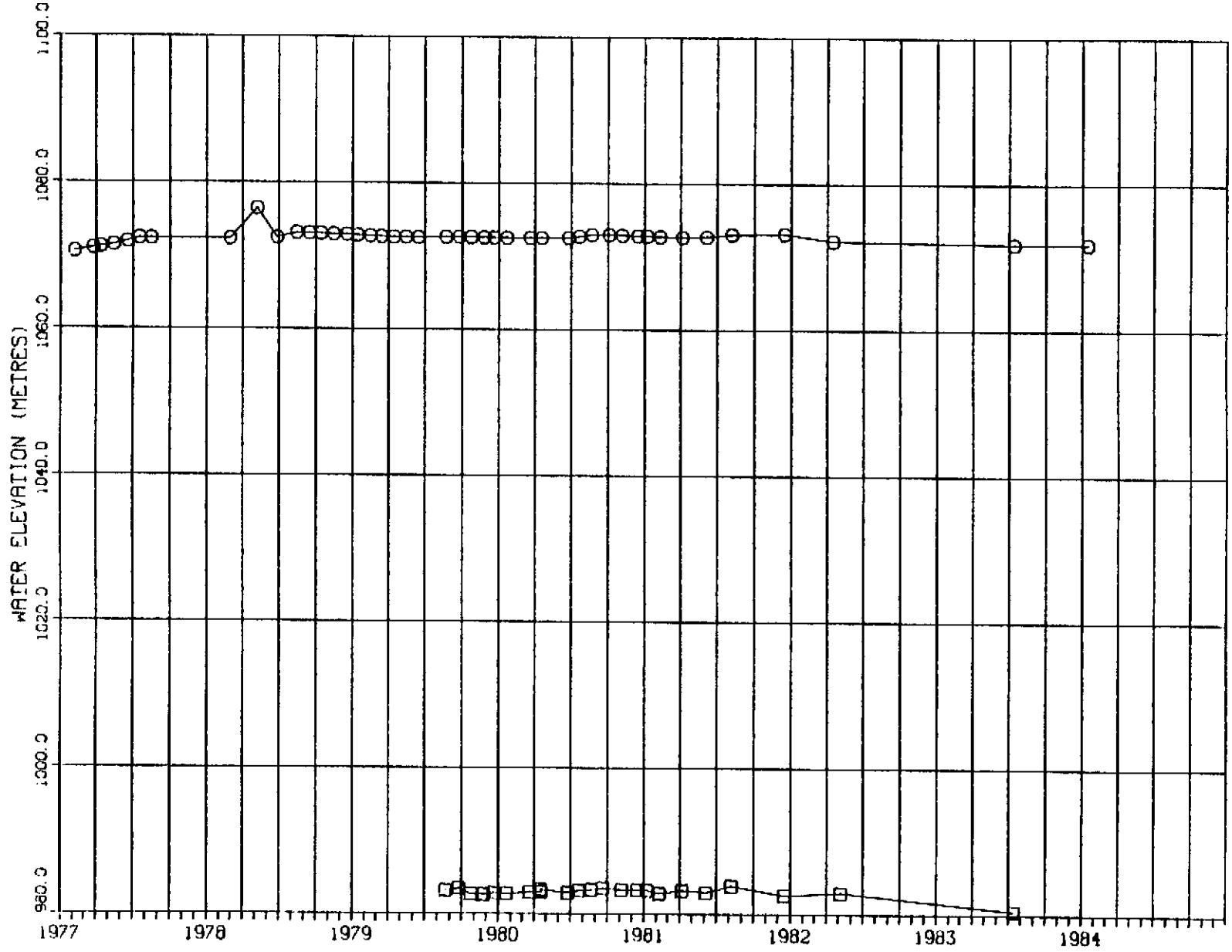
DT 3 19.06.02 AED 26 APR, 1984 JOB=ARCHG . BCS - EXS DISPLA VER 0.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-803



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

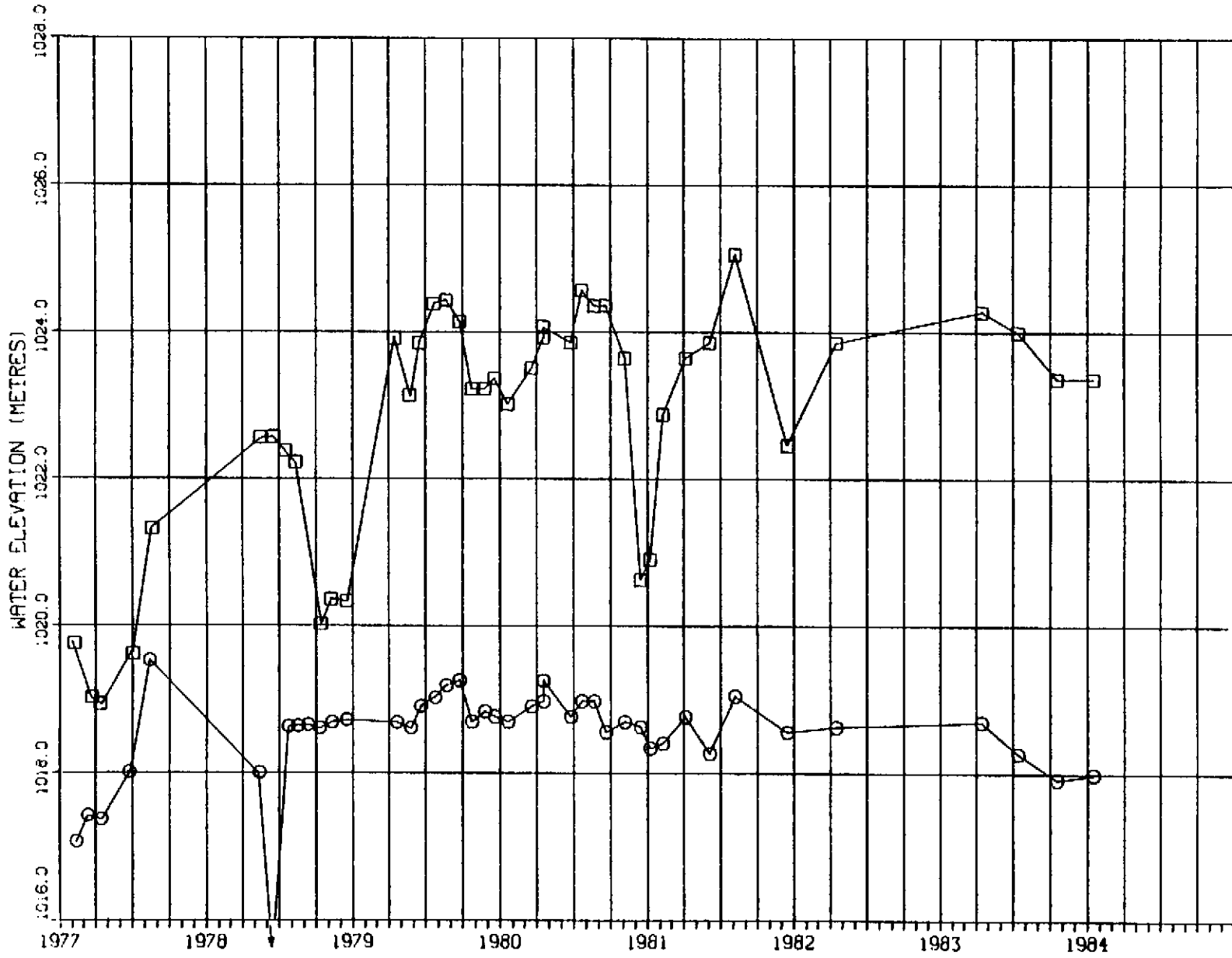
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-804



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

LOT 4 9.06.06 FED 26 MAR, 1984 106-1/20466 . 905 - EXS DISPLAY VER 3.2

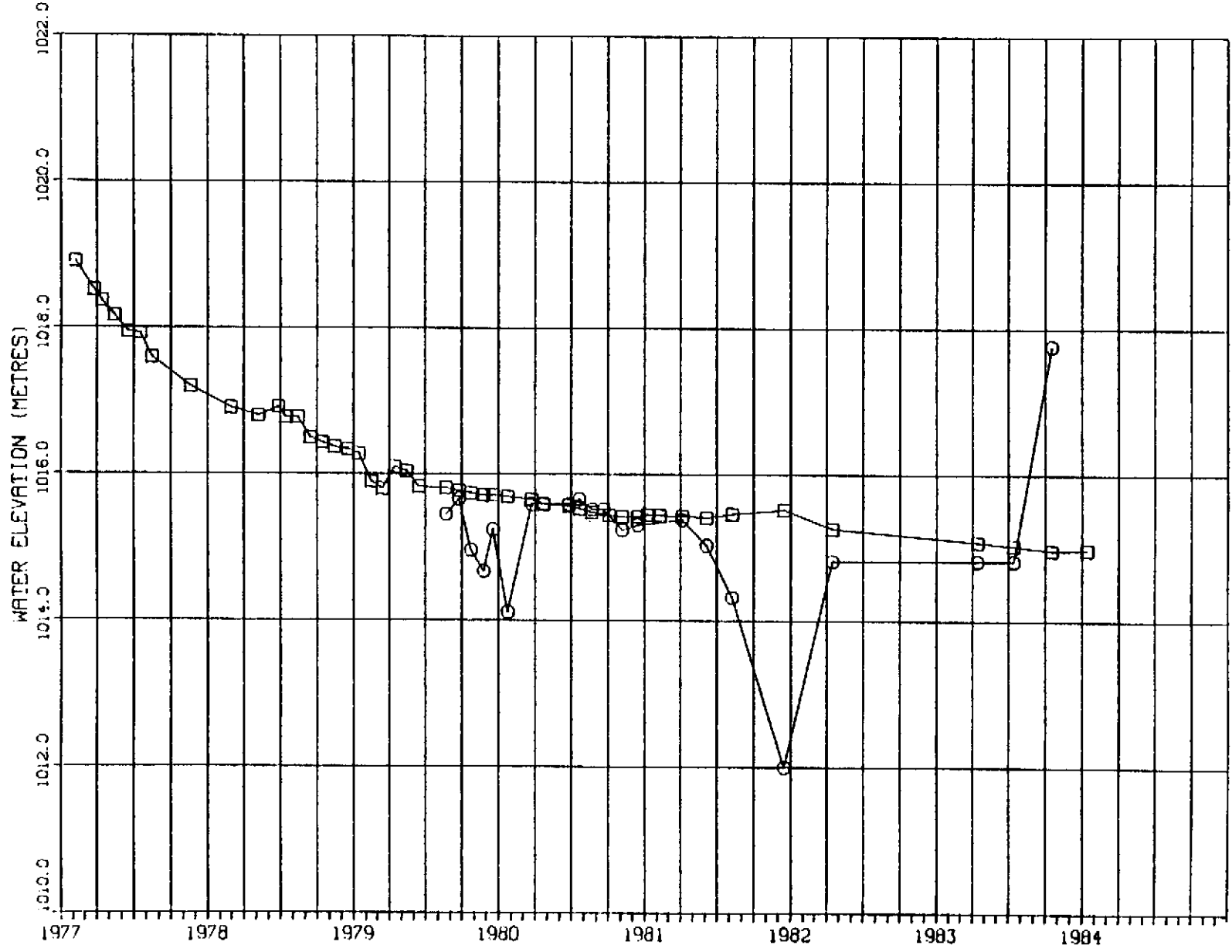
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-805



LEGEND
 □ - PIEZO. NO. 1
 ○ - PIEZO. NO. 2

19.12.96 HED 28 MAR, 1984 JOB=VBOH11 . BCS - EXS DISSOLA VER 2.2

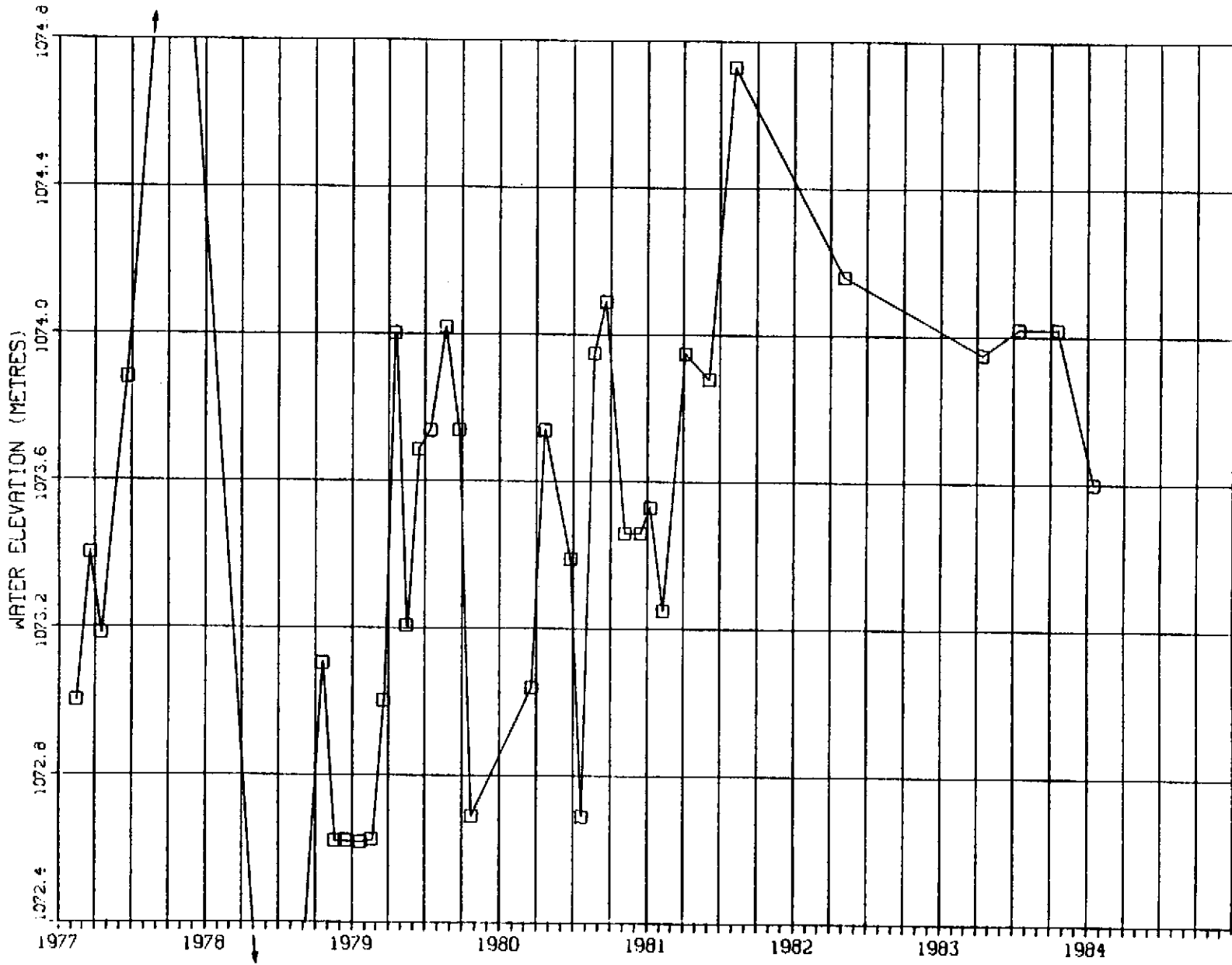
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-806



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

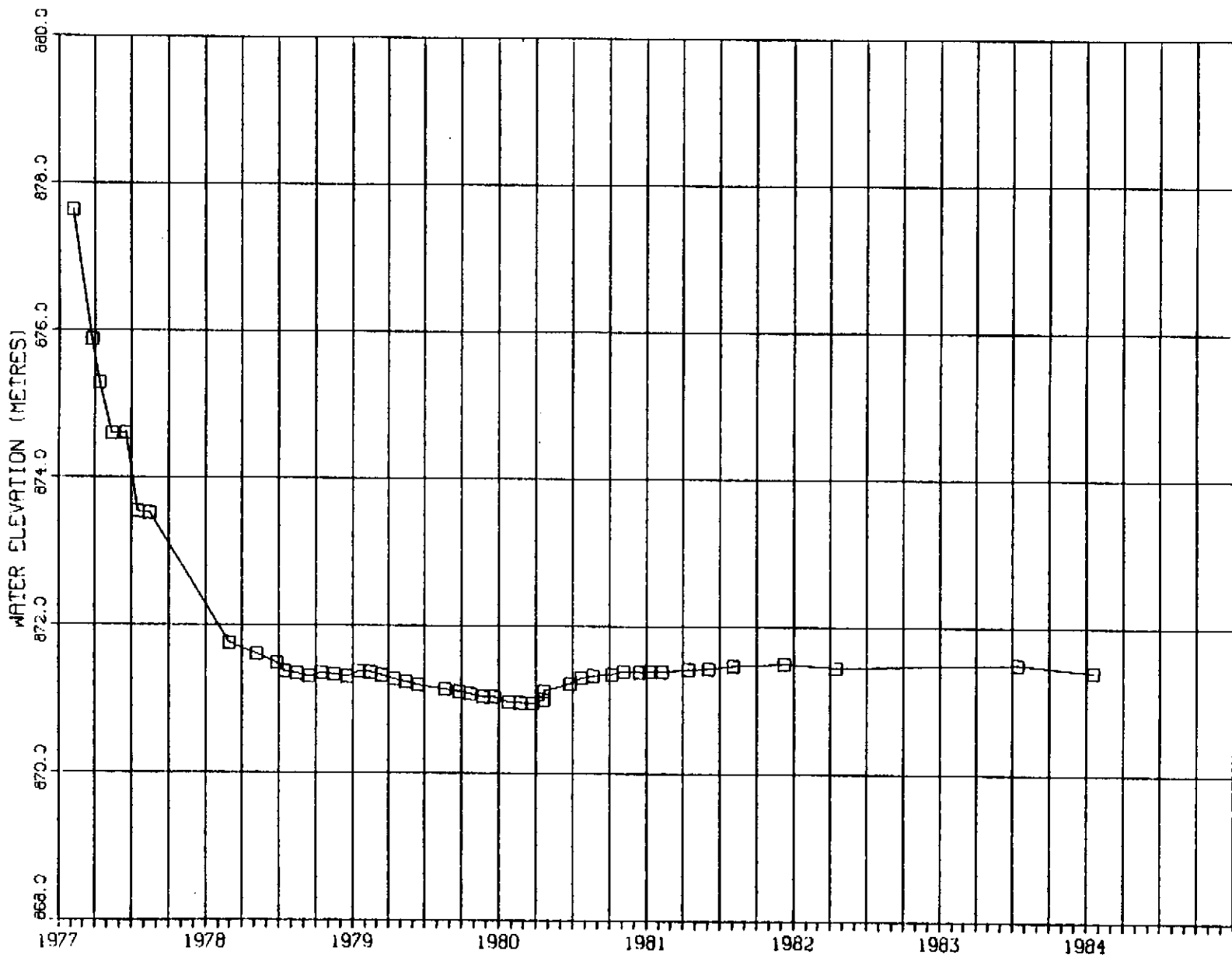
LOT 2 19.02.44 WED 26 MAR, 1984 108~\R0411 . BCS - EXS DISSPLA VER 8.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-807



LEGEND
□ - PIEZO. NO. 1

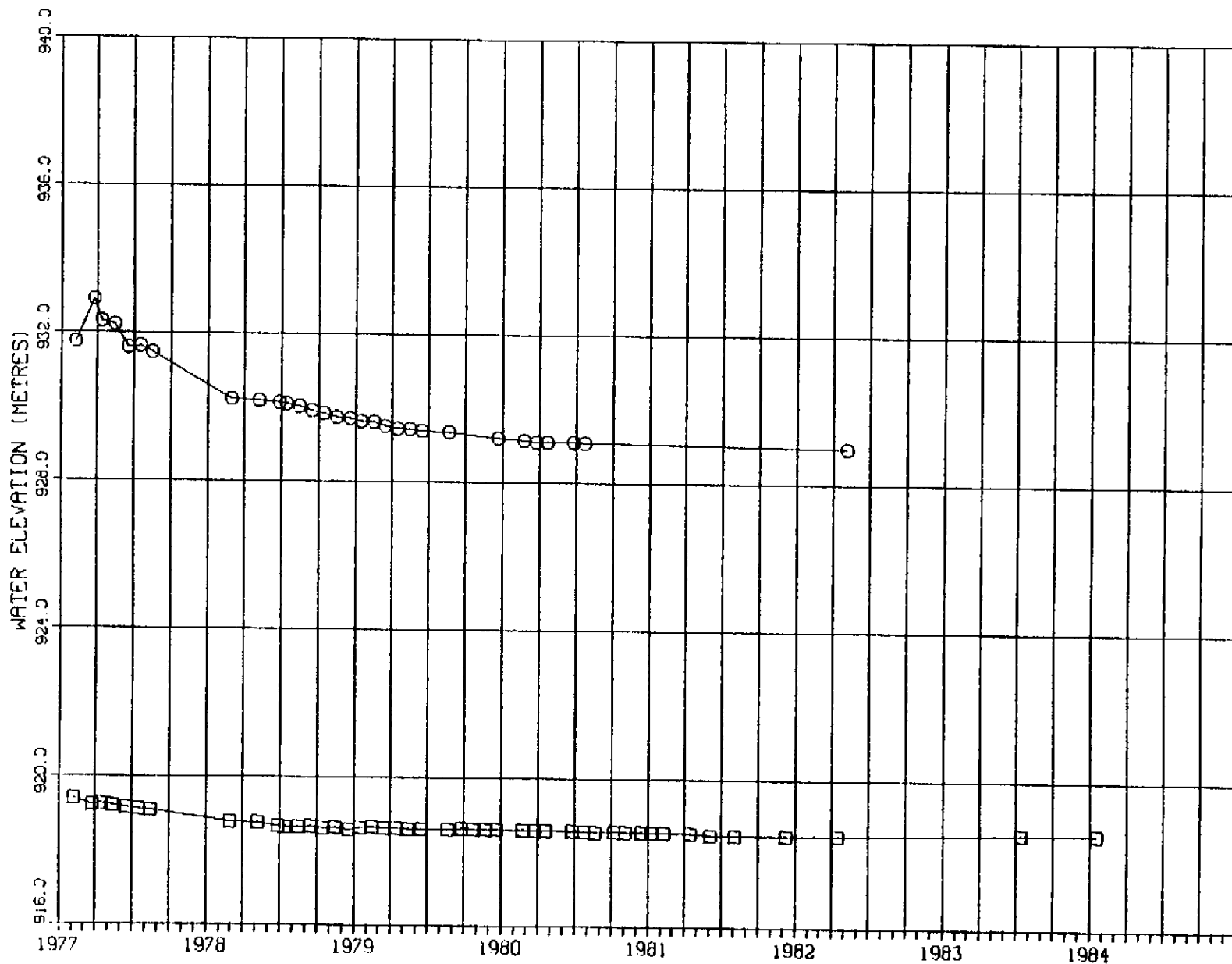
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-808



LEGEND
□ - PIEZO. NO. 1

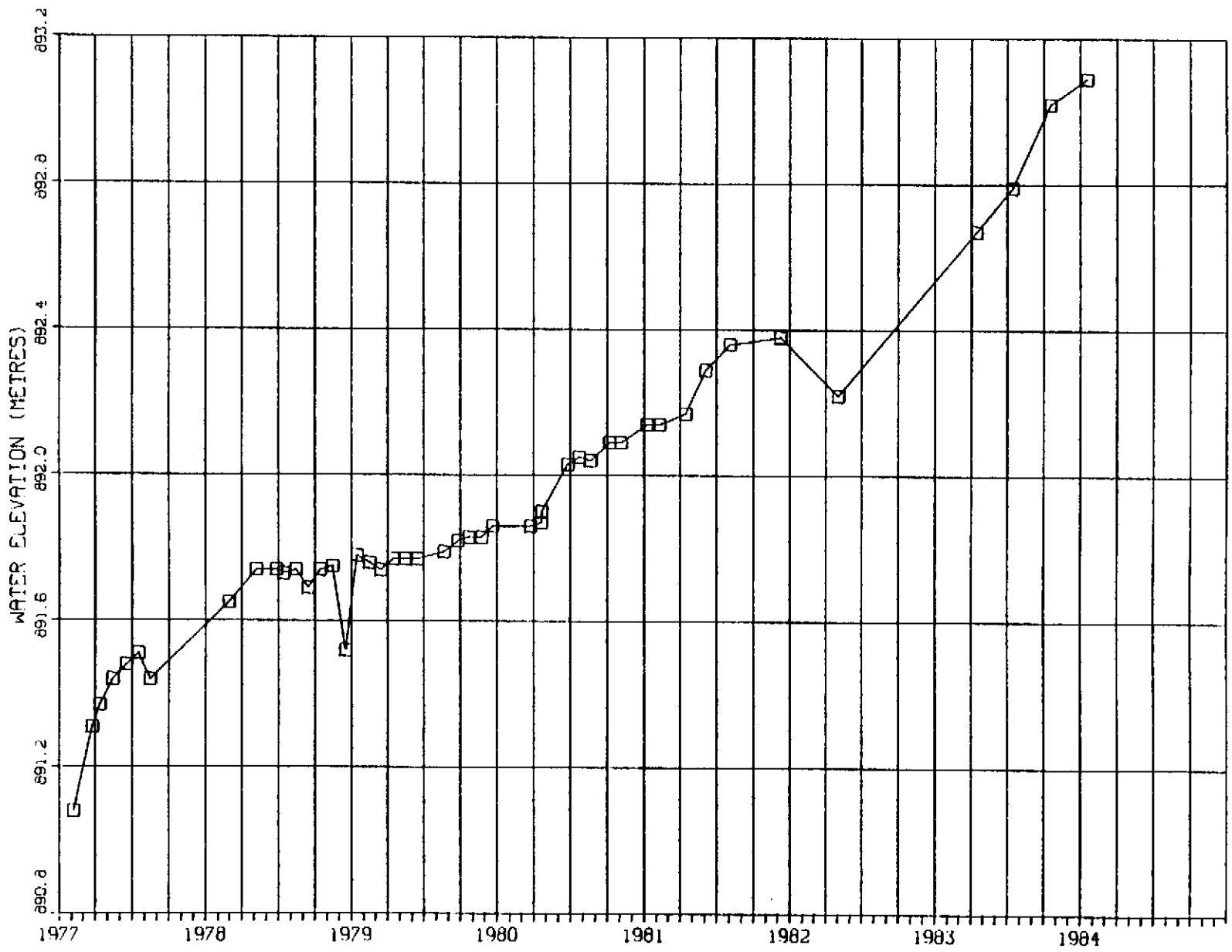
LOT 4 19.06.85 MED 28 MAR, 1984 JOB-ARCHIT. SCS - EKS DISPLAY VER 8.2

HAI CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-809



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

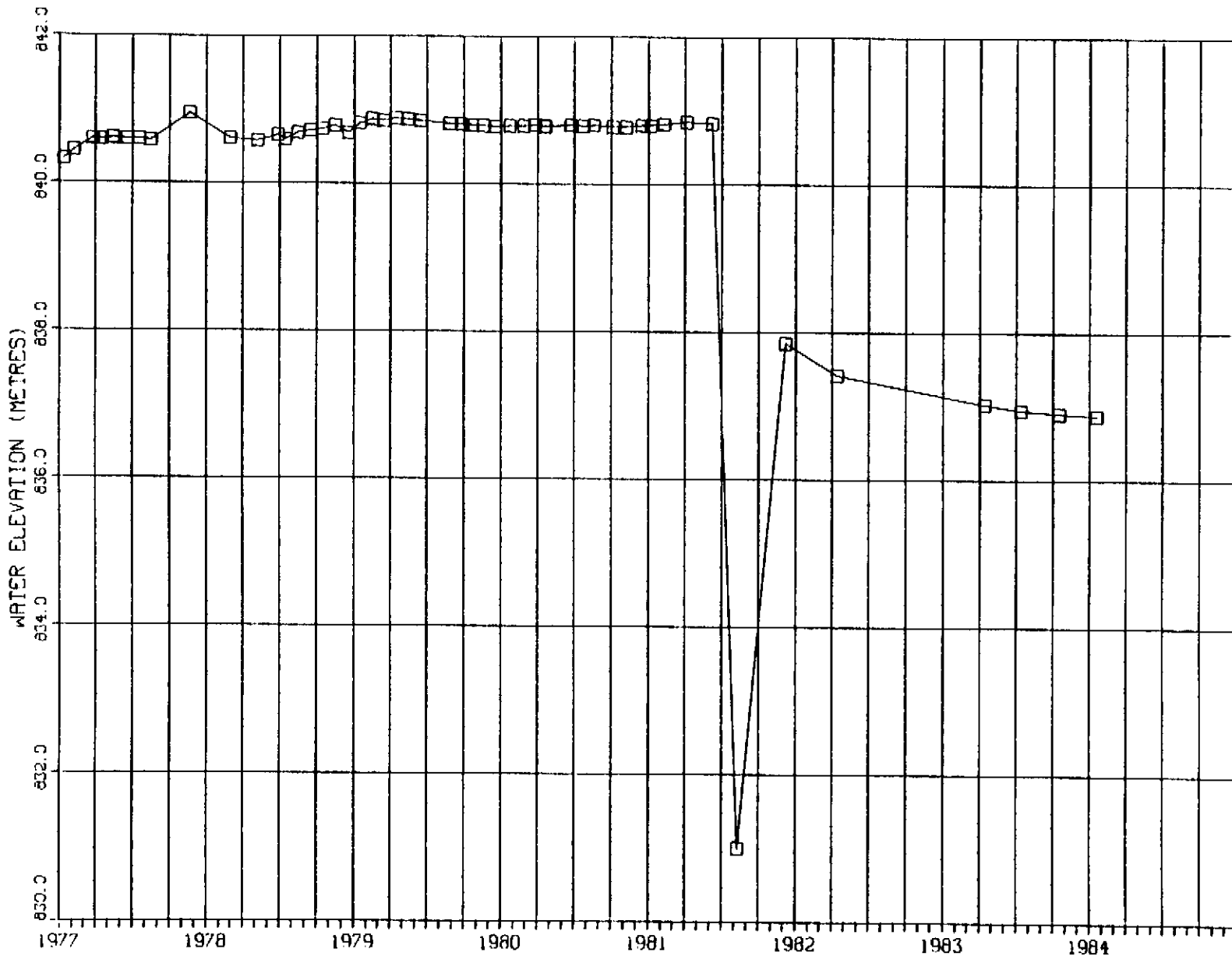
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-811



LEGEND
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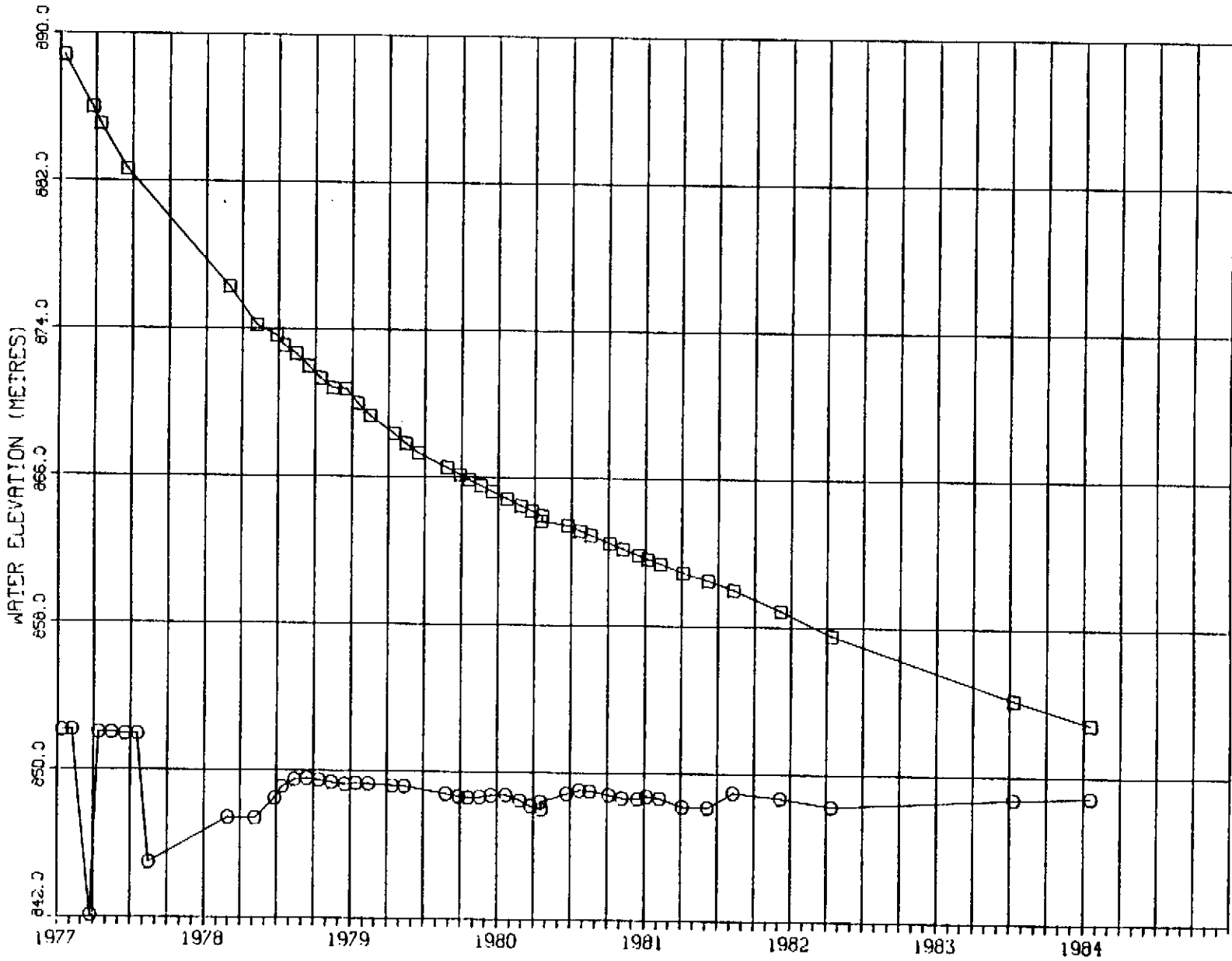
LOT 6 19.03.07 WED 26 MAR, 1984 JOB: W/ARCH111 SCS - EXS DISPLAY VER 6.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-813



LEGEND
□ - PIEZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-814

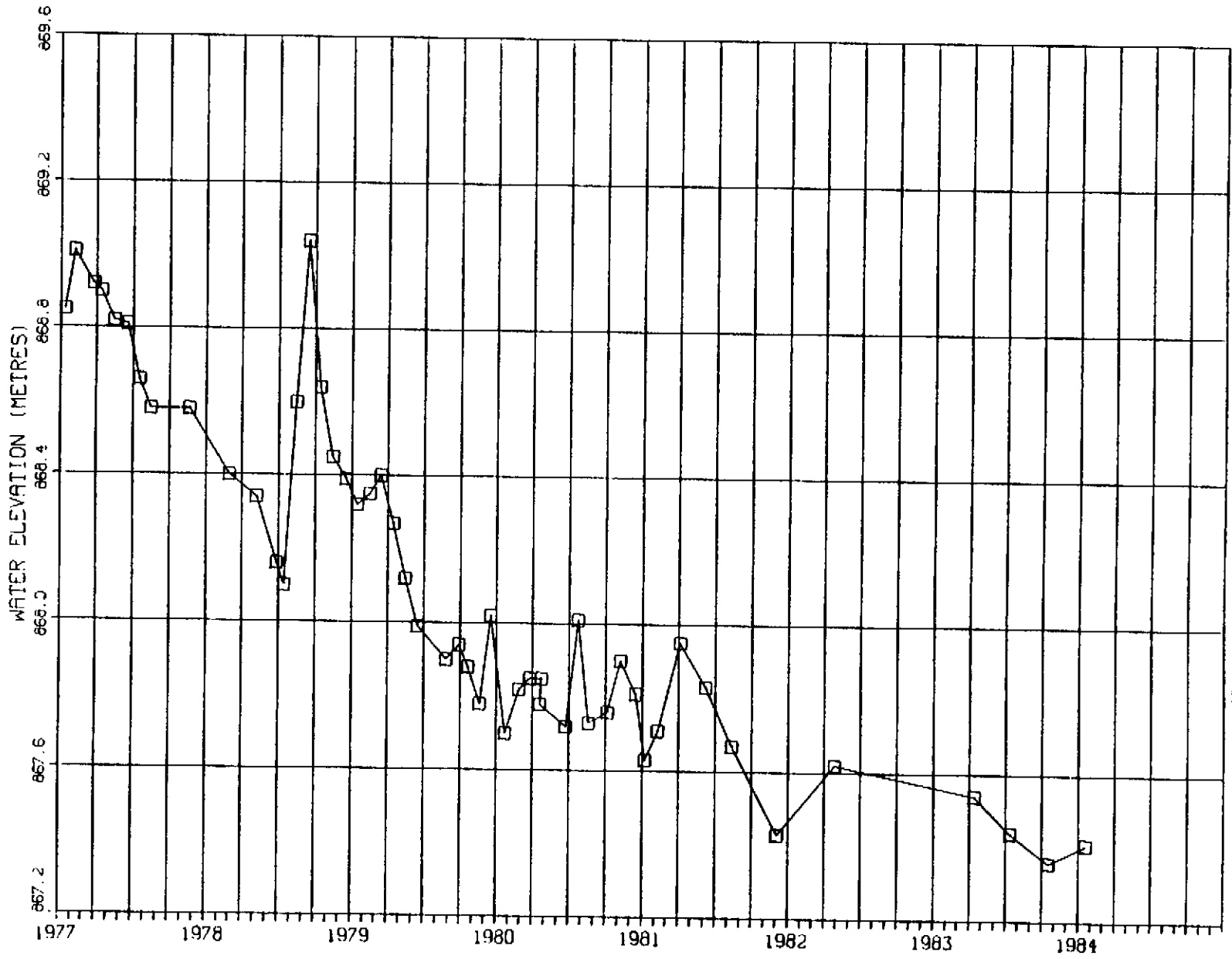


LEGEND
 □ - PIEZO. NO. 1
 ○ - PIEZO. NO. 2

PL01 6 19.00.00 4ED 28 MAR. 1984 JOB=JACH11 BCS - EKS DISPLA VER 8.2

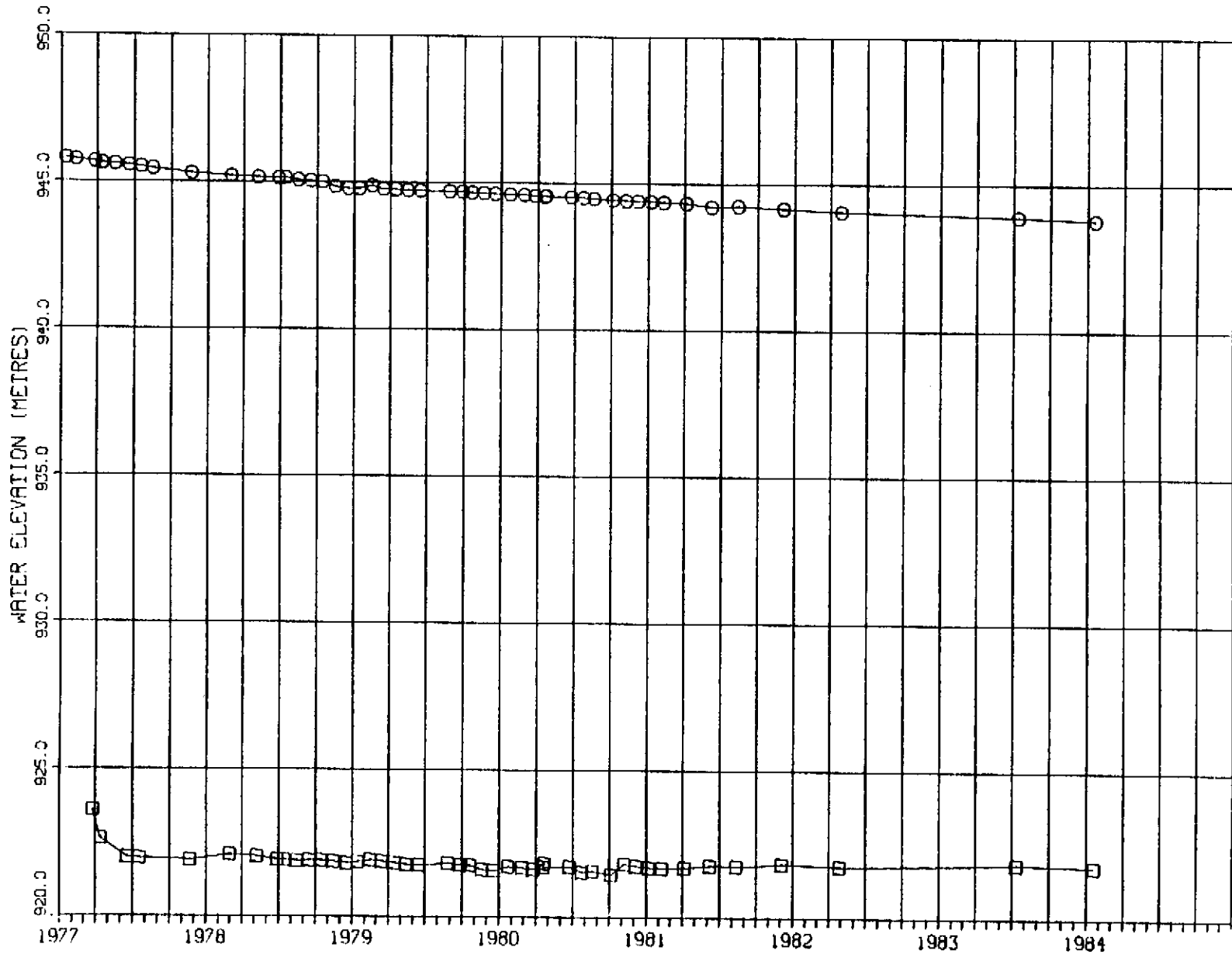
PLOT 9 19.36.36 4ED 28 MAR, 1964 .JOB=AROHIT .SOS - EKS DISSPLA VER 0.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-815



LEGEND
□ - PIEZO. NO. 1

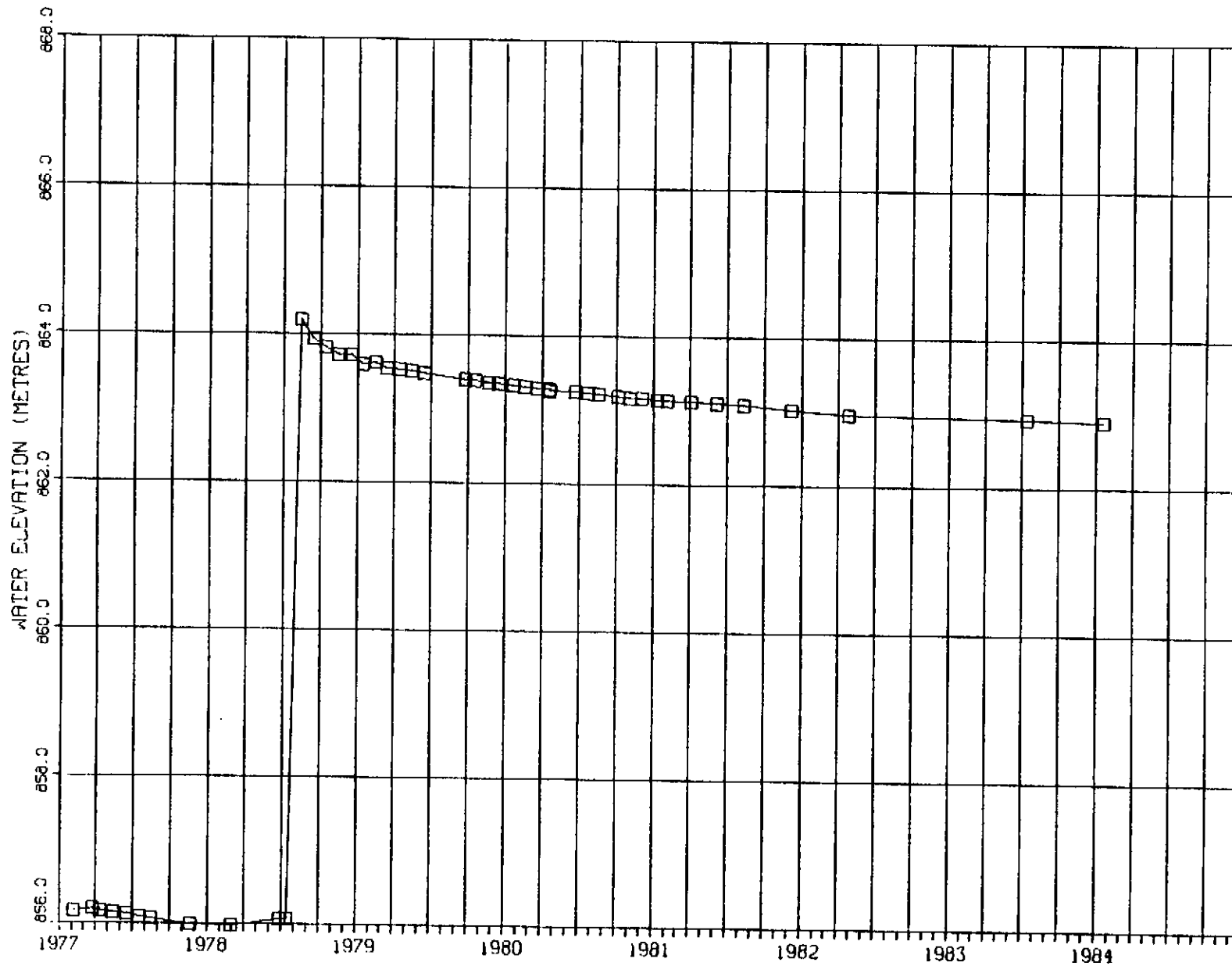
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-816



LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

PLT 10 19 37 35 MED 28 MAR 1984 JOB=LARCH11 . 905 - EKS DISPLA VER 8.2

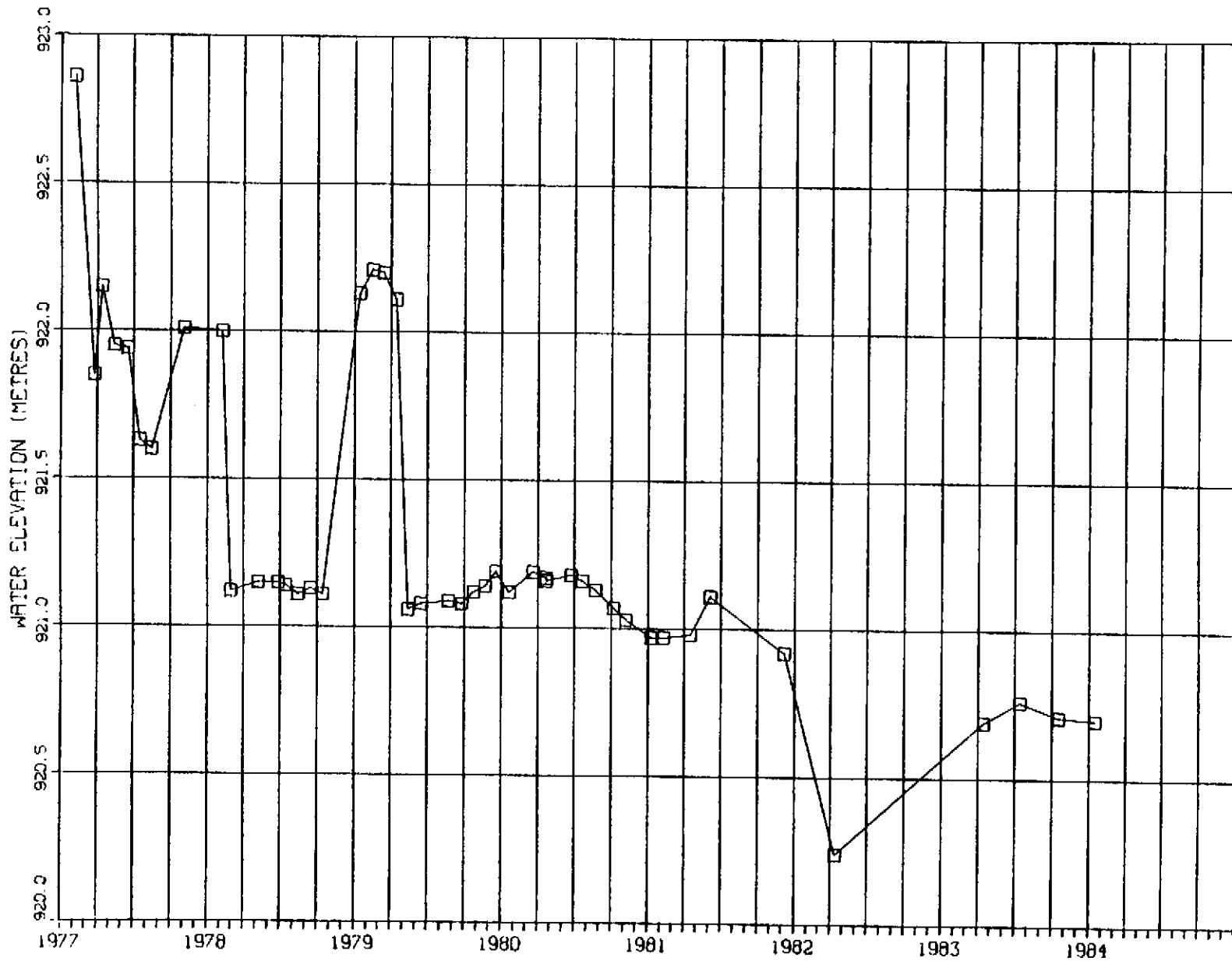
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-817



LEGEND
□ - PIEZO. NO. 1

19. JUL. 46 HED 2d MKR. 1904 PUB. W. 2000KT. 905 - EXS. DISPLA. PER 0.2

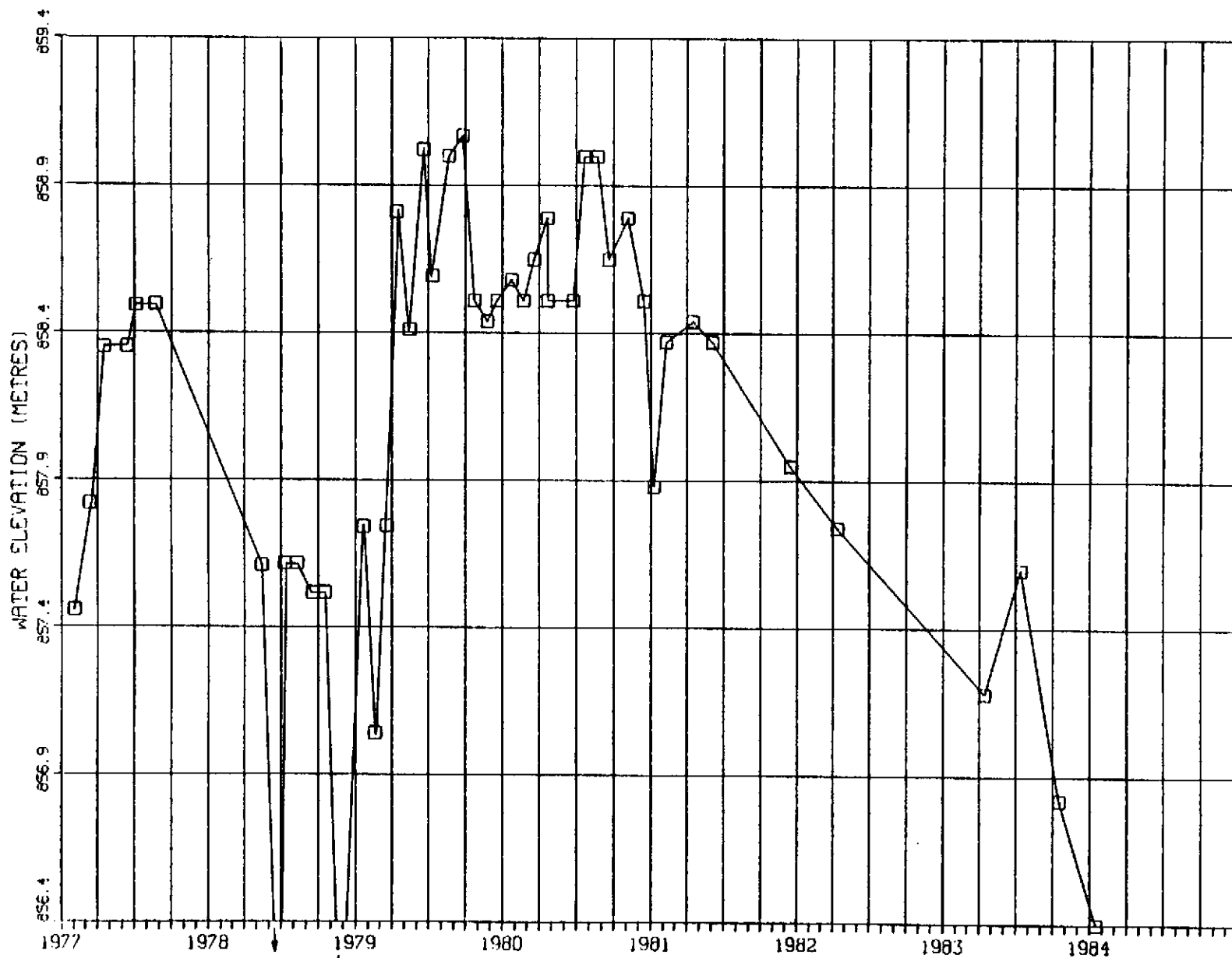
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-818



LEGEND
□ - PIEZO. NO. 1

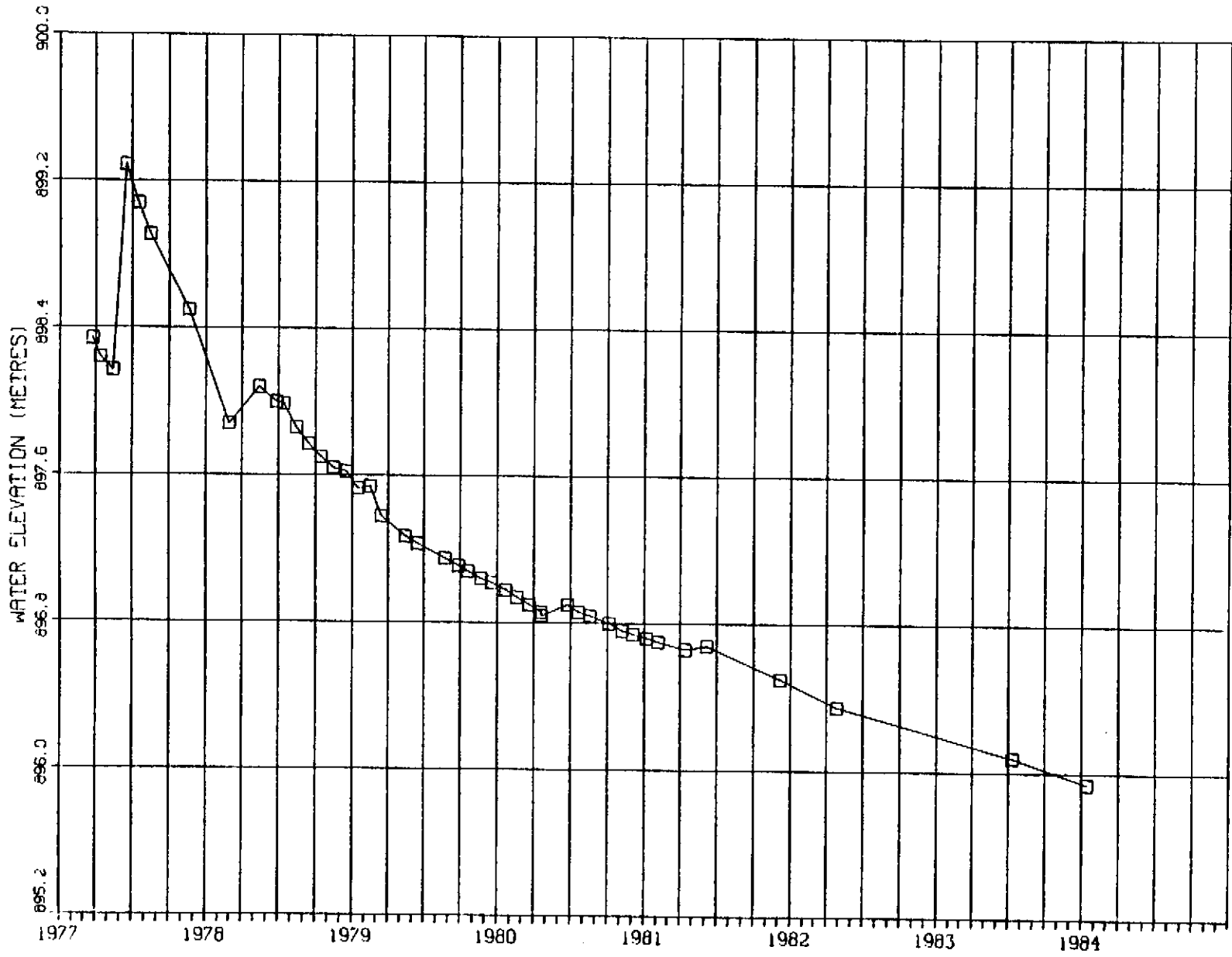
LOT 2 19-1-53 WED 28 APR, 1984 109-LVROK1 . 905 - EX5 DISPLA (ER 8.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-819



LEGEND
□ - PIEZO. NO. 1

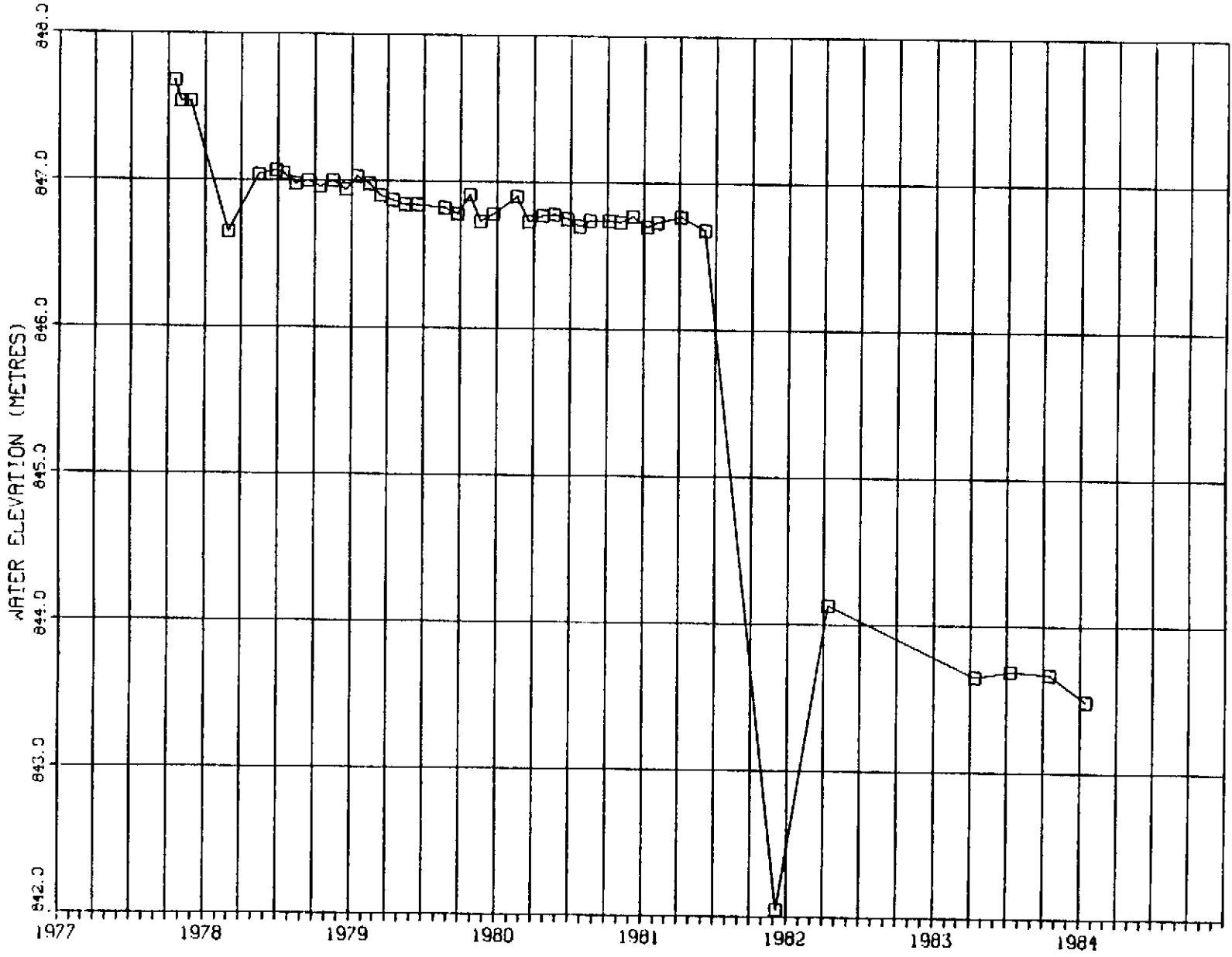
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-76-821



LEGEND
□ - PIEZO. NO. 1

LOT 4 19.00.02 4ED 26 MAR. 1984 JOB=JPHK1 . BCS - EYS DISPLA VER 8.2

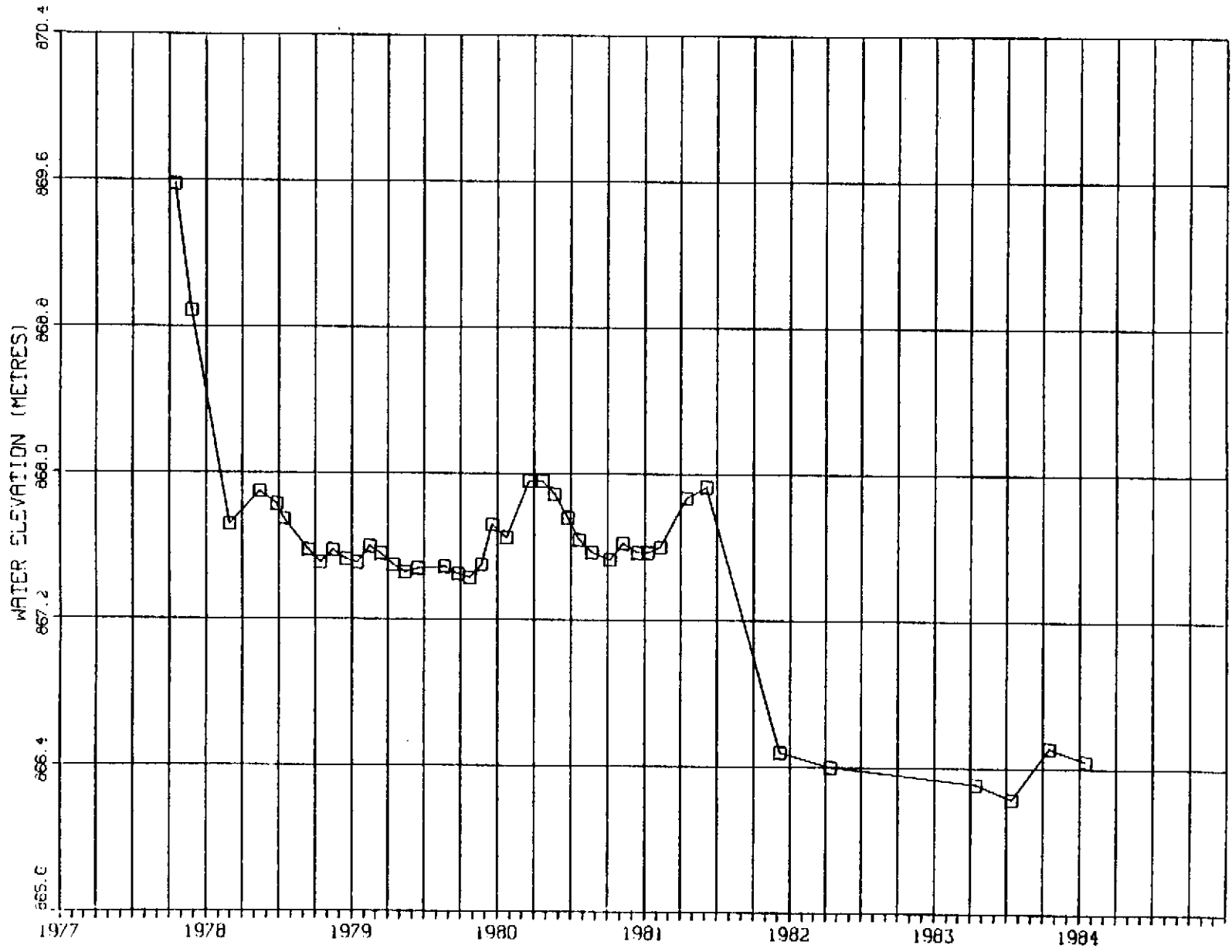
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-829



LEGEND
□ - PIEZO. NO. 1

19. J. 1. 14 14ED 28 MAR. 1984 JOB-L/RCHLT . 905 - EXS DISSPLA VER 8.2

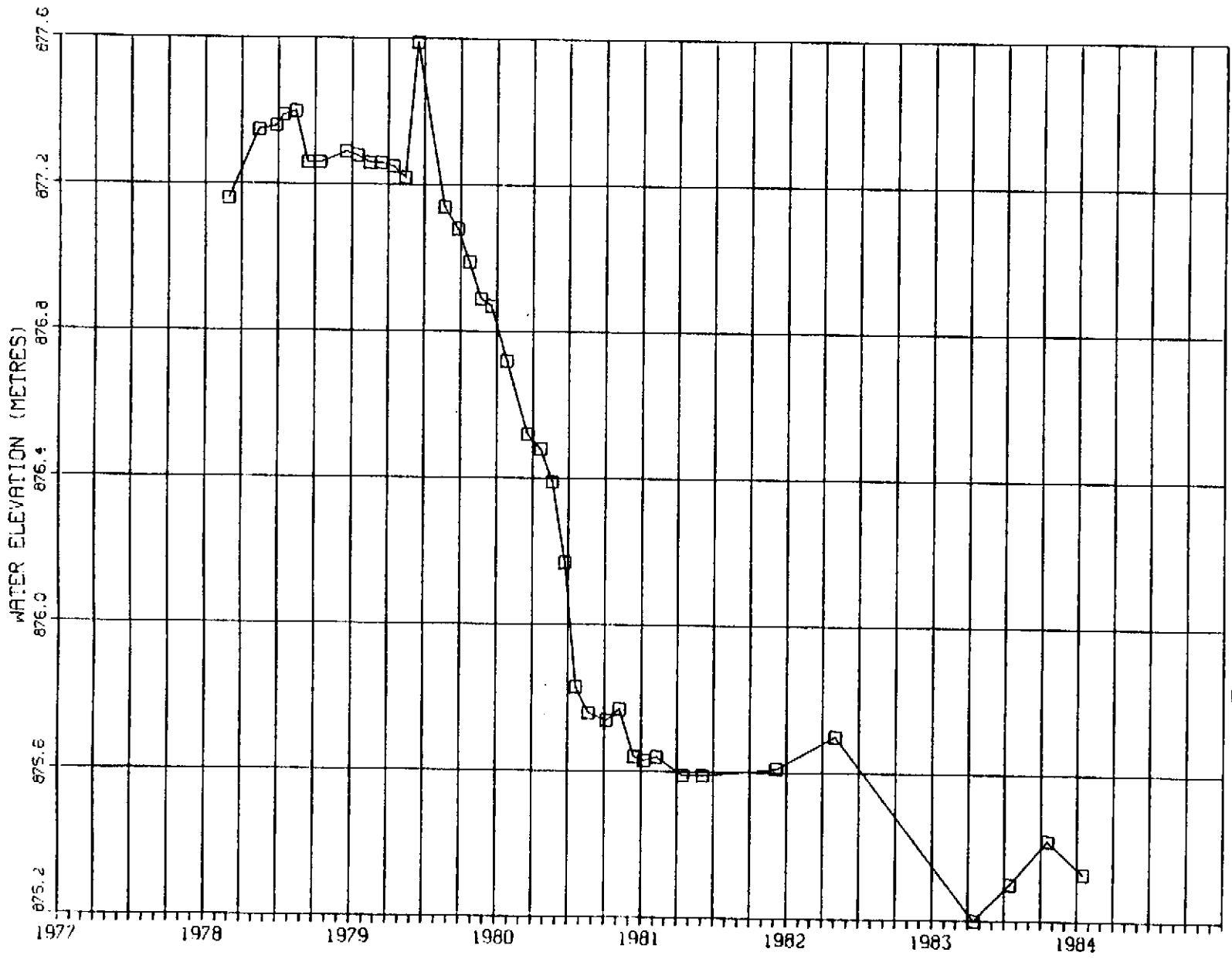
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-831



LEGEND
□ - PIEZO. NO. 1

LOT 2 19.01.80 WED 28 MAR, 1984 JOB=RDHJT .9CS - EWS DISPLA VER 0.2

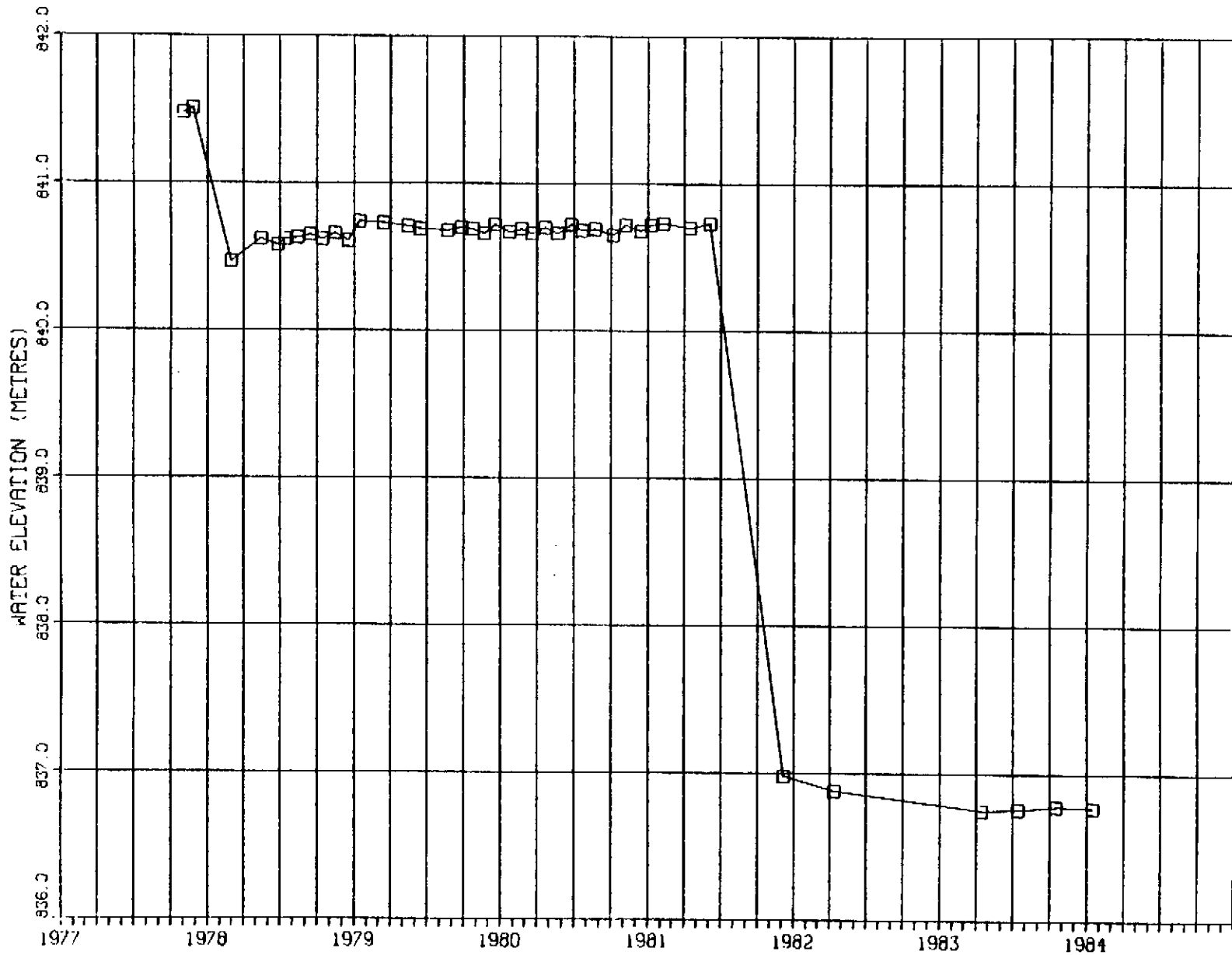
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-833



LEGEND
□ - PIEZO. NO. 1

LOT 3 19...74 MED 28 MAR, 1984 108-L/ROH-LT . PCS - EKS DISPLAY PER 8.2

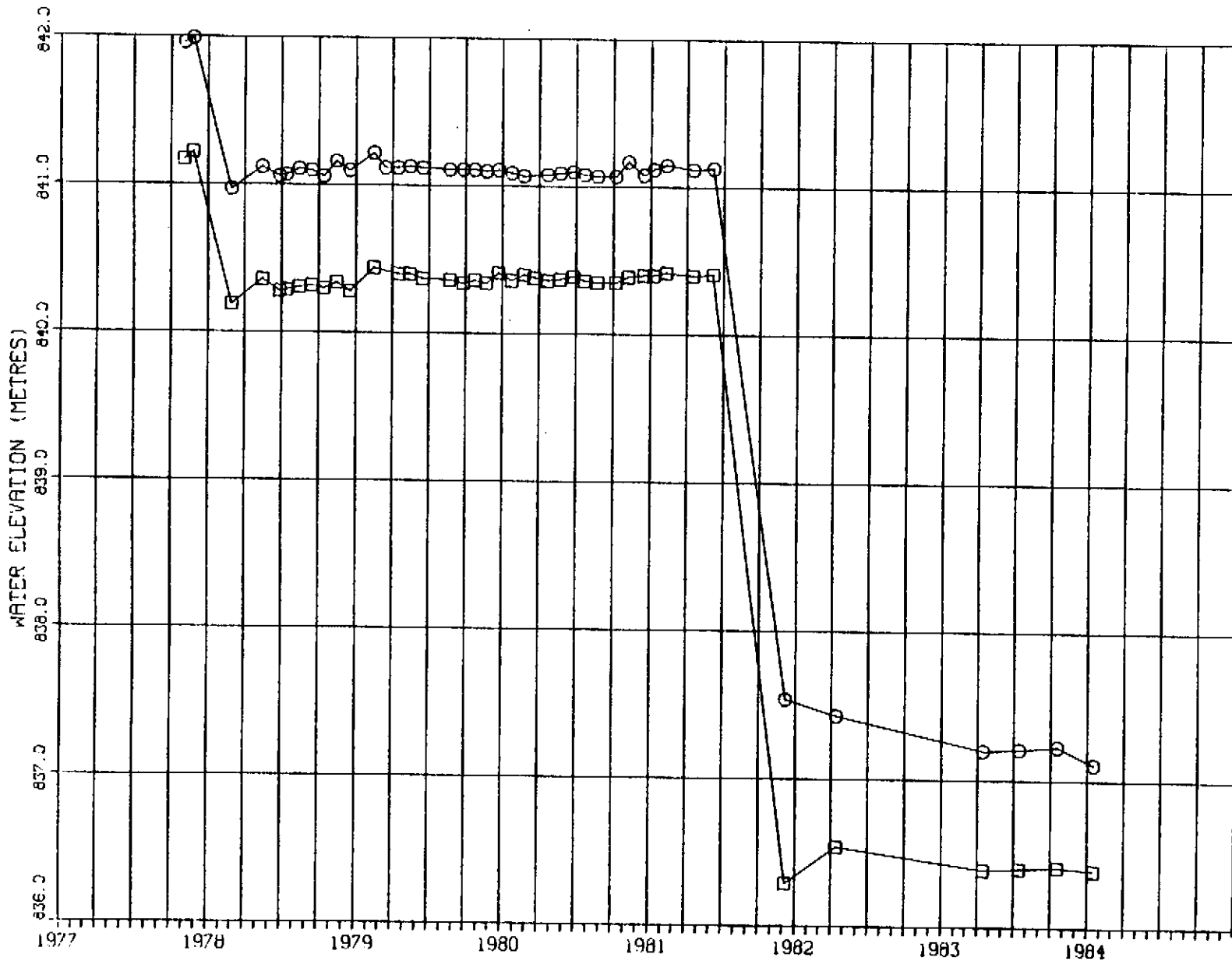
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-834



LEGEND
□ - PIEZO. NO. 1

1074 .9.1.59 MED 26 MAR. 1984 JOB=RDH.L. SCS - EXS DISPLAY VER 6.2

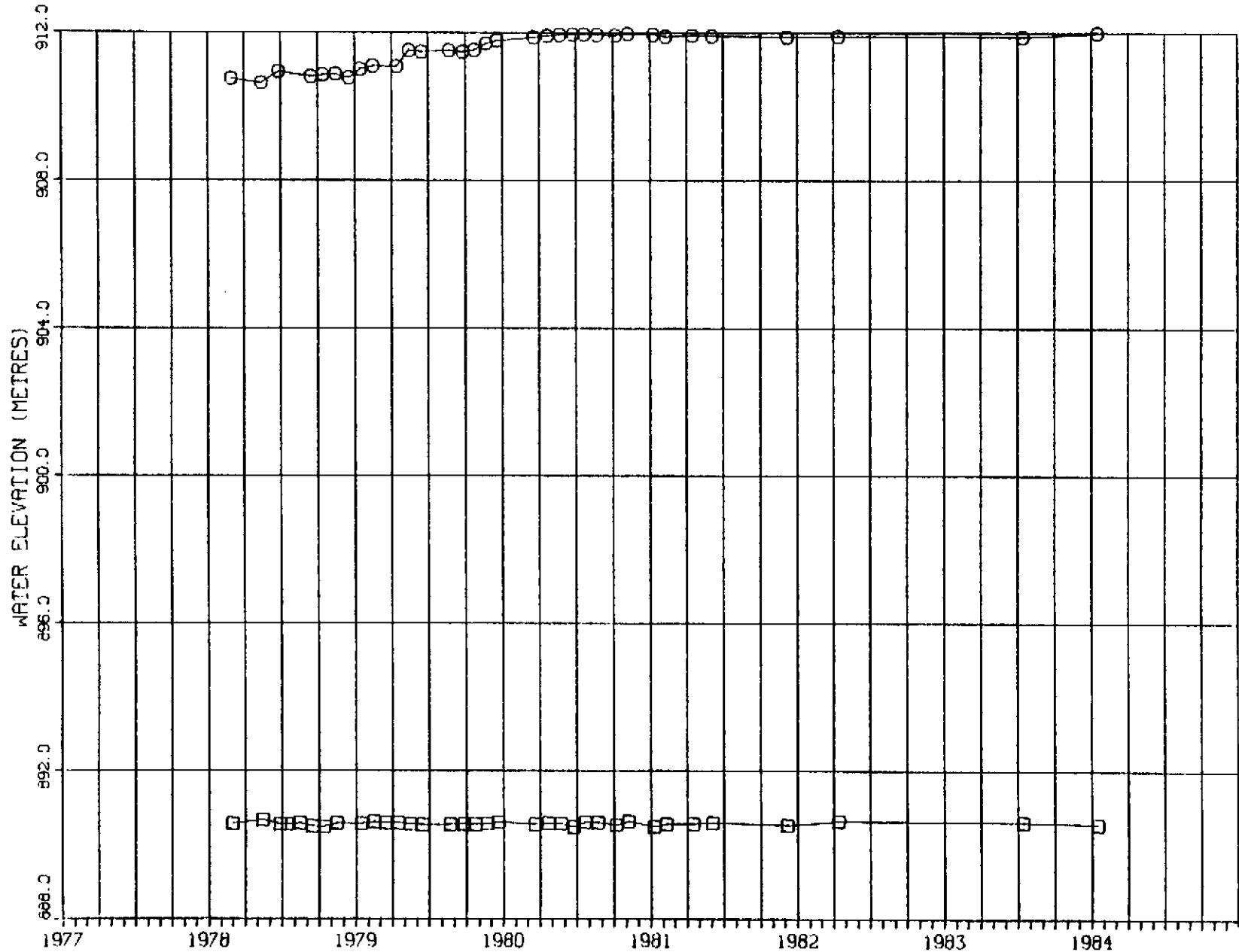
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-835



LEGEND
 □ - PIEZO. NO. 1
 ○ - PIEZO. NO. 2

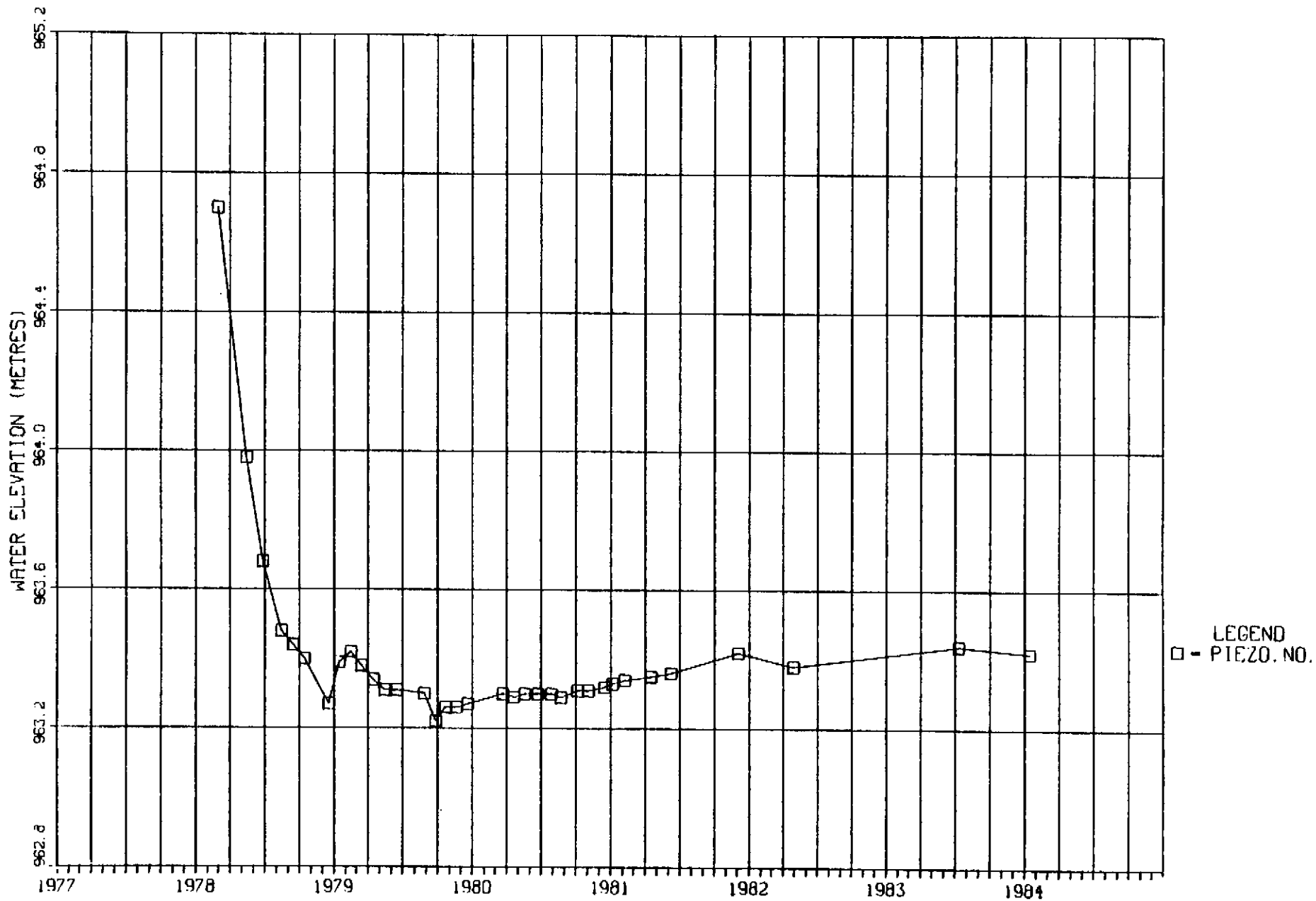
PLOT 5 .9.32.36 AED 28 MAR, 1984 308-L-AR-DLT, 505 - EXS DISSPLA VER 2.2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-837

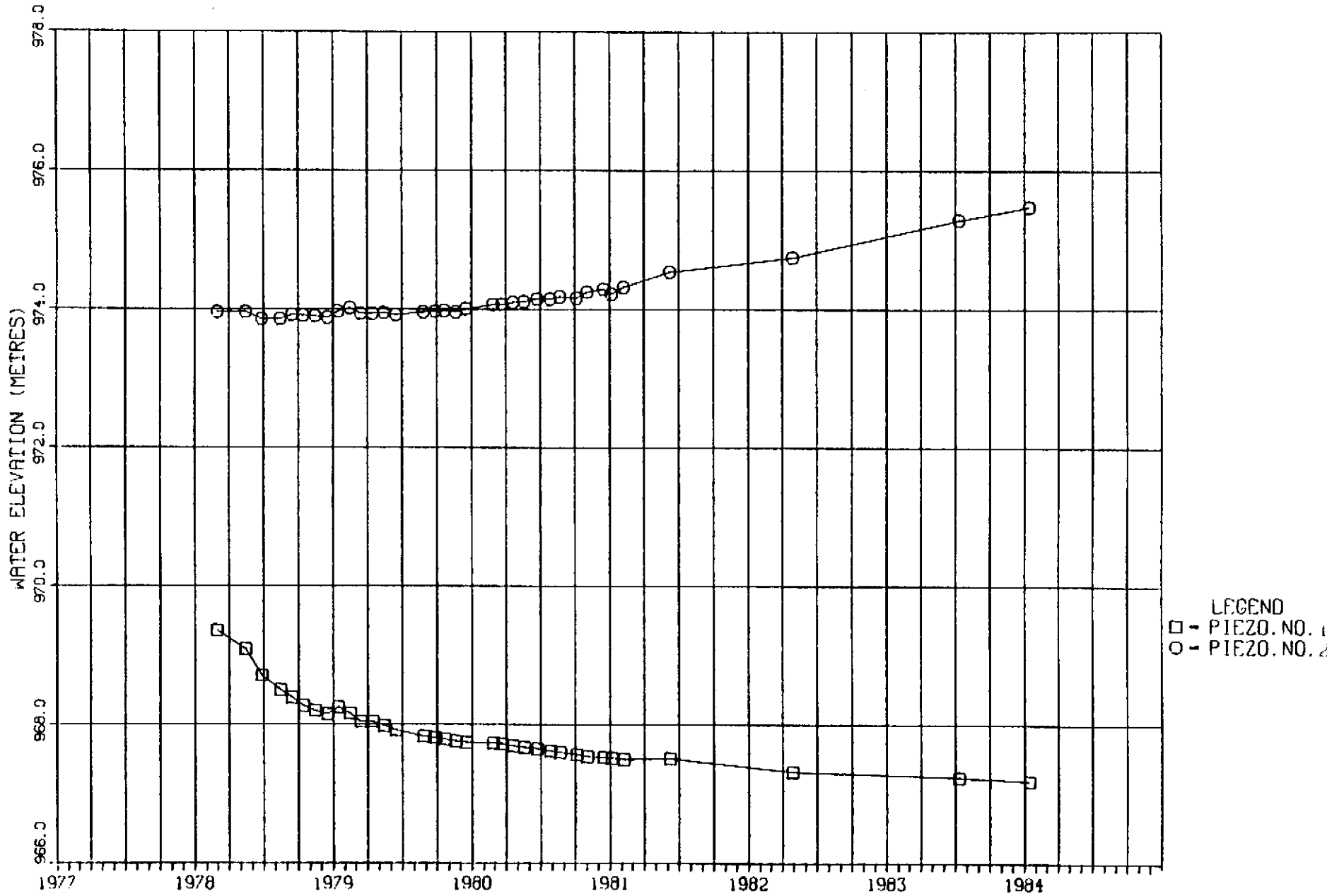


LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

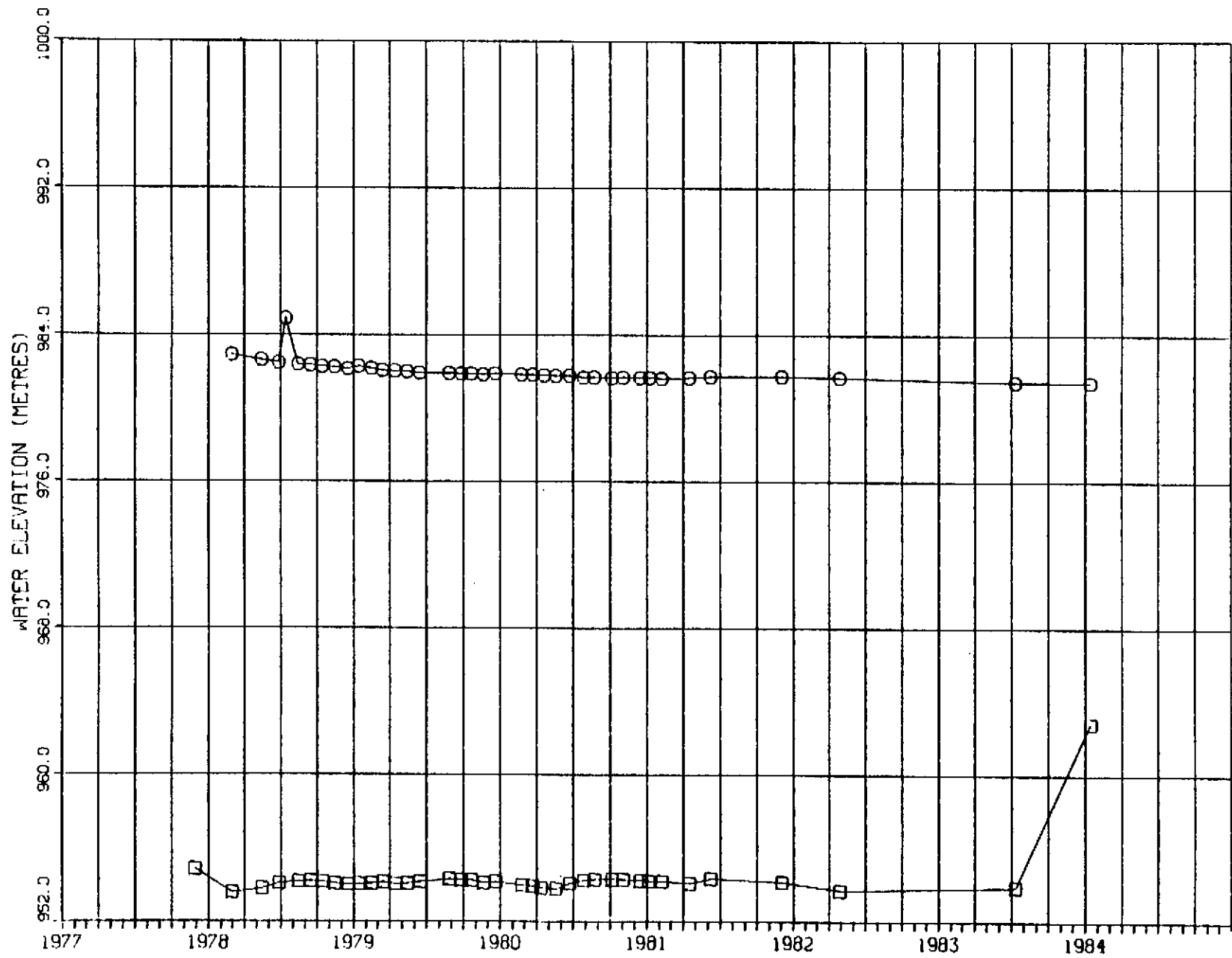
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-838



HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-839

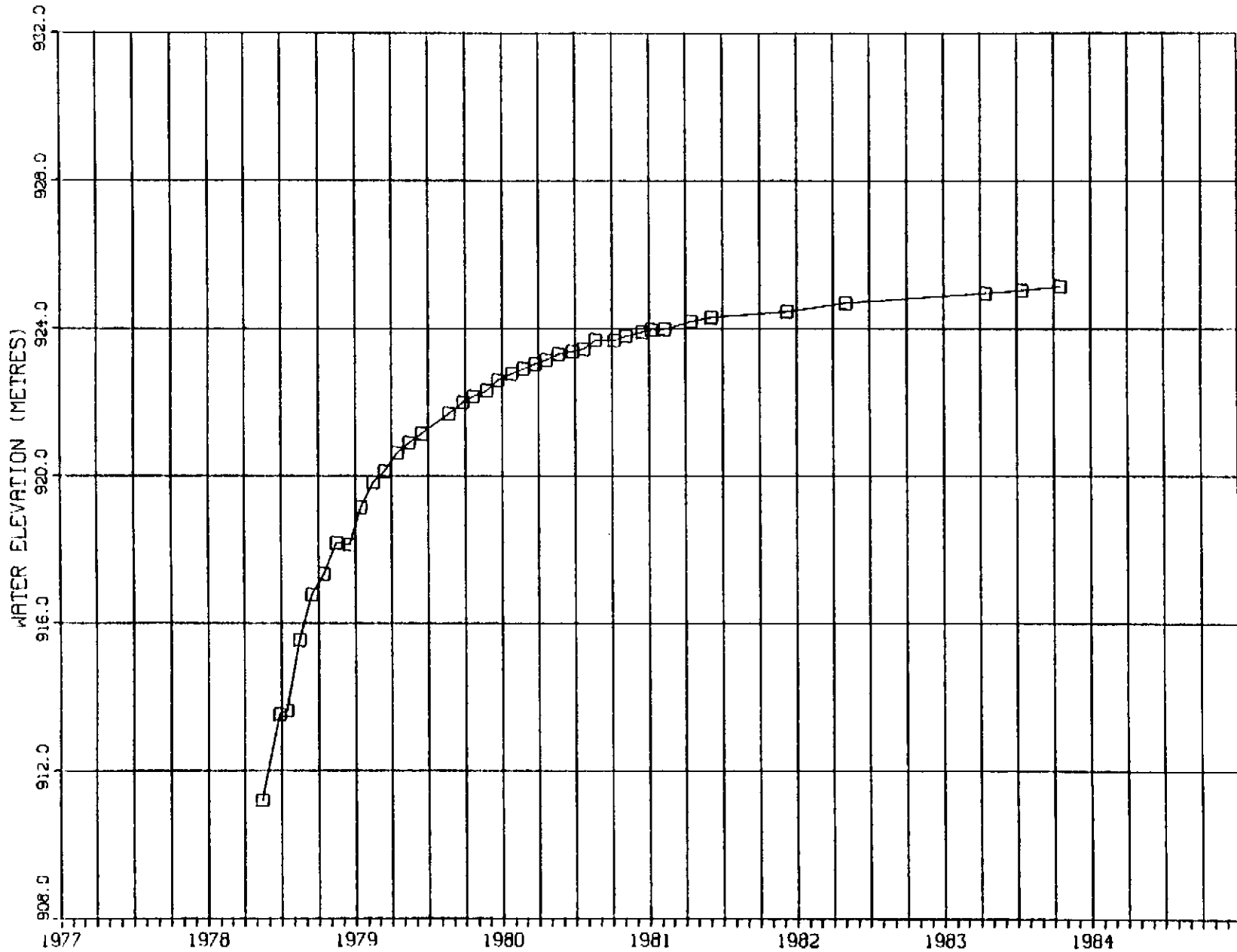


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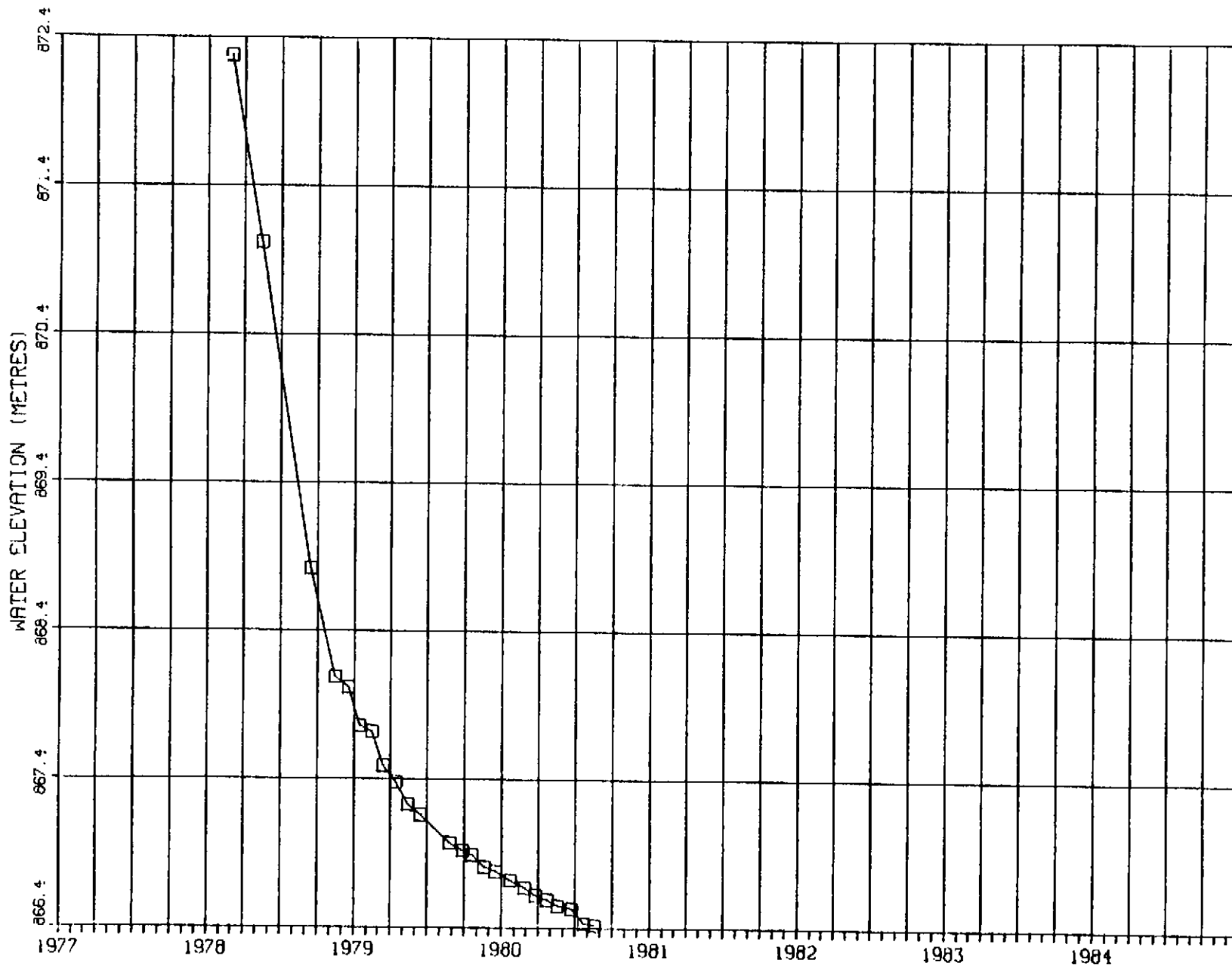
LEGEND
□ - PIEZO. NO. 1
○ - PIEZO. NO. 2

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-842



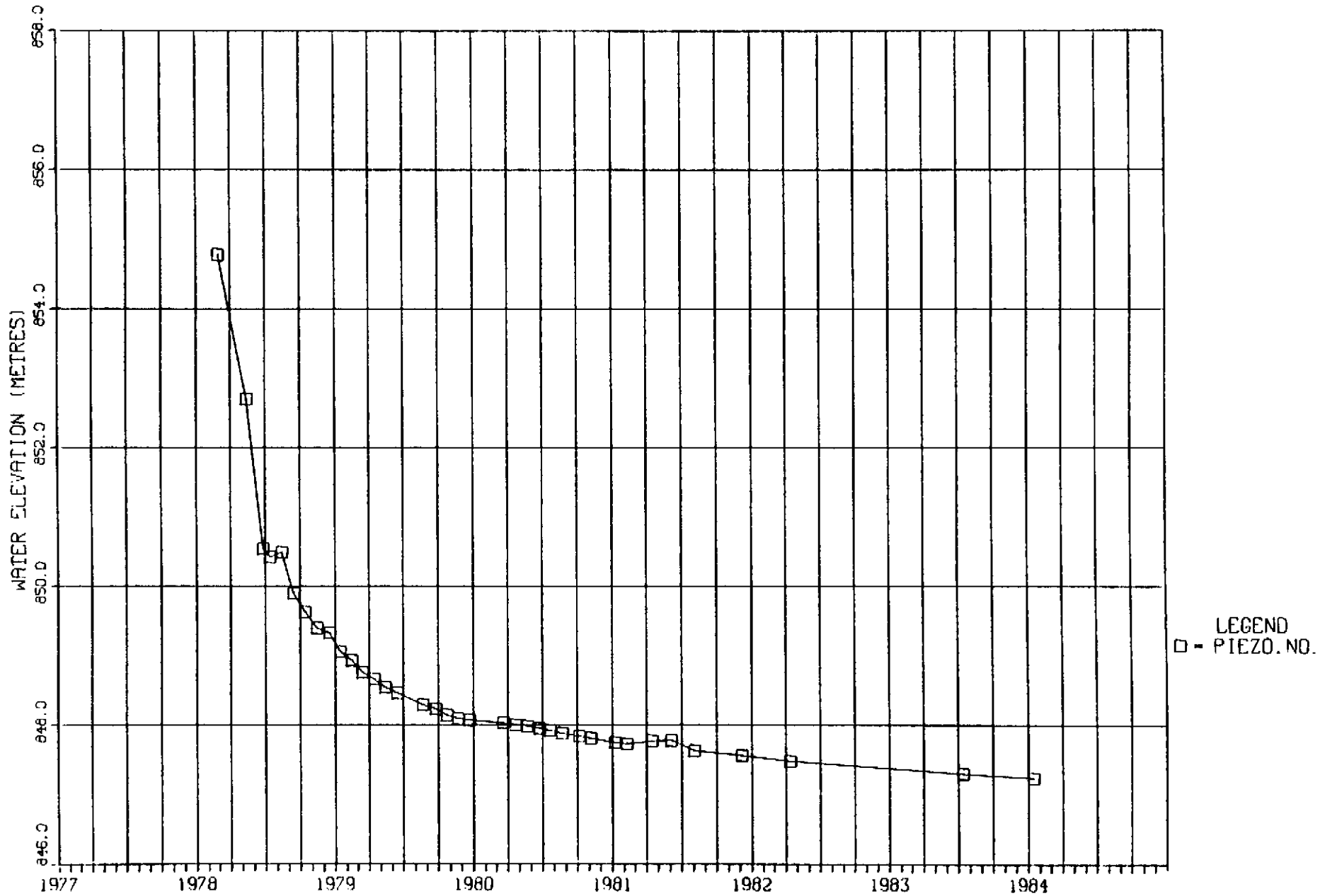
LEGEND
□ - PIEZO. NO. 1

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-77-846

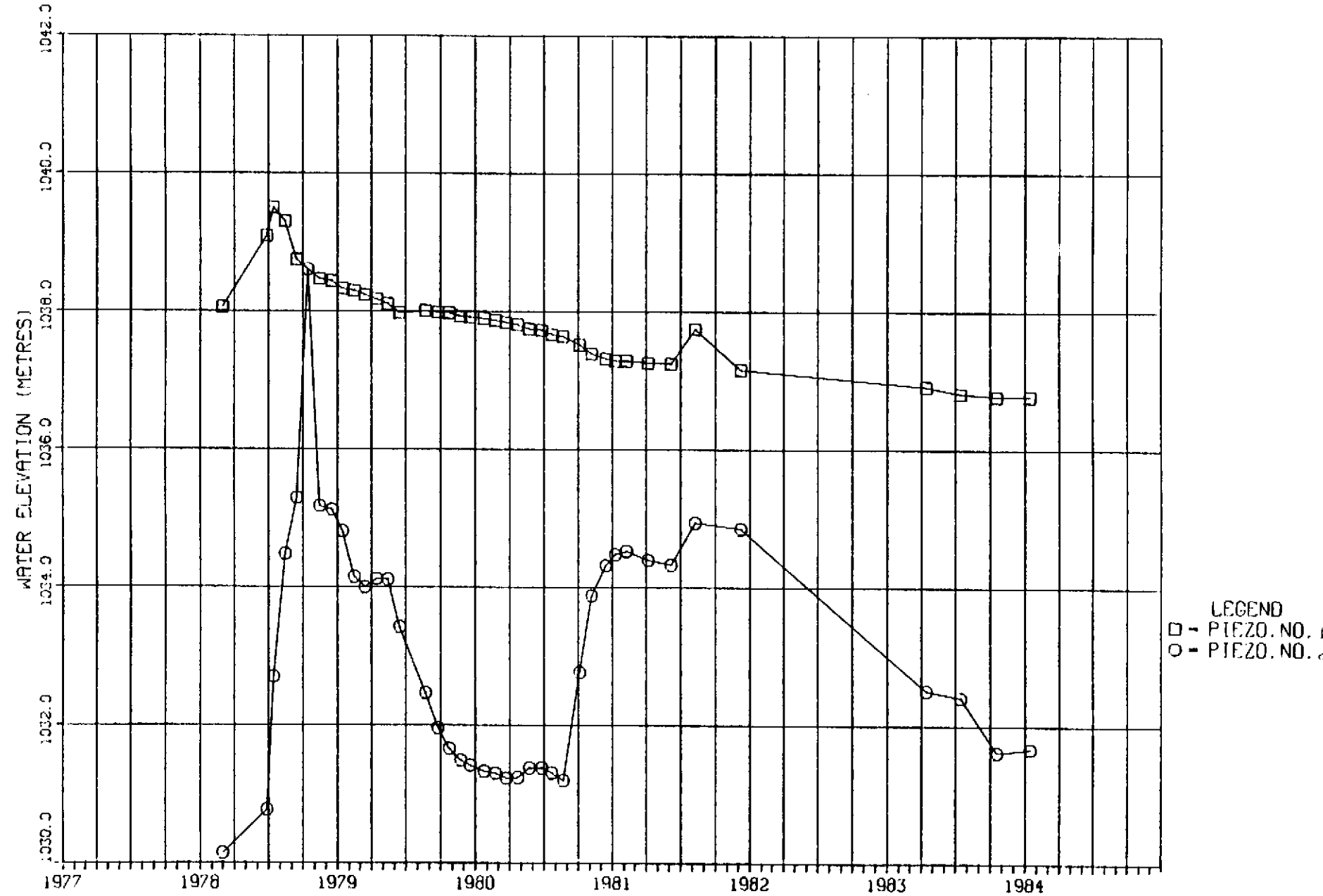


LEGEND
□ - PIEZO. NO. 1

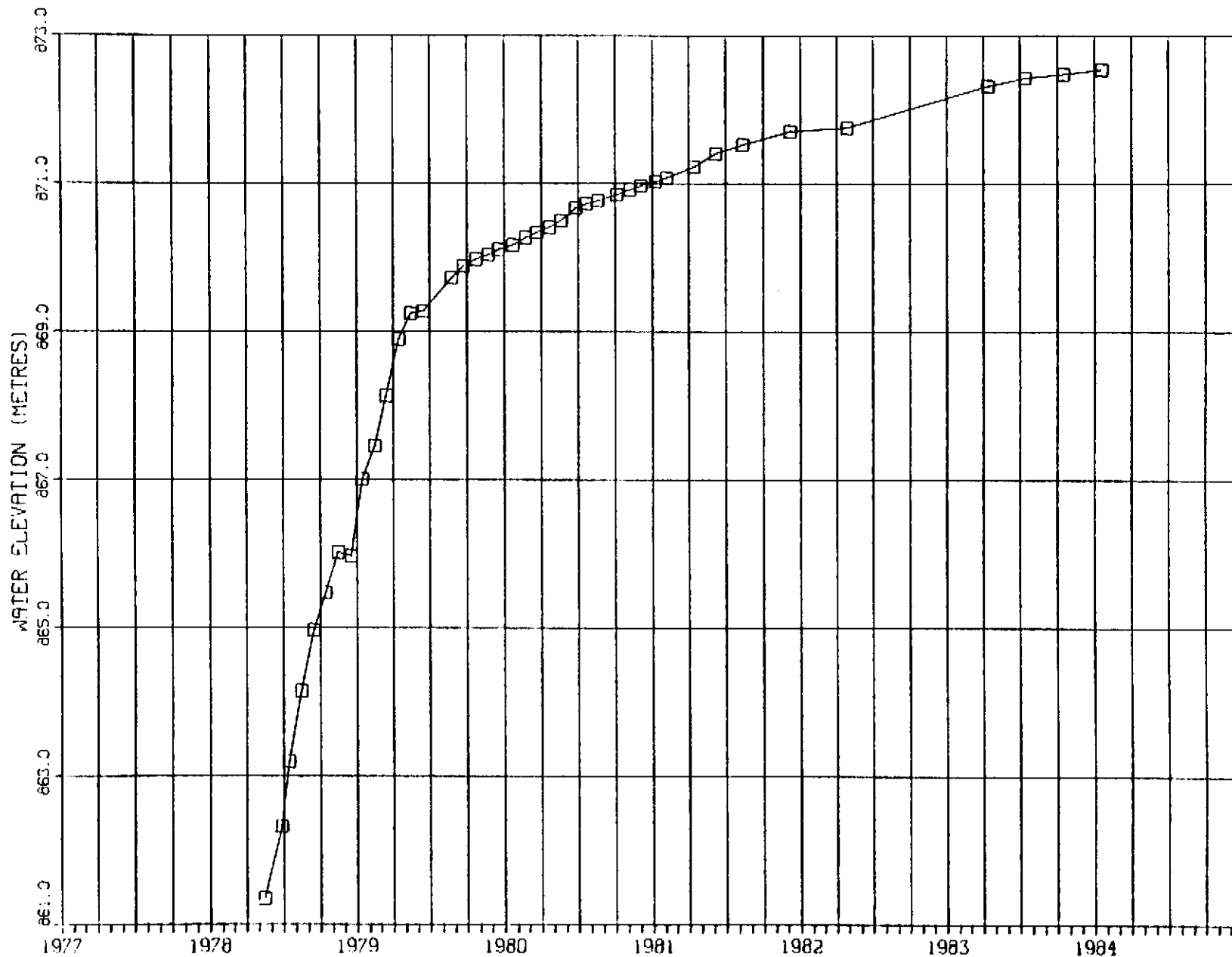
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-851



HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-852

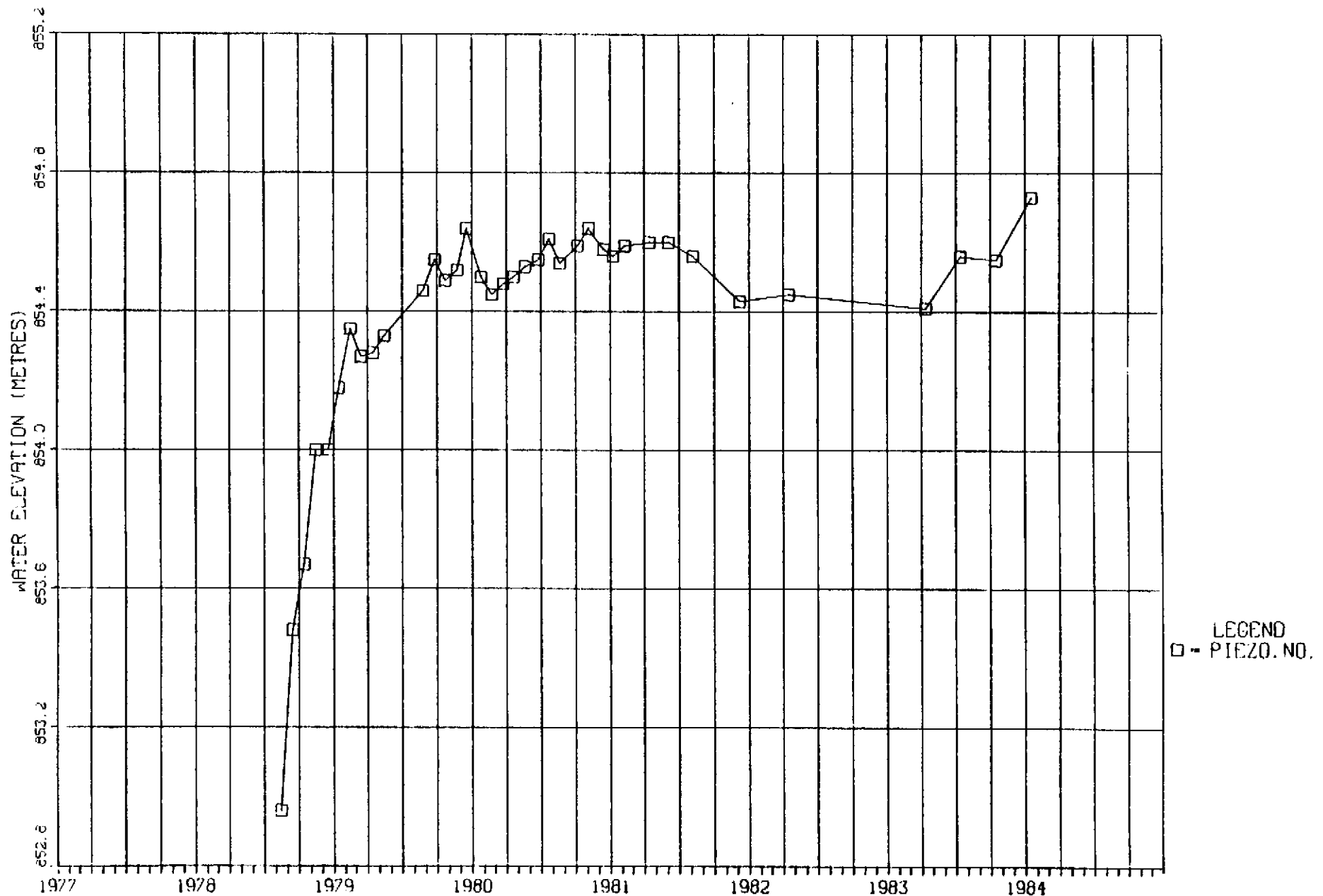


HAI CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-853

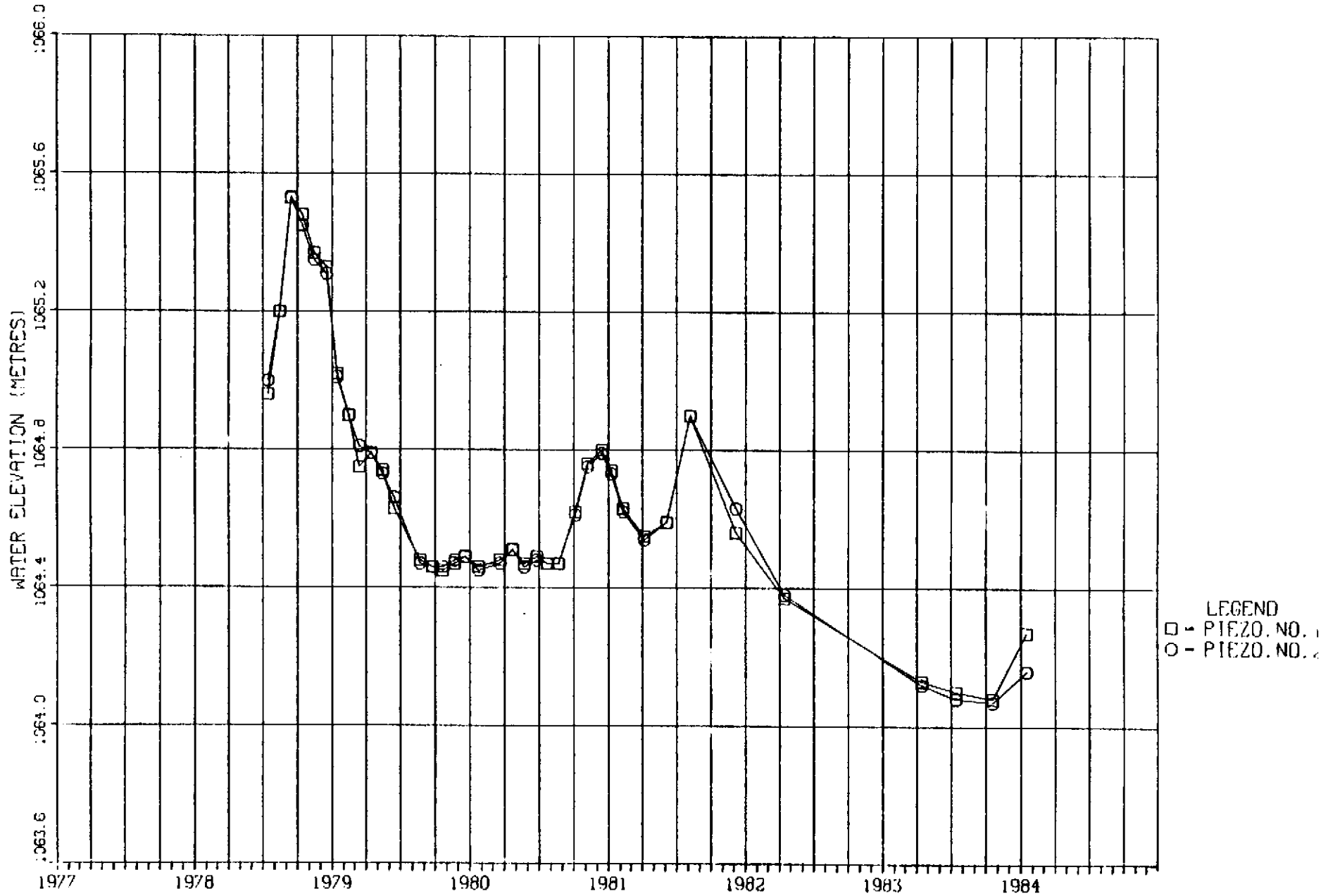


LEGEND
□ - PTEZO. NO. 1

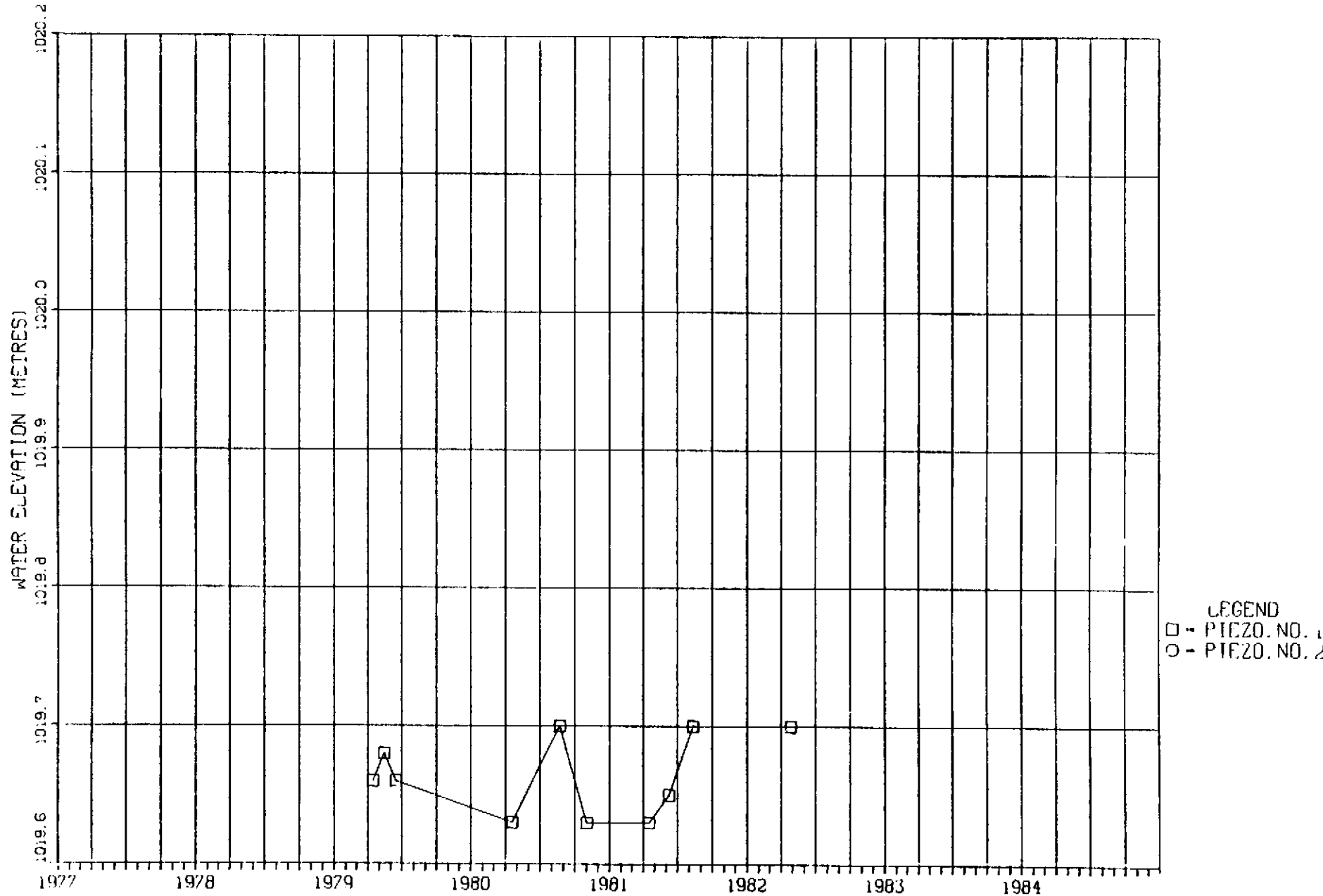
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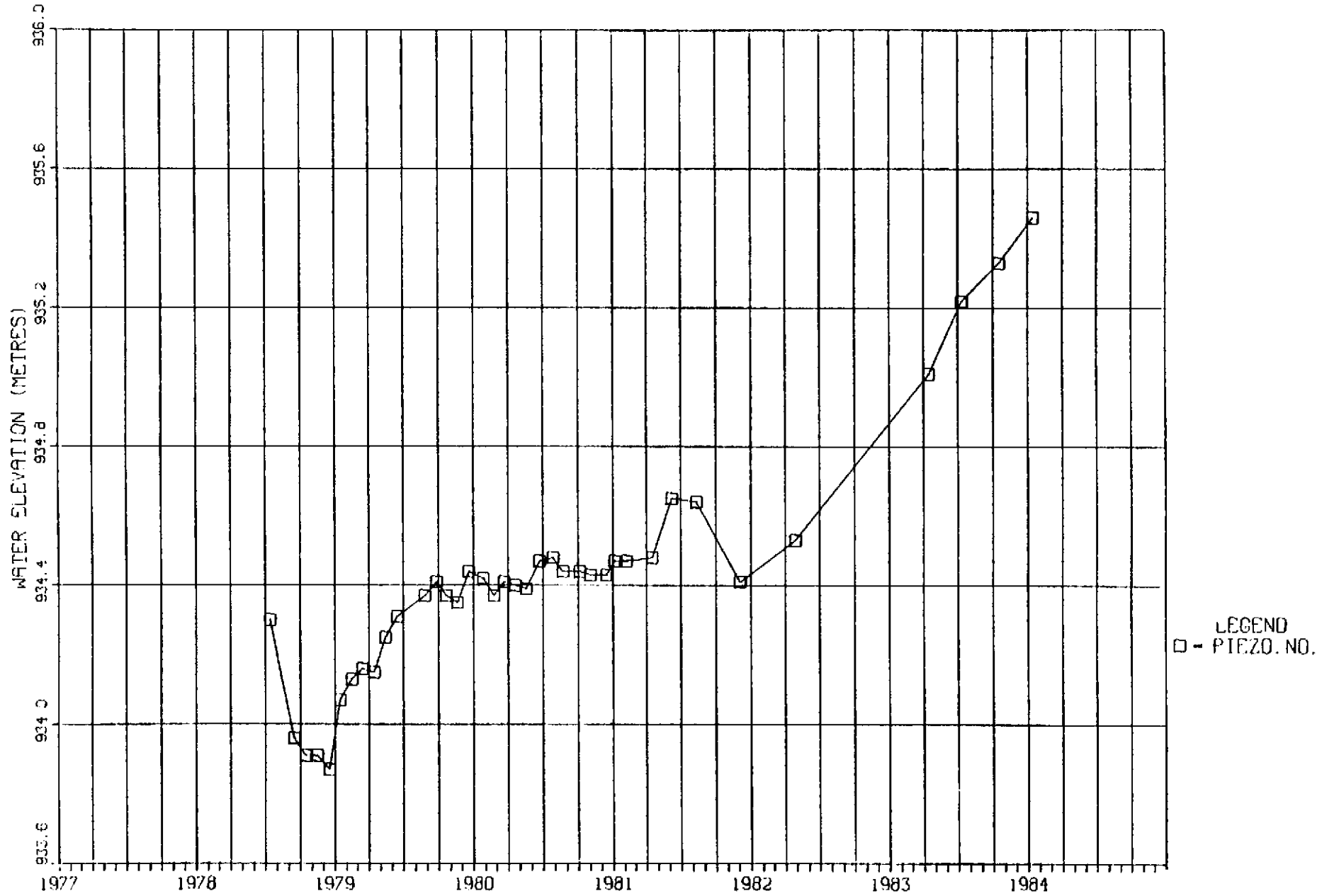
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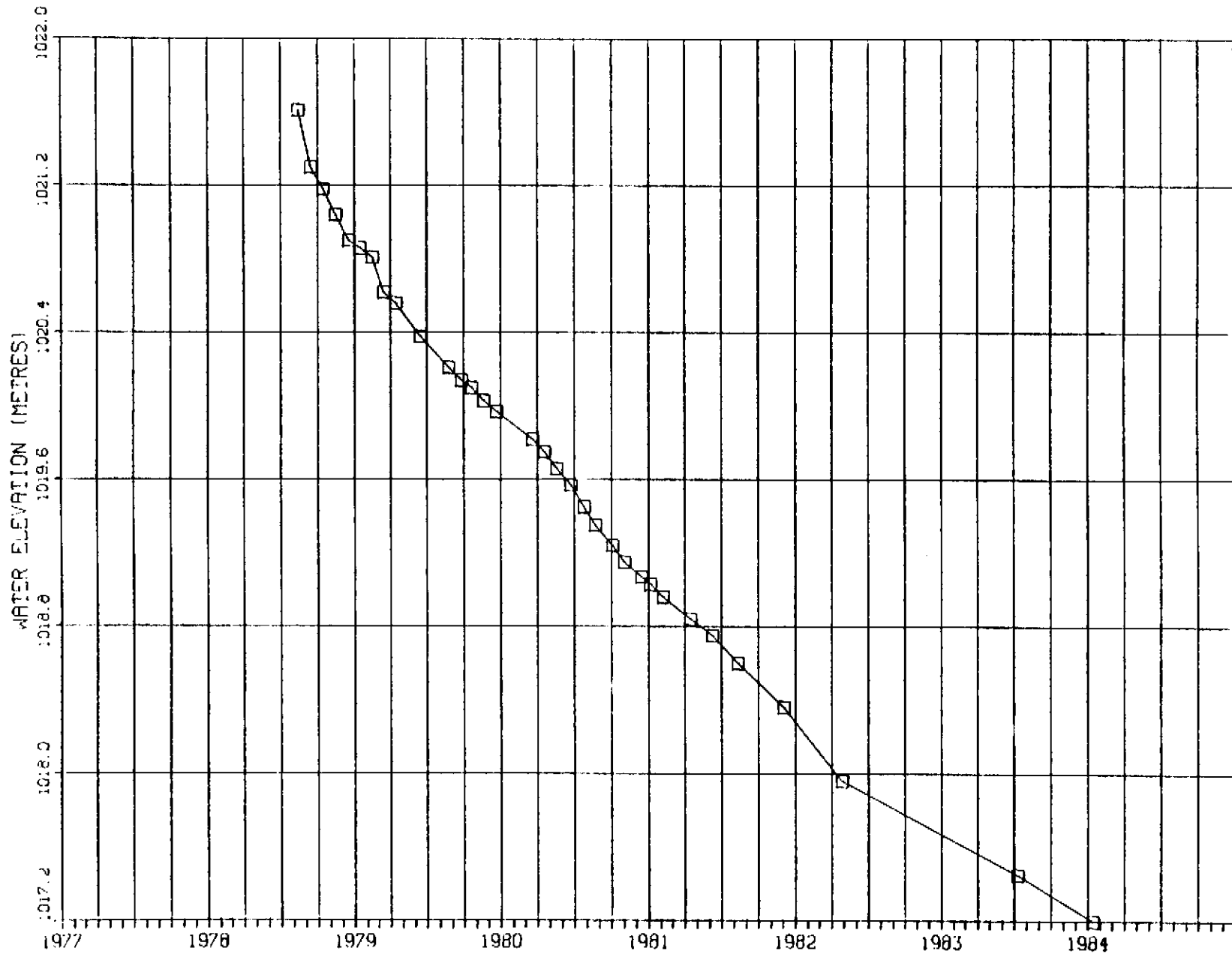
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-859



HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-860

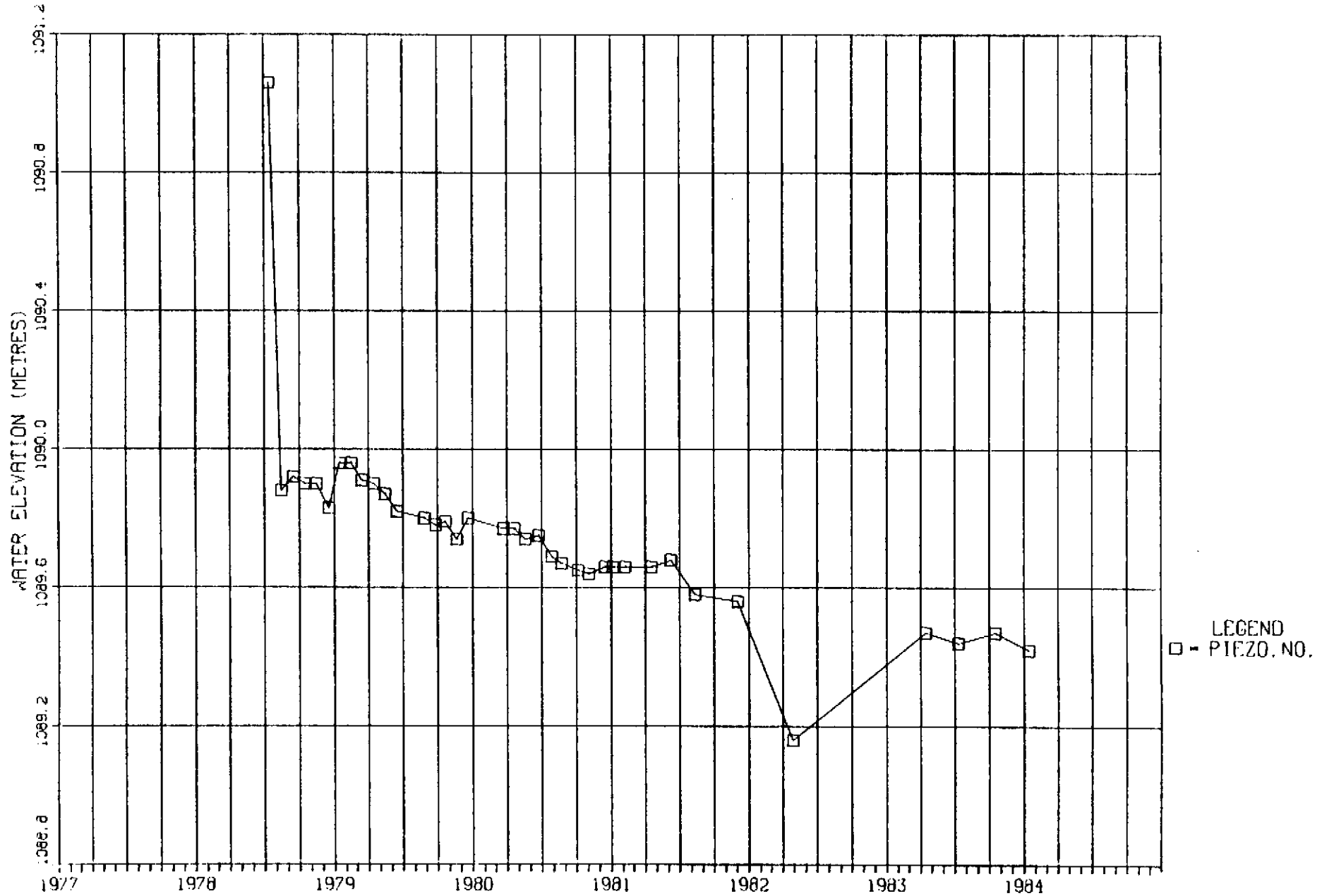


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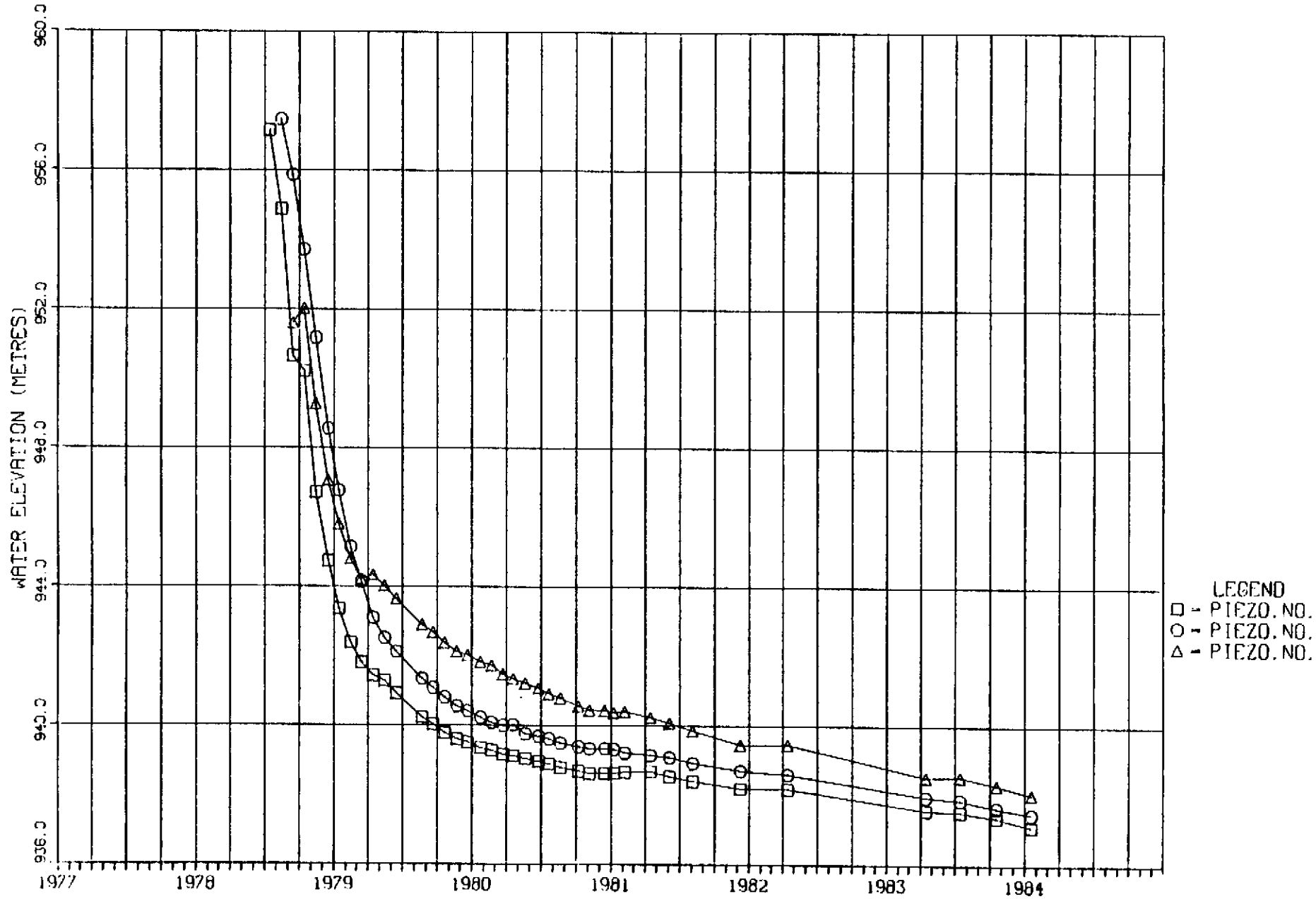


LEGEND
□ - PIEZO. NO.

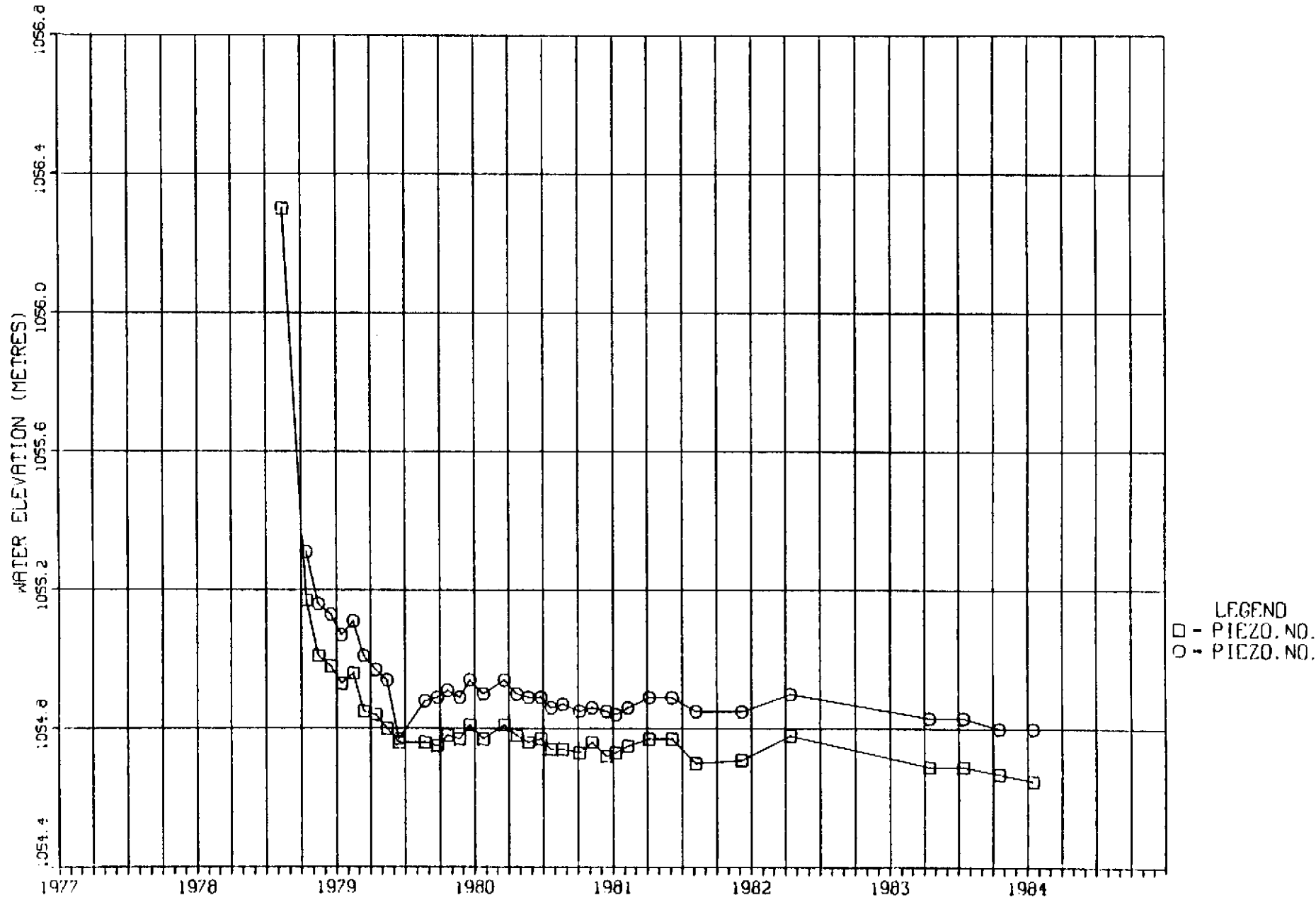
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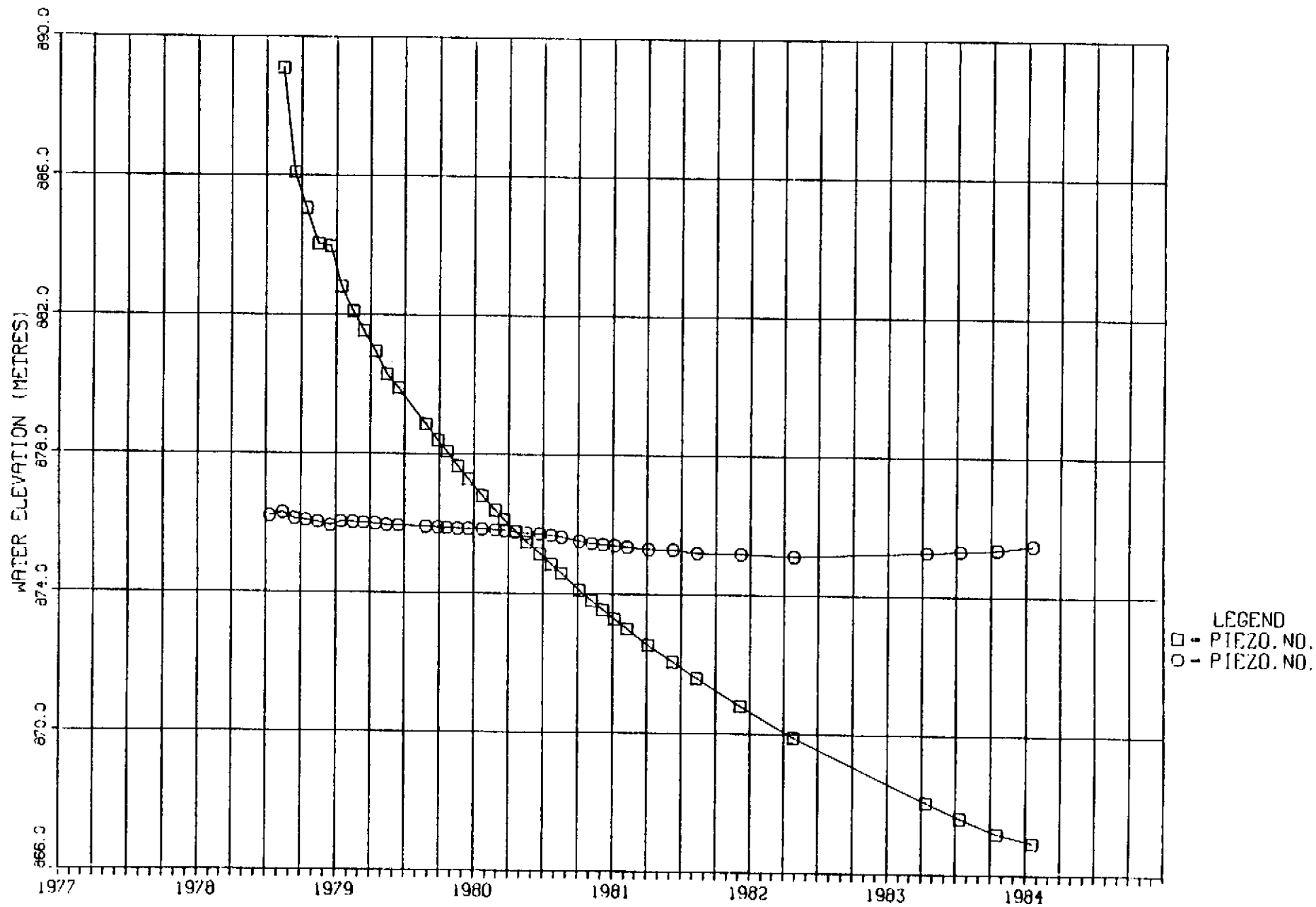
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-865



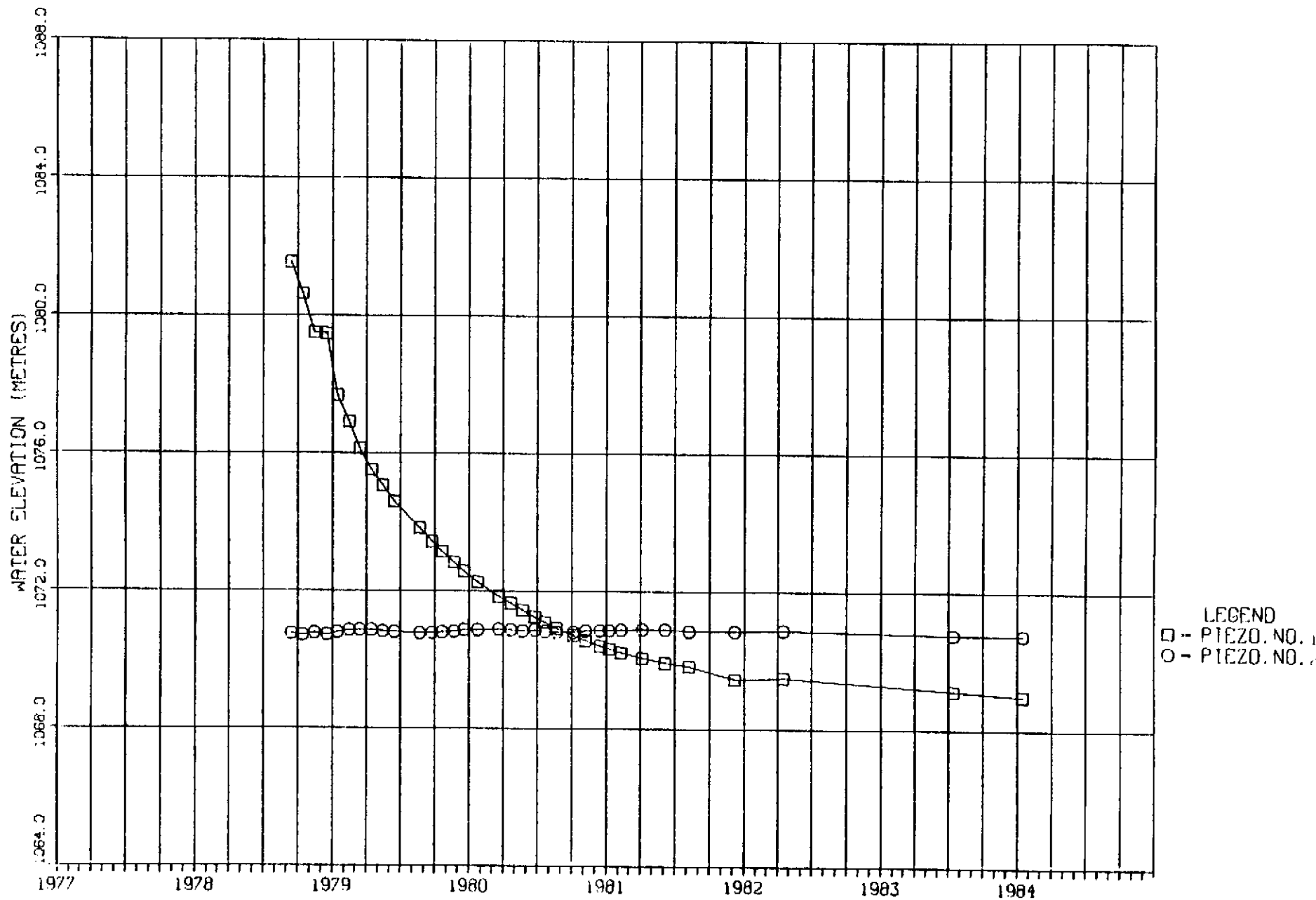
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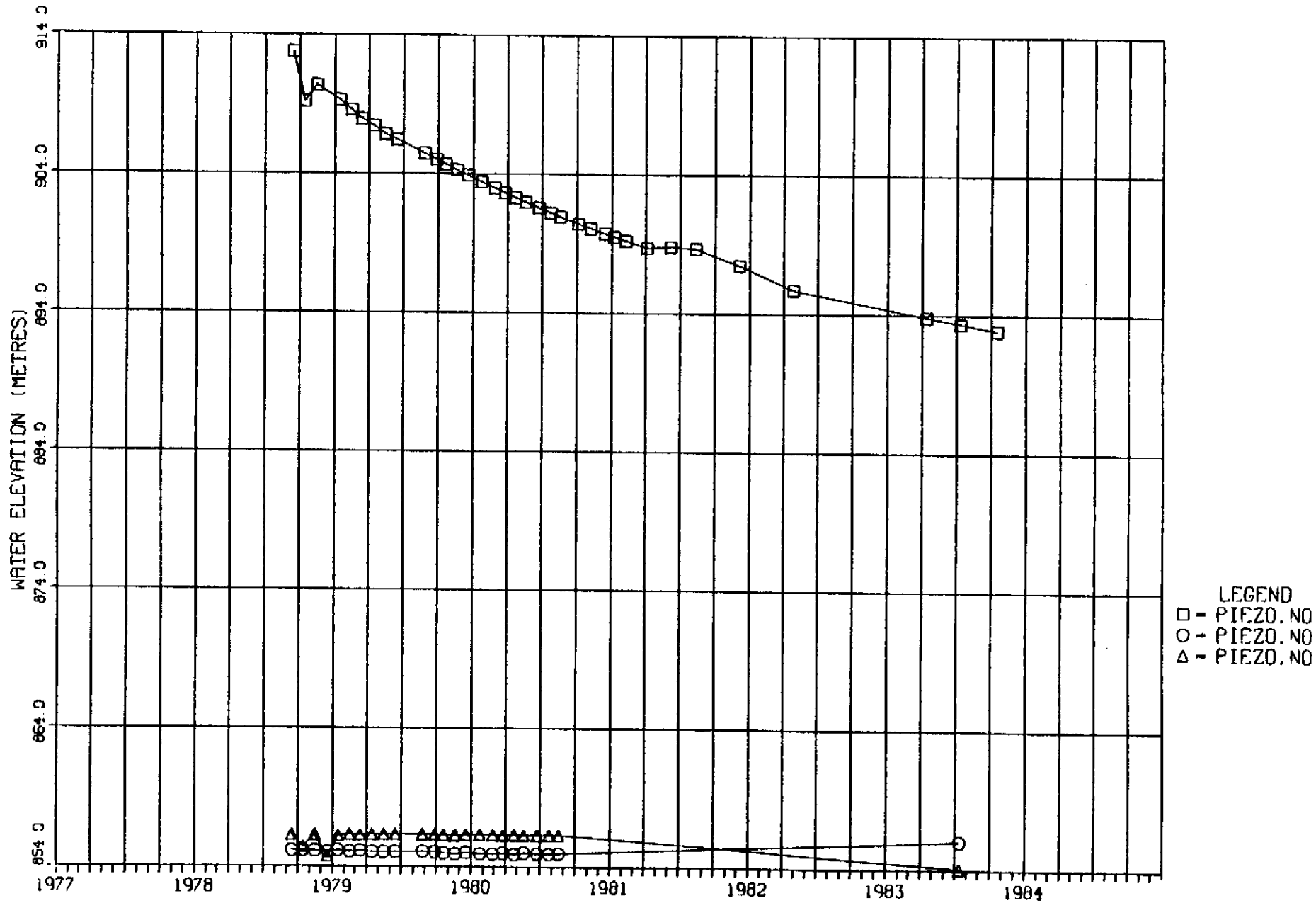
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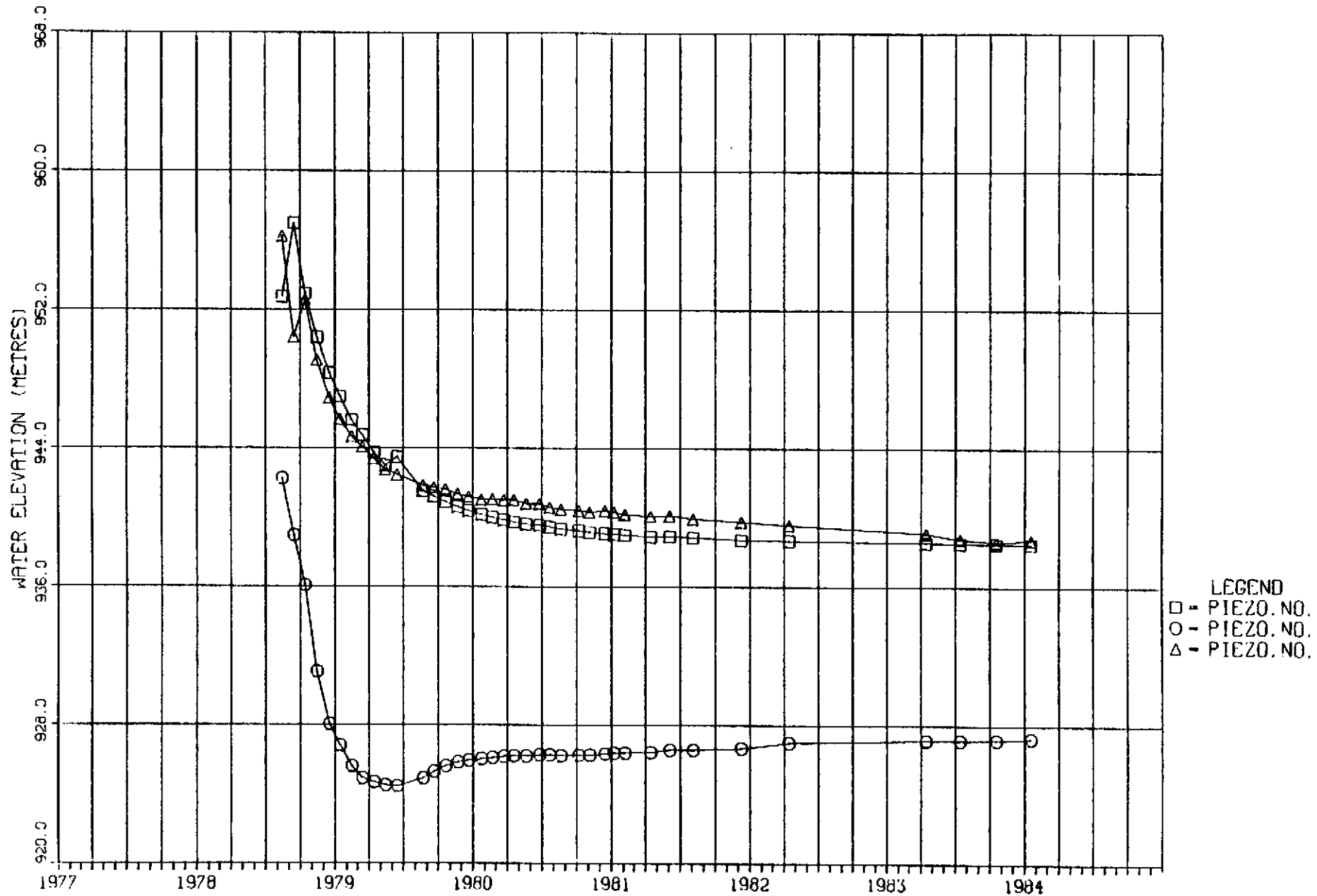
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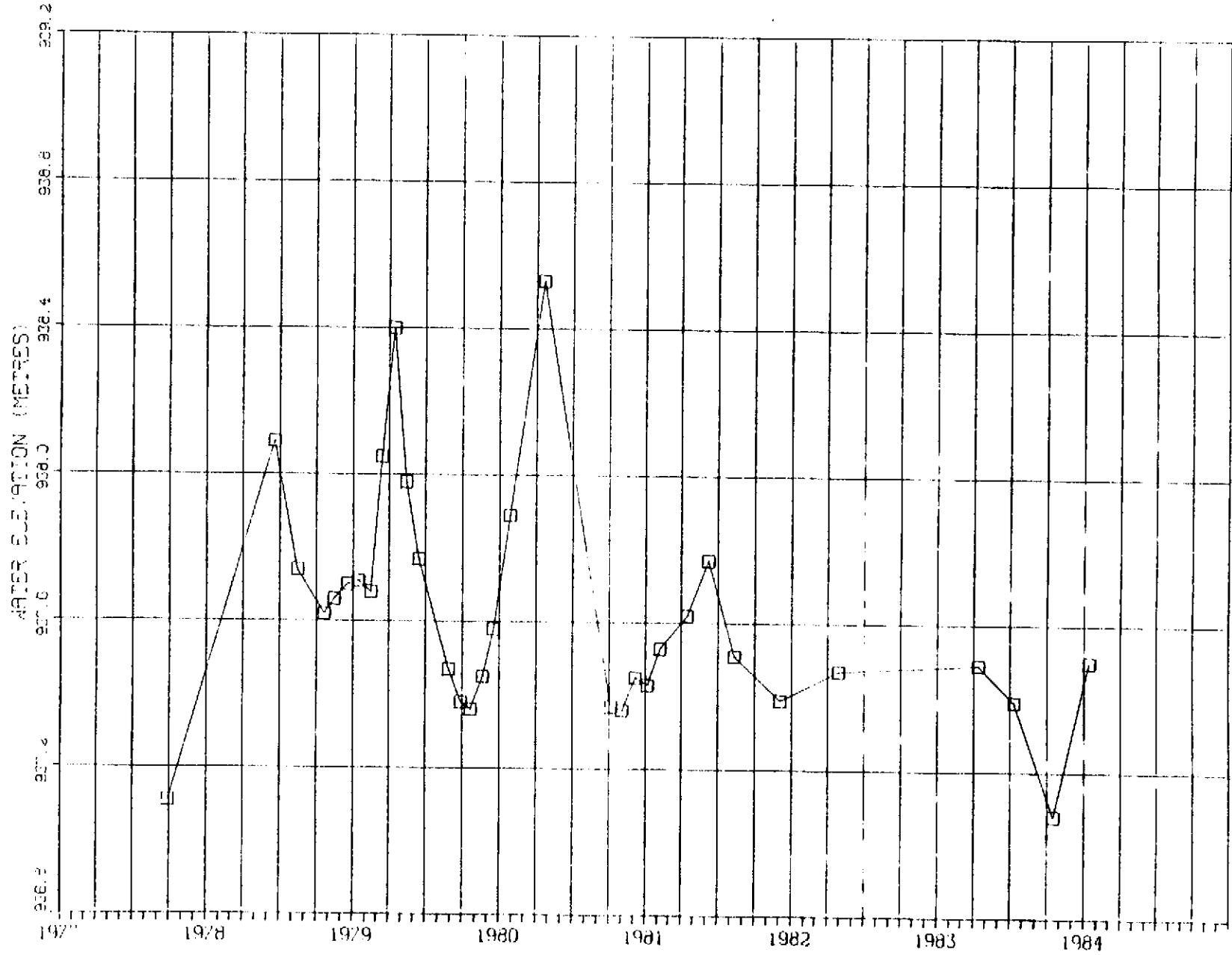
HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-870



HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. DDH-78-871

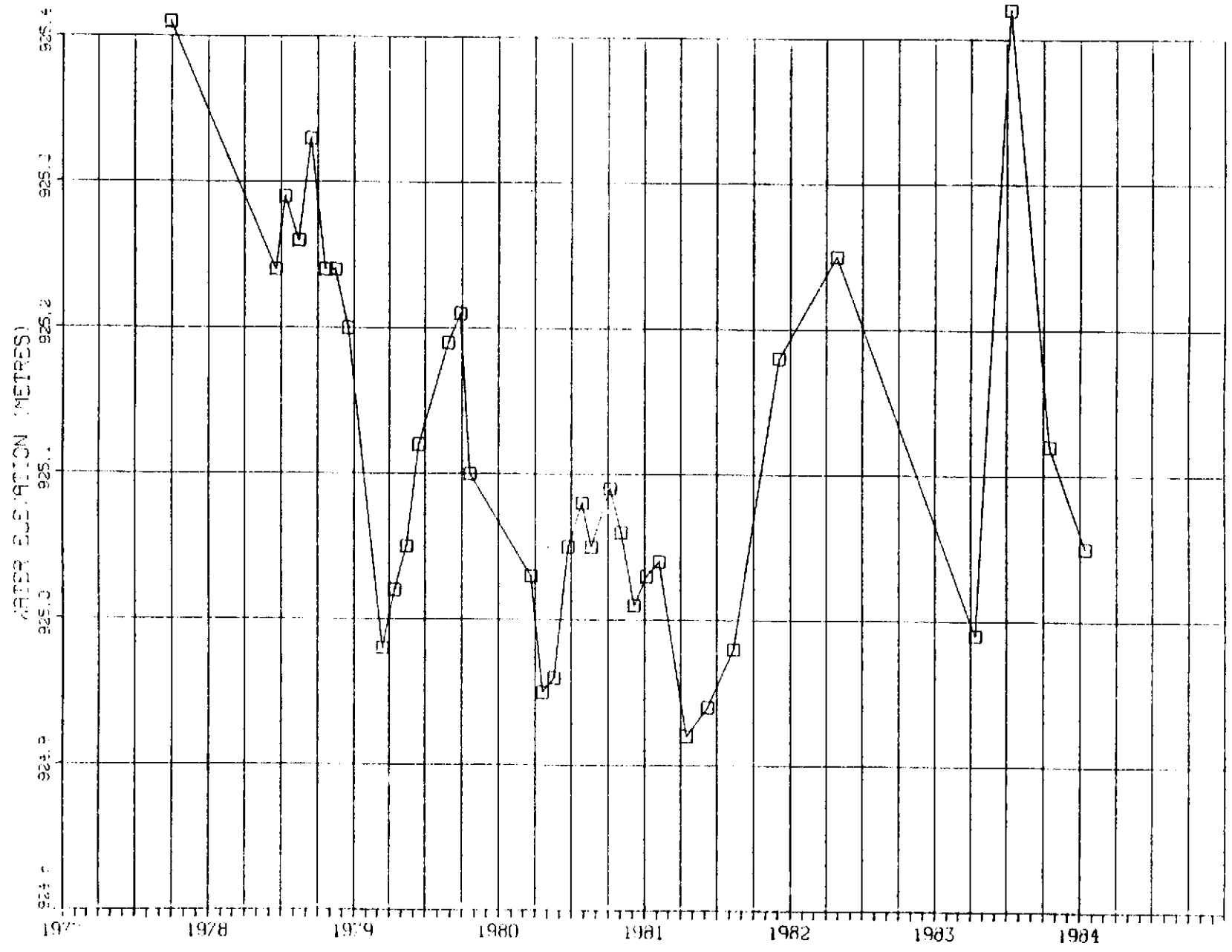


HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. P-77-50



LEGEND
□ - PIEZO. NO.

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. P-77-51



LEGEND
□ - PTEZO. NO.

HAT CREEK WATER LEVEL MONITORING - OBSERVATION WELL NO. P-77-61

