Mini-Report #9

BWIP GROUNDWATER LEVELS: WILL FURTHER STABILIZATION SIGNIFICANTLY REDUCE UNCERTAINTY

Basalt Waste Isolation Project
Subtask 2.5
Numerical Evaluation of Conceptual Models

Prepared by

Terra Therma, Inc.

for

Nuclear Waste Consultants

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TERRA THERMA, INC.

WATER CONSULTANTS AND ENGINEERS

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1.0 INTRODUCTION

1.1 GENERAL STATEMENT OF THE PROBLEM

Due to various hydrologic and other investigative activities at the BWIP site, such as drilling and testing, the groundwater system has been perturbed. In general, water levels have fallen in response to water produced during testing and drilling (although some increases have been noted due to fluid losses during drilling) (See TTI mini-reports #5 and 8 (TTI, 1986a and 1986b). The perturbations to date have complicated any effort to determine pre-emplacement gradients. However, because of ongoing investigations, it is unlikely that the BWIP groundwater system will remain "static" or be permitted to "fully" recover in the foreseeable future. Therefore, given the accuracy of water level measurement and conversion to heads, will further stabilization of water levels significantly improve the accuracy of heads used to calculate gradients?

1.2 RELEVANCE TO THE NRC

Since gradients are an intregral part of the groundwater travel time (GWTT) determination as required by Subpart E of 10 CFR Part 60, any analysis which explores the quality of gradient data is of fundamental relevance to the NRC.

1.3 RELATIONSHIP TO OTHER SITE CHARACTERIZATION/REGULATORY TASKS

Comments have been made by various contractors to NRC and YIN (Yakima Indian Nation) that in order to calculate pre-emplacement groundwater travel times, the groundwater system will have to be allowed to recover fully before gradients can be calculated. Since this recovery period could conceivably take years, requiring that drilling and testing be put on hold during this period, it seems that the NRC should determine the extent to which this recovery period would reduce any uncertainty in gradients calculated with data presently available.

2.0 OBJECTIVE

The objective of this mini-report is to determine whether further stabilization of groundwater levels will significantly reduce the uncertainty of heads used to calculate pre-emplacement groundwater travel time.

3.0 EVALUATION

3.1 OPERATIONAL APPROACH

In general, the approach of this analysis is to compare graphical extrapolations of all available water level data from three monitored horizons in two specific piezometers to the uncertainties of heads determined from both direct water level measurement and conversion of down-hole pressure. This comparison should provide information to determine whether extended periods of quiescences at the BWIP site will significantly reduce the present uncertainty in what might be considered baseline piezometric conditions.

3.2 TECHNICAL APPROACH

Hydrographs were constructed of data graphically taken from hydrographs provided by DOE (January 1985 - April 1986) and supplemented (January 1984 - December 1984) with hydrographs presented in YIN Task 6.a.1 - Hydrology Baseline (Lehman, 1986). The YIN hydrographs are computer plots of DOE data provided to YIN on magnetic tape. All data used from Lehman (1986) are uncorrected for barometric effects. Rather than use continuous data to determine trends, data for the first of each month was selected graphically. Generally, this data could be read to the nearest .1 to .05 feet, based on the median of the various natural fluctuations such as barometric and earth tide effects. After entry into a database system, data plots at the desired scale were computer generated (Figures 1 - 6).

Water level data from DC-19C and 20C (Rocky Coulee, Umtanum, and Cohassett) were plotted at a scale sufficient to graphically extrapolate any trends which are evident. Using a straight line extrapolation, water level changes per year were estimated. The estimates were then used to calculate what total changes might be expected between now and any particular time, for example, January 1, 1992, the Congressional deadline for the Geologic Repositories program. These two piezometers were selected on the basis of the reported high quality of this series of installations, and more importantly, the availability of the longest data record. The horizons were selected on the basis of data availability and proximity to proposed repository placement.

Two extrapolations were made for each curve, a "conservative" straight line which incorporates the steepest trend during the last 12 months of data, and a "best fit" straight line which extends a best fit curve to all recovery data. Since a linear extrapolation was used in both cases, both values should be conservative relative to the use of best fit curves.

The water level changes per year and the total change anticipated to January 1, 1992 were compared to the uncertainty in both water level measurement and head conversion from pressure.

4.0 ANALYSIS

Selection of water level data from the first of each month from January, 1984 to April, 1986 resulted in hydrographs presented in figures 1 - 6. Using the method described in section 3.2, values for change per year and total change to January 1, 1992 are presented in Table 1. In addition, values reported by DOE (DOE, 1985) for these same piezometers and horizons are also reported in Table 1.

4.1 HYDROGRAPHS

All hydrographs show considerable flattening after the initial impacts from drilling. In all cases, flattening becomes more pronounced during the latter half of 1985 and the beginning of 1986. However, DC-20C does show a response in March, 1986, which appears to dissipate back to the pre-response trend by April, 1986.

Of particular note in reviewing the six hydrographs is the similarity in the three graphs from DC-20C. The Rocky Coulee and Cohassett piezometers appear to respond and recover identically throughout the data period (1984-1986). The Umtanum piezometer responds similarly to the other two zones, but is consistently a foot higher in elevation. If the similarity of response is correct, then either the area around DC-20 is extremely leaky or the well completion does not fully isolate the various piezometers. This will have to be resolved as more information becomes available.

4.2 UNCERTAINTY

4.2.1 Water Level Measurement

TTI was unable to locate any published account of the precision assigned to DOE's direct water level measurement efforts. However, based on both experience and observation of the DOE's methodology, estimates of the precision can be made. The use of a steel tape by experienced individuals to measure water levels at the depths found at BWIP could have an expected accuracy of a few hundredths of a foot. Therefore, the error assigned to direct water level measurement might be on the order of .01 to .03 feet.

4.2.2 Down-hole Pressure Measurement

Down-hole measurements at BWIP have been the subject of much inspection and criticism. It is not clear what precision can be assigned to this group of measurements, primarily because of significant transducer drift and failure to perform to manufacturer technical specifications. The quality of this data-set, from the perspective of equipment uncertainty, remains unresolved at this time.

4.2.3 Heads

Since heads are used to calculate hydraulic gradients, the uncertainty of heads used is an important issue. TTI Mini-Report #6 (TTI, 1986c) assesses uncertainties in head due to water-density differences in the piezometer column. The conclusion of Mini-Report #6 is that the range of salinities at the BWIP site could result in an uncertainty of about 1 foot when using water surface measurements as formation head.

The uncertainty in using the down-hole pressure transducer data as formation head is not known. However, given the technical problems with the transducers and unknown density variations in the water column of each piezometer, the uncertainty is likely to be greater than 1 foot, based on the sum of the equipment/measurement uncertainty (which is unknown at this time) and the pressure to head conversion uncertainty (estimated to be about 1 foot).

If density differences varied consistently (naturally) between piezometers, an argument could be made that gradients calculated between piezometers would negate the uncertainty. However, because of various activities at the BWIP site, such as filling some piezometers with Columbia River water and airlift development of other piezometers, density variations between holes are not likely to be consistent. Additionally, natural variation in gas content and/or dissolved constituents might be sufficiently random to produce random density variations.

4.3 EXTRAPOLATIONS

Using methods described in section 3.2, linear extrapolations of water level data between January, 1984 and April, 1986 were made and the results are listed in Table 1.

TABLE 1: LINEAR EXTRAPOLATION OF WATER LEVEL CHANGES (Jan. 1984 - April 1986)
(TOTAL FEET (TOT FT) refers to total anticipated change to January 1, 1992)

WELL/AQUIFER	CONSERVATIVE		BEST FIT		DOE REPORTED FT/YR (1)	
	FT/YR	TOT FT	FT/YR	TOT FT	LINEAR	THEIS
DC-19						
ROCKY COULEE	.35	2.1	.10	.6	2.55	.10
UMTANUM	.20	1.2	.10	.6	1.56	.14
COHASSETT	.20	1.2	.075	.45	.76	.15
DC-20						
ROCKY COULEE	.65	3.9	.20	1.2	1.78	.32
UMTANUM	.65	3.9	.20	1.2	2.32	.43
COHASSETT	.65	3.9	.20	1.2	1.65	.30

1 (DOE, 1985) Changes (Ft/Yr) taken from DOE forecasts for 12/1/86 and 12/1/87.

The "best fit" columns of Table 1 suggest that the total projected change in present water levels are on the order of 1 foot for the two piezometers studied (between April, 1986 and January, 1992). The changes per year reported by DOE when the Theis curve is used are comparable, but slightly higher, to those of the "best fit" column. It should be noted, however, that the DOE projections were based on data available to December, 1985 and, therefore, reflect earlier times during the recovery period.

5.0 CONCLUSIONS

1. Comparison of total projected water level changes between April, 1986 and January, 1992 for the best fit straightline (approximately 1 ft) to known uncertainty in the water level measurements and head calculation (greater than 1 ft), suggest that further stabilization of the water levels will not provide any significant improvement in the quality of the data for gradient calculation. Therefore, for the purpose of establishing pre-emplacement gradients or at least considering a range of possible gradients for groundwater travel time calculations, existing water level data appear to be sufficient.

2. Hydrographs from various piezometers at the DC-20C site suggest that the area is either very leaky or the piezometer fails to isolate all zones.

6.0 DISCUSSION

During the upcoming Data Review at the Hanford site, it is anticipated that water level data from April, 1986 to the present will be made available. If no major perturbations have occurred between April and December, 1986, this data could be useful in verifying the linear extrapolations made in this mini-report. A short analysis of this data will be performed and will either be included as an addendum to this report or as separate mini-report.

As the data becomes available, review of water level data from other piezometers would also provide a check on the results of this mini-report. Establishing recovery trends spatially across the BWIP site might provide additional information regarding possible boundaries.

Since the DC-20C installation is considered to be a high quality piezometer nest, verification of the well completion is essential. It is recommended that this information be located and reviewed during the scheduled Data Review. Should the integrity of the well installation be demonstrated, the leaky nature of the basalt in the vicinity of DC-20C should be assessed.

7.0 REFERENCES CITED

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Lehman, L., 1986, Hydrology Baseline: Status Report: YIN Task 6.a.1

Terra Therma, Inc., 1986a, Analysis of Drilling Response at the Hanford Site: Theory: Mini-Report #5 prepared for Nuclear Waste Consultants.

Terra Therma, Inc., 1986b, Analysis of Drilling Response at the Hanford Site: Analysis: Mini-Report #8 prepared for Nuclear Waste Consultants.

Terra Therma, Inc., 1986c, Use of Hydraulic Head for Evaluating Groundwater Flow in a Variable Density System: A Simple Analytical Evaluation: Mini-Report #6 prepared for Nuclear Waste Consultants.

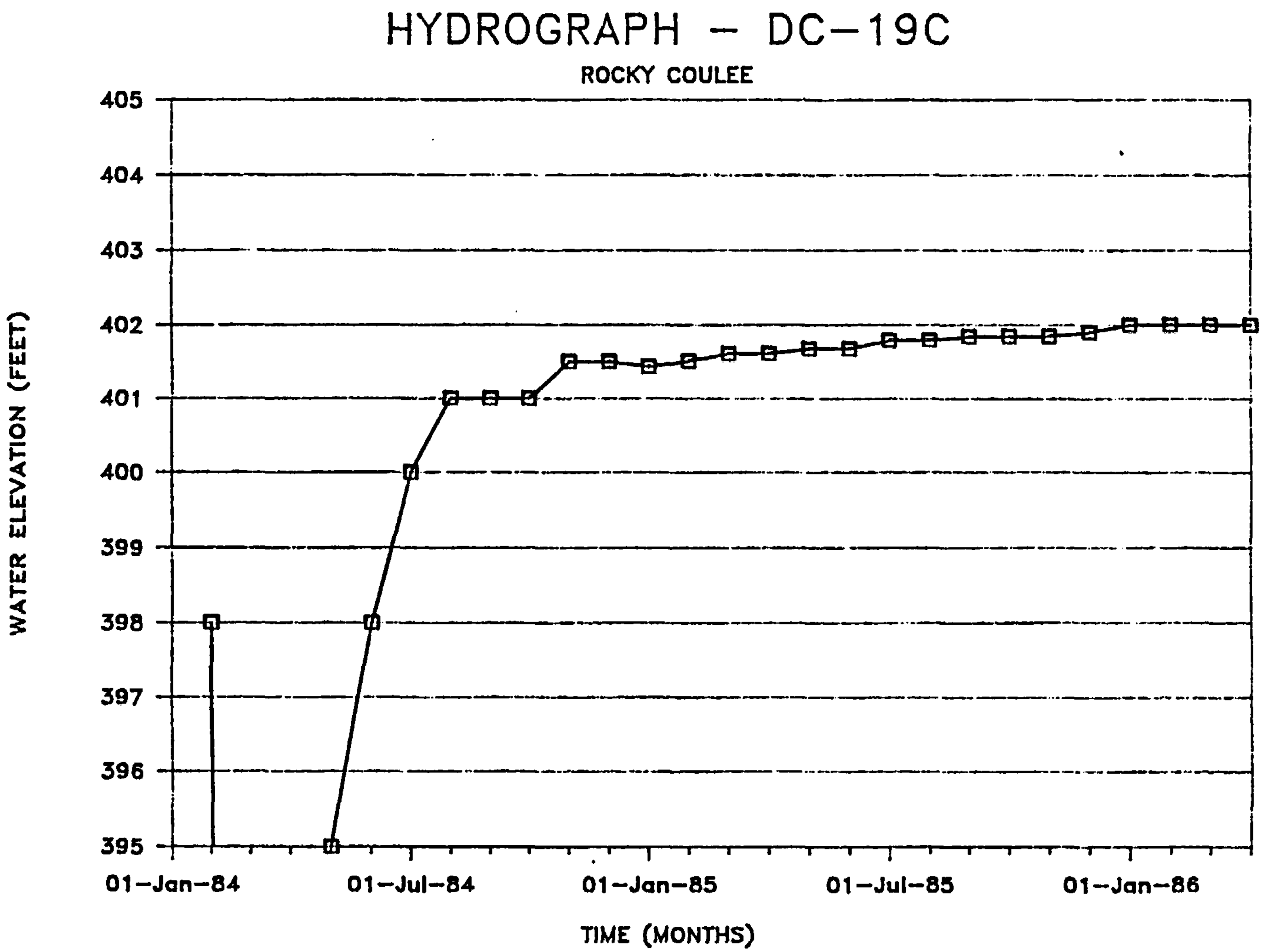

FIGURE 1. HYDROGRAPH - DC-19C - ROCKY COULEE

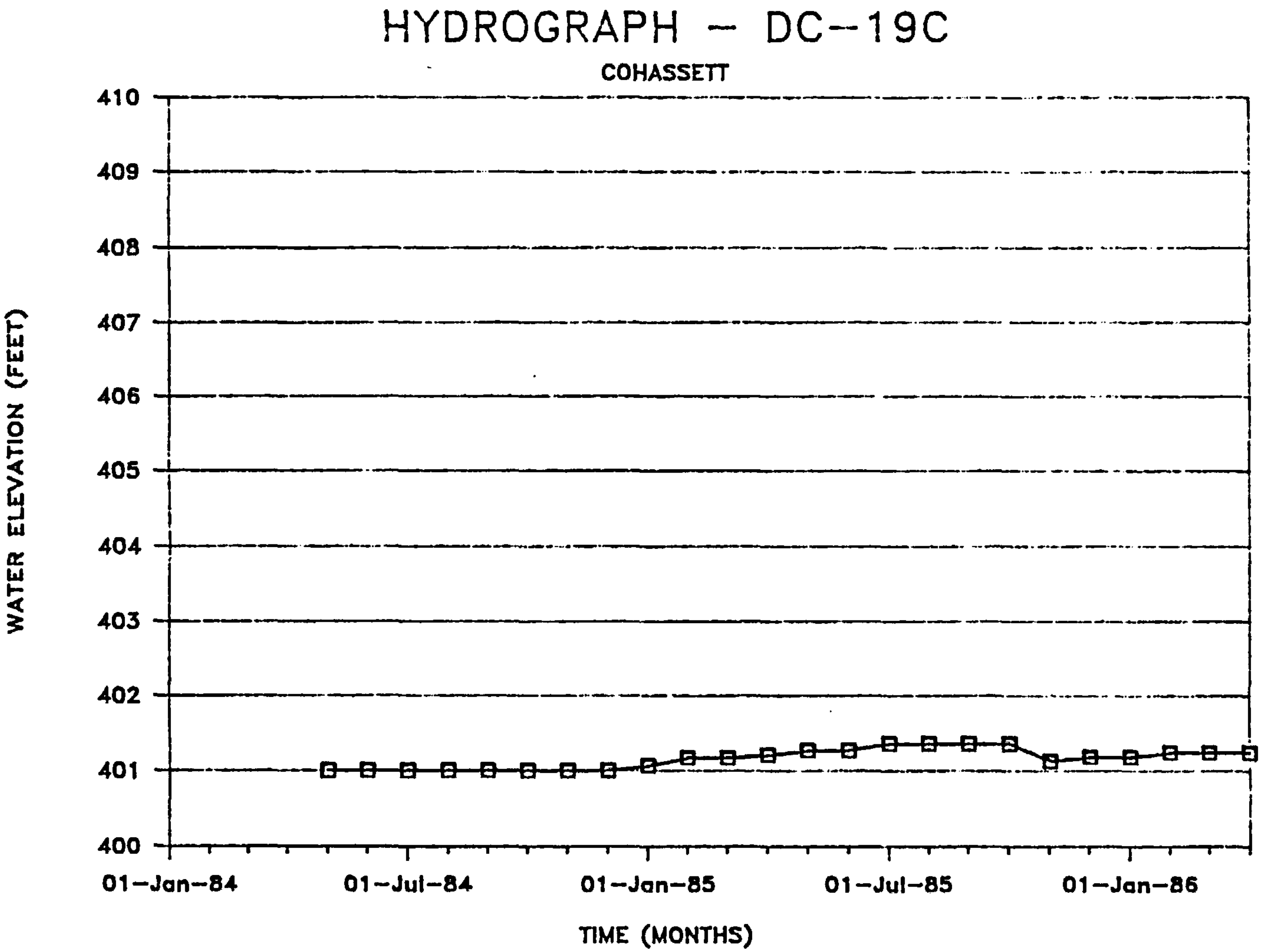

FIGURE 2. HYDROGRAPH - DC-19C - COHASSETT

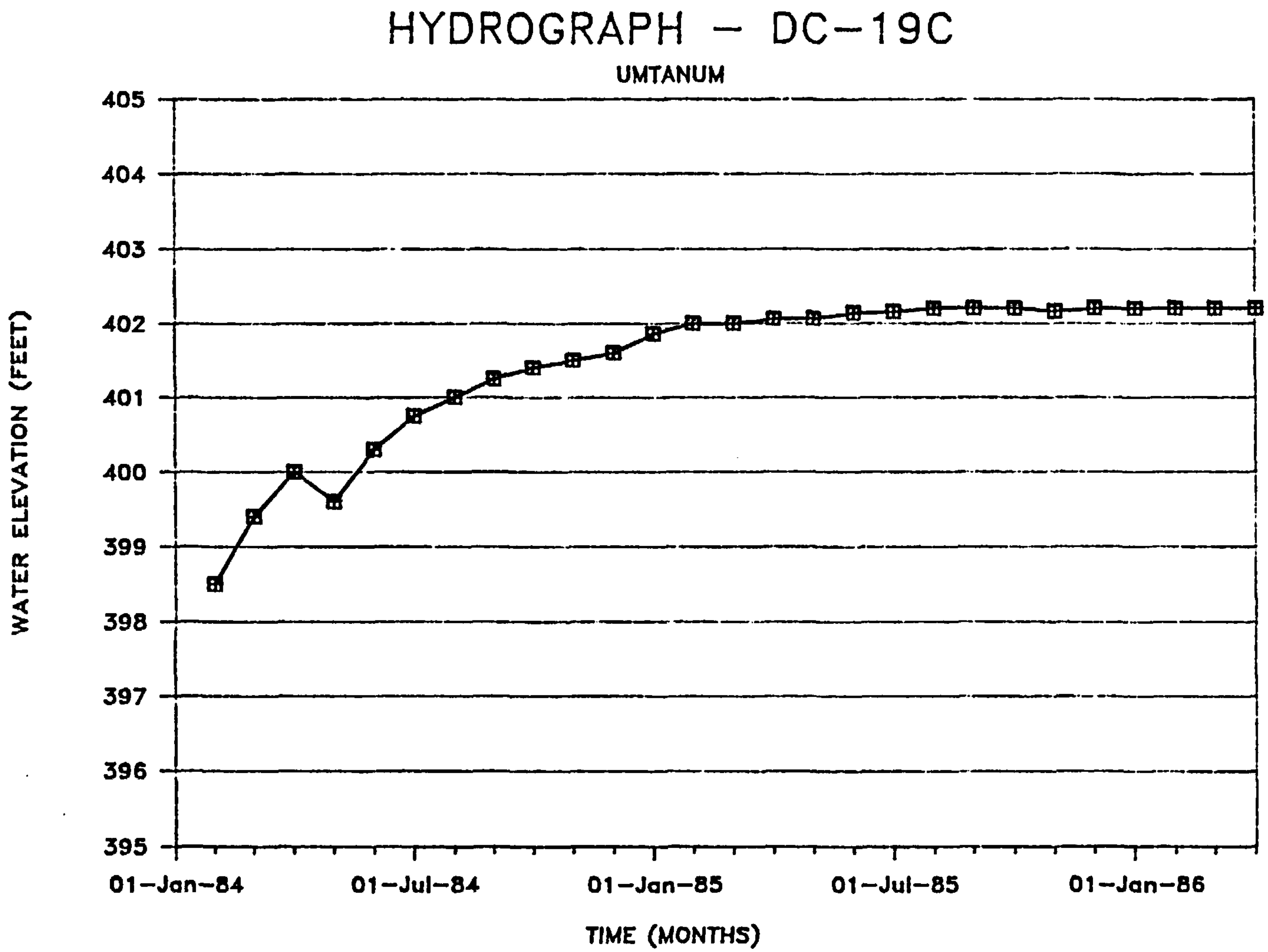

FIGURE 3. HYDROGRAPH - DC-19C - UMTANUM

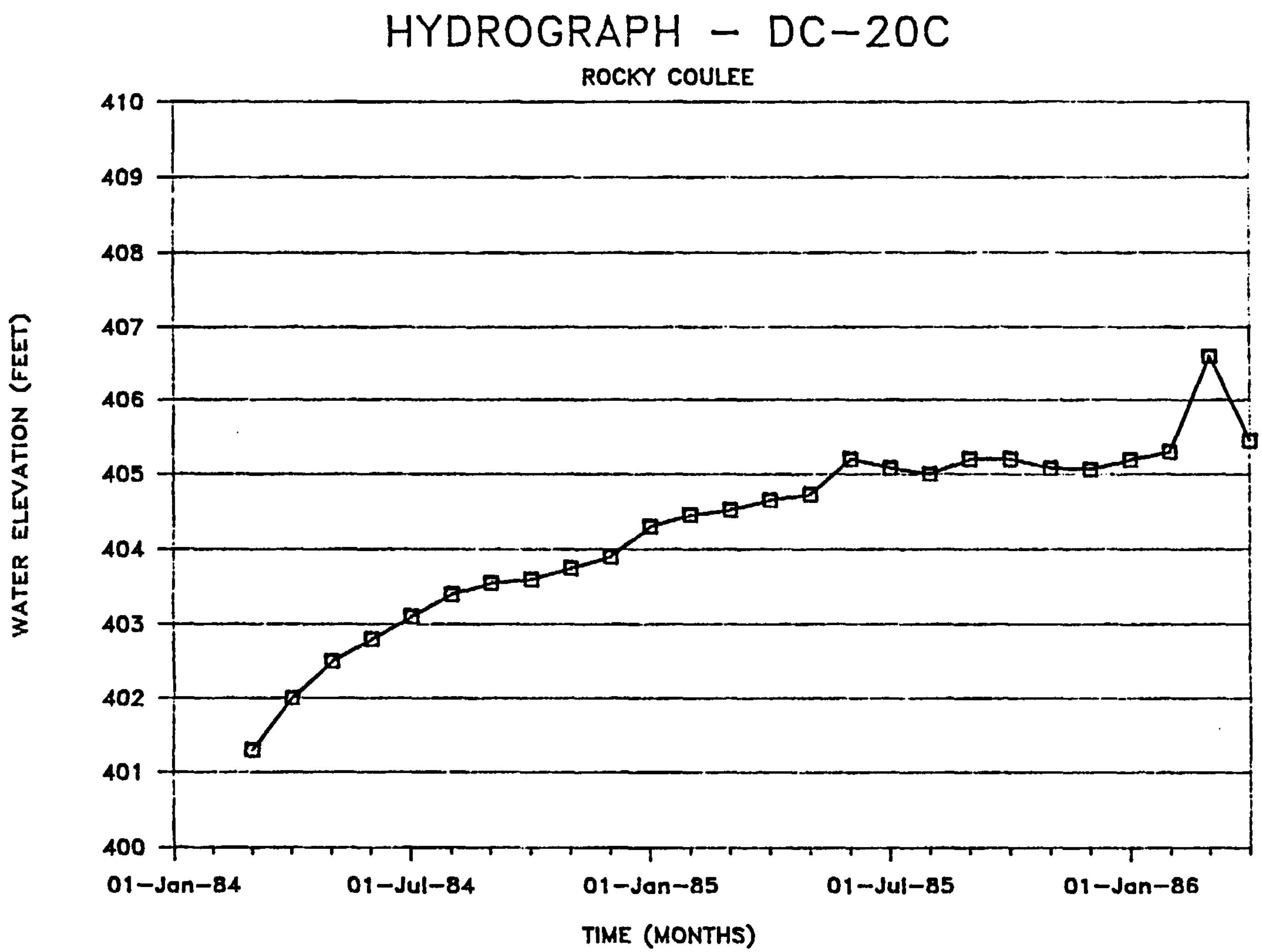

FIGURE 4. HYDROGRAPH - DC-20C - ROCKY COULEE

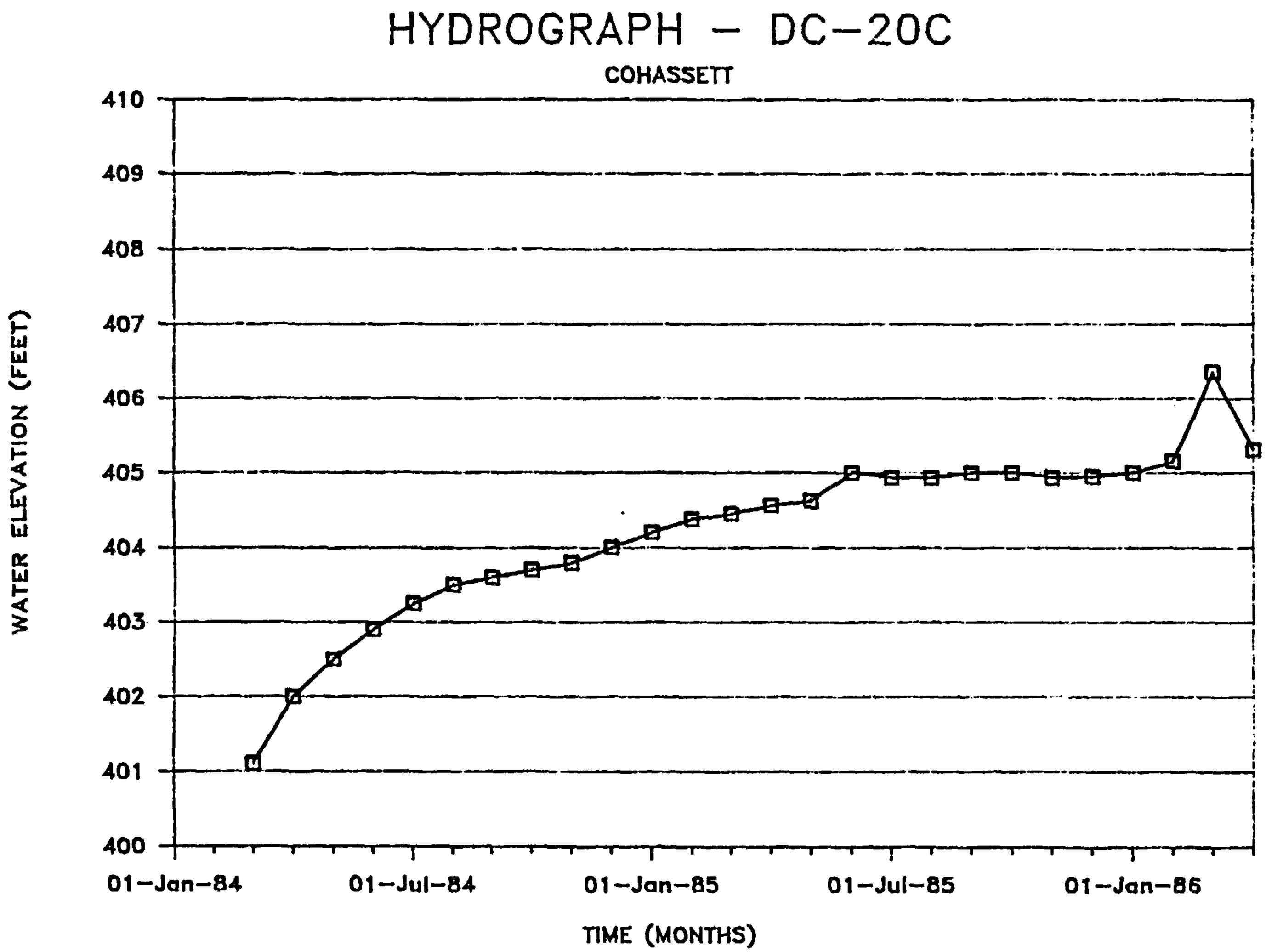

FIGURE 5. HYDROGRAPH - DC-20C - COHASSETT

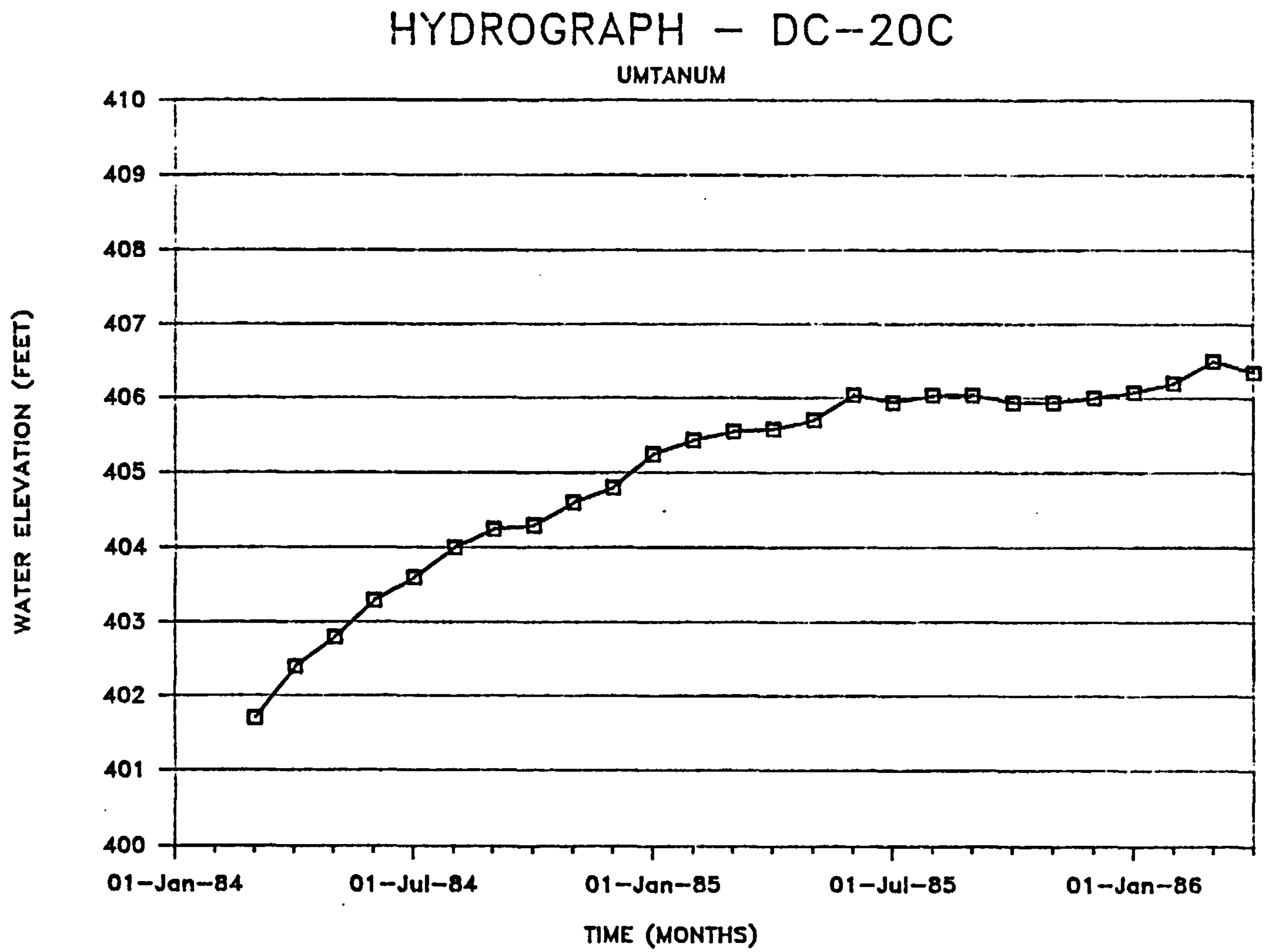

FIGURE 6. HYDROGRAPH - DC-20C - UMTANUM