IRISH - DUTCH RAISED BOG STUDY

GEOHYDROLOGY AND ECOLOGY

18

- National Parks and Wildlife Service of the Office of Public Works, Dublin
- Department of Nature Conservation, Environmental Protection and Wildlife Management, The Hague
- Geological Survey of Ireland, Dublin
- National Forest Service, Driebergen

HYDROLOGY OF CLARA AND RAHEENMORE BOG

CONSOLIDATION, EVAPOTRANSPIRATION, STORAGE COEFFICIENTS, ACROTELM TRANSMISSIVITY, PIEZOMETER TEST, GROUNDWATER dBASE, RETENTION

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Sketch of Clara Bog by Catherine O' Brien, Clara, County Offaly.

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PREFACE

Bogs and hydrology go together well. This is not necessarily so for bogs and hydrologists, but fortunately we both usually enjoyed working on the bog, although we sometimes had the feeling, especially when on Raheenmore, that even God had left the place.

In general, our five to six months in Ireland have been a great pleasure, for which we thank the people we lived and worked with: Jan Willem, Judy, Dan, Ethel, Malcolm, Els, Richard, Lara, Mary, Norbert, Margaret, Oscar and Brian, our supervisors and the people of Clara. We wish to thank especially our supervisor Sake v/d Schaaf for his dailly assistance, Dr. van Montfort for his great help with the statistic analyses and Oscar for his help with the interpretation of the augerings.

During our stay we got acquanted with the Irish way of living, with games like pool and snooker and with the traditional Irish sports: hurling and Gaelic football. It appeared to be quite hard to forget about all this back home, and once in a while we go for a pint or a Bailey's in the 'Vlaamsche Reus' and to talk about the good old days in Clara.

Over half a year after having been in Ireland, this report was finished. We thank everyone for their patience in waiting for our contribution to the Dutch-Irish peatland study.

Wageningen, August 1992.

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SUMMARY

To reconstruct the accumulation of the peat, drillings have been made along 3 transects on Raheenmore Bog and along 2 transectson Clara Bog. The drillings on Raheenmore Bog are positioned in transects crossing the centre of the bog, while the drillings on Clara Bog were placed to study the existence and the history of the mound. The peat has been sampled and a detailed log of the whole core was taken, noting changes in vegetation type, the degree of humification, colour and density of the peat. The crossections on Raheenmore show a typical, dome shaped bog in a basin that rises above the surrounding area with the highest densities at the edges. The hight of the bog is mainly due to a thick layer of White Sphagnum Peat.
With the distribution of organic matter collected from the undisturbed peat samples an attempt is made to make a reconstruction of the transects before consolidation due to drainage. Both bulk density and volumetric concentration of the whole core and per kind of peat were estimated, showing that it is most accurate to use the volumetric concentration per kind of peat. The volumetric concentration of undisturbed Sphagnum Peat is around 0.04 g/cm^3. This might be a good reference to look at the disturbance of other bogs and the possibilities of their conservation.
On Raheenmore the drillings were compared with drilling 330, while on Clara drilling 56 was used as reference. The results of Raheenmore show that the centre of the bog can't be taken as a reference, since the accumulation of the peat varies with the location on the bog. The influence of the main drain around Raheenmore is noticable up to about 100 m from the edge of the Bog. The amount of subsidence is hard to tell, but estimated to be 1.5 m at drilling 313, which is close to the edge.

Two important features for the water balance, the evapotranspiration and the storage coefficient were studied with the use of lysimeters. It concerned a total of 16 lysimeters placed on Raheenmore bog. The formation of the lysimeters was as follows:

Vegetation / Acrotelm	*Calluna vulgaris*	*Narthecium ossifragum*	*Eriophorum vaginatum*	*Sphagnum* spec.
Poor	1 , 2	3 , 5	4 , 6	7 , 8
Good	15 , 16	13 , 14	11 , 12	9 , 10

For the period may 1991 until december 1991 the evapotranspiration has been calculated (the results of the lysimeter study from december 1991 will be presented by Veldkamp & Westein). The results are compared with the measurements of the open pan evaporation at Derrygreenagh, a nearby meterological station and with the Penman evaporation determined at Birr and Mullingar weather station.
The evaporation measured at Derrygreenagh and the evapotranspiration measured with lysimeters show a good correlation. The total evaporation of the open pan was slightly higher

(398 mm versus 361 mm).
During the growing season the total evapotranspiration of the lysimeters was equal to the Penman evaporation. In October and November the actual evapotranspiration was 20 mm higher, so in the winter half-year the difference between Penman and actual evapo(transpi)ration may exceed 50 mm. There appeared to be no evapotranspiration reduction during periods of low phreatic level.
The different plant species showed significant variation in the evapotranspiration. *Sphagnum* showed a higher evapotranspiration, *Narthecium* a lower.
Significant difference in evapotranspiration due to acrotelm development could not be proved, not even under conditions of relatively low water tables.
Finally, it was demonstrated that the LAI and evapotranspiration were related for the *Eriophorum* lysimeters. This was not the case for the *Narthecium* ones.

The storage coefficient is determined in two ways: by measuring the water level and the corresponding weight, and by measuring the water level before and after removing water from or adding water to the lysimeters. There appeared to be no significant difference in storage coefficient between the two methods.
However there was significant difference in storage coefficient due to acrotelm development. Also the difference because of the height of the phreatic level was significant:

	water level	
	0–10 cm	10–20 cm
Good acrotelm	0.32	0.21
Bad acrotelm	0.27	0.14

One of the characteristics of living peat bog is that the water table is always in the acrotelm. The hydraulic conductivity of the acrotelm is much larger than of the underlying catotelm, and the conductivity of the acrotelm increases greatly towards the surface (Ingram and Bragg, 1984). Consequently the major part of the discharge takes place through the acrotelm. Therefore, the determination of the acrotelm–transmissivity is one of the aspects of this research.
The objective was to find a way to describe the transmissivity over the entire bog at any water level.
The transmissivity was measured with the Guinness method, on Raheenmore bog at the L and 600 grid lines, for four water levels. The vegetation cover around the holes as well as at all sites of acrotelm thickness measurement (by van't Hullenaar and ten Kate) was described by Larissa Kelly (a botanist).
A relation between vegetation cover, water level and transmissivity was determined. With these results, a correlation between acrotelm thickness and transmissivity was found.
The vegetation cover at the O.P.W. 100 m. grid was also described. It appeared that a clear relation between vegetation and acrotelm depth could not be found, except for very typical dry and wet vegetation types.
From a practical point of view it seems advisable to use acrotelm thickness as a measure to assess transmissivity parameters. Vegetation description may be used to evaluate the outcome of the acrotelm thickness mapping.

A piezometertest is performed to compare 3 different field methods of determining the hydraulic conductivity in a saturated soil (Falling-, Rising- and Constant Head Test) and the influence of the shape of the screen. In the test the perforation rate of the screen (10 % or 20 %), screen length (10 cm or 20 cm) and sealing (cork or ferrule) were taken into account. No significant influence of the perforation rate and sealing of the piezometer on the hydraulic conductivity could be found. The test did show a significant influence of the Test used and the Screen length. The variation in apparent hydraulic conductivity is much larger while using the Constant Head or the Rising Head than while using the Falling Head. The most accurate way of estimating the permeability is with a filter length of 10 cm, a tube sealed with a cork and with the Falling Head test.

In this report the analyzing of the monitoring data was started. First of all the files with the fixed data of the piezometers had to be reconsidered. Then a program was written to convert monitoring data to MOD-levels. Part of the conversion was carried out. Too little time was left to work on interpretation of the data.

1 INTRODUCTION

1.1 The project

This research took place as part of the Irish-Dutch Peatland Geohydrology and Ecology Study, a joined research project by the Irish and Dutch governments. This project is a multidisciplinairy study into the hydrology, geology and ecology of raised bogs focussing on the Nature Reserves Clara Bog and Raheenmore Bog, owned by the Irish Wildlife Service. The information gathered will enable the Wildlife Service to draw up appropriate management programmes for raised bogs and will help the Dutch government in their attempts to regenerate bog growth in the Netherlands.

The organisations taking part in this project are:
-Geological Survey of Ireland;
-Dutch Forestry Service;
-Irish Wildlife Service;
-Agricultural University of Wageningen;
-Imperial College London;
-Sligo Regional Technical College;
-Teagasc;
-Trinity College Dublin;
-University of Amsterdam;
-University College Galway.

Ireland is the only country apart from Russia which uses peat as an energy source (Moore, e.a. 1974). Raised bogs once covered an area of over 317,000 ha. of the land surface of Ireland. As a result of turfcutting, drainage and afforestation only 21,000 ha. or 7 % of the original area is now suitable for conservation. All domed mires on the iseland have suffered some degree of drainage and excavation at their margins.

Bogs are physically unique geological deposits because water is forming about 90% of their volume. Therefore they are sensitive to the amount and quality of the water available. There are many reasons for conserving peatlands; they are essential parts of the biosphere and habitats for plants and animals which are adapted to the poor, waterlogged and exposed conditions. Also they are reservoirs of genetic resources and records of climate and human history of the last 10,000 years.

1.2 Description of the sites

The iseland consists of a large central lowland of limestone, surrounded by mountains along the coast of varying geological structures. The Central Plain, which is broken in places with low hills, is extensively covered with glacial deposits of clay and sand. Series of east-west trending eskers cross the region of County Offaly. Raised bogs, varying in size from a couple of acres to a few square miles, occur in the Central Plain in areas of impeded drainage while mountain bogs are common in western areas with heavy rainfall.

Clara Bog

Clara Bog is an internationally important raised bog, situated in Co. Offaly at the Central Plain of the Irish Midlands. It is located 2 km. south of Clara town on either side of the road to Rahan. The bog lies in between the River Brosna to the north and the Silver River to the south, and is bounded on the northern side by the esker Riada and to the south by a cut-away bog. With an area of 665 ha. it is one of the largest remaining Midland raised bogs and it is the only raised bog in Ireland that has a well developped soak system, consisting of series of lakes interconnected by natural drains. In addition it has also a well developed hummock and hollow system.

Since 1983 the eastern side has been badly affected by a network of drains, installed by Bord na Mona, who aquired it for peat excavation. In 1987 the government comitted itself to conserving this bog and in 1987 declared it as a National Nature Reserve. The edge of the south-west area of the bog though is still under private ownership and is being actively cut for use as fuel. Also the north-south running road has (had) a great effect on the hydrology of the bog. From the road several abandoned, limestone-based tracks lead onto the bog. These were probably built during the famines of the 19th century.

Raheenmore Bog

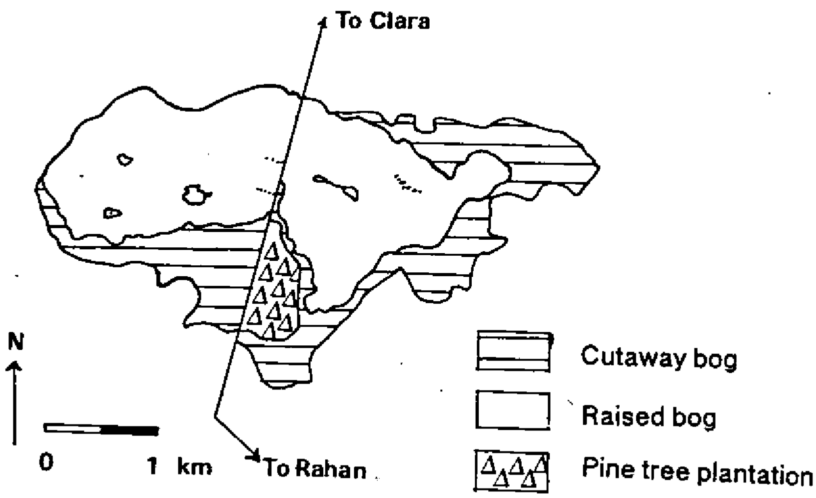
Raheenmore Bog is one of the best examples of a raised bog in a basin situation, also situated in Co. Offaly on the Central Plain of the Irish Midlands. It is much smaller than Clara Bog (213 ha.) and located 4 km. south of Tyrrelspass. The depth of the peat is exceptional, being over 15 m in places. There are no pools, but it has well-developed hummocks and hollows. The bog is surrounded by a deep drain and on the surface of the bog, on the eastern side, some old drains are present. There are a few cut-a-way areas at the edges, but actual turf cutting has stopped.

1.3 The report

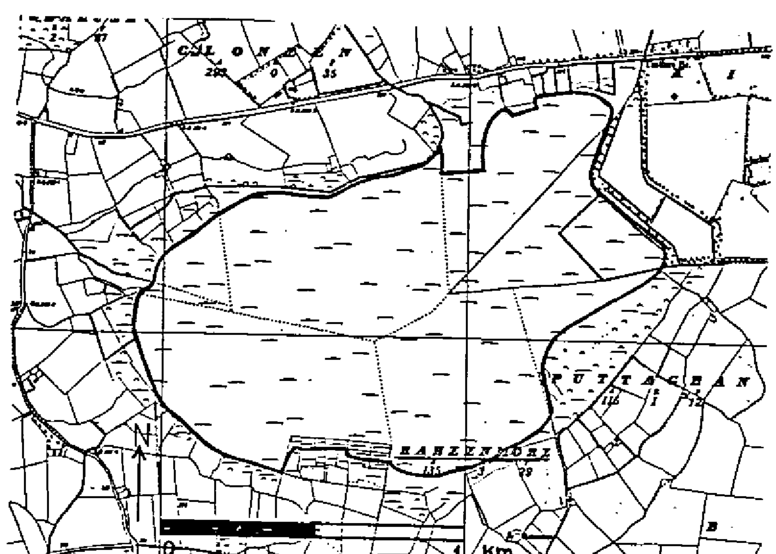
This research aims to assess the quantative elements of the waterbalance: the evapotranspiration, the precipitation, the storage coefficient, the hydraulic conductivity and the discharge. Furthermore it studies the impact of the artificial drains on the bog. The impact of the drains is examined by drilling and sampling the peat. This way the changes in vegetation type, the degree of humification, colour and density of the peat could be assessed.

During five months of fieldwork all the data needed have been collected. Analysis of the data and writing this report also took five months.

In Chapter 2 a description of the transects drilled on Clara and Raheenmore Bog is given. An attempt is made to make a reconstruction of the surface level before consolidation due to drainage. Two important features of the waterbalance, the evapotranspiration and the storage coefficient are studied with the use of lysimeters. The results are in respectively Chapter 3 and Chapter 4. The major part of the discharge takes place through the acrotelm. Chapter 5 includes the estimation of the acrotelm-transmissivity. The piezometertest to find the most appropriate test and materials to estimate the hydraulic conductivity, is described in Chapter 6. In the last chapter, Chapter 7, the organisation of the ground water dBase is discussed.



CLARA BOG



RAHEENMORE BOG

2. STRATIGRAPHICAL DESCRIPTION AND RECONSTRUCTION

In this chapter drillings on Raheenmore and Clara are discussed and a description of the transects is given. An attempt is made to make a reconstruction of the transects before consolidation due to drainage.

2.1. Introduction

Peat is the accumulated remains of partly decomposed dead plants, preserving , with distortion, the history of a peat-forming system. Different plants decay at different rates so it is not in general possible to reconstruct the vegetation history in detail, but major changes from for example Reed (Phragmites) to Bog Moss (Sphagnum) are of value as indicators of a change in the nature of the peat-forming vegetation.
Climatic change is of prime importance for the changes in vegetation, but is not the only factor the development of mires is dependent on. Many internal and external factors (like local conditions, the topography, mineral status and hydrology) determine the evolution of a mire.

The main types of peatland found in Ireland are:
-Blanket Bogs in
:Low land (occuring mainly in the west of the country)
:High land
-Raised Bogs (mainly found in the centre of the iseland)
-Fens (most fens are to be found in the raised bogs zones but some isolated examples occur elsewhere throughout the country.)
-Valley Bogs (along the rivers)

2.2 The formation of raised bogs

Some 10.000 years ago the last glaciation had ended and the glaciers had retreated northwards. Much of central Ireland was covered with shallow lakes left behind by the melting ice or formed where glacial ridges, such as eskers, impeded free drainage and trapped the water. This was the environment where raised bog formation could start.

Raised bogs form in open water (lake filling) or by swamping (paludification) wherever the ground is moist enough throughout the year. In shallow lakes the process starts with the deposition of inorganic sediment, generally silts and clays (see Figure 2.1).
These lakes were fed with mineral-rich groundwater and springs. On the bottom of the lake debris of floating plant material accumulated, while the shores overgrew with a fen-bed, existing mainly of rooted floating leaf aquatics (waterlillies), bulrushes and other members of the open reed swamp community. As these plants died their remains fell into the water, decomposed only partly because of the anaerobic conditions and collected as peat on the bottom of the lake (the reotrophic stage) (Hobbs, 1986).

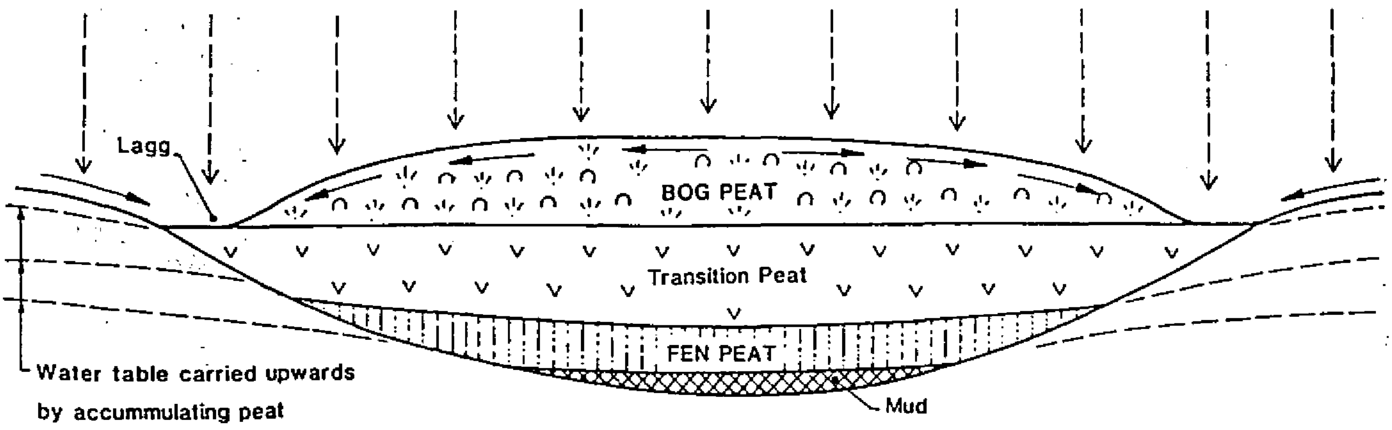


Figure 2.1 Raised bog confined in a deep basin.

Through accumulation of the plant material the lake got shallower and an environment developed where sedges could grow and later on even alder and birch. Once a lake was overgrown the influence of eutrophic water gradually declined because the roots of the plants could not get in contact with the mineral-rich groundwater anymore and a mesotrophic environment developed (the transitional stage). As a result plants invaded that were able to grow in the mineral-poor habitat, such as Sphagnum, which made the ground even more acid, by its ion exchange activity. Sphagnum is very important for sustaining the bog, drawing up water and keeping the surface wet and waterlogged, in all but the driest periods. In time the plants became solely dependent on the nutrient-poor meteoric/atmospheric water (the ombrotrophic stage) and plants typical of raised bogs, such as Heather, Sundews and Deer Sedge invaded the tops of the Sphagnum hummocks, completing the invasion of bog species.

Accumulation of peat at the margins of the bog is much slower than at the centre, because nutrient-rich seepage water encourages rapid decomposition of the dead vegetation (Hobbs, 1986). As a result the bog will be confined by a mesotrophic fen vegetation: the lagg zone, and have a convex surface raising above its surroundings.

2.3 Description of the distinguished layers

Fen Peat is the peat containing layers of reed, sedges and trees, accumulated under eutrophic conditions.

The Sphagnum peat can roughly be divided into two parts: the Older, Black Sphagnum Peat (or Transition Peat) and the Younger White Spagnum Peat (or Bog Peat).
The Black Sphagnum Peat is a highly humified peat consisting out of Sphagna and many roots and twigs from plants like Heather. It originates from a relatively drier and warmer climate that occured some 4500 years ago in Ireland. This caused the bog surface to dry and weather without further peat growth or at least at a much slower rate than during the formation of the white peat. This influence though can be much modified and camouflaged or changed by local conditions of various origin.

The Grenzhorizont is the transition between the older, stronger humified Sphagnum peat and the very slightly humified, ombrogenous Sphagnum peat.

The Younger White Peat also consists of Sphagna, but with less twigs and roots. The peat is poorly humified due to a wetter and colder climate and accumulated under ombrotrophic conditions.

2.4 Methods and materials

A special auger (Eykelkamp) was used to sample the peat. The drill consists of a sampling body, with a solid brass auger head and a cover fin. While pushing the auger into the soil the sampling body was kept empty by the auger head and the cover fin. At the desired sampling depth the body was filled and closed at the same time by turning the auger half a circle; the cover fin kept the body at the same place. Once back at the surface the sampling body was turned back again and a non-disturbed sample taken. The sample may be assumed to be saturated if it was not markedly disturbed by fibres.

A detailed log of the whole core was taken, noting humification degree, colour and vegetation type of the peat. Humification degree and colour were assessed using the "Von Post and Granlund Index" and "Munsell's standard soil colour charts" respectivly. The criteria for assessing the humification degree include the colour of the water released when the peat is squeezed in the hand, and the proportion and the character of the material which remains in the hand after squeezing the peat. These techniques are still comparatively crude, but used, in a relative way, give useful insights into some of the processes of peat formation. Drilling stopped once the clay was reached or earlier if an impenetrable layer was encountered.

From approximately every 50 cm a peat sample of 5 cm was taken and stored in a closed box immediately. The inside diameter of the sampling body being 4.68 cm the volume of the sample is about 43 cm^3. The saturated samples collected with the peat auger were weighed in the boxes and dried in an oven at 105°C until the weight is constant and all the water is evaporated. This takes about 24-36 hours for a 43 cm^3 sample. The dried sample is weighed again as wel as the empty box. This gives the weight of organic matter in the sample. The weight of the water in the sample is calculated by subtracting the weight of the organic matter from the total weight before drying.

The characteristics to classify peat used in this study are:
-Botanical composition;
-Humification degree;
-Density (dry matter mass per unit volume of peat);
-Volumetric concentration (dry matter mass per calculated volume of peat);
-Water content;
-Colour;

2.5 Results of the drillings

The vertical scale of the crosssections is 1:200, while the horizontal scale is 1:10,000, unless stated different.

2.5.1 Profiles Raheenmore

On Raheenmore drilling has been carried out along two transects, perpendicular to each other, and one extra transect 206* (see Figure 2.2). The first two transects aimed to give a description of the history of the bog and the influence of the main drain around the bog. With the extra crossection an attempt is made to study the impact of the smaller drains across the bog.

Figure 2.3 and 2.4 show the present-day peat crosssections along the E-W and the N-S Transect on Raheenmore, with a corresponding drilling number 330. The clay hasn't been reached in all places because of an impenetrable layer (numbers 201 and 313) or tree roots (330 and 327). From the figures it can be seen that Raheenmore Bog is a perfect example of a single dome shaped raised bog; it is a cupola positioned in a basin and rising above the surrounding area. The figures show the main three layers of the bog:

The thickness of the Fen Peat ranges from about 1 - 3 m with no clear connection between clay level and thickness. The Fen Peat was not totally penetrated in the centre of the bog. The thickness of the Black Sphagnum Peat ranges from 0.40 m at the sides of the bog to 4.30 m in the centre. The picture shows a relatively flat surface level of the Black Peat in the centre of the bog. Fen Peat and Black Sphagnum Peat follow the contours of the underlying mineral soil. This does not correspond with the theory, in which the top of the different layers are all very smooth (see figure 2.1). In figure 2.3 and 2.4 Fen Peat (at the sides) and Black Sphagnum Peat (in the centre of the bog) should then have been growing at the same time. This is not very plausible; a eutrophic vegetation growing at the sides and a mesotrophic vegetation in the centre of the bog. The present shape of Fen and Black Peat might be due to quagmire growing in from the shores, filling the lake surface, but leaving water underneath the peat. When Sphagnum Peat grows on the Fen Peat it pushes the peat down, until the floating peat bed 'stands' on the bottom of the lake. Defining the age of the peat might give more insight in the accumulation history of the peat.
The White Sphagnum Peat shows a clear dome that rises above the surrounding surface. The thickness varies from 1.60 at the edges to 7.25 in the centre of the dome. Due to drainage all around the bog, no lagg-zone is evident.

The existence of Sphagnum Cuspidatum at different depths in the White Sphagnum peat (see Appendix 2.3) can be explained by two theories. The first is the formerly held view of a cyclic evolution of hummocks and hollows in which the hollows are gradually replaced by hummocks and vice versa (Dooge, 1972 in Gore, 1983). This theory is replaced by the idea of a climate that oscillated (Gore, 1983). During the active growth of the bog, the topographical position of hummocks and ponds remains constant.

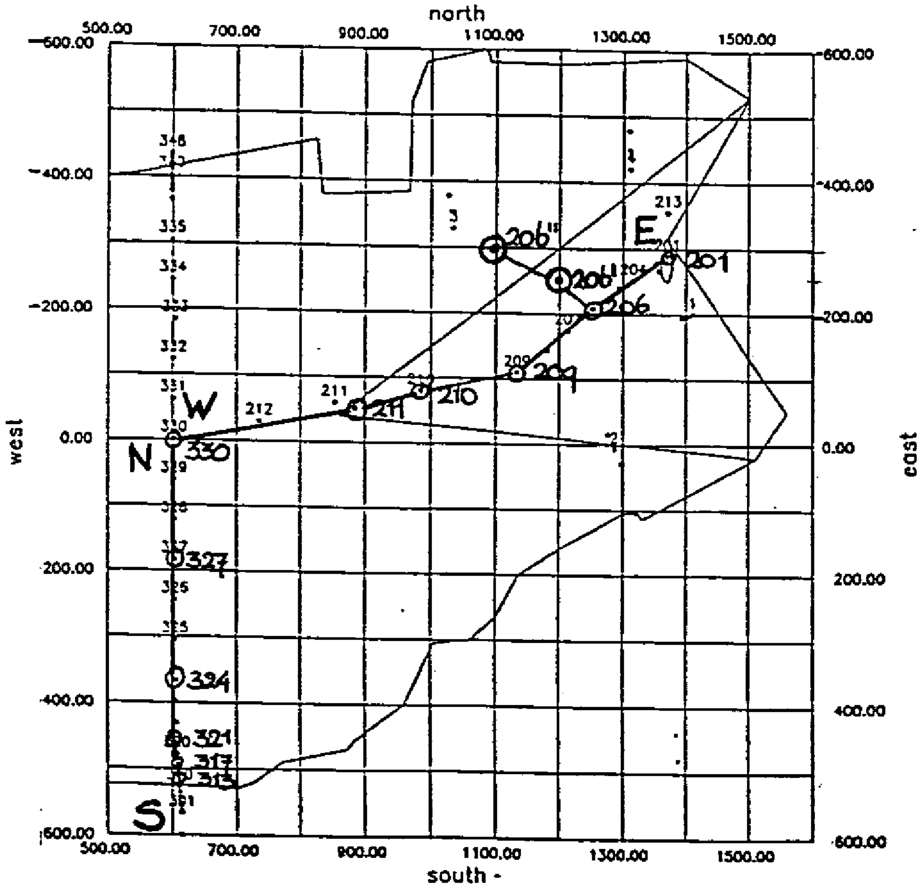


Figure 2.2 Raheenmore, N–S and E–W transect

The humification degrees of the reedpeat are very low (see Appendix 2.3), due to a misinterpretation of the H–scale; instead of the peat matrix, the reedplants themselves were used to assess the degree of decomposition. Still they are usefull for comparison in this study.

Transect 206 appeared to be placed over a mound in the mineral subsoil (see Figure 2.5), which makes this transect not reliable for estimating the influence of the drains.

2.5.2 Profiles Clara

The aim of the drillings done at Clara Bog is to study the existence and the history of the mound (see Figure 2.6). The profiles in figure 2.7 and 2.8 both start of at the mound, one of them ending near the soak–lake.

The profiles show the peat mound arises because of a mound in the underlying mineral soil. The surface of the Fen Peat is smoother compared with Raheenmore, ranging from 2.2 – 3.3 m, following the contours of the underlying clay.
On top of the mound only a small layer of Black Sphagnum Peat is found (0.25 m). The Mound Transect consists of a thick layer of Black Peat rising to a thickness of 4.15 m at drilling 59. This in contrast with the Soak Transect, where the thickness rises up to 2.3 m.
No White Sphagnum is found on top of the mound, so maybe since the drier and warmer climate 4500 years ago, the mound has not been wet enough to let the peat start growing again. Or it has either been removed or oxidised. The Soak Transect shows a thicker layer of White Peat (ranging up to 4.15) than the Mound Transect, where the thickest layer is 1.2 m.

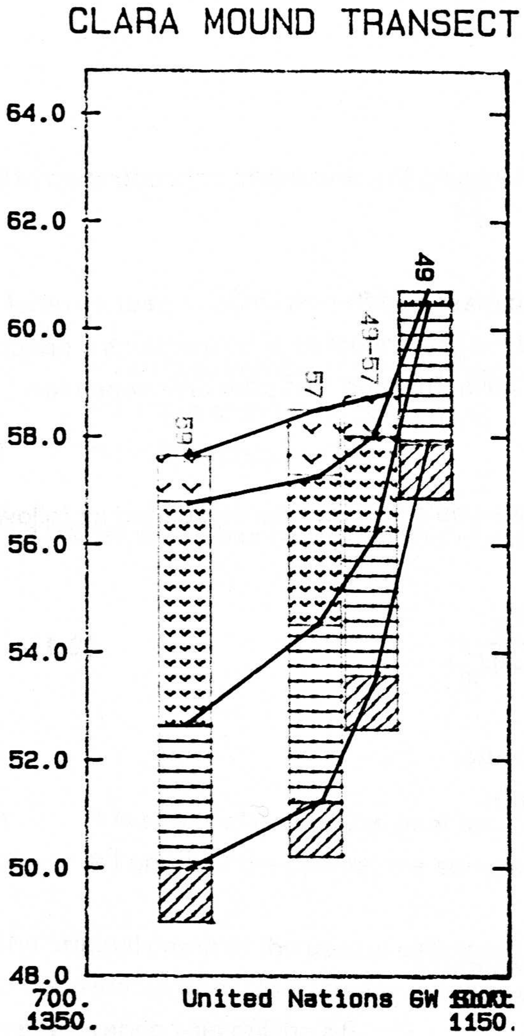


Figure 2.8 Mound Transect Clara

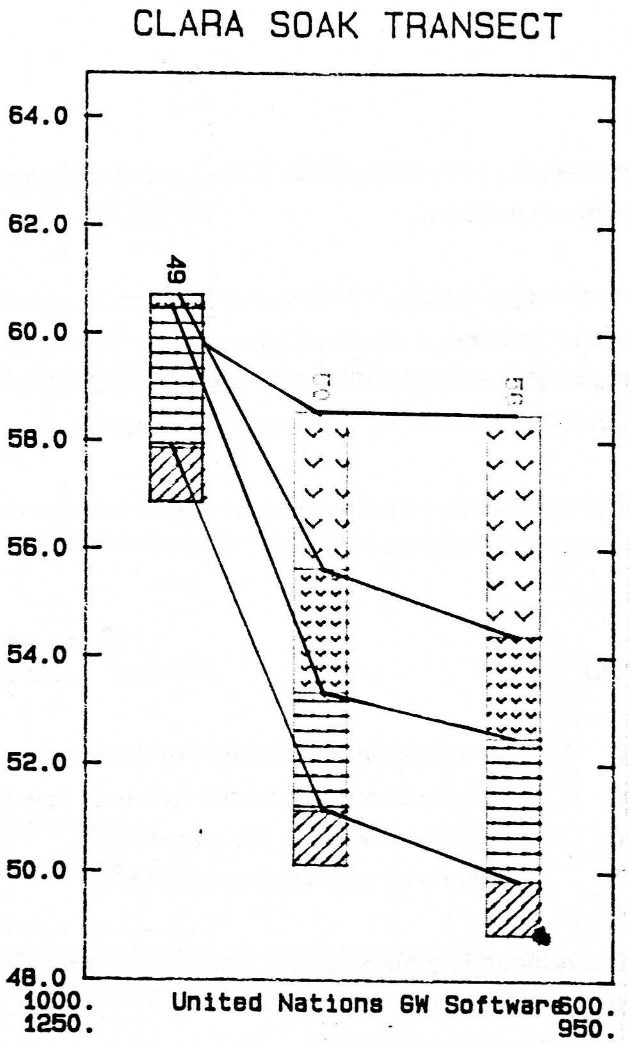


Figure 2.7 Soak Transect Clara

2.6. Consolidation of the peat

2.6.1 Theory

Data collected from the undisturbed peat samples show the distribution of the organic matter along a vertical profile. Comparing the distribution of the organic matter along a consolidated profile with the distribution along a unconsolidated profile can give a rough idea of the subsidence of the bog surface. The assumptions made with this estimation are:
-The accumulation of the peat is the same all over the bog.
-The change in total amount of organic matter in the profile with time is negligible.
-The volume of the sample taken is exactly 43 cm^3.

Density and volumetric concentration of the peat can be easily determined as explained in methods and materials. The sampling however doesn't result in a precise volume of the peat; the cutting of the core can not be done very accurately. Errors can be made when measuring the sample with a ruler. Also the cutting resistance of the peat can cause a considerable compression of the peat, especially when it is fibrous material. This affects, amongst others, the water content and the volume of the peat. A higher accuracy in determining the volumetric concentration of organic matter would be attained if the volume of the sample would be irrelevant in the calculation. This can be achieved by using the volumetric concentration of the organic material.

Acording to Galvin (1976) the difference in specific mass in different kinds of peat material in Irish raised bogs is extremely small. For young and old Spaghnum peat he mentions a specific mass of 1.36 kg/dm^3. Almost the same values are given for reed-fen peat and woody fen peat: 1.38 and 1.36-1.38 kg/dm^3 respectivily.

The volumetric concentration of organic matter in a sample can then be calculated as follows:

$$C_o = \frac{V_o}{V_o + V_w} \tag{2.1}$$

C_0 = volumetric concentration of the organic matter
V_0 = volume of organic matter in the sample (m^3).
V_w = volume of water in the sample (m^3).
V_{0+w} = volume of saturated sample (m^3).

The relation between volume, specific gravity and weight is :

$$V = \frac{W}{\rho} \tag{2.2}$$

where
V = volume (m^3)
W = weight (kg)
ρ = specific gravity (kg/m^3)

Substitution of V in equation 2.1 using equation 2.2 yields:

$$C_o = \frac{\rho_w W_o}{\rho_w W_o + \rho_o W_w} \tag{2.3}$$

where the subscripts o and w refer to the organic matter and the water in the sample respectivly.

The average volumetric concentration of organic matter in a full column is described by:

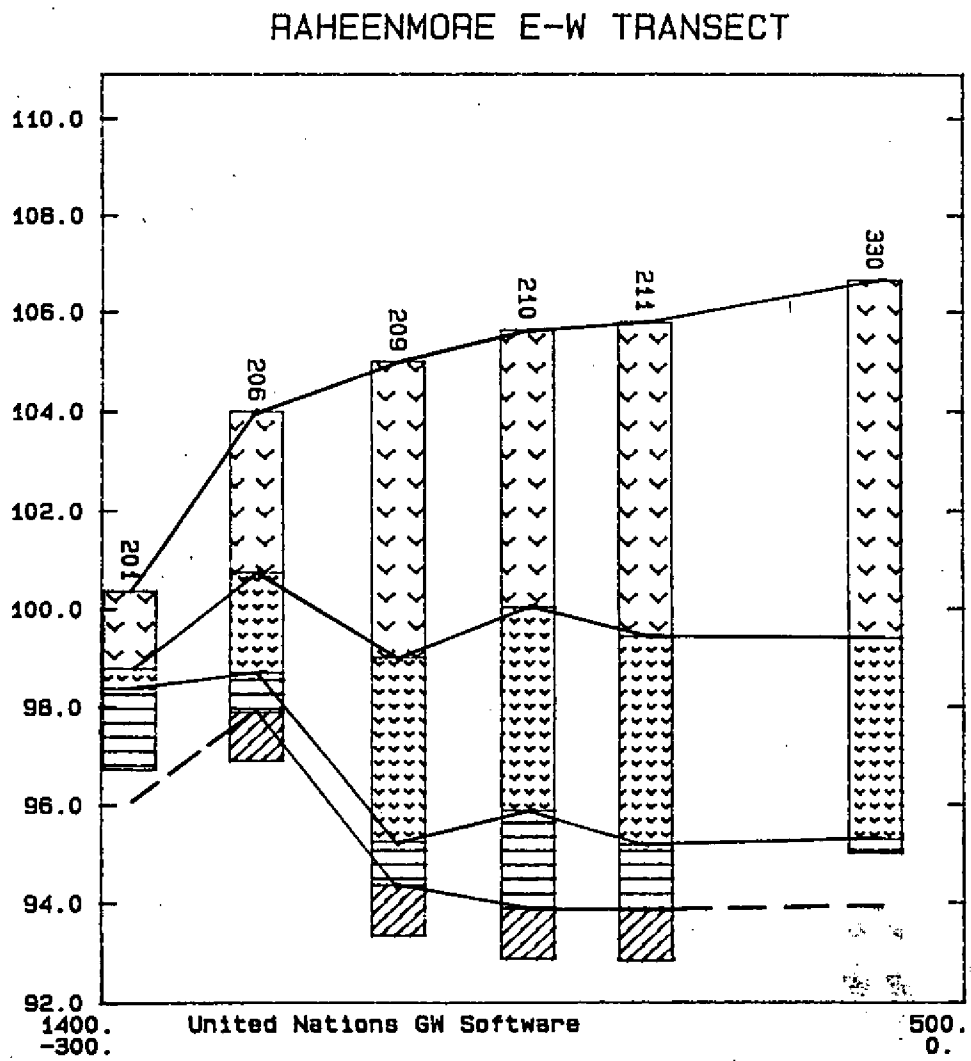


Figure 2.3 E-W Transect Raheenmore

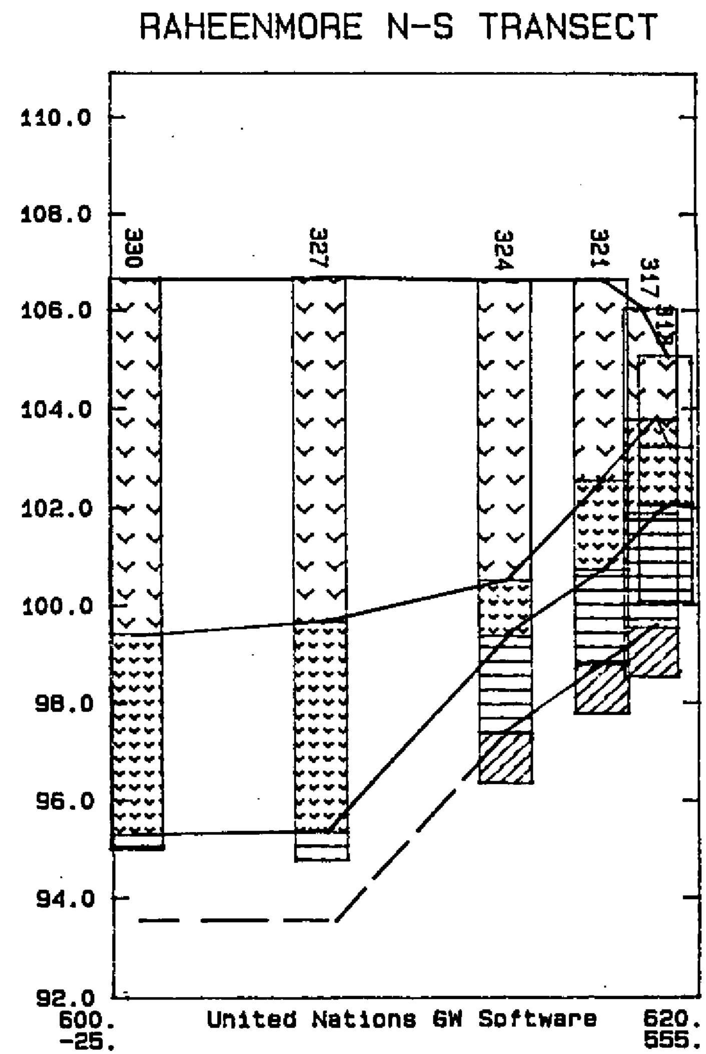


Figure 2.4 N-S Transect Raheenmore

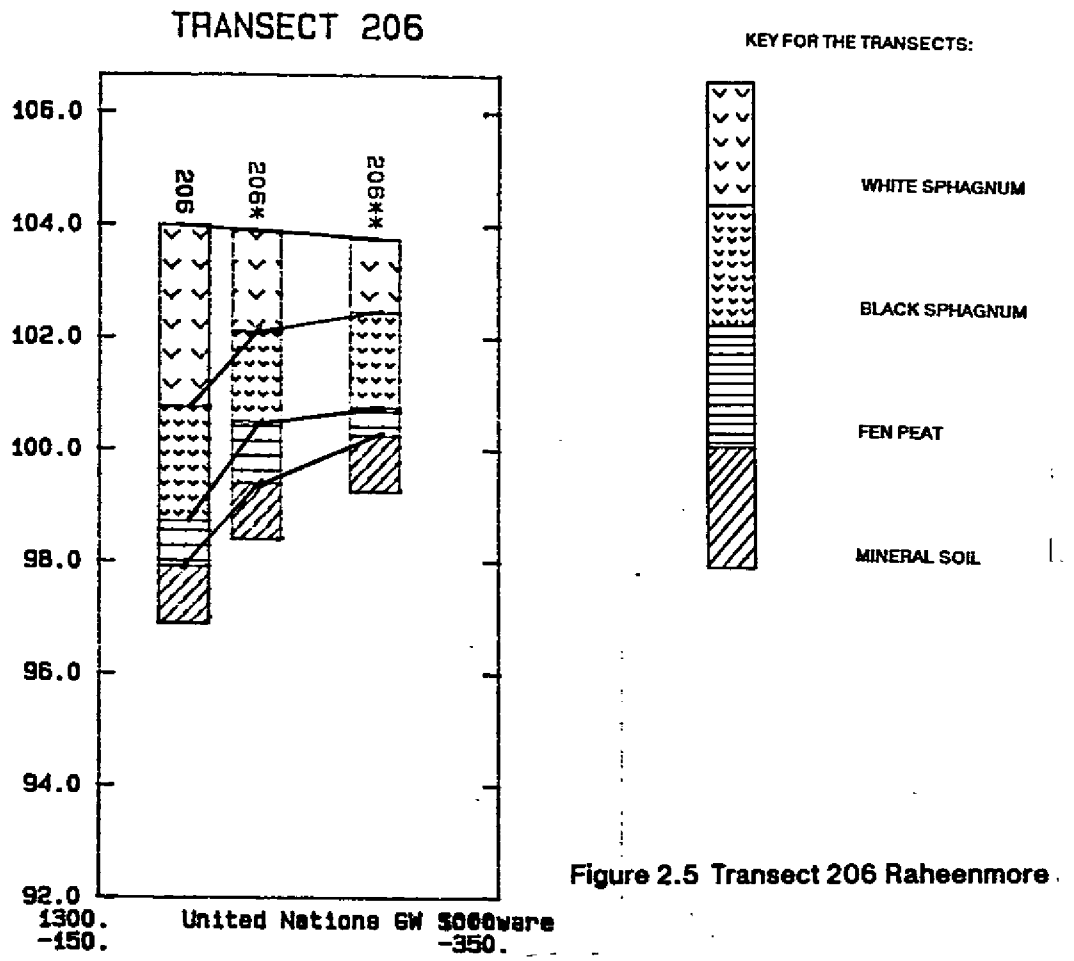


Figure 2.5 Transect 206 Raheenmore

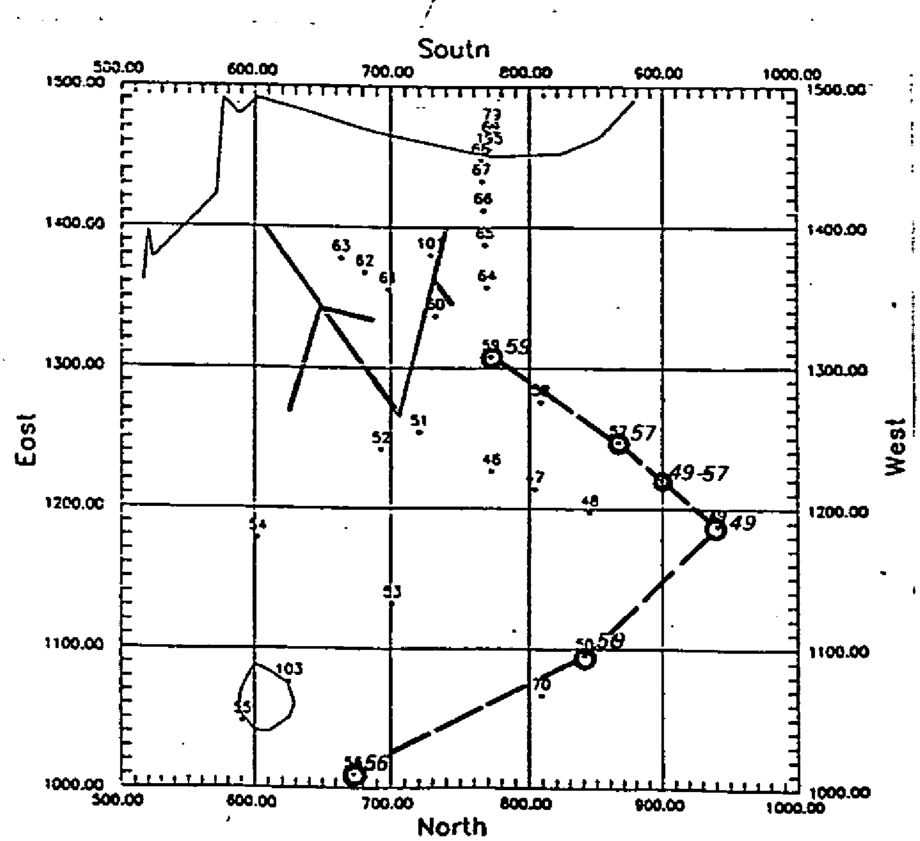


Figure 2.6 Clara, transects

$$\overline{C_o} = \frac{1}{L}\int_0^L C_o(z)\,dz \tag{2.4}$$

Co = Average volumetric concentration of organic matter in the whole column [m^3/m^3]
L = Length of the peat column [m]
z = Vertical distance [m]

In a profile which has been sampled at n different depths equation 2.5 is approximated by:

$$\overline{C_o} \approx \frac{1}{L}\sum_{i=1}^{i=n} C_{oi}(\Delta L)_i \tag{2.5}$$

n = Number of depths the peat has been sampled
ΔL = Length of the column the sample represents [m]

The original depth of the peat is estimated by comparing the consolidated column with an uncosolidated one. On Raheenmore Bog drilling 330 is used as reference and on Clara Bog the reference was drilling 56.

The consolidation ratio S is estimated by dividing the total length of the consolidated column by the length before consolidation:

$$S \approx \frac{L_c}{L_u} \approx \frac{\overline{C_{ou}}}{\overline{C_{oc}}} \tag{2.6}$$

C_{ou} = Average volumetric concentration of organic matter in the column before consolidation [m^3/m^3]
C_{ou} = Idem, after consolidation

The original length of the consolidated column is estimated a second time, using not the average volumetric concentration for the whole column but an average volumetric concentration per kind of peat (Young Sphagnum–, Old Sphagnum– and Fen Peat). The calculations and results are in appendix 2.4 & 2.5. The calculated original lengths are in table 2.1.

2.6.2 Results

The results are presented in table 2.1. The unconsolidated length of the columns are calculated using the density (assuming the volume of the sample to be exactly 43 cm^3), the average volumetric concentration of organic matter in the whole column (calculating the volumn of the sample with the known specific mass) and using the average volumetric concentration per peat type (the volumn of the sample also calculated with the known specific mass).

Table 2.1 RESULTS

		CLARA COMPARED WITH 56 RAHEENMORE COMPARED WITH 330					
Piezometer Number	*Present-Day Consolidated Length*	*Unconsolidated Using an average Density*		*Unconsolidated Using an average Co*		*Unconsolidated Using an average Co per peat type*	
		Length	*S*	*Length*	*S*	*Length*	*S*
Clara							
56	*8.65*			*8.65*	*1*	*8.65*	*1*
50	*7.40*			*9.50*	*0.78*	*9.72*	*0.76*
49	*2.85*			*4.58*	*0.62*	*3.41*	*0.84*
57-49	*5.20*			*7.48*	*0.70*	*7.57*	*0.69*
57	*7.30*			*9.68*	*0.75*	*9.46*	*0.77*
59	*7.65*			*8.76*	*0.87*	*8.71*	*0.88*
Raheenmore							
*201**	*3.65*	*8.92*	*0.41*	*7.92*	*0.46*	*6.70*	*0.54*
206	*6.1*	*10.45*	*0.58*	*9.37*	*0.65*	*9.66*	*0.63*
209	*10.65*	*13.03*	*0.82*	*12.38*	*0.86*	*13.42*	*0.79*
210	*11.75*	*13.96*	*0.84*	*13.42*	*0.88*	*13.13*	*0.89*
211	*11.95*	*13.84*	*0.86*	*13.05*	*0.92*	*13.31*	*0.90*
*330**	*11.65*	*11.65*	*1*	*11.65*	*1*	*11.65*	*1*
*327**	*11.90*	*12.55*	*0.95*	*12.55*	*0.95*	*13.49*	*0.88*
324	*9.25*	*12.17*	*0.76*	*11.80*	*0.78*	*12.01*	*0.77*
321	*7.85*	*12.65*	*0.62*	*11.79*	*0.73*	*10.78*	*0.73*
317	*6.50*	*13.43*	*0.48*	*11.58*	*0.56*	*10.16*	*0.64*
*313**	*5.00*	*12.28*	*0.41*	*10.76*	*0.46*	*9.42*	*0.53*

* = not drilled until the clay

2.6.2.1 Profiles Raheenmore

The figures referred to in this paragraph are all to be found in Appendix 2.6.

Figure 1,2 and 3 are attempts to calculate the original surface level of the E-W Transect of Raheenmore, before drainage. In all three figures drilling 330 (in the centre of the bog) is used as reference. In figure 1 the average bulk density of the whole column is compared, while in figure 2 the average volumetric concentration is used and in figure 3 the average volumetric concentration per peat layer.

The first striking result is the difference between the calculated original shape of the bog (with a dip in the centre) and the present-day dome shape. This feature is less pronounced in figure 2. Also the Black Peat still has a concave shape.
The main difference between figure 1 and 2 is the surface level of the bog, which is much higher using the bulk density. This can be explained by the inaccuracy in cutting the peat sample which error ranges from minus to plus 10 %. Therefor the use of the volumetric concentration seems to be more appropriate, since the specific mass of the organic material is known (Galvin, 1976).

However, the difference between the volumetric concentration of White Sphagnum-, Black Sphagnum- and Fen Peat seems to be such that it is better to compare the different layers with eachother instead of with the whole column. This resulted in the profile in figure 3. The approximated subsidence would then be 3.5 m at the edges (drilling 206, because 201 is in partly cut-away area). The main consolidation found using the volumetric concentration per kind of peat, appeared in the upper layers, the White Sphagnum. Consolidation (S) ranged from 0.42 at the edge (drilling 313) to 0.92 near the centre (drilling 210) (see Appendix 2.4). The Fen Peat hardly contributes to the consolidation. The consolidation of the total depth varies from 0.53 at 313 to 0.90 at 211.

The original surface levels of the other profiles in this report were all calculated with a volumetric concentration per kind of peat.

Figure 4 shows the present-day N-S Transect again, but at a bigger scale so as to get a better view of the edge of the bog. The drillings in this profile are also compared with drilling 330 which resulted in figure 5. The striking feature here, as in the E-W Transect, is the change of the cupola into a saucer. Taking the history of the bog into account, this doesn't seem to be reasonable. The cause is the different accumulation of the peat in the centre than at the edges of the bog (see Figure 2.1) through which the edges can't be compared with eachother.
Looking at figure 4, the drillings 330-321 don't show any consolidation, so instead of drilling 330, drilling 321 is taken as reference for 317 and 313 (see Figure 6). This still gives an edge higher than the centre of the bog, but less pronounced as in figure 5.

Transect 206 is compared with drilling 206 and with drilling 330 (see Figure 7 & Appendix

2.4). The two comparisons do show that the main consolidation appeared in the White Sphagnum or else that it didn't grow as fast as elsewere on the bog.

The graphs of volumetric concentration with depth (see Appendix 2.7) show a definite higher concentration of organic matter nearer to the edge of the bog and thus also nearer to the drain. From drilling 209 onwards to drilling 321 no influence of the drain is apparent.All the volumetric concentrations in the middle of the bog seem to circle around 0.04 g/cm^3, except the deepest samples which rise up to 0.13 g/cm^3. (the Fen Peat at 330 is only sampled once, at the second drilling).

In drilling 324 and 321 the volumetric concentration gets higher, respectivly at two third and halfway the peat depth, which is the Grenzhorizont between White Sphagnum and Black Sphagnum Peat. This could be the result of the drier and warmer climate having a greater impact on the higher areas of the bog (which were at that time the edges, due to shrinkage of the peat). Almost the same feature can be seen at drilling 206, positioned at a clay ridge aswell. Here the volumetric concentration starts to rise again at a depth of about 3m, the same depth the Black Peat starts.

The drains across the bog seem to have an impact on the peat to a depth of approximately 1 m.

2.6.2.2 Profiles Clara

The figures referred to in this paragraph are all to be found in Appendix 2.6.

The volumetric concentration of the organic matter of the different peat layers in the two profiles on Clara are compared with drilling 56, being in the most undisturbed part of the bog. Again comparison might be inaccurate because of the different accumulation history (see Figure 2.1). The subsidence ranges from 1 m on top of the mount to 2 m close at the side.

Sampling of the Black Sphagnum Peat was impossible on top of the mound, so instead the volumetric concentration of drilling 49-57 has been used, allthough the one of 49 might have been higher.

Comparing the mound with drilling 56 shows that the mound would have been always the highest part of the bog. The consolidation of the peat there has been estimated to be about 1 m. Either the accumulation of peat on top of the mound has been slower for the Black Sphagnum Peat or weathering of the peat was much severe there than it was at lower points of the bog. On the other hand the hydrology on the mound might have been different from the surroundings, resulting in initial higher densities.

The value of the volumetric concentration range of drilling 56 seems to agree with the values found in the centre of Raheenmore. At drilling 50 and 56 it starts to rise at a depth of respectivly 3.5 and 4 m, both being the boundary between White and Black Peat. This boundary isn't as clear for the other drillings. The layer of White Sphagnum is thinner, through which the boundary is camouflaged by drainage or other local conditions.

2.7. Conclusions

The accumulation history is more complex than assumed in the theory. Fen Peat and Black Sphagnum Peat follow the contours of the underlying mineral soil. This does not correspond with the theory, in which the top of the different layers are all very smooth. The now-a-day shape might have been due to quagmire growing in from the shores, filling the lake surface, but leaving water underneath the peat. Defining the age of the peat might give more insight in the accumulation history of the peat.

No final reference point can be given to calculate the consolidation of any given bog, due to a different accumulation history at different locations on a bog.

The volumetric concentration of undisturbed Sphagnum Peat is around 0.04 g/cm^3, rising for Black Sphagnum at the edges of the bog. This could be a good reference to look at the disturbance of other bogs.

The boundary between White and Black Sphagnum Peat near the edge of the bog can be checked by the change in volumetric concentration. The Grenzhorizont between White and Black Sphagnum Peat corresponds with a rising of the volumetric concentration of the organic matter.

The influence of the main drain around Raheenmore Bog is noticable up to about 100 m from the edge (see N-S Transect). The amount of subsidence is hard to tell, but estimated to be 1.5 m at drilling 313.

The amount of augerings is too small to draw final conclusions.

3. EVAPOTRANSPIRATION

3.1 Introduction

The evapotranspiration is estimated to be 450 - 500 mm/year on raised bogs in Western Europe (Streefkerk & Casparie, 1989). This is about 60 % of the annual rainfall in the Irish Midlands.

The evapotranspiration is the vertical flux of water vapour of an overgrown surface. It depends on various factors: plant physiology, leaf area index (LAI), meteorological factors, soil physics, phreatic level.

For practical purposes ways to determine the evapotranspiration with standard meteorological data have been developed like the Penman-Monteith method. In this study a direct method is chosen: the evapotranspiration is measured with lysimeters.

3.2. Methods and materials

Lysimeters

A lysimeter is a weighable container filled with a column of soil. The vegetation growing in a lysimeter should also be found in the direct vicinity of the lysimeter, thus being part of the environment.

The lysimeters used on Raheenmore are 0,50 meter deep and have a diameter of 0,40 meter (weight ca. 60 kg). The bottom is sealed. A piezometer was installed in each lysimeter to measure the water level. The containers are placed in holes in the bog in which they fit exactly (figure 3.1, Van't Hullenaar and Ten Kate 1991).

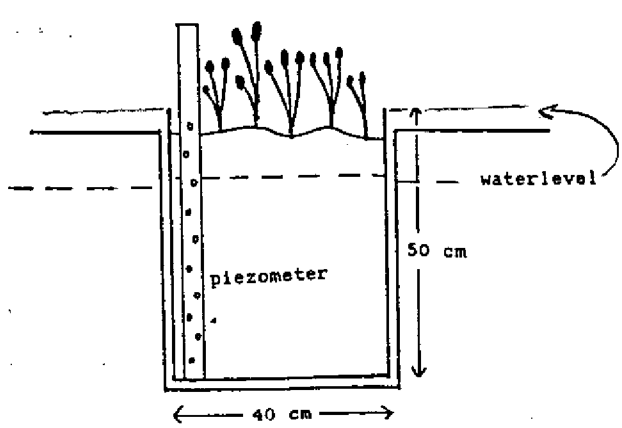


figure 3.1: Positioning of a lysimeter in the field.

In February 1991, 16 lysimeters were installed on Raheenmore bog. In table 3.1 (Van't Hullenaar and Ten Kate) an outline is presented, in which the main plant species and the acrotelm condition of the lysimeters is given.

Table 3.1: Vegetation and Acrotelm development of lysimeters.

Vegetation / Acrotelm	*Calluna vulgaris*	*Narthecium ossifragum*	*Eriophorum vaginatum*	*Sphagnum* spec.
Poor	1, 2	3, 5	4, 6	7, 8
Good	15, 16	13, 14	11, 12	9, 10

The objectives of the lysimeter research are:
- determination of evapotranspiration
- determination of storage coefficients
- determination of swelling and shrinkage.

For these purposes the following measurements were done:
- Checking water levels (2–3 times a week)
- Weighing (once a week)
- Adding or removing water (1–3 times a week)
- Taking surface levels (twice a month)
- Estimation of the *Sphagnum* Cover (once a month)
- Measuring the Leaf Area Index (once a month)
- Removal of "weeds" (whenever necessary).

The above mentioned duties consumed about 25 % of the hydrologists time. This is partly due to the location of Raheenmore bog. Installation of the lysimeters on Clara bog will reduce this percentage a little since Clara bog is closer to the field office than Raheenmore bog.
The lysimeters will be transferred to Clara bog in spring 1992. This is better, not only on practical grounds, but also from a scientific point of view. For in december 1991 a weather station was installed on Clara bog, so the lysimeter–evapotranspiration can be compared with the evaporation based on meteorological data.

Evapotranspiration

With the lysimeters described above, the actual evapotranspiration can be measured directly. For this purpose the conditions in and around the lysimeter should be equal. Proper installation as described in the previous section is necessary. Since the lysimeters are sealed, neither vertical nor lateral flow is possible. To imitate these flows, water is added to or removed from the lysimeters in such a way that the phreatic levels in the lysimeters are similar to the phreatic levels of its natural environment.

The evapotranspiration over a certain period is calculated as follows:

$$E = P + \frac{V_a - \Delta V}{A} \quad (3.1)$$

in which:

E:	Evapotranspiration	(mm)
P:	Precipitation	(mm)
V_a:	Volume of water added	(l)
A:	Surface area of lysimeter	(m^2)
ΔV:	Volume change of stored water	(l)

Just after the weighing procedure, the precipitation is measured. The volume of water added is calculated by adding up the amounts added or removed between two weighings. The volume change of stored water is determined by the difference in weight of the lysimeters between two weighings.

3.3. Results and conclusions

The results of the lysimeter measurements that form the basis of the calculations are presented in the following appendices:

- appendix 3.1: Fixed data
- appendix 3.2: The leaf area index (LAI)
- appendix 3.3: The *Sphagnum* cover index (SCI)
- appendix 3.4: Weighing data
- appendix 3.5: Water levels
- appendix 3.6: Volumes added/removed
- appendix 3.7: Surface levels
- appendix 3.8: Rainfall data
- appendix 3.9: Open pan evaporation (Derrygreenagh).

In this section the results of the evapotranspiration calculations are compared with the open pan measurements of Derrygreenagh (a nearby weather station operated by Bord na Mona) and with Penman measurements at Birr and Mullingar. Then the results of the 4 different plant species are dealt with and a comparison between good and bad acrotelm with regard to evapotranspiration is made. Finally the correlation between LAI and evapotranspiration is discussed.

3.3.1. Lysimeter vs Penman and open pan

The results of the evapotranspiration calculations are presented in appendix 3.10 and 3.11. In appendix 3.12, the weekly results are presented per plant species. In figure 3.2 and 3.3 you will find the monthly evapo(transpi)ration (based on table 3.2).

Table 3.2: Monthly Evapo(transpi)ration (mm) of open pan, Penman and plant species lysimeters

	Pan	Penman		Lysimeter				
		Birr	Mullingar	Avg.	C.V.	N.O.	E.V.	Sph.
may91	86.2	68.0	76.0	76.1	76.4	63.3	68.9	95.6
jun91	65.7	69.0	74.0	68.7	63.2	65.9	65.9	79.7
jul91	81.3	69.0	80.0	71.2	68.5	63.2	73.9	79.1
aug91	72.7	58.0	61.0	58.0	59.3	49.1	57.4	66.1
sep91	55.9	41.0	47.0	48.3	47.0	39.0	49.6	57.5
oct91	25.1	16.0	16.0	21.3	19.8	17.9	23.9	23.5
nov91	11.2	3.8	2.6	16.9	13.8	16.2	19.2	18.2
Total	398.1	324.8	356.6	360.5	348.0	314.6	358.8	419.7
				Averaged per day				
may91	2.8	2.2	2.5	2.5	2.5	2.0	2.2	3.1
jun91	2.2	2.3	2.5	2.3	2.1	2.2	2.2	2.7
jul91	2.6	2.2	2.6	2.3	2.2	2.0	2.4	2.6
aug91	2.3	1.9	2.0	1.9	1.9	1.6	1.9	2.1
sep91	1.9	1.4	1.6	1.6	1.6	1.3	1.7	1.9
oct91	0.8	0.5	0.5	0.7	0.6	0.6	0.8	0.8
nov91	0.4	0.1	0.1	0.6	0.5	0.5	0.6	0.6

Pan = Open pan (Derrygreenagh)
Birr = Penman evaporation, Birr
Mull = Penman evaporation, Mullingar
Avg. = Average (lysimeters

C.V. = Calluna vulgaris
N.O. = Narthecium ossifragum
E.V. = Eriophorum vaginatum
Sph. = Sphagnum species

The Penman evaporation is measured at Mullingar and Birr weather station. They are the nearest official weather stations from Raheenmore bog (20–30 km). Only monthly evaporation figures are available. The Derrygreenagh weather station, where the open pan evaporation is measured is located about 5 km from Raheenmore. Daily figures are available.

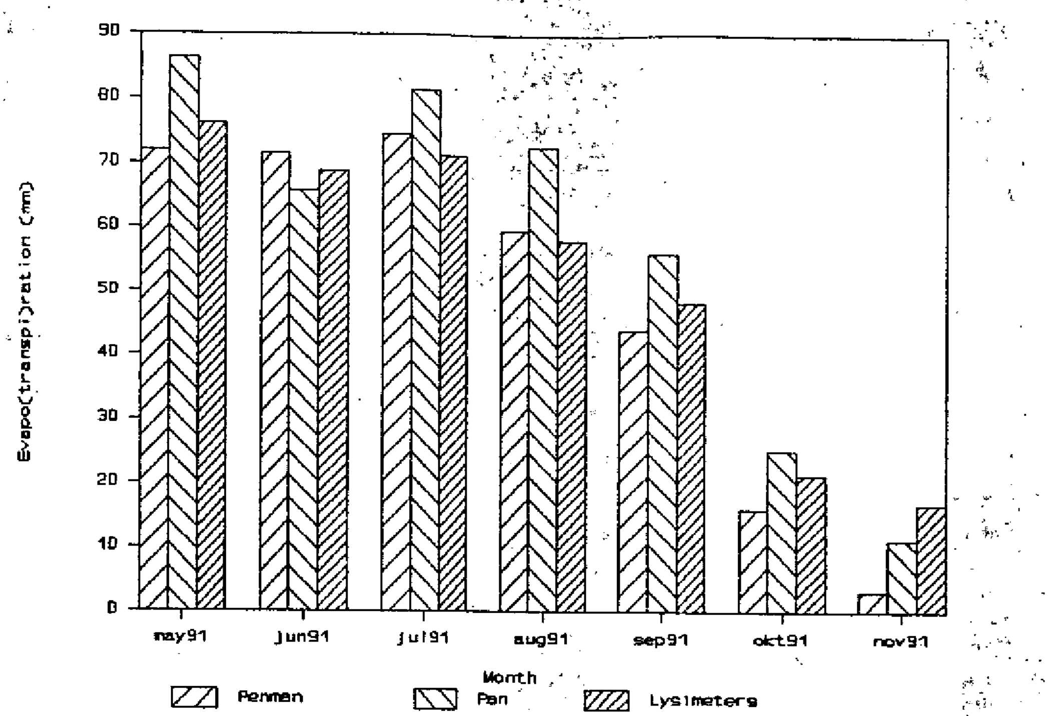


Figure 3.2: The monthly open pan, Penman and average lysimeter evapo(transpi)ration (may–nov. 1991).

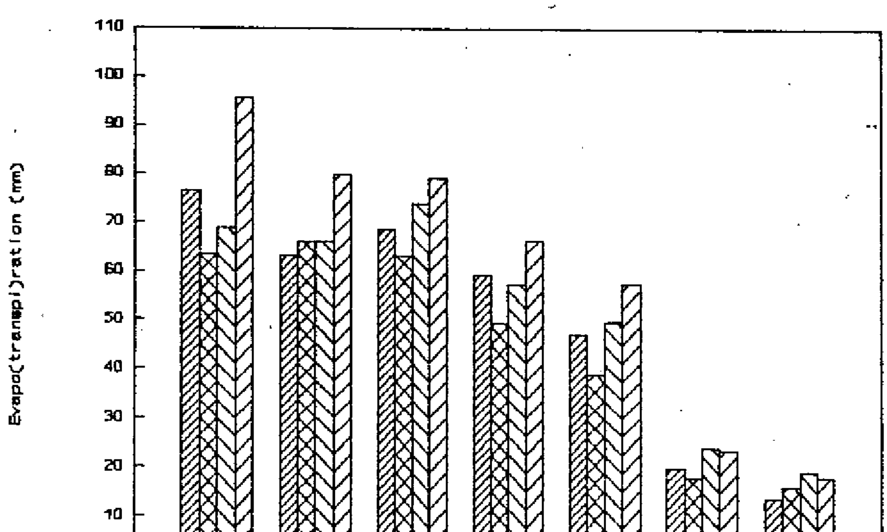


Figure 3.3: The monthly evapotranspiration of the lysimeters.

Over the whole period (may – nov) the open pan evaporation exceeds the mean lysimeter evapotranspiration by about 38 mm (10%). This is to be expected, since in the growing season warming of the pan will cause extra evaporation. However from April until early May and from halfway October until the end of November, it is the other way around ($E_{lys} > E_{pan}$). In general one can conclude that the open pan evaporation is higher in the summer season (May–September). After and before the growing season (from October until May) water levels are generally very high. Soil evaporation together with transpiration of interception water and leaf evaporation then easily exceed the open pan evaporation. This is due to the relatively high temperature of the peat body, as it cools down slowly.

Comparison of the averaged lysimeter evapotranspiration and the averaged Penman evaporation of Birr and Mullingar shows that the lysimeter evaporation is 20 mm higher over the whole period. However, when only regarding the growing season (May–September), the Penman and the lysimeter evaporation are exactly the same (322 mm). In figure 3.3 it is shown that the differences per month in that period are very small (+/- 5 %). Also during the periods of low phreatic level in May and September, the differences between Penman and actual evaporation are negligible, not implying evapotranspiration reduction due to decreasing availability of water.
The lysimeter research has shown, that during the growing season of 1991 the evapotranspiration of Raheenmore bog was equal to the Penman evaporation. The months following the growing season showed an underestimation of the actual evapotranspiration, October–November 20 mm. In the winter half year this underestimation could exceed 50 mm, which is considerable with regard to the water balance. Veldkamp and Westein will continue the research.

3.3.2. Acrotelm development – Evapotranspiration

In chapter 4 it is shown that the acrotelm development is of influence on the storage coefficient. It was not expected, that the evapotranspiration was correlated with the acrotelm. In table 3.3a it is statistically proved, that there is no significant difference in evapotranspiration between lysimeters with and without an acrotelm. In table 3.3b statistical analysis shows, that no significant difference occurs under relatively dry conditions (low water table). Therefore the conclusion can be drawn, that the acrotelm condition is of no direct influence on the evapotranspiration. Interactions Species x Acrotelm are not dealt with since the effect of the acrotelm itself is negligible.

Table 3.3a: Total evaporation may-nov; a statistical analysis on the effect of acrotelm and species.

	Calluna	Narthec.	Eriophor.	Sphagnum	Total
Bad Acrotelm	386.8	297.5	329.3	423.3	
	343.5	315	309.3	447.8	2852.5
Good Acrotelm	290.5	314	398.3	419.2	
	371.1	331.8	398.4	388.4	2911.7
Total	1391.9	1258.3	1435.3	1678.7	5764.2
$total^2$	1937386	1583319	2060086	2818034	

$sum(y^2)$	2113892
Y_{B}^2	2076625
Y_{ac}^2*	219.04
Y_{sp}^2*	23080.97
Y_{rest}^2	13966.69

ANOVA-table

	DF	Sum of squares	Mean square	F
Level	1	2076625		
Acrotelm*	1	219.04	219.04	0.17
Species*	3	23080.97	7693.66	6.06
Rest	11	13966.69	1269.7	
Total	16	2113892		

Acrotelm: $F = 0.17 < F^{1}_{11}$ $(\gamma=0.95) = 4.85$

Species: $F = 6.06 > F^{3}_{11}$ $(\gamma=0.95) = 3.59$

Table 3.3b: The effect of species and acrotelm on the evapotranspiration in periods of a low water table (may 23 - june 7 and aug 29 - sep 20)

ANOVA-table

	DF	Sum of squares	Mean square	F
Level	1	109111.9		
Acrotelm*	1	43.1	43.1	0.25
Species*	3	3141.3	1047.1	6.17
Residue	11	1868.2	169.8	
Total	16	104059.2		

Acrotelm: $F = 0.25 < F^{1}_{11}$ $(\gamma=0.95) = 4.85$

Species: $F = 6.17 > F^{3}_{11}$ $(\gamma=0.95) = 3.59$

Analysis of variance is briefly discussed in appendix 3.16. For a detailed description, the reader is referred to literature on statistics. In "ANOVA's" following this one the calculation part is not printed. Table 3.3a should be considered an example.

3.3.3. Plant species – Evapotranspiration

Plant species all have different characteristics. With regard to evaporation this means that systematic differences occur between species. In our lysimeter research we therefore expect significant differences in evapotranspiration between the plant species.
In accordance with this, table 3.3 shows a significant difference in evaporation between the different plant species ($F = 6.06 > F^{3}_{11} = 3.59$). In appendix 3.13 it is shown that the evaporation data of *Narthecium* and *Sphagnum* deviate significantly. The results of the *Sphagnum* lysimeters are relatively high, those of the *Narthecium* ones are relatively low. The relatively bad vegetation cover of the *Narthecium* lysimeters, implies that the evapotranspiration of these lysimeters approximates the bare peat soil one.

Part of the field work involved estimating the *Sphagnum* cover index (SCI). This is the percentage of the lysimeter area covered by *Sphagnum.* Since the *Sphagnum* lysimeters show a relatively high evapotranspiration, the *Sphagnum* cover is an important factor with regard to evaporation. In this respect the *Sphagnum* Cover Index can be used as a measure.

3.3.4. LAI – Evapotranspiration

In table 3.4 the monthly results of the leaf area index, the *Sphagnum* cover index and the evapotranspiration are given.
In general the leaf area index development is normal, showing increasing values until about August, then decreasing. In November the leaf area index of *Narthecium* was 0. The heather and cotton grass plants still were partly green.

Table 3.4: Monthly evapotranspiration compared with LAI and SCI

	Calluna Vulgaris				*Sphagnum*			
	Evapotranspiration							
	lys.1	*lys.2*	*lys.15*	*lys.16*	*lys.7*	*lys.8*	*lys.9*	*lys.10*
may91	*96.3*	*73.0*	*58.8*	*77.4*	*93.6*	*108.1*	*89.9*	*90.7*
jun91	*66.9*	*68.8*	*54.1*	*63.1*	*72.6*	*78.4*	*81.1*	*86.7*
jul91	*73.5*	*72.4*	*55.3*	*72.7*	*80.4*	*86.8*	*74.6*	*74.6*
aug91	*68.4*	*54.8*	*48.5*	*65.5*	*68.1*	*74.9*	*61.2*	*60.1*
sep91	*54.7*	*43.3*	*36.7*	*53.4*	*61.8*	*66.1*	*52.6*	*49.3*
	Sphagnum Cover Index							
may91	*0.2*	*0.8*	*0.4*	*0.4*	*1.0*	*1.0*	*1.0*	*0.9*
jun91	*0.2*	*0.8*	*0.5*	*0.5*	*1.0*	*1.0*	*1.0*	*0.9*
jul91	*0.2*	*0.8*	*0.6*	*0.6*	*1.0*	*0.9*	*0.8*	*0.7*
aug91	*0.2*	*0.9*	*0.9*	*0.8*	*1.0*	*1.0*	*0.8*	*0.6*
sep91	*0.3*	*0.9*	*0.9*	*0.8*	*1.0*	*1.0*	*0.9*	*0.7*

	Narthecium ossifragum				*Eriophorum vaginatum*			
	Evapotranspiration							
	lys.3	*lys.5*	*lys.13*	*lys.14*	*lys.4*	*lys.6*	*lys.11*	*lys.12*
may91	*63.7*	*49.5*	*67.1*	*73.0*	*62.1*	*57.7*	*77.0*	*78.6*
jun91	*60.4*	*71.2*	*65.5*	*66.2*	*65.8*	*57.2*	*74.8*	*65.9*
jul91	*61.0*	*66.2*	*60.2*	*65.5*	*68.1*	*69.3*	*79.6*	*78.4*
aug91	*46.1*	*48.8*	*47.2*	*54.3*	*51.4*	*52.7*	*64.8*	*60.8*
sep91	*37.8*	*40.8*	*37.8*	*39.4*	*47.7*	*44.0*	*51.5*	*55.3*
	Sphagnum Cover Index							
may91	*0.0*	*0.2*	*0.1*	*0.3*	*0.2*	*0.5*	*0.2*	*0.7*
jun91	*0.0*	*0.0*	*0.0*	*0.2*	*0.2*	*0.5*	*0.2*	*0.7*
jul91	*0.0*	*0.1*	*0.0*	*0.2*	*0.2*	*0.7*	*0.2*	*0.5*
aug91	*0.1*	*0.1*	*0.1*	*0.2*	*0.3*	*0.7*	*0.3*	*0.7*
sep91	*0.1*	*0.1*	*0.1*	*0.2*	*0.3*	*0.8*	*0.4*	*1.0*
	Leaf Area Index							
may91	*0.7*	*0.9*	*0.4*	*0.5*	*0.5*	*0.4*	*1.3*	*0.6*
jun91	*1.2*	*1.5*	*0.8*	*1.1*	*0.7*	*0.6*	*1.5*	*1.0*
jul91	*1.0*	*1.4*	*0.9*	*1.4*	*0.7*	*0.6*	*1.7*	*1.1*
aug91	*0.9*	*1.2*	*1.5*	*2.1*	*0.7*	*0.7*	*2.3*	*1.1*
sep91	*0.8*	*0.9*	*1.2*	*1.8*	*0.7*	*0.6*	*2.0*	*1.0*

As shown above, the evapotranspiration is correlated with water levels, plant species, potential evaporation and *Sphagnum* cover. The leaf area index (LAI) is supposed to be an indicator for the evapotranspiration as well. The soil evaporation will decrease, but the leaf transpiration and evaporation will increase with higher LAI values; the nett effect is an increase in evapotranspiration.
Because of the factors mentioned, it is hard to correlate the LAI and the evapotranspiration directly. For *Narthecium* and *Eriophorum* a simple statistical test is done to see whether LAI and evapotranspiration are positively correlated.
The mean monthly values of May – September are considered. To filter the effect of potential evapotranspiration, the measured evapotranspiration is divided by the open pan evaporation. Other factors like the SCI and phreatic level are not filtered.
A rank list of both the LAI and the (filtered) evapotranspiration is drawn up. With this the rank-correlation test of Spearman is carried out (appendix 3.14). The theory of the rank correlation test is briefly discussed in appendix 3.17.

It could not be proved that there is a correlation between LAI and evapotranspiration for *Narthecium ossifragum*. This means that the other factors that determine the evapotranspiration play such an important role in the bog asphodel lysimeters, that the relative effect of the LAI is not significant.

However for *Eriophorum vaginatum* the assumption that the LAI and the evapotranspiration are positively correlated proved to be right. The kind of relation is unknown.

The LAI of *Calluna vulgaris* was too hard to measure. In april, counting the green tops is tried.

In summer, the length of the living parts is determined twice. In general the vegetation was better developed on the lysimeter 1 and 16 (appendix 3.2). It appeared that the evapotranspiration of those lysimeters exceeded the evapotranspiration of lysimeter 2 and 15.

The LAI of the Moss lysimeters was not measured at all. Instead the *Sphagnum* Cover Index (SCI) was estimated. It would not be appropriate to apply the Spearman test, since it is hardly possible to make a rank list of SCI values (over half of the values is 100 %).

In appendix 3.15 the composition of the lysimeters is shown. Lysimeters 7 and 8 are mainly covered with *Sphagnum magellanicum*, whereas 9 and 10 are covered with *Sphagnum papillosum*.

In table 3.5 the results of the analysis of variance (ANOVA) are presented. There is no statistical evidence that *Sphagnum magellanicum* has a higher evaporation than *Sphagnum papillosum* ($F = 3.4 < F^1_2 = 18.5$). This is mainly due to the number of lysimeters (only 4), leading to a degree of freedom in the residue of 2.

Table 3.5: Statistical analysis on the differences in evapotranspiration between *Sphagnum* species in lysimeters

ANOVA - table

Sphagnum magellanicum - Sphagnum papillosum

	DF	Sum of squares	Mean square	F
Level	1	22856.7		
Species*	1	49.1	49.1	3.4
Rest	2	28.7	14.3	
Total	4	22934.5		

$F^1_2\ (\gamma=0.95) = 18.5 > F = 3.4$

4. STORAGE COEFFICIENT

4.1. Introduction

For hydrological purposes, such as water-balance studies, it is interesting to know the storage coefficient μ; it is the ratio of the water quantity (mm) added/subtracted to the change in water table (mm).

This coefficient depends on:

- The phreatic level:

The upper part of a bog (acrotelm) has unlinear physical properties. It is assumed that the storage coefficient increases with higher ground water tables.

- "Mooratmung":

The level of the peat surface changes throughout the year and with that the density of the acrotelm. These changes have impact on the storage coefficient.

- Time:

When the phreatic level is changed instantaneously (for instance as a result of a heavy shower), some air will be trapped in the smaller pores. It will take time for the soil to be de-aerated depending on the pore-size distribution.

- Acrotelm development:

It is assumed that the better the acrotelm development, the higher the storage-coefficient, due to the higher proportion of large pores.

4.2. Methods and materials

The storage coefficient of the upper 20 cm of the bog is determined with the use of lysimeters. This is done in two ways:

- by measuring weights and corresponding water tables weekly.
- by taking water tables just before and after a known quantity of water has been added or subtracted.

The following formulas are derived successively:

$$\mu = \frac{(W_1 - W_2)}{\rho_w A (h_1 - h_2)} \qquad (4.1)$$

$$\mu = \frac{\Delta V / A}{h_1 - h_2} \qquad (4.2)$$

in which:

μ	: Storage coefficient	(-)
W_1	: Mass of lysimeter at time 1	(kg)
W_2	: Mass of lysimeter at time 2	(kg)
ρ_w	: Density of water	(kg/l)
ΔV	: Volume of water added/subtracted	(l)
A	: Area of lysimeter	(m^2)
h_1	: Phreatic level at time 1	(mm)
h_2	: Phreatic level at time 2	(mm).

4.3. Results and conclusions

In appendix 3.4, 3.5 and 3.6, the weighing, adding and water level data are presented. The results of the calculations are shown in appendix 4.1 (weighing) and appendix 4.2 (adding). A summary of the results is given in table 4.1.

Table 4.1: Storage coefficients (water levels, wl, in cm below surface

Lysimeter nummer	*Average weight*	*Average add/sub*	*wl 0-10 weight*	*wl 0-10 add/sub*	*wl >10 weight*	*wl >10 add/sub*
1	0.23	0.21	0.26	0.22	0.11	0.19
2	0.23	0.42	0.34	0.50	0.12	0.18
3	0.21	0.18	0.23	0.19	0.14	0.15
4	0.19	0.20	0.22	0.22	0.09	0.10
5	0.14	0.15	0.16	0.16	0.09	0.09
6	0.25	0.24	0.27	0.25	0.18	0.13
7	0.29	0.28	0.35	0.33	0.14	0.19
8	0.29	0.27	0.34	0.33	0.17	0.18
9	0.24	0.20	0.27	0.20	0.17	0.20
10	0.24	0.19	0.25	0.19	0.21	0.18
11	0.29	0.41	0.37	0.41	0.20	
12	0.32	0.39	0.38	0.42	0.16	0.26
13	0.25	0.28	0.30	0.28	0.17	
14	0.29	0.29	0.34	0.29	0.20	
15	0.36	0.41	0.41	0.41	0.30	
16	0.30	0.31	0.33	0.32	0.20	0.23
Col. avg.	0.26	0.28	0.30	0.29	0.17	0.17

Add/rem.

	Avg.	0-10 cm	>10 cm
Bad acrotelm	0.24	0.27	0.15
Good acrotelm	0.31	0.32	0.22

Weighing

	Avg.	0-10 cm	>10 cm
Bad acrotelm	0.23	0.27	0.13
Good acrotelm	0.29	0.33	0.20

To reduce the influence of measuring inaccuracies, the storage coefficient is only calculated for $|h_1-h_2|>3.0$ cm.

Looking at the figures of table 4.1 and 4.2 one can conclude that the storage coefficients for lysimeters with a good acrotelm are slightly but significantly higher than with a bad acrotelm. It is striking that this does not account for the *Sphagnum* lysimeters. This is probably due to the structure of the upper layer of the *Sphagnum* cover.
In appendix 4.3 the composition of the lysimeters is given in which a distinction has been made between *Sphagnum* species. It appears that lysimeter 7 and 8 (bad acrotelm) are typical *Sphagnum magellanicum* lysimeters unlike 9 and 10 (good acrotelm). The latter two have an 80 percent *Sphagnum papillosum* cover, which seems to affect the structure of the top layer differently.
Lysimeter 2 (*Calluna vulgaris*, bad acrotelm) and lysimeter 15 (*Calluna vulgaris*, good acrotelm) both have relatively high storage coefficient values in the upper 10 cm. They are completely covered by *Sphagnum* (or *Hypnum*), but more than that, it is a well developed *Sphagnum* cover. The other two *Calluna* lysimeters (1, 16) both have a good *Sphagnum* cover (95 %, 70 %) but this is a more shallow one.
The *Narthecium* lysimeters (3,5 bad acrotelm, 13, 14 good acrotelm) show a distinctive difference in storage coefficient between well developed and poorly developed acrotelm. They all have a thin *Sphagnum* cover of 30–50 %. This implies that the difference in storage coefficient is entirely due to the acrotelm.
Lysimeter 4 and 6 (bad acrotelm) and lysimeter 11 and 12 (good acrotelm) have an *Eriophorum vaginatum* cover. The storage coefficients of the top layer of the latter are relatively high (0.4). They both are entirely covered by a thick *Sphagnum* layer. Lysimeter 4 has a low *Sphagnum* cover index (30 %) and a low storage coefficient (0.2). Lysimeter 6 has index of 70 % and a storage coefficient of 0.25.

In general it can be concluded that the acrotelm development is of importance to the storage coefficient. *Sphagnum* cover index and the thickness of the *Sphagnum* layer are related with acrotelm development and can also be considered indicators for the storage coefficient.

In table 4.2 it is statistically analyzed whether plant species, acrotelm, water level and measuring method have a significant influence on the storage coefficient.

Table 4.2: Statistical analysis on storage coefficients.

(a) ANOVA table

The effects of water level, adding/weighing and acrotelm condition.

	DF	Sum of squares	Mean square	F
Level	1	3.3958		
*Watlev**	1	0.24142	0.24142	62.23
*Add/weig**	1	0.00124	0.00124	0.32
*Acrotelm**	1	0.06883	0.06883	17.74
Rest	56	0.21723	0.00388	
Total	60	3.92452		

$\gamma = 0.90$
$F^{1}_{56} = 2.80$

(b) ANOVA table

The effects of adding/weighing, acrotelm condition and different species in the top 10 cm.

	DF	Sum of squares	Mean square	F
Level	1	2.82717		
*Add/weig**	1	0.00023	0.00023	0.04
*Acrotelm**	1	0.02192	0.02192	3.85
*Species**	3	0.0477	0.0159	2.79
Rest	26	0.14791	0.00569	
Total	32	3.04493		

$\gamma = 0.90$
$F^{1}_{26} = 2.92$
$F^{3}_{26} = 2.32$

The difference in storage coefficient between the adding/subtracting data and the weighing data is not significant (table 4.2 a/b). In some cases it is the opposite of what was expected (table 4.1: lysimeter 2, 11, 12). This can be explained as follows:
Lysimeter 2 has an extremely high porosity in the top few centimetres. Water had to be pumped out regularly after heavy rainfall, yielding relatively high storage coefficient results for lysimeter 2 and thus overestimating the storage coefficient for adding/subtracting data.
The relatively high values of lysimeter 11 and 12 are due to some surface water in parts of the lysimeter after heavy rainfall. (Surface water has a storage coefficient of 1.)

Statistical inference shows (table 4.2b), that the type of vegetation (moss, heather, cottongrass, bog asphodel) has correlates significantly with the storage coefficient of the top 10 cm

($F = 2.79 > F^{3}_{26} = 2.32$). Calluna shows the highest storage coefficient (μ=0.35), followed by *Eriophorum* (μ=0.32), *Sphagnum* (μ=0.28) and *Narthecium* has the lowest coefficient (μ=0.25).

It is assumed that the storage coefficient increases with higher water levels. In this study a distinction has been made between two layers: 0–10 cm below surface level and 10–20 cm below surface level. The statistics in table 4.2a proof that the storage coefficients of the two layers are significantly different ($F = 62.2 >> F^{1}_{56} = 2.8$).

Generally, with regard to the storage coefficient, you need to distinguish between good and bad acrotelm development, high and low phreatic levels and plant species.

In a previous study for acrotelm transmissivity calculations a storage coefficient of 0.5 was assumed. This is proven to be overestimated. A storage coefficient of 0.30–0.35 would be more realistic.

5. TRANSMISSIVITY

5.1. Introduction

From a hydrological point of view, the acrotelm is the most important part of the bog; the water table always resides in the acrotelm and the major part of the discharge takes place through this relatively thin surface layer (Ingram & Bragg, 1984).
The properties of the acrotelm are described in reports preceding this one. In short, the acrotelm has a swelling and shrinkage capacity, has a high hydraulic conductivity compared to the catotelm, the conductivity increases greatly towards the surface and the layer is poorly humified.

In their report, van't Hullenaar and ten Kate conclude that the hydraulic conductivity depends on the humification degree. In addition, it was concluded that transmissivity and water level are related. Furthermore it was obvious, that the transmissivity varied in the horizontal direction.

For modelling purposes, you need to know the transmissivity of the entire acrotelm at any water level. It would be impossible to monitor the transmissivity over the entire bog, as it already takes a day's work to monitor the about 20 existing acrotelm holes for one water level. Therefore, finding a relation between transmissivity and water level is a necessity, as well as a relation valid in the horizontal direction.

Larissa Kelly is involved in the Dutch-Irish project as a botanist. Part of her work is to describe the plant communities on the bog. A relation between the plant communities and the transmissivity, would imply a relation in the horizontal direction.

Ivanov (1957) and Romanov (1961) suggest the following relation between hydraulic conductivity and water level (from Ingram and Bragg, 1984):

$$k(z) = \frac{A}{(z+1)^m} \qquad (5.1)$$

in which:

k	= Hydraulic conductivity	(cm/s)
z	= Depth from surface	(cm)
A	= Empirical factor	
m	= Empirical factor.	

The transmissivity T (=kD) at depth d from the surface can be calculated according to:

$$T = \int_d^{\infty} k(z)\,dz = \int_d^{\infty} \frac{A\,dz}{(z+1)^m} \qquad (5.2)$$

Integration yields (m > 1):

$$T = kD = \frac{A}{(m-1)(d+1)^{m-1}} \qquad (5.3)$$

in which the transmissivity is in cm^2/s. To get the transmissivity in m^2/d the results have to be multiplied by 8.64. It should be noted that the equations are empirical, so dimensions can be ignored.

From filtration flume tests on the monoliths from the acrotelm of Dun Moss the parameters A and m were estimated as follows (from Ingram & Bragg, 1984):

Dominant *Sphagnum*	A	m
Sphagnum capillifolium	2000	3.6
Sphagnum magellanicum	5000	3.5

The formula shows that the transmissivity is related to water depth. Ingram and Bragg found different parameter values for different vegetation covers. In this chapter the method is considered for Raheenmore bog. Furthermore the humification–permeability relation will be looked into, but first a brief description of the methods and materials used is given.

5.2. Methods and materials

For the measurements of the transmissivity, the same holes used by van't Hullenaar and ten Kate were used in our measurements. The holes are situated across the bog along the L and the 600 grid lines.

Because of the high hydraulic conductivity of the acrotelm, no existing method known was suitable to measure the transmissivity. A new method was developed by van der Schaaf. It is described comprehensively by van't Hullenaar and ten Kate (1991) and will be dealt with briefly.

A square hole, penetrating the acrotelm (about 40 cm deep), is dug. The size of the hole (approximately 20x20 cm wide) is measured and the effective radius is calculated with:

$$r_{eff} = \frac{\frac{a+b}{2\sqrt{\pi}} + \frac{a+b}{\pi}}{2} \qquad (5.4)$$

in which:

a,b	: sides of the hole	(m)
r_{eff}	: effective radius	(m).

With a pump a constant discharge is taken out, until the water level in the acrotelm hole is constant. The drawdown, the discharge and the time of pumping is measured.
Assuming radial flow towards a well, the transmissivity can be calculated according to:

$$T = \frac{Q \ln(n)}{2\pi s_w} \qquad (5.5)$$

with:

T	= Transmissivity	(m^2/s)
Q	= Discharge	(m^3/s)
n	= Ratio of the radius of the well to the radius of the drawdown cone	(-)
s_w	= Drawdown	(m)

With the following implicit equation n can be calculated:

$$t = \left(1 + \frac{\mu(n^2 - 2\ln(n) - 1)}{2\ln(n)}\right) \times \frac{\pi r_w^2 s_w}{Q} \qquad (5.6)$$

in which:

t	= Time needed to reach "semi steady state"	(s)
μ	= Storage coefficient	(-)
r_w	= Radius of the well	(m)

This new method is called the Guinness method and is suitable for acrotelm-transmissivity values of 25 m^2/day and more.

Prof. van der Molen developed a computer program to calculate the transmissivity measured with the Guinness method numerically. This program is used to calculate the transmissivity for the new measurements as well as the measurements of van't Hullenaar and ten Kate. The storage coefficient μ, derived from the lysimeter research of this study, is taken 30%.

The most important conditions that have to be met to apply the Guinness method are:
- Horizontal and radial flow, which implies a wholly penetrating hole, relative impermeability of the catotelm, a horizontal phreatic level before pumping and a relatively small drawdown (5-10% of the aquifer). It should be realized that the transmissivity of the acrotelm is

? waarom.

underestimated considerably anyway, especially when water levels are high. Usually the drawdown during high water levels is less than 5 %.

- A homogeneous aquifer
- A constant thickness of the acrotelm
- A constant discharge.

For transmissivities lower than 25 m^2/day, the Pit Bailing method is convenient. A detailed description is also given by van't Hullenaar and ten Kate (1991). It is discussed briefly.

The Pit Bailing method was developed in 1973 by Healy and Laak. From the same acrotelm hole an amount of water is subtracted instantaneously, causing a drawdown. The subsequent rising-rate of the water level is measured.
With this the hydraulic conductivity can be calculated.

The Thiem equation describes constant steady state flow to a wholly penetrating hole. It is assumed that the catotelm is impermeable and that the radius of influence is four times the radius of the pit. An additional assumption is that, in the non-steady state flow situation of the experiment the Thiem equation in combination with dh/dt can be applied in the pit.

$$k = \frac{dh}{dt}\,\frac{A}{2.27(H^2-h^2)} \qquad (5.7)$$

so under:

$$D \approx \frac{H+h}{2} \qquad (5.8)$$

$$kD = \frac{dh}{dt}\,\frac{A}{4.54(H-h)} \qquad (5.9)$$

with:

k	= Hydraulic conductivity	(m/s)
A	= Area of water surface	(m^2)
h	= Height of the water table above the impermeable layer	(m)
dt	= Time interval	(s)
H	= Equilibrium height of the water table above the impermeable layer	(m).

In case the water level is below the acrotelm, the Thiem equation cannot be used. Because of the similarity between the flow systems of Pit Bailing method and the piezometer method, the piezometer equation can be applied, which does account for upwelling of water through the bottom of the pit. In this case only the hydraulic conductivity is calculated.

$$k = \frac{\pi r}{\frac{A_p}{r} t} \ln\left(\frac{y_0}{y_t}\right) \qquad (5.10)$$

with:

k	= Hydraulic conductivity	(m/s)
r	= Average radius of the hole	(m)
y_0	= Drawdown at t=0	(m)
y_t	= Drawdown at time t	(m)
t	= Time from start measurement	(s)
A_p	= Geometry factor	(m)

The measurements of the transmissivity are the basis of the results and conclusion. The following practical problems should be acknowledged:

– Swelling and shrinkage of the bog surface may change the physical properties of the acrotelm, so the hydraulic conductivity may change in time.

– The edges of the acrotelm holes are exposed to air very well during dry periods. This could have influence on for instance the humification degree and thus on the original hydraulic conductivity.

– The properties of the acrotelm vary over small distances, and therefore the conditions for the use of the methods described are not met completely, which may cause important deviations. In addition, the transmissivity itself may differ over small distances.

– Measuring inaccuracies:

* the pumping discharge may fluctuate.
* the measured drawdown can be different from the actual drawdown, due to disturbances by moving.
* the initial water level can be misjudged for the same reason.
* the actual time of equilibrium is hard to assess.

5.3. Results and conclusions

The transmissivity measurements and the calculations performed are presented in appendix 5.1 and 5.2. It concerns two of a total of four measuring days, as two of them were already presented by van't Hullenaar and ten Kate. The transmissivity values vary from < 1 m^2/day on the edges of the bog to > 1000 m^2/day at a spot in the centre of the bog.

5.3.1. Permeability-humification

Van't Hullenaar and ten Kate (1991) showed, that the permeability and humification were related as far as the acrotelm is concerned. Poorly humified acrotelms (humification 2,3,4 on the Von Post scale) show significantly higher permeabilities than more catotelm-like topsoils (humification 6,7).
In figure 5.1 their results as well as our results are projected. The same conclusion can be drawn. The variation is large, so determining the humification degree is not enough to assess the permeability.

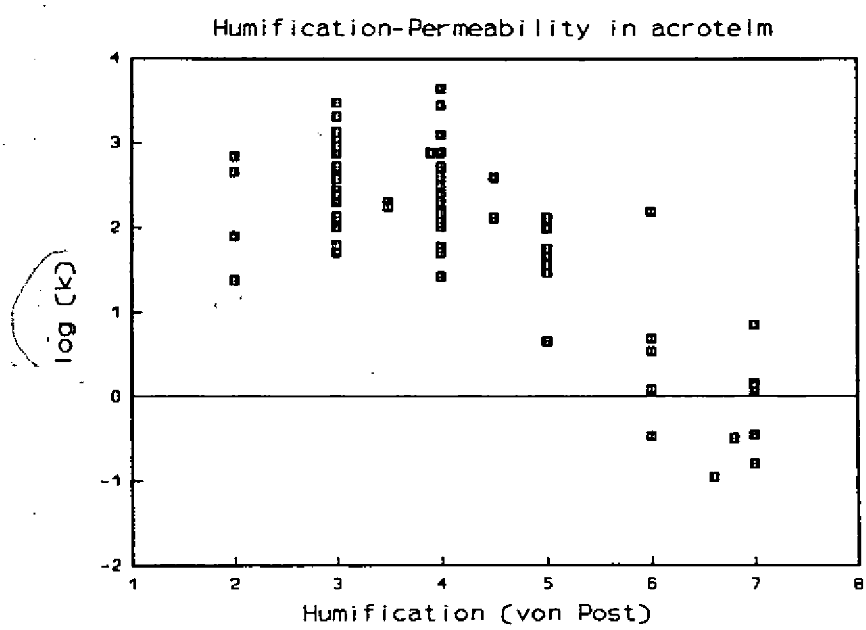


Figure 5.1: Humification - Permeability correlation in acrotelm.

5.3.2. Transmissivity in relation with vegetation cover and depth

As stated before, the acrotelm is the most important part of the bog, from a hydrological point of view. For hydrological modelling, variations of the hydraulic permeability occurring in both the horizontal and vertical direction, cause important problems.

In this section relations between transmissivity-water table and vegetation cover, as described in the introduction, are investigated. For that purpose Larissa Kelly described the vegetation cover around the transmissivity holes (appendix 5.3). In addition she distinguished 8 different vegetation types (table 5.1).

It is assumed that each vegetation type has its own typical empirical factors A and m (equation 5.3). High A-values more or less indicate high transmissivities. The m-value shows the transmissivity-depth relation. High m-values imply a fast decreasing transmissivity with lower water tables. A well developed acrotelm will have a relatively high A and m.

For the different vegetation types the optimum A and m value had to be calculated. In order to get the optimum values a computer program was written (appendix 5.4). It is based on formula 5.3. It was assumed that the transmissivity at 40 cm below surface level was less than 2 m^2/day. Some of the measurements were omitted for calculations, because there was no way of reconciling these measurements with the other measurements.

The results of the calculations are summarized in table 5.1. In the remainder of this section the results are discussed per vegetation type. In appendix 5.5 you will find the transmissivity-water depth data on which the calculations are based.

It can be concluded, that the equation suggested by Ivanov and Romanov gives good results. The A and m values were however significantly lower than suggested by Ingram and Bragg. This could be caused by:
- the different methods used to determine the transmissivity/ hydraulic permeability;
- the properties of the bog;
- systematic underestimation of the transmissivity with the Guinness method.

Table 5.1: Optimum m and A values of equation for 7 vegetation types.

m	*A*	*Holes*	*Description*
2.0	*9*	*L13, L2, L1, L-1, K6*	*Low Sphagnum magellanicum hummocks*
2.3	*37*	*L6, O6, P6, N6*	*Sphagnum lawns, probably infilled pools*
2.4	*55*	*L11, M6, L12*	*Variable vegetation on wettest part of the bog*
3.0	*770*	*L3, L5*	*Hollow vegetation*
3.2	*1790*	*L8, L9*	*Eriophorum vaginatum/angustifolium*
3.0	*190*	*Q6*	*Hollow channel in Scirpus caesitiposus/Calluna vulgaris zone*
1.7	*1*	*L0, L4, L7, J6*	*Narthecium ossifragum hollows, variable Sphagnum cover*

The ŝ-values mentioned on the next pages show a standard deviation calculated according to:

$$\hat{s} = \sqrt{\frac{\sum_{i=1}^{n} (T_{meas} - T_{calc})^2}{n-1}} \tag{5.11}$$

and the coefficient of variation, cv according to:

$$cv = \frac{\hat{s}}{\overline{|T_{meas} - T_{calc}|}} \tag{5.12}$$

with:

$\hat{s}$	= Standard deviation	(m^2/day)
cv	= Coefficient of variation	(-)
n	= Number of measurements	(-)
T_{meas}	= Measured transmissivity	(m^2/day)
T_{calc}	= Calculated transmissivity	(m^2/day)

The coefficient of variation is standardized and therefore provides a way to compare the variations of the different pictures.

The water level (watlev) is in cm below surface, The measured transmissivity, T(meas) and the calculated transmissivity, T(calc) are given in m^2/day.

Holes: L0, L4, L7, J6; *Narthecium ossifragum* hollows, variable *Sphagnum* cover.

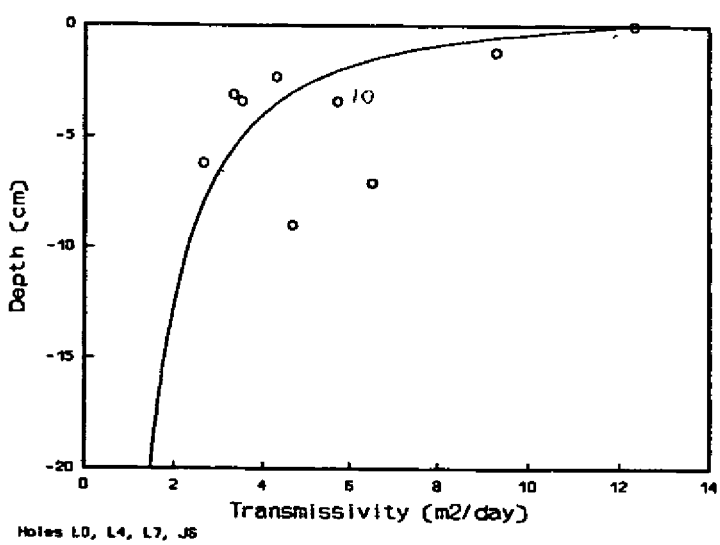
The data used are:

Watlev	T(meas)	T(calc)
3.0	6.3	4.7
2.2	4.4	5.5
3.0	3.4	4.7
6.0	2.7	3.2
3.4	3.5	4.4
8.9	4.8	2.5
7.1	6.4	2.9
1.0	11.4	7.6
-0.6	16.0	23.4

Not used:

Watlev	T(meas)
7.0	20.0
-0.2	5.2

The optimum parameter values are (ŝ= 3.4; cv= 1.37):
m = 1.7
A = 1



The transmissivity values of this type are low. A variable percentage of *Sphagnum* cover plus the occurrence of different species of *Sphagnum* will cause some variation in transmissivity. It has been shown that the *Sphagnum* species that tend to occur in hollow vegetation communities have a higher decomposition rate, therefore the peat will tend to be more humified than the surrounding hummock communities. In the previous section we have seen that the permeability (and therefore the transmissivity) decreases with increasing humification degrees.

Holes: L13, L2, L1, L-1, K6; Low *Sphagnum magellanicum* hummocks.

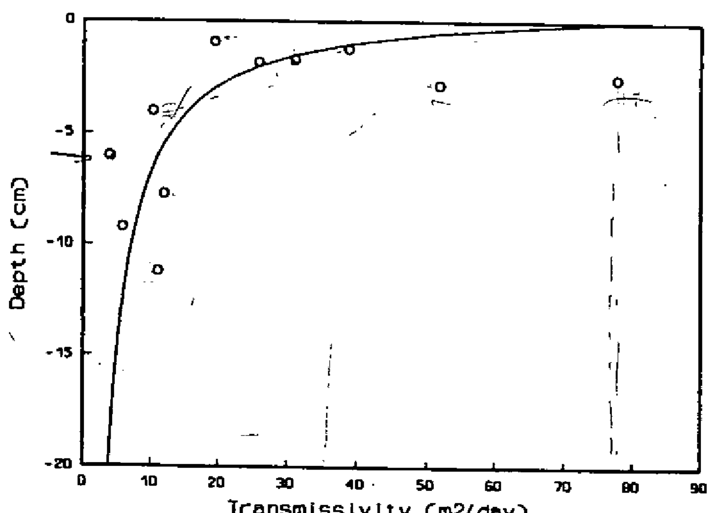
The data used are:

Watlev	T(meas)	T(calc)
2.0	28.0	25.9
-11.5	10.8	6.2
3.0	63.0	19.4
2.9	50.0	19.9
-8.0	11.2	8.6
-7.1	2.9	9.6
-9.2	5.7	7.6
2.0	24.0	25.9
-0.9	19.0	40.9
-4.0	10.4	15.6
1.4	34.0	32.4

Not used:

Watlev	T(meas)
5.0	71.0
6.0	82.0
2.0	10.6

The optimum parameter values are (ŝ= 18.4, cv= 1.66):
m = 2.0
A = 9



Holes: L13, L2, L1, L-1, K6

The 5 sites of this group are very low hummocks of predominantly *Sphagnum magellanicum*. These are not large hummocks, as *Sphagnum magellanicum* does not tend to be a major hummock forming species like *Sphagnum imbricatum*. Development of the acrotelm, influenced by for instance the wetness of the bog at that site, may cause important variations in the transmissivity.

The high value of the coefficient of variation indicates the presence of (an) outlier(s), influencing the outcome of the statistical analysis.

The parameter values found by Ingram and Bragg for a *Sphagnum magellanicum* vegetation are m=3.5 and A=5000. This is completely different from our results, which shows that using results of experiments performed on other bogs, is hazardous.

Holes: L6, O6, P6, N6; *Sphagnum* lawns, probably infilled pools.

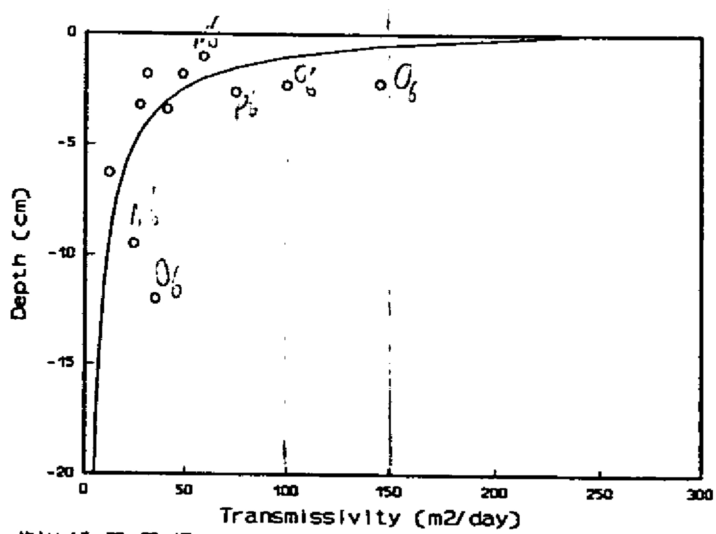
The data used are:

Watlev	T(meas)	T(calc)
6.3	11.3	18.6
1.9	29.0	61.6
2.0	43.0	59.0
12.7	34.0	8.2
2.0	160.0	59.0
2.2	104.0	54.2
3.0	28.0	40.6
2.4	81.0	50.1
3.2	43.0	38.1
9.2	25.0	12.0
1.1	53.0	93.7

Not used:

Watlev	T(meas)
0.0	58.0
0.9	22.0
15.0	40.0

The optimum parameter values are (ŝ= 42.0; cv= 1.38):
m = 2.3
A = 37



The transmissivity values of this vegetation type can be categorized as moderate. The group consists mainly of *Sphagnum* lawns (probably infilled pools) and they are all situated along the N/S transect, which crosses the wettest sections of Raheenmore bog.

Holes: L11, L12, M6; Variable vegetation in wettest part of bog.

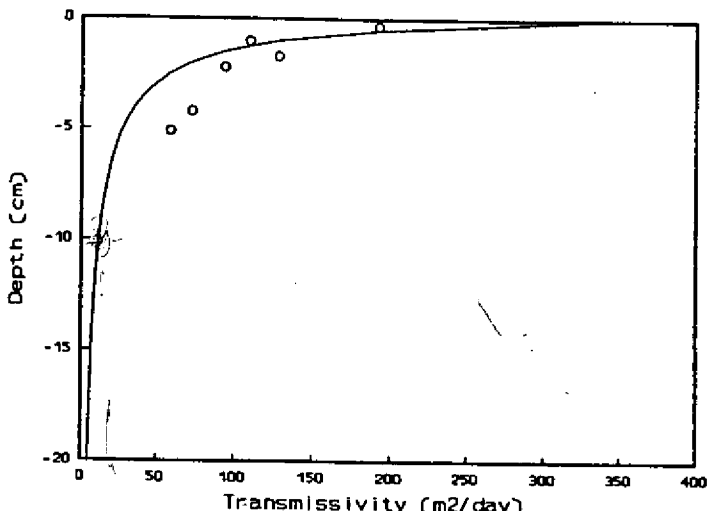
The data used are:

Watlev	T(meas)	T(calc)
2.0	116.0	72.9
4.0	84.0	35.7
5.0	61.0	27.6
2.0	100.0	72.9
0.7	131.0	161.5
1.0	110.0	128.6

Not used:

Watlev	T(meas)
10.5	50.0
6.4	59.0

The optimum parameter values are ($\hat{s}$= 38.2; cv= 1.14):
m = 2.4
A = 55



Holes L11, L12, M6

The same explanation as for the previous group applies to this one. Moderate transmissivity values on sites located on the wettest part of the bog. *Sphagnum* development is quite fast and the humification degree of the top 15 cm is fairly low.
The small coefficient of variation shows, that the influence of all measurements are approximately equal.

As far as the transmissivity is concerned, this group can be joined with the previous one.

Holes: L3 and L5; Hollow vegetation.

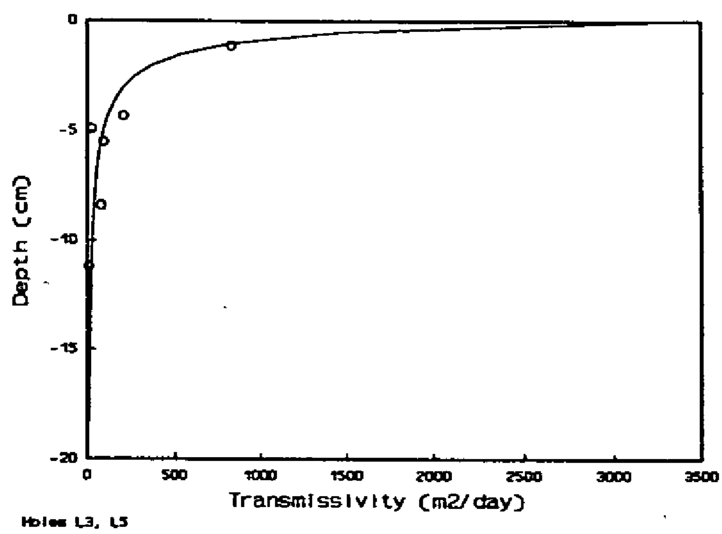
The data used are:

Watlev	T(meas)	T(calc)
8.5	77.0	36.9
4.5	190.0	110.0
5.4	96.0	81.2
11.0	8.5	23.1
4.9	25.0	95.6
1.0	851.0	831.6

Not used:

Watlev	T(meas)
0.0	51.0
2.0	85.0

The optimum parameter values are ($\hat{s}$= 52.6; cv= 1.32):
m = 3.0
A = 770



The parameter values as well as the graph show that the transmissivity values are high. This implies that the acrotelm is well developed. The sites are hollows/lawns of predominantly *Sphagnum papillosum.* The *Sphagnum* layer is deep and relatively umhumified.

Holes: L8 and L9; *Eriophorum vaginatum/angustifolium.*

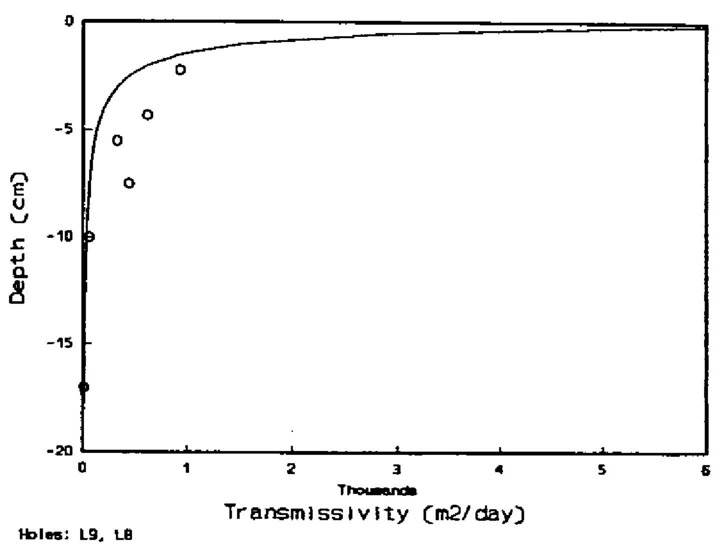
The data used are:

Watlev	T(meas)	T(calc)
20.4	12.3	8.3
10.1	62.0	35.3
5.5	339.0	114.4
2.0	1182.0	627.0
17.5	11.5	11.5
7.5	442.0	63.4
4.2	733.0	187.0

Not used:

Watlev	T(meas)
0.0	67.0

The optimum parameter values are ($\hat{s}$= 365.3; cv= 1.47):
m = 3.2
A = 1790



As well as the previous group, this group has high transmissivity values. Especially under conditions of high transmissivity, the water level from surface becomes important as well as hard to assess. Adding one cm to the water levels would yield a standard deviation of 268 m^2/day.

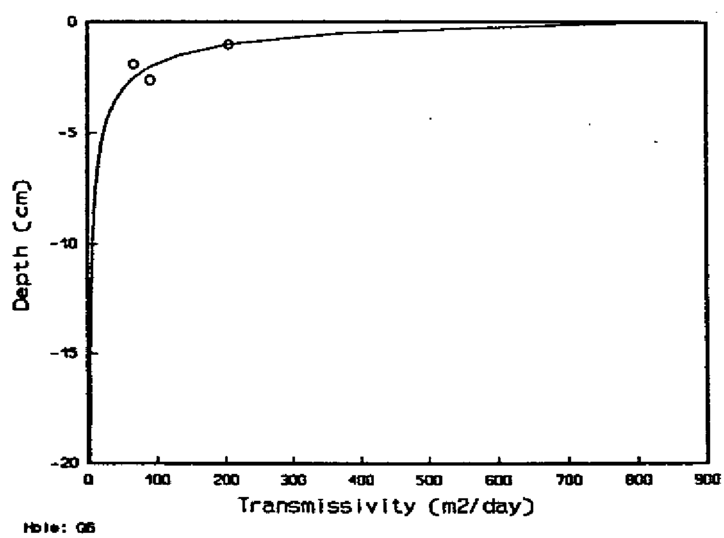
The sites are situated within the *Eriophorum vaginatum/angustifolium* dominated zone, which lies in the central part of the bog. It is quite extensive. The area is very wet and the surface is spongy. The *Sphagnum* cover is good. The results of Ingram and Bragg are approximately equal to the results of this vegetation group. Vegetation may be considered an indicator for hydrological circumstances, but on different bogs on relative close geographical distance this may be different.

Holes: Q6; Hollow channel in *Scirpus caespitosus/ Calluna vulgaris* zone.

The data used are:

Watlev	T(meas)	T(calc)
2.0	62.0	110.9
0.8	259.0	238.5
2.5	95.0	88.0

The optimum parameter values are (ŝ= 28.9; cv= 1.38):
m = 3.0
A = 190



The transmissivity-values of this site are quite high, indicating a well developed acrotelm. However, this would not be expected. Q6 is situated in a *Sphagnum magellanicum/ Narthecium ossifragum* hollow within the *Scirpus/ Calluna vulgaris* zone, which forms the dominant community type on the marginal areas of the bog.
A vegetation type almost similar to the type of Q6 is found around R6, L14, I6 and L-2. The transmissivity there is less than 1 m^2/day.
It is hard to give a satisfactory explanation for this. The only 3 measurements were performed under conditions of high water levels. Larissa Kelly suggested that water could possibly be flowing through the surface layers of the channels close to the bog edge.

5.3.3 Transmissivity and acrotelm thickness

At Raheenmore bog van't Hullenaar and ten Kate (1991) did a survey on the top meter of the bog. Part of the work involved estimating the thickness of the acrotelm. The research was done at the OPW 100 meter grid.
The transmissivity is related with the thickness of the aquifer, on the bog this is the acrotelm. If the empirical quantities A and m of equation 5.3, estimated in the previous section, are typical for the thickness of the acrotelm, then it is possible to model the transmissivity over the entire bog. In table 5.2 the thickness of the acrotelm and the empirical factors A and m are given.

Table 5.2 : Thickness of the acrotelm at the transmissivity holes

Hole	*Surface*	*Acrotelm bottom*	*d (cm)*	*m*	*A*
L-2	104.79	104.74	5	–	<1
L-1	105.21	105.11	10	2.0	9
L0	105.84	105.74	10	1.7	1
L1	106.73	106.58	15	2.0	9
L2	107.00	106.60	40	2.0	9
L3	106.97	106.57	40	3.0	770
L4	106.92	106.77	15	1.7	1
L5	106.72	106.52	20	3.0	770
L6	106.69	106.49	20	2.3	37
L7	106.21	106.09	12	1.7	1
L8	105.83	105.38	45	3.2	1790
L9	105.71	105.31	40	3.2	1790
L11	105.15	105.00	15	2.4	55
L12	104.61	104.41	20	2.4	55
L13	104.08	103.88	20	2.0	9
L14	103.34	103.29	5	–	<1
I6	105.72	105.72	0	–	<1
J6	106.31	106.21	10	1.7	1
K6	106.57	106.47	10	2.0	9
M6	106.77	106.62	15	2.4	55
N6	106.70	106.55	15	2.3	37
O6	106.75	106.55	20	2.3	37
P6	106.69	106.34	35	2.3	37
Q6	106.59	106.49	10	3.0	190

The thicker the acrotelm, the better developed it will be. Therefore you expect increasing A and m values with increasing acrotelm thickness. In appendix 5.6 the Spearman rank correlation test (described in appendix 3.17) is carried out on the data of table 5.2. A correlation coefficient of 0.80 was found on the rank correlations, which means that there is a significant correlation between A and acrotelm thickness. If hole Q6 is omitted, the correlation coefficient becomes 0.87.

A correlation coefficient of 0.80 justifies investigation of a relation between acrotelm thickness and the empirical factors A and m. Regression on the data of table 5.2 yields the following results.

Table 5.3: Estimated m and A values for acrotelm depths

d	*A*	*m*
50	4255	3.4
45	1751	3.2
40	720	3.0
35	296	2.8
30	122	2.6
25	50	2.4
20	21	2.2
15	8.5	2.0
10	3.5	1.8
5	1.4	1.7
0	0.6	1.6

The figures of table 5.3 are based on linear regression on acrotelm thickness and ln (A), carried out in appendix 5.7. An exponential relation between A and acrotelm thickness appeared to be a better approximation than a linear relation.

The approach used gives a relation between acrotelm thickness and transmissivity, given the water level from surface. So a map of the acrotelm thickness, would also be a map for transmissivity.

In the previous section a relation between the vegetation type and the transmissivity was given. It was assumed that from a vegetation map, also a transmissivity map could be produced. The results of both mappings should be compared. If they coincide significantly, then a way is found to estimate the transmissivity parameters over the entire bog. In the next section acrotelm thickness is related with vegetation type.

The discharge through an aquifer like the acrotelm, depends on transmissivity and gradient of hydraulic potential. With the figures of van't Hullenaar and ten Kate, a three dimensional picture of the acrotelm can be made, so the transmissivity and the discharge measured at the outlet point of the catchment can be correlated. Amongst others, it can be investigated whether the transmissivities are realistic.

5.3.4. Transmissivity, vegetation and acrotelm thickness

A survey of the vegetation at the points of acrotelm thickness measurement (the O.P.W. 100 grid) was performed by Larissa Kelly. The results in combination with the acrotelm thickness are presented in appendix 5.8. The vegetation was categorized into 10 types (table 5.4), the 7 types mentioned in 5.3.2 and 3 additional ones. In order to give a better overview, in appendix 5.9 the coordinates and the acrotelm thickness are shown, sorted on vegetation type. A statistical summary is presented in table 5.5.

Table 5.4: Distinguished vegetation types.

0 *Sphagnum magellanicum hollow*
1 *Narthecium ossifragum hollow, variable Sphagnum cover*
2 *Low Sphagnum hummock*
3 *Sphagnum lawns (infilled pools)*
4 *Variable vegetation on the wettest part of the bog*
5 *Hollow vegetation*
6 *Eriophorum angustifolium/vaginatum dominated*
7 *Hollow channel in Scirpus/Calluna zone*
8 *Calluna/Narthecium/Hypnum zone*
9 *Cutaway area*

Table 5.5: Statistical summary of the acrotelm vegetation type/acrotelm thickness relation.

Veg. type	number	avg.acrot. thickness	standard deviation	min.acrot. thickness	max.acrot. thickness
0	9	13.3	11.2	0	25
1	21	6.8	5.5	0	20
2	18	9.2	7.3	0	30
3	11	13.2	10.3	0	30
4	3	18.3	2.9	15	20
5	8	11.3	9.9	0	30
6	4	37.5	9.6	30	50
7	1	0.0	-	-	-
8	14	1.8	3.2	0	10
9	3	3.3	5.8	0	10

Interpretation of table 5.5 is not easy. A clear relation between acrotelm thickness and vegetation type can not be found. Acrotelm thickness ranges significantly within one vegetation type. Only between certain types an obvious difference can be observed.
The vegetations typical for the bog edge (types 7,8,9) generally have no acrotelm, whereas vegetation type 6, typical for very well developed raised bog, shows acrotelm depths ranging from 30 to 50 cm. The remaining vegetation types in general show quite ranging acrotelm depths (0–30 cm), with means from 7 to 18 cm. The high standard deviations indicate that assessing the acrotelm depth based on vegetation may introduce important errors.

Unlike measuring the acrotelm thickness, describing the vegetation is non-destructive, which makes using the vegetation to estimate the parameters for acrotelm transmissivity interesting. Comparing the results of Ingram and Bragg (1984) with the results of this report has shown that vegetation may be an indicator for the local hydrological situation, but that this could be different on relative close geographical distance. In addition, areal interpolation of vegetation types on a bog is impossible.
Interpolation of acrotelm thicknesses may give errors, but is possible, and a direct relation between transmissivity parameters and acrotelm thickness is already derived.
Considering the above, it seems advisable to use the acrotelm thickness as the basis to assess the parameters A and m of formula 5.3. Vegetation mapping may be used to evaluate the acrotelm thickness interpolation. Especially vegetation types 6, 7, 8 and 9 are useful in this respect.

6. PIEZOMETERTEST

6.1. Introduction

The hydraulic conductivity is a measure of a soil's ability to transmit water and one of the fundamentals on which the waterbalance is based. The hydraulic conductivity controls the infiltration rate of precipitation and herewith also the proportion of water entering ombrogenous mires and water carried away by surface flow. Conversely, it regulates the rate at which water stored at depth is supplied to the surface layers of the mire from which evapotranspiration occurs (Rycroft e.a., 1975). This means that the effect of drainage on peatland is dependent on the hydraulic conductivity and that it can help to determine the types of peatlands that develop.

The hydraulic conductivity of a saturated soil can be measured either in the field or in a laboratory. Conductivity experiments in the field though have three main advantages. The first advantage is that the structure and the porosity of the peat is as little disturbed as possible. Furthermore, peat is a structurally complex substance, and with field methods the effective sample size can be large enough to allow for local variations in composition of the peat and the conductivity can be tested in the actual moisture situation. The third advantage is that there is no need for a laboratory or a place to store the samples.
The permeability of peat depends upon 7 factors (Gore, 1983):

- -Botanical composition
- -Degree of humification
- -Bulk density
- -Fibre content
- -Void ratio or porosity
- -Drainable void ratio or porosity
- -Surface loading

A few authors have used more than one method to estimate hydraulic conductivitties in peat. However, results in the literature are conflicting and difficult to interpret. It apparently provides an inadequate basis for assessing the relative suitability of the various methods available for measuring the hydraulic conductivity of peat (Rycroft et all, 1975).

6.2. Purpose of the test

The purpose of this study is to compare different field methods of estimating the hydraulic conductivity of a saturated soil and the influence of the shape of the filter on the rate of inflow after changing the head. In this test the perforation rate, filter length and sealing of the tube were taken into account.

The results of a previous test (van 't Hullenaar et all, 1991) weren't complete and raised more

questions. Checking the tubes showed that they had swapped the filter types. Perforation rate and length of filter of the tubes didn't agree with the number of the tubes as written in the report.
The test done by van 't Hullenaar e.a. (1991) gave conductivities that differed 1 to 20 times. A close look at the scheme site showed that the tubes were placed in and at the side of a pool that was filled in again with *Sphagnum*. Hence the tubes were placed in layers with variable conductivities through which the results of different tubes couldn't be compared with each other. Also the conductivities were sometimes too high to be measured. The test scheme is kept the same, but reinstalled on another, more homogeneous location with lower conductivities.

The test scheme used in the field is shown below.

1	*2*	*3*	*4*
5	*6*	*7*	*8*
9	*10*	*11*	*12*
13	*14*	*15*	*16*

Checking the formulas used for the three different methods showed that a different shape factor was used for the Constant Head test. The shape factors in all three formulas however should be the same.

6.3. Theory

The equations with which the hydraulic conductivity is calculated from the field experiments are all based on the assumption that steady state conditions of water movement exists and that the soil water content does not vary with time. Hence the saturated flow through the peat takes place in accordance with Darcy's law:

$$v = -k.\frac{dh}{dx} \qquad (6.1)$$

v = flow velocity [m/d]
k = hydraulic conductivity [m/d]
dh/dx = hydraulic gradient [m/m]

6.4 Methods, materials and results

Piezometer method

The methods used in this test to measure the hydraulic conductivity are all three piezometer methods. The piezometer method consists of measuring the flow rate into or out of a plastic tube, through a filter made at the end of the tube. The piezometer method requires the knowledge of a shape factor A to take into account the effect of the shape of the cavity at the end of the piezometer on the rate of inflow after changing the head. This shape factor can be found in the graph in Appendix 6.1 3. For this test a tube with a fairly small diameter of 2.1 cm and a filter at the end is pushed into the peat. The length of the filter of the tubes used are large compared with its diameters and the bottom of the tubes are sealed. Hence the horizontal conductivity is estimated. See also fig. 6.1. For all permeability tests bog water is used, so as to keep the same chemistry in the peat. A change in water chemistry can have an effect on the absorption complex and herewith also on the permeability of the peat.

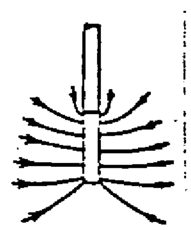


Figure 6.1 Schematic flow lines for the piezometer method

6.4.1. Rising & Falling Head

In the recovery tests the water is either suddenly lowered or suddenly raised and the rate of recession of the water level is monitored (see fig. 6.2). The hydraulic conductivity can be calculated from:

$$k = r^2 . \frac{\ln(y_1/y_2)}{A(t_2 - t_1)} \qquad (6.2)$$

k	= hydraulic conductivity [cm/d]
r	= the internal radius of the tube [cm]
y_1, y_2	= the displacements of the water level from the equilibrium level at times t1, t2 [s] respectively
A	= shape factor, depending on the shape of the filter of the piezometer [cm]

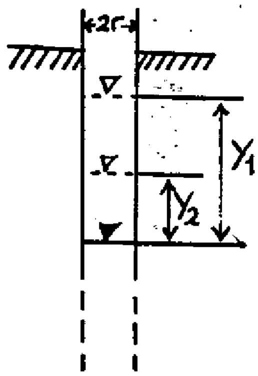


Figure 6.2 The recovery mode

6.4.2. Constant Head

In the constant head test a constant waterlevel above the original equilibrium level in the tube is maintained until the flow rate Q into the tube gets constant. The constant imposed heads were obtained with Marriote vessels. The hydraulic conductivity can be calculated from:

$$k = \frac{Q}{(A*h)} \tag{6.3}$$

K = hydraulic conductivity [m/d]
Q = the rate of outflow from the vessel [m/d]
A = shape factor, depending on the shape of the filter of the piezometer [m]

The tests were carried out with 16 piezometers, all made by hand so all slightly different (Hullenaar van 't et all, 1991).
For the fixed data of the piezometers see table 6.1.

CORK			Ferrule		
Tubenr.	Screen Length (cm)	Perfo- ration (%)	Tubenr.	Screen Length (cm)	Perfo- ration (%)
1	20	20	9	20	20
2	10	10	10	20	10
3	20	10	11	10	20
4	10	20	12	10	10
5	20	20	13	20	20
6	20	10	14	20	10
7	10	20	15	10	20
8	10	10	16	10	10

The design of the experiment is a split plot with a 2^3–experiment with factors Sealing (S), Filter Length (F) and Perforation Rate (P), each on two levels, applied on each tube. Within each of the $2 \cdot 2^3 = 16$ tubes a factor T (tests) (3 levels) is investigated (see table 6.2).

Explanation of the numbers:

	S	F	P	T
1	Cork	10 cm	10 %	Rising Head
2	Ferrule	20 cm	20 %	Falling Head
3				Constant Head

Table 6.2

Sealing	*Filter Screen Length*	*Perforation Rate*	*Duplos*	T_1 T_2 T_3
1	*1*	*1*		
		2		
	2	*1*		
		2		
2	*1*	*1*		
		2		
	2	*1*		
		2		

To determine the permeability in the Rising and Falling Head Test, $Ln(Y_0/Y_2)$ is plotted against time [s] (see Appendix 6.1 and 6.2). In theory this should give a straight line (see Formula 6.2) in which the slope equals $k/(r^2.A)$. The graphs in appendix 6.1 and 6.2 however show an initialy steeper curve. The permeability is estimated twice; once at the steeper first quarter of the curve and once at last quarter of the curve. The points of the curves used are circled. The permeability determined at the last quarter of the graphs is used in the further study.

For the results of the test see table 6.3:

Table 6.3: Original values of k [mm/d]

OBS	TUBE	Sand	Flow	P-l	T meth.	Y
1	1	1	2	2	1	5.6
2	1	1	2	2	2	7.3
3	1	1	2	2	3	30.8
4	2	1	1	1	1	35.5
5	2	1	1	1	2	17.7
6	2	1	1	1	3	118.7
7	3	1	2	1	1	7.5
8	3	1	2	1	2	7.7
9	3	1	2	1	3	15.8
10	4	1	1	2	1	12.3
11	4	1	1	2	2	11.2
12	4	1	1	2	3	24.9
13	5	1	2	2	1	5.9
14	5	1	2	2	2	10.6
15	5	1	2	2	3	14.7
16	6	1	2	1	1	5.4
17	6	1	2	1	2	7.2
18	6	1	2	1	3	12.2
19	7	1	1	2	1	32.8
20	7	1	1	2	2	16.3
21	7	1	1	2	3	53.3
22	8	1	1	1	1	18.1
23	8	1	1	1	2	102.1
24	8	1	1	1	3	34.3
25	9	2	2	2	1	35.9
26	9	2	2	2	2	21.0
27	9	2	2	2	3	593.4
28	10	2	2	1	1	2.4
29	10	2	2	1	2	8.0
30	10	2	2	1	3	29.4
31	11	2	1	2	1	6.1
32	11	2	1	2	2	20.3
33	11	2	1	2	3	77.5
34	12	2	1	1	1	10.3
35	12	2	1	1	2	12.1
36	12	2	1	1	3	22.4
37	13	2	2	2	1	11.9
38	13	2	2	2	2	24.5
39	13	2	2	2	3	66.5
40	14	2	2	1	1	2.3
41	14	2	2	1	2	9.2
42	14	2	2	1	3	28.4
43	15	2	1	2	1	10.2
44	15	2	1	2	2	9.1
45	15	2	1	2	3	21.9
46	16	2	1	1	1	13.3
47	16	2	1	1	2	44.0
48	16	2	1	1	3	28.7

6.5. Statistical analyses

In this paragraph the estimated k-values with the Rising Head, Falling Head and Constant Head are analysed with several statistical techniques.

6.5.1. Distribution-free tests

Distribution-free methods are not influenced by gross errors in the observations and are applicable and valid for any kind of distribution. The tests are simple and quick to perform as to give a rough idea of the results.

6.5.1.1 The Sign-Test

The Sign-test is a simple test to get a quick overvieuw of the measurements. It is a first attempt to get any correlation between the different tests used to estimate the hydraulic conductivity. The test consists of counting how many times the hydraulic conductivity estimated with one test is bigger than the one estimated with another test. The test is described in appendix 6.10.

The test shows that hydraulic conductivities measured with the Constant Head Test are significantly higher. The hydraulic conductivity measured with the Falling- & Rising Head Tests are all calculated with a lower head than with the Constant Head. As in natural circumstances heads of 20 to 30 cm do not occur, the Constant Head test doesn't look suitable to measure the conductivity in peat.

6.5.1.2 The Wilcoxon-Test

This is a rank sum test for two independent samples. The test is used for testing the independence of the hydraulic conductivity on filter length, filter perforation rate and sealing of the tubes. The test has been carried out seperately for the Falling-, Rising- and Constant Head test (see appendix 6.9). The null hypothesis is that the hydraulic conductivity is independent of the filter properties we test for.

From the Wilcoxon-test no dependency from the hydraulic conductivity on the filter perforation rate or sealing of the tube can be derived. It doesn't mean there is no correlation whatsoever, but it doesn't show in this test. The filter length however does show to have an influence on the conductivity. To study this problem more statistical analyses are done with the test results.

6.5.1.3 The Spearman-Test

This is a rank correlation test for two dependent samples. This test is used to figure out the rank correlation for the different means to measure the hydraulic conductivity (Falling-, Rising- and Constant Head). The null hypothesis is that there is no rank correlations between the tests.

Like in the Wilcoxon-test all conductivities in one test were put in a single array and rank numbers were given to the conductivities (the smallest conductivity has number 1. See appendix 6.8). The test is carried out at two tests at the time on the conductivities of one piezometer. The test criterion d^2 is the square of the difference of the coupled rank numbers.

The Spearman-test shows a significant rank correlation between the several tests.

6.5.2 Fishers F-test

6.5.2.1 Introduction

The design of the experiment is a split plot with a 2^3-experiment with factors Sealing (S), Filter Length (F) and Perforation Rate (P), each on two levels, applied on each tube. Within each of the $2 \cdot 2^3 = 16$ tubes a factor T (tests) (3 levels) is investigated. The results of the experiment are evaluated with Fishers F-test, using the GLM-procedure of SAS.

An analysis of variance on conductivities is performed on its logarithms, in order to stabilise the variance. Apart from stabilising the variance, this log-transformation could give rise to a non complicated model (without higher order interactions). The complete ANOVA-tables are given in appendix 6.7.

6.5.2.2 Results from the first, second and third analyses

The first analysis (All Data) is performed on the original data, and a second one on the original data with a modified 27th observation; its hydraulic conductivity was extremely high (593.4 mm/d) compared to all other conductivities, in an order of magnitude of 200. To get an impression of the influence of this single value on the outcome of the analysis a lower value (200 mm/d) was given instead. The two analyses gave the same results, so this high value is of little importance to the outcome of the analysis.

To get a better insight in the factors that do influence the hydraulic conductivity, a third analysis (Reduced Model) is performed. In this analysis only the factors that influenced the

TABEL 6.5 Means of log(k) for the factor Test
with k in (mm/day)

TEST	*Means (mm/d)*	
	Log(k)	*k*
Rising Head	*0.990*	*9.8*
Falling Head	*1.170*	*14.8*
Constant Head	*1.547*	*35.2*

The least significant difference (lsd) for the log(k)-means for the factor Test is calculated with

$$\sqrt{s_2^2 * \frac{2}{16}} * t_{24}(0.025) = \sqrt{0.0560 * \frac{2}{16}} * 2.064 = 0.173 \qquad (6.4)$$

t_{24} = Students-distribution for n=24

Comparing the differences between the means with this lsd shows that all three tests give significant different hydraulic conductivities from each other! From table 6.4 it can also be seen that the k-values estimated with the Constant Head are a factor 2.3 larger than with the Falling Head, while with the Falling Head the k-values are a factor 0.7 larger than with the Rising Head. (See also figures 6.10, 6.11 and 6.12 for the variation of the apparent conductivities with the different methods).

The properties of the tubes
The P-value of the FPS-interaction is larger than 0.05, so there is no significant FPS-interaction.

There is however a significant 2*2-interaction between Sealing (S), Filter Length (F) and Perforation Rate (P). All three p-values are smaller than 0.05. The lsd for the SF-, SP- and PF-means is

$$\sqrt{s_1^2 * \left(\frac{1}{12} + \frac{1}{12}\right)} * t_8(0.025) = \sqrt{0.0806 * \frac{1}{6}} * 2.306 = 0.267 \qquad (6.5)$$

Table 6.6: (S,F)-differences (lsd = 0.267)

S	F	Means [mm/d] Log(k)	1.1	1.2	2.1
1	1	1.472	****	****	****
1	2	0.975	-0.497	****	****
2	1	1.247	-0.225	0.272	****
2	2	1.289	-0.183	0.314	0.042

The graph of the interaction S*F (see Fig. 6.3) demonstrates nearly no F-effect at S_2 and a heavy negative effect at S_1. There is also a significant positive S-effect at F_2 and some S-effect at F_1.

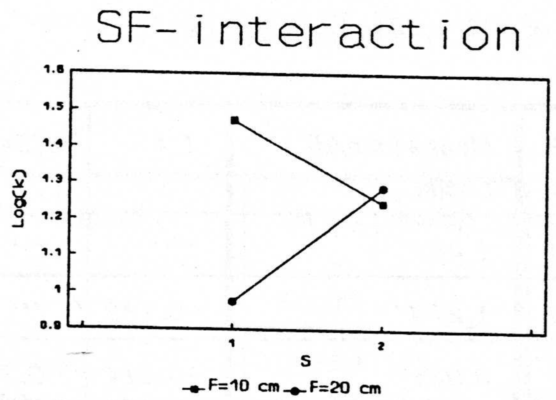


Figure 6.3.

Table 6.7: (S,P)-differences (lsd = 0.267)

S	P	Means [mm/d] Log(k)	1.1	1.2	2.1
1	1	1.276	****	****	****
1	2	1.171	-0.105	****	****
2	1	1.100	-0.176	-0.071	****
2	2	1.436	0.160	0.265	0.336

The graph of the interaction S*P (see Fig. 6.4) demonstrates little P-effect at S_1 and a significant positive effect at S_2. There is little S-effect at P_1 and at P the effect is almost significant.

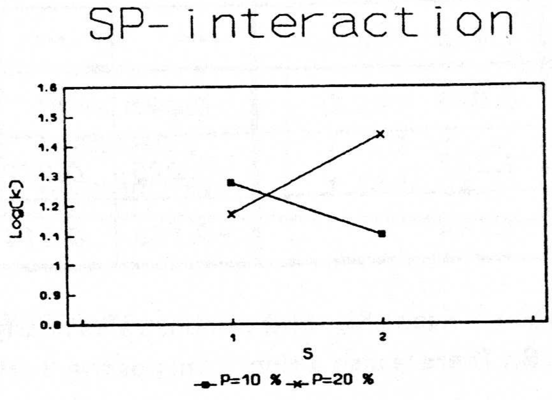


Figure 6.4.

Table 6.8: (F,P)-differences (lsd = 0.267)

F	P	Means [mm/d] Log(k)	1.1	1.2	2.1
1	1	1.445	****	****	****
1	2	1.273	-0.172	****	****
2	1	0.931	-0.514	-0.342	****
2	2	1.333	-0.112	0.060	0.402

The graph of the interaction F*P (see Fig. 6.5) demonstrates nearly no F-effect at P_2, and a significant negative effect at P_1. It also shows a significant possitive P-effect at F_2 and a very little effect at F_1.

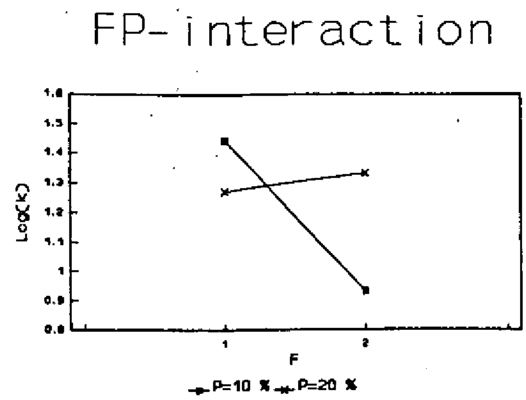


Figure 6.5.

The analyses of the 2*2-interactions of S,P and F are very difficult to interpret, because they don't lead to the same conclusion.

Of the single properties of the tubes only the filter length seems to have an effect on the hydraulic conductivity. The p-value is smaller than 0.05. The means for the different Filter Lengths are given in table 6.9.

Table 6.9

Filter Length	*Means [mm/d]*	
	Log(k)	*k*
10 cm	*1.359*	*23*
20 cm	*1.132*	*14*
20 cm no 27th obs.	*1.061*	*12*

The lsd for the F-means is:

$$\sqrt{s_1^2 * \left(\frac{1}{24}+\frac{1}{24}\right)} * t_8(0.025) = \sqrt{0.0806 * \frac{1}{12}} * 2.306 = 0.189 \quad (6.6)$$

The difference between the two means of the filter lengths is 0.227, which means that there is a significant difference in hydraulic conductivity measured in tubes with different filter lengths.

Conclusions

Statistical inference of the ANOVA shows that especially the Tests, the Filter length and the 2*2-interactions between Filter length, Perforation rate and Sealing have a significant influence on the hydraulic conductivity.
The analyses of the 2*2-interaction between F,P and S don't lead to the same conclusion. To study this problem and because of the significance of the filter length two other analyses are performed on the different filter lengths in 6.4.5.3.
The Tests used seem to have the main influence on the estimated hydraulic conductivities.
The conclusions of the reduced model are in close agreement with those mentioned above, but less pronounced because of the fact that the skipped effects were not significant but had F-values > 1.

6.5.2.3 Results from the fourth and fifth analysis

To study the influence the factor Filterlength has on the hydraulic conductivity, two other analyses are performed. For these analyses the data is split up according to filterlength which results in two sets of data, one with F=10 cm and one with F=20 cm, each with 24 observations. This results in the following split of degrees of freedom in the ANOVA-table (table 6.10):

Tabel 6.10:
The ANOVA-tables of F=10 cm and F=20 cm.

	F = 10 cm		*F = 20 cm*	
SV DF	*F*	*Pr>F*	*F*	*Pr>F*
Total 23				
S 1	*3.82*	*>0.05*	*7.25*	*0.095*
P 1	*2.23*	*>0.05*	*11.93*	*0.027*
*S*P 1*	*0.89*	*>0.05*	*8.09*	*0.048*
REST1 4	$S_1=0.282$		$S_1=0.286$	
T 2	*5.40*	*0.0183*	*19.10*	*0.0001*
REST2 14	$S_2=0.265$		$S_2=0.248$	

Conclusions

The T-effect still turns out to be significant in both tests.

The P- and SP- effects however only occur in the analysis of F = 20 cm, so it seems to be best to use a filter length of 10 cm. This feature that all effects are more pronounced with a Filter length of 20 cm. could also be due to the fact that the piezometers with different Filter lengths are not entangled.

6.6 Discussion and conclusions.

Discussion

Figure 6.6 and 6.7 show the hydraulic conductivities measured with the Falling, Rising and Constant Head at all 16 piezometers. The conductivity in the Falling and Rising Head Test is determined twice: at the beginning and at the end of the test. (Notice the difference in scale of the y-axis).

All three seepage tube methods show an initially higher hydraulic conductivity. This is especially true for the piezometers 9-16 which are the tubes sealed with a ferrule. To emphasize this Figure 6.8 shows only the conductivities determined with the Constant Head Test and at the beginning of the Falling and Rising Head Test. Figure 6.9 is the same graph as Figure 6.8 but without piezometer 9, to get a clearer view on the conductivities of the other piezometers. This last figure confirms the conclusion drawn with the ANOVA that the Constant Head yields significant higher conductivities than the Falling and Rising Head. This agrees with the fact that the Rising- and Falling Head yield lower conductivities with decreasing hydraulic gradient. Waine e.a., 1985 suggested two explanations for this non-linearity, presupposing a structuring of water in the pore spaces and taking the independence of pore space on pressure difference into account. The conductivities estimated with the Constant Head test refer to peat in which the void ratio or water content has been raised from a lower initial value corresponding to its natural state. Thus the Constant Head test can not be used to estimate the permiability of peat at its natural water content. This is because the permeability is influenced by the adsorption complex which depends upon the natural water content, not an artificial higher one (Hobbs, 1986, page 46).

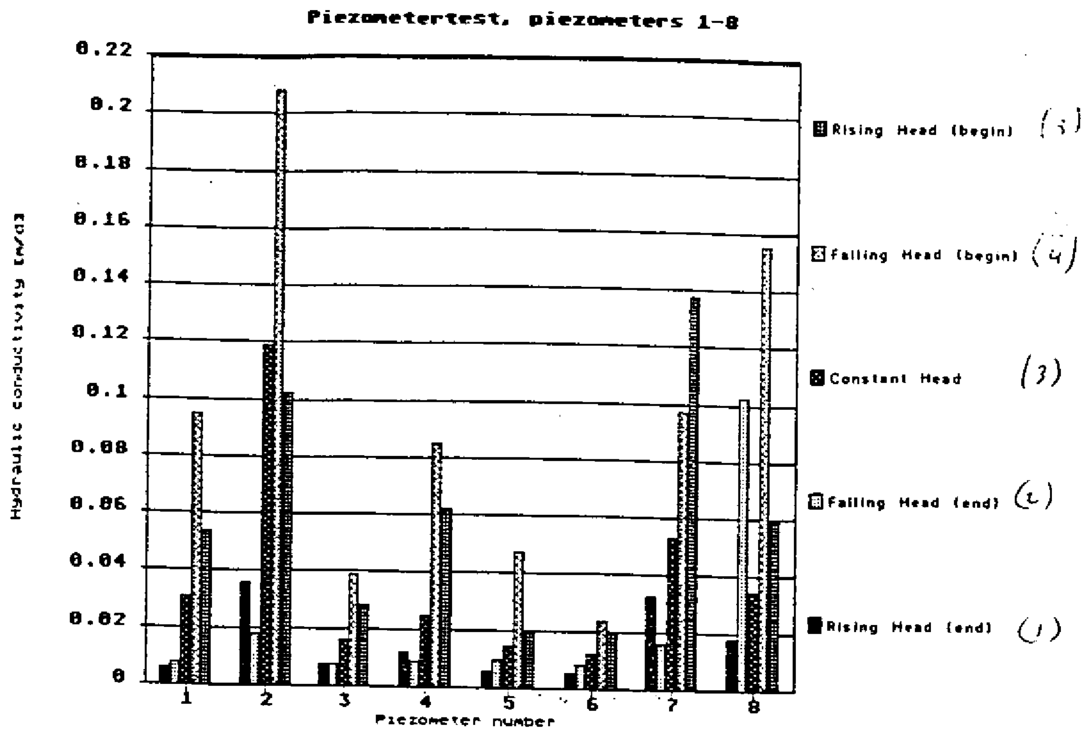


Figure 6.6. Results of all tests, piezometer 1-8, closed with a cork

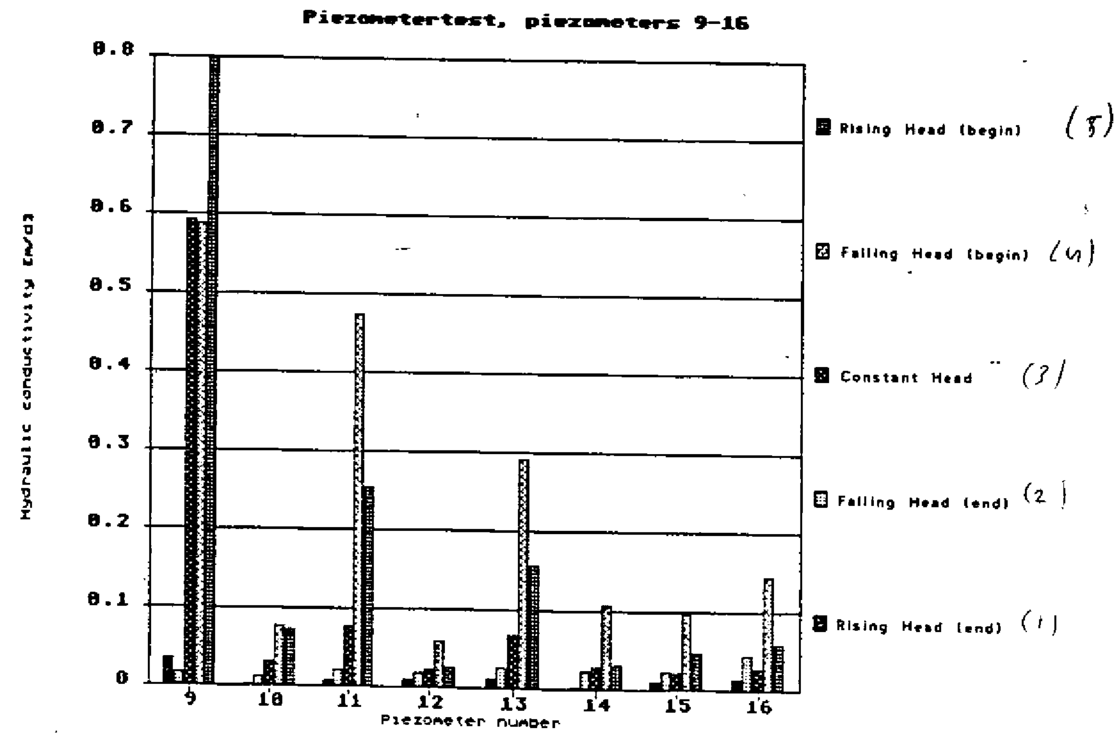


Figure 6.7. Results of all tests, piezometer 9-16, closed with a ferrule

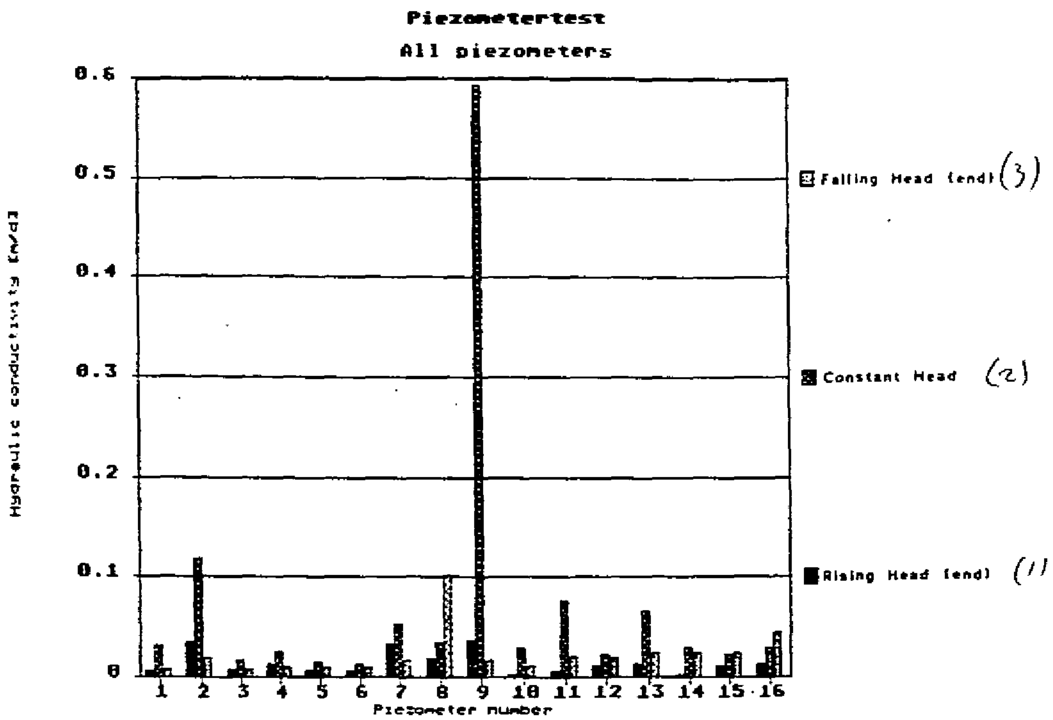


Figure 6.8. Rising, Falling and Constant Head for all piezometers

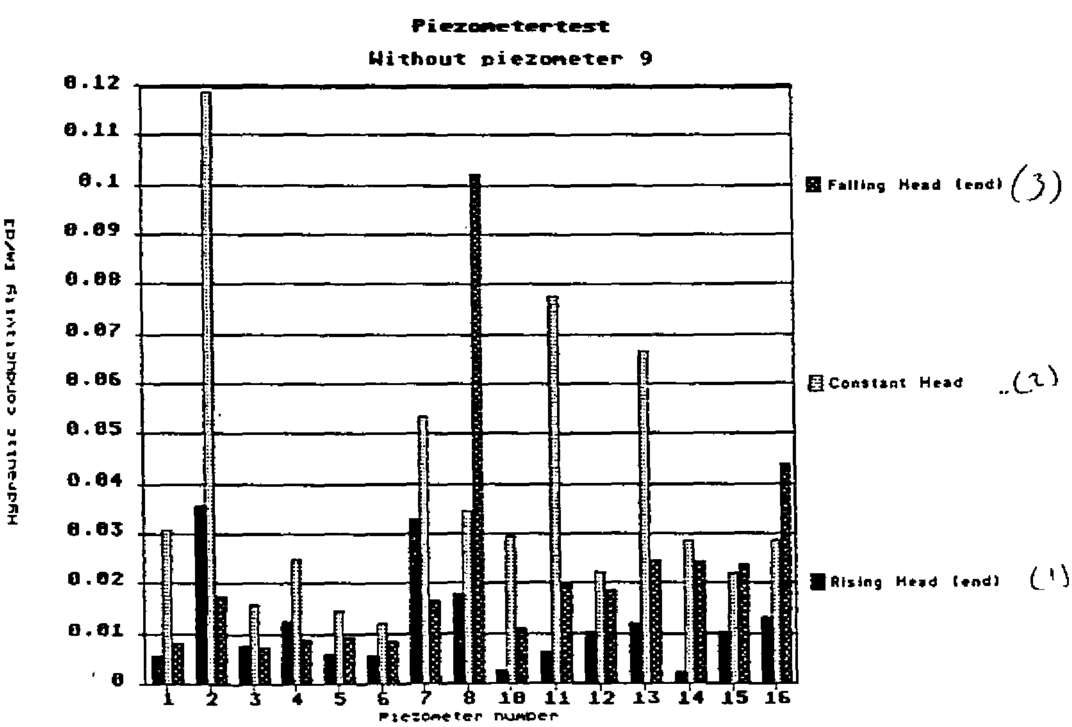


Figure 6.9. Rising, Falling and Constant Head for all piezometers, except piezometer 9

The conductivity is, in the case of the Rising and the Falling Head test, independent of the head which the test started of with (see appendix 6.11) This can be explained by the elastic

storativity (Hemond e.a., 1985); "the property of saturated, compressible porous material to gain or give up water by expansion or contraction of the solid matrix and the accompanying changes in total pore volume". Which means that initially there is no steady-state flow, Darcy's law can not be used and the hydraulic conductivity can't be determined at the beginning of the Falling and Rising Head test. Rycroft e.a. (1975) even question whether or not the transmission of water through peat takes place according to Darcy's law at all. The apparent hydraulic conductivity varies with the potential gradient under which it is measured. Such a variation is a contradiction in terms, for according to Darcy's law, the flow rate should be proportional to the gradient of hydraulic potential. Ingram e.a. (1974) concluded that humified *Sphagnum* peat does not transmit water in accordance with Darcy's law and that it can only be applied in peat of low humification. Hemond e.a. (1985) argued that even in humified peats (as in the catotelm) under natural conditions the application of Darcy's law is allowed. "Field-measurement methods which provide steady-state conditions and minimal alteration of effective stress are likely to provide the most accurate information for hydrologic models". The Falling Head method, given a small head applied, seems to meet best with these requirements. The Constant Head causes too much stress on the peat.
The correlation between the head at the beginning of the test and the quotient of the k's at the beginning and at the end of the test is very low (see appendix 6.11). This means that the influence of the initial head on the conductivity at the end of the test is very low. It shows that the changes to the peat are reversible and that the peat has enough time to recover during the test from the disturbance of the raised water level (if the head is smaller than about 80 cm, like in this test).

The conductivities of tubes 9, 11 & 13 show definite higher values in the beginning of the test than the other tubes (see Fig. 6.7). These high conductivities can be caused by the use of ferrules to seal the piezometers. The ferrules close the tubes on the outside and thus have a slightly larger diameter then the tubes, hence make a bigger hole in the peat then tubes sealed with a cork. The result is that around a tube sealed with a ferrule a gap between tube and peat occurs, which disturbs the flow of peat water in or out of the tube. From figure 6.6 and 6.7 it can be seen that the ferrules have mainly an impact on the initial estimated conductivity, that is why no significant influence could be found with the ANOVA which was performed only on the final estimated conductivity. Hence for permeability measurements (to be on the safe side) it is best to use a tube sealed with a cork instead of a ferrule. This also means that the piezometers, allready on Clara- and Raheenmore Bog, used for measuring the hydraulic level of the peat can't be used to measure the hydraulic conductivity because they are sealed with ferrules. Another problem with these piezometers is that a cavity is formed around the filter after flushing and testing the piezometer for responsiveness by filling it with water.

Figure 6.10 is a graph showing the heads with which the conductivities are measured in the Constant Head test. It can be seen that the 4 piezometers with the smallest heads give the highest hydraulic conductivity of the peat. No relation can be found between the day of observation and the measured conductivities. Additionally, the drillings near eight of the sixteen piezometers (see appendix 6.12) give all the same peatstructure: reedpeat.

The conclusion can be that large heads applied during the Constant Head test disturb the peat too much to get a representative permeability; the hydraulic conductivity varies with head or head gradient because of the variation of the structure of the material. On the other hand 3 measurements is very little to build a conclusion on.
The conclusion of Rycroft e.a. (1975 II) that the head is largely responsible for the variation in hydraulic conductivity can be confirmed with the k-values for each individual tube in the Falling- and Rising Head experiments. From the figures 6.10, 6.11 and 6.12 and the Fishers F-test in 6.5.2 it can also be seen that the test itself has a great influence on the apparent conductivity. The largest variation in k occurs with the Constant Head Test and the smallest with the Falling Head (leaving out the highest and lowest values). The Constant Head Test itself though doesn't give such a clear picture (see Figure 6.9). Comparing all three tests with each other (see Fig. 6.10, 6.11 and 6.12) does show a significant dependence between permeability and head.

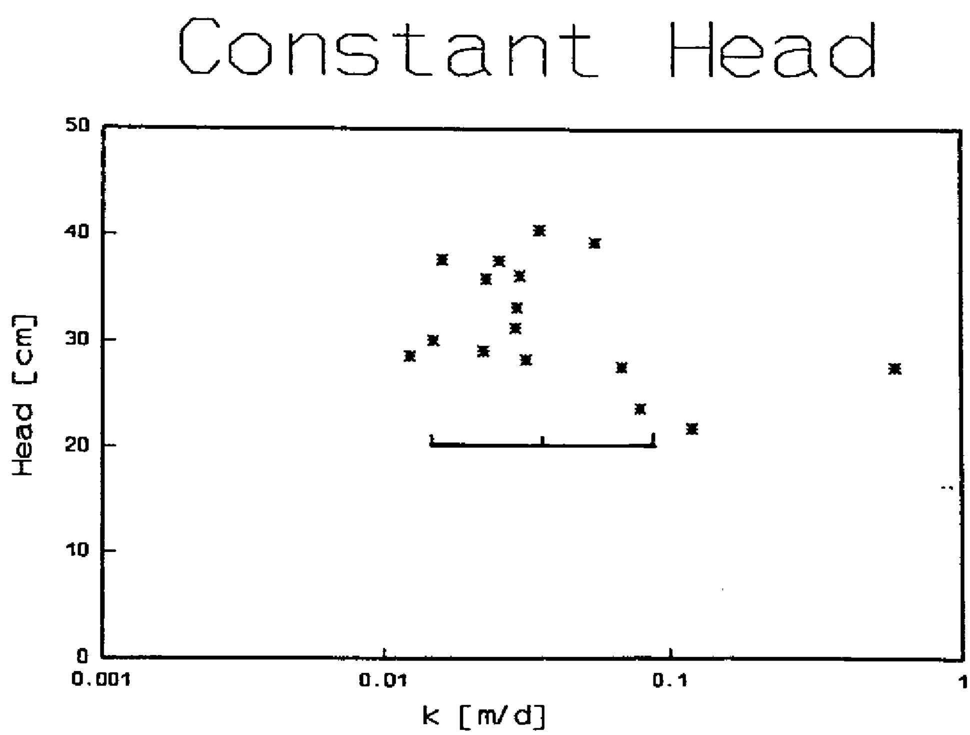


Figure 6.10 Variation of apparent conductivity, with Constant Head, all piezometers

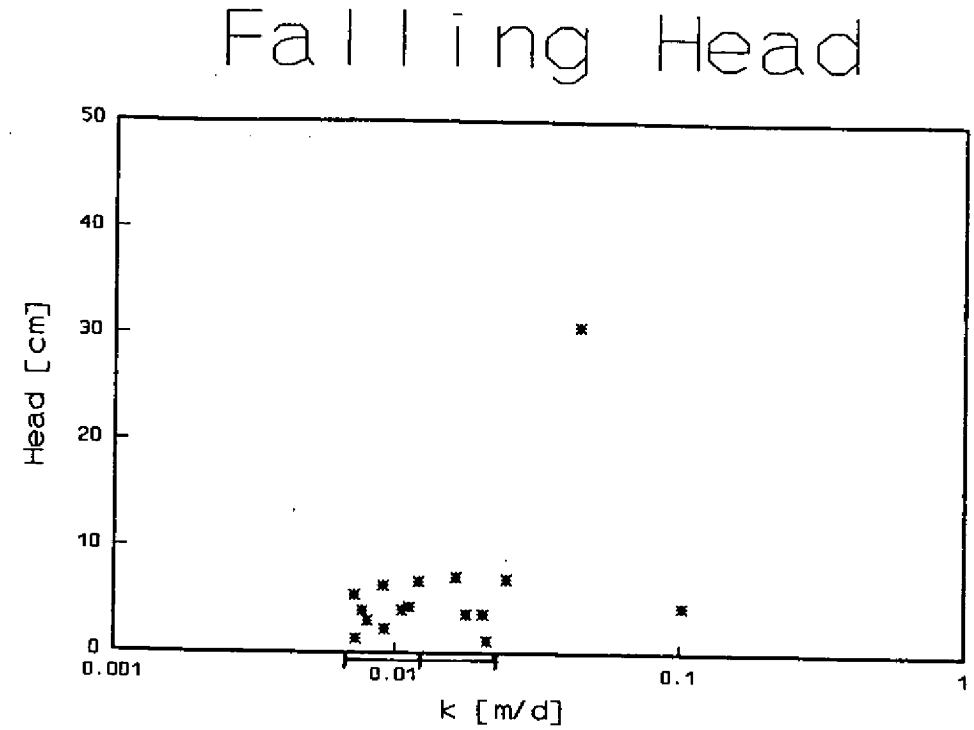


Figure 6.11 Variation of apparent conductivity, with Falling Head, all 16 piezometers.

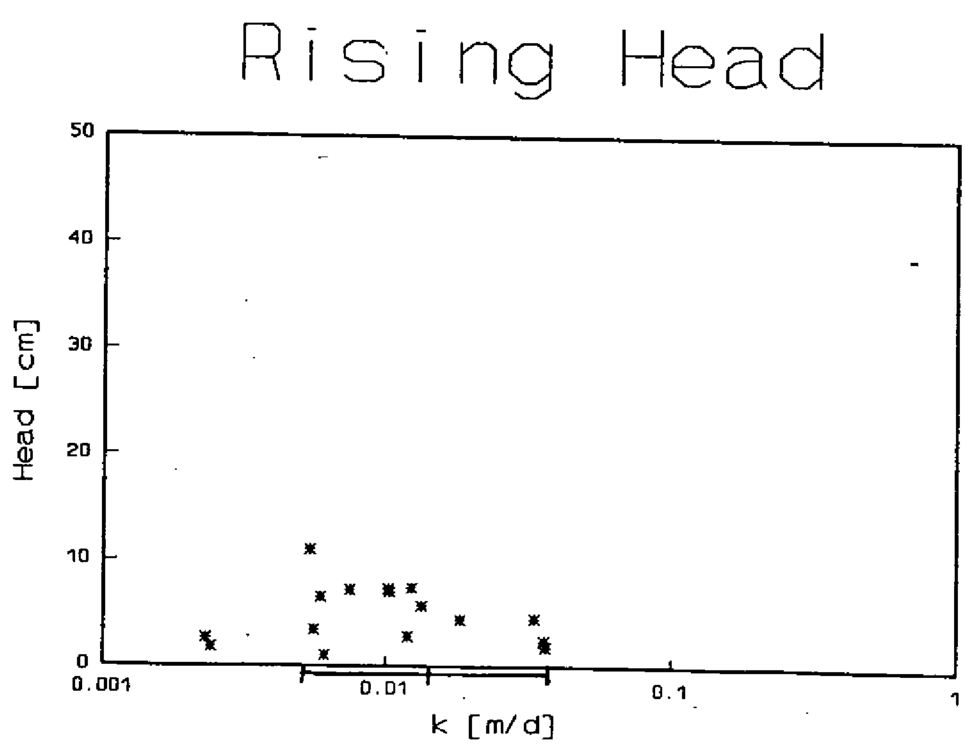


Figure 6.12 Variation of apparent conductivity, with Rising Head, all 16 piezometers.

Conclusions

The head applied with the Constant Head test alters the effective stress in the peat too much to give an accurate estimation of the permeability under natural conditions.
The differences between the k-values with Rising- and Falling Head are very small. The variance however with Falling Head test is much smaller. To study if a "failure" like observation 23 occurs often the same test should be performed again at a different location. For now the conclusion is drawn that it is best to use the Falling Head test.

With a filter length of 10 cm no S-, P- or SP-effects occur, so the most accurate way of testing seems to be with a filter length of 10 cm. Perforation rate and sealing are of no importance anymore then, but because of lesser disturbance of the sealing with a cork seems to be the best.

7. GROUND WATER dBASE

7.1. Introduction

In 1987 the first ground water tubes were installed on Raheenmore bog. Monitoring on a regular basis (every two weeks) started in 1989, when this project was started. In addition many more piezometers were installed on both Raheenmore and Clara bog. The transects and plots were the tubes are placed are:

On Raheenmore bog:
- North-south transect
- East-west transect
- Lag zone (monitoring stopped june 1991)
- Boundary survey (monitoring stopped august 1991)

On Clara bog west:
- A-A' transect
- B-B' transect
- Soak transect (in december 1991 extra tubes were installed)
- Facebank

On Clara bog east:
- Plot A
- Plot B
- Plot C (monitoring of the plots was stopped in october 1991.)

In the transects the piezometers are organized in so-called nests. Each nest consists of 1 or more piezometers. The piezometers all have different lengths or filter lengths. The following tubes can be distinguished:

Table 7.1: Types of piezometers.

Code	Material	Tube length (cm)	Perforation (cm)
GWD	Drainage tube	50	50
GW	PVC	120	100
A	PVC	120	15
B	PVC	200-300	15
C	PVC	300-400	15
D	PVC	400-600	15
E	PVC	500-1200	15
F	PVC	to bottom of peat	15
S	PVC	into subsoil	15

7.2. Organization of the ground water data

All data concerning the ground water levels are stored in a ground water dBase . There are 3 types of data: monitoring data, levelling data and fixed data. For each transect and each type, a different file is opened.

The monitoring data of a transect are stored in one record for each monitoring day like:

date	201A	201B	201D	202A	etc.
01/01/91	20.1	23.4	75.5	20.9	rec 1
01/15/91	23.5	25.0	80.4	22.0	rec 2
etc.					

The names of the monitoring files are:
For Clara: C*TUBM--.DBF
For Raheenmore: R*TUBM--.DBF

('' stands for a letter of the transect; 'C' = C-C' transect)*
('--' stands for the file number; '03' chronologically is the third file)

Usually the monitoring tubes are levelled in once, and together with other data like the tube length and the X and Y coordinate, the Z coordinate (in MOD) is stored in a file with fixed data. Thus the monitored values can easily be transformed into piezometric heads above the reference level.

However, on bogs the problem of swelling and shrinkage of the bog surface (mooratmung) occurs. Therefore the ground water tubes are levelled in four times a year. The results of each levelling are stored in a dBase file (one file per transect). The records contain the tube number, the tube level, the ground level and the levelling date:

Tubenr	Tubelev	Groundlev	Date	
201A	100.32	100.20	01/02/91	rec 1
202B	100.33	100.20	01/02/91	rec 2
etc.				

The names of the levelling files are:
For Clara: C*TUBP--.DBF
For Raheenmore: R*TUBP--.DBF

The fixed data of the piezometers are stored in different files for each transect. The organization of the records had to be reconsidered. It was decided to include the following data (in appendix 7.1 the dBase structure is given):

- Tube number
- Tube number for Hydro base
- X- coordinate
- Y- coordinate
- Tube length
- Top filter from top tube
- Bottom filter from top tube
- Diameter
- Date of installation
- Date of removal
- Remarks
- Topping (part sawn off)

The Fixed file names are:

For Clara:	C*TUBF--.DBF
For Raheenmore:	R*TUBF--.DBF

In october and december 1990, some of the piezometers in nests were sawn off in such a way, that all piezometers had the same reference height. On top of that, the piezometers were clustered, to minimize vertical movements.
Sawing off a part of the piezometer implies removal of the old tube and at the same time installation of a new one (with the same tube number). The tubelength is corrected, as well as the top and the bottom of the filter.

7.3. Determination of the piezometric heads above MOD

For the determination of the piezometric heads three aspects have to be considered: the monitored values, the levelling data and possibly the sawing off (topping) data. A computer program (in turbo Pascal) is written (appendix 7.2) to convert the data into a piezometric heads. Because of the difference in structure between the dBase files, it was not possible to solve the problem in the dBase programming language.

The program assumes linearity of swelling and shrinkage between two levelling periods. Although the assumption is definitely not right, there is no need to change the assumption, as the swelling and shrinkage usually is no more than 1 or 2 cm. So the error caused by the assumption will probably be less than a centimetre.

Input and output of the program

The disadvantage of not using the dBase programming language is, that the data have to be converted into a DOS-text. This can be achieved with the help of the LOTUS package. Printing the range to use into a print file (extension .PRN) is an easy way of getting the right data type and the right format for the input files. The formats of the different files are described in appendix 7.3.

The format of the output files is such, that it can be used as input for the quality check program of van der Schaaf and de Vries (described by Lensen, 1991). An example is given in appendix 7.4.

When running the program, first 3 possibilities are given:

1. The monitoring data of the file are either before the first, or after the last levelling. In this case no interpolation between two levellings is possible.
2. The monitoring data are between two levellings, and no sawing has taken place. In this case interpolation between the levellings is carried out.
3. The monitoring data are between two levellings, and sawing has taken place. In this case interpolation is carried out and the values are corrected whenever necessary.

Then, the input files are asked for. The extension .PRN is assumed. The program calculates the piezometric heads in MOD.

After this the possibility is given to either write the output to already existing output files or to open (or re-open) new output files.

The program calculates the number of output files and asks for names; the extension .PRN is given automatically. The output of only 5 tubes per file is possible, otherwise the output would not be suitable for the quality check program.

The piezometric heads are written to the output files and you have the possibility to quit or to continue. In case of continuation of the program, the piezometric heads of the new period are automatically added to the output files.

8. WATER RETENTION

8.1. Theory

The amount of water in a soil is in itself no effective indication of its availability; it is easier to pump water out of a sandy soil than it is out of a clay soil. To get a better insight in the problems of the flow of water in the unsaturated soil the relationship between the volumetric soil water content and the water suction of the soil can be very helpful. This relationship is characteristic for different types of soil and is therefore often called the soil water characteristic or water retention curve. It describes the distribution of the water in the pores and with what force the water is kept by the soil. A means to visualise this relationship is the pF-curve: the suction is expressed in cm. water and plotted on a logarithmic scale against the volumetric water content.

Several things can be derived from a pF-curve:

- A very important property of the soil is the storage capacity: the quantity of moisture that can be stored into a layer of the peat. From the storage capacity at different suctions the available amount of water can be derived.
- Another property is the pore size distribution and therewith the capillary binding of the water.

The relationship between soil moisture content and soil moisture tension is to a great extent dependent on the size and distribution of the pores in the soil. Soils with a wide range of pore sizes release the water very gradually compared to soils that only contain a small range of pore sizes.

- The capillary rise and therewith the total watersupply for the toplayer of the soil and the plants on it. The height of the capillary rise is inversely proportional to the diameter of the pore.
- The air-filled porosity (the fraction of the bulk volume occupied by air) and therewith the aeration of the rootzone.

The relationship between moisture tension and moisture content of a soil is in general not unique. At a given tension a soil will contain less water while wetting than while drying. This phenomenon is called hysteresis. The pF-curves measured here are characteristic desorption curves.

8.2. Method

For pF-measurements it is nescessary to take undisturbed soil samples, since the structure of the sample affects the water retention. The samples were obtained by pushing stainless steel cylinders (contents 100 cm^3 or 250 cm^3) vertically into the desired horizon, exposed by digging a pit, and removed carefully.

The equipement in which the samples were put to measure the water retention curve is shown in fig. 7.1. The sample (S) was closed with rubberrings (R) and the ceramic plate (K) prevented loss of air. Water though could move freely out of the sample and into the burette (B). Initially the sample was saturated by raising the waterlevel of the burette above the sample. At the beginning of the measurement the top of the sample was placed at the same level as the overflow pipe (O), so the waterlevel in the sample would be the same during the whole of the measurement. A compressor produced a pressure (P) on top of the sample and water flew out of the sample into the burette. When equilibrium was reached the amount of water that had flown in the burette was measured and the sample was subjected to a higher pressure.

The pressures used were:

10 cm.	pF=1
30 cm.	pF=1.5
61 cm.	pF=1.8
100 cm.	pF=2
300 cm.	pF=2.5
1000 cm.	pF=3

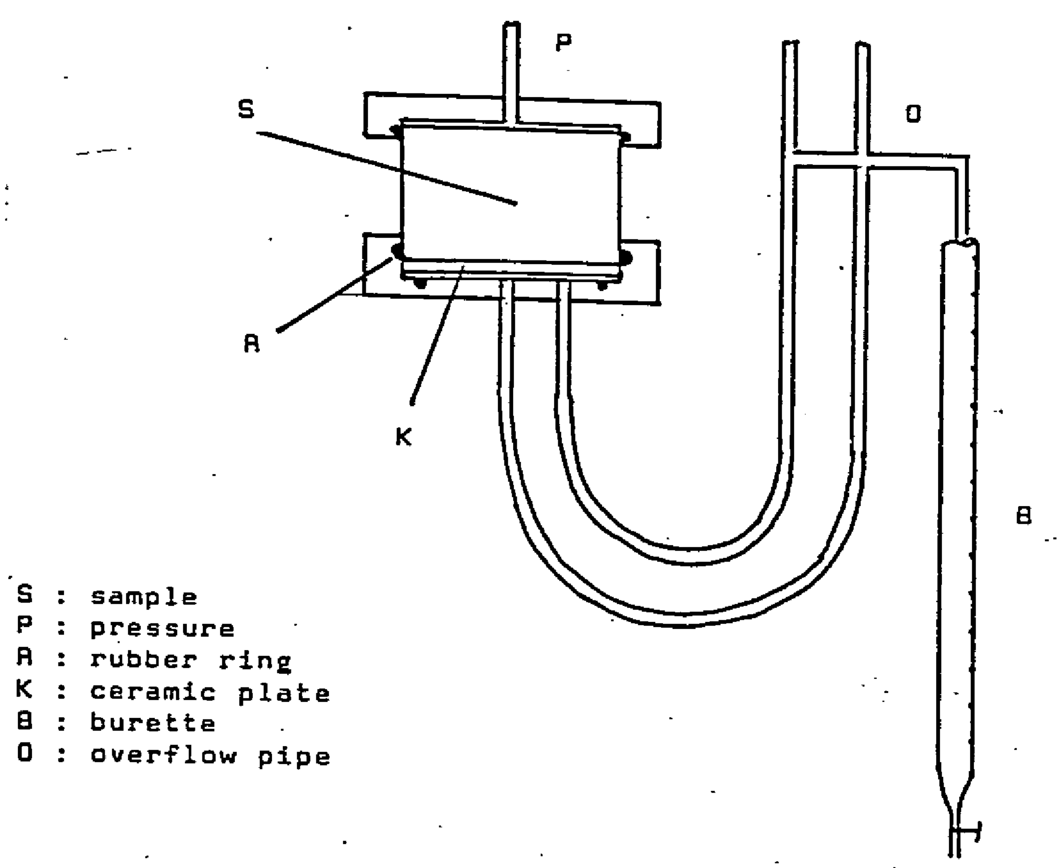


Figure 7.1. Equipment used in the outflow method (from: Gerven '90)

The saturated water content of the sample was measured after the measurements were finished. Therefore the samples were saturated again, weighed, dried in an oven at 105° and weighed again.

8.3. Results

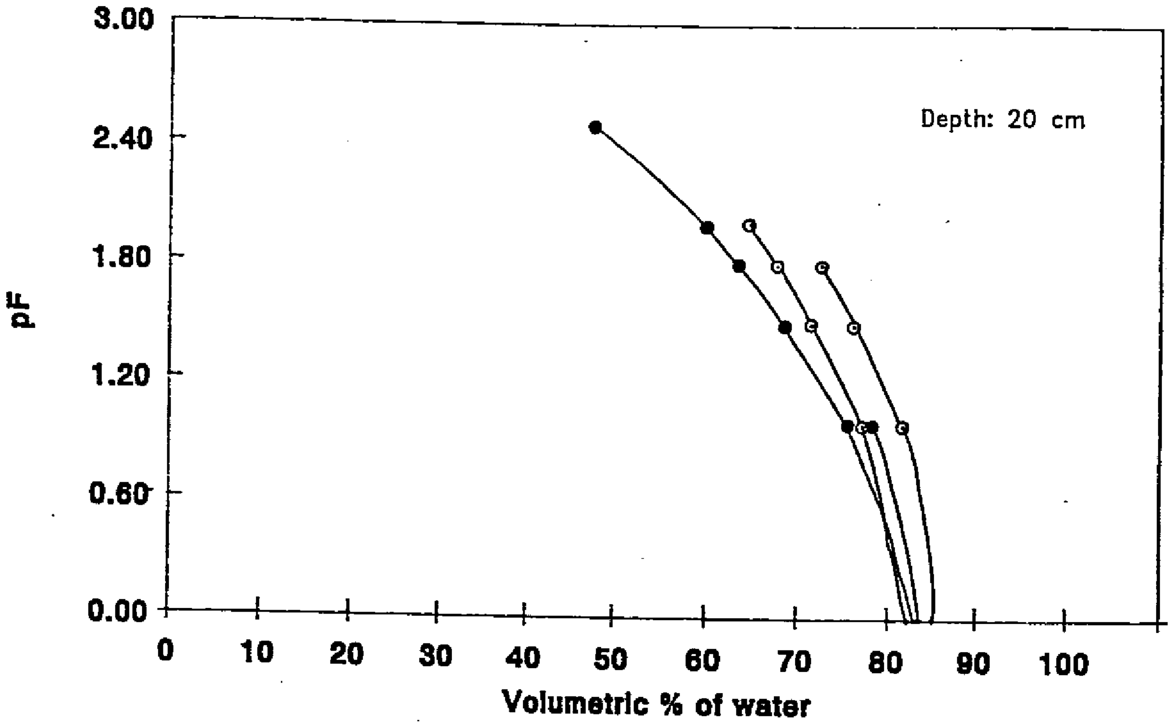
The samples were taken at the old facebank, between piezometer 71 & 72. The retention curves are shown in Figure 1 to 4. None of the curves reach pF= 3 and some curves even end before pF= 2.5. This is due to air entering the sample. No further calculations are done with the results.

In previous retention tests in this project, probably not enough time is allowed for the sample to reach equilibrium. These results should therefore be interpretted with great caution.

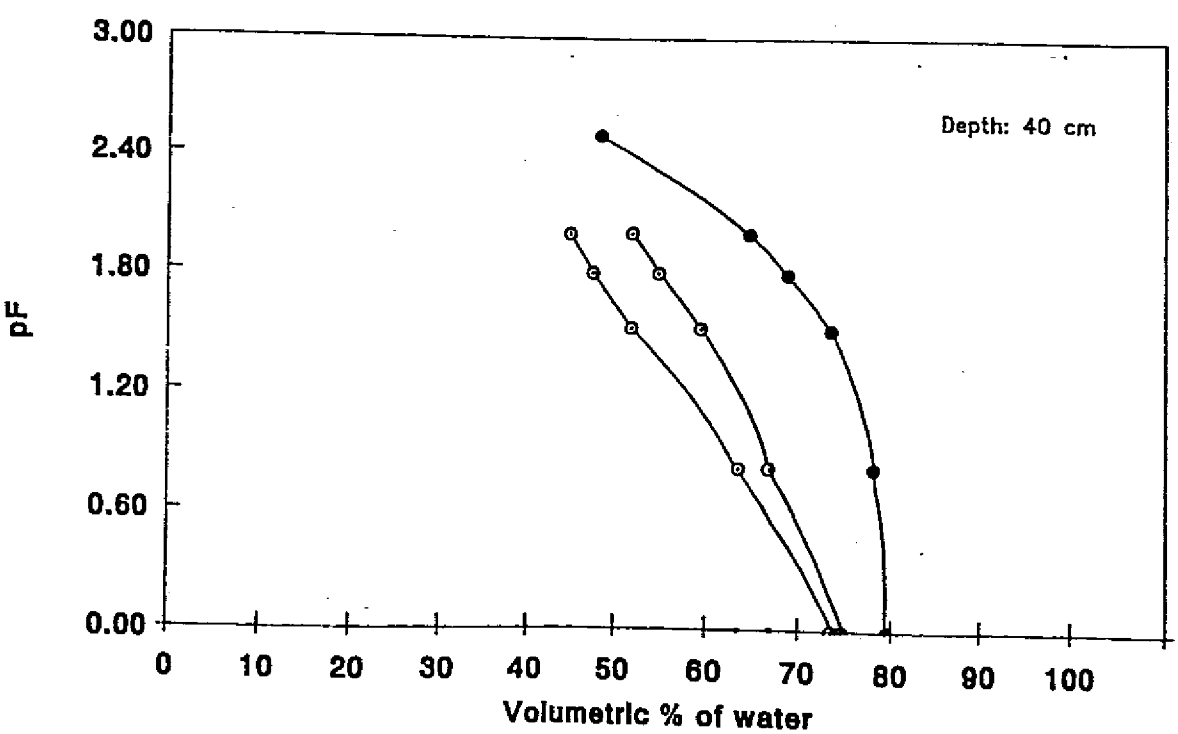
Key for the figures:

- o sample of 100 cm^2
- • sample of 250 cm^2

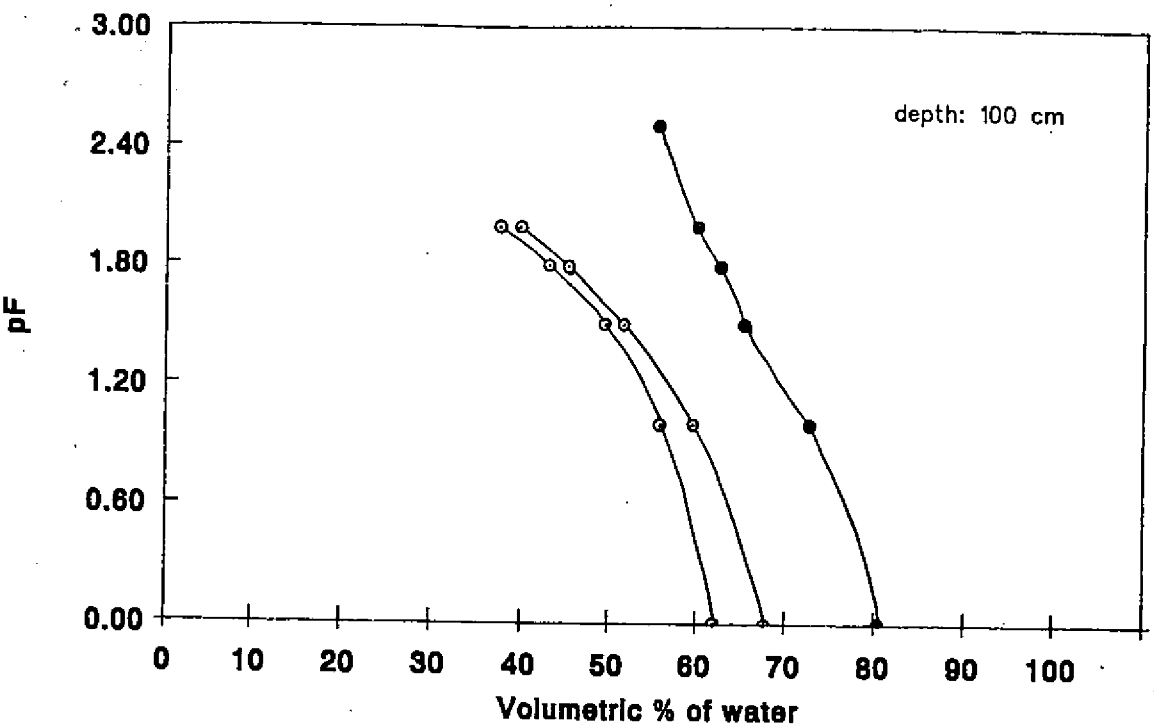
Old Facebank
Between piezometer 71 & 72



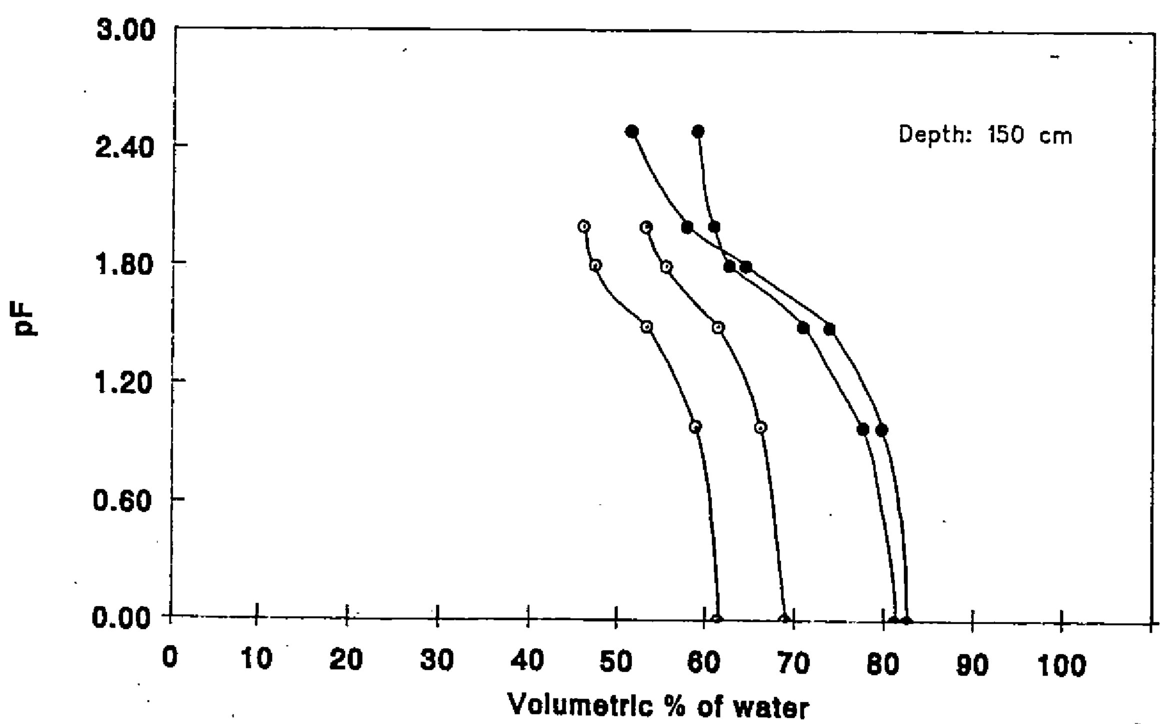
Old Facebank
Between piezometer 71 & 72



Old Facebank
Between piezometer 71 & 72



Old Facebank
Between piezometer 71 & 72



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APPENDIX 2.1

Places of the augerings

PLACES OF THE AUGERINGS

Piezo. Number	*X coordinate*	*Y coordinate*	*Surface Level [M.O.D.]*
CLARA			
56	*673.0*	*1010*	*58.49*
50	*840.5*	*1095*	*58.53*
49	*941.0*	*1188*	*60.71*
49–57	*903.4*	*1218*	*58.75*
57	*865.7*	*1248*	*58.5*
59	*772.0*	*1308*	*57.64*
RAHEENMORE			
201	*1370*	*-290*	*100.37*
206	*1253*	*-209*	*103.99*
209	*1133*	*-110*	*104.99*
210	*985*	*-80*	*105.62*
211	*853*	*-60*	*105.78*
330	*602*	*-1*	*106.64*
327	*603*	*183*	*106.64*
324	*605*	*366*	*106.59*
321	*606*	*461*	*106.62*
317	*609*	*509*	*106.02*
313	*611*	*523*	*105.06*

APPENDIX 2:2

The Von Post and Granlund Humification scale

THE VON POST AND GRANLUND HUMIFICATION SCALE

H1 Completely unhumified plant remains, from which by hand only almost colourless water can be squeezed.

H2 Almost unhumified plant remains; the squeeze water is light brown and almost clear.

H3 Very poorly humified plant remains; the squeeze water is cloudy and brown.

H4 Poorly humified plant remains; peaty substance does not escape from between the fingers by squeezing.

H5 Moderately humified plant remains; the structure is however still clearly visible; the squeeze water is dark brown and very cloudy, while some peat escapes between the fingers.

H6 Fairly highly humified plant remains; the structure (texture) is unclear. About a third part of the peat escapes through the fingers. The part remaining in the hand has a more clear plant structure than the part that was squeezed out.

H7 Highly humified plant remains; about half of the material escapes when squeezed. The water which may escape is dark brown in colour.

H8 Very highly humified plant remains; two-thirths escapes through the fingers. The remainder consists mainly of resistant bits of roots, wood etc.

H9 Almost completely humified plant remains; almost all the peat escapes through the fingers. Structure is almost absent.

H10 Totally humified plant remains; amorphous peat; all the peat escapes the fingers without any water being squeezed out.

APPENDIX 2.3

The Augerings

Method: Drilling with a peat auger
Place: RAHEENMORE BOG, PIEZOMETER 201
Date: 29-8-1991
Surfacelevel (M.O.D.): 100.37

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.15			
0.15-0.25	Sphagnum	5	2/4 5YR
0.25-0.50	Sphagnum, Bog Cotton	2	3/4 5YR
0.50-0.60	Heather, Sphagnum	4	2/3 5YR
0.60-1.00	Bog Cotton, Sphagnum	3	4/6 5YR
1.00-1.25	Sphagnum, Heather, Bog Cotton	4	3/3 5YR
1.25-1.60	Sphagnum, Bog Cotton	3	4/6 7.5YR
1.60-1.80	Heather, Bog Cotton	7	2/4 2.5YR
1.80-2.00	Heather, Sphagnum, Bog Cotton	5	2/3 2.5YR
2.00-2.50	Reed, Alder	6	2/4 5YR
2.50-2.90	Reed	5	3/2 5YR
2.90-3.00	Reed, Birch, Alder	6	2/2 5YR
3.00-3.30	Reed, Alder	7	2/2 5YR
3.30-3.50	Reed, Birch	7	2/2 5YR
3.50-3.52	Clayish		
3.52-3.65	Reed, Alder (earthend)	6	1.7/1 5YR

Couldn't get further through the peat; no clay found yet.

Method: Drilling with a peat auger
Place:
Date: 23-9-1991
Surfacelevel (M.O.D.): 103.99

RAHEENMORE PIEZOMETER 206

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.15	Roots	5	2/2 7.5YR
0.15-0.25	Sphagnum, Small Fibre	4	2/3 7.5YR
0.25-0.35	Sphagnum	4	3/4 7.5YR
0.35-0.50	Sphagnum, Small Fibre	2	2/4 5YR
0.50-0.60	Sphagnum, Small Fibre	2	2/4 5YR
0.60-0.70	Sphagnum, Small Fibre	2/3	3/3 2.5YR
0.70-0.95	Small Fibre, Sphagnum	6	2/4 2.5YR
0.95-1.00	Sphagnum, Small Fibre	2/3	3/3 2.5YR
1.00-1.10	Sphagnum, Heather, Small Fibre	3	4/5 5YR
1.10-1.25	Heather, Small Fibre, Sphagnum	6	3/3 2.5YR
1.25-1.30	Sphagnum, Heather	3/4	2/4 2.5YR
1.30-1.45	Heather, Small Fibre, Sphagnum	5	2/3 2.5YR
1.45-1.50	Sphagnum, Small Fibre	4	2/4 5YR
1.50-1.65	Sphagnum, Small Fibre	7	2/4 5YR
1.65-1.90	Small Fibre, Sphagnum	7	2/4 2.5YR
1.90-2.00	Sphagnum, Small Fibre, Bog Cotton	3/4	2/4 5YR
2.00-2.05	Sphagnum, Heather, Small Fibre	4	3/5 5YR
2.05-2.20	Heather, Sphagnum, Small Fibre	7	2/4 5YR
2.20-2.40	Sphagnum, Small Fibre, Heather	3	2/4 2.5YR
2.40-2.50	Heather, Sphagnum, Small Fibre	7	3/3 2.5YR
2.50-2.80	Sphagnum, Small Fibre	4	2/4 2.5YR
2.80-3.00	Sphagnum, Small Fibre, Heather	2	3/4 2.5YR
3.00-3.25	Sphagnum, Heather, Bog Cotton	5	2/4 5YR
3.25-3.50	Bog Cotton, Heather, Sphagnum	5	2/4 2.5YR
3.50-3.60	Bog Cotton, Small Fibre	5	2/3 2.5YR
3.60-3.70	Old Sphagnum, Bog Cotton, Small Fibre	4	2/3 2.5YR
3.70-4.00	Old Sphagnum, Bog Cotton, Small Fibre, Heather	4	3/2 2.5YR
4.00-4.25	Heather, Small Fibre	6	2/4 2.5YR
4.25-4.30	Old Sphagnum, Bog Cotton, Heather	4	3/2 2.5YR
4.30-4.40	Old Sphagnum, Heather, Small Fibre	5	3/3 5YR
4.40-4.50	Old Sphagnum, Bog Cotton, Heather	5	2/3 2.5YR
4.50-5.00	Old Sphagnum, Bog Cotton, Heather	4	3/3 2.5YR
5.00-5.10	Old Sphagnum, Bog Cotton, Heather	7	
5.10-5.30	Old Sphagnum, Bog Cotton, Heather	5	
5.30-5.40	Birch, Small Fibre, Reed	6	
5.40-5.50	Reed Peat		
5.50-5.60	Reed Peat	5/6	2/2 5YR
5.60-5.77	Reed Peat, Alder	6	2/2 7.5YR
5.77-5.95	Reed Peat, Alder	5	2/3 5YR
5.95-6.10	Reed Peat	6	2/4 5YR
6.10	Clay (boulder clay)		5/1 10y

Method: Drilling with a peatauger
Place: RAHEENMORE BETWEEN PIEZOMETER 206 AND PEG 206*
(BETWEEN THE DRAINS)

Date: 6-11-'91
Surfacelevel (M.O.D.):103.88

Depth (m)	Vegetation Type	Humification Degree	Color
0.00-0.25	Sphagnum Peat, Many Roots, Small Fibre	5	2/4 5YR
0.25-0.50	Sphagnum Peat, Small Fibre	5	2/3 5YR
0.50-0.85	Small Fibre	4	3/3 5YR
0.85-0.95	Sphagnum Peat, Small Fibre	4	3/3 5YR
0.95-1.00	Bog Cotton, Small Fibre	4	2/3 5YR
1.00-1.15	Reed, Small Fibre	4	3/4 5YR
1.15-1.35	Small Fibre, Heather, Red Roots	5	2/4 5YR
1.35-1.60	Small Fibre, Heather, Sphagnum	4	2/2 5YR
1.60-1.70	Sphagnum Peat	4	3/6 5YR
1.70-1.80	Sphagnum Peat, Many Small Fibre	4	3/4 5YR
1.80-1.90	Sphagnum Peat, Many Small Fibre	7	2/3 5YR
1.90-2.00	Sphagnum Peat	4	2/4 5YR
2.00-2.15	Sphagnum Peat	5	3/2 5YR
2.15-2.50	Old Sphagnum, Many Small Fibre, Heather, Bog Cotton	4	3/3 5YR
2.50-2.60	Sphagnum Peat	4	2/4 5YR
2.60-2.75	Sphagnum Peat, Bog Cotton, Small Fibre	4	3/2
2.5YR			
2.75-3.00	Small Red Roots, Alder(?)	5	3/2 5YR
3.00-3.40	Small Red Roots, A lot of Bog Cotton	5	2/2 5YR
3.40-3.50	Small Red Roots, Much Reed, Alder, Small Fibre	5	2/3 5YR
3.50-3.65	Wood Peat, Alder	5	2/4 5YR
3.65-4.00	Reed Peat, Bog Cotton, Wood	5	3/2 5YR
4.00-4.05	Reed Peat, Alder	6	2/3 5YR
4.05-4.30	Reed Peat, Birch	6	2/2
7.5YR			
4.30-4.40	Boulderclay		7/2 5Y
4.40-4.50	Reed Peat, Wood	5	2/2 5YR
4.50	Boulderclay		9Y

Method: Drilling with a peat auger
Place:

NEXT TO PIEZOMETER 206
*206***
(OUTSIDE DRAINS)

Date: 6-11-1991
Surfacelevel (M.O.D.): 103.73

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.25	Sphagnum Peat, Roots	6	2/2 5YR
0.25-0.45	Sphagnum Peat	4	4/6 5YR
0.45-0.50	Sphagnum Peat, many Small Fibre	4	3/3 5YR
0.50-0.80	Sphagnum Peat, many Small Fibre, Reed, Bog Cotton	4	4/6 5YR
0.80-1.00	Sphagnum Peat, Bog Cotton	3	4/6
7.5YR			
1.00-1.30	Sphagnum Peat, many Small Fibre, big Roots	4	3/4 5YR
--			
-			
1.30-1.50	Sphagnum Peat, many Small Fibre	5/6	2/2 5YR
1.50-1.90	Sphagnum Peat, many Small Fibre, Bog Cotton	4	2/2 5YR
1.90-2.00	Sphagnum Peat, many Small Fibre	5	3/3 5YR
2.00-2.25	Sphagnum Peat, Bog Cotton, Small Fibre	5	2/2 5YR
2.25-2.40	Sphagnum Peat, Small Fibre	5	2/2 5YR
2.40-2.50	Sphagnum Peat, Small Fibre, Birch	6	2/2 5YR
2.50-2.80	Sphagnum Peat, Small Fibre	8	2/2 5YR
2.80-2.85	Sphagnum Peat, Alder	8	2/2 5YR
2.85-3.00	Sphagnum Peat, Wood, Small Fibre	9	2/2
7.5YR			
--			
-			
3.00-3.25	Reed Peat	9	2/2
7.5YR			
3.25-3.45	Reed Peat, Alder –	9	2/3
7.5YR			
3.45-3.50	Birch in slush		3/2 10YR
3.50-3.60	Clay with Birch in slush		
--			
-			
3.60	Boulderclay		7/1 7.5Y

Method: Drilling with a peat auger
Place:
Date: 25-9-1991
Surfacelevel (m): 104.99

RAHEENMORE PIEZOMETER 209

Depth (m)	Vegetation Type	Humification Degree
0.00-0.20	Roots, Sphagnum	6
0.20-0.35	Bog Cotton, Small Fibre, Sphagnum	5
0.35-0.50	Sphagnum, Small Fibre, Heather	6
0.50-0.85	Sphagnum, Small Fibre, Heather	3
0.85-1.00	Small Fibre, Heather, Sphagnum	6
1.00-1.05	Small Fibre, Heather, Sphagnum	6
1.05-1.50	Sphagnum, Small Fibre	2
1.50-1.70	Sphagnum, Small Fibre	2/3
1.70-2.00	Bog Cotton, Sphagnum, Small Fibre	4
2.00-2.10	Bog Cotton, Sphagnum	4
2.10-2.30	Sphagnum	8
2.30-2.35	Sphagnum, Bog Cotton	2/3
2.35-2.45	Sphagnum, Heather, Small Fibre	5
2.45-2.65	Sphagnum, Heather, Bog Cotton	6
2.65-2.75	Sphagnum, Heather	6
2.75-2.85	Sphagnum, Heather, Small Fibre	7
2.85-3.00	Sphagnum, Heather, Bog Cotton	6
3.00-3.10	Sphagnum, Heather	4
3.10-3.55	Sphagnum, Bog Cotton	9
3.55-3.75	Sphagnum, Small Fibre	9
3.75-3.85	Heather, Small Fibre, Sphagnum	7
3.85-4.00	Sphagnum, Small Fibre, Heather	4
4.00-4.25	Bog Cotton, Sphagnum, Heather	4
4.25-4.40	Sphagnum, Heather	2
4.40-4.50	Sphagnum, Small Fibre, Heather	3/4
4.50-5.00	Sphagnum, Small Fibre, Heather	7
5.00-5.30	Heather, Sphagnum, Bog Cotton	8
5.30-5.50	Sphagnum, Heather	3
5.50-6.00	Heather, Sphagnum, Small Fibre	3
6.00-6.50	Heather, Sphagnum, Small Fibre, Bog Cotton	7
6.50-7.00	Small Fibre, Heather, Sphagnum, Bog Cotton	8
7.00-7.50	Sphagnum, Heather	5
7.50-7.70	Small Fibre, Heather, Sphagnum	5
7.70-8.00	Bog Cotton, Small Fibre, Sphagnum	7
8.00-8.50	Sphagnum, Heather, Bog Cotton	5
8.50-8.70	Heather, Sphagnum	7/8
8.70-8.80	Bog Cotton, Heather	6
8.80-8.90	Sphagnum, Heather	9
8.90-9.00	Small Fibre, Heather	5
9.00-9.20	Sphagnum, Heather	4
9.20-9.50	Heather, Sphagnum	7
9.50-9.75	Sphagnum, Heather, Small Fibre	7
9.75-10.00	Reed, Heather, Birch	6
10.00-10.30	Reed, Alder, Small Fibre	5
10.30-10.35	Alder, Reed, Small Fibre	5
10.35-10.40	Reed, Small Fibre	7
10.40-10.50	Reed, Small Fibre	4
10.50-10.65	Reed, Small Fibre	
10.65	Clay with small Pebble Stones	

Method: Drilling with a peat auger
Place:
Date: 25-9-1991
Surfacelevel (M.O.D.): 105.62

RAHEENMORE PIEZOMETER 210

Depth (m)	Vegetation Type	Humification Degree
0.00-0.75	Small Fibre, Sphagnum, Roots	4
0.75-0.95	Sphagnum, Small Fibre	2
0.95-1.00	Small Fibre, Sphagnum	2
1.00-1.10	Sphagnum, Small Fibre	3
1.10-1.20	Sphagnum, Small Fibre	2
1.20-1.30	Small Fibre, Sphagnum, Heather	3
1.30-1.50	Sphagnum, Small Fibre, Heather	2
1.50-1.55	Sphagnum, Small Fibre, Bog Cotton	4
1.55-2.00	Sphagnum, Small Fibre	2
2.00-2.50	Sphagnum, Small Fibre, Heather	2
2.50-2.70	Sphagnum, Small Fibre	5
2.70-2.80	Bog Cotton, Sphagnum, Heather	3
2.80-3.00	Sphagnum, Small Fibre, Heather, Bog Cotton	2
3.00-3.20	Sphagnum, Heather	2
3.20-3.50	Bog Cotton, Sphagnum, Heather, Small Fibre	2
3.50-3.75	Sphagnum, Small Fibre	9
3.75-4.00	Sphagnum, Bog Cotton	2/3
4.00-4.50	Sphagnum, Small Fibre, Bog Cotton, Heather	2
4.50-4.70	Sphagnum, Small Fibre, Heather	5
4.70-4.85	Sphagnum, Heather, Small Fibre	3
4.85-5.00	Sphagnum, Heather	3
5.00-5.15	Heather, Sphagnum, Small Fibre, Bog Cotton	8
5.15-5.30	Sphagnum, Heather, Small Fibre	3
5.30-5.40	Bog Cotton, Heather	7
5.40-5.50	Heather, Sphagnum	3
5.50-5.60	Sphagnum, Heather	3

Depth (m)	Vegetation Type	Humification Degree
5.60-5.75	Heather, Sphagnum	5
5.75-5.85	Bog Cotton, Heather, Sphagnum	4
5.85-6.00	Small Fibre, Heather	9
6.00-6.25	Bog Cotton, Sphagnum	7
6.25-6.50	Bog Cotton, Heather, Sphagnum	6
6.50-6.75	Bog Cotton, Heather, Sphagnum	5
6.75-6.90	Heather, Small Fibre, Sphagnum	5
6.90-7.00	Bog Cotton, Small Fibre	5
7.00-7.30	Heather, Sphagnum, Small Fibre	8
7.30-7.50	Bog Cotton, Heather, Sphagnum	8
7.50-7.60	Bog Cotton, Heather	5
7.60-7.70	Sphagnum Cuspidatum (yellow/green)	10
7.70-8.00	Bog Cotton, Heather	5
8.00-8.25	Bog Cotton	3
8.25-8.40	Small Fibre	8
8.40-8.50	Heather, Roots, Small Fibre	6
8.50-9.00	Heather, Small Fibre	9
9.00-9.50	Small Fibre, Bog Cotton, Heather	7
9.50-9.75	Small Fibre, Heather	5

Depth (m)	Vegetation Type	Humification Degree
9.75-10.00	Reed	5

10.00–10.10	*Reed, (Birch)*	*4/5*
10.10–10.30	*Reed, Birch, Heather*	*5*
10.30–10.50	*Birch, Reed, Heather*	*5*
10.50–10.70	*Heather, Sphagnum*	*5*
10.70–10.75	*Reed, Birch*	*8*
10.75–10.85	*Birch, Reed*	*6*
10.85–11.00	*Alder, Small Fibre*	*6*
11.00–11.40	*Alder, Small Fibre, Reed*	*7*
11.40–11.50	*Reed, Small Fibre*	*4*
11.50–11.60	*Reed, Small Fibre*	*7*
11.60–11.75	*Small Fibre, Reed*	*7*

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11.75 *Clay*

Method: Drilling with a peat auger
Place:
Date: 26-9-1991
Surfacelevel (M.O.D.): 105.78

RAHEENMORE PIEZOMETER 211

Depth (m)	Vegetation Type	Humification Degree
0.00-0.20	Roots, Sphagnum	
0.20-0.45	Sphagnum, Small Fibre, Roots	5
0.45-0.50	Sphagnum, Small Fibre	4
0.50-0.70	Small Fibre, Sphagnum, Heather	6
0.70-0.80	Sphagnum, Small Fibre, Heather	4
0.80-0.95	Bog Cotton, Sphagnum, Small Fibre	4
0.95-1.00	Sphagnum, Small Fibre	2
1.00-1.25	Sphagnum, Small Fibre	3
1.25-1.30	Sphagnum Cuspidatum	9
1.30-1.40	Sphagnum, Small Fibre	5
1.40-1.45	Small Fibre, Sphagnum, Heather	5
1.45-1.50	Sphagnum, Small Fibre	3
1.50-1.60	Sphagnum, Small Fibre	3
1.60-1.75	Sphagnum, Heather, Small Fibre	3
1.75-1.90	Heather, Small Fibre, Sphagnum	7
1.90-2.00	Sphagnum, Heather, Small Fibre	3
2.00-2.50	Sphagnum, Small Fibre, Heather	2
2.50-2.70	Sphagnum, Bog Cotton, Small Fibre, Heather	3
2.70-2.85	Sphagnum, Heather, Small Fibre	5
2.85-3.00	Sphagnum, Small Fibre	2
3.00-3.15	Sphagnum, Small Fibre	2
3.15-3.35	Sphagnum, Small Fibre, Heather	2
3.35-3.40	Sphagnum Cuspidatum	9
3.40-3.50	Sphagnum, Heather, Small Fibre	6
3.50-3.80	Sphagnum, Heather, Small Fibre	4
3.80-4.00	Bog Cotton, Heather, Sphagnum	5
4.00-4.10	Sphagnum, Small Fibre, Heather	4
4.10-4.25	Small Fibre, Sphagnum	6
4.25-4.30	Sphagnum, Heather	2
4.30-4.50	Heather, Bog Cotton, Small Fibre, Sphagnum	5
4.50-4.75	Small Fibre, Sphagnum, Heather	6
4.75-4.90	Bog Cotton, Sphagnum, Heather, Small Fibre	5
4.90-5.00	Sphagnum, Heather, Small Fibre	2
5.00-5.05	Bog Cotton, Sphagnum	2
5.05-5.20	Sphagnum, Heather, Bog Cotton	4
5.20-5.55	Small Fibre, Sphagnum, Heather	7
5.55-5.70	Bog Cotton, Small Fibre, (Sphagnum)	7
5.70-6.00	Bog Cotton, Heather, (Sphagnum)	7
6.00-6.25	Bog Cotton, Sphagnum	5
6.25-6.35	Sphagnum, Small Fibre	2

6.35-6.50	Bog Cotton, Heather	6/7
6.50-7.00	Bog Cotton, Heather	8
7.00-7.15	Small Fibre, Heather, Sphagnum	8
7.15-7.50	Bog Cotton, Heather, Small Fibre	7
7.50-8.00	Bog Cotton, Heather	5
8.00-8.50	Bog Cotton	5
8.50-8.70	Bog Cotton, Heather, Small Fibre	8
8.70-8.80	Small Fibre, Heather, Sphagnum	9
8.80-9.00	Bog Cotton, Small Fibre	4
9.00-9.20	Sphagnum, Small Fibre, Bog Cotton	4

9.20–9.50	Bog Cotton	4
9.50–9.90	Sphagnum	7
9.90–10.00	Bog Cotton	5
10.00–10.30	Small Fibre, Sphagnum	5
10.30–10.50	Bog Cotton, Heather, Sphagnum	6
10.50–10.60	Small Fibre, Heather	4

10.60–10.75	Birch, Small Fibre	5
10.75–10.90	Small Fibre, Reed, Birch	8
10.90–11.00	Reed, Birch, Small Fibre	7
11.00–11.50	Wood	
11.50–11.75	Reed, Small Fibre, Birch	4
11.75–11.80	Charcoal, Small Fibre, Reed	5
11.80–11.95	Small Fibre, Reed	5

11.95–11.97	Small Fibre, Clay
11.97	Clay

Method: Drilling with a peat auger
Place:
Date: 1-10-1991 & 3-10-1991
Surfacelevel (M.O.D.): 106.64

RAHEENMORE PIEZOMETER 330 (1ST DRILLING)

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.20	Sphagnum Peat, Roots	7	3/3 5YR
0.20-0.35	Sphagnum Peat, Small Fibre	2	4/5 5YR
0.35-0.50	Sphagnum Peat, Bog Cotton, Heather, Small Fibre	7	3/3 5YR
0.50-0.60	Sphagnum Peat, Heather, Small Fibre	3	3/4 2.5YR
0.60-0.70	Sphagnum Peat, Small Fibre, Heather	7	2/4 5YR
0.70-0.75	Sphagnum Peat, Small Fibre, Heather	2	3/6 5YR
0.75-1.10	Sphagnum Peat, Small Fibre, Heather	3	3/3 5YR
1.10-1.50	Sphagnum Peat, Small Fibre, Heather	2	3/4 5YR
1.50-2.00	Sphagnum Peat, Small Fibre, Heather	2	3/6 5YR
2.00-2.30	Sphagnum Peat, Small Fibre, Heather	2	2/6 5YR
2.30-2.50	Sphagnum Peat, Small Fibre, Heather	3	3/4 5YR
2.50-2.75	Sphagnum Peat, Small Fibre	4	3/3 5YR
2.75-2.95	Sphagnum Peat, Small Fibre, Heather	2	4/6 5YR
2.95-3.00	Sphagnum Peat, Bog Cotton, Heather, Small Fibre	2	3/6 5YR
3.00-3.40	Sphagnum Peat, Small Fibre	2	3/4 5YR
3.40-3.50	Sphagnum Peat, Small Fibre, Bog Cotton	3	3/3 7.5YR
3.50-3.80	Sphagnum Peat, Heather, Small Fibre	3	4/6 5YR
3.80-3.95	Sphagnum Peat, Small Fibre, Heather, Bog Cotton	2	3/4 5YR
3.95-4.00	Sphagnum Peat	2	3/6 5YR
4.00-4.20	Sphagnum Peat, Heather, Small Fibre, Bog Cotton	4	3/4 5YR
4.20-4.25	Sphagnum Peat (Cuspidatum ?)	4/3	7.5YR
4.25-4.50	Sphagnum Peat, Small Fibre, Heather	4	3/4 5YR
4.50-4.70	Sphagnum Peat, Heather, Small Fibre	6	4/6 5YR
4.70-4.72	Sphagnum Peat (Cuspidatum ?)	3/4	7.5YR
4.72-4.76	Sphagnum Peat, Heather	3/4	5YR
4.76-4.78	Sphagnum Peat (Cuspidatum ?)	3/4	7.5YR
4.78-5.00	Sphagnum Peat, Heather	6	3/4 5YR
5.00-5.15	Sphagnum Peat, Heather	6	3/4 5YR
5.15-5.30	Sphagnum Peat, Bog Cotton, Heather, Small Fibre	5	2/4 5YR
5.30-5.35	Sphagnum Peat, Heather	6	3/3 5YR
5.35-5.50	Sphagnum Peat, Heather, Small Fibre	8	2/3 5YR
5.50-5.55	Sphagnum Peat (Cuspidatum)	9	3/4 5YR
5.55-5.75	Sphagnum Peat, Heather	8	3/6 5YR
5.75-6.00	Bog Cotton, Sphagnum Peat, Heather, Small Fibre	7	3/4 5YR
6.00-6.10	Bog Cotton, Sphagnum Peat, Heather	4	3/3 2.5YR
6.10-6.15	Sphagnum Peat		
6.15-6.25	Small Fibre (Sphagnum Cuspidatum ?)	3	3/4 7.5YR
6.25-6.50	Sphagnum Peat, Small Fibre, Heather	5	3/3 5YR
6.50-6.60	Sphagnum Peat, Heather	3	3/3 2.5YR
6.60-6.70	Sphagnum Peat, Heather	7	2/4 5YR
6.70-7.00	Bog Cotton, Sphagnum Peat, Heather, Reed	6	2/4 5YR
7.00-7.25	Sphagnum Peat, Bog Cotton, Heather	3	3/6 5YR

7.25-7.50	Bog Cotton, Sphagnum Peat, Heather	5	2/3 5YR
7.50-7.70	Bog Cottob, Sphagnum Peat, Heather	5	2/3 5YR
7.70-8.00	Sphagnum Peat, Heather	8	2/4 5YR

8.00–8.10	Sphagnum Peat, Heather, Small Fibre	8	3/3 5YR
8.10–8.30	Heather, Bog Cotton	5	2/4 5YR
8.30–8.50	Heather, Bog Cotton	7	3/2 5YR
8.50–8.70	Sphagnum Peat, Heather, Small Fibre	7	2/4 5YR
8.70–8.95	Sphagnum Peat, Bog Cotton, Alder, Small Fibre	5	3/3 5YR
8.95–9.00	Sphagnum Peat (Cuspidatum ?), Heather	7	3/4 5YR
9.00–9.50	Sphagnum Peat, Heather, Bog Cotton, Small Fibre	5	2/4 5YR
9.50–9.55	Sphagnum Peat (Cuspidatum)	8	3/4 5YR
9.55–9.90	Sphagnum Peat, Heather, Small Fibre	7	2/4 5YR
9.90–10.00	Sphagnum Peat, Bog Cotton, Heather	5	3/4 5YR
10.00–10.10	Sphagnum Peat, Heather, Small Fibre	6	2/3 5YR
10.10–10.40	Sphagnum Peat, Heather	7	3/3 5YR
10.40–10.50	Sphagnum Peat, Bog Cotton	5	3/3 5YR
10.50–10.70	Sphagnum Peat, Heather, Bog Cotton	6	3/3 5YR
10.70–10.95	Sphagnum Peat, Small Fibre, Heather	5	2/4 5YR
10.95–11.00	Heather, Bog Cotton, Sphagnum	8	2/3 5YR
11.00–11.10	Heather, Small Fibre, Sphagnum, Bog Cotton	6	3/2 5YR
11.10–11.35	Heather, Sphagnum, Small Fibre	5	2/4 5YR
11.35–11.50	Bog Cotton, Alder (Root)	7	2/3 5YR
11.50–11.65	Roots Birch, Bog Cotton	9	2/2 5YR

No clay drilled yet

Method: Drilling with a peat auger
Place: RAHEENMORE PIEZOMETER 330 (2ND DRILLING)
Date: 8-10-1991
Surfacelevel (M.O.D.): 106.64

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.15	Roots	5	2/3 5YR
0.15-0.40	Sphagnum Peat, Roots, Heather, Small Fibre	5	2/3 5YR
0.40-0.60	Sphagnum Peat, Roots, Heather, Small Fibre	5	2/4 5YR
0.60-0.70	Sphagnum Peat, Small Fibre, Heather	6	2/3 5YR
0.70-0.95	Sphagnum Peat, Heather, Small Fibre, Bog Cotton	4	3/3 5YR
0.95-1.00	Sphagnum Peat, Small Fibre, Heather, Bog Cotton	6	2/3 5YR
1.00-1.40	Sphagnum Peat, Small Fibre, Heather	5	3/3 5YR
1.40-1.75	Sphagnum Peat, Small Fibre, Heather	3	2/4 5YR
1.75-2.00	Sphagnum Peat, Small Fibre, Heather	4	2/2 5YR
2.00-2.35	Small Fibre, Sphagnum Peat, Heather	7	2/3 5YR
2.35-2.50	Sphagnum Peat, Heather, Small Fibre	4	3/3 5YR
2.50-3.00	Sphagnum Peat, Bog Cotton, Small Fibre, Heather	3	3/4 5YR
3.00-3.45	Sphagnum Peat, Small Fibre, Heather	3	3/4 5YR
3.45-3.50 7.5YR	Sphagnum Peat (Cuspidatum ?)	6	3/3
3.50-3.95	Sphagnum Peat, Small Fibre, Heather	4	3/3 5YR
3.95-4.00	Bog Cotton	4	
4.00-4.15	Sphagnum Peat	4	
4.15-4.25	Sphagnum Peat (green) (Cuspidatum)	8/9	
4.25-4.35	Sphagnum Peat	7	
4.35-4.50	Sphagnum Peat, Bog Cotton	7/8	
4.50-4.70	Sphagnum Peat	7	
4.70-4.75	Sphagnum Peat (green) (Cuspidatum)	9	
4.75-5.00	Sphagnum Peat	4	
5.00-5.15	Sphagnum Peat	4	
5.15-5.30	Sphagnum Peat (small pieces of Reed)	6	
5.30-5.45	Sphagnum Peat	6	
5.45-5.60	Sphagnum Peat, Bog Cotton, Heather roots	6	
5.60-5.80	Sphagnum Peat	4	
5.80-6.10	Sphagnum Peat, Bog Cotton, Heather roots	4	
6.10-6.20	Sphagnum Peat	4	
6.20-6.50	Sphagnum Peat, many Heather Roots	4	
6.50-6.70	Sphagnum Peat	4	
6.70-6.90	Sphagnum Peat	4	
6.90-7.00	Sphagnum Peat, Bog Cotton	4	
7.00-7.15	Sphagnum Peat, much Bog Cotton	4	
7.15-7.30	Sphagnum Peat	5	
7.30-7.50	Sphagnum Peat, much Bog Cotton	4/5	
7.50-7.85	Sphagnum Peat, Bog Cotton	5	
7.85-8.00	Sphagnum Peat, Heather, Bog Cotton	7	
8.00-8.30	Sphagnum Peat, Heather	5	
8.30-8.40	Sphagnum Peat, Heather	4/5	
8.40-8.50	Sphagnum Peat	7	
8.50-8.80	Sphagnum Peat, Bog Cotton	5	
8.80-9.00	Sphagnum Peat, Bog Cotton, Heather	5	
9.00-9.10	Sphagnum Peat, much Bog Cotton	5	
9.10-9.30	Sphagnum Peat	7	
9.30-9.50	Sphagnum Peat, much Bog Cotton, Heather	6	
9.50-9.80	Sphagnum Peat, Bog Cotton	4/5	
9.80-10.00	Sphagnum Peat	4	
10.00-10.10	Sphagnum Peat, Bog Cotton	4/5	
10.10-10.50	Sphagnum Peat	4	

10.50–11.00	Sphagnum Peat, Bog Cotton, Heather	4
11.00–11.10	Sphagnum Peat, Bog Cotton, Heather	4
11.10–11.30	Bog Cotton	4
11.30–11.50	Sphagnum, Alder (firm)	6
11.50–11.65	Sphagnum, Alder	6/7
11.65–11.70	Old Sphagnum (black)	5
11.70–11.90	Reed Peat	4/5
11.90–12.00	Birch in Reed Peat	4

Method: Drilling with a peatauger
Place:
Date:
Met Jan Streefkerk
Surfacelevel (M.O.D.): 106.64

RAHEENMORE PIEZOMETER 330

Depth (m)	Vegetation Type	Humification Degree
0.00–0.20	Sphagnum Peat, Bog Cotton	4
0.20–0.40	Sphagnum Peat, Bog Cotton	4
0.40–0.50	Sphagnum Peat, Heather roots	4
0.50–0.70	Sphagnum Peat, Heather roots	5/6
0.70–0.80	Sphagnum Peat	4
0.80–0.85	Bog Cotton	4
0.85–1.00	Sphagnum Peat	3
1.00–1.10	Sphagnum Peat, Heather roots	6
1.10–1.50	Sphagnum Peat	3
1.50–1.75	Sphagnum Peat	4/5
1.75–1.85	Sphagnum Peat, Bog Cotton	4
1.85–2.00	Sphagnum Peat	3
2.00–2.40	Sphagnum Peat	3/4
2.40–2.50	Sphagnum Peat	7/8
2.50–2.70	Sphagnum Peat	4
2.70–3.00	Sphagnum Peat	4/5
3.00–3.25	Sphagnum Peat	4
3.25–3.40	Sphagnum Peat	7
3.40–3.50	Sphagnum Peat	3/4
3.50–3.95	Sphagnum Peat	4
3.95–4.00	Sphagnum Peat, Heather roots	6/7
4.00–4.25	Sphagnum Peat	4
4.25–4.50	Sphagnum Peat	5
4.50–4.75	Sphagnum Peat	5/6
4.75–5.00	Sphagnum Peat	7
5.00–5.50	Sphagnum Peat	4/5
5.50–5.60	Sphagnum Peat	4
5.60–5.75	Sphagnum Peat	8
5.75–5.90	Sphagnum Peat	4
5.90–6.00	Sphagnum Peat	7
6.00–6.20	Sphagnum Peat	7
6.20–6.45	Sphagnum Peat, Bog Cotton	9
6.45–6.50	Bog Cotton	5
6.50–6.70	Sphagnum Peat	7/8
6.70–6.85	Sphagnum Peat, Bog Cotton	4
6.85–7.00	Bog Cotton	4/5
7.00–7.30	Sphagnum Peat	7
7.30–7.45	Sphagnum Peat	5
7.45–7.50	Bog Cotton	4/5
7.50–7.75	Bog Cotton	4/5
7.75–7.85	Sphagnum Peat	8/9
7.85–8.00	Sphagnum Peat, Bog Cotton	7

Method: Drilling with a peat auger
Place:
Date: 22-10-1991
Surfacelevel (M.O.D.): 106.64

RAHEENMORE PIEZOMETER 327

Depth (m)	Vegetation Type	Humification Degree
0.00-0.30	Sphagnum Peat	4
0.30-0.60	Sphagnum Peat (ligth orange)	2
0.60-0.75	Sphagnum Peat, Small Fibre	4
0.75-0.85	Sphagnum Peat, Small Fibre	3
0.85-0.95	Sphagnum Peat	3
0.95-1.00	Sphagnum Peat (Cuspidatum) (green)	9
1.00-1.15	Sphagnum Peat	4
1.15-1.20	Sphagnum Peat (Cuspidatum)	8
1.20-1.30	Sphagnum Peat	3
1.30-1.40	Sphagnum Peat	3
1.40-1.50	Sphagnum Peat, Bog Cotton	7
1.50-1.80	Sphagnum Peat	3
1.80-2.25	Sphagnum Peat	2
2.25-2.30	Sphagnum Peat (green) (Cuspidatum)	4
2.30-2.35	Sphagnum Peat	3
2.35-2.50	Sphagnum Peat, Some Heather	6
2.50-2.60	Sphagnum Peat	4
2.60-2.80	Sphagnum Peat (orange)	2
2.80-3.00	Sphagnum Peat	3
3.00-3.50	Sphagnum Peat, Small Fibre	2
3.50-3.70	Sphagnum Peat	4
3.70-3.80	Sphagnum Peat	7
3.80-3.90	Sphagnum Peat	4
3.90-4.00	Sphagnum Peat	5
4.00-4.35	Sphagnum Peat, Much Bog Cotton	5
4.35-4.45	Sphagnum Peat (green) (Cuspidatum)	5
4.45-4.50	Sphagnum Peat	7
4.50-4.80	Sphagnum Peat	7
4.80-5.00	Sphagnum Peat, Much Bog Cotton	4
5.00-5.05	Sphagnum Peat	7
5.05-5.25	Sphagnum Peat, Much Bog Cotton	4
5.25-5.50	Sphagnum Peat, Heather Roots, Bog Cotton	5
5.50-5.55	Sphagnum Peat	5
5.55-5.75	Sphagnum Peat	3
5.75-6.00	Sphagnum Peat, Much Heather	6
6.00-6.10	Bog Cotton	3
6.10-6.30	Sphagnum Peat, Bog Cotton	3
6.30-6.50	Sphagnum Peat	4
6.50-6.90	Sphagnum Peat, Bog Cotton	3
6.90-7.00	Sphagnum Peat (green) (Cuspidatum)	6
7.00-7.35	Sphagnum Peat, a little Reed	6
7.35-7.50	Sphagnum Peat	6
7.50-7.75	Sphagnum Peat, Some Heather	5
7.75-7.90	Sphagnum Peat, Reed	5
7.90-8.00	Sphagnum Peat, Bog Cotton	5
8.00-8.10	Sphagnum Peat	7
8.10-8.25	Bog Cotton, Sphagnum Peat	6
8.25-8.50	Sphagnum Peat, Bog Cotton	7
8.50-8.55	Sphagnum Peat	9
8.55-9.00	Sphagnum Peat, Bog Cotton	5

9.00–9.25	*Sphagnum Peat*	*7/8*
9.25–9.50	*Sphagnum Peat, Bog Cotton*	*7*
9.50–9.90	*Sphagnum Peat, much Heather*	*5*
9.90–10.00	*Sphagnum Peat*	*5*
10.00–10.20	*Sphagnum Peat*	*5*
10.20–10.35	*Bog Cotton*	*4*
10.35–10.40	*Sphagnum Peat (grenish)*	*7/8*
10.40–10.50	*Sphagnum Peat, Bog Cotton, piece of Birch*	*4*
10.50–10.80	*Sphagnum Peat (dry)*	*4*
10.80–11.00	*Sphagnum Peat, Small Fibre*	*4*
11.00–11.30	*Transition Sphagnum–Reed Peat, Wood*	*4/5*

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11.30–11.50	*Reed Peat, Birch, Small Fibre*	*5*
11.50–11.60	*Alder Roots, Small Fibre (black)*	*5*
11.60–11.80	*Small Fibre, Birch, Alder (not black)*	*5*
11.80–11.90	*Reed Peat, Birch*	*4*

No clay drilled yet

Method: Drilling with a peatauger
Place:
Date: 23-10-1991
Surfacelevel (M.O.D.): 106.59

RAHEENMORE PIEZOMETER 324

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.15	Sphagnum Peat, Roots	5	
0.15-0.25	Sphagnum Peat, Small Fibre, Roots	4	
0.25-0.40	Sphagnum Peat, Small Fibre	4	2/3 5YR
0.40-0.50	Sphagnum Peat, Many Small Fibre	3	
0.50-0.75	Sphagnum Peat, Many Small Fibre	3	
0.75-1.00	Sphagnum Peat, Many Small Fibre	3	2/2 5YR
1.00-1.20	Sphagnum Peat, Many Small Fibre	3	
1.20-1.30	Sphagnum Peat, Bog Cotton	3	
1.30-1.35	Sphagnum Peat, Many Small Fibre	4	
1.35-1.50	Sphagnum Peat, Many Small Fibre	3	2/4 5YR
1.50-1.70	Sphagnum Peat, Many Small Fibre	4	3/3 10YR
1.70-1.90	Sphagnum Peat (orange)	2	
1.90-2.00	Sphagnum Peat, Bog Cotton	3/4	
2.00-2.10	Sphagnum Peat	4	
2.10-2.30	Sphagnum Peat	3	2/1 5YR
2.30-2.45	Sphagnum Peat	3	
2.45-2.50	Sphagnum Peat, Bog Cotton, Heather	5	
2.50-2.65	Sphagnum Peat	4/5	
2.65-2.85	Sphagnum Peat, Bog Cotton	4	2/2 5YR
2.85-2.95	Sphagnum Peat (orange)	3	
2.95-3.05	Sphagnum Peat	4	
3.05-3.25	Sphagnum Peat (Cuspidatum)	6/7	3/3 10YR
3.25-3.30	Sphagnum Peat, Bog Cotton	4	
3.30-3.35	Sphagnum Peat	3	
3.35-3.50	Sphagnum Peat, Bog Cotton	4	
3.50-3.75	Sphagnum Peat, Bog Cotton	4/5	
3.75-3.85	Sphagnum Peat (Cuspidatum)	7	
3.85-4.00	Sphagnum Peat	3	2/3 10YR
4.00-4.10	Sphagnum Peat	7	
4.10-4.20	Sphagnum Peat	4	
4.20-4.30	Sphagnum Peat, Bog Cotton	3	
4.30-4.55	Sphagnum Peat	4/5	2/1 5YR
4.55-4.65	Sphagnum Peat	6	
4.65-4.70	Sphagnum Peat, Reed	5	
4.70-4.90	Sphagnum Peat, Small Fibre, Bog Cotton	7	2/3 10YR
4.90-5.00	Sphagnum Peat	4	
5.00-5.10	Sphagnum Peat	7	
5.10-5.20	Sphagnum Peat, Bog Cotton	4/5	
5.20-5.30	Sphagnum Peat	5	3/1 5YR
5.30-5.35	Sphagnum Peat	3/4	
5.35-5.50	Sphagnum Peat, Bog Cotton, Heather	5	
5.50-5.65	Bog Cotton	4	
5.65-5.70	Sphagnum Peat	4	
5.70-5.80	Bog Cotton	4	
5.80-5.90	Sphagnum Peat, Heather	4	2/3 5YR
5.90-6.00	Sphagnum Peat, Bog Cotton, Heather	5	
6.00-6.10	Sphagnum Peat, Bog Cotton, Heather	5	
6.10-6.30	Sphagnum Peat, Alder, Heather	5	1.7 5YR
6.30-6.35	Bog Cotton	4	

6.35–6.50	Sphagnum Peat, Heather (dark)	6	
6.50–6.60	Sphagnum Peat, Bog Cotton, Heather (dark)	6	
6.60–6.80	Sphagnum Peat, Alder (dark)	4/5	1.7 5YR
6.80–6.85	Sphagnum Peat, Bog Cotton (dark)	5	
6.85–7.00	Sphagnum Peat, Much Heather (dark)	5	
7.00–7.25	Sphagnum Peat, Much Heather (darker)	7	1.7 10YR

7.25–7.45	Reed Peat, Alder (darker)	4/5	
7.45–7.50	Reed Peat, Bog Cotton (darker)	5	
7.50–7.60	Reed Peat (ligther)	5	
7.60–7.75	Reed Peat, Wood	4/5	
7.75–8.00	Reed Peat, Birch	5	2/2 10YR
8.00–8.35	Reed Peat, Alder, Birch	4	2/2 10YR
8.35–8.38	Roots with lumps, orange/brown Seeds		
8.38–8.50	Reed Peat, Birch	4	
8.50–8.60	Reed Peat, Birch	5	
8.60–8.75	Reed Peat, Seeds	4	
8.75–8.95	Reed Peat, Alder	4	1.7 10YR
8.95–9.00	Reed Peat, Birch (very dark)	5	
9.00–9.25	Reed Peat, Birch	5	1.7 10YR

9.25	Clay with Reed	4/1	7.5Y

Method: Drilling with a peatauger
Place:
Date: 25-10-1991
Surfacelevel (M.O.D.): 106.62

RAHEENMORE PIEZOMETER 321

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.25	Roots, Sphagnum Peat	5	2/3 10YR
0.25-0.40	Sphagnum Peat, Roots	4	4/4 7.5YR
0.40-0.50	Sphagnum Peat, Small Fibre	3/4	3/3 10YR
0.50-0.60	Sphagnum Peat	4	3/3 5YR
0.60-1.00	Sphagnum Peat, Small Fibre, Bog Cotton	3/4	3/4 5YR
1.00-1.10	Sphagnum Peat	3	3/4 5YR
1.10-1.20	Sphagnum Peat, Many Small Fibre	2/3	4/6 5YR
1.20-1.40	Sphagnum Peat, Small Fibre	2/3	3/4 5YR
1.40-1.50	Sphagnum Peat, Small Fibre	2/3	4/6 5YR
1.50-1.60	Sphagnum Peat	2/3	4/6 5YR
1.60-1.75	Sphagnum Peat, Bog Cotton	2/3	4/6 5YR
1.75-1.85	Sphagnum Peat, Heather, Smalll Fibre	6	2/4 5YR
1.85-2.00	Sphagnum Peat	5	2/4 5YR
2.00-2.10	Sphagnum Peat	3/4	3/3 5YR
2.10-2.20	Sphagnum Peat, Small Fibre	4	2/4 5YR
2.20-2.30	Sedges, Reed	4	3/3 5YR
2.30-2.40	Sphagnum Peat	3/4	3/4 5YR
2.40-2.50	Sphagnum Peat	2/3	3/4 5YR
2.50-2.70	Sphagnum Peat	4	3/3 5YR
2.70-2.80	Sphagnum Peat	3	3/3 5YR
2.80-3.00	Sphagnum Peat	2	3/4 5YR
3.00-3.20	Sphagnum Peat	4/5	2/4 5YR
3.20-3.30	Sphagnum Peat, Bog Cotton, Small Fibre	5/6	3/4 7.5YR
3.30-3.50	Sphagnum Peat, Small Fibre	4	3/4 5YR
3.50-3.60	Sphagnum Peat	4	3/4 5YR
3.60-3.80	Sphagnum Peat, Reed	4	3/4 5YR
3.80-4.00	Sphagnum Peat, Bog Cotton, Heather	6	2/4 5YR
4.00-4.10	Sphagnum Peat, Small Fibre, Heather	5	3/4 5YR

4.10-4.50	Sphagnum Peat, Bog Cotton	5	2/3 5YR
4.50-4.60	Sphagnum Peat, Heather	4/5	3/3 5YR
4.60-4.90	Old Sphagnum Peat, Heather Roots, Small Fibre	5	2/2 5YR
4.90-5.00	Old Sphagnum, Bog Cotton	5	2/3 5YR
5.00-5.05	Bog Cotton	4	3/4 5YR
5.05-5.25	Old Sphagnum, Many Small Fibre, Red Roots	5	3/3 5YR
5.25-5.35	Old Sphagnum, Many Small Fibre	4/5	3/3 5YR
5.35-5.50	Old Sphagnum, Bog Cotton, Alder	4	3/3 5YR
5.50-5.60	Old Sphagnum, Small Fibre	5	2/4 5YR
5.60-5.85	Small Fibre, Bog Cotton	4	3/4 5YR
5.85-5.88	Birch, Old Sphagnum	5	3/3 7.5YR

5.88-5.95	Alder, Small Fibre	5	2/2 5YR
5.95-5.97	Birch, Small Fibre, Heather	4/5	2/3 5YR
5.97-6.00	Birch	5	2/3 5YR
6.00-6.20	Alder, Birch, Reed	5	2/3 5YR
6.20-6.50	Reed Peat	4/5	3/4 7.5YR

6.50–6.65 7.5YR	Reed Peat, Alder	5	3/3
6.65–7.00 7.5YR	Birch, Reed Peat	4	3/3
7.00–7.50 7.5YR	Reed Peat, Birch	4/5	2/3
7.50–7.62	Reed Peat	7	2/3 7.5YR
7.62–7.80 7.5YR	Alder, Reed Peat	6	2/3
7.80–7.85	Clay with Reed		

7.85	Clay

Method: Drilling with a peatauger
Place:
Date: 25-10-1991
Surfacelevel (M.O.D.): 106.02

RAHEENMORE PIEZOMETER 317

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.20	Sphagnum Peat, Roots	4	2/4 5YR
0.20-0.40	Sphagnum Peat, Small Fibre	4	2/2 5YR
0.40-0.65	Sphagnum Peat, Small Fibre	3	3/4 5YR
0.65-0.85	Sphagnum Peat, A lot of Small Fibre	4	2/4 5YR
0.85-1.00	Sphagnum Peat, Reed	3	3/4 5YR
1.00-1.20	Sphagnum Peat	2/3	4/8 5YR
1.20-1.30	Sphagnum Peat, Bog Cotton, Heather	4	3/4 5YR
1.30-1.50	Sphagnum Peat, Small Fibre	5	2/2 5YR
1.50-1.70	Sphagnum Peat	3	3/4 5YR
1.70-1.90	Sphagnum Peat, Bog Cotton, Small Fibre	4	2/4 5YR
1.90-2.00	Sphagnum Peat	3	3/6 5YR
2.00-2.20	Sphagnum Peat	3	3/6 5YR
2.20-2.25	Bog Cotton	4	3/4 5YR
2.25-2.35	Old Sphagnum Peat, Small Fibre, Reed, Sphagnum	5	2/2 5YR
2.35-2.50	Old Sphagnum Peat, Heather	6	2/2 5YR
2.50-2.60	Old Sphagnum Peat, Small Fibre	6	2/4 5YR
2.60-2.80	Reed Peat	4	3/4 5YR
2.80-2.85	Bog Cotton in (?)	4	3/3 5YR
2.85-3.00	Reed Peat, Heather Roots	5	2/2 5YR
3.00-3.20	Reed, Small Fibre, Heather, Bog Cotton	4/5	2/3 5YR
3.20-3.50	Bog Cotton, Old Sphagnum	4	2/3 5YR
3.50-3.65	Bog Cotton, Small Fibre	7	2/3 5YR
3.65-3.70	Old Sphagnum	5	2/3 5YR
3.70-3.80	Bog Cotton	4	2/3 5YR
3.80-3.90	Old Sphagnum, Small Fibre	5	2/3 5YR
3.90-4.00	Bog Cotton, Old Sphagnum	5	3/3 7.5YR
4.00-4.15	Old Sphagnum, Small Fibre	4	3/3 5YR
4.15-4.20	Reed, Small Red Seeds (Fen Peat)	5	3/4 7.5YR
4.20-4.30	Reed Peat, Small Layer of Heather Peat	4	2/3 5YR
4.30-4.50	Reed Peat, Roots	4	2/3 7.5YR
4.50-4.70	Old Sphagnum, Small Fibre, Small Red Roots	4	2/4 5YR
4.70-4.85	Big Fibre in Reed Peat	4	3/3 7.5YR
4.85-4.90	Reed Peat, Birch, Alder	4/5	3/3 5YR
4.90-5.00	Reed Peat	5	2/2 5YR
5.00-5.40	Reed Peat, Birch, Alder	4	2/3 7.5YR
5.40-5.55	Reed Peat	3/4	2/3 7.5YR
5.55-5.70	Reed Peat, Alder, Big Fibre	3/4	3/4 7.5YR
5.70-5.95	Reed Peat, Wood	4	2/3 7.5YR
5.95-6.00	Alder		
6.00-6.30	Reed Peat (earthend)	5	2/3 7.5YR
6.30-6.50	Reed Peat	9	2/2 5YR
6.50-6.55	Clay, Reed		3/2 2.4Y
6.55	Clay		3/2 2.4Y
6.50-6.65	Reed Peat, Alder	5	3/3 7.5YR
6.65-7.00	Birch, Reed Peat	4	3/3 7.5YR
7.00-7.50	Reed Peat, Birch	4/5	2/3 7.5YR
7.50-7.62	Reed Peat	7	2/3 7.5YR
7.62-7.80	Alder, Reed Peat	6	2/3 7.5YR
7.80-7.85	Clay with Reed		
7.85	Clay		

Method: Drilling with a peat auger
Place:
Date: 4-11-1991
Surfacelevel (M.O.D.): 105.06

RAHEENMORE PIEZOMETER 313

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.10	Roots		2/2 5YR
0.10-0.40	Sphagnum Peat, Orange Roots	4	2/2 5YR
0.40-0.50	Sphagnum Peat	3/4	2/2 5YR
0.50-0.60	Sphagnum Peat	5	2/2 5YR
0.60-0.80	Sphagnum Peat, Bog Cotton	4	2/4 5YR
0.80-0.95	Sphagnum Peat, Many Small Fibre, Heather	4	3/2 5YR
0.95-1.00	Sphagnum Peat	3	3/4 5YR
1.00-1.15	Sphagnum Peat	3	3/6 5YR
1.15-1.25	Sphagnum Peat, Small Fibre	4	2/4 5YR
1.25-1.40	Sphagnum Peat	3	4/6 5YR
1.40-1.50	Sphagnum Peat,Bog Cotton	4/5	3/4 5YR
1.50-1.65	Sphagnum Peat, Bog Cotton, Small Fibre	4	3/4 7.5YR
1.65-1.85	Bog Cotton	5	2/2 5YR
1.85-2.00	Old Sphagnum, Bog Cotton	5	2/3 5YR
2.00-2.25	Old Sphagnum, Bog Cotton	5	3/3 5YR
2.25-2.50	Old Sphagnum, Bog Cotton	4/5	3/4 5YR
2.50-2.80	Old Sphagnum, Bog Cotton	5	3/3 5YR
2.80-2.90	Old Sphagnum, Birch	5	3/3 5YR
2.90-3.00	Old Sphagnum, Bog Cotton	5/6	2/4 5YR
3.00-3.10	Reed Peat	5	4/4 7.5YR
3.10-3.40	Reed Peat, Alder	5	3/3 7.5YR
3.40-3.50	Reed Peat, Alder	5	3/3 7.5YR
3.50-3.85	Reed Peat	4/5	3/4 7.5YR
3.85-3.95	Reed Peat, Birch	4	3/3 7.5YR
3.95-4.00	Reed Peat, Alder	4	3/2 7.5YR
4.00-4.60	Reed Peat, Birch, Alder	5	2/3 7.5YR
4.60-5.00	Reed Peat, Birch, Bog Cotton	6	2/2 7.5YR

Method: Drilling with a peat auger
Place:
Date: 24-8-1991
Surfacelevel (M.O.D.): 60.71

CLARA BOG, PIEZOMETER 49

Depth (m)	Vegetation type	Humification Degree	Colour
0.00–0.05	Heather	–	
0.05–0.15	Heather, Bog Cotton	–	2/3
2.5YR			
0.15–0.25	Heather, Bog Cotton	–	2/3
2.5YR			
–			
0.25–0.50	Reed, Alder, Small Fibre	3	2/1 5YR
0.50–0.75	Reed, Small Fibre	3	2/2 5YR
0.75–1.00	Reed, Alder, Small Fibre	3	2/2
7.5YR			
1.00–1.20	Reed, Small Fibre	5	3/3 5YR
1.20–1.50	Reed, Small Fibre	5	2/3 5YR
1.50–1.75	Reed, Small Fibre	8	2/2 5YR
1.75–1.80	Reed	7	2/2 5YR
1.80–1.85	Reed, Small Fibre	5	3/4
7.5YR			
1.85–2.00	Reed, Small Fibre	4	3/3 5YR
2.00–2.10	Sphagnum	7	
2.10–2.30	Reed	7	–
2.30–2.50	Reed	7	
2.50–2.70	Reed, Birch	8	2/2 5YR
2.70–2.85	Alder, Reed	–	
2.85	Clay, Pebble stones, Tree roots		4/2 2.5Y

Method: Drilling with a peat auger
Place: CLARA BOG, BETWEEN PIEZOMETER 49 AND 57
Date: 4-9-1991
Surfacelevel (M.O.D.): 58.75 Dry

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.20	Sphagnum, Small Fibre	3	4/5 5YR
0.20-0.30	Bog Cotton, Heather, Sphagnum	3	2/2 5YR
0.30-0.50	Bog Cotton, Heather, Sphagnum	4	2/2 5YR
0.50-0.75	Bog Cotton, Sphagnum, Heather, Small Fibre	5	3/2 5YR
0.75-1.00	Bog Cotton, Sphagnum, Heather, Small Fibre, Alder	7	3/3 5YR
1.00-1.30	Sphagnum, Birch, Small Fibre	7	3/2 5YR
1.30-1.50	Bog Cotton, Sphagnum, Heather	6	2/3 5YR
1.50-1.60	Sphagnum, Bog Cotton, Heather	8	2/2 5YR
1.60-2.00	Bog Cotton, Sphagnum	8	2/1 5YR
2.00-2.15	Sphagnum	7	2/2 5YR
2.15-2.50	Sphagnum, Bog Cotton, Heather	5	3/3 5YR
2.50-2.75	Heather, Sphagnum, Birch	6	2/1 5YR
2.75-2.85	Birch		
2.85-3.00	Alder, Reed	6	2/2 5YR
3.00-3.20	Alder, Birch, Reed	5	3/1 5YR
3.20-3.50	Birch, Reed	5	3/2 5YR
3.50-4.00	Reed, Birch, Alder	5	2/3 10YR
4.00-4.10	Reed, Small Fibre	5	2/2 5YR
4.10-4.20	Birch, Alder		
4.20-4.50	Birch, Reed, Small Fibre	4	3/3 7.5YR
4.50-5.00	Birch, Reed, Small Fibre	5	2/2 10YR
5.00-5.20	Birch, Reed, Small Fibre	9	2/1 5YR
5.20	Clay with Pebbles		6/1 5Y

Method: Drilling with a peatauger
Place: CLARA BOG, PIEZOMETER 57
Date: 26-8-1991
Surfacelevel (M.O.D.): 58.50 Dry

Depth (m)	Vegetation Type	Humification Degree	Color
0.00-0.25	Spaghnum, Heather	5	2/3 5YR
0.25-0.35	Spaghnum, Bog Cotton	3	4/6 7.5YR
0.35-0.50	Spaghnum, Heather, Bog Cotton	3	3/4 5YR
0.50-0.75	Spaghnum, Heather, Bog Cotton	5	3/3 5YR
0.75-1.00	Spaghnum, Bog Cotton, Small Fibre	7	2/3 5YR
1.00-1.10	Spaghnum, Bog Cotton, Small Fibre	7	2/3 5YR
1.10-1.20	Spaghnum, Small Fibre	3	3/3 5YR
1.20-1.40	Spaghnum, Heather, Bog Cotton, Small Fibre	7	2/3 5YR
1.40-1.50	Spaghnum, Heather, Small Fibre	8	3/3 2.5YR
1.50-1.75	Small Fibre, Spaghnum, Heather, Bog Cotton	8	2/3 5YR
1.75-2.00	Spaghnum, Heather, Small Fibre	8/9	3/3 5YR
2.00-2.10	Bog Cotton	9	2/2 5YR
2.10-2.40	Bog Cotton, Heather, Spaghnum	4	3/3 7.5YR
2.40-2.60	Spaghnum, Bog Cotton, Heather	5	2/4 5YR
2.60-2.80	Spaghnum, Bog Cotton	3	3/6 5YR
2.80-3.00	Bog Cotton	4	3/3 5YR
3.00-3.35	Spaghnum, Heather	5	3/2 7.5YR
3.35-3.50	Bog Cotton, Heather	5	3/2 5YR
3.50-3.80	Spaghnum, Bog Cotton, Heather	4	3/2 5YR
3.80-4.00	Heather, Birch	4	2/1 5YR
4.00-4.50	Heather, Birch	5	3/2 5YR
4.50-4.90	Alder, Reed, Heather	6	3/2 5YR
4.90-5.00	Reed, Birch, Heather	5	2/1 5YR
5.00-5.25	Reed	6	2/1 5YR
5.25-5.50	Reed, Birch	7	2/2 5YR
5.50-5.60	Reed, Birch	8/9	2/2 5YR
5.60-5.65	Birch, Alder		
5.65-6.00	Reed, Birch	7	3/2 7.5YR
6.00-6.50	Reed, Birch	6	2/1 5YR
6.50-6.90	Reed, Birch	5	2/2 5YR
6.90-7.00	Birch	5	2/2 5YR
7.00-7.30	Reed, Birch	7	2/1 5YR
7.30 Clay			N 5/0

Drilling with a peat auger
Place: CLARA BOG, PIEZOMETER 59
Date: 17-6-1991
Surfacelevel (M.O.D.): 57.64

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.15		3	3/4 10YR
0.15-0.35		7	2/3 7.5YR
0.35-0.60		5	2/3 5YR
0.60-0.85		6	2/3 2.5YR
0.85-1.10		7	2/2 2.5YR
1.10-1.70	"Heather peat"	6	2/4 5YR
1.70-1.80		8	3/4 7.5YR
1.80-2.00		6	2/2 2.5YR
2.00-2.20		6	
2.20-2.35		8	2/3 5YR
2.35-2.50		7	2/3 5YR
2.50-3.00		8	2/3 2.5YR
3.00-3.50	Sphagnum	5	3/3 5YR
3.50-3.65	Sphagnum	7	2/3 5YR
3.65-3.80	Wood	4	3/2 5YR
3.80-3.90	Sphagnum	7	2/3 5YR
3.90-4.00	Sphagnum	6	2/2 2.5YR
4.00-4.25	Sphagnum	5	2/3 2.5YR
4.25-4.50	Sphagnum, Heather	6	2/1 2.5YR
4.50-4.75	Sphagnum, Heather	7	2/1 5YR
4.75-5.00	Sphagnum, Heather	6	3/1 5YR
5.00-5.50	Birch, Heather, (Beatle)	7	2/2 7.5YR
5.50-5.90		7	2/2 7.5YR
5.90-6.00	Alder, Birch	8	2/2 7.5YR
6.00-6.50	Alder, Birch, Small Fibre	7	2/1 5YR
6.50-7.00	Alder, Birch	7	2/1 5YR
7.00-7.65			
7.65	Clay with pebbles		

Method: Drilling with a peat auger
Place: CLARA BOG, PIEZOMETER 50
Date: 3-9-1991
Surfacelevel (M.O.D.): 58.53 dry

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-0.50	Sphagnum, Bog Cotton, Small Fibre	7	2/2 5YR
0.50-1.00	Bog Cotton, Heather, Small Fibre	7	2/3 5YR
1.00-1.30	Bog Cotton, Sphagnum, Heather	7	2/4 5YR
1.30-1.40	Bog Cotton, Heather, Sphagnum	6	2/3 5YR
1.40-1.50	Heather, Sphagnum, Bog Cotton	6	2/4 5YR
1.50-2.00	Sphagnum, Bog Cotton, Heather, Small Fibre	7	2/3 5YR
2.00-2.65	Sphagnum, Bog Cotton, Small Fibre	3	3/4 5YR
2.65-2.75	Sphagnum, Bog Cotton	7	2/2 5YR
2.75-2.90	Sphagnum, Bog Cotton	3	2/3 5YR
2.90-2.95	Sphagnum, Bog Cotton	7	2/4 5YR
2.95-3.00	Sphagnum, Bog Cotton	8	2/4 5YR
3.00-3.25	Sphagnum, Bog Cotton	8	2/2 5YR
3.25-3.50	Sphagnum, Bog Cotton	7	3/4 5YR
3.50-3.70	Bog Cotton	9	3/3 7.5YR
3.70-4.00	Sphagnum, Heather, Bog Cotton	3	3/6 5YR
4.00-4.40	Bog Cotton, Sphagnum, Heather	5	2/2 5YR
4.40-4.80	Bog Cotton, Sphagnum, Heather	5	3/3 5YR
4.80-5.00	Bog Cotton, Sphagnum, Heather	4	2/1 5YR
5.00-5.20	Bog Cotton, Heather	7	2/2 5YR
5.20-5.40	Reed, Alder, Heather	7	2/1 7.5YR
5.40-5.50	Reed	5	3/4 7.5YR
5.50-5.85	Reed, Alder	5	2/1 5YR
5.85-6.00	Birch, Reed	5	2/1 5YR
6.00-6.50	Alder, Reed, Small Fibre	7	2/1 5YR
6.50-7.00	Reed, Birch, Small Fibre	8	2/2 5YR
7.00-7.40	Reed, Birch, Small Fibre	5	2/1 5YR
7.40	Clay (laminated)	N5	

Method: Drilling with a peat auger
Place:
Date: 4-9-1991
Surfacelevel (M.O.D.): 58.49

CLARA BOG, PIEZOMETER 56

Depth (m)	Vegetation Type	Humification Degree	Colour
0.00-1.00	Sphagnum, Roots	–	
1.00-1.50	Bog Cotton, Small Fibre, Heather, Sphagnum	9	2/2 5YR
1.50-1.75	Sphagnum, Bog Cotton, Small Fibre	4	2/2 5YR
1.75-2.00	Sphagnum, Bog Cotton, Small Fibre	3	2/3 5YR
2.00-2.25	Sphagnum, Bog Cotton, Small Fibre	7	2/2 5YR
2.25-2.50	Sphagnum, Bog Cotton, Small Fibre, Heather	6	2/3 5YR
2.50-3.00	Sphagnum, Bog Cotton, Heather	2	2/4 5YR
3.00-3.50	Sphagnum	2	3/3 2.5YR
3.50-4.10	Sphagnum, Heather	2	2/4 2.5YR
4.10-4.30	Bog Cotton, Small Fibre	8	3/4 5YR
4.30-4.45	Sphagnum, Bog Cotton, Heather	2	3/6 5YR
4.45-4.50	Bog Cotton, Small Fibre, Sphagnum	9	2/4 5YR
4.50-4.70	Sphagnum	2	3/3 2.5YR
4.70-5.00	Bog Cotton,Heather	8	3/4 7.5YR
5.00-5.25	Sphagnum, Bog Cotton	9	3/4 7.5YR
5.25-5.50	Sphagnum	4	3/3 5YR
5.50-6.00	Bog Cotton, Sphagnum	9	3/4 5YR
6.00-6.15	Reed, Alder	5	2/3 7.5YR
6.15-6.30	Reed, Small Fibre	5	2/3 7.5YR
6.30-6.50	Birch, Reed, Small Fibre	7	3/4 7.5YR
6.50-6.90	Birch, Alder, Reed	5	3/1 7.5YR
6.90-7.00	Birch, Alder, Reed	7	2/2 7.5YR
7.00-7.25	Alder, Reed, Birch	7	2/2 7.5YR
7.25-7.50	Reed, Alder	5	2/3 7.5YR
7.50-8.00	Reed, Small Fibre, Birch, Alder	6	2/2 7.5YR
8.00-8.25	Reed	9	2/2 10YR
8.25-8.50	Reed	5	2/2 10YR
8.50-8.65	Reed	5	2/2 5YR
8.65-8.75	Clay with Reed		5/2 5Y
8.75	Clay (stiff)		4/1 10Y

APPENDIX 2.4

Subsidence of Raheenmore

RAHEENMORE (1991)						
	Thickness [M]					
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat	Total Peat	Surface Level [M.O.D]	Clay Level [M.O.D.]
201	1.60	0.40	1.65	3.65	100.37	96.72*
206	3.25	2.05	0.80	6.10	103.99	97.89
209	6.00	3.75	0.90	10.65	104.99	94.34
210	5.60	4.15	2.00	11.75	105.62	93.87
211	6.35	4.25	1.35	11.95	105.78	93.83
330	7.25	4.10	0.30	11.65	106.64	94.99*
327	7.00	4.30	0.60	11.90	106.64	94.74*
324	6.10	1.15	2.00	9.25	106.59	97.34
321	4.10	1.80	1.95	7.85	106.62	98.77
317	2.25	1.90	2.35	6.50	106.02	99.52
313	1.85	1.15	2.00	5.00	105.06	100.06*

RAHEENMORE						
	Thickness [M]					
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat	Total Peat	Surface Level [M.O.D.]	Clay Level [M.O.D.]
206	3.25	2.05	0.80	6.10	103.99	97.89
206*	1.80	1.60	1.10	4.50	103.88	99.38
206**	1.30	1.70	0.50	3.50	103.73	100.23

* = between the drains
** = outside the drains

RAHEENMORE
ORIGINAL SURFACE LEVEL
CALCULATED WITH AN AVERAGE Co PER PEAT DEPTH
AND COMPARED WITH 330

		Thickness [M]				
Piezo. Number	Co [g/cm^3] (avg)	Young Sphagnum	Old Sphagnum	Fen Peat	Total	Original Surface Level [M.O.D.]
201	0.083	3.47	0.87	3.58	7.92	104.64
206	0.059	4.99	3.15	1.23	9.37	107.26
209	0.044	6.98	4.36	1.05	12.38	106.72
210	0.044	6.39	4.74	2.28	13.42	107.29
211	0.042	6.93	4.64	1.47	13.05	106.88
330	0.038	7.25	4.10	0.30	11.65	106.64
327	0.040	7.38	4.53	0.63	12.55	107.29
324	0.049	7.78	1.47	2.55	11.80	109.14
321	0.057	6.16	2.70	2.93	11.79	110.56
317	0.068	4.01	3.38	4.19	11.58	111.10
313	0.082	3.98	2.48	4.31	10.76	110.82

RAHEENMORE ORIGINAL SURFACE LEVEL CALCULATED WITH AN AVERAGE DENSITY PER PEAT DEPTH AND COMPARED WITH 330						
		Thickness [M]				
Piezo. Number	Density [g/cm^3] (avg)	Young Sphagnum	Old Sphagnum	Fen Peat	Total	Original Surface Level [M.O.D.]
201	0.116	3.91	0.98	4.03	8.92	105.64
206	0.081	5.57	3.51	1.37	10.45	108.34
209	0.058	7.34	4.59	1.10	13.03	107.37
210	0.056	6.65	4.93	2.38	13.96	107.83
211	0.055	7.35	4.92	1.56	13.84	107.67
330	0.047	7.25	4.10	0.30	11.65	106.64
327	0.050	7.38	4.54	0.63	12.55	107.29
324	0.062	8.03	1.51	2.63	12.17	109.51
321	0.076	6.61	2.90	3.14	12.65	111.42
317	0.098	4.65	3.92	4.85	13.43	112.95
313	0.116	4.54	2.82	4.91	12.28	112.34

	RAHEENMORE Co-VALUES [g/cm^3]		
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat
201	0.071	0.071	0.096
206	0.051	0.065	0.073
209	0.042	0.047	0.053
210	0.034	0.045	0.075
211	0.039	0.035	0.077
330.1	0.031	0.038	
330.2	0.036	0.039	0.069
327	0.036	0.041	0.093
324	0.043	0.055	0.071
321	0.043	0.060	0.083
317	0.060	0.059	0.085
313	0.074	0.081	0.089

	RAHEENMORE Co-VALUES [g/cm^3]		
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat
206	0.051	0.065	0.84
206*	0.067	0.059	0.064
206**	0.058	0.055	0.057

* = between the drains

** = outside the drains

RAHEENMORE ORIGINAL SURFACE LEVEL CALCULATED WITH AN AVERAGE Co PER KIND OF PEAT AND COMPARED WITH 330									
	Thickness [M]								
Piezo. Number	Young Sphagnum		Old Sphagnum		Fen Peat		Total Peat		Original Surface Level [M.O.D.]
		S		S		S		S	
201	3.64	0.44	0.76	0.53	2.31	0.71	6.70	0.54	103.42
206	5.28	0.62	3.53	0.58	0.84	0.95	9.66	0.63	107.55
209	8.06	0.74	4.67	0.80	0.69	1.30	13.42	0.79	107.76
210	6.06	0.92	4.91	0.85	2.17	0.92	13.13	0.89	107.00
211	7.85	0.81	3.95	1.08	1.51	0.89	13.31	0.90	107.14
330	7.25	1	4.10	1	0.30	1	11.65	1	106.64
327	7.98	0.88	4.70	0.91	0.81	0.74	13.49	0.88	108.23
324	8.28	0.74	1.67	0.69	2.05	0.98	11.99	0.77	109.33
321	5.57	0.74	2.87	0.63	2.35	0.83	10.78	0.73	109.55
317	4.28	0.53	2.98	0.64	2.91	0.81	10.16	0.64	109.68
313	4.39	0.42	2.46	0.47	2.58	0.78	9.42	0.53	109.48

RAHEENMORE
ORIGINAL SURFACE LEVEL
CALCULATED WITH AN AVERAGE Co PER KIND OF PEAT
AND COMPARED WITH 330

	Thickness [M]								
Piezo. Number	White Sphagnum		Black Sphagnum		Fen Peat		Total Peat		Surface Level [M.O.D.]
	Thn.	S	Thn.	S	Thn.	S	Thn.	S	
206	5.28	0.62	3.53	0.58	0.84	0.95	9.66	0.63	107.55
206*	3.36	0.54	2.32	0.69	0.91	1.21	6.59	0.68	105.96
206**	2.80	0.46	2.66	0.64	0.46	1.09	5.92	0.59	106.15

* = between the drains
** = outside the drains

RAHEENMORE
ORIGINAL SURFACE LEVEL
CALCULATED WITH AN AVERAGE Co PER KIND OF PEAT
AND COMPARED WITH 260

	Thickness [M]								
Piezo. Number	White Sphagnum		Black Sphagnum		Fen Peat		Total Peat		Surface Level [M.O.D.]
	Thn.	S	Thn.	S	Thn.	S	Thn.	S	
206	3.25	1	2.05	1	0.8	1	6.10	1	103.99
206*	2.07	0.87	1.35	1.19	0.86	1.28	4.28	1.05	103.65
206**	1.72	0.76	1.54	1.10	0.44	1.14	3.70	0.95	103.93

RAHEENMORE ORIGINAL SURFACE LEVEL CALCULATED WITH AN AVERAGE Co PER KIND OF PEAT AND COMPARED WITH 321					
	THICKNESS [M]				
Piezo. Number	White Sphagnum	Black Sphagnum	Fen Peat	Total Peat	Original Surface Level [M.O.D.]
321	4.10	1.80	1.95	7.85	106.62
317	3.15	1.87	2.42	7.43	106.95
313	3.23	1.54	2.14	6.91	106.97

	RAHEENMORE DENSITY-VALUES [g/cm^3]		
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat
201	0.085	0.094	0.150
206	0.068	0.093	0.096
209	0.053	0.061	0.077
210	0.040	0.060	0.102
211	0.049	0.045	0.113
330.1	0.037	0.051	
330.2	0.042	0.051	0.105
327	0.040	0.054	0.157
324	0.050	0.078	0.101
321	0.049	0.081	0.124
317	0.079	0.086	0.125
313	0.093	0.122	0.131

RAHEENMORE ORIGINAL SURFACE LEVEL CALCULATED WITH AN AVERAGE DENSITY PER KIND OF PEAT					
	Thickness [M]				
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat	Total Peat	Original Surface Level [M.O.D.]
201	3.69	0.74	2.35	6.78	103.50
206	5.95	3.77	0.73	10.46	108.35
209	8.66	4.51	0.66	13.82	108.16
210	6.05	4.88	1.93	12.86	106.73
211	8.44	3.80	1.46	13.69	107.52
330	7.25	4.10	0.30	11.65	106.64
327	7.54	4.58	0.90	13.02	107.76
324	8.18	1.77	1.93	11.83	109.17
321	5.48	2.89	2.30	10.67	109.44
317	4.78	3.20	2.79	10.77	110.29
313	4.65	2.76	2.50	9.91	109.97

APPENDIX 2.5

Subsidence of Clara

CLARA						
	Thickness [M]					
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat	Total Peat	Surface Level [M.O.D]	Clay Level [M.O.D.]
56	4.1	1.9	2.65	8.65	58.49	49.84
50	2.9	2.3	2.2	7.4	58.53	51.13
49	0	0.25	2.6	2.85	60.71	57.86
49-57	0.75	1.75	2.7	5.2	58.75	53.55
57	1.2	2.8	3.3	7.3	58.5	51.2
59	0.85	4.15	2.65	7.65	57.64	49.99

CLARA ORIGINAL SURFACE LEVEL CALCULATED WITH A Co-AVERAGE AND COMPARED WITH 56						
		Thickness [M]				
Piezo. Number	Co (avg)	Young Sphagnum	Old Sphagnum	Fen Peat	Total Peat	Original Surface Level [M.O.D.
56	0.045534	4.10	1.90	2.65	8.65	58.49
50	0.058466	3.72	2.95	2.82	9.50	60.63
49	0.073219		0.40	4.18	4.58	62.44
57-49	0.065469	1.08	2.52	3.88	7.48	61.03
57	0.060354	1.59	3.71	4.37	9.68	60.88
59	0.052119	0.97	4.75	3.03	8.76	58.75

	CLARA Co-VALUES [g/cm^3]		
Piezo. Number	Young Sphagnum	Old Sphagnum	Fen Peat
56	0.039143	0.040968	0.055888
50	0.048026	0.059837	0.071215
49			0.073219
57-49	0.101935	0.061104	0.062277
57	0.061421	0.05644	0.062918
59	0.045394	0.047121	0.062198

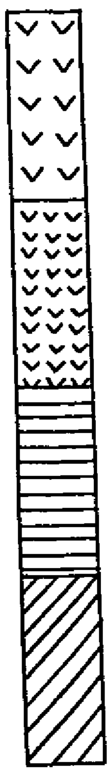
CLARA ORIGINAL SURFACE LEVEL CALCULATED WITH AN AVERAGE Co PER KIND OF PEAT									
	Thickness [M]								
Piezo. Number	White Sphagnum		Black Sphagnum		Fen Peat		Total Peat		Original Surface Level [M.O.D.]
		S		S		S		S	
56	4.10	1	1.90	1	2.65	1	8.65	1	49.84
50	3.56	0.81	3.36	0.68	2.80	0.79	9.72	0.76	48.81
49	0.00		0.37	0.68	3.41	0.76	3.41	0.75	57.30
57-49	1.95	0.38	2.61	0.67	3.01	0.90	7.57	0.69	51.18
57	1.88	0.64	3.86	0.73	3.72	0.89	9.46	0.77	49.04
59	0.99	0.86	4.77	0.87	2.95	0.90	8.71	0.88	48.93

For the Co-value of Black Sphagnum the value of 57-49 is used.
(Maybe it is better to use the S-value of the top layer (White Sphagnum) of 57-49 instead.

APPENDIX 2.6

Calculated Transects

KEY FOR THE TRANSECTS:



WHITE SPHAGNUM

BLACK SPHAGNUM

FEN PEAT

MINERAL SOIL

2.6

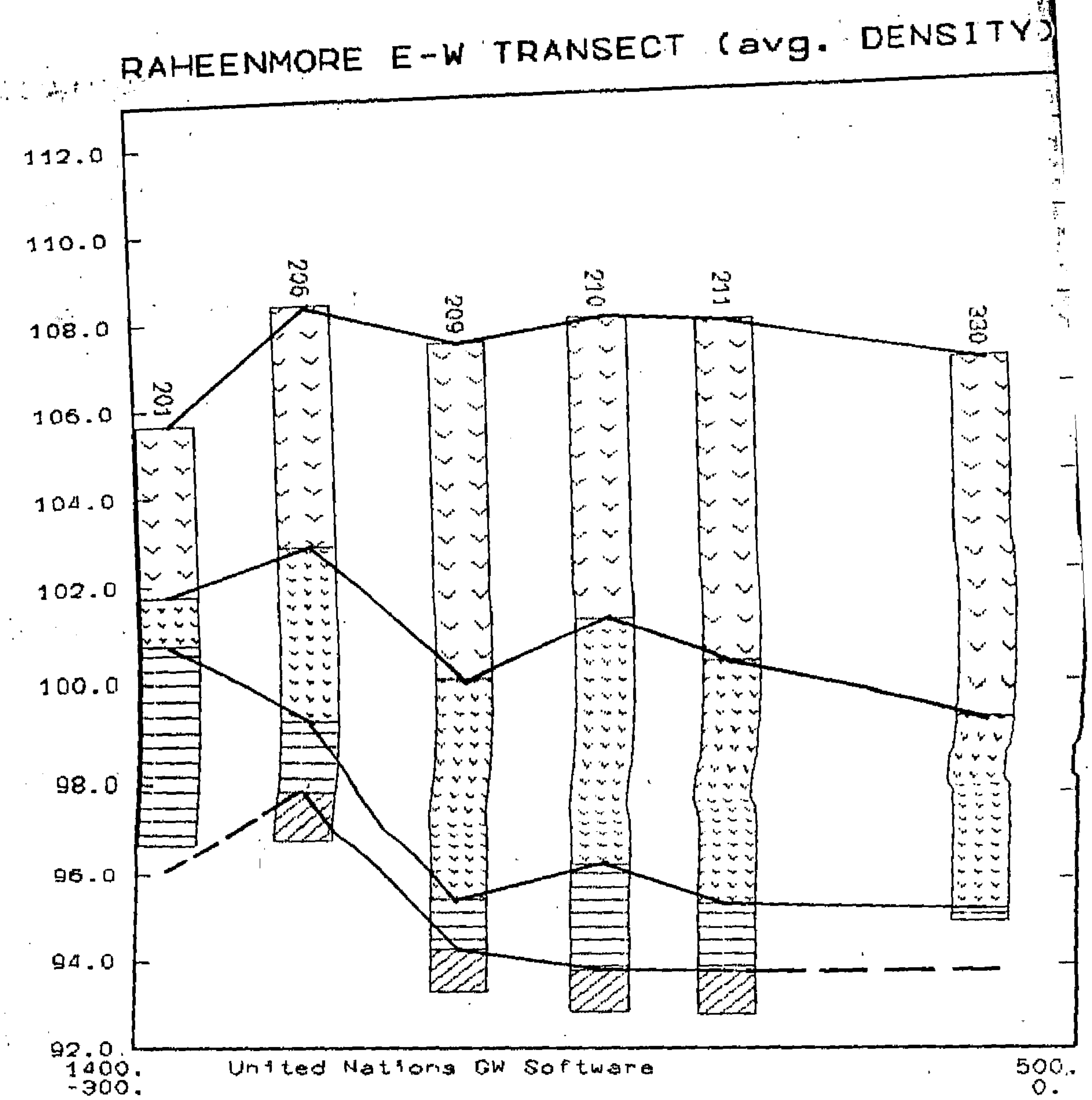

RAHEENMORE E-W TRANSECT (avg. DENSITY)
112.0
110.0
108.0
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
1400.
-300.
United Nations GW Software
500.
0.
201
206
209
210
211
330

FIGURE 1

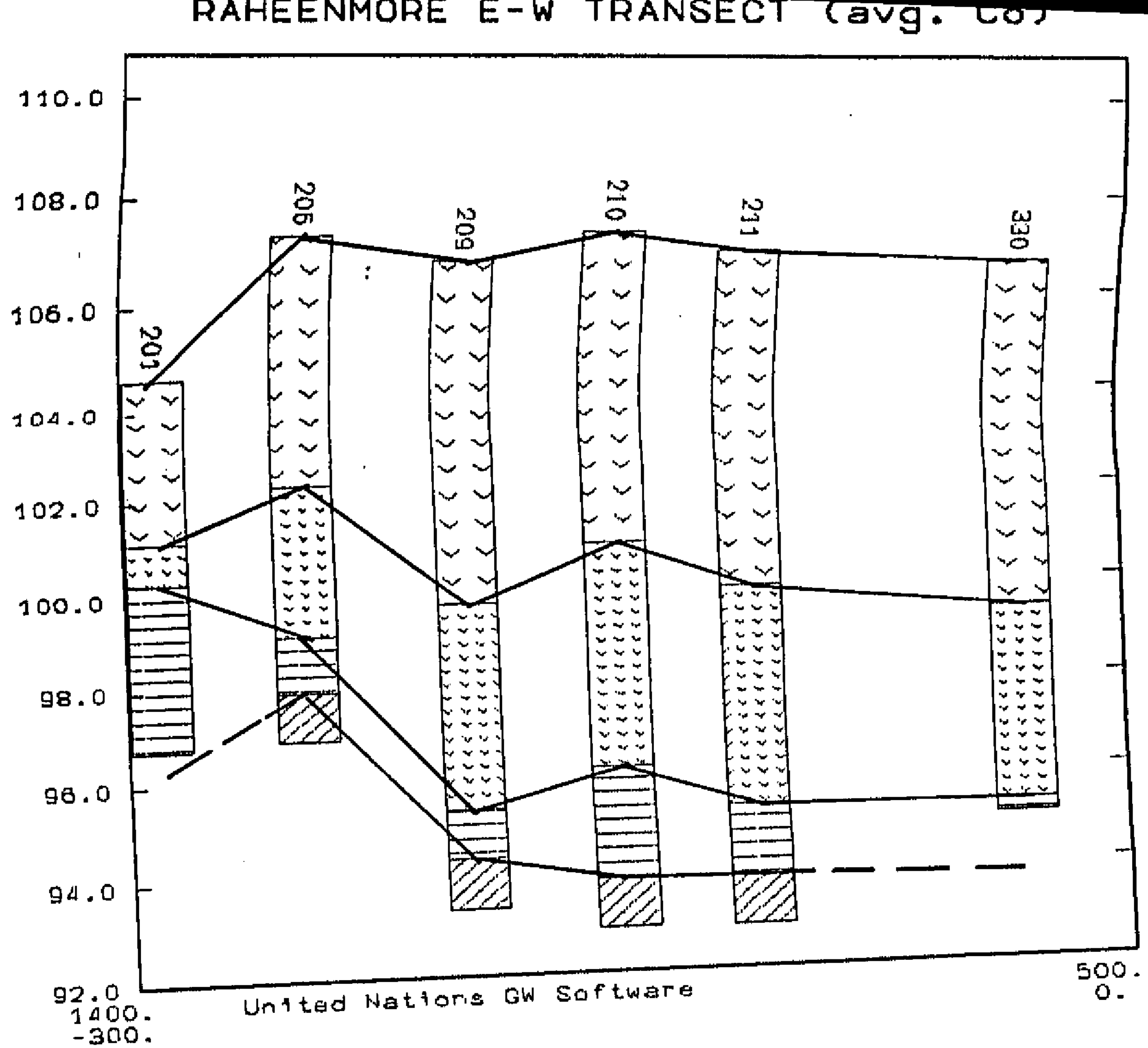

RAHEENMORE E-W TRANSECT (avg. Co)
110.0
108.0
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
1400.
-300.
500.
0.
201
206
209
210
211
330
United Nations GW Software

FIGURE 2

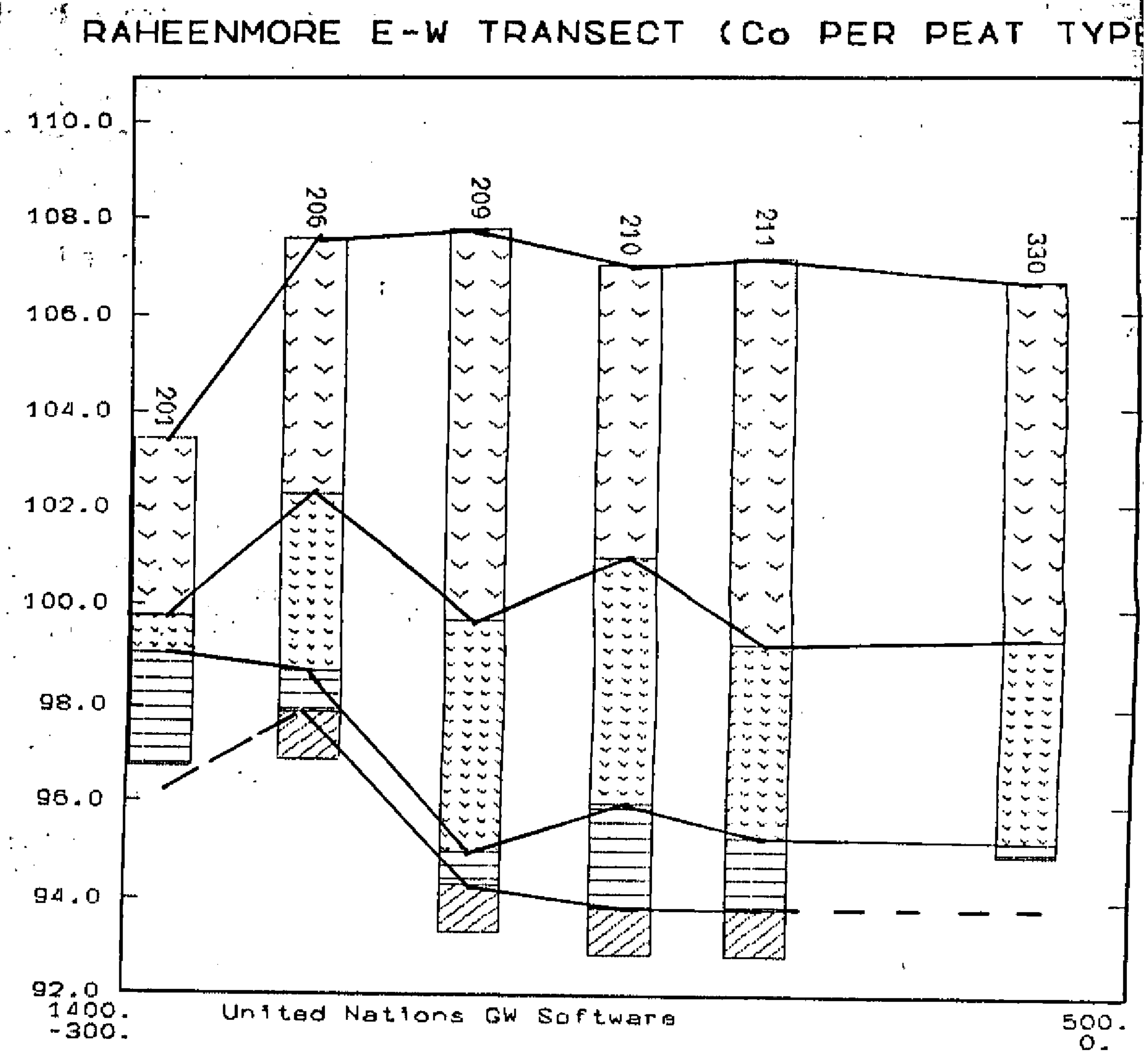
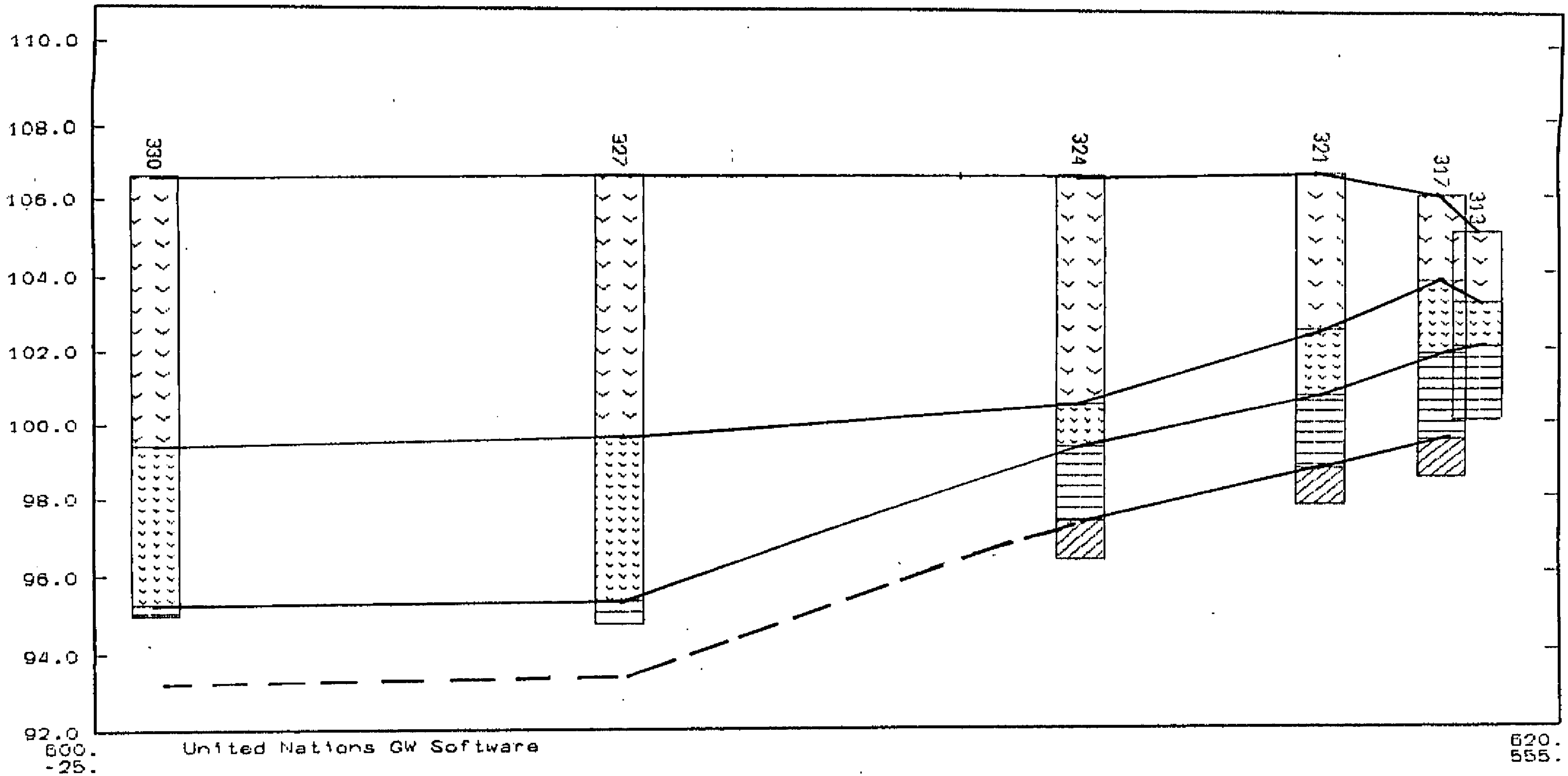

RAHEENMORE E-W TRANSECT (Co PER PEAT TYPE
110.0
108.0
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
1400.
-300.
United Nations GW Software
500.
0.
203
206
209
210
211
330

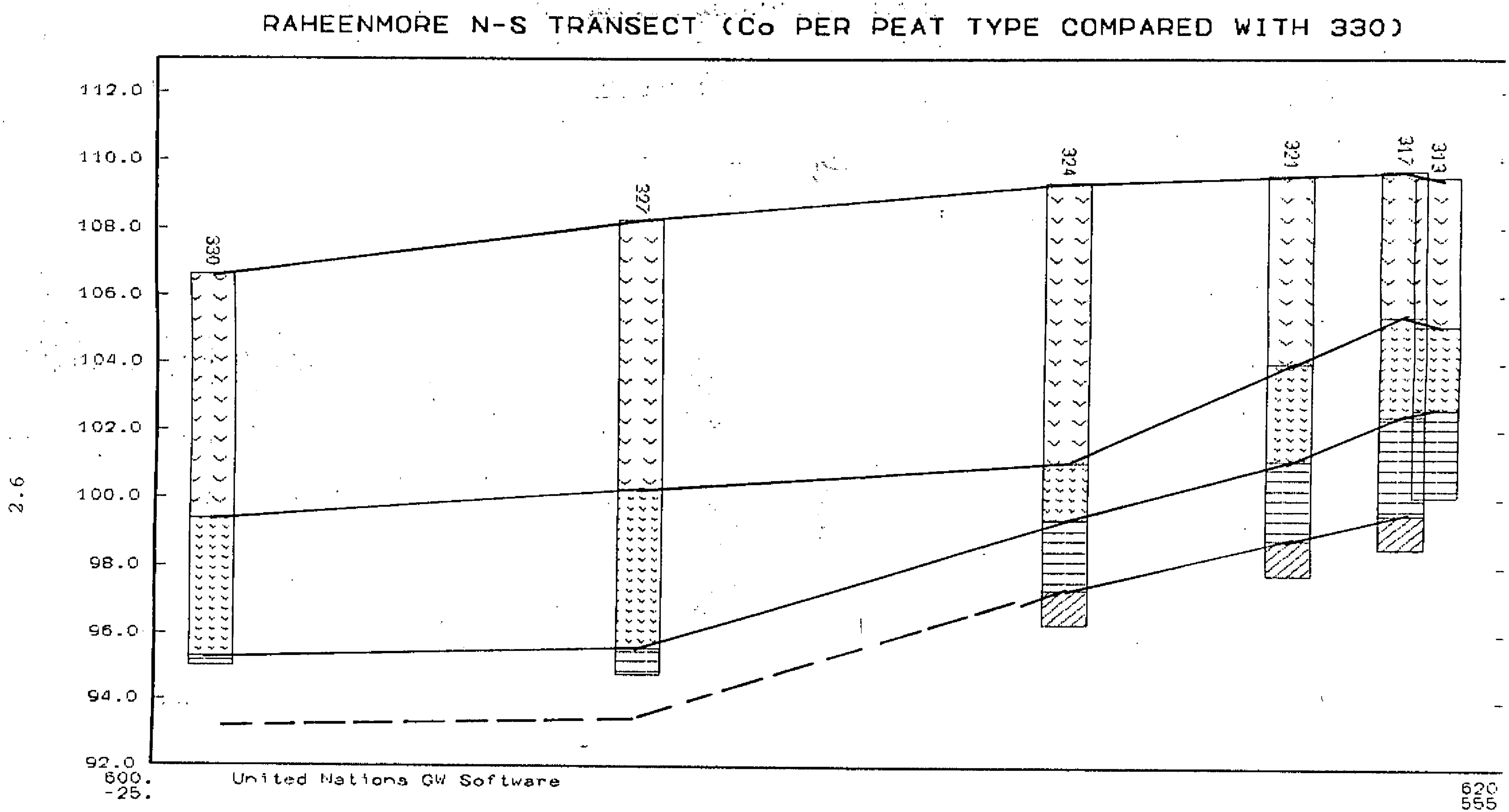
FIGURE 3

RAHEENMORE N-S TRANSECT (1991)



2.6

FIGURE 4



RAHEENMORE N-S TRANSECT (Co PER PEAT TYPE COMPARED WITH 330)
112.0
110.0
108.0
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
2.6
330
327
324
321
317
313
600.
-25.
United Nations GW Software
620
555

FIGURE 5

RAHEENMORE N-S TRANSECT (313 & 317 COMPARED WITH 321)

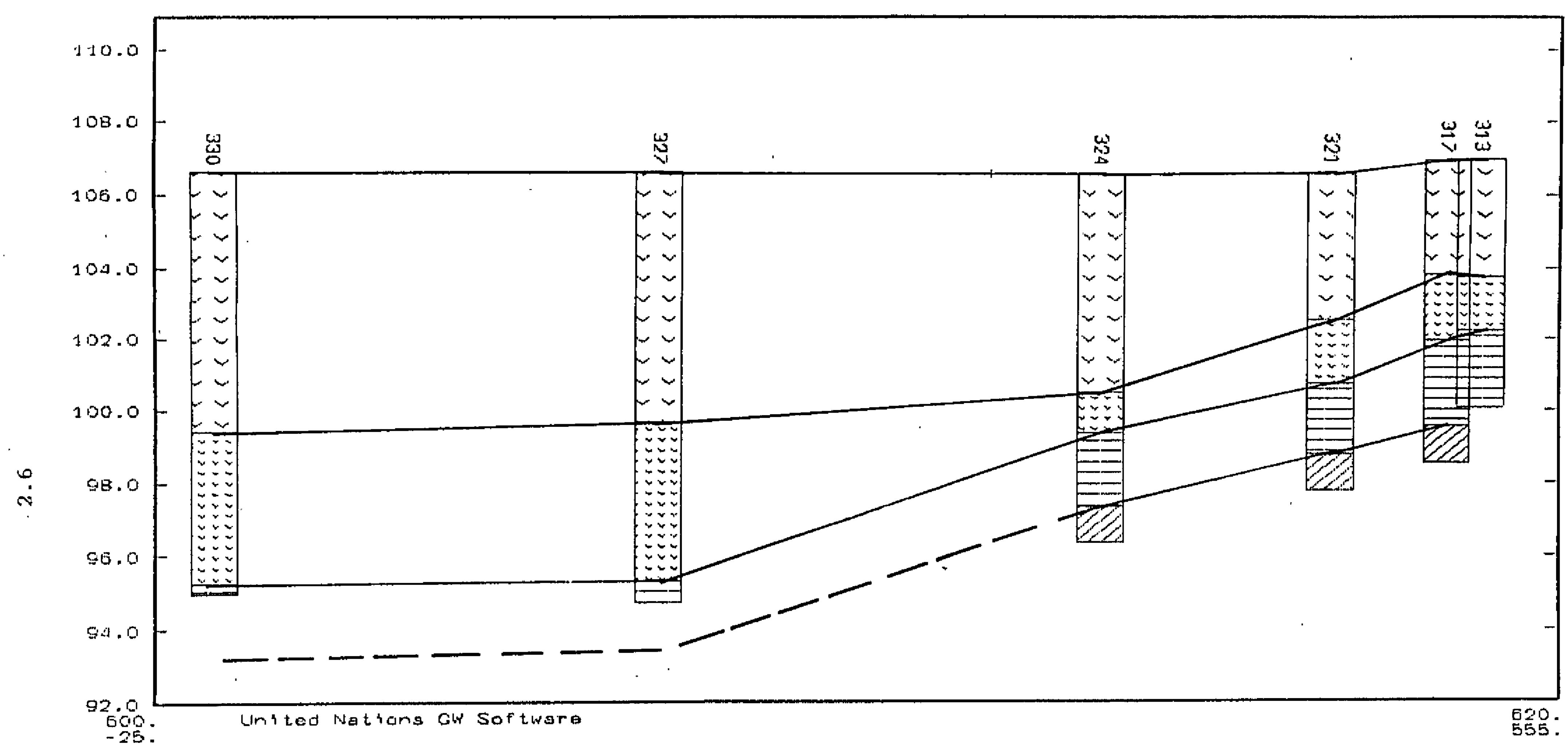


FIGURE 6

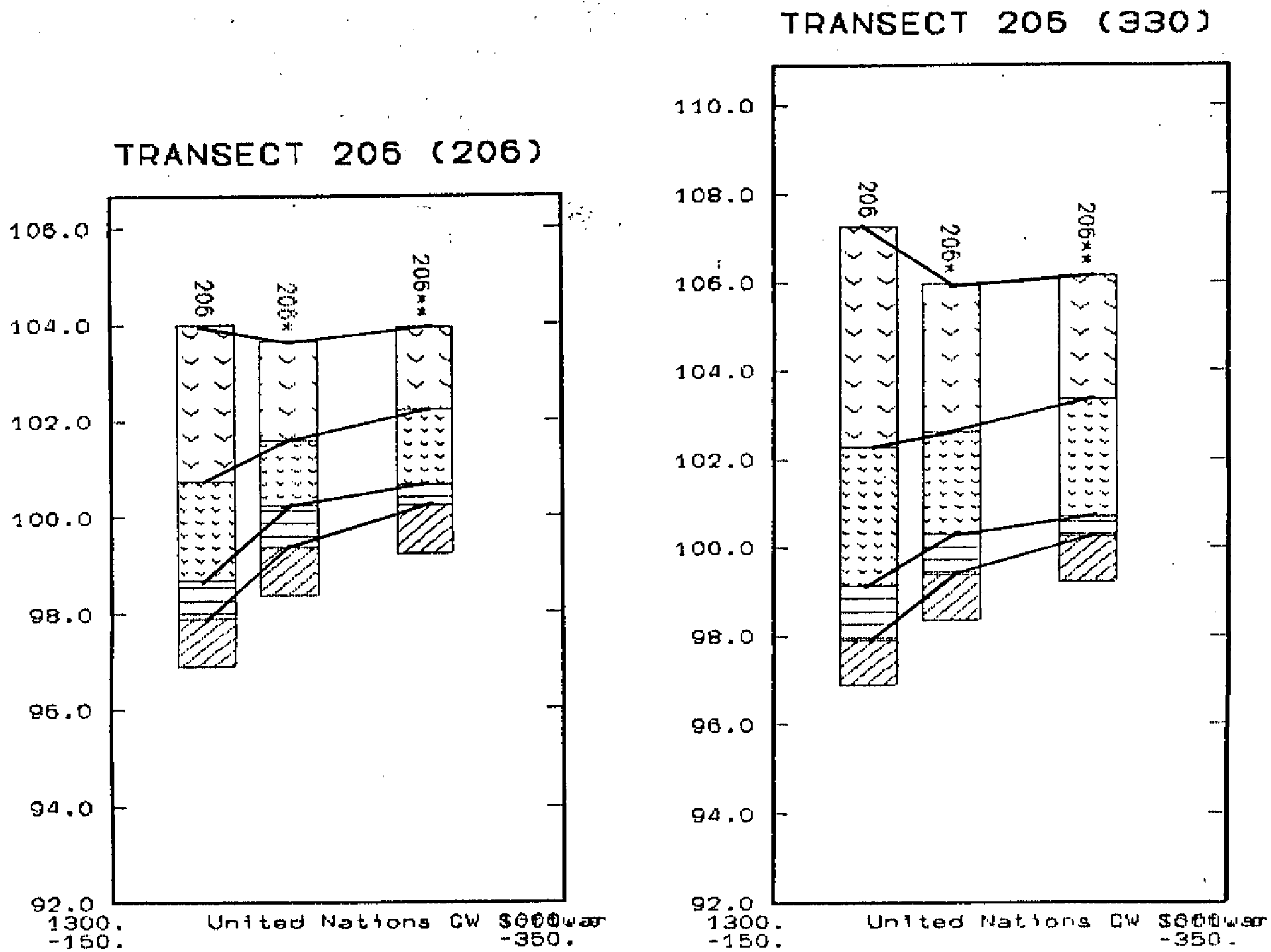

TRANSECT 206 (206)
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
206
206*
206**
1300.
-150.
United Nations CW
-350.
TRANSECT 206 (330)
110.0
108.0
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
206
206*
206**
1300.
-150.
United Nations CW
-350.

FIGURE 7

Co PER PEAT TYPE COMPARED WITH 56

CLARA MOUND TRANSECT

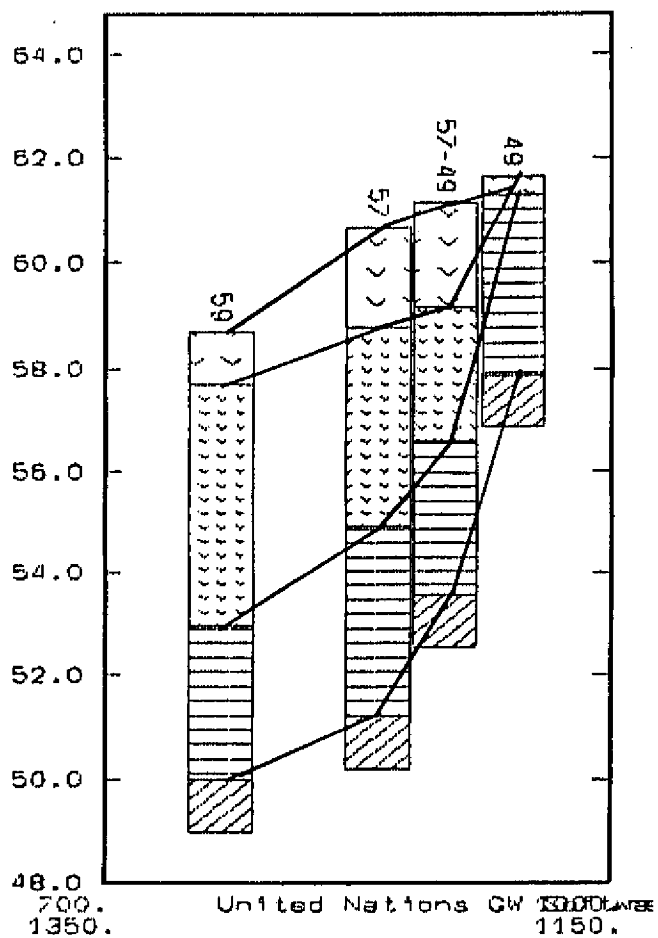


FIGURE 9

CLARA SOAK TRANSECT

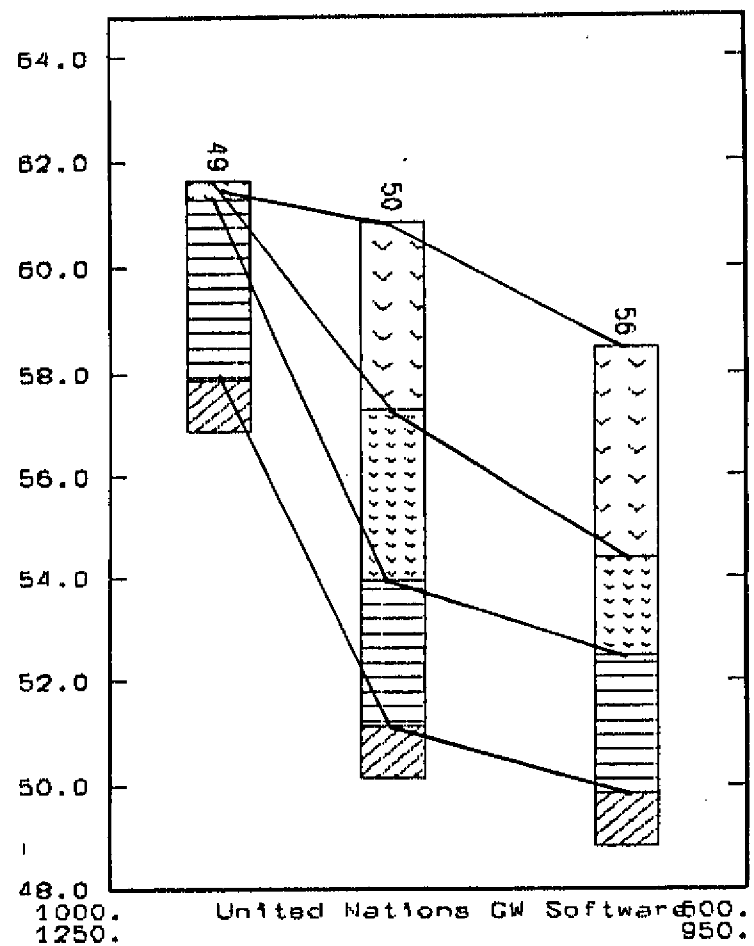
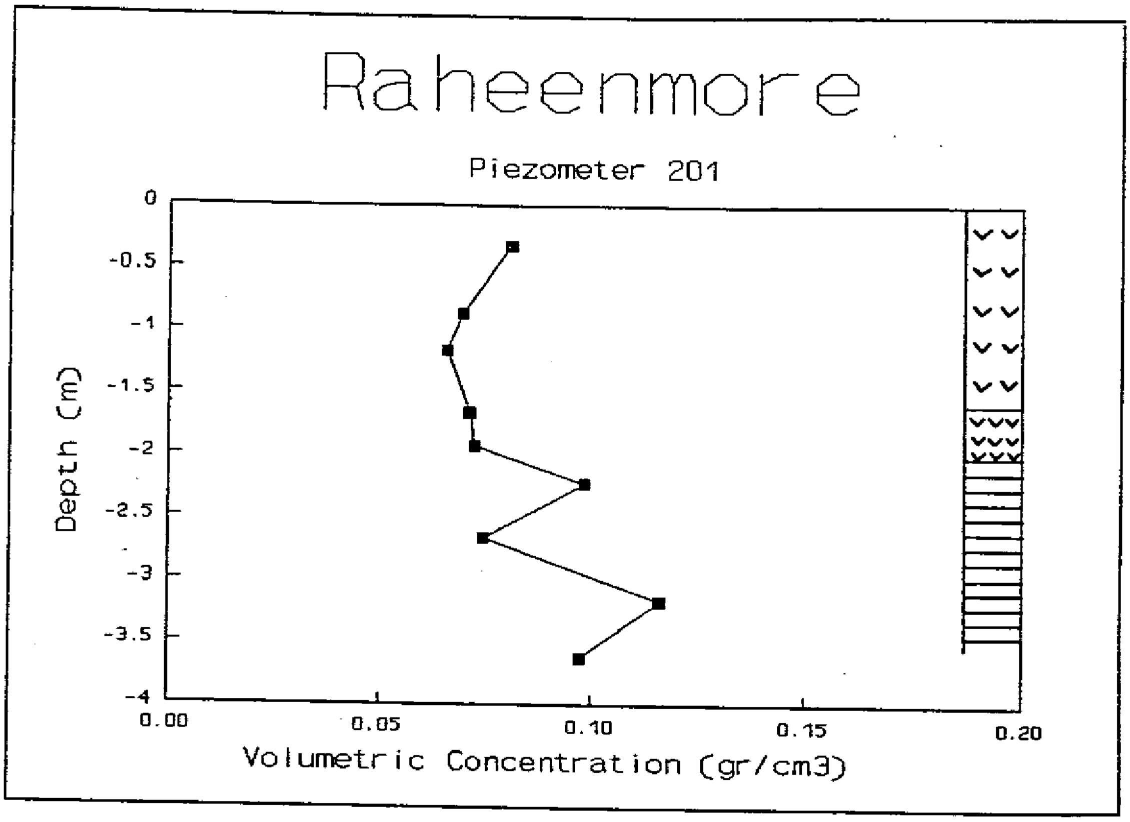
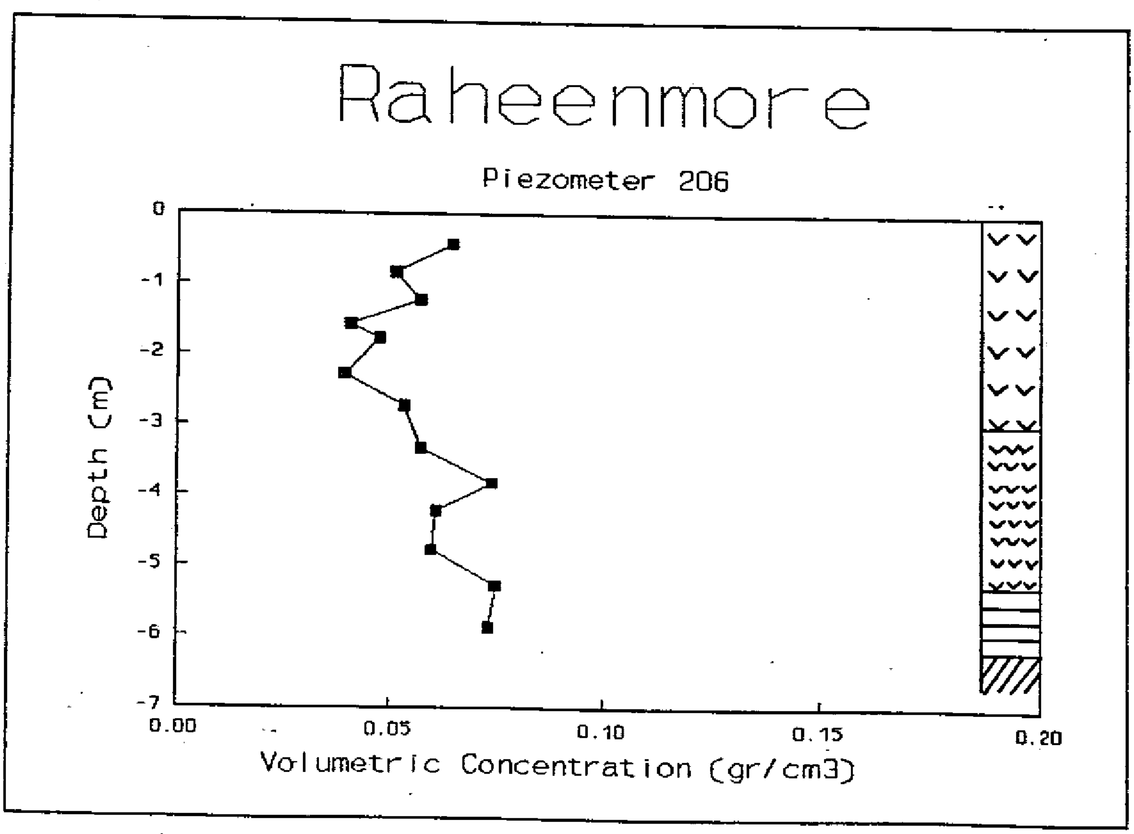


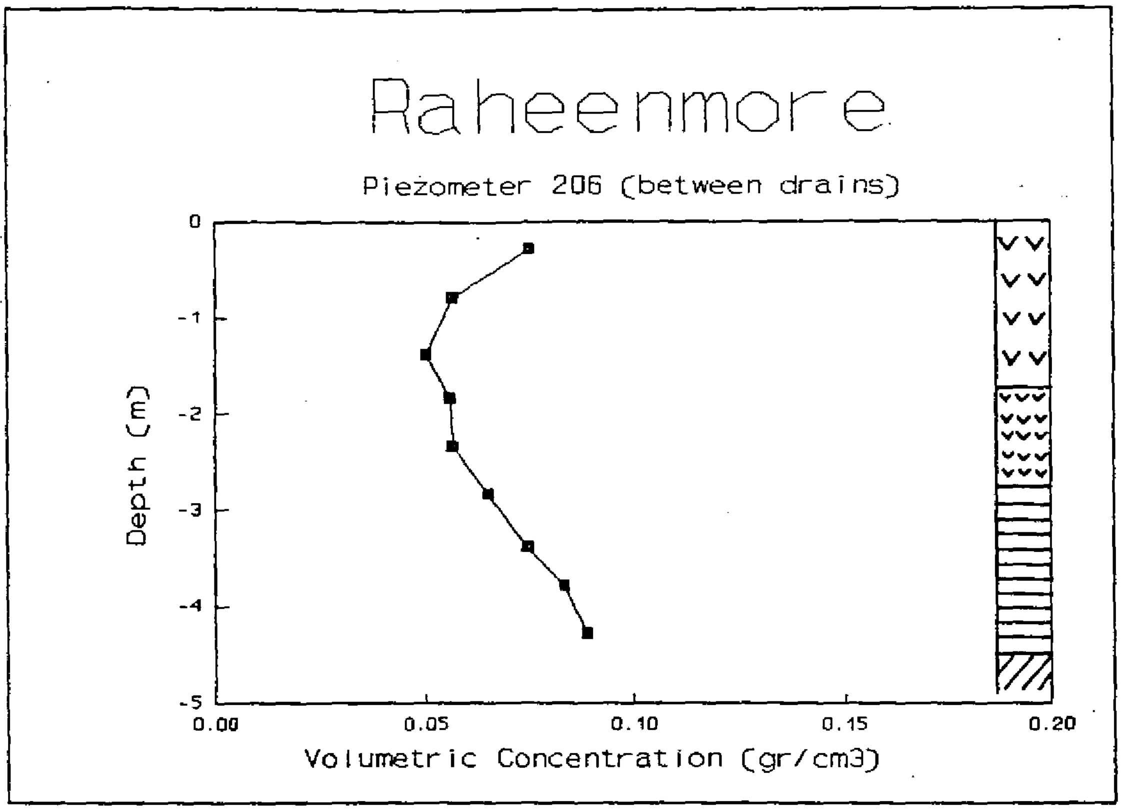
FIGURE 8

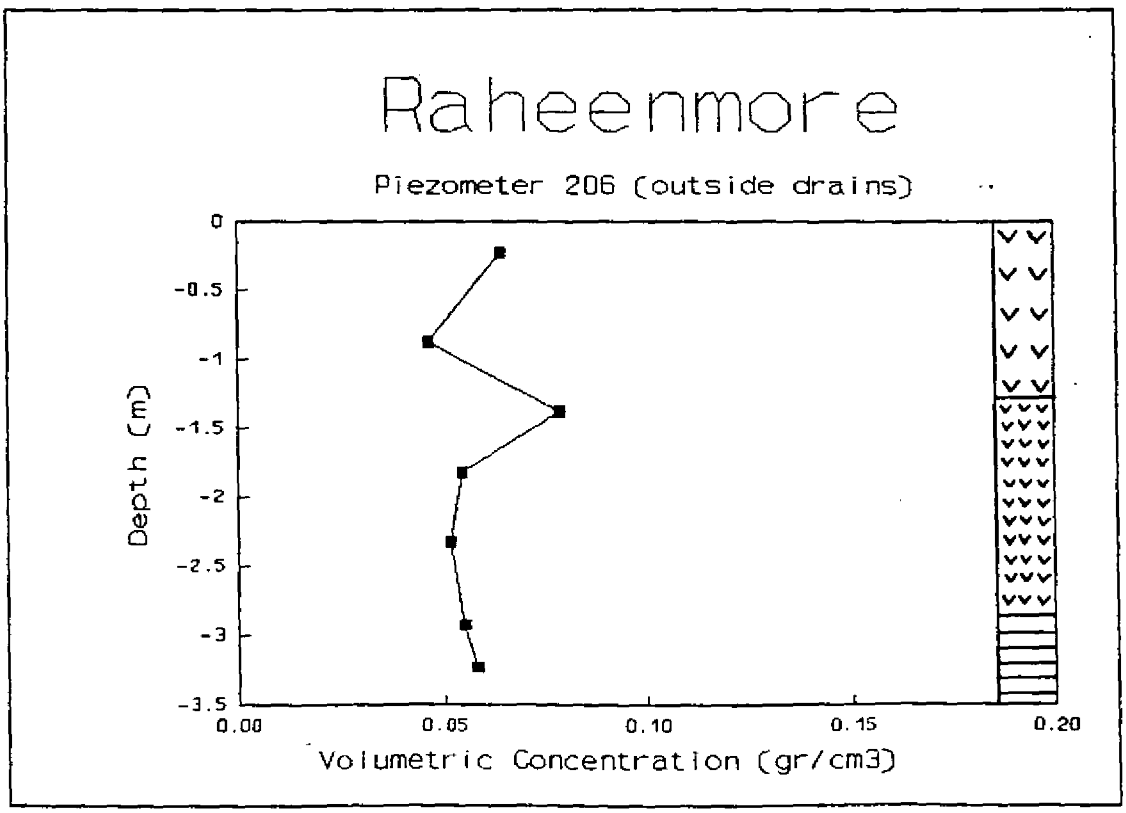
APPENDIX 2.7

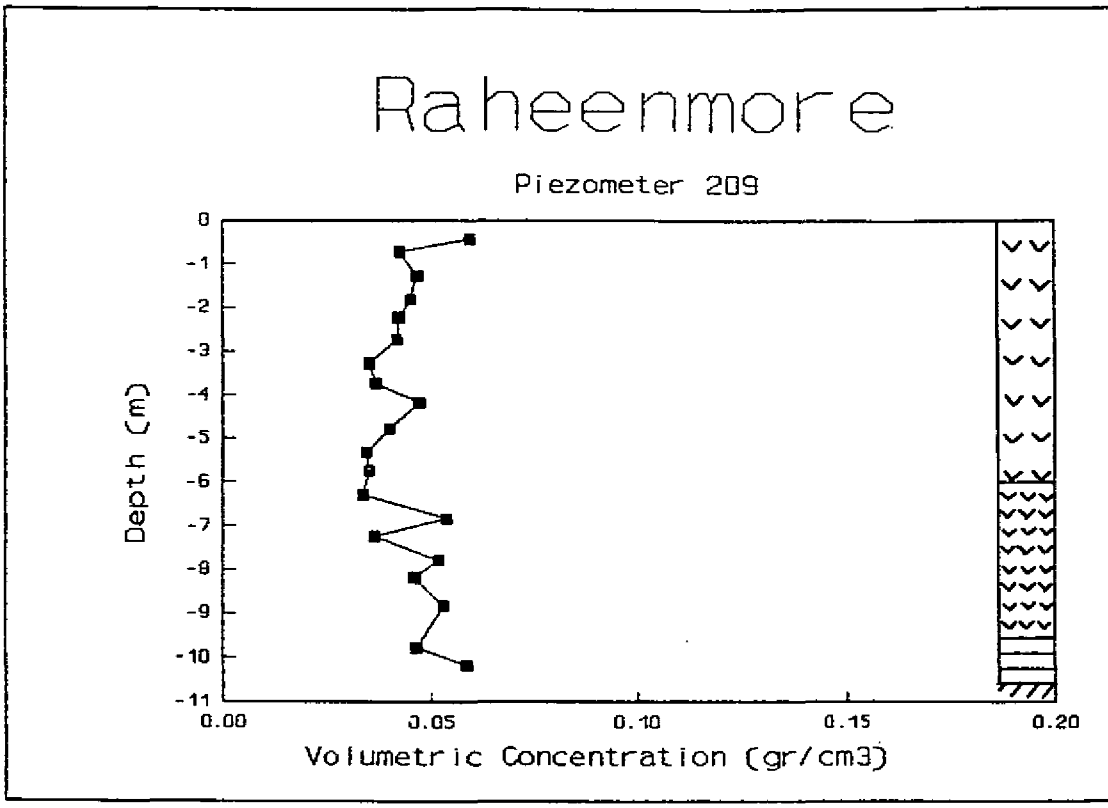
Graphs of Volumetric Concentration

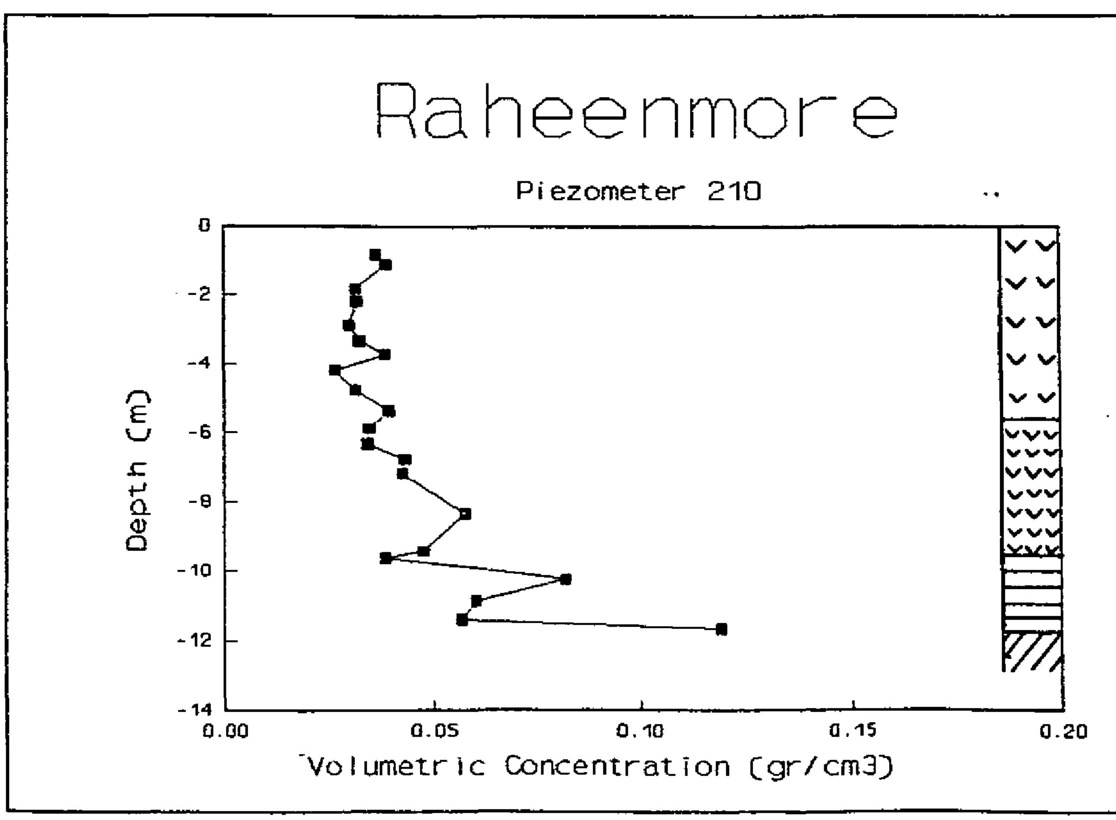

Raheenmore
Piezometer 201
Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

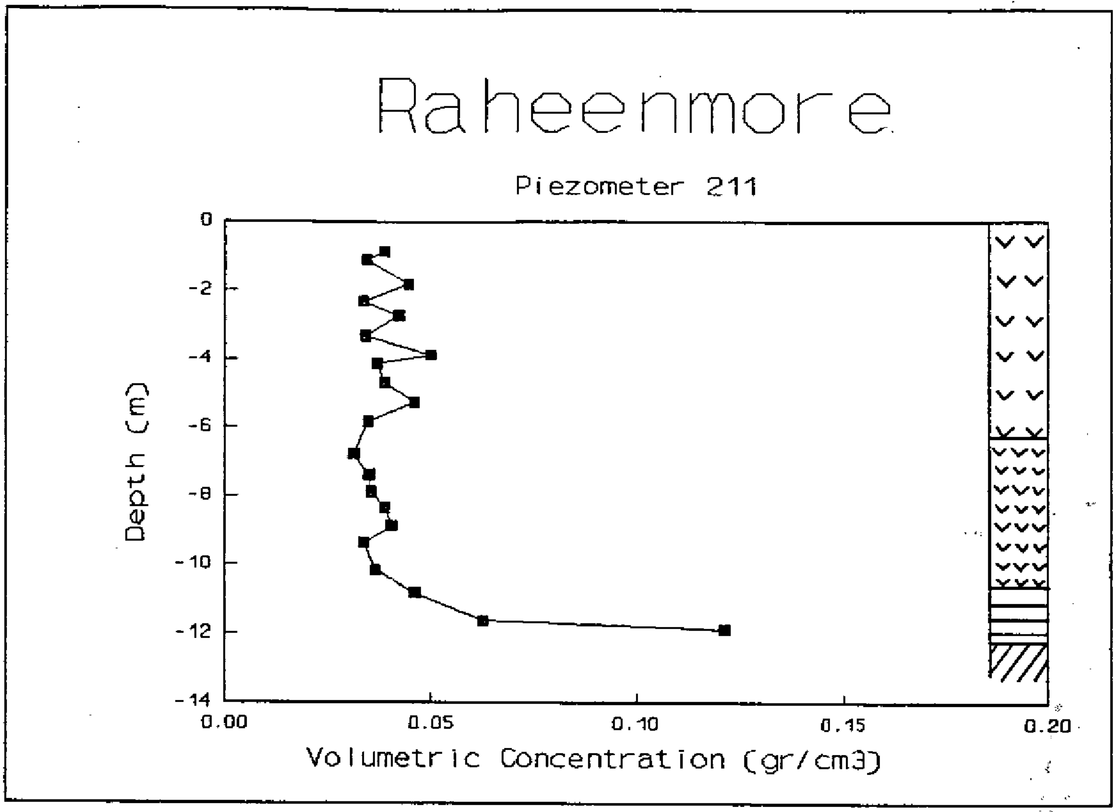

Raheenmore
Piezometer 206
Depth (m)
0
-1
-2
-3
-4
-5
-6
-7
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

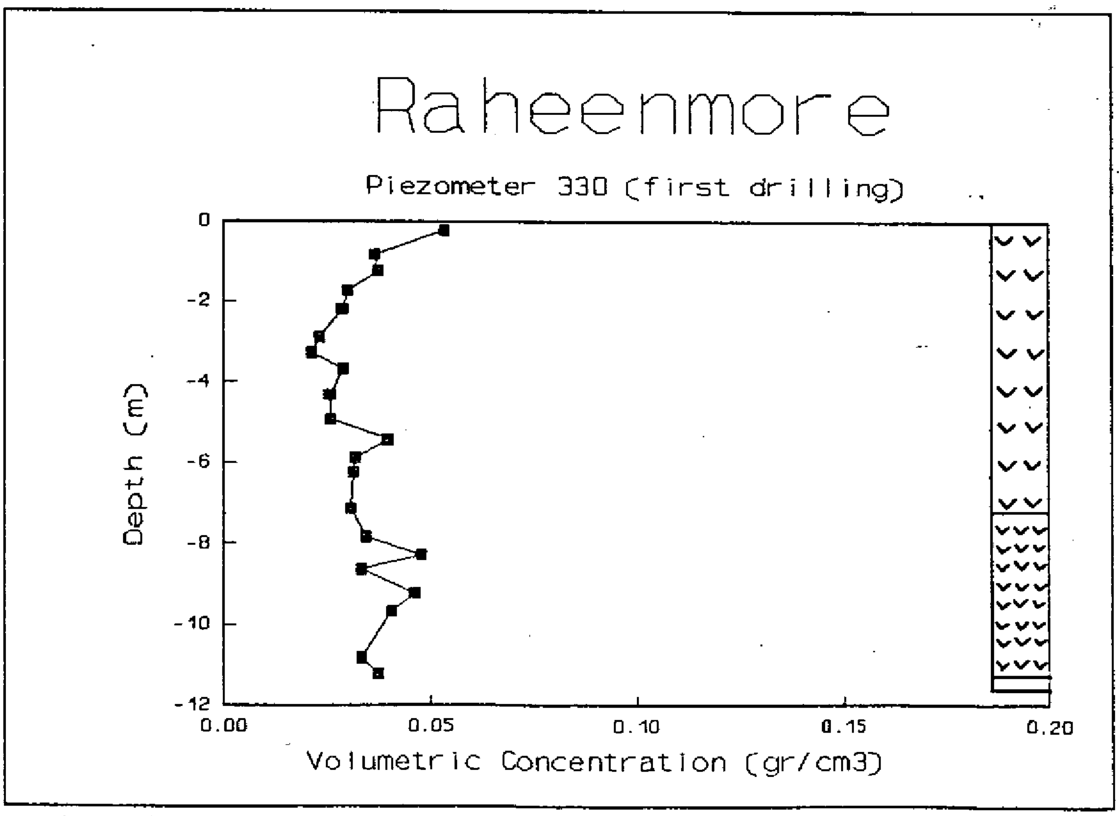

Raheenmore
Piezometer 206 (between drains)
Depth (m)
0
-1
-2
-3
-4
-5
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

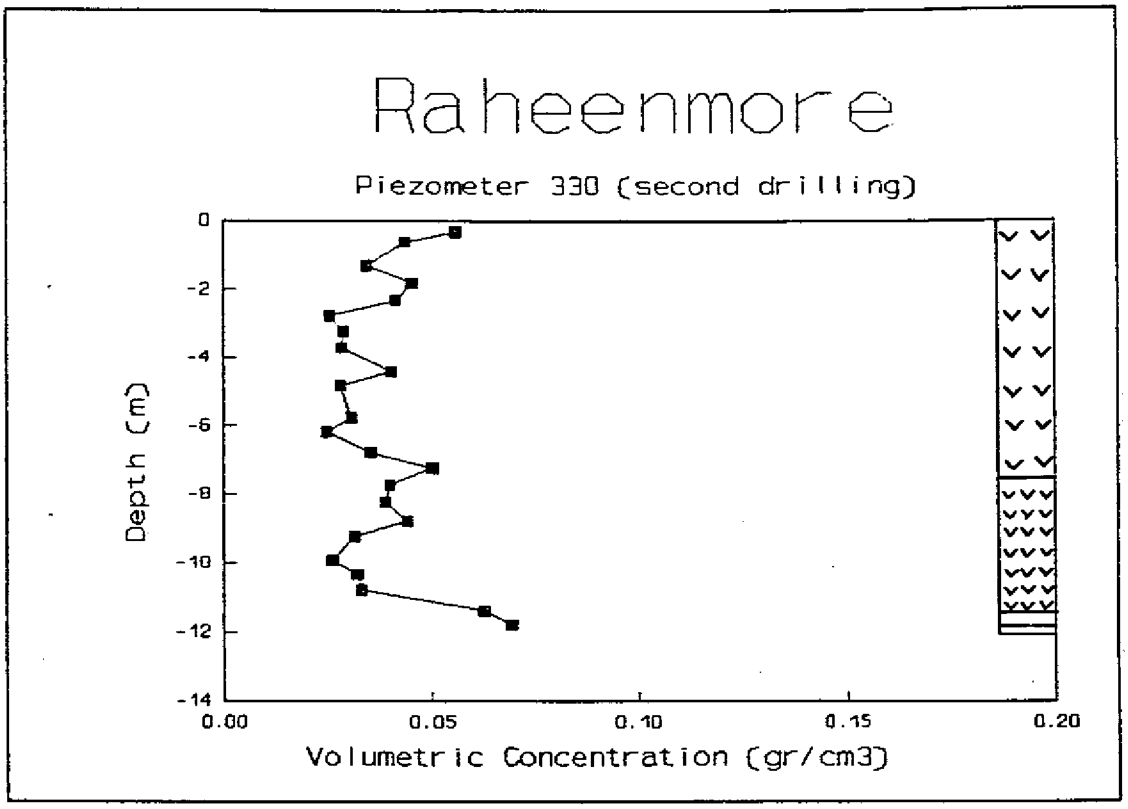

Raheenmore
Piezometer 206 (outside drains)
Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

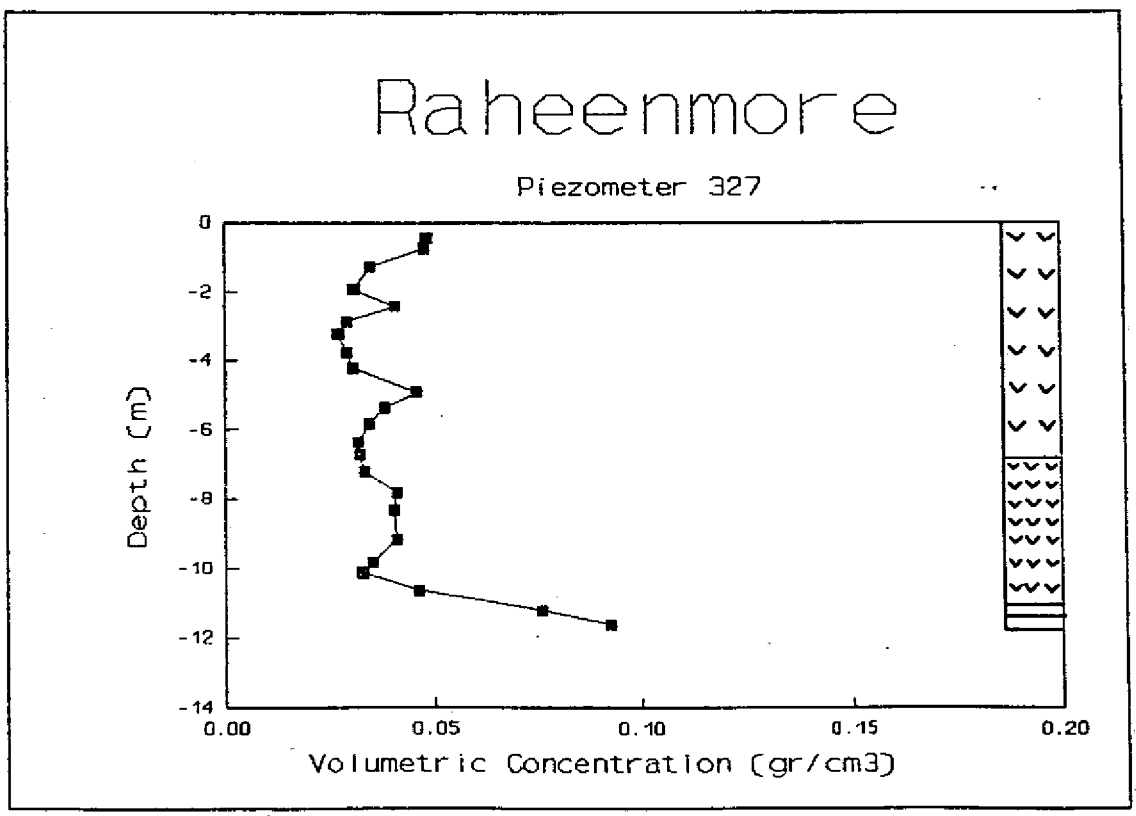

Raheenmore
Piezometer 209
Depth (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

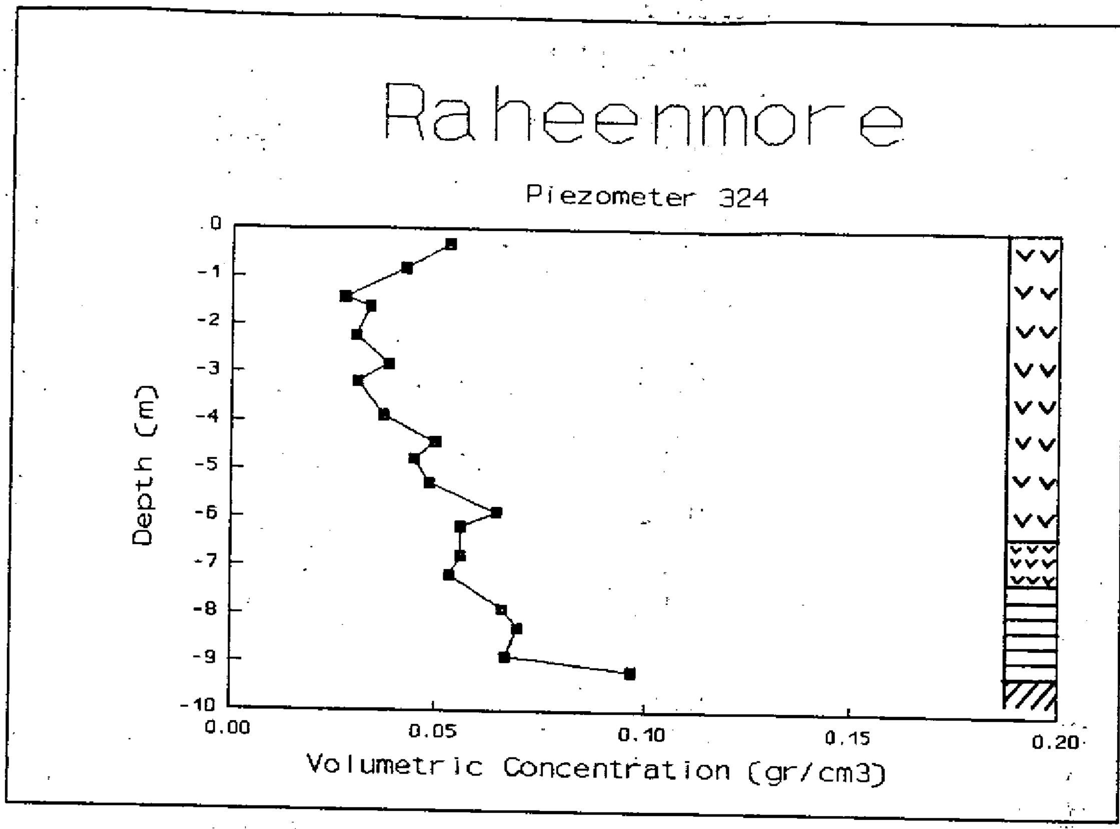

Raheenmore
Piezometer 210
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

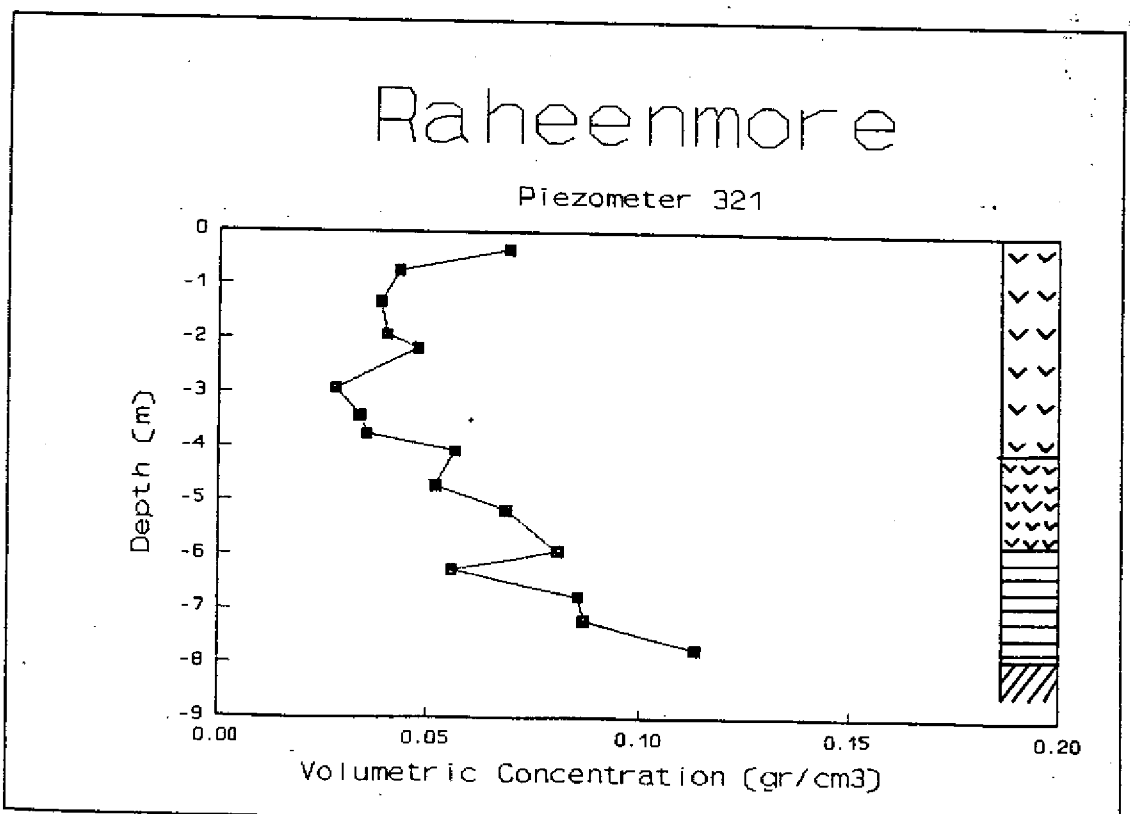

Raheenmore
Piezometer 211
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

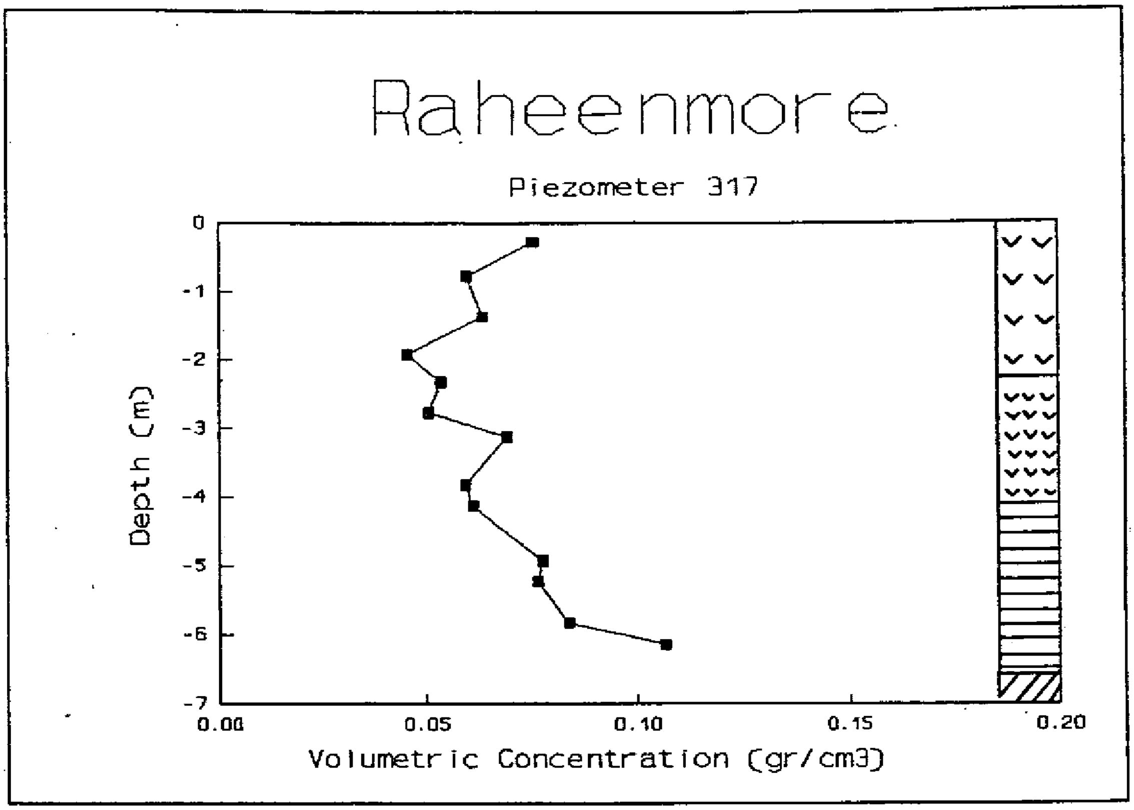

Raheenmore
Piezometer 330 (first drilling)
Depth (m)
0
-2
-4
-6
-8
-10
-12
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

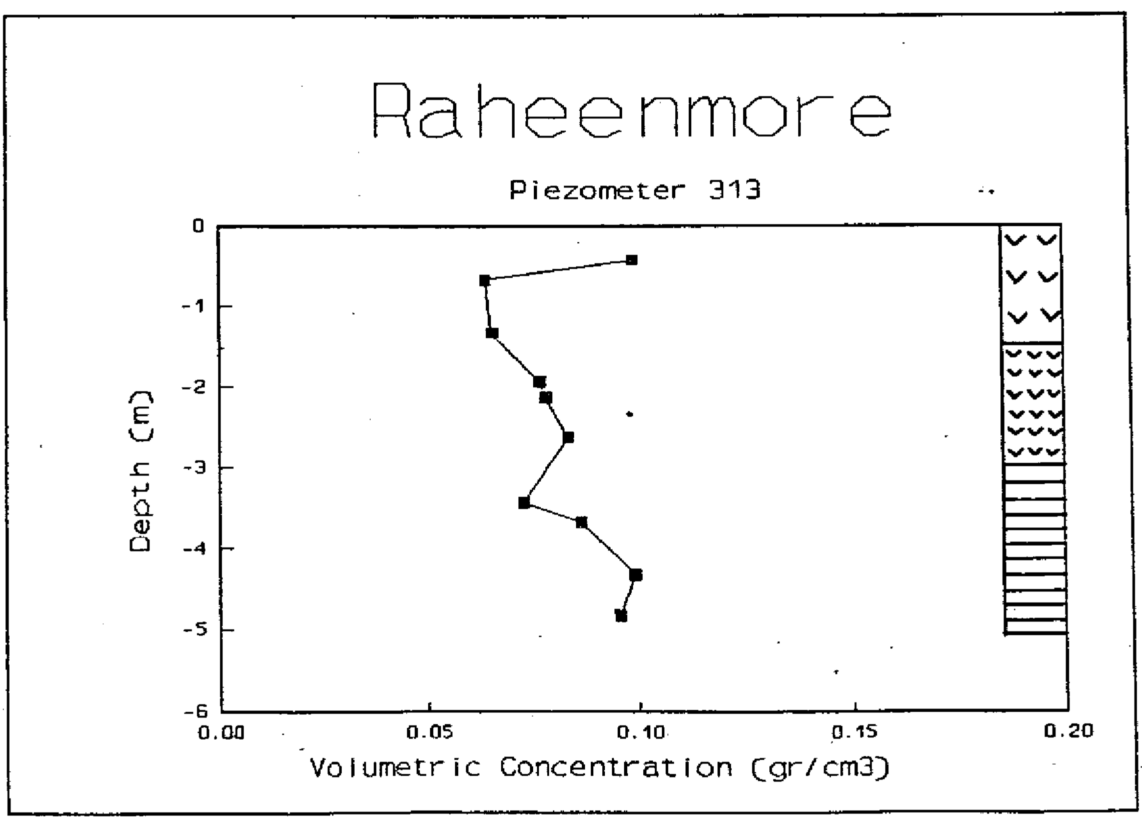

Raheenmore
Piezometer 330 (second drilling)
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

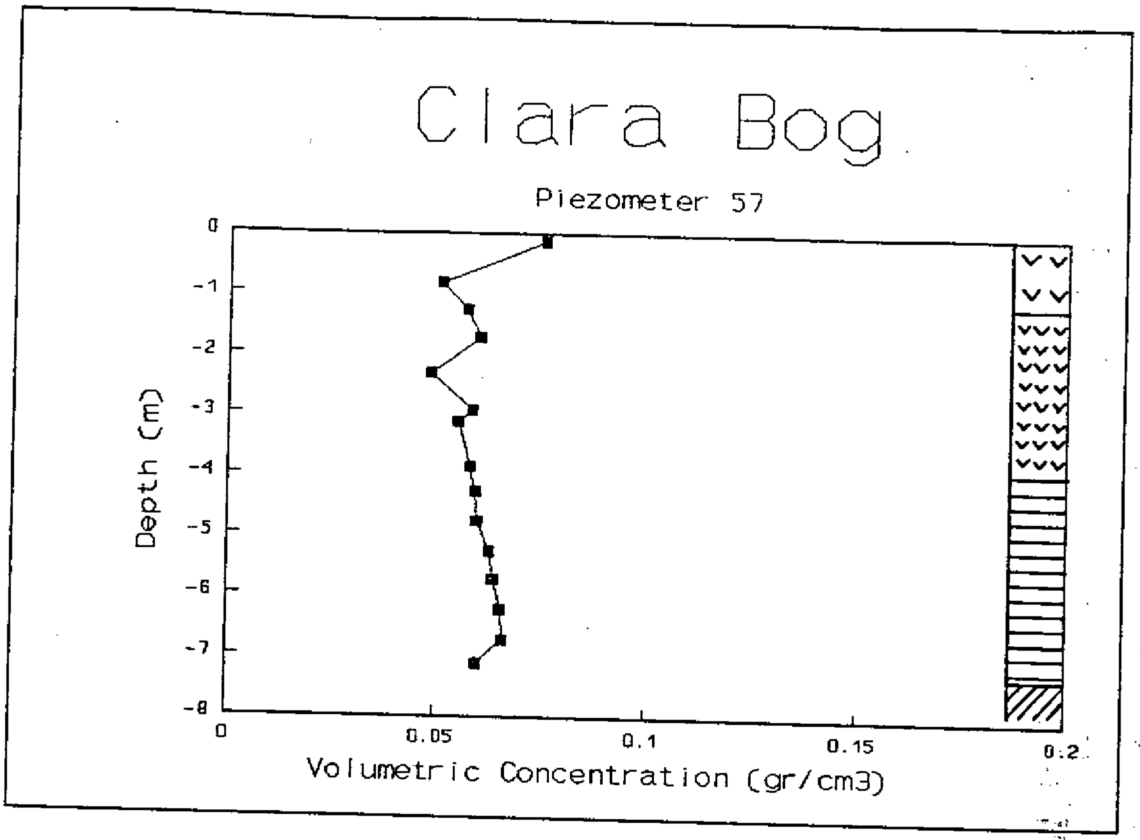

Raheenmore
Piezometer 327
Depth (m)
0
-2
-4
-6
-8
-10
-12
-14
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

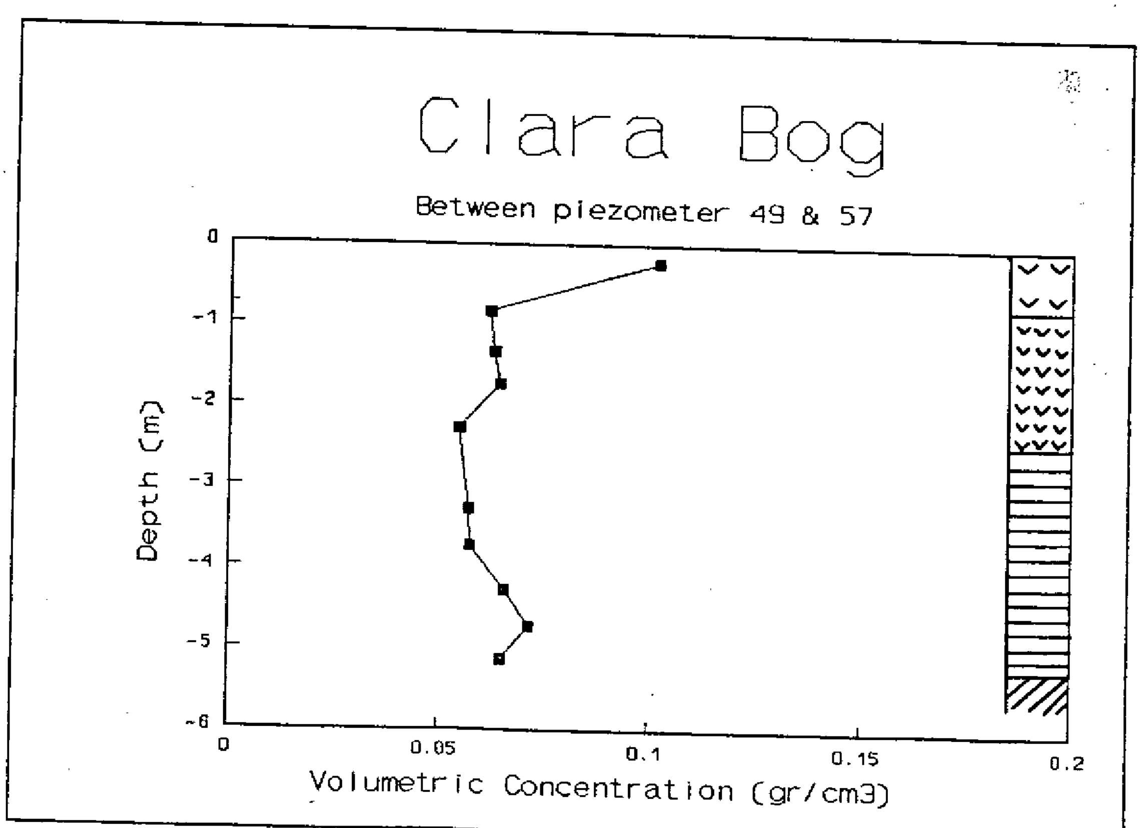

Raheenmore
Piezometer 324
Depth (m)
Volumetric Concentration (gr/cm3)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0.00
0.05
0.10
0.15
0.20

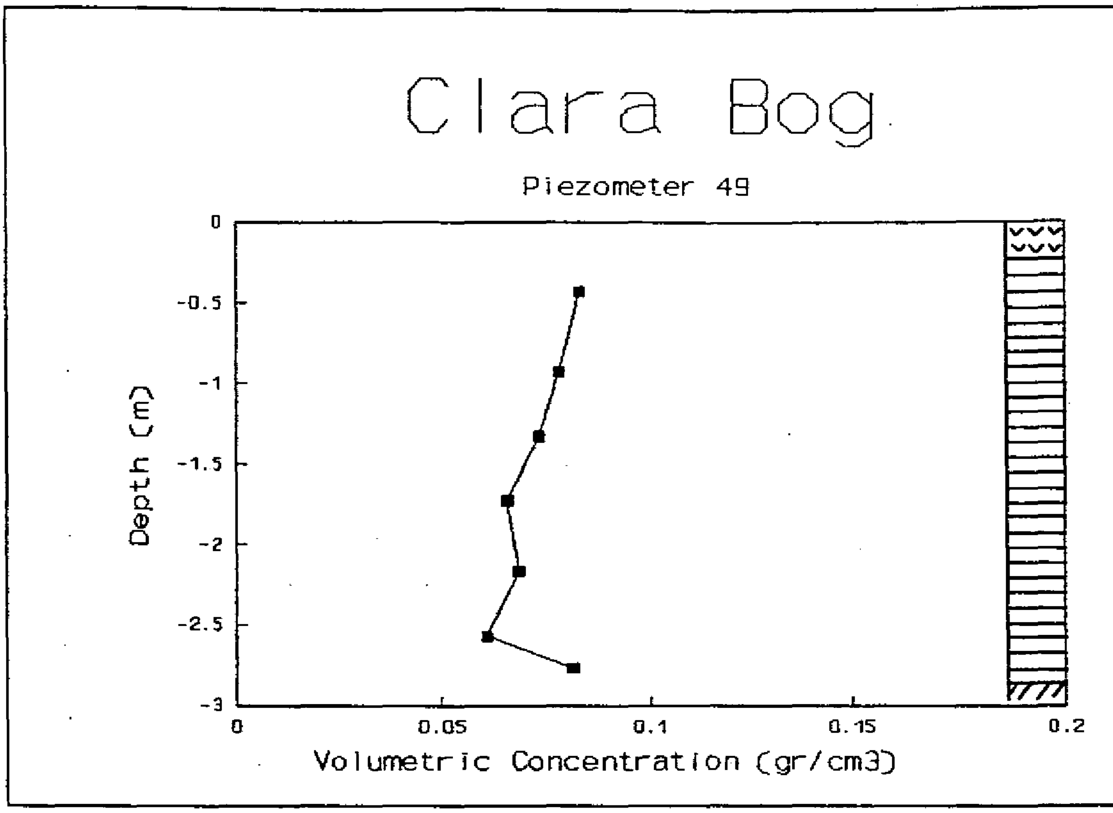

Raheenmore
Piezometer 321
Depth (m)
Volumetric Concentration (gr/cm3)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
0.00
0.05
0.10
0.15
0.20

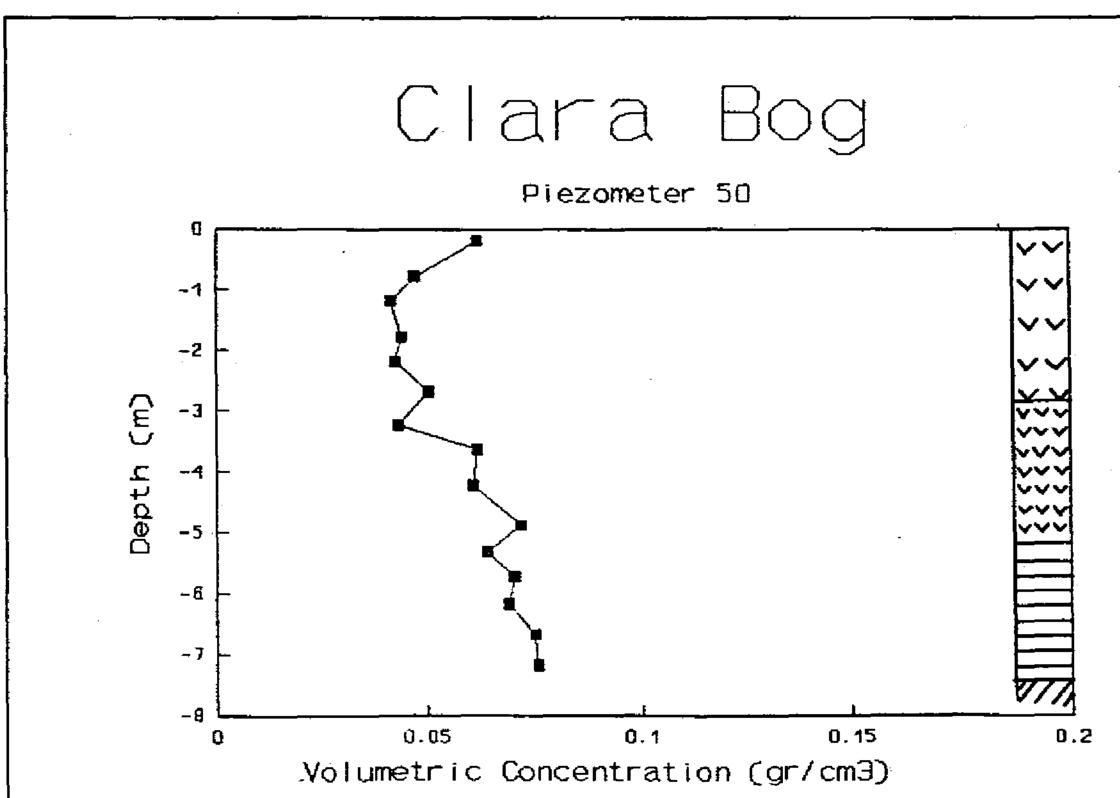

Raheenmore
Piezometer 317
Depth (m)
0
-1
-2
-3
-4
-5
-6
-7
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)

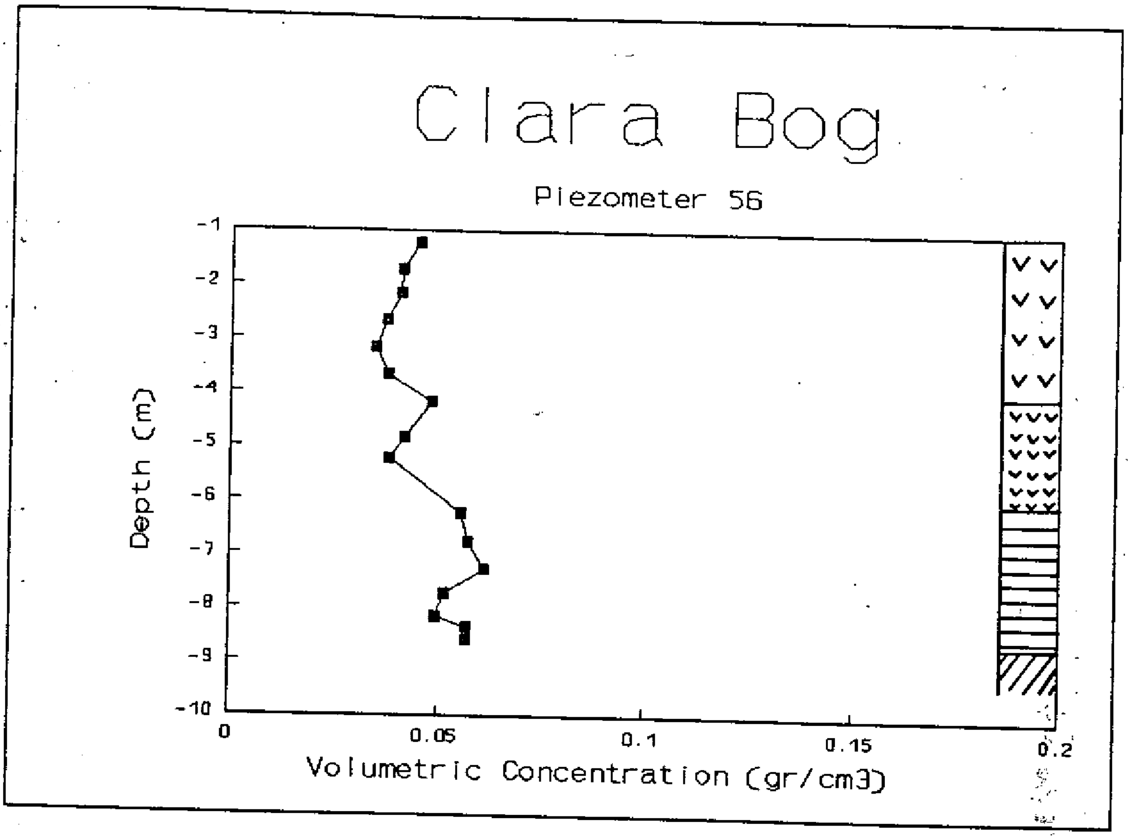

Raheenmore
Piezometer 313
Depth (m)
0
-1
-2
-3
-4
-5
-6
0.00
0.05
0.10
0.15
0.20
Volumetric Concentration (gr/cm3)


Clara Bog
Piezometer 57
Depth (m)
Volumetric Concentration (gr/cm3)
0
-1
-2
-3
-4
-5
-6
-7
-8
0
0.05
0.1
0.15
0.2


Clara Bog
Between piezometer 49 & 57
Depth (m)
Volumetric Concentration (gr/cm3)
0
-1
-2
-3
-4
-5
-6
0
0.05
0.1
0.15
0.2


Clara Bog
Piezometer 49
Depth (m)
0
-0.5
-1
-1.5
-2
-2.5
-3
0
0.05
0.1
0.15
0.2
Volumetric Concentration (gr/cm3)


Clara Bog
Piezometer 50
Depth (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
0
0.05
0.1
0.15
0.2
Volumetric Concentration (gr/cm3)



Clara Bog
Piezometer 56
Depth (m)
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
0
0.05
0.1
0.15
0.2
Volumetric Concentration (gr/cm3)

APPENDIX 3.1

Fixed data lysimeters at Raheenmore

Nr.	Install.	Vegetation (lat)	Vegetation (eng)	Acro-telm	Tube length
01	12/02/91	*Calluna vulgaris* (+ *Erica*)	Heather	bad	66.8
02	12/02/91	*Calluna vulgaris* (+*Erica*)	Heather	bad	88.0
03	12/02/91	*Narthecium ossifragum*	Bog Asphodel	bad	67.7
04	12/02/91	*Eriophorum vaginatum*	Common Cotton-Grass	bad	67.1
05	12/02/91	*Narthecium ossifragum*	Bog Asphodel	bad	67.8
06	12/02/91	*Eriophorum vaginatum*	Common Cotton-Grass	bad	68.7
07	12/02/91	*Sphagnum* (*magellanicum*)	Peat Moss	bad	67.4
08	12/02/91	*Sphagnum* (*magellanicum*)	Peat Moss	bad	68.5
09	19/02/91	*Sphagnum* (*papillosum*)	Peat Moss	good	68.8
10	19/02/91	*Sphagnum* (*papillosum*)	Peat Moss	good	69.4
11	19/02/91	*Eriophorum vaginatum*	Common Cotton-Grass	good	68.6
12	19/02/91	*Eriophorum vaginatum*	Common Cotton-Grass	good	69.2
13	19/02/91	*Narthecium ossifragum*	Bog Asphodel	good	67.8
14	19/02/91	*Narthecium ossifragum*	Bog Asphodel	good	69.5
15	19/02/91	*Calluna vulgaris* (+*Erica*)	Heather	good	68.5
16	19/02/91	*Calluna vulgaris* (+*Erica*)	Heather	good	70.5

Height: 50 cm
Diameter: 40 cm

Locations:
Lysimeters with good acrotelm: K70 1160
Lysimeters with bad acrotelm: K20 880

All moved to K20 880

APPENDIX 3.2

Leaf area index (16/04/91 - 01/10/91)

APPENDIX 3.3

Sphagnum Cover Index (16/04/91 - 01/10/91)

APPENDIX 3.2

DATE	LAI1	LAI2	LAI3	LAI4	LAI5	LAI6	LAI7	LAI8
16/04/91	2.30	2.02	0.05	0.24	0.06	0.24		
05/06/91			1.22		1.57			
11/06/91				0.73		0.61		
03/08/91	3920*	2560*	0.84	0.61	1.23	0.57		
28/08/91			1.00	0.86	1.23	0.82		
01/10/91			0.56	0.50	0.64	0.35		
04/11/91	3930*	2620*						

DATE	LAI9	LAI10	LAI11	LAI12	LAI13	LAI14	LAI15	LAI16
16/04/91			1.13	0.26	0.00	0.00	2.40	3.16
05/06/91					0.76	1.02		
11/06/91			1.48	0.96				
03/08/91			1.80	1.14	0.99	1.61	1840*	3660*
28/08/91			2.83	1.09	1.95	2.63		
01/10/91			1.22	0.84	0.63	1.15		
04/11/91							2030*	4580*

APPENDIX 3.3

DATE	SCI1	SCI2	SCI3	SCI4	SCI5	SCI6	SCI7	SCI8
16/04/91	0.15	0.75	0.02	0.20	0.40	0.50	0.95	1.00
05/06/91			0.01		0.00			
11/06/91				0.15		0.50	0.99	1.00
03/08/91	0.25	0.85	0.05	0.20	0.10	0.75	0.95	0.90
28/08/91	0.25	0.95	0.05	0.35	0.05	0.70	1.00	1.00
01/10/91	0.30	0.95	0.05	0.25	0.05	0.80	1.00	1.00

DATE	SCI9	SCI10	SCI11	SCI12	SCI13	SCI14	SCI15	SCI16
16/04/91	1.00	1.00	0.10	0.60	0.15	0.30	0.35	0.30
05/06/91					0.01	0.25		
11/06/91	1.00	0.90	0.25	0.80				
03/08/91	0.65	0.60	0.15	0.40	0.05	0.15	0.70	0.60
28/08/91	0.95	0.60	0.50	1.00	0.05	0.20	0.95	0.90
01/10/91	0.95	0.80	0.25	1.00	0.05	0.15	0.85	0.80

APPENDIX 3.4

Weighing data lysimeters (kg), 07/04/91 - 30/11/91

DATE	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16
07/04/91	65.5	62.5	63.2	64.4	66.9	64.0	64.4	64.4	65.1	63.6	63.3	63.9	62.2	63.1	59.4	63.3
15/04/91	65.4	63.0	63.1	64.2	67.0	64.0	65.0	63.8	65.0	63.0	62.9	64.7	62.8	63.4	61.9	65.0
19/04/91	64.3	61.7	61.8	62.9	65.9	62.9	63.3	61.9	63.5	61.6	61.4	62.8	61.7	61.9	60.8	63.3
26/04/91	66.1	63.8	63.7	64.8	67.4	65.4	65.4	63.6	65.9	63.8	63.5	64.8	64.2	64.1	63.2	65.5
03/05/91	66.3	64.2	63.5	64.6	66.7	64.7	66.1	64.2	65.1	64.4	64.2	65.1	63.6	64.1	62.5	65.5
10/05/91	64.9	63.0	62.7	63.1	65.8	63.5	64.3	62.9	64.6	63.8	62.6	63.3	62.4	62.6	61.4	63.9
17/05/91	62.9	61.2	62.4	62.6	65.8	62.3	63.1	62.3	64.2	63.9	61.8	62.3	61.9	62.4	60.1	63.1
23/05/91	62.5	60.3	61.8	62.1	65.8	62.0	63.1	62.2	65.0	64.6	61.9	63.1	62.6	63.1	59.9	62.8
31/05/91	60.1	57.8	59.5	61.3	64.0	59.9	60.1	59.4	62.3	61.7	59.5	60.7	60.4	60.6	57.6	59.7
07/06/91	60.0	58.5	59.9	61.7	65.1	60.4	61.0	60.7	63.4	62.8	60.6	62.6	61.6	61.2	56.9	60.6
14/06/91	62.9	60.6	62.1	62.9	65.8	62.8	63.3	63.0	64.7	63.9	62.2	63.9	62.7	63.0	59.0	62.6
22/06/91	64.3	61.0	63.5	63.4	67.0	63.5	64.8	64.0	65.8	65.1	63.0	64.3	63.8	64.0	60.1	63.6
27/06/91	66.4	62.0	63.7	63.8	66.9	64.8	66.1	64.9	66.3	64.9	64.1	65.5	63.5	64.5	61.5	64.8
04/07/91	65.6	63.0	63.1	64.2	66.5	63.7	65.7	65.7	64.7	63.7	63.0	66.0	62.7	63.0	59.7	65.4
11/07/91	66.0	63.3	62.9	63.2	66.3	63.6	64.7	64.3	64.8	63.9	62.1	64.4	62.5	63.5	60.5	64.2
31/07/91	64.4	61.9	62.2	62.1	65.3	62.6	62.8	62.2	63.5	62.6	60.7	62.4	62.0	62.7	60.4	62.7
09/08/91	66.7	62.8	63.3	64.6	66.2	64.1	65.0	66.0	65.2	63.8	62.1	64.3	62.6	63.4	60.6	64.0
15/08/91	64.3	61.6	62.1	62.3	65.4	62.9	63.8	64.0	63.9	62.7	61.3	63.6	61.1	61.8	59.3	62.8
23/08/91	64.4	61.3	62.4	62.8	65.6	63.0	64.0	64.0	63.7	62.5	61.4	63.1	61.0	61.8	58.4	62.3
29/08/91	64.8	61.4	62.8	63.0	65.9	63.1	63.9	64.2	63.8	63.1	62.1	63.0	60.8	61.3	57.8	62.1
05/09/91	61.2	59.4	61.1	61.7	64.4	61.2	61.8	61.7	61.4	60.7	59.9	60.6	59.1	59.4	56.2	59.3
12/09/91	61.1	58.8	60.0	61.4	64.1	60.1	61.1	61.3	60.8	59.7	58.8	59.6	58.1	58.5	54.8	58.6
20/09/91	62.2	59.5	61.1	62.5	65.3	61.2	61.7	61.6	61.5	60.7	59.7	60.3	59.4	59.8	56.6	59.2
27/09/91	64.7	61.7	62.6	63.0	65.7	62.5	63.6	63.9	63.3	62.4	62.0	62.3	60.4	61.5	58.2	61.5
03/10/91	66.2	63.1	63.1	63.9	66.3	63.3	65.3	65.1	64.7	63.8	63.1	63.9	62.0	63.0	59.6	63.1
11/10/91	65.5	62.7	62.4	63.0	65.8	63.2	66.0	66.0								
12/10/91									65.3	63.8	63.8	65.3	62.5	63.2	59.8	64.4
17/10/91	65.2	63.0	62.2	62.9	65.9	62.7	65.5	65.8	64.7	63.6	63.1	64.3	61.7	62.5	59.0	63.6
24/10/91	64.6		62.0	62.4	65.6	62.3	65.0	65.1	64.3	63.2	62.3	63.6	61.4	62.2	58.8	63.1
01/11/91	66.0	64.1	63.4	64.2	66.4	64.2	66.8	66.7	65.1	64.0	64.1	65.8	63.0	64.1	61.2	65.4
08/11/91	65.3	63.2	63.1	63.4	66.3	63.6	65.9	66.0	65.2	62.9	64.0	65.3	62.4	63.5	60.8	64.9
15/11/91	65.7	63.6	63.1	63.6	66.2	63.5	65.8	66.1	65.0	63.2	64.3	65.4	61.9	63.5	60.6	64.9
22/11/91	65.9	63.7	63.3	63.9	66.4	63.8	66.3	66.5	65.2	63.6	64.3	65.4	62.6	63.6	60.7	65.1
30/11/91	65.6	64.4	63.8	64.3	66.8	64.6	66.5	67.1	65.7	64.5	64.3	65.6	63.0	63.9	60.7	65.6

Date	Remarks
15/04/91	lysimeter 5 missed the bungs, water in/out flow
23/05/91	first waterlevels, then adding, then weighing.
27/06/91	notes got wet, difficult to read.
09/08/91	overflow for 4, drizzle during measurements.
23/08/91	Rain started after lysimeter 9.
11/10/91	1-8 weighed, problems with weighing scale
12/10/91	Other half weighed
01/11/91	Previous period useless, due to heavy rain
08/11/91	Lysimeter 2 leaking

APPENDIX 3.5

Waterlevels lysimeters from top tube (cm) period
07/04/91 – 30/11/91

Date Time	WL1	WL2	WL3	WL4	WL5	WL6	WL7	WL8	WL9	WL10	WL11	WL12	WL13	WL14	WL15	WL16
07-Apr 09:15	23.7	24.1	26.4	23.2	24.2	26.6	25.1	26.0	25.6	27.7	26.5	27.5	27.7	28.5	29.5	31.4
15-Apr	25.9	24.7	27.6	24.9	23.8	26.7	24.2	26.6	26.6	30.0	27.1	26.5	26.6	27.7	26.5	27.7
19-Apr	29.1	26.9	31.0	29.3	28.0	29.8	28.0	31.0	29.7	23.0	30.3	29.4	28.7	30.2	28.1	30.5
19-Apr	20.9	23.7	25.4	23.7	21.2	23.7	23.2	25.8	23.9	27.2	26.0	25.3	24.5	25.5	24.2	25.2
26-Apr	21.8	23.5	23.8	22.1	20.5	23.1	23.1	27.2	23.5	27.3	25.5	25.6	24.0	26.4	23.3	25.8
03-May	21.2	23.0	26.0	23.1	24.7	24.9	22.2	26.3	25.9	25.7	24.7	25.2	25.6	26.2	25.2	26.0
10-May	26.2	24.1	27.5	27.5	27.5	27.5	25.5	27.5	26.3	27.7	27.5	28.2	27.3	29.0	26.2	29.1
15-May	29.7	25.9	30.9	31.8	29.2	30.2	28.8	32.9	30.1	32.0	29.8	30.7	29.4	31.2	28.0	31.7
15-May	27.3	26.1	26.4	26.2	24.5	30.4	26.0	26.2	25.6	25.0	26.8	27.8	26.7	27.4	28.2	29.0
17-May 09:15	30.3	26.8	29.2	29.1	26.6	31.1	28.2	29.5	27.9	28.7	28.6	29.7	28.1	29.0	28.7	30.8
21-May	31.0	29.2	32.0	34.0	28.6	33.0	30.3	32.1	28.5	29.9	29.7	31.3	29.0	29.2	29.4	31.5
23-May	31.2	28.3	30.5	30.7	26.1	31.3	29.5	32.3	28.1	29.2	28.8	30.2	28.3	28.5	28.5	30.4
28-May	36.8	33.6	34.6	38.7	32.2	34.7	35.4	37.0	31.6	32.8	32.5	32.2	30.5	31.7	31.0	34.5
31-May 11:10	37.7	36.6	37.0	34.1	35.9	36.1	36.1	36.1	32.0	32.8	33.3	32.7	31.1	32.7	31.9	35.7
04-Jun 15:00	41.2	38.0	38.5	41.4	34.8	36.2	37.8	40.5	32.8	33.9	34.6	33.4	32.2	35.1	33.2	36.3
07-Jun 16:00	34.3	31.6	33.0	29.9	27.1	33.4	31.3	31.4	28.0	28.9	30.2	27.7	28.1	30.0	31.7	33.3
10-Jun 10:30	27.0	26.2	25.6	23.0	19.8	26.7	24.1	24.4	22.2	21.8	25.6	24.8	24.1	25.1	28.5	28.5
14-Jun	28.5	27.6	29.3	27.0	26.2	29.0	27.1	27.3	27.1	28.5	27.8	26.7	26.4	28.0	29.5	30.7
18-Jun	29.0	28.7	28.5	27.9	27.5	29.6	25.5	26.8	26.2	27.3	28.0	27.5	26.6	28.5	29.8	30.4
22-Jun 18:00	25.1	26.0	23.2	24.5	21.3	25.9	23.2	25.3	23.2	22.7	26.0	25.0	23.3	25.8	27.3	27.4
26-Jun	21.8	25.5	23.2	22.9	21.5	24.8	22.8	25.4	23.9	22.6	25.4	23.9	24.0	25.8	26.8	27.0
27-Jun	20.0	24.5	23.1	23.0	21.4	23.5	22.0	24.1	21.5	23.3	24.0	22.9	23.8	25.2	25.8	26.0
28-Jun 17:00	23.5	25.7	27.0	25.0	25.4	26.5	23.0	25.8	26.1	29.5	24.5	25.1	26.7	27.5	27.9	27.2
01-Jul 12:00	20.5	22.9	22.4	20.1	20.3	23.6	21.0	22.6	22.1	25.4	23.0	21.5	23.9	24.7	25.5	24.5
04-Jul 10:00	23.6	23.9	27.0	21.7	23.9	26.7	23.0	22.9	26.3	27.8	25.5	22.5	26.6	27.2	27.9	27.7
09-Jul 13:00	27.3	29.5	31.0	30.8	26.9	30.8	28.7	29.6	30.6	33.0	32.0	30.5	31.4	32.0	32.5	32.7
11-Jul 12:00	21.6	23.7	26.5	24.7	24.4	26.8	24.4	25.3	25.3	27.3	28.0	25.5	26.4	26.4	26.6	26.9
31-Jul 11:30	28.3	26.3	29.9	28.0	28.3	30.6	28.5	29.7	29.6	30.5	29.9	29.0	27.6	28.9	27.9	30.1
02-Aug 15:00	29.4	28.8	28.8	28.3	27.4	31.1	29.6	29.9	31.5	33.2	32.1	30.8	31.0	31.6	31.1	32.0
06-Aug 12:30	19.1	21.7	20.5	19.9	19.3	22.0	21.1	21.5	20.8	20.9	23.8	22.2	21.2	21.6	22.9	23.2
09-Aug 12:30	20.6	24.6	25.3	20.0	26.1	26.2	24.4	21.8	25.2	28.3	27.7	25.4	27.2	27.0	26.8	27.6
10-Aug 11:35	19.9	23.9	23.1	20.9	23.2	25.0	22.7	22.1	23.8	25.4	25.4	24.6	24.6	25.9	26.8	27.0
10-Aug 13:00	25.1	25.2	27.1	26.4	26.9	26.2	22.7	24.3	25.9	28.1	25.4	24.6	27.6	28.7	28.3	28.7
15-Aug 12:00	27.5	26.6	28.6	29.5	28.2	28.4	25.3	26.2	27.6	30.1	29.0	26.6	28.6	30.0	28.9	31.1
19-Aug 12:00	30.0	29.3	31.5	32.9	29.4	31.9	28.0	30.2	29.9	31.9	32.9	29.5	30.5	31.4	30.3	31.8
19-Aug 13:00	24.0	26.0	24.0	22.5	23.9	27.0	23.1	24.5	26.0	27.9	27.6	26.7	28.2	28.2		28.5
23-Aug 11:30	27.0	27.3	28.4	27.0	26.1	29.1	25.2	26.4	28.0	30.0	29.3	27.9	29.2	29.6	30.4	30.2
23-Aug 11:30								24.8		26.9	26.5					

Date	Time	Remarks
19-Apr		waterlevel before adding water and weighing
19-Apr		after adding water and weighing
03-May		dipped after pumping
15-May		waterlevels before adding water; no weighing
15-May		waterlevels after adding water
17-May	09:15	waterlevel before weighting and adding water
23-May		first waterlevel, then adding, then weighing.
06-Aug	12:30	Lysimeter 5 overflown, 3,4,9,10,13,14 very high waterlevel
10-Aug	13:00	Waterlevels after substraction
19-Aug	13:00	After adding
23-Aug	11:30	After refilling

Date	Time	WL1	WL2	WL3	WL4	WL5	WL6	WL7	WL8	WL9	WL10	WL11	WL12	WL13	WL14	WL15	WL16
28-Aug	10:30	34.6	34.0	35.8	35.6	33.8	36.0	32.6	32.9	35.5	35.6	34.0	35.0	35.8	36.6	35.7	37.8
28-Aug	11:00	29.0	30.5	30.1	29.5	27.7	29.4	28.9	29.7	31.2	31.2	31.3	31.7	33.6	34.2		34.1
29-Aug	09:00	31.4	31.5	32.2	31.7	30.2	31.0	30.4	31.0	33.1	33.2	32.1	33.0	34.7	35.3	35.9	35.7
02-Sep	16:00	34.8	31.1	31.0	34.0	29.6	30.6	30.2	32.0	32.0	32.4	30.3	30.6	31.4	34.3	33.2	33.9
02-Sep	16:30	31.3			28.9			27.2	28.4								
05-Sep	11:45	35.2	32.7	32.4	33.6	32.7	31.9	30.8	32.5	33.6	33.9	32.0	31.9	32.4	35.7	33.8	34.9
05-Sep	12:45	30.6	29.1		28.9	27.4		29.2	28.2	30.9					33.5		33.0
09-Sep	15:30	40.1	39.1	38.4	40.9	38.9	38.9	39.0	38.9	39.8	40.9	39.8	39.1	39.2	41.8	39.3	40.9
09-Sep	16:00	36.9	36.3		36.3	34.2		35.6	35.1	36.9	38.8	38.2	37.0				
12-Sep	12:00	39.8	39.7	40.3	40.9	38.9	40.5	38.9	39.0	40.5	41.8	40.5	39.6	41.2	42.5	40.0	42.3
16-Sep	15:30	28.6	26.9	28.1	25.7	23.7	28.9	28.5	28.4	29.0	30.9	29.9	30.4	29.4	31.4	30.8	33.3
20-Sep	10:30	31.8	30.5	30.9	30.0	26.2	31.1	31.2	32.4	31.7	33.7	33.0	33.2	31.1	33.5	32.5	35.5
20-Sep	11:15	28.4				29.1		28.5	28.4			30.5	30.5	32.5		33.5	32.8
24-Sep	16:00	23.8	24.9	24.6	21.8	19.6	25.0	25.8	24.9	26.5	27.3	26.4	27.2	27.3	28.4	30.5	30.3
24-Sep	16:30	25.8	26.1	27.3	26.1	24.7	27.2							28.9	30.1		
27-Sep	10:30	27.0	26.4	27.6	26.5	25.3	27.8	26.7	26.2	27.5	28.8	27.0	28.3	29.5	30.5	29.9	30.9
01-Oct	10:20	20.9	23.7	21.6	22.0	19.4	22.9	23.8	23.8	23.9	24.8	25.1	25.7	25.7	26.7	27.4	27.9
01-Oct	11:10	24.5	24.8	28.2	25.4	25.6	27.1		25.2	26.2	27.8	26.1		28.2	28.9	28.6	
03-Oct	11:15	21.1	24.1	25.5	23.5	22.8	25.1	23.6	24.9	24.5	26.0	25.5	25.5	26.3	27.1	27.9	27.9
03-Oct	12:45	25.2	24.6	27.5	26.5	27.0	27.7	23.3	24.2	26.7	27.2	25.4	26.2	28.2	28.3	28.5	27.6
05-Oct	13:45	19.6	21.7	20.3	20.1	18.6	21.6	20.3	21.3	22.1	21.4	22.4	23.3	22.4	23.1	24.5	24.8
05-Oct	14:45	22.6	23.1	26.0	23.7	22.9	24.2	22.8	23.9	25.2	25.9	24.8	25.5	26.7	27.1	27.4	26.3
07-Oct	13:20	19.4	22.2	22.7	21.9	20.6	22.5	21.5	22.7	22.6	22.6	23.5	23.8	24.2	25.1	25.3	24.5
07-Oct	14:30	24.2	24.6	28.0	25.2	25.9	26.4	23.7	23.9	26.3	29.2	25.4	25.6	27.9	28.6	28.2	27.3
11-Oct	11:30	18.4	23.3	22.5	21.6	20.4	22.6	21.2	21.7	22.6	24.4	23.6	23.5	24.8	25.5	25.9	24.4
11-Oct	12:30	24.7	24.6	29.2	28.3	27.2	27.2	23.3	23.6	25.8	28.2	24.7	25.3	27.4	27.9	28.2	26.8
11-Oct	13:05	24.3	24.5	28.5	27.5	27.0	26.6	22.4	23.3	25.7	27.9	24.7	25.3	27.4	27.8	28.1	26.9
12-Oct	10:50	22.4	20.3	26.2	25.1	24.7	24.8	21.7	20.9	24.3	26.0	24.4	24.2	25.9	26.7	27.1	25.5
12-Oct	13:35	25.7	23.8	28.2	26.9	26.9	27.3	23.2	22.8	26.6	28.6	25.8	25.2	27.2	28.5	28.9	28.3
14-Oct	15:30	21.4	19.6	23.1	22.4	21.3	23.3	21.2	21.2	23.3	24.7	24.3	23.3	24.3	26.0	27.2	25.8
14-Oct	16:30	25.8	22.8	28.1	26.2	25.9	27.1	23.4	23.2	26.2	28.5	25.1	24.9	27.4	28.1	28.4	27.9
16-Oct	10:15	24.3	22.9	26.6	24.6	24.5	25.8	22.8	22.6	24.8	27.0	24.7	24.4	26.6	27.3	27.4	27.2
16-Oct	11:00			29.4	27.8	26.8	28.3	23.8	24.8	26.3		25.7	25.7	27.9	28.8	29.2	28.3
17-Oct	10:40	25.6	24.1	29.2	27.8	26.4	28.2	23.6	24.1	26.4	27.4	26.2	25.8	27.8	29.3	29.1	28.6
17-Oct	10:50	25.3	24.6	29.2	27.4	26.3	27.6	23.5	24.1	25.9	27.5	26.5	25.8	28.0	28.7	28.9	28.2

Date	Time	Remarks
28-Aug	11:00	After adding water
02-Sep	16:30	After adding water to 1,4,7,8
05-Sep	12:45	after adding water.
09-Sep	16:00	After adding water
20-Sep	11:15	After alterations
24-Sep	16:30	After substracting water
01-Oct	11:10	After substracting water
03-Oct	12:45	After weighing, a light shower and subtracting
05-Oct	13:45	Heavy rainfall during previous night
05-Oct	14:45	After subtracting
07-Oct	14:30	After subtraction
11-Oct	11:30	Lysimeter 1 unreliable
11-Oct	12:30	After subtraction
11-Oct	13:05	After substaction and weighing
12-Oct	10:50	Lysimeter 2 unreliable
12-Oct	13:35	After weighing and subtracting
14-Oct	15:30	Lysimeter 2 problems
14-Oct	16:30	After subtraction
16-Oct	10:15	Lysimeter2 leaks
16-Oct	11:00	After removing water
17-Oct	10:50	After weighing

Date	Time	WL1	WL2	WL3	WL4	WL5	WL6	WL7	WL8	WL9	WL10	WL11	WL12	WL13	WL14	WL15	WL16
22-Oct	09:50	27.3		29.8	29.5	27.6	28.7	24.4	25.2	27.2	29.1	26.7	26.9	28.7	29.7	29.7	29.5
24-Oct	15:15	27.3		29.8	29.6	27.6	28.6	24.2	25.3	27.2	29.2	26.9	27.0	28.6	29.7	29.7	29.5
24-Oct	16:45	26.3		30.2	29.6	27.4	28.1	24.7	25.6	27.1	28.8	27.1	27.3	28.2	29.4	29.8	29.2
29-Oct	13:15	20.4	23.0	23.7	23.5	21.3	23.3	22.1	22.8	23.3	23.3	24.8	24.6	24.8	25.8	27.0	25.6
29-Oct	14:10	24.8	24.5	28.2	26.8	26.0	26.6	23.4	24.2	26.3	28.2			27.2	28.0	29.1	27.6
31-Oct	11:50	17.0		19.0	19.6	19.0	18.5	19.3	20.4	20.3	19.2	20.5	21.0	20.3	21.1	22.9	20.8
31-Oct	13:15	23.9	0.0	26.3	24.1	26.3	24.5	23.4	24.2	27.1	28.0	24.7	24.4	26.1	26.7	26.8	25.5
01-Nov	10:30	21.4	22.8	24.2	23.0	23.8	23.1	21.8	22.6	25.6	25.8	24.0	23.6	24.8	25.3	25.8	24.7
01-Nov	11:30	21.8	22.8	24.7	23.5	23.1	23.0	21.7	22.4	25.0	25.9	23.9	23.4	24.9	25.2	26.2	25.2
01-Nov	12:20	25.6	24.3	28.3	26.8	25.4	26.2	23.4	24.2	26.8	29.1	24.9	24.3	26.8	27.0	27.5	26.8
04-Nov		20.0	22.0	21.9	22.6	19.0	21.7	20.6	21.5	22.6	22.6	23.0	22.8	23.0	23.4	25.2	24.0
04-Nov		23.7	23.4	25.8	25.2	24.1	24.8	23.1	23.6	25.6	28.7	24.3	24.1	26.1	26.5	27.1	26.5
08-Nov	11:30	19.3	19.5	21.2	21.6	18.7	20.9	20.5	20.8	22.5	21.9	22.2	22.4	22.2	22.8	24.2	23.0
08-Nov	12:50	24.7		26.7	26.7	24.6	25.5	23.8	24.1	26.0	29.9	24.3	24.7	26.9	27.6	27.3	26.8
08-Nov	15:15	25.4	24.7	27.2	26.4	25.4	25.4	23.8	23.7	26.1	30.0	24.7	24.8	27.1	27.6	26.9	26.8
12-Nov	10:30	20.0	22.2	21.9	21.8	19.7	21.8	20.8	21.4	20.7	24.1	22.7	22.2	23.3	23.7	24.0	23.5
14-Nov	13:10	18.8	20.9	21.0	20.9	18.4	20.7	20.7	20.6	21.0	21.9	21.8	21.8	22.7	22.6	23.5	22.5
14-Nov	14:40	24.8	23.9	27.9	25.7	26.0	26.2	24.0	24.7	26.3	29.8	24.2	24.9	28.1	27.9	27.3	26.9
15-Nov	14:45	24.5	23.8	27.3	25.3	25.4	25.7	23.8	24.3	25.9	29.2	23.9	24.5	27.6	27.3	27.1	26.6
15-Nov	15:45	24.5	24.0	26.4	25.6	24.6	25.4	23.4	23.9	26.0	28.8	23.8	24.7	27.7	27.2	27.4	25.7
18-Nov	14:20	19.4	22.2	21.4	21.2	18.6	21.5	20.5	21.4	21.9	22.3	21.8	22.1	23.9	23.4	24.6	22.5
18-Nov	15:35	24.7	24.2	27.3	25.4	25.8	25.8	23.4	24.3	26.7	29.5	24.2	25.4	27.4	28.0	27.6	26.5
22-Nov	10:00	24.1	24.0	26.2	24.4	24.2	24.5	22.5	23.2	25.3	27.9	23.9	25.0	26.4	27.1	27.2	25.5
22-Nov	11:34	23.3	23.5	26.4	24.4	24.4	24.9	22.5	23.5	25.2	27.9	24.8	24.2	25.7	27.1	27.3	25.9
25-Nov	14:15	19.5	20.6	20.9	20.0	18.5	20.6	20.0	20.5	22.5	20.9	22.4	21.0	21.0	22.5	23.5	21.7
25-Nov	16:00	26.2	23.4	27.7	25.3	26.1	24.9	24.4	24.4	27.4	28.0	25.5	24.6	27.1	28.1	27.6	26.4
30-Nov	14:20	24.1	22.6	24.0	23.0	22.2	23.3	22.3	22.4	23.5	24.6	24.7	23.8	25.4	27.0	26.7	25.0
30-Nov	16:30	26.8	25.6	26.9	26.0	26.6	25.7	24.8	25.7	27.0	29.3	27.2	25.9	27.8	30.1	26.9	26.7

Date	Time	Remarks
24-Oct	16:45	After weighing
29-Oct	14:10	After subtraction
31-Oct	11:50	Lys 1,3,4,5,7,8,9,10,11,12,16 probably overflown
01-Nov	11:30	After weighing
01-Nov	12:20	After weighing and subtracting
04-Nov		After subtraction
08-Nov	11:30	Lysimeter 2 useless
08-Nov	12:50	After subtracting
08-Nov	15:15	After weighing (and subtracting)
14-Nov	13:10	Lysimeter 1 may have overflown
14-Nov	14:40	After pumping
15-Nov	14:45	Before weighing
15-Nov	15:45	After weighing
18-Nov	15:35	After pumping
22-Nov	11:34	After weighing
25-Nov	16:00	After subtraction
30-Nov	16:30	After pumping

APPENDIX 3.6

Added and removed water (1).
data 13/04/91 – 30/11/91

DATE	B/A	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16
13/04/91	-	-2.30	-3.23	-3.55	-3.04	88.88	-3.21	-2.27	-3.00	-1.30	-3.10	-3.44	-3.14	-1.75	-2.61	-0.86	-1.52
19/04/91	aft	2.00	2.00	1.50	1.68	1.26	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
26/04/91	aft	-0.70	-0.44	0.00	-0.44	-0.96	-0.69	-0.26	0.00	-0.31	0.00	-0.38	-0.40	-0.79	-0.37	-0.80	-0.47
03/05/91	bef	0.00	-0.94	-1.32	-0.46	-0.46	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.83	0.00	-0.84	-0.42
08/05/91	-	0.50	0.50	0.50	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
15/05/91	-	1.00	0.00	1.07	1.00	1.00	0.00	1.00	2.00	1.50	2.00	1.00	1.00	1.00	1.50	0.00	1.00
17/05/91	aft	1.00	0.00	0.00	0.00	0.00	0.00	0.45	0.55	1.00	1.00	0.50	0.50	0.50	0.50	0.00	0.50
21/05/91	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
23/05/91	bef	0.00	0.00	0.00	0.00	0.00	0.00	0.70	1.00	1.00	1.00	0.50	1.00	0.81	0.50	0.00	0.00
28/05/91	_	0.70	0.00	0.00	1.00	0.00	0.00	1.00	1.50	1.00	1.00	0.50	0.50	0.50	0.50	0.00	0.00
31/05/91	aft	1.00	1.00	0.55	0.00	1.00	1.00	1.50	1.00	1.50	1.50	0.98	1.00	0.55	0.45	0.00	0.00
04/06/91	-	1.00	0.55	0.45	0.65	0.50	0.00	1.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
07/06/91	aft	0.00	0.00	0.00	-0.59	-0.52	0.00	0.35	0.65	0.00	0.00	0.00	-0.53	-0.24	0.00	-0.35	0.00
10/06/91		0.00	0.00	0.00	0.69	0.90	0.00	0.00	0.00	0.62	0.99	0.00	0.00	0.40	0.60	0.00	0.00
14/06/91		0.50	0.00	0.57	0.00	0.00	0.00	0.97	0.92	0.52	0.47	0.52	0.00	0.00	0.00	0.00	0.52
18/06/91		0.00	0.00	0.00	-0.73	0.00	-0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22/06/91		0.00	0.00	-0.50	-0.32	-0.83	0.00	0.00	0.00	-0.72	-0.82	0.00	0.00	-0.94	-0.84	-0.40	0.00
26/06/91	aft	-0.34	0.00	-0.48	-0.48	-0.49	0.00	0.00	0.00	0.00	-0.55	0.00	0.00	-0.47	-0.36	0.00	0.00
27/06/91	aft	-0.86	-0.34	-0.96	-0.98	-0.94	-0.85	-0.49	-0.89	-1.38	-1.34	-0.45	-0.90	-1.41	-1.39	-1.17	-0.42
28/06/91		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
01/07/91		-0.95	-0.48	-0.87	-2.44	-0.58	-0.96	-0.71	0.00	-1.13	-0.35	-1.29	-1.46	-0.97	-0.98	-1.41	-1.00
04/07/91	aft	0.52	0.00	0.00	-0.95	0.59	0.93	0.00	0.00	0.99	0.47	0.00	-1.00	0.00	0.00	0.00	0.00
09/07/91		1.00	1.47	0.29	0.72	0.00	0.00	0.51	0.51	0.54	0.98	0.48	0.54	0.56	1.30	0.98	0.97
11/07/91	aft	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.49	0.00	0.00	0.00	0.00	0.00
31/07/91	aft	0.00	-0.43	0.00	0.00	0.00	0.00	0.54	0.65	0.00	0.00	0.00	0.00	-0.49	-0.51	-0.73	0.00
02/08/91		0.00	-0.52	-0.39	-0.39	-0.46	0.00	0.00	0.00	0.31	0.52	0.37	0.35	0.00	0.39	0.00	0.00
06/08/91		-1.07	-1.47	-1.47	-1.57	-1.48	-1.55	-0.95	-1.37	-1.23	-1.90	-1.80	-1.51	-2.04	-2.10	-1.92	-1.47
09/08/91	bef	0.00	0.00	0.00	-0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10/08/91		-1.46	-0.47	-0.78	-1.77	-0.32	-0.51	0.00	-0.93	-0.44	-0.50	0.00	0.00	-0.90	-0.96	-0.84	-0.44
15/08/91	aft	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19/08/91		1.64	0.99	0.91	1.46	0.97	0.97	1.53	1.93	0.97	0.98	1.91	0.97	0.57	0.95	0.00	0.97
23/08/91	aft	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.58	0.75	0.00	0.00	0.00	0.00	0.00
28/08/91		1.62	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	0.54	0.54	0.00	1.08
02/09/91		0.86	0.00	0.00	0.62	0.00	0.00	0.67	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
05/09/91	aft	0.93	0.55	0.00	0.46	0.41	0.00	0.46	0.89	0.50	0.00	0.00	0.00	0.00	0.42	0.00	0.47
09/09/91		0.56	0.42	0.00	0.51	0.43	0.00	0.69	0.66	0.49	0.42	0.54	0.50	0.00	0.00	0.00	0.00
20/09/91		0.92	0.00	0.00	0.00	-0.50	0.00	0.57	0.85	0.00	0.00	0.46	0.45	-0.46	0.00	-0.44	0.51
24/09/91		-0.44	-0.50	-0.80	-0.94	-0.91	-0.43	0.00	0.00	0.00	0.00	0.00	0.00	-0.45	-0.50	0.00	0.00
01/10/91		-0.82	-0.51	-1.49	-0.95	-1.28	-1.03	0.00	-0.48	-0.48	-0.54	-0.53	0.00	-0.51	-0.53	-0.50	0.00
03/10/91	aft	-0.82	-0.38	-0.27	-0.65	-0.47	-0.47	0.00	0.00	-0.42	-0.39	0.00	0.00	-0.45	-0.49	-0.49	0.00
05/10/91		-1.03	-1.07	-1.93	-1.51	-1.37	-1.04	-1.08	-1.44	-0.90	-1.52	-1.54	-1.01	-1.33	-1.52	-1.27	-1.05
07/10/91		-1.48	-1.89	-1.00	-1.02	-1.18	-1.31	-1.06	-0.52	-1.02	-1.56	-1.00	-0.73	-1.29	-1.34	-1.44	-1.08
11/10/91	bef	-2.29	-0.78	-1.30	-1.56	-1.30	-1.30	-0.78	-0.78	-0.78	-0.78	-0.52	-0.78	-0.78	-0.78	-1.04	-0.78
12/10/91	aft	-0.51	-2.81	-0.25	-0.26	-0.25	-0.49	-0.51	-1.03	-0.50	-0.51	-0.50	-0.51	-0.52	-0.51	-0.52	-0.51
14/10/91		-1.01	-2.50	-0.88	-0.91	-0.75	-0.93	-1.00	-0.93	-0.71	-0.75	-0.50	-0.76	-0.98	-0.76	-0.51	-0.75
16/10/91		0.00	0.00	-0.49	-0.50	-0.25	-0.49	-0.25	-0.54	-0.35	0.00	-0.47	-0.42	-0.50	-0.53	-0.66	-0.28
23/10/91		-0.93	-0.70	-0.70	-0.60	-0.70	-0.71	-0.41	-0.55	-0.68	-1.05	0.00	0.00	-0.72	-0.51	-0.70	-0.52
31/10/91		-2.50	-2.50	-3.00	-2.50	-2.00	-2.50	-1.75	-2.00	-1.75	-3.25	-3.25	-2.25	-3.00	-2.50	-2.00	-2.50
01/11/91	aft	-0.93	-0.93	-0.61	-0.90	-0.25	-0.93	-0.68	-0.87	-0.32	-0.77	-0.54	-0.43	-0.72	-0.70	-0.69	-0.66
04/11/91		-0.95	-1.00	-1.01	-0.84	-1.08	-1.01	-1.03	-1.02	-0.63	-1.27	-0.90	-0.63	-0.90	-1.03	-0.86	-0.97
08/11/91	bef	-1.46	-3.00	-1.47	-1.64	-1.33	-1.54	-1.45	-1.66	-0.89	-1.94	-1.43	-0.99	-1.64	-1.67	-1.41	-1.61
12/11/91		-1.85	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50	-1.50
14/11/91		-1.89	-2.18	-1.97	-1.56	-1.70	-1.90	-1.47	-1.94	-1.35	-1.71	-1.50	-1.48	-1.93	-1.92	-1.97	-1.88
18/11/91		-1.51	-1.51	-1.50	-1.49	-1.50	-1.51	-1.22	-1.49	-1.28	-1.53	-1.49	-1.62	-1.00	-1.53	-1.51	-1.50
25/11/91		-2.02	-1.98	-2.13	-1.98	-1.80	-1.88	-2.04	-2.06	-1.19	-2.02	-2.00	-1.83	-2.00	-2.03	-2.31	-1.97
30/11/91	aft	-0.52	-1.50	-0.48	-0.48	-0.54	-0.55	-0.50	-0.99	-0.51	-0.96	-1.04	-0.51	-0.38	-1.10	-0.26	-0.53

bef/aft = Before or after weiging

APPENDIX 3.7

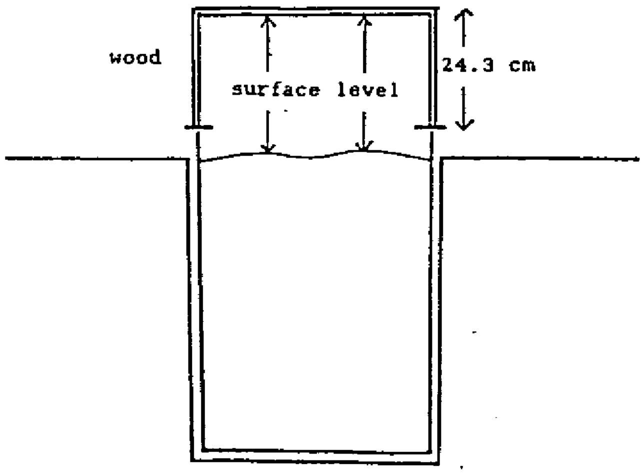
Surface levels (cm) from top "wood"
(17/05/91 - 22/11/91)
Height above edge lysimeter: 26.4 cm.

APPENDIX 3.8

Weekly rainfall (mm) measured
at Raheenmore

APPENDIX 3.7

Date	lev1	lev2	lev3	lev4	lev5
17/05/91	27.4	28.8	29.6	28.7	27.7
15/08/91	27.9	28.7	29.0	29.4	26.7
29/08/91	27.7	27.7	29.3	29.2	26.9
05/09/91	28.0	27.5	29.3	29.5	26.6
12/09/91	27.7	26.9	29.6	29.2	27.0
20/09/91	27.8	27.0	29.1	29.4	26.8
27/09/91	27.9	27.3	29.2	29.2	27.0
03/10/91	27.6	27.0	29.3	29.8	27.3
10/10/91	28.0	26.9	29.4	29.5	26.8
17/10/91	27.3	27.4	29.2	28.6	26.7
24/10/91	27.2	27.8	29.3	29.2	27.0
08/11/91	27.4	27.5	29.3	29.3	26.8
22/11/91	27.4	27.5	29.4	29.4	26.8



Date	lev6	lev7	lev8	lev9	lev10	lev11	lev12	lev13	lev14	lev15	lev16
17/05/91	28.1	26.7	25.7	28.4	29.6	25.0	24.7	30.0	28.6	31.9	27.0
15/08/91	27.4	27.2	27.4	27.4	29.5	27.2	24.2	30.2	29.3	30.7	27.4
29/08/91	27.5	26.4	27.6	28.0	29.5	26.2	23.7	30.6	29.2	31.2	26.7
05/09/91	28.3	26.3	27.6	28.1	29.4	26.0	25.3	30.5	29.0	31.0	26.4
12/09/91	28.6	26.3	27.2	28.1	30.0	25.8	25.3	30.4	29.5	31.4	27.4
20/09/91	28.7	26.3	26.9	28.2	29.4	25.7	24.1	30.4	29.0	31.5	27.9
27/09/91	27.6	26.6	26.6	27.8	29.2	26.5	25.2	30.7	28.8	31.9	27.5
03/10/91	28.0	26.8	27.1	27.9	29.4	26.1	25.1	30.4	29.0	30.7	27.1
10/10/91	27.8	26.4	26.8	27.7	29.5	26.0	24.2	30.5	29.3	30.9	26.9
17/10/91	28.5	26.2	26.7	28.1	29.2	25.1	24.8	30.0	29.8	30.6	26.7
24/10/91	28.6	26.6	26.8	28.3	29.3	25.4	24.3	30.2	29.2	30.9	26.2
08/11/91	28.7	26.4	26.7	27.8	29.1	26.2	24.5	29.9	29.2	30.6	26.1
22/11/91	28.4	27.1	26.9	28.2	29.4	26.0	24.0	30.3	29.3	31.1	26.2

APPENDIX 3.8

Date	Rainfall	Date	Rainfall	Date	Rainfall	Date	Rainfall
12/04/91	66.05	14/06/91	31.15	29/08/91	0.15	17/10/91	11.85
19/04/91	0.30	22/06/91	23.75	06/09/91	0.00	24/10/91	1.10
26/04/91	15.50	27/06/91	23.10	12/09/91	0.00	01/11/91	47.45
03/05/91	24.80	04/07/91	19.45	20/09/91	21.20	08/11/91	26.25
10/05/91	3.15	11/07/91	12.15	27/09/91	23.05	15/11/91	30.80
17/05/91	1.25	31/07/91	33.70	03/10/91	21.95	22/11/91	15.50
23/05/91	0.40	09/08/91	37.00	07/10/91	37.30	29/11/91	23.30
31/05/91	0.30	15/08/91	6.05	12/10/91	2.55	30/11/91	1.50
07/06/91	7.35	23/08/91	8.50				

APPENDIX 3.9

Open pan evaporation (mm) measured at Derrygreenagh

Date	E	Date	E	Date	E	Date	E
01-Apr-91	0.2	01-May-91	4.4	01-Jun-91	2.8	01-Jul-91	2.7
02-Apr-91	2.4	02-May-91	2.1	02-Jun-91	2.9	02-Jul-91	2.2
03-Apr-91	2.0	03-May-91	0.9	03-Jun-91	4.2	03-Jul-91	1
04-Apr-91	1.4	04-May-91	3.9	04-Jun-91	2.4	04-Jul-91	4.8
05-Apr-91	1.9	05-May-91	2.6	05-Jun-91	0	05-Jul-91	5.8
06-Apr-91	1.6	06-May-91	3	06-Jun-91	0.7	06-Jul-91	3.6
07-Apr-91	2.7	07-May-91	1.4	07-Jun-91	3	07-Jul-91	4
08-Apr-91	0.9	08-May-91	2.4	08-Jun-91	0	08-Jul-91	0.4
09-Apr-91	1.1	09-May-91	0.4	09-Jun-91	0.1	09-Jul-91	3.7
10-Apr-91	0.4	10-May-91	2	10-Jun-91	3.4	10-Jul-91	1.9
11-Apr-91	1.1	11-May-91	2.7	11-Jun-91	2	11-Jul-91	4.7
12-Apr-91	0.8	12-May-91	1.5	12-Jun-91	3.2	12-Jul-91	2.5
13-Apr-91	1.5	13-May-91	2	13-Jun-91	3.6	13-Jul-91	2.9
14-Apr-91	2.7	14-May-91	3.6	14-Jun-91	2.6	14-Jul-91	1.4
15-Apr-91	2.6	15-May-91	3	15-Jun-91	2.3	15-Jul-91	2.9
16-Apr-91	3.8	16-May-91	1.9	16-Jun-91	2	16-Jul-91	3.6
17-Apr-91	2.2	17-May-91	2.8	17-Jun-91	2.9	17-Jul-91	1.2
18-Apr-91	1.8	18-May-91	0.5	18-Jun-91	1.3	18-Jul-91	1.2
19-Apr-91	3.3	19-May-91	3	19-Jun-91	2.1	19-Jul-91	2.6
20-Apr-91	0.4	20-May-91	2.3	20-Jun-91	2.9	20-Jul-91	0.9
21-Apr-91	2.4	21-May-91	4.1	21-Jun-91	2.5	21-Jul-91	2.8
22-Apr-91	1.9	22-May-91	2.9	22-Jun-91	2.5	22-Jul-91	0.6
23-Apr-91	1.3	23-May-91	5.8	23-Jun-91	3.3	23-Jul-91	1.7
24-Apr-91	1.9	24-May-91	4.1	24-Jun-91	0.3	24-Jul-91	3.3
25-Apr-91	1.6	25-May-91	2.2	25-Jun-91	3.2	25-Jul-91	2.5
26-Apr-91	3.3	26-May-91	4.2	26-Jun-91	2.1	26-Jul-91	2
27-Apr-91	1.7	27-May-91	4.1	27-Jun-91	2.1	27-Jul-91	3.6
28-Apr-91	0.4	28-May-91	2.6	28-Jun-91	2.6	28-Jul-91	3.6
29-Apr-91	0.4	29-May-91	3.8	29-Jun-91	1.1	29-Jul-91	4.7
30-Apr-91	2.4	30-May-91	2.9	30-Jun-91	1.6	30-Jul-91	2.2
		31-May-91	3.1			31-Jul-91	0.3
Total	52.1		86.2		65.7		81.3

Date	E	Date	E	Date	E	Date	E
01-Aug-91	0.8	01-Sep-91	2	01-Oct-91	2.4	01-Nov-91	1.4
02-Aug-91	3	02-Sep-91	3.6	02-Oct-91	0.7	02-Nov-91	0.2
03-Aug-91	2.8	03-Sep-91	3.6	03-Oct-91	2	03-Nov-91	0.5
04-Aug-91	1.8	04-Sep-91	2.2	04-Oct-91	2.2	04-Nov-91	0.2
05-Aug-91	0.6	05-Sep-91	2.9	05-Oct-91	1.1	05-Nov-91	0.2
06-Aug-91	1.8	06-Sep-91	2.6	06-Oct-91	1.3	06-Nov-91	0.1
07-Aug-91	1.7	07-Sep-91	2.6	07-Oct-91	1	07-Nov-91	0.6
08-Aug-91	3.2	08-Sep-91	2	08-Oct-91	0.9	08-Nov-91	0.5
09-Aug-91	0.2	09-Sep-91	1.3	09-Oct-91	0.4	09-Nov-91	0
10-Aug-91	1.2	10-Sep-91	2.9	10-Oct-91	0.2	10-Nov-91	0.4
11-Aug-91	3.6	11-Sep-91	1.6	11-Oct-91	0.1	11-Nov-91	0.5
12-Aug-91	2.4	12-Sep-91	0.6	12-Oct-91	0.4	12-Nov-91	1.4
13-Aug-91	2.3	13-Sep-91	3.1	13-Oct-91	0.5	13-Nov-91	0
14-Aug-91	2.6	14-Sep-91	1.9	14-Oct-91	0.9	14-Nov-91	0
15-Aug-91	3.4	15-Sep-91	1	15-Oct-91	0.4	15-Nov-91	0
16-Aug-91	1.5	16-Sep-91	3.1	16-Oct-91	1.9	16-Nov-91	0.2
17-Aug-91	3.1	17-Sep-91	2.8	17-Oct-91	1.7	17-Nov-91	0
18-Aug-91	2.3	18-Sep-91	2.5	18-Oct-91	0.8	18-Nov-91	0.7
19-Aug-91	2	19-Sep-91	1.9	19-Oct-91	0.6	19-Nov-91	0
20-Aug-91	4.2	20-Sep-91	1.7	20-Oct-91	0	20-Nov-91	0.8
21-Aug-91	2.1	21-Sep-91	0.3	21-Oct-91	0.1	21-Nov-91	0.2
22-Aug-91	3	22-Sep-91	1.1	22-Oct-91	0.5	22-Nov-91	0.3
23-Aug-91	2.3	23-Sep-91	0.5	23-Oct-91	0.4	23-Nov-91	0.5
24-Aug-91	0.6	24-Sep-91	2.6	24-Oct-91	0	24-Nov-91	0.5
25-Aug-91	0.8	25-Sep-91	0.9	25-Oct-91	0	25-Nov-91	1
26-Aug-91	2.1	26-Sep-91	1	26-Oct-91	0.2	26-Nov-91	0
27-Aug-91	1.9	27-Sep-91	0.3	27-Oct-91	0.1	27-Nov-91	0
28-Aug-91	4	28-Sep-91	0.9	28-Oct-91	0.4	28-Nov-91	0.2
29-Aug-91	3.6	29-Sep-91	2.1	29-Oct-91	0	29-Nov-91	0.1
30-Aug-91	4.2	30-Sep-91	0.3	30-Oct-91	3.4	30-Nov-91	0.7
31-Aug-91	3.6			31-Oct-91	0.5		
Total	72.7		55.9		25.1		11.2

APPENDIX 3.10

Evapotranspiration (mm/day)
of lysimeters.

Begindate		Enddate	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8
15/04/91	-	19/04/91	2.3	2.7	2.7	2.7	2.3	2.3	3.5	3.9
19/04/91	-	26/04/91	2.4	2.1	1.8	2.0	1.9	1.6	2.1	2.6
26/04/91	-	03/05/91	2.5	1.5	2.3	2.7	2.7	2.4	2.5	2.9
03/05/91	-	10/05/91	2.6	2.4	1.9	2.2	1.5	1.8	2.5	3.1
10/05/91	-	17/05/91	3.6	2.2	1.7	1.9	1.3	1.5	2.7	3.1
17/05/91	-	23/05/91	3.2	2.6	2.2	2.1	1.4	1.8	2.9	3.6
23/05/91	-	31/05/91	3.1	2.5	2.3	1.8	1.8	2.1	4.0	4.3
31/05/91	-	07/06/91	3.4	2.0	1.7	1.3	1.5	1.6	2.9	3.0
07/06/91	-	14/06/91	1.2	2.1	1.9	3.2	4.1	1.7	2.2	2.6
14/06/91	-	22/06/91	2.1	2.6	2.1	1.7	1.8	1.8	2.4	2.9
22/06/91	-	27/06/91		3.0	2.7	2.7	2.7	2.6	2.6	3.2
27/06/91	-	04/07/91	1.6		1.4		1.5	2.0	1.9	0.9
04/07/91	-	11/07/91	3.0	3.1	2.3	2.6	2.6	2.9	3.5	3.9
11/07/91	-	31/07/91	2.3	2.2	2.0	2.1	2.1	2.1	2.4	2.8
31/07/91	-	09/08/91	1.1	1.2	1.5		1.6	1.4	1.8	
09/08/91	-	15/08/91	2.3	2.0	1.6	1.7	1.6	1.9	2.6	2.4
15/08/91	-	23/08/91	2.6	2.3	1.7	2.0	1.8	1.9	2.4	3.0
23/08/91	-	29/08/91	1.6	1.3	0.9	1.2	1.1	1.3	1.6	1.9
29/08/91	-	05/09/91		2.3	1.9	2.2	1.7	2.2	3.1	3.6
05/09/91	-	12/09/91	1.8	1.8	1.3	1.4	1.3	1.3	2.1	2.2
12/09/91	-	20/09/91	1.6	2.0	1.6	1.6	1.5	1.6	2.1	2.4
20/09/91	-	27/09/91	1.0	0.2	0.7	1.7	1.2	1.3	1.8	1.6
27/09/91	-	03/10/91	0.6	1.1	1.0	1.2	1.2	1.2	1.4	1.4
03/10/91	-	11/10/91		1.0	0.9	0.8	0.9	0.7	1.1	1.0
03/10/91	-	12/10/91								
11/10/91	-	17/10/91	0.4		0.1		0.2	0.1	0.4	
12/10/91	-	17/10/91								
17/10/91	-	24/10/91	0.8		0.4	0.7	0.5	0.6	0.7	1.0
24/10/91	-	01/11/91								
01/11/91	-	08/11/91	0.7		0.6	0.8	0.8	0.5	1.2	0.5
08/11/91	-	15/11/91			0.5	0.7	0.9	0.6	1.1	0.4
15/11/91	-	22/11/91	0.3	0.4	0.3	0.2	0.3	0.2	0.3	0.1
22/11/91	-	30/11/91	1.2	0.2	0.3	0.5	0.7	0.2	0.7	0.3

Begindate		Enddate	EV_9	EV_10	EV_11	EV_12	EV_13	EV_14	EV_15	EV_16
15/04/91	-	19/04/91	3.1	2.9	3.1	3.9	2.3	3.1	2.3	3.5
19/04/91	-	26/04/91	1.8	2.0	2.1	2.2	1.6	2.0	1.8	2.0
26/04/91	-	03/05/91	4.1	2.9	2.3	2.7	2.4	3.1	2.5	2.5
03/05/91	-	10/05/91	2.2	2.3	2.3	2.5	1.8	2.2	1.7	2.3
10/05/91	-	17/05/91	2.3	2.3	2.2	2.5	1.9	2.1	1.7	2.2
17/05/91	-	23/05/91	3.0	3.1	2.6	2.3	2.2	1.8	1.7	2.5
23/05/91	-	31/05/91	3.7	3.9	2.9	2.9	2.7	3.0	2.3	3.1
31/05/91	-	07/06/91	2.6	2.6	2.1	1.2	1.4	2.0	1.8	1.2
07/06/91	-	14/06/91	3.7	4.3	2.6	2.4	3.4	3.1	1.7	2.2
14/06/91	-	22/06/91	2.4	2.2	2.7	2.6	1.9	2.0	1.9	2.5
22/06/91	-	27/06/91	2.7	2.8	2.9	2.7	2.9	1.9	1.8	2.7
27/06/91	-	04/07/91	1.7	2.2	2.1		1.0	1.8	1.9	1.8
04/07/91	-	11/07/91	3.4	3.2	3.3	3.0	2.6	2.6	1.9	2.8
11/07/91	-	31/07/91	2.2	2.2	2.4	2.5	1.9	2.0	1.7	2.3
31/07/91	-	09/08/91	1.8	1.8	1.6	1.4	1.3	1.5	1.6	1.7
09/08/91	-	15/08/91	2.1	1.8	2.1	1.9	1.8	1.9	1.6	2.0
15/08/91	-	23/08/91	2.2	2.2	2.9	2.5	1.7	2.0	2.0	2.5
23/08/91	-	29/08/91	1.3	1.4	1.5	1.6	1.0	1.4	0.8	1.7
29/08/91	-	05/09/91	2.7	2.7	2.5	2.7	1.9	2.2	1.8	3.2
05/09/91	-	12/09/91	1.8	1.6	1.9	1.7	1.1	1.5	1.6	1.3
12/09/91	-	20/09/91	2.0	1.7	1.8	2.0	1.4	1.4	0.9	2.1
20/09/91	-	27/09/91	1.2	1.4	1.2	1.5	1.1	0.8	1.0	1.3
27/09/91	-	03/10/91	1.2	1.1	1.5	1.5	0.9	1.0	1.1	1.5
03/10/91	-	11/10/91								
03/10/91	-	12/10/91	1.1	0.7	1.1	1.0	0.6	0.6	0.5	0.7
11/10/91	-	17/10/91								
12/10/91	-	17/10/91	0.8	0.7	1.1	1.3	0.5	0.6	1.0	1.2
17/10/91	-	24/10/91	0.6	0.6	1.1	1.0	0.5	0.5	0.4	0.7
24/10/91	-	01/11/91								
01/11/91	-	08/11/91	1.5	0.5	0.6	2.0	0.7	0.6	0.8	0.6
08/11/91	-	15/11/91	1.4	0.4	0.6	0.9	1.1	0.5	0.7	0.6
15/11/91	-	22/11/91	0.5	0.0	0.5	0.4	0.3	0.4	0.4	0.3
22/11/91	-	30/11/91	1.2	0.0	0.9	0.9	0.5	0.6	0.6	0.5

APPENDIX 3.11

Evapotranspiration (mm) lysimeters
(weekly).

Begindate		Enddate	EV_1	EV_2	EV_3	EV_4	EV_5	EV_6	EV_7	EV_8
15/04/91	-	19/04/91	9.1	10.6	10.6	10.6	9.1	9.1	13.8	15.4
19/04/91	-	26/04/91	17.1	14.7	12.3	13.7	13.6	11.5	14.7	17.9
26/04/91	-	03/05/91	17.6	10.6	15.9	19.2	19.1	16.9	17.2	20.0
03/05/91	-	10/05/91	18.3	16.7	13.5	15.1	10.3	12.7	17.5	21.5
10/05/91	-	17/05/91	25.1	15.6	12.2	13.2	9.2	10.8	18.8	21.9
17/05/91	-	23/05/91	19.5	15.5	13.1	12.3	8.4	10.7	17.5	21.5
23/05/91	-	31/05/91	25.0	20.2	18.6	14.6	14.6	17.0	32.1	34.5
31/05/91	-	07/06/91	24.1	14.1	12.1	9.3	10.5	11.3	20.1	20.9
07/06/91	-	14/06/91	8.1	14.4	13.6	22.4	28.6	12.1	15.6	18.0
14/06/91	-	22/06/91	16.6	20.6	17.1	14.0	14.2	14.8	19.5	23.1
22/06/91	-	27/06/91		15.1	13.7	13.6	13.4	12.8	12.8	15.9
27/06/91	-	04/07/91	11.4		9.7		10.5	13.8	13.1	6.0
04/07/91	-	11/07/91	21.1	21.5	16.0	18.3	18.4	20.3	24.2	27.3
11/07/91	-	31/07/91	46.4	44.8	39.3	42.5	41.7	41.7	48.8	55.1
31/07/91	-	09/08/91	10.2	10.6	13.4		14.4	12.7	16.2	
09/08/91	-	15/08/91	13.5	11.9	9.4	10.3	9.9	11.5	15.6	14.6
15/08/91	-	23/08/91	20.8	18.8	13.4	16.1	14.6	15.4	19.1	23.9
23/08/91	-	29/08/91	9.9	7.9	5.6	7.2	6.4	7.9	9.5	11.2
29/08/91	-	05/09/91		15.9	13.5	15.3	11.9	15.1	22.0	25.5
05/09/91	-	12/09/91	12.7	12.5	8.8	10.1	9.1	8.8	14.7	15.5
12/09/91	-	20/09/91	12.4	15.6	12.4	12.4	11.7	12.4	16.4	18.8
20/09/91	-	27/09/91	7.0	1.6	4.7	11.6	8.6	9.3	12.5	11.5
27/09/91	-	03/10/91	3.5	6.8	6.1	7.2	7.0	7.4	8.4	8.6
03/10/91	-	11/10/91		7.7	7.1	6.7	6.9	5.3	8.5	8.3
11/10/91	-	17/10/91	2.6		0.7		1.3	0.8	2.2	2.2
17/10/91	-	24/10/91	5.9		2.7	5.1	3.5	4.3	5.1	6.7
24/10/91	-	01/11/91								
01/11/91	-	08/11/91	5.2		4.0	5.7	5.9	3.3	8.3	3.6
08/11/91	-	15/11/91			3.2	4.9	6.1	4.5	8.0	2.6
15/11/91	-	22/11/91	1.9	2.7	2.0	1.3	2.0	1.1	1.8	0.5
22/11/91	-	30/11/91	9.6	2.0	2.4	4.4	5.8	2.0	5.5	2.1

Begindate		Enddate	EV_9	EV_10	EV_11	EV_12	EV_13	EV_14	EV_15	EV_16
15/04/91	-	19/04/91	12.2	11.4	12.2	15.4	9.1	12.2	9.1	13.8
19/04/91	-	26/04/91	12.3	13.9	14.7	15.5	11.5	13.9	12.3	13.9
26/04/91	-	03/05/91	28.7	20.0	16.2	19.2	16.7	21.9	17.3	17.7
03/05/91	-	10/05/91	15.1	15.9	15.9	17.5	12.7	15.1	11.9	15.9
10/05/91	-	17/05/91	16.4	16.4	15.6	17.2	13.2	14.8	11.6	15.6
17/05/91	-	23/05/91	17.9	18.7	15.5	13.9	13.2	10.7	9.9	14.7
23/05/91	-	31/05/91	29.7	31.3	23.4	23.4	21.8	24.2	18.6	25.0
31/05/91	-	07/06/91	18.5	18.5	14.4	8.1	10.1	14.1	12.9	8.1
07/06/91	-	14/06/91	25.7	30.3	18.4	16.6	23.7	21.6	11.7	15.2
14/06/91	-	22/06/91	19.1	17.9	21.5	20.6	15.0	15.8	15.0	19.9
22/06/91	-	27/06/91	13.4	13.8	14.3	13.6	14.3	9.6	8.8	13.6
27/06/91	-	04/07/91	12.2	15.6	14.4		6.9	12.5	13.2	12.9
04/07/91	-	11/07/91	23.5	22.1	23.1	21.2	18.2	18.5	13.6	19.9
11/07/91	-	31/07/91	44.0	44.0	48.7	49.6	37.7	40.1	34.5	45.6
31/07/91	-	09/08/91	16.2	16.5	14.5	12.6	12.1	13.8	14.3	15.0
09/08/91	-	15/08/91	12.9	10.8	12.4	11.6	10.8	11.1	9.7	12.1
15/08/91	-	23/08/91	17.8	17.9	22.9	20.2	13.8	16.1	15.7	20.2
23/08/91	-	29/08/91	7.9	8.6	9.1	9.5	6.0	8.4	4.9	10.3
29/08/91	-	05/09/91	19.1	19.1	17.5	19.1	13.5	15.1	12.7	22.3
05/09/91	-	12/09/91	12.7	11.3	13.1	11.9	8.0	10.5	11.1	9.3
12/09/91	-	20/09/91	15.6	13.2	14.0	15.6	10.9	10.9	6.9	16.4
20/09/91	-	27/09/91	8.7	9.5	8.4	10.7	7.9	5.5	6.8	8.8
27/09/91	-	03/10/91	7.0	6.5	9.0	9.2	5.2	5.8	6.8	9.2
03/10/91	-	11/10/91	10.2	6.0	9.9	8.7	5.2	5.4	4.5	6.3
11/10/91	-	17/10/91	4.2	3.4	5.7	6.4	2.3	3.1	4.8	6.0
17/10/91	-	24/10/91	4.3	4.3	7.5	6.7	3.5	3.5	2.7	5.1
24/10/91	-	01/11/91								
01/11/91	-	08/11/91	10.8	3.3	4.2	13.9	5.1	4.0	5.9	4.4
08/11/91	-	15/11/91	9.7	2.9	4.5	6.3	7.5	3.6	4.8	3.9
15/11/91	-	22/11/91	3.7	0.1	3.6	2.6	2.0	2.5	2.7	2.0
22/11/91	-	30/11/91	9.9	0.1	7.4	7.1	4.2	4.8	4.9	3.6

APPENDIX 3.12

Weekly evapotranspiration of plant species and open pan

Beg_date		End_date	Lysimeter Avg.	C.V.	N.O.	E.V.	Sph.	Pan	Pan-Avg.
15/04/91	-	19/04/91	2.9	2.7	2.6	3.0	3.3	2.6	-0.3
19/04/91	-	26/04/91	2.0	2.1	1.8	2.0	2.1	1.8	-0.2
26/04/91	-	03/05/91	2.6	2.3	2.6	2.6	3.1	2.1	-0.5
03/05/91	-	10/05/91	2.2	2.2	1.8	2.2	2.5	2.1	-0.1
10/05/91	-	17/05/91	2.2	2.4	1.8	2.0	2.6	2.4	0.2
17/05/91	-	23/05/91	2.4	2.5	1.9	2.2	3.2	2.6	0.2
23/05/91	-	31/05/91	2.9	2.8	2.5	2.4	4.0	3.7	0.8
31/05/91	-	07/06/91	2.0	2.1	1.7	1.5	2.8	2.3	0.3
07/06/91	-	14/06/91	2.6	1.8	3.1	2.5	3.2	2.2	-0.4
14/06/91	-	22/06/91	2.2	2.3	1.9	2.2	2.5	2.3	0.1
22/06/91	-	27/06/91	2.6	2.5	2.5	2.7	2.8	2.3	-0.3
27/06/91	-	04/07/91	1.7	1.8	1.4	2.0	1.7	1.9	0.2
04/07/91	-	11/07/91	2.9	2.7	2.5	3.0	3.5	3.5	0.6
11/07/91	-	31/07/91	2.2	2.1	2.0	2.3	2.4	2.5	0.3
31/07/91	-	09/08/91	1.5	1.4	1.5	1.5	1.8	1.8	0.3
09/08/91	-	15/08/91	2.0	2.0	1.7	1.9	2.2	2.1	0.1
15/08/91	-	23/08/91	2.2	2.4	1.8	2.3	2.5	2.7	0.5
23/08/91	-	29/08/91	1.4	1.4	1.1	1.4	1.6	2.0	0.6
29/08/91	-	05/09/91	2.6	3.1	1.9	2.4	3.1	3.3	0.7
05/09/91	-	12/09/91	1.6	1.6	1.3	1.6	1.9	2.3	0.7
12/09/91	-	20/09/91	1.7	1.6	1.4	1.7	2.0	2.1	0.4
20/09/91	-	27/09/91	1.2	0.9	1.0	1.4	1.5	1.2	0
27/09/91	-	03/10/91	1.2	1.1	1.0	1.4	1.3	0.6	-0.6
03/10/91	-	12/10/91	0.8	0.5	0.7	0.9	1.0	1.0	0.2
12/10/91	-	17/10/91	0.6	0.9	0.4	0.6	0.6	1.2	0.6
17/10/91	-	24/10/91	0.7	0.6	0.5	0.8	0.7	0.6	-0.1
24/10/91	-	01/11/91						0.6	
01/11/91	-	08/11/91	0.8	0.7	0.7	1.0	0.9	0.5	-0.3
08/11/91	-	15/11/91	0.6	0.2	0.7	0.7	0.8	0.4	-0.2
15/11/91	-	22/11/91	0.3	0.3	0.3	0.3	0.2	0.3	0
22/11/91	-	30/11/91	0.6	0.6	0.5	0.7	0.5	0.4	-0.2

Avg. = Average over all lysimeters
C.V. = *Calluna vulgaris*
N.O. = *Narthecium ossifragum*
E.V. = *Eriophorum vaginatum*
Sph. = *Sphagnum* spp.

APPENDIX 3.13

Evapotranspiration: Analysis of variance on plant species

ANOVA-table CALLUNA

	DF	sum of squares	mean square	F
Level	1	2076625.1		
Acro*	1	219.0	219.0	0.1
Calluna	1	805.2	805.2	0.3
Rest	13	36242.4	2787.9	
Total	16	2113891.8		

ANOVA-table NARTHECIUM

	DF	sum of squares	mean square	F
Level	1	2076625.1		
Acro*	1	219.0	219.0	0.1
Narthec.	1	11132.5	11132.5	4.0
Rest	13	25915.1	1993.5	
Total	16	2113891.8		

ANOVA-table ERIOPHORUM

	DF	sum of squares	mean square	F
Level	1	2076625.1		
Acro*	1	219.0	219.0	0.1
Narthec.	1	11.0	11.0	0.0
Rest	13	37036.6	2849.0	
Total	16	2113891.8		

ANOVA-table SPHAGNUM

	DF	sum of squares	mean square	F
Level	1	2076625.1		
Acro*	1	219.0	219.0	0.1
Sphagnum	1	18825.8	18825.8	6.8
Rest	13	18221.8	1401.7	
Total	16	2113891.8		

F^{t}_{11} (γ = 0.95) = 4.67

APPENDIX 3.14

Rank-correlation (Spearman) test on Cotton grass and Bog asphodel

Eriophorum vaginatum

x	Evap.	LAI	y	x-y	$(x-y)^2$
1	1.14	1.5	4	-3	9
2	1.00	1.0	8	-6	36
3	1.00	0.7	10	-7	49
4	0.99	1.0	9	-5	25
5	0.98	1.7	3	2	4
6	0.96	1.1	6	0	0
7	0.92	2.0	2	5	25
8	0.91	0.6	15	-7	49
9	0.89	1.3	5	4	16
10	0.89	2.3	1	9	81
11	0.87	0.6	16	-5	25
12	0.85	0.7	11	1	1
13	0.85	0.6	17	-4	16
14	0.84	0.7	12	2	4
15	0.84	1.1	7	8	64
16	0.79	0.6	18	-2	4
17	0.72	0.7	13	4	16
18	0.72	0.5	19	-1	1
19	0.71	0.7	14	5	25
20	0.67	0.4	20	0	0
				d^2 =	450
				r_s =	0.7
				t_v =	3.7

Narthecium ossifragum

x	Evap.	LAI	y	x-y	$(x-y)^2$
1	1.08	1.5	3	-2	4
2	1.01	1.1	10	-8	64
3	1.00	0.8	16	-13	169
4	0.92	1.2	7	-3	9
5	0.85	0.5	19	-14	196
6	0.81	1.4	5	1	1
7	0.81	1.4	6	1	1
8	0.78	0.4	20	-12	144
9	0.75	1.0	11	-2	4
10	0.75	2.1	1	9	81
11	0.74	0.9	12	-1	1
12	0.74	0.7	18	-6	36
13	0.73	0.9	13	0	0
14	0.70	1.8	2	12	144
15	0.68	1.2	8	7	49
16	0.68	0.8	17	-1	1
17	0.67	1.2	9	8	64
18	0.65	1.5	4	14	196
19	0.63	0.9	14	5	25
20	0.57	0.9	15	5	25
				d^2 =	1214
				r_s =	0.1
				t_v =	0.4

Student distribution: t_v; t_{18} (γ = 0.95) = 1.73

APPENDIX 3.15

Main plant species of the lysimeters 03-12-91
taken by Larissa Kelly.

No.	Main species	Cover (%)
1.	*Calluna vulgaris*	65
	Erica tetralix	3
	Hypnum jutlandicum	50
	Sphagnum magellanicum	40
	Odontoschisma Sphagni	5
2.	*Calluna vulgaris*	40
	Erica tetralix	2
	Hypnum jutlandicum	50
	Sphagnum magellanicum	25
	Sphagnum subnitens	20
3.	*Narthecium ossifragum*	70
	Sygongonium ericetorum	25
	Sphagnum subnitens	5
4.	*Eriophorum vaginatum*	20
	Sphagnum capillifolium	20
	Sphagnum magellanicum	5
	Sphagnum tellenum	2
	Campylopus paradoxus	2
	Hypnum jutlandicum	1
5.	*Narthecium ossifragum*	80
	Hypnum jutlandicum	20
	Odontoschisma Sphagni	10
	Campylopus paradoxus	2
	Sphagnum capillifolium	2
6.	*Eriophorum vaginatum*	20
	Sphagnum magellanicum	60
	Hypnum jutlandicum	10
7.	*Sphagnum magellanicum*	100
	Campylopus paradoxus	1
	Hypnum jutlandicum	1
8.	*Sphagnum magellanicum*	97
	Sphagnum capillifolium	3

No.	Main species	Cover (%)
9.	*Sphagnum papillosum*	80
	Odontoschisma Sphagni	10
	Sphagnum capillifolium	5
	Sphagnum magellanicum	5
10.	*Sphagnum papillosum*	70
	Sphagnum magellanicum	20
	Odontoschisma Sphagni	10
11.	*Eriophorum vaginatum*	70
	Sphagnum papillosum	40
	Sphagnum magellanicum	40
	Sphagnum capillifolium	20
	Hypnum jutlandicum	10
12.	*Eriophorum vaginatum*	50
	Sphagnum capillifolium	75
	Hypnum jutlandicum	20
	Sphagnum tellenium	5
13.	*Narthecium ossifragum*	80
	Odontoschisma Sphagni	40
	Sphagnum capillifolium	5
	Hypnum jutlandicum	5
	Sphagnum magellanicum	3
	Andromeda polyfolia	1
14.	*Narthecium ossifragum*	70
	Odontoschisma Sphagni	15
	Sphagnum capillifolium	15
	Sphagnum magellanicum	10
	Campilopus paradoxus	1
15.	*Calluna vulgaris*	50
	Erica tetralix	10
	Sphagnum magellanicum	80
	Sphagnum capillifolium	10
	Odontoschisma Sphagni	5
	Hypnum jutlandicum	5
16.	*Calluna vulgaris*	80
	Erica tetralix	10
	Sphagnum capillifolium	60
	Sphagnum magellanicum	10
	Hypnum jutlandicum	2

APPENDIX 3.16

Analysis of variance

Analysis of variance is used to determine the effect of factors on mean sample values of a normal distribution.
It is based on arithmetical partition of the sum of squares
(= sum of squares of the deviations between the sample values and the sample mean).
The random variation is compared with 'explained' variation to see whether the effect of a factor is significant. A classical example is the effect on the growth of animals fed with different kinds of food.

Let us consider the following situation:
We have a sample of size n, which is subdivided into r groups:

$$
\begin{array}{l}
y_{11}, y_{12}, \ldots, y_{1n1} \\
y_{21}, y_{22}, \ldots, y_{2n2} \\
\vdots \\
y_{r1}, y_{r2}, \ldots, y_{rnr}
\end{array}
$$

The sizes of the groups are: 1 : n1; 2: n2; ...; r: nr, so
n = n1 + n2 + ... + nr.

We assume that the r groups of numbers arise from r normally distributed populations with the same σ^2 and with means $\mu_1, \mu_2, \ldots, \mu_r$. We want to test the hypothesis H_0 that the means are equal.

For that purpose we have to decompose our data y_i into:

$$y = y_N + y_g{}^* + y_R \qquad (3\text{-i})$$

with:

y	= Sample data
y_N	= Part explained by mean
$y_g{}^*$	= Part explained by diffences in group
y_R	= Residu (Random effect).

Because of the orthogonality of the factors mentioned it is allowed to write:

$$y^2 = y_N^2 + y_g^2{}^* + y_R^2 \qquad (3\text{-ii})$$

The mean square (= proj^2/dim) equals the square per degree of freedom. The dimensions are:

dim y = n;
dim y_N = 1;
dim y_g = r−1;
dim y_R = n−r.

The projections are calculated as follows:

$$y^2 = \sum_{i=1}^{n} y_i^2 \qquad (3\text{-iii})$$

$$y_N^2 = \left(\sum_{i=1}^{n} y_i \right)^2 \qquad (3\text{-iv})$$

$$y_g^2 * = \sum_{j=n_1}^{r} \left\{ \frac{\left(\sum_{i=1}^{n_j} y_i \right)^2}{n_j} \right\} - y_N^2 \qquad (3\text{-v})$$

$$y_R^2 = y^2 - y_N^2 - y_g^2 * \qquad (3\text{-vi})$$

To give a better overview the results of the calculations are often precented in an ANOVA−table. For example:

Table 3.4: Statistical analysis on the differences in evapotranspiration between *Sphagnum* species in lysimeters

ANOVA - table

Sphagnum magellanicum - Sphagnum papillosum

	DF	sum of squares	mean square	F
Level	1	22856.7		
Species*	1	49.1	49.1	3.4
Rest	2	28.7	14.3	
Total	4	22934.5		

F^1_2 (γ=0.95) = 18.5

The quotient F:

$$F = \frac{y_g^2 * / (r-1)}{y_R^2 / (n-r)} \qquad (3\text{-vii})$$

is F−distributed with (r−1,n−r) degrees of freedom. From statistical tables the critical value F_c for a

choosen significance level can be looked up. If $F > F_c$, then F falls outside the acceptance region and H_0 is to be rejected.
In the example of table 1, F = 3.4. The crital value F is 8.5, so F falls within the acceptance region. H_0, stating that there is no difference in evapotranspiration between the two considered *Sphagnum* species, is therefore not rejected.

The above explained analysis is a one-way experimental layout; only the effect of one factor is taken into account. The analysis of variance on a two or three-way layout (2 or 3 factor experiment) goes analogously.

APPENDIX 3.17

Rank correlation test (Spearman)

To see whether to stochastical components $(\underline{x},\underline{y})$ are correlated, the rank correlation test of Spearman can be applied. Positive correlation means that relatively high $\underline{x}$ values correspond with relatively high $\underline{y}$ values.
We consider n pairs of sample data:

$(\underline{x}_1,\underline{y}_1), (\underline{x}_2,\underline{y}_2), \ldots, (\underline{x}_n,\underline{y}_n)$.

The hypothesis H_0: No positive correlation.
We assume no further knowledge about the relation $(\underline{x},\underline{y})$, nor about the distribution.
The values of x, in pairs coupled with y, are replaced by their rank number in the x-list. The same goes for y. Naming the x rank numbers r_i and the y rank numbers s_i yields:

$(r_1,s_1), (r_2,s_2), \ldots, (r_n,s_n)$.

With the (r_i,s_i)-pairs $\underline{d}^2$ is calculated:

$$\underline{d}^2 = \sum_{i=1}^{n} (\underline{r}_i - \underline{s}_i)^2 \qquad \text{(3-viii)}$$

With this the rank correlation coefficient is calculated:

$$\underline{r}_s = 1 - \frac{6\,\underline{d}^2}{n(n^2-1)} \qquad \text{(3-ix)}$$

For n > 15:

$$\frac{\underline{r}_s\sqrt{n-2}}{\sqrt{1-\underline{r}_s^2}} = \underline{t}_{n-2} \qquad \text{(3-x)}$$

in which $\underline{t}_{n-2}$ is a Student distribution with n-2 degrees of freedom. The critical values of this distribution (with different significance levels) are given in statistical tables.
If the calculated $t > \underline{t}_{n-2}$, t falls outside the acceptance region and the hypothesis: no significant correlation is to be rejected.

APPENDIX 4.1

Storage coefficients, μ, calculated with weighing data.

Date	mu1	mu2	mu3	mu4	mu5	mu6	mu7	mu8	mu9	mu10	mu11	mu12	mu13	mu14	mu15	mu16
15-Apr-91															0.66	0.37
19-Apr-91	0.27		0.30	0.24	0.21	0.28	0.36	0.34	0.39	0.16	0.37					
26-Apr-91	0.20	0.49	0.21	0.21	0.16	0.30	0.34	0.36	0.31	0.41	0.35	0.42	0.42	0.46	0.40	0.37
03-May-91					0.13											
10-May-91	0.22			0.27			0.43					0.48				0.41
17-May-91	0.39					0.27										
23-May-91																
31-May-91	0.29	0.24	0.28	0.19	0.15	0.35	0.28	0.38	0.35	0.42	0.34			0.38	0.54	0.47
07-Jun-91	0.02	0.11	0.08	0.08	0.10		0.15	0.22	0.22	0.22	0.28	0.30	0.32			
14-Jun-91	0.40	0.42	0.47			0.43	0.44	0.45								
22-Jun-91	0.33		0.18		0.19	0.18	0.31		0.22	0.16			0.28			0.24
27-Jun-91	0.33															
04-Jul-91	0.18		0.12			0.27			0.27	0.21						
11-Jul-91				0.27								0.42				
31-Jul-91	0.19		0.16	0.27	0.20	0.21	0.37	0.38	0.24	0.32		0.45				0.37
09-Aug-91	0.24		0.19	0.34		0.27	0.43	0.38	0.31			0.42				
15-Aug-91	0.28		0.29	0.27				0.36								0.27
23-Aug-91																
29-Aug-91	0.07	0.02	0.08	0.03	0.06		0.02	0.03	0.02	0.15		0.02	0.03	0.07	0.09	0.03
05-Sep-91																
12-Sep-91	0.02	0.07	0.11	0.03	0.04	0.10	0.07	0.05	0.07	0.10	0.10	0.10	0.09	0.11	0.18	0.08
20-Sep-91	0.11	0.06	0.09	0.08	0.08	0.09	0.06	0.04	0.06	0.10	0.10	0.09	0.10	0.11	0.19	0.07
27-Sep-91	0.41	0.43	0.36	0.11		0.31	0.34	0.30	0.34	0.28	0.31	0.32		0.45		0.40
03-Oct-91	0.20			0.24	0.19	0.24	0.44		0.37	0.40			0.40	0.35		0.42
17-Oct-91	0.18		0.19	0.19	0.09	0.15										
24-Oct-91																
01-Nov-91	0.23		0.19	0.22	0.18	0.30		0.42		0.21	0.46	0.47	0.37	0.37	0.48	0.41
08-Nov-91				0.20						0.22						
15-Nov-91																
22-Nov-91																
30-Nov-91										0.22						

	lys1	lys2	lys3	lys4	lys5	lys6	lys7	lys8	lys9	lys10	lys11	lys12	lys13	lys14	lys15	lys16
Avg. μ	0.23	0.23	0.21	0.19	0.14	0.25	0.29	0.29	0.24	0.24	0.29	0.32	0.25	0.29	0.36	0.30
Wl 10-20	0.11	0.12	0.14	0.09	0.09	0.18	0.14	0.17	0.17	0.21	0.20	0.16	0.17	0.20	0.30	0.20
Wl 0-10	0.26	0.34	0.23	0.22	0.16	0.27	0.35	0.34	0.27	0.25	0.37	0.38	0.30	0.34	0.41	0.33

APPENDIX 4.2

Storage coefficients, μ, calculated with water adding/removing data.

Date	mu1	mu2	mu3	mu4	mu5	mu6	mu7	mu8	mu9	mu10	mu11	mu12	mu13	mu14	mu15	mu16
19-Apr-91	0.19	0.50	0.21	0.24	0.15	0.26	0.33	0.31	0.27		0.37	0.39	0.38	0.34	0.41	0.30
15-May-91			0.19	0.14	0.17			0.24	0.27	0.23	0.27			0.31		
10-Aug-91	0.22		0.16	0.26	0.07								0.24			
19-Aug-91	0.22	0.24	0.10	0.11	0.14	0.16	0.25	0.27	0.20	0.19	0.29			0.24		0.23
23-Aug-91										0.15						
28-Aug-91	0.23	0.25	0.15	0.14	0.14	0.13	0.23	0.27	0.20	0.20		0.26				0.23
02-Sep-91	0.20			0.10			0.18	0.15								
05-Sep-91	0.16	0.12		0.08	0.06			0.16								
09-Sep-91	0.14			0.09	0.07		0.16	0.14		0.16						
20-Sep-91	0.22							0.17								
24-Sep-91				0.17	0.14											
01-Oct-91	0.18		0.18	0.22	0.16	0.20				0.14						
03-Oct-91	0.16		0.11	0.17	0.09											
05-Oct-91	0.27		0.27	0.33	0.25				0.23	0.27			0.25	0.30		
07-Oct-91	0.25		0.15	0.25	0.18	0.27			0.22	0.19			0.28	0.30		
11-Oct-91	0.29		0.15	0.19	0.15	0.22			0.19	0.16						
12-Oct-91	0.12	0.64														
14-Oct-91	0.18	0.62	0.14	0.19	0.13	0.19				0.16			0.25			
16-Oct-91				0.12												
29-Oct-91	0.17		0.12	0.14	0.12	0.17			0.18	0.17						
31-Oct-91	0.29		0.33	0.44	0.22	0.33	0.34	0.42	0.20	0.29	0.62	0.53	0.41	0.36	0.41	0.42
01-Nov-91	0.19		0.13	0.22		0.23				0.19						
04-Nov-91	0.20		0.21		0.17	0.26			0.17	0.17			0.23	0.26		
08-Nov-91	0.22		0.21	0.26	0.18	0.27	0.35	0.40	0.20	0.19			0.28	0.28	0.36	0.34
14-Nov-91	0.25	0.58	0.23	0.26	0.18	0.27	0.35	0.38	0.20	0.17		0.38	0.28	0.29	0.41	0.34
18-Nov-91	0.23		0.20	0.28	0.17	0.28			0.21	0.17		0.39	0.23	0.26	0.40	0.30
25-Nov-91	0.24		0.25	0.30	0.19	0.35	0.37	0.42	0.19	0.23	0.51	0.40	0.26	0.29	0.45	0.33
30-Nov-91		0.40		0.13	0.10			0.24	0.12	0.16				0.28		
	lys1	lys2	lys3	lys4	lys5	lys6	lys7	lys8	lys9	lys10	lys11	lys12	lys13	lys14	lys15	lys16
Avg. μ	0.21	0.42	0.18	0.20	0.15	0.24	0.28	0.27	0.20	0.19	0.41	0.39	0.28	0.29	0.41	0.31
Wl 10-20	0.22	0.50	0.19	0.22	0.16	0.25	0.33	0.33	0.20	0.19	0.41	0.42	0.28	0.29	0.41	0.32
Wl 0-10	0.19	0.18	0.15	0.10	0.09	0.13	0.19	0.18	0.20	0.18		0.26				0.23

APPENDIX 5.1

Transmissivity measurements 1 nov. 1991 and 19 nov. 1991

Transmissivity measurement 1 november 1991

Locat.	r_effec cm	WL-surf cm	μ	Q l/min	Time min	s_w cm	T m^2/d	Hum.	k m/d	wl-tube cm
L11	10.2	16.9	0.30	1.22	4.25	2.0	28	6		16.9
L9	10.2	7.5	0.30	5.70	0.50	0.7	442	3	1360	7.5
L8	8.1	10.1	0.30	2.79	2.07	2.4	62	3.5	178	12.1
L7	9.6	8.9	0.30				4.8	6	155	3.9
L6	9.9	1.9	0.30	1.22	3.45	1.9	29	4	160	3.9
L5	8.7	4.9	0.30	1.22	2.72	2.1	25	4	166	6.9
L4	9.0	6.0	0.30				2.7	5	30	6
L3	9.0	4.5	0.30	2.14	0.83	0.6	190	3	535	4.5
L2	9.9	5.0	0.30	1.16	1.17	0.7	71	4	203	5
L1	10.2	7.1	0.30				2.9	5	37	1.1
L0	9.6	2.2	0.30				4.4	5	56	1.2
L-1	9.3	1.4	0.30	1.16	1.50	1.3	34	4.5	395	-0.6
J6	9.6	-0.6	0.30	1.16	2.67	2.5	16	4	151	0.4
K6	9.9	0.9	0.30	1.16	2.00	2.0	19	4	209	0.9
M6	11.1	0.7	0.30	2.14	0.50	0.6	131	3	916	0.7
N6	11.4	1.1	0.30	1.16	1.83	0.9	53	3	381	3.1
O6	11.4	2.0	0.30	2.14	0.80	0.6	160	2	696	2
P6	12.0	2.4	0.30	1.16	0.83	0.5	81	3	248	1.4
Q6	11.4	0.8	0.30	2.34	1.17	0.5	259	4	2815	0.8

Tranmissivity measurement 19 november 1991

Locat.	r_effec cm	WL-surf cm	μ	Q l/min	Time min	s_w cm	T m^2/d	Hum.	k m/day	wl-tube cm
L13	10.5	2.9	0.30	1.20	0.67	0.7	50	4	413	1.9
L12	7.8	6.4	0.30	1.20	0.67	0.8	59	3	434	3.4
L11	10.2	4.0	0.30	1.20	1.20	0.5	84	3	764	4
L9	10.2	4.2	0.30	6.20	0.17	0.4	733	3	2047	4.2
L8	8.1	5.5	0.30	2.54	0.38	0.4	339	3	858	7.5
L7	9.6	7.1	0.30				6.4	5	131	2.1
L6	9.9	0.9	0.30	1.20	1.75	1.8	22	4	115	2.9
L5	8.7	1.0	0.30	6.20	0.20	0.4	851	4	4479	3
L4	9.0	3.4	0.30				3.5	5	30	3.4
L3	9.0	5.4	0.30	1.20	0.58	0.5	96	3	277	5.4
L2	9.9	6.0	0.30	1.20	2.58	0.8	82	4	241	6
L1	10.2	9.2	0.30				5.7	5	98	3.2
L0	9.6	3.0	0.30				3.4	5	49	2
L-1	9.3	2.0	0.30				10.6	4.5	133	0
J6	9.6	-0.2	0.30				5.2	4	51	0.8
K6	9.9	1.7	0.30				9.9	4	119	1.7
M6	11.1	1.0	0.30	1.20	1.20	0.5	110	3	786	1
N6	11.4	0.9	0.30	1.20	1.25	0.8	55	3	390	2.9
O6	11.4	2.2	0.30	1.20	1.10	0.5	104	2	456	2.2
P6	12.0	3.2	0.30	1.20	0.97	0.8	43	3	135	2.2
Q6	11.4	2.5	0.30	1.20	0.90	0.5	95	4	1267	2.5

APPENDIX 5.2

Calculations of the permiability and the transmissivity with the Pit-Bailing method.

Calculation for hole L7			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	01-11-91		0	35.6	-1.3					m/s	m/d
Area	0.0256	m^2	9	36.0	-0.9	0.004	9	4.4E-04	8.8E-04	5.7E-03	492.1
Wl-tube	3.9	cm	22	36.4	-0.5	0.004	13	3.1E-04	9.4E-04	3.7E-03	320.3
hsur-htub	5.0	cm	39	36.8	-0.1	0.004	17	2.4E-04	9.6E-04	2.8E-03	238.8
Depth	35	cm	50	37.0	0.1	0.002	11	1.8E-04	9.6E-04	2.1E-03	184.5
Equil. Waterdep	3.1	cm	69	37.4	0.5	0.004	19	2.1E-04	9.4E-04	2.5E-03	219.2
H0	40	cm	93	37.8	0.9	0.004	24	1.7E-04	8.8E-04	2.1E-03	184.5
D-perm	12	cm	119	38.1	1.2	0.003	26	1.2E-04	8.2E-04	1.6E-03	137.6
k	155	m/d	146	38.4	1.5	0.003	27	1.1E-04	7.4E-04	1.7E-03	147.1
kD	4.8	m^2/d	188	38.7	1.8	0.003	42	7.1E-05	6.4E-04	1.3E-03	109.3
			243	39.0	2.1	0.003	55	5.5E-05	5.2E-04	1.2E-03	102.2

Calculation for hole L7			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	45.0	-0.1					m/s	m/d
Area	0.0256	m^2	22	46.0	0.9	0.01	22	4.5E-04	2.3E-03	2.2E-03	190.9
Wl-tube	2.1	cm	45	47.0	1.9	0.01	23	4.3E-04	2.0E-03	2.4E-03	207.7
hsur-htub	5.0	cm	58	47.5	2.4	0.005	13	3.8E-04	1.8E-03	2.4E-03	205.3
Depth	35	cm	79	48.0	2.9	0.005	21	2.4E-04	1.6E-03	1.7E-03	148.7
Equil. Waterdep	4.9	cm	120	48.4	3.3	0.004	41	9.8E-05	1.3E-03	8.4E-04	72.5
H0	50	cm	162	48.7	3.6	0.003	42	7.1E-05	1.1E-03	7.3E-04	63.0
D-perm	12	cm	240	48.9	3.8	0.002	78	2.6E-05	9.6E-04	3.0E-04	26.1
k	131	m/d									
kD	6.4	m^2/d									

Calculation for hole L4			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	01-11-91		0	41.2	5.2					m/s	m/d
Area	0.0221	m^2	12	41.5	5.5	0.003	12	2.5E-04	5.1E-03	4.8E-04	41.4
Wl-tube	6	cm	35	42.0	6.0	0.005	23	2.2E-04	4.5E-03	4.7E-04	40.6
hsur-htub	0.0	cm	68	42.5	6.5	0.005	33	1.5E-04	3.9E-03	3.8E-04	32.9
Depth	32.0	cm	109	42.9	6.9	0.004	41	9.8E-05	3.3E-03	2.8E-04	24.6
Equil. Waterdep	9	cm	152	43.3	7.3	0.004	43	9.3E-05	2.8E-03	3.3E-04	28.2
H0	45	cm	186	43.5	7.5	0.002	34	5.9E-05	2.5E-03	2.3E-04	20.0
D-perm	15	cm	235	43.8	7.8	0.003	49	6.1E-05	2.0E-03	3.0E-04	25.5
k	30	m/d									
kD	2.7	m^2/d									

Calculation for hole L4			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	44.5	6.1					m/s	m/d
Area	0.0221	m^2	22	45.3	6.9	0.008	22	3.6E-04	8.7E-03	4.1E-04	35.2
Wl-tube	3.4	cm	36	45.8	7.4	0.005	14	3.6E-04	8.0E-03	4.4E-04	37.6
hsur-htub	0	cm	55	46.3	7.9	0.005	19	2.6E-04	7.2E-03	3.6E-04	30.7
Depth	32.0	cm	77	46.9	8.5	0.006	22	2.7E-04	6.2E-03	4.3E-04	36.8
Equil. Waterdep	11.6	cm	107	47.4	9.0	0.005	30	1.7E-04	5.4E-03	3.0E-04	26.2
H0	50	cm	127	47.9	9.5	0.005	20	2.5E-04	4.4E-03	5.5E-04	47.5
D-perm	15	cm	172	48.2	9.8	0.003	45	6.7E-05	3.9E-03	1.7E-04	14.6
k	29.9	m/d	205	48.5	10.1	0.003	33	9.1E-05	3.3E-03	2.7E-04	23.5
kD	3.5	m^2/d	245	48.8	10.4	0.003	40	7.5E-05	2.6E-03	2.8E-04	23.9
			300	49.1	10.7	0.003	55	5.5E-05	2.0E-03	2.6E-04	22.9

Calculation for hole L1			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	01-11-91		0	47	4.9					m/s	m/d
Area	0.0289	m^2	29	47.5	5.4	0.005	29	1.7E-04	3.3E-03	6.6E-04	57.0
Wl-tube	1.1	cm	57	47.9	5.8	0.004	28	1.4E-04	2.9E-03	6.3E-04	54.6
hsur-htub	6.0	cm	105	48.2	6.1	0.003	48	6.2E-05	2.5E-03	3.2E-04	27.3
Depth	37	cm	140	48.4	6.3	0.002	35	5.7E-05	2.3E-03	3.2E-04	27.7
Equil. Waterdep	7.9	cm	190	48.7	6.6	0.003	50	6.0E-05	1.9E-03	4.1E-04	35.0
H0	50.0	cm	275	48.9	6.8	0.002	85	2.4E-05	1.6E-03	1.9E-04	16.0
D-perm	15	cm									
k	40.1	m/d									
kD	3.2	m^2/d									

Calculation for hole L1			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	47.0	0.8					m/s	m/d
Area	0.0289	m^2	12	47.5	1.3	0.005	12	4.2E-04	3.2E-03	1.7E-03	143.5
Wl-tube	3.2	cm	30	48	1.8	0.005	18	2.8E-04	3.0E-03	1.2E-03	100.5
hsur-htub	6	cm	52	48.5	2.3	0.005	22	2.3E-04	2.8E-03	1.0E-03	88.2
Depth	37	cm	76	49.0	2.8	0.005	24	2.1E-04	2.6E-03	1.0E-03	88.8
Equil. Waterdep	5.8	cm	102	49.5	3.3	0.005	26	1.9E-04	2.3E-03	1.1E-03	93.0
H0	52.0	cm	140	50.0	3.8	0.005	38	1.3E-04	1.9E-03	8.7E-04	75.4
D-perm	15.0	cm	190	50.5							
k	72.4	m/d									
kD	4.2	m^2/d									

Calculation for hole L0			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	01/11/91		8	46.5	4.3					m/s	m/d
Area	0.0255	m^2	24	46.9	4.7	0.004	16	2.5E-04	3.9E-03	7.2E-04	62.6
Wl-tube	1.2	cm	38	47.2	5	0.003	14	2.1E-04	3.6E-03	6.7E-04	58.0
hsur-htub	1	cm	53	47.5	5.3	0.003	15	2.0E-04	3.3E-03	6.9E-04	59.3
Depth	39	cm	75	47.9	5.7	0.004	22	1.8E-04	2.8E-03	7.2E-04	62.2
Equil. Waterdep	7.8	cm	106	48.3	6.1	0.004	31	1.3E-04	2.4E-03	6.1E-04	53.0
H0	50	cm	133	48.6	6.4	0.003	27	1.1E-04	2.0E-03	6.3E-04	54.2
D-perm	10.0	cm	167	48.9	6.7	0.003	34	8.8E-05	1.6E-03	6.2E-04	53.7
k	46.3	m/d	220	49.2	7.0	0.003	53	5.7E-05	1.2E-03	5.4E-04	46.4
kD	3.6	m^2/d									

Calculation for hole L0			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	45.0	2.0					m/s	m/d
Area	0.0255	m^2	19	45.5	2.5	0.005	19	2.6E-04	4.3E-03	6.9E-04	59.7
Wl-tube	2	cm	39	46.0	3.0	0.005	20	2.5E-04	4.0E-03	7.0E-04	60.7
hsur-htub	1	cm	64	46.5	3.5	0.005	25	2.0E-04	3.7E-03	6.1E-04	52.8
Depth	39	cm	94	47	4	0.005	30	1.7E-04	3.3E-03	5.7E-04	49.0
Equil. Waterdep	7	cm	136	47.5	4.5	0.005	42	1.2E-04	2.9E-03	4.7E-04	40.2
H0	50	cm	210	48.0	5.0	0.005	74	6.8E-05	2.4E-03	3.2E-04	27.3
D-perm	10	cm									
k	46.4	m/d									
kD	3.2	m^2/d									

Calculation for hole L-1			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	44.0	2.0					m/s	m/d
Area	0.024	m^2	13	45.0	3.0	0.01	13	7.7E-04	5.5E-03	1.5E-03	127.8
Wl-tube	0	cm	29	46.0	4.0	0.01	16	6.3E-04	4.8E-03	1.4E-03	118.9
hsur-htub	2	cm	44	47.0	5.0	0.01	15	6.7E-04	3.9E-03	1.8E-03	156.2
Depth	41	cm	68	48	6	0.01	24	4.2E-04	2.8E-03	1.6E-03	135.9
Equil. Waterdep	8	cm	87	48.5	6.5	0.005	19	2.6E-04	2.2E-03	1.3E-03	110.5
H0	50	cm	112	49	7	0.005	25	2.0E-04	1.5E-03	1.4E-03	121.8
D-perm	10	cm	150	49.5	7.5	0.005	38	1.3E-04	7.8E-04	1.8E-03	155.1
k	100.7	m/d									
kD	8.1	m^2/d									

Calculation for hole J6			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	47.0	7.2					m/s	m/d
Area	0.0256	m^2	24	47.8	8.0	0.008	24	3.3E-04	4.0E-03	9.4E-04	81.1
Wl-tube	1	cm	44	48.2	8.4	0.004	20	2.0E-04	3.3E-03	6.7E-04	58.2
hsur-htub	-1.0	cm	65	48.5	8.7	0.003	21	1.4E-04	2.8E-03	5.7E-04	49.1
Depth	31	cm	90	48.8	9.0	0.003	25	1.2E-04	2.3E-03	5.9E-04	50.7
Equil. Waterdep	10.2	cm	120	49	9.2	0.002	30	6.7E-05	1.9E-03	3.9E-04	33.5
H0	50	cm	160	49.2	9.4	0.002	40	5.0E-05	1.6E-03	3.6E-04	31.1
D-perm	10	cm									
k	63.2	m/d									
kD	6.5	m^2/d									

Calculation for hole X6			Time	Reading	h	h'	t'	dh/dt	H2-h2	k	k
Date	19/11/91		0	46.0	4.3					m/s	m/d
Area	0.0272	m^2	13	47.0	5.3	0.01	13	7.7E-04	4.1E-03	2.3E-03	195.2
Wl-tube	1.7	cm	24	47.5	5.8	0.005	11	4.5E-04	3.5E-03	1.5E-03	133.5
hsur-htub	0	cm	34	47.9	6.2	0.004	10	4.0E-04	3.0E-03	1.6E-03	136.0
Depth	38	cm	52	48.4	6.7	0.005	18	2.8E-04	2.4E-03	1.4E-03	119.8
Equil. Waterdep	8.3	cm	83	48.9	7.2	0.005	31	1.6E-04	1.7E-03	1.1E-03	97.9
H0	50	cm	110	49.2	7.5	0.003	27	1.1E-04	1.3E-03	1.1E-03	91.0
D-perm	10	cm	145	49.4	7.7	0.002	35	5.7E-05	9.6E-04	7.1E-04	61.6
k	119.3	m/d									
kD	9.9	m^2/d									

APPENDIX 5.3

Description of the vegetation around the acrotelm transmissivity holes (source: Larissa Kelly)

Hole	Vegetation type	Description
L1400	*Calluna vulgaris/Hypnum jutlandicum* zone	A zone of vegetation close to the bog edge. Mostly *Calluna vulgaris* and *Hypnum jutlandicum*. A poor *Sphagnum* cover.
L1300	Very low hummock of *Sphagnum magellanicum*	*Sphagnum magellanicum* hummock overgrown by *Calluna vulgaris* and *Erica Tetralix* with some *Narthecium ossifragum* and *Hypnum*.
L1200	Low hummock with few hollows zone	Very low hummock of mainly *Sphagnum capillifolium* and *Sphagnum magellanicum* overgrown with *Eriophorum vaginatum* and *Eriophorum augustifolium*.
L1100	Flat area in hummock/hollow zone	Intermediate between very low hummock/hollow. Mainly *Sphagnum magellanicum*, *Sphagnum capillifolium* and *Sphagnum papillosum*.
L900	*Eriophorum* zone	Mixed *bryophyte* layer with species which may indicate nutrient flushing (*Polytrichum alpestre, Pleurozium scherberi*). Also *S. magellanicum*, *S.capillifolium* and *Hypnum j.* overgrown by *Calluna v.* and *E. augustifolium*. *Cladonia* indicates NON burning.
L800	*Eriophorum vaginatum* and *Calluna vulgaris* zone	A very low hummock of mainly *Sphagnum capillifolium* and *Sphagnum magellanicum* overgrown by *Eriophorum vaginatum* and *Calluna vulgaris*.
L700	Elevated hollow	A *Narthecium ossifragum* hollow with *Sphagnum tenellum, Sphagnum capillifolium, Erica tetralix* and *Calluna vulgaris*. Hollow vegetation in hummock hollow zone, slightly elevated.
L600	*Sphagnum* lawn	*Sphagnum papillosum/Sphagnum capillifolium* lawn with *Narthecium ossifragum, Rhyniospora alba* and some *Erica Tetralix, Eriophorum vaginatum* and *Eriophorum augustifolium*.
L500	Hollow in pool area	Hollow in hummock/hollow pool area. Mainly *Sphagnum papillosum* with some *Sphagnum capillifolium* and both *Eriophorum* species.
L400	Hollow	Hollow of *Narthecium ossifragum, Eriophorum* and *Calluna vulgaris* in an area where *Eriophorum* species dominate with a good *Sphagnum* cover
L300	*Sphagnum* lawn/hollow	A *Sphagnum magellanicum/Sphagnum papillosum* lawn/hollow with *Narthecium ossifragum* and *Eriophorum* species in area of large hummocks and hollows.
L200	Very low hummock of *Sphagnum magellanicum*	Very low hummock of *Sphagnum magellanicum* with *Calluna vulgaris* and *Eriophorum vaginatum* overgrowing it. Intermediate between lawn and hollow vegetation.

Hole	Vegetation type	Description
L100	Very low hummock of *Sphagnum magellanicum*	Very low hummock of mainly *Sphagnum magellanicum* with *Eriophorum vaginatum* and *Calluna vulgaris*. The presence of *Polytrichum alpestre* suggests a slight enrichment. This area corresponds to one of the soaks indicated Modres 1955 map of Raheenmore.
L000	Hollow	*Narthecium ossifragum* and *Sphagnum tellenum* hollow with *Odontoschisma Sphagni, Calluna vulgaris Eriophorum augustifolium* and *Scirpus*.
L-100	A very low hummock of *Sphagnum magellanicum*	Very low *Sphagnum magellanicum* hummock with *Calluna vulgaris, Cladonia portentosa* and both *Eriophorum* species.
L-200	*Calluna/Hypnum* zone	*Calluna/Hypnum* zone behind *Scirpus* zone. Part of facebank complex. No *Sphagnum* species.
I600	*Calluna/Scirpus/Hypnum* zone	
J600	*Sphagnum* lawn/hummock	*Narthecium ossifragum, Sphagnum magellanicum* and *Sphagnum capillifolium*. intermediate beween lawn and hummock.
K600	Low hummock of *Sph. magellanicum* and *Sphagnum capillifolium*	Low hummock with *Sphagnum magellanicum* and *Sphagnum capillifolium* with *Calluna vulgaris* and *Eriophorum* species in hummock/hollow area.
M600	Very low hummock in wet area	Very wet area of hummock/hollow complex. *Sphagnum capillifolium* and *Sphagnum papillosum* with *Calluna vulgaris, Eriophorum vaginatum* and *Cladonia portentosa* overgrowing.
N600	*Sphagnum* lawn	*Sphagnum capillifolium* and *Sphagnum magellanicum Calluna vulgaris* and *Eriophorum* Species.
O600	*Sphagnum* lawn	*Sphagnum magellanicum* lawn with *Eriophorum vaginatum* and some *Calluna vulgaris*. Possibly an infilled pool.
P600	Infilled *Sphagnum* pool/hummock	*Sphagnum capillifolium, papillosum* and *magellanicum* infilled pool starting to develop into a hummock.
Q600	*Calluna/Scirpus* Zone	Hollow/hummock transition of *Sphagnum magellanicum, Narthecium ossifragum* with *Calluna vulgaris* and *Scirpus*.
R600	*Calluna/Hypnum* zone	*Calluna vulgaris/Hypnum jutlandicum* zone with *Narthecium ossifragum* erosion channel.

APPENDIX 5.4

Computer program to determine the optimum values for m and A in equation (5.3); Written in turbo-Pascal.

```
(**********************************************************************)
(* Program      : Optim_mA                                            *)
(* Purpose      : Optimizes m and A in the emperical formula for the  *)
(*                acrotelm transmissivity                              *)
(* Interface    : A file with measured depth and transmissivity is read *)
(*              : the output is written to the screen and to an outfile *)
(* Date         : Februari 1992                                       *)
(* Author       : Ab Veldhuizen                                       *)
(**********************************************************************)
PROGRAM Optim_mA (INPUT, OUTPUT, INFILE, OUTFILE);
VAR
    FILENAME    : ARRAY [1..16] OF STRING [12];
    OUTFILE     ,
    INFILE      : TEXT;
    m           ,                        (* Empirical quantity        *)
    A           : REAL;                  (* idem                      *)
    d           : ARRAY [1..30] OF REAL; (* Depth of water table      *)
    diff        ,
    mindiff     ,
    SIGMA       ,
    m_opt       ,
    A_opt       : REAL;
    T_calc      : REAL;                  (* Calculated transmissivity *)
    T_meas      : ARRAY [1..30] OF REAL; (* Measured transmissivity   *)
    I,J         ,
    mI          ,
    AI          ,
    NR_OF_LINES ,
    nr_of_data  : INTEGER;
    x           : CHAR;
    DESCRIPTION1,
    DESCRIPTION2: STRING[70];
    INFO        : ARRAY[1..500] OF STRING[67];

(**********************************************************************)
(* Function         : Trans                                           *)
(* Purpose          : Calculates the transmissivity, given A, m, d..  *)
(**********************************************************************)
FUNCTION Trans (m,A,d:REAL):REAL;
VAR
    x       : REAL;
BEGIN
    x:= (m-1)*exp((m-1)*ln(d+1));
    Trans:=8.64*A/x;
END(*Trans*);

BEGIN
    WRITELN ('This program is written to determine the optimum m and A for');
    WRITELN('acrotelm holes with the same vegetation type.');
    FILENAME[1]:='TRANS1.DAT';
    FILENAME[2]:='TRANS2.DAT';
    FILENAME[3]:='TRANS3.DAT';
    FILENAME[4]:='TRANS4.DAT';
    FILENAME[5]:='TRANS5.DAT';
    FILENAME[6]:='TRANS6.DAT';
    FILENAME[7]:='TRANS7.DAT';
    WRITELN;
    FOR J:=1 TO 7 DO

    BEGIN
    ASSIGN(INFILE,FILENAME[J]);
```

```
RESET(INFILE);

I:=0;
READLN (INFILE, DESCRIPTION1);
READLN(INFILE, DESCRIPTION2);

WHILE NOT EOF(INFILE) DO
BEGIN
    I:=I+1;
    READ(INFILE,d[I],T_meas[I]);
    READLN(INFILE);
END(*WHILE*);
nr_of_data:=I;

mindiff:=10e9;
FOR mI:= 11 TO 40 DO
BEGIN
    FOR AI:=1 TO 200 DO
    BEGIN
         diff:=0;
         m:=mI/10;
         IF (J=4) OR (J=8) OR (J=10) OR (J=12) THEN
             A:=AI*10
         ELSE
             A:=AI;
         IF (TRANS(m,A,40)<2) THEN
         BEGIN
         FOR I:=1 TO nr_of_data DO
         BEGIN
             T_calc:=Trans(m,A,d[I]);
             diff:=diff+ SQR(T_calc-T_meas[I]);
         END(*FOR*);
         IF (diff<mindiff) THEN
         BEGIN
             mindiff:=diff;
             m_opt:=m;
             A_opt:=A;
         END(*IF*);
        END(*IF*);
    END(*FOR*);
    WRITE('.');
END(*FOR*);
WRITELN;

SIGMA:= SQRT (mindiff/(nr_of_data-1));

ASSIGN (OUTFILE, 'OUT1.DAT');
RESET (OUTFILE);
I:=0;

WHILE NOT EOF(OUTFILE) DO
BEGIN
    I:=I+1;
    READLN (OUTFILE, INFO[I]);
END(*WHILE*);
NR_OF_LINES:=I;
CLOSE (OUTFILE);
ASSIGN(OUTFILE, 'OUT1.DAT');
REWRITE(OUTFILE);
FOR I:=1 TO NR_OF_LINES DO
BEGIN
    WRITELN (OUTFILE, INFO[I]);
```

```
    END(*FOR*);

    WRITELN (OUTFILE,DESCRIPTION1);
    WRITELN (OUTFILE);
    WRITELN(OUTFILE,'The data used are:');
    WRITELN(OUTFILE);
    WRITELN (OUTFILE, '   Watlev  T(meas)  T(calc)');
    FOR I:=1 TO nr_of_data DO
    BEGIN
        T_calc:=Trans(m_opt,a_opt,d[I]);
        WRITELN(OUTFILE, d[I]:9:1,T_meas[I]:9:1,T_calc:9:1);
    END(*FOR*);
    WRITELN(OUTFILE);
    WRITELN (OUTFILE,'The optimum parameter values are (SIGMA= ',SIGMA:4:1,'
    ):');
    WRITELN (OUTFILE,'m = ',m_opt:4:1);
    WRITELN (OUTFILE,'A = ',A_opt:4:0);
    WRITELN (OUTFILE);
    CLOSE (OUTFILE);

    WRITELN (DESCRIPTION1);
    WRITELN ('The optimum parameter values are (SIGMA= ',SIGMA:4:1,' ):');
    WRITELN ('m = ',m_opt:3:1);
    WRITELN ('A = ',A_opt:4:0);
    CLOSE (INFILE);
    END(*FOR*);
END.
```

APPENDIX 5.5

Results of acrotelm-transmissivity measurements

loc.	date: 17/04/91 wat_lev -surface	T m²/dag	date: 05/06/91 wat_lev -surface	T m²/dag	date: 01/11/91 wat_lev -surface	T m²/dag	date: 19/11/91 wat_lev -surface	T m²/dag
L13 20	3	63					2.9	50
L12 20	5	61					6.4	59
L11 15	2	116			16.9	28	4.0	84
L9 40	2	1182	17.5	11.5	7.5	442	4.2	733
L8 45	0	67	20.4	12.3	10.1	62	5.5	339
L7 12	7	20			8.9	4.8	7.1	6.4
L6 20	0	58	6.3	11.3	1.9	29	0.9	22
L5 20	0	51	11	8.5	4.9	25	1.0	851
L4 15	2	17			6.0	2.7	3.4	3.5
L3 40	2	85	8.5	77	4.5	190	5.4	96
L2 40	2	28	11.5	10.8	5.0	71	6.0	82
L1 15	8	11.2			7.1	2.9	9.2	5.7
L0 10	3	6.3			2.2	4.4	3.0	3.4
L-1 10	4	10.4			1.4	34	2.0	10.6
J6 10	1	11.4			-0.6	16	-0.2	5.2
K6 10	2	24			0.9	19	1.7	9.9
M6 15	2	100	10.5	50	0.7	131	1.0	110
N6 15	0	31	9.2	25	1.1	53	0.9	55
O6 20	2	43	12.7	34	2.0	160	2.2	104
P6 35	3	28	15	40	2.4	81	3.2	43
Q6 10	2	62			0.8	259	2.5	95

APPENDIX 5.6

Correlation between A and the acrotelm thickness calculated with the Spearman test

Hole	d	m	A	x	y	d	m	A	Hole	(x-y)2
L8	45	3.2	1790	1	1	45	3.2	1790	L8	0
L9	40	3.2	1790	2	2	40	3.2	1790	L9	0
L3	40	3	770	3	3	40	3	770	L3	0
L2	40	2	9	4	6	20	3	770	L5	4
P6	35	2.3	37	5	18	10	3	190	Q6	169
L5	20	3	770	6	9	20	2.4	55	L12	9
L13	20	2	9	7	11	15	2.4	55	L11	16
L6	20	2.3	37	8	14	15	2.4	55	M6	36
L12	20	2.4	55	9	5	35	2.3	37	P6	16
O6	20	2.3	37	10	8	20	2.3	37	L6	4
L11	15	2.4	55	11	10	20	2.3	37	O6	1
L1	15	2	9	12	15	15	2.3	37	N6	9
L4	15	1.7	1	13	4	40	2	9	L2	81
M6	15	2.4	55	14	7	20	2	9	L13	49
N6	15	2.3	37	15	12	15	2	9	L1	9
L7	12	1.7	1	16	19	10	2	9	K6	9
L0	10	1.7	1	17	20	10	2	9	L-1	9
Q6	10	3	190	18	13	15	1.7	1	L4	25
K6	10	2	9	19	16	12	1.7	1	L7	9
L-1	10	2	9	20	17	10	1.7	1	L0	9
J6	10	1.7	1	21	21	10	1.7	1	J6	0
L-2	5		0	22	22	5		0	L-2	0
L14	5		0	23	23	5		0	L14	0
I6	0		0	24	24	0		0	I6	0

d^2 464
r_s 0.80
t_v 6.22

$t_{22} = 1.32 < t_v = 6.22$, so the positive correlation between A and d is significant.

APPENDIX 5.7

Linear regression on acrotelm thickness, d and ln(A)

The linear regression is carried out on the average ln (A) at any acrotelm thickness measured, to avoid disturbances due to the number of measurements at certain acrotelm depths; the number of measurements at 45 cm is one, at 10 cm the number is 5.

d	A	ln(A)
45	1790	7.49
40	856.3	6.75
35	37.0	3.61
20	181.6	5.20
15	31.4	3.45
10	4.2	1.44
0	0.1	-2.30

Regression Output:

Constant	-0.52416
Std Err of Y Est	1.672798
R Squared	0.791675
No. of Observations	7
Degrees of Freedom	5
X Coefficient(s)	0.177599
Std Err of Coef.	0.040743

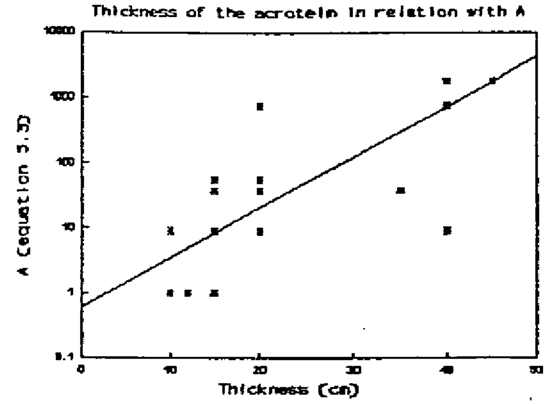


Figure 5–i: A linear relation between acrotelm thickness / ln A

According to the results A can be estimated using:

$$A_{est} = e^{xd+b} \quad (5\text{–i})$$

with:

A_{est} = Estimated A-value

x = Coefficient (=0.178) (cm^{-1})

d = Thickness of the acrotelm (cm)

b = Constant ($\ln(A_0)$ = -0.524)

APPENDIX 5.8

Vegetation description, vegetation type and acrotelm thickness (cm) at the OPW-grid.

Vegetation types:

0	Sphagnum magellanicum hollow
1	Narthecium ossifragum hollow, variable Sphagnum cover
2	Low Sphagnum hummock
3	Sphagnum lawns (infilled pools)
4	Variable vegetation on the wettest part of the bog
5	Hollow vegetation
6	Eriophorum angustifolium/vaginatum dominated
7	Hollow channel in Scirpus/Calluna zone
8	Calluna/Narthecium/Hypnum zone
9	Cutaway area
-	Other

Coord.	Acrotelm thickness	Vegetation type	Vegetation description
H1000	0	1	Hollow of Spagnum capillifolium and Nartecium ossifragum
H1100	5	1	Hollow of Sphagnum capillifolium and Nartecium ossifragum
H1200	5	1	Hollow of Sphagnum capillifolium and Nartecium ossifragum
H1300	0	2	Low hummock of Sphagnum cappilifolium and Calluna vulgaris
H1400	5	8	Calluna vulgaris/Narthecium ossifragum and Hypnum jutlanicum zone
I000	0	9	Cutaway area of Molinia caerula and Calluna vulgaris
I100	0	8	Beside facebank Calluna vulgaris/Scirpus caespitosus/Hypnum jutlanicum zone
I200	0	8	Beside facebank Calluna vulgaris/Scirpus caepitosa/Hypnum jutlanicum zone (area of surface runoff)
I300	5	2	Low hummock of Sphagnum capillifolium/ Scirpus caespitosus with some Eriophorum angustifolium
I400	5	2	Low hummock of Sphagnum capillifolium topped with Calluna vulgaris
I500	10	9	Area of cutaway. Hummock of Polytrichum alpestre/ Sphagnum capillifolium with some Pleurozium scherberi
I700	0	8	Flat area of Calluna vulgaris/Hypnum jutlanicum/Nartecium ossifragum
I800	0	8	Calluna vulgaris/ Hypnum jutnanicum zone
I900	0	9	Cutaway area Calluna vulgaris/ Sphagnum capillifolium and Lucobryum glacum
I1000	0	8	Calluna vulgaris/ Hypnum jutlanicum zone
I1100	10	2	Low hummock of Sphagnum capillifolium and Calluna vulgaris
I1200	10	1	Hollow dominated by Nartecium ossifragum and Sphagnum tenellum with some Eriophorum vaginatum
I1300	0	1	Hollow dominated by Nartecium ossifragum and Sphagnum tenellum
J-100	0	8	Zygogium erosion channel in Calluna vulgaris/Hypnum jutlanicum/Scirpus caespitosus zone
J000	5	8	Hollow of Narthecium ossifragum/ Sphagnum tenellum in Calluna vulgaris/ Hypnum jutlanicum/ Scirpus caespitosus zone
J100	5	1	Hollow of Narthecium ossifragum/ Odontoschisma sphagni with some Erica tetralix
J200	10	0	Edge of hummock of predominantly Sphagnum papillosum with Sphagnum tenellum and Narthecium ossifragum

Coord.	Acrotelm thickness	Vegetation type	Vegetation description
J300	20	1	Narthecium ossifragum/ Sphagnum cuspidatum/ Sphagnum tenellum hollow
J400	10	1	Narthecium ossifragum/ Sphagnum tnellum hollow with Eriophorum vaginatum
J500	10	1	Hollow of mainly Shagnum capillifolium with Eriophorum vaginatum
J700	10	1	Small Sphagnum capillifolium dominated hollow
J800	5	1	Sphagnum magellanicum/ Sphagnum capillifolium/ Narthecium ossifragum hollow
J900	15	1	Eriophorum vaginatum/ Sphagnum magellanicum and Nartecium ossifragum hollow
J1000	8	1	Narthecium ossifragum/ Sphagnum tenellum hollow
J1100	5	1	Sphagnum magellanicum and Narthecium ossifragum lawn
J1200	0	8	Hummock of Lucobryum glacum/ Calluna vulgaris/ Hypnum jutlanicum and Eriophorum vaginatum
J1300	0	8	Low hummock of Hypnum jutlanicum and Calluna vulgaris
K-100	0	7	Erosion channel in Scirpus caespitosus/ Calluna vulgaris/ Hypnum jutlanicum zone
K000	10	1	Hollow of Sphagnum capillifolium/ Hypnum jutlanicum and Narthecium ossifragum
K100	10	1	Narthecium ossifragum/ Campylopus flexuosa/ Erica tetralix/ Sphagnum papillosum hollow
K200	30	6	Sphagnum magellanicum lawn with Eriophorum angustifolium and Eriophorum vaginatum
K300	30	6	Low hummock of Sphagnum capillifolium/ Eriophorum vaginatum/ Eriophorum angustifolium/ Scirpus caespitosus
K400	15	4	Low Calluna vulgaris/ Eriophorum vaginatum hummock topped with Cladonia portentosa
K500	30	3	Lawn of predominantly Sphagnum magellanicum
K700	5	1	Sphagnum capillifolium and Nartecium ossifragum hollow
K800	10	2	Very low hummock of Sphagnum magellanicum/ Eriophorum vaginatum and Eriophorum angustifolium
K900	30	5	Hollow of Narthecium ossifragum and Sphagnum tenellum
K1000	5	3	Sphagnum capillifolium and Eriophorum vaginatum flat area
K1100	10	5	Hollow of Narthecium ossifragum and Sphagnum tenellum
K1200	5	3	Sphagnum capillifolium lawn
K1300	5	2	Low hummock of Sphagnum capillifoium and Scirpus caespitosus
M-100	10	8	Sphagnum capillifolium/ Hypnum jutlanicum flat area

Coord.	Acrotelm thickness	Vegetation type	Vegetation description
M000	15	3	Sphagnum capillifolium/ Sphagnum magellanicum lawn with Eriophorum vaginatum and Eriophorum angustifolium
M100	10	2	Very low Sphagnum capillifolium/ Calluna vulgaris hummock
M200	30	2	Very low Sphagnum capillifolium/ Calluna vulgaris hummock
M300	30	3	Shallow pool of Lucobryum glacum/ Sphagnum capillifolium/ Sphagnum magellanicum/ Sphagnum cuspidatum
M400	10	2	Low Sphagnum capillifolium/ Calluna vulgaris hummock
M500	0	0	Sphagnum capillifolium and Eriophorum vaginatum flat area
M700	25	0	Sphagnum magellanicum hollow
M800	20	4	Sphagnum magellanicum/ Calluna vulgaris and Eriophorum vaginatum flat area
M900	15	3	Sphagnum magellanicum lawn
M1000	20	5	Sphagnum magellanicum hollow with Calluna vulgaris
M1100	10	5	Shallow hollow of Sphagnum capillifolium and Eriophorum vaginatum
M1200	0	2	Low hummock of Sphagnum magellanicum with Eriophorum vaginatum
M1300	0	0	Drain side Calluna vulgaris/ Scirpus caespitosus and Eriophorum vaginatum
M1400	5	2	Very low Sphagnum capillifolium hummock
M1500	0	0	Calluna vulgaris/ Scirpus caespitosus zone
N-100	5	2	Low Sphagnum magellanicum hummock with Calluna vulgaris in the Hypnum jutlanicum/ Calluna vulgaris/ Scirpus caespitosus zone
N000	5	0	Sphagnum magellanicum/ Sphagnum tenellum/ Narthecium ossifragum hollowin Calluna vulgaris/ Eriophorum vaginatum zone
N100	0	5	Small Sphagnum magellanicum hollow with Eriophorum vaginatum/ Eriophorum angustifolium
N200	20	4	Low hummock of Sphagnum capillifolium, Aulacomium palustre and Polytrichum alpeste with Eriophorum vaginatum/ Eriophorum angustifolium and Calluna vulgaris
N300	10	2	Low hummock of Sphagnum magellanicum with Eriophorum vaginatum/ Eriophorum angustifolium and Calluna vulgaris
N400	20	4	Sphagnum capillifolium/ Sphagnum tenellum/ Narthecium ossifragum hollow
N500	20	3	Sphagnum magellanicum lawn with Eriophorum vaginatum
N700	0	0	Sphagnum capillifolium/ Sphagnum magellanicum hollow with some Eriophorum vaginatum

Coord.	Acrotelm thickness	Vegetation type	Vegetation description
N800	50	6	Sphagnum capillifolium and Eriophorum vaginatum dominated area
N900	10	2	Sphagnum magellanicum hollow
N1000	5	3	Sphagnum magellanicum lawn
N1100	10	1	Sphagnum magellanicum/ Narthecium ossifragum hollow
N1200	0	1	Sphagnum capillifolium/ Narthecium ossifragum hollow
N1300	0	8	Dry area of Calluna vulgaris and Hypnum jutlanicum
O-100	0	8	Scirpus caespitosus/ Calluna vulgaris/ Hypnum jutlanicum zone (area of surface runoff)
O000	0	0	Sphagnum magellanicum lawn in area of predominantly Scirpus caespitosus/ Calluna vulgaris/ Eriophorum vaginatum
O100	0	1	Narthecium ossifragum hollow with Sphagnum tenellum, Calluna vulgaris and Scirpus caespitosus
O200	15	2	Low Sphagnum magellanicum hummock topped with Calluna vulgaris
O300	40	6	Sphagnum magellanicum/ Sphagnum capillifolium hollow with Eriophorum angustifolium
O400	10	2	Sphagnum papillosum/ Sphagnum capillifolium hummock
O500	0	3	Sphagnum magellanicum lawn
O700	5	0	Sphagnum magellanicum / Eriophorum vaginatum hollow
O800	10	0	Sphagnum magellanicum/ Eriophorum vaginatum hollow
O900	15	1	Sphagnum magellanicum/ Narthecium ossifragum hollow
O1000	10	2	Very low Sphagnum magellanicum hummock
O1100	10	0	Sphagnum capillifolium/ Eriophorum vaginatum hollow
P200	0	2	Low Sphagnum capillifolium hummock
P300	0	1	Sphagnum magellanicum/ Sphagnum capillifolium/ Narthecium ossifragum hollow
P400	5	1	Sphagnum capillifolium/ hyncospora alba/ Narthecium ossifragum/ Sphagnum cuspidatum hollow
P500	15	3	Small lawn of Sphagnum magellanicum/ Sphagnum capillifolium and Narthecium ossifragum
P700	35	6	Sphagnum magellanicum hollow with Eriophorum vaginatum/angustifolium
P800	10	0	Sphagnum magellanicum/ Sphagnum capillifolium hollow with some Narthecium ossifragum
P900	20	0	Sphagnum magellanicum hollow
P1000	5	1	Sphagnum magellanicum/ Narthecium ossifragum hollow

APPENDIX 5.9

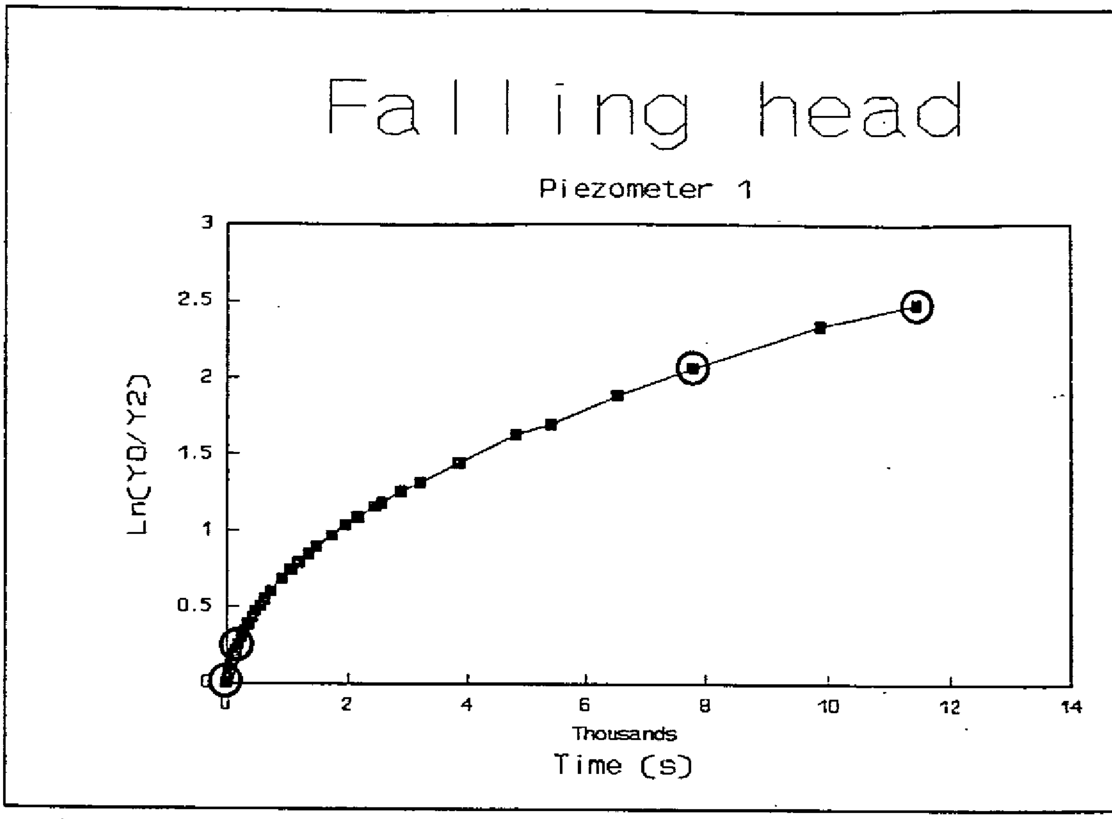
Coordinates, Acrotelm thickness (cm) sorted on vegetation type.

Tube	Acrot. thikn.	Code
O000	0	0
N700	0	0
N000	5	0
O700	5	0
O800	10	0
O1100	10	0
P800	10	0
P900	20	0
M700	25	0
O100	0	1
P300	0	1
N1200	0	1
h1000	0	1
I1300	0	1
H1100	5	1
P400	5	1
J100	5	1
H1200	5	1
J1100	5	1
K700	5	1
J800	5	1
P1000	5	1
J1000	8	1
J500	10	1
J700	10	1
N1100	10	1
J400	10	1
I1200	10	1
K100	10	1
K000	10	1
J900	15	1
O900	15	1
J300	20	1
H1300	0	2
M1200	0	2
P200	0	2
I300	5	2
M1400	5	2
N-100	5	2
I400	5	2
K1300	5	2
O400	10	2
N300	10	2
I1100	10	2
M100	10	2
K800	10	2
O1000	10	2
M400	10	2
N900	10	2
O200	15	2
M200	30	2

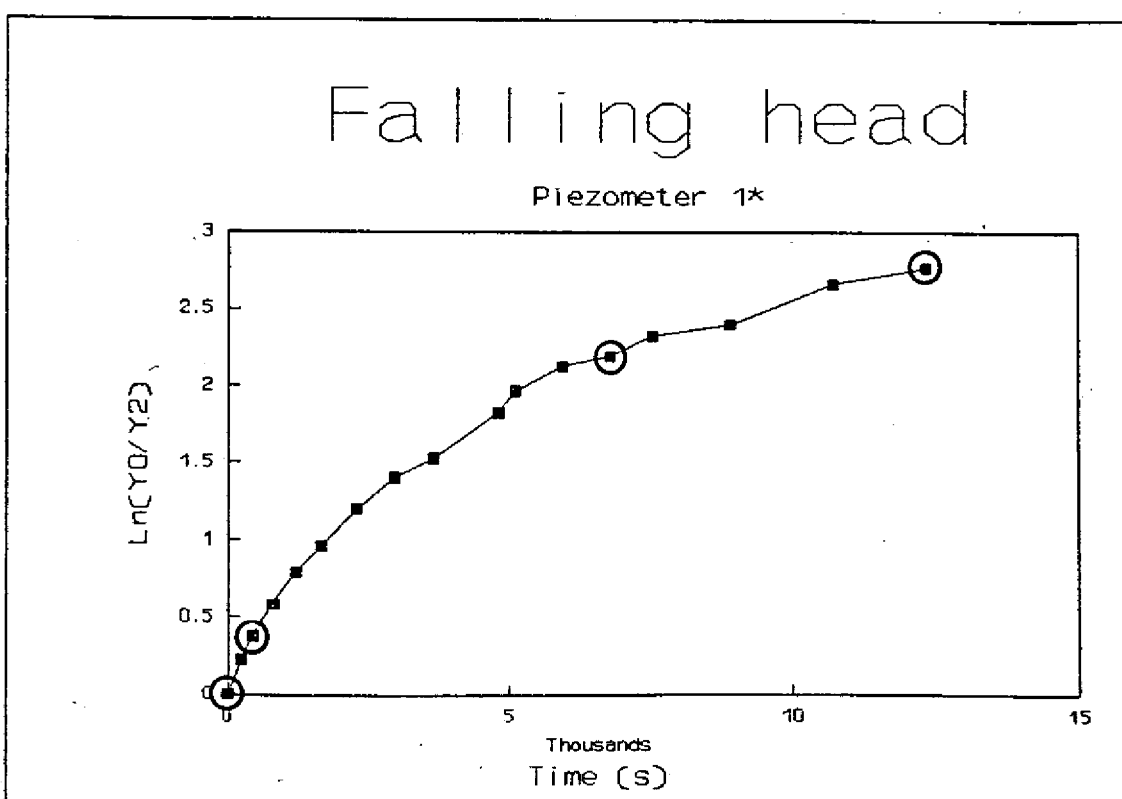
Tube	Acrot. thikn.	Code
O500	0	3
K1200	5	3
K1000	5	3
N1000	5	3
M900	15	3
M000	15	3
P500	15	3
N500	20	3
K500	30	3
M300	30	3
K400	15	4
M800	20	4
N200	20	4
N400	20	4
N100	0	5
M1100	10	5
K1100	10	5
M1000	20	5
K900	30	5
K200	30	6
K300	30	6
P700	35	6
O300	40	6
N800	50	6
K-100	0	7
O-100	0	8
J1300	0	8
J1200	0	8
I1000	0	8
J-100	0	8
I100	0	8
I200	0	8
I800	0	8
I700	0	8
N1300	0	8
H1400	5	8
J000	5	8
M-100	10	8
I900	0	9
I000	0	9
I500	10	9
M1300	0	-
M1500	0	-
M500	0	-
J200	10	-

APPENDIX 6.1

Falling Head



Falling head
Piezometer 1
Ln(YO/Y2)
Thousands
Time (s)



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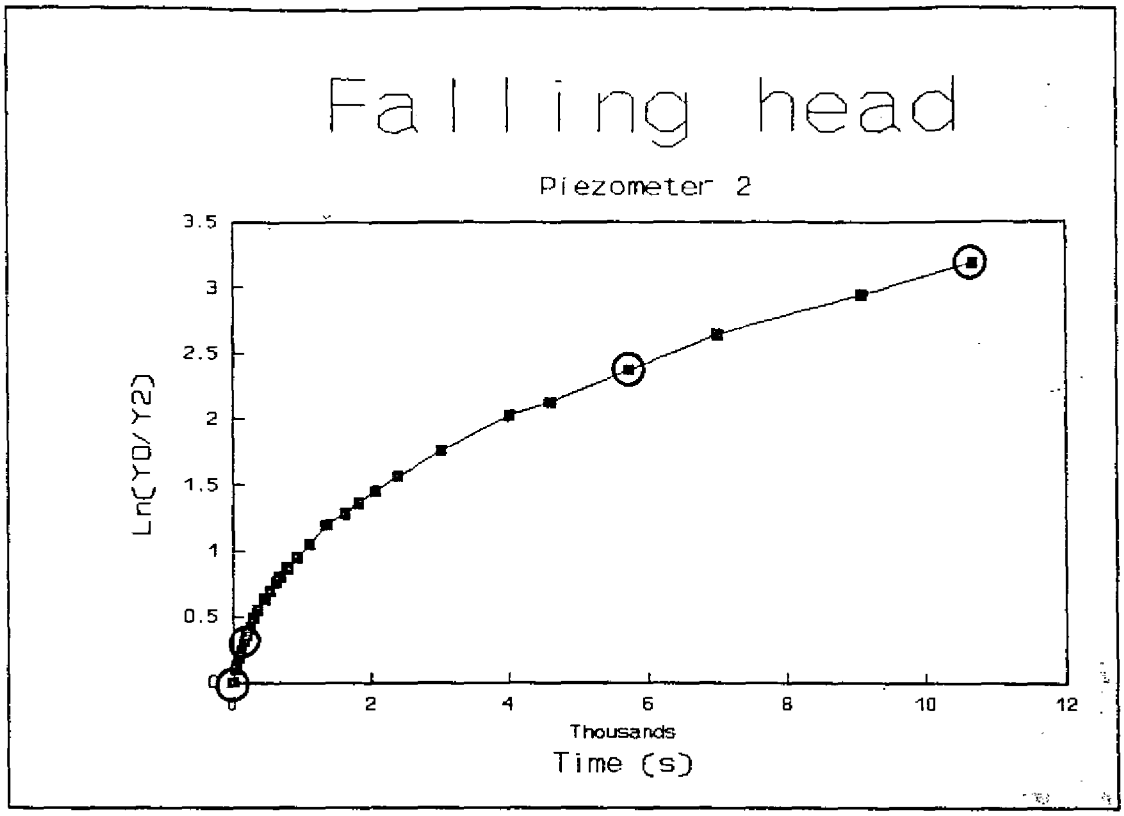
Piezometer 1*
Ln(YO/Y2)
Thousands
Time (s)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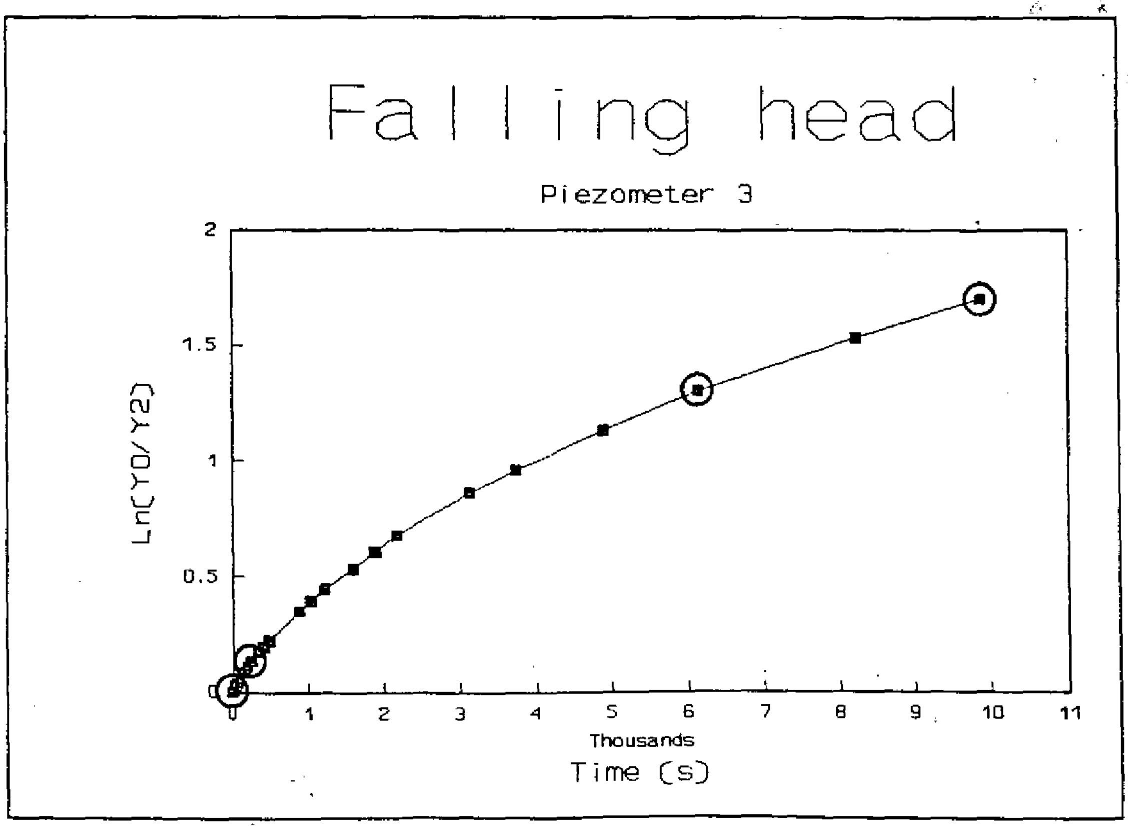
Thousands
Time (s)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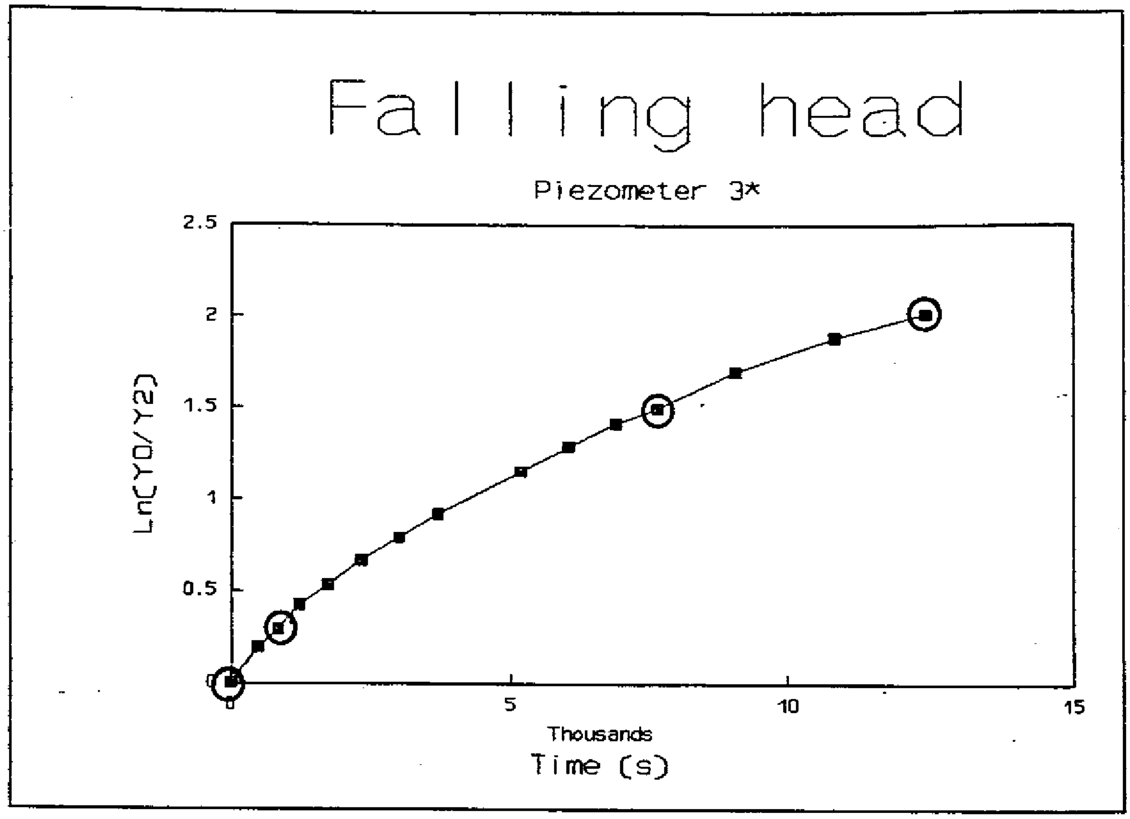
Piezometer 3
Ln(Y0/Y2)
Thousands
Time (s)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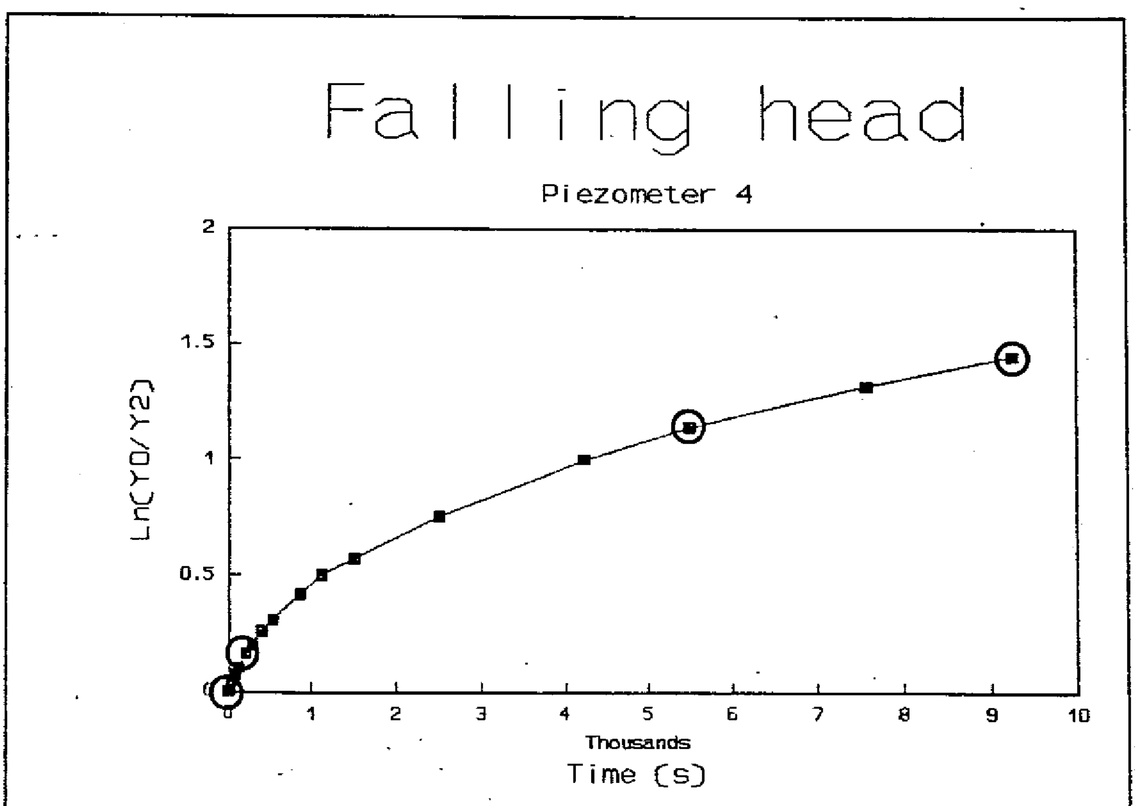
Piezometer 3*
Ln(YO/Y2)
Thousands
Time (s)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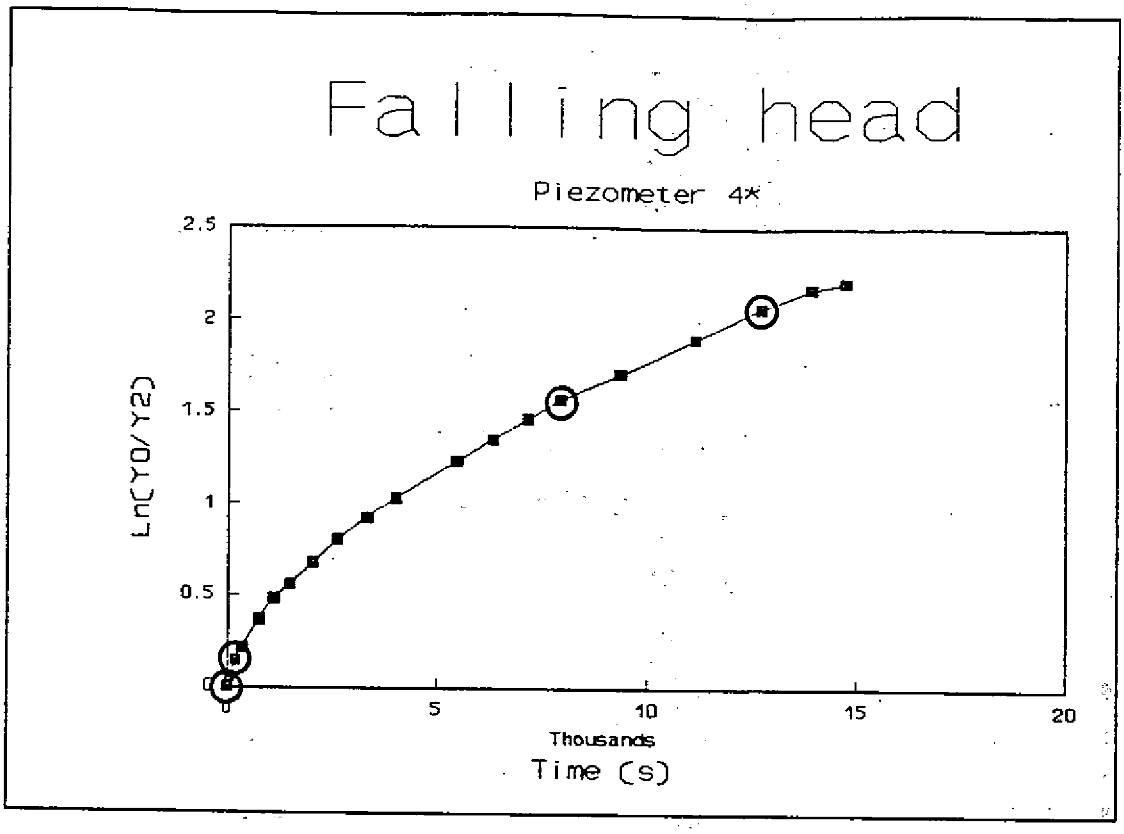
Ln(YO/Y2)
Thousands
Time (s)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Piezometer 4*
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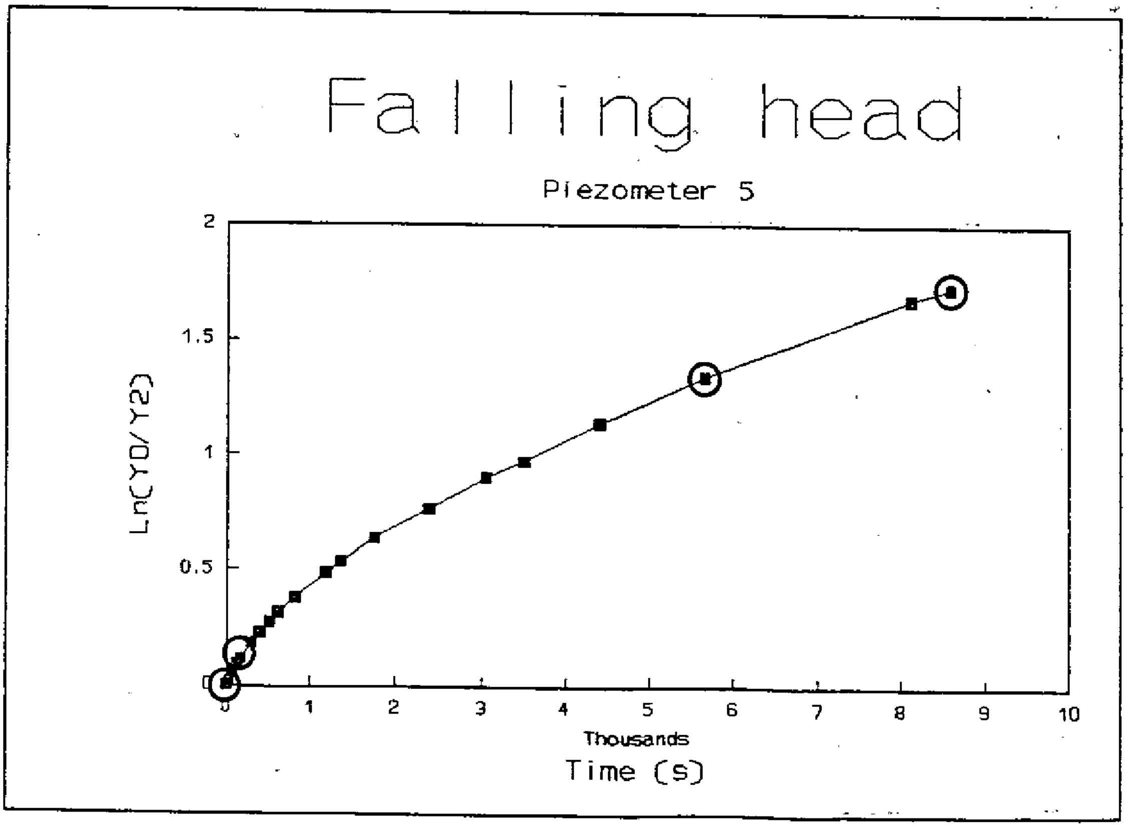
2
1.5
1
0.5
0
0
5
10
15
20
Thousands
Time (s)


Falling head
Piezometer 5
Ln(Y0/Y2)
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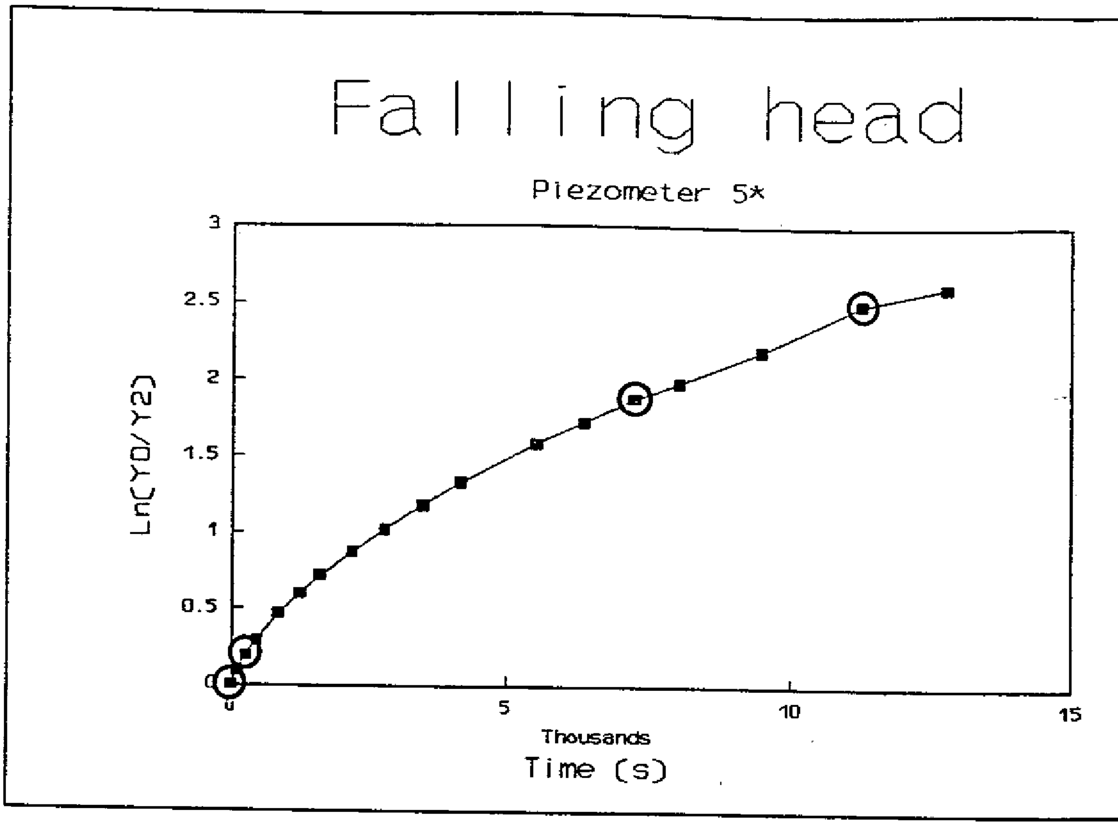
1.5
1
0.5
0
0
1
2
3
4
5
6
7
8
9
10
Thousands
Time (s)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Piezometer 5*
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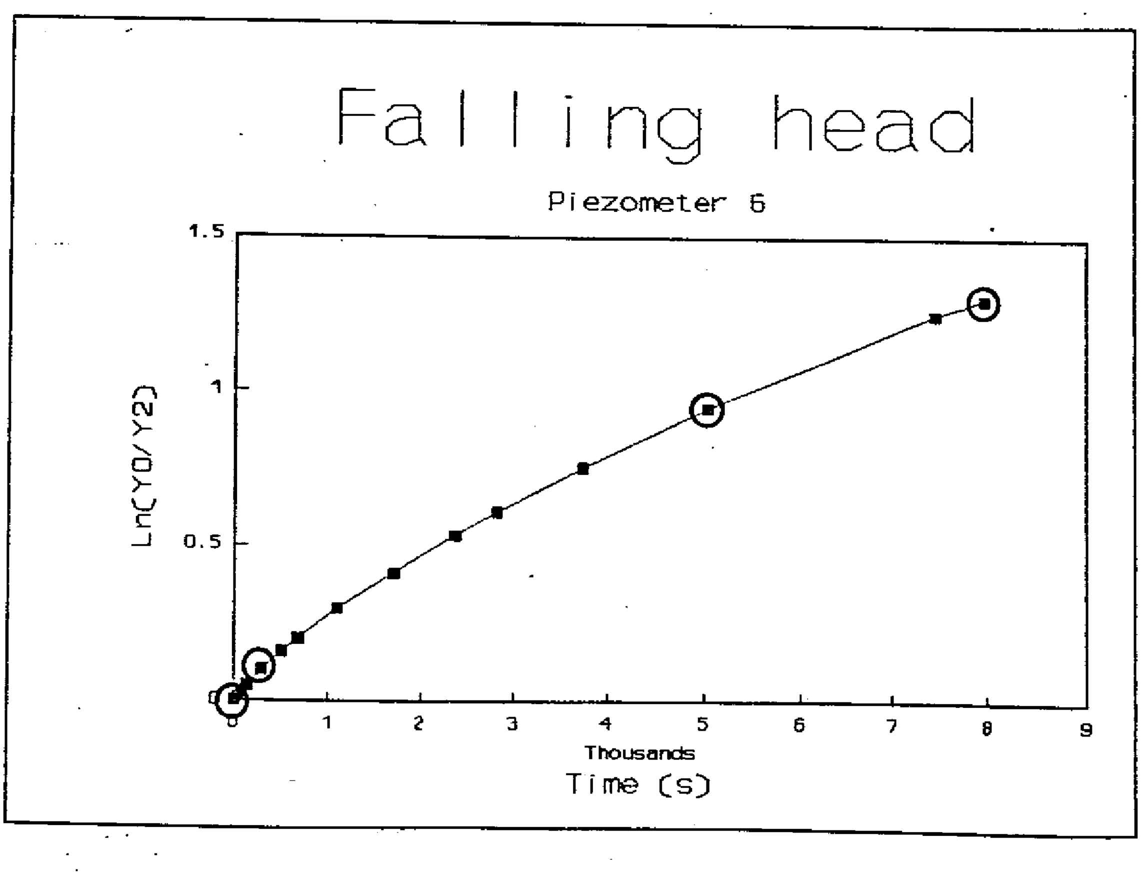
2.5
2
1.5
1
0.5
0
0
5
10
15
Thousands
Time (s)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Piezometer 6
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0
1
2
3
4
5
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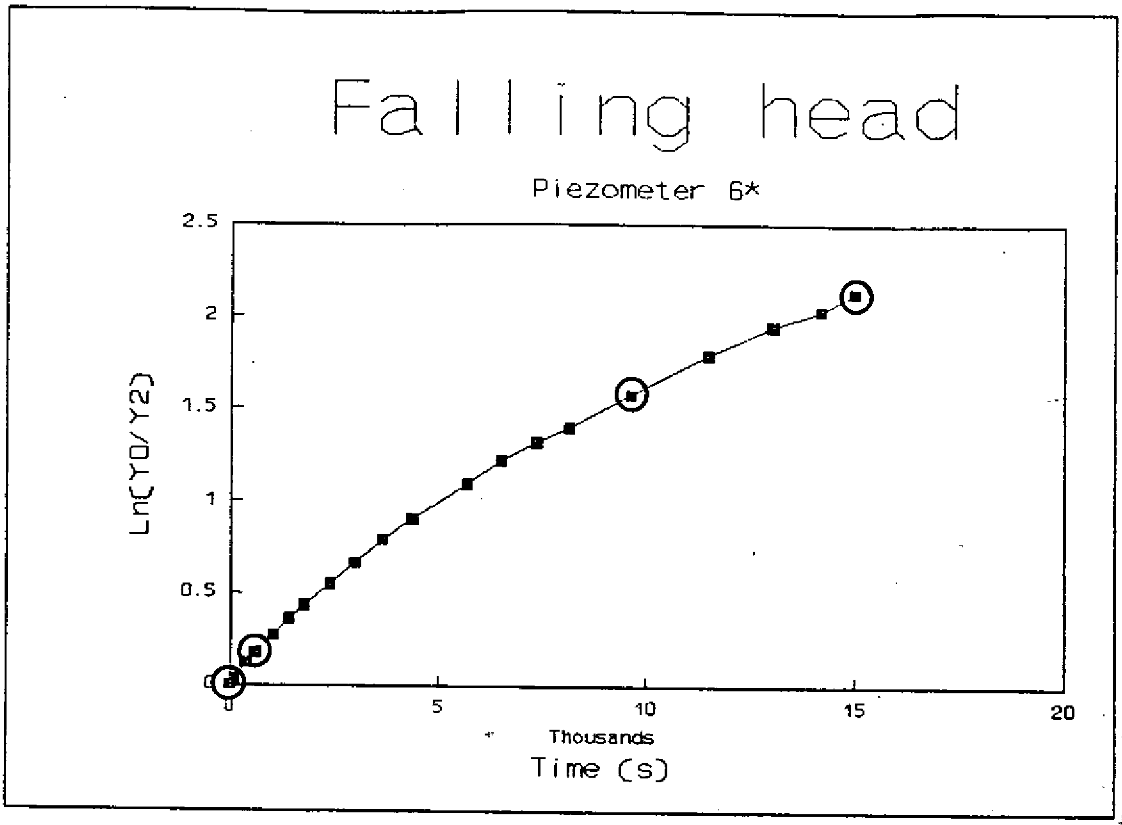
8
9
Thousands
Time (s)



Falling head
Piezometer 6*
Ln(Y0/Y2)
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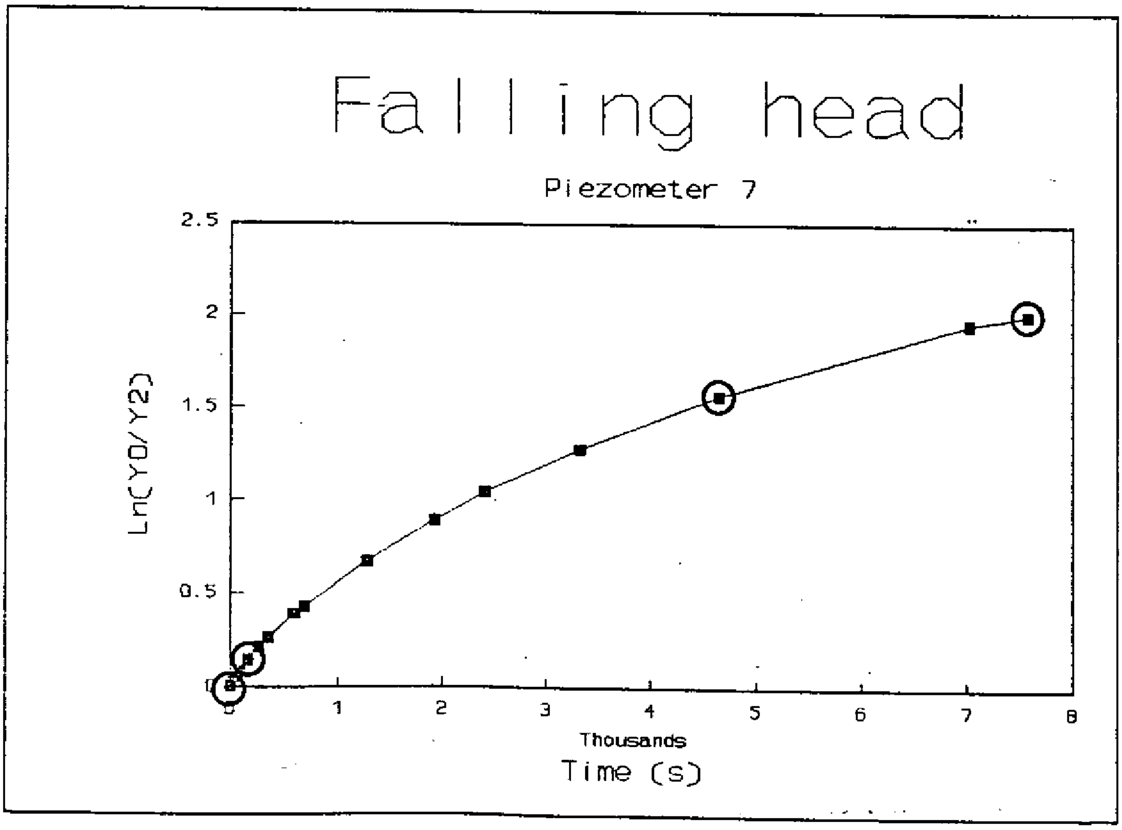
2
1.5
1
0.5
0
0
5
10
15
20
Thousands
Time (s)



Falling head
Piezometer 7
Ln(Y0/Y2)
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2
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1
0.5
0
0
1
2
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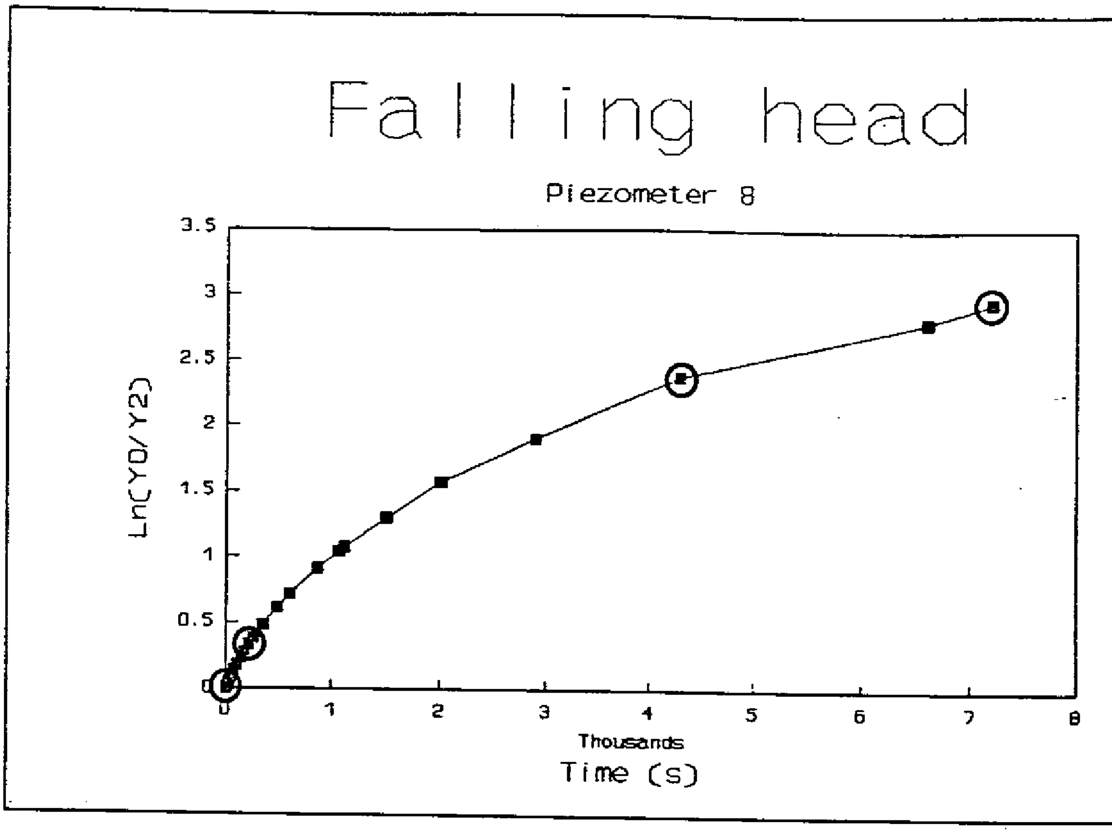
7
8
Thousands
Time (s)


Falling head
Piezometer 8
Ln(YO/Y2)
Thousands
Time (s)
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1
1.5
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2.5
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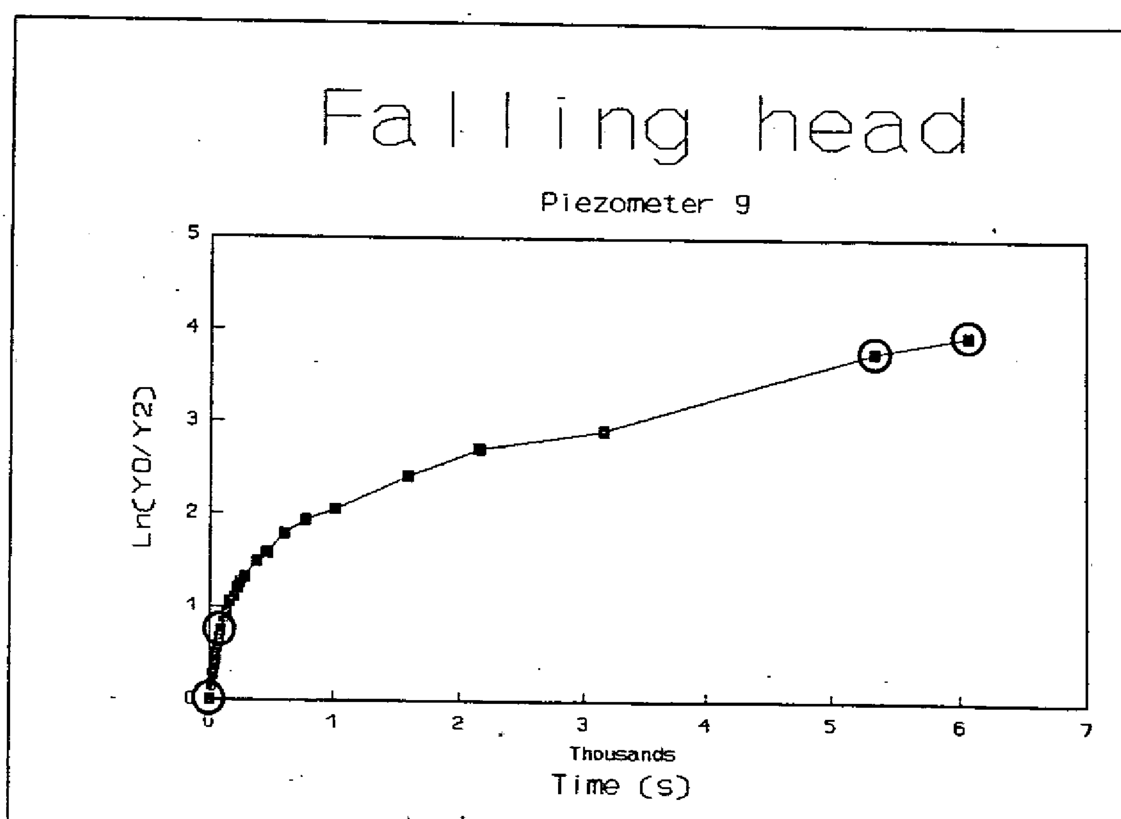
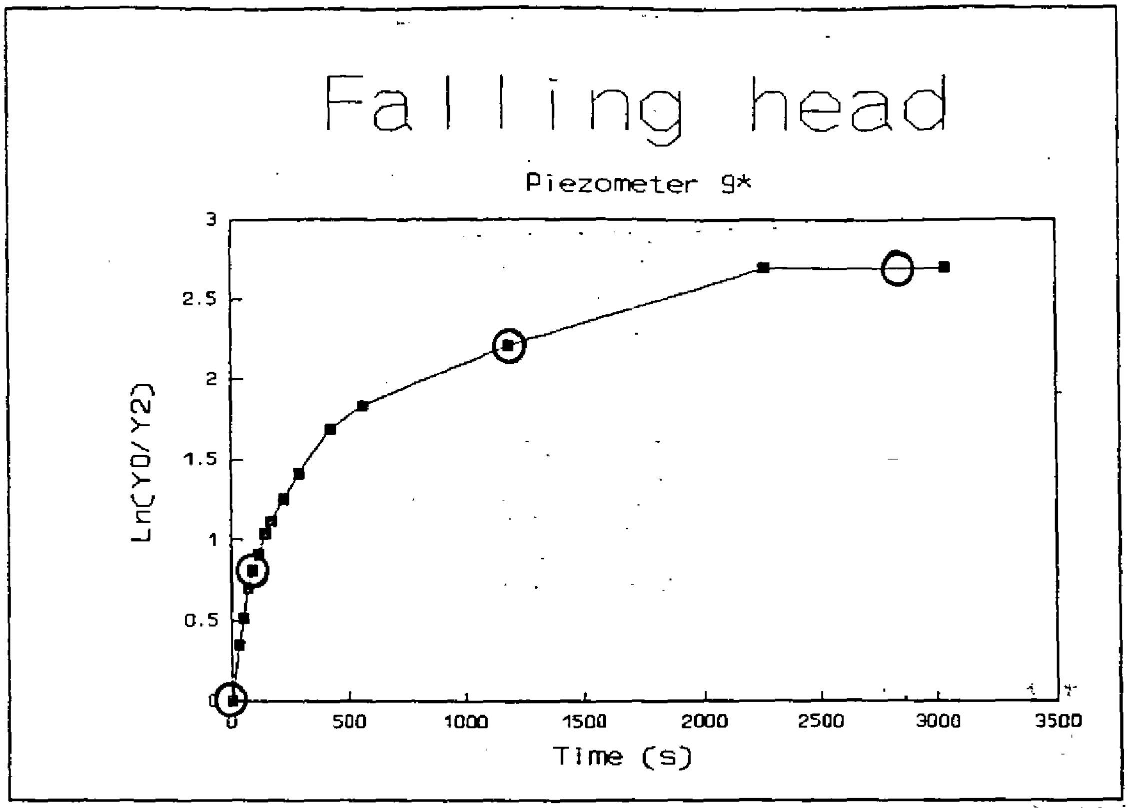
4
5
6
7
8


Falling head
Piezometer 9
Ln(YO/Y2)
Thousands
Time (s)
0
1
2
3
4
5
6
7


Falling head
Piezometer 9*
Ln(Y0/Y2)
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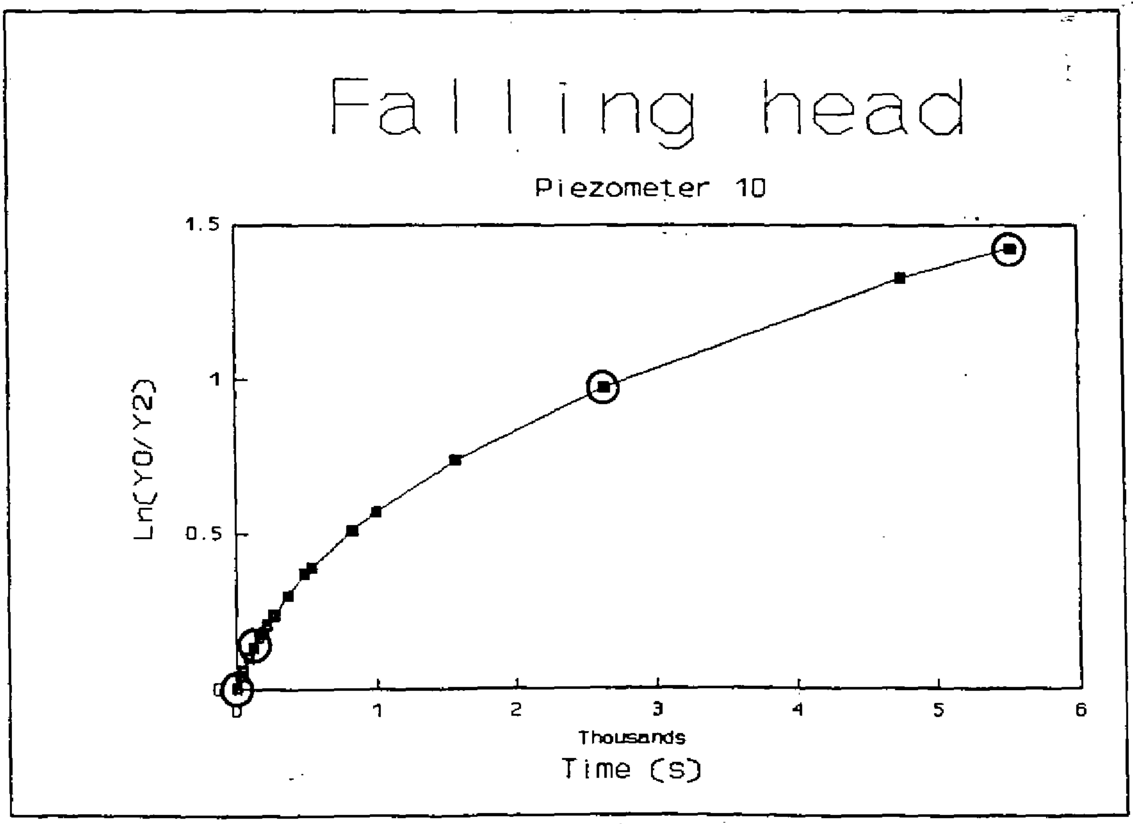
0.5
1
1.5
2
2.5
3
0
500
1000
1500
2000
2500
3000
3500
Time (s)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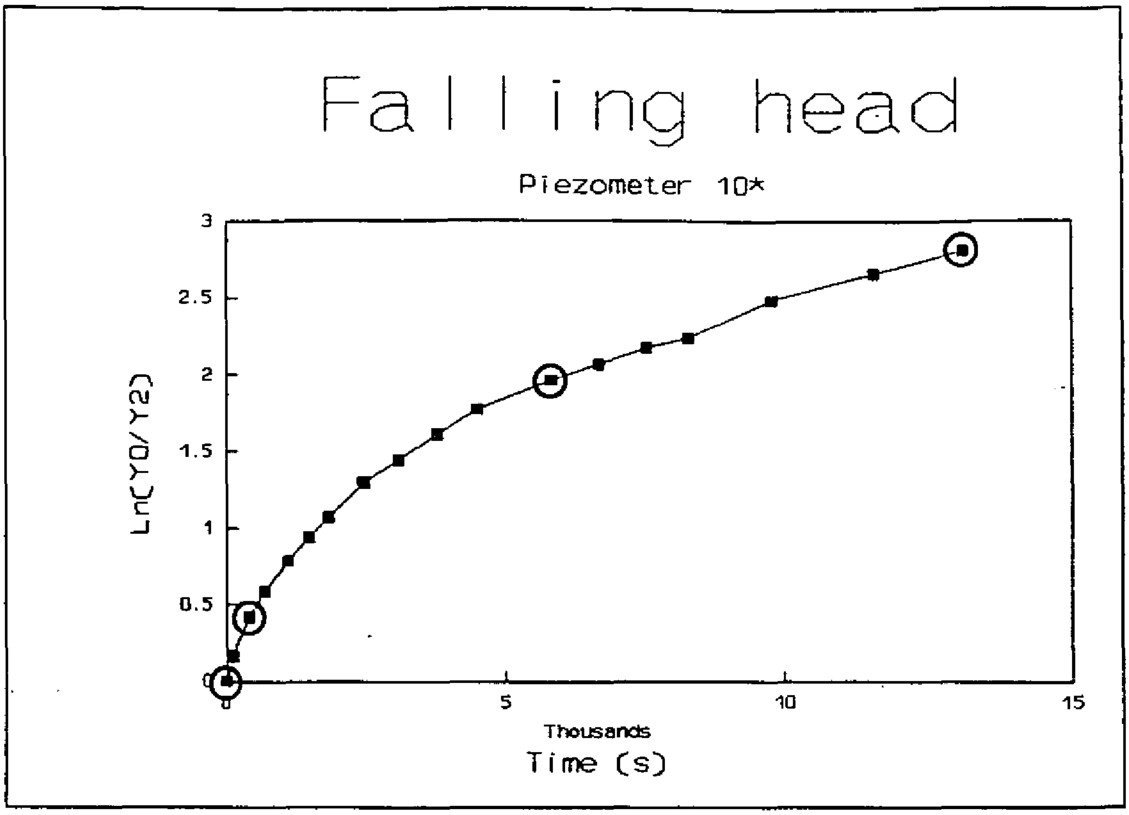
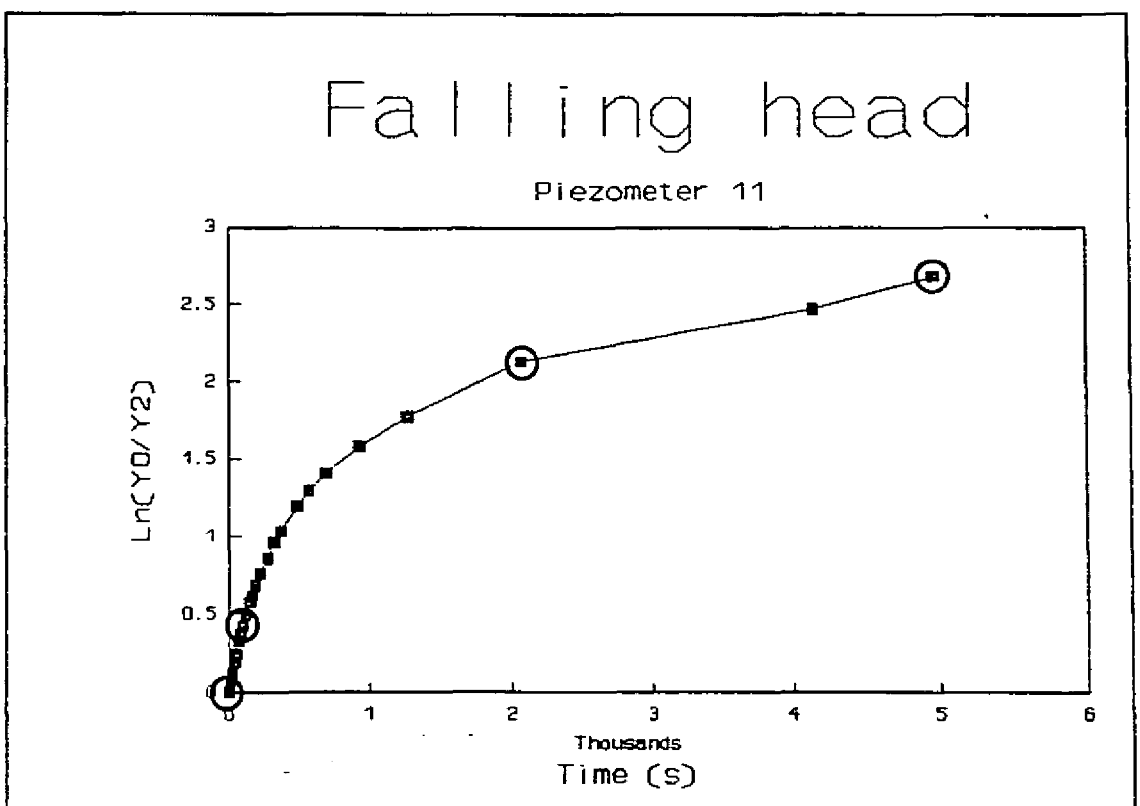
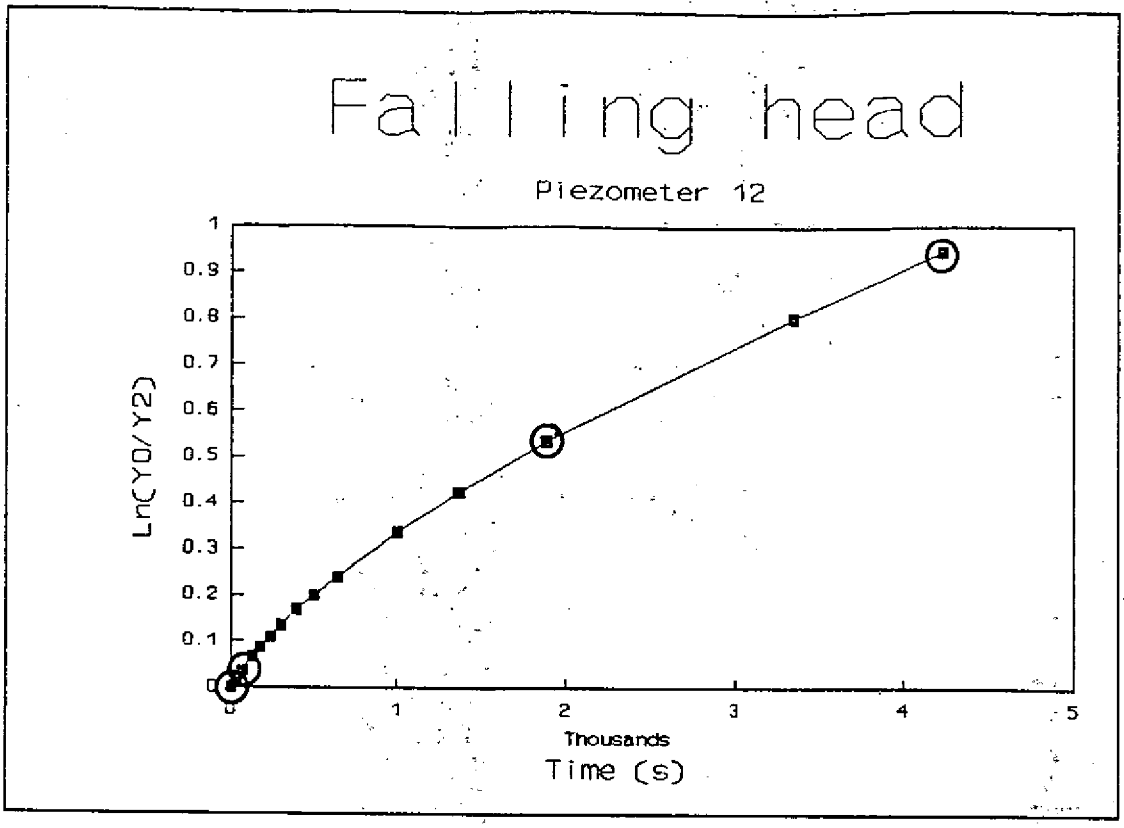
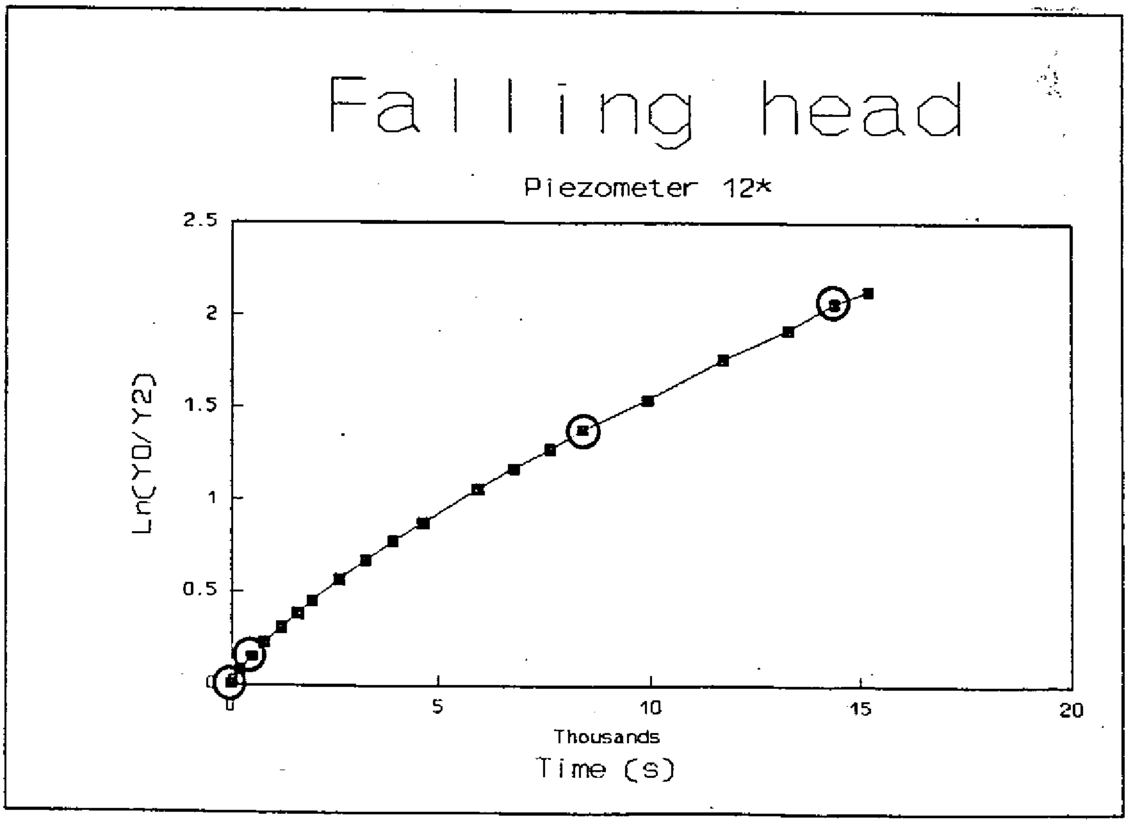
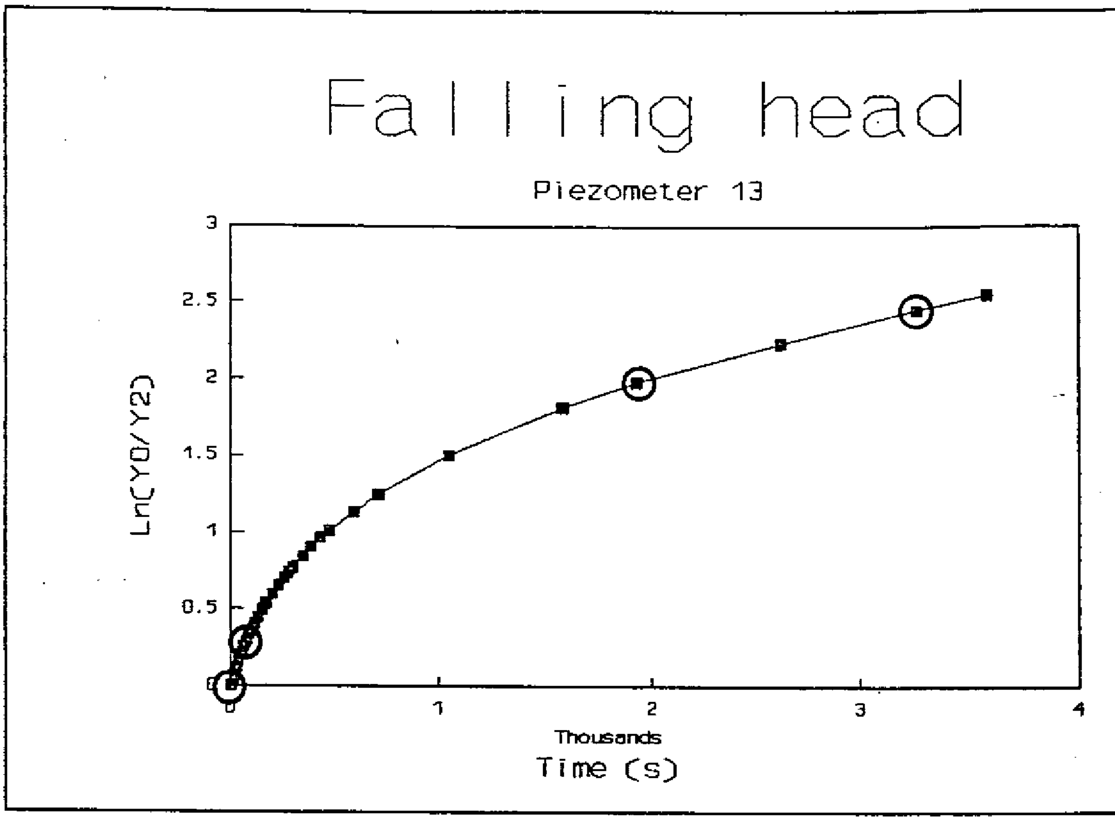
Piezometer 10
Ln(Y0/Y2)
0
0.5
1
1.5
0
1
2
3
4
5
6
Thousands
Time (s)

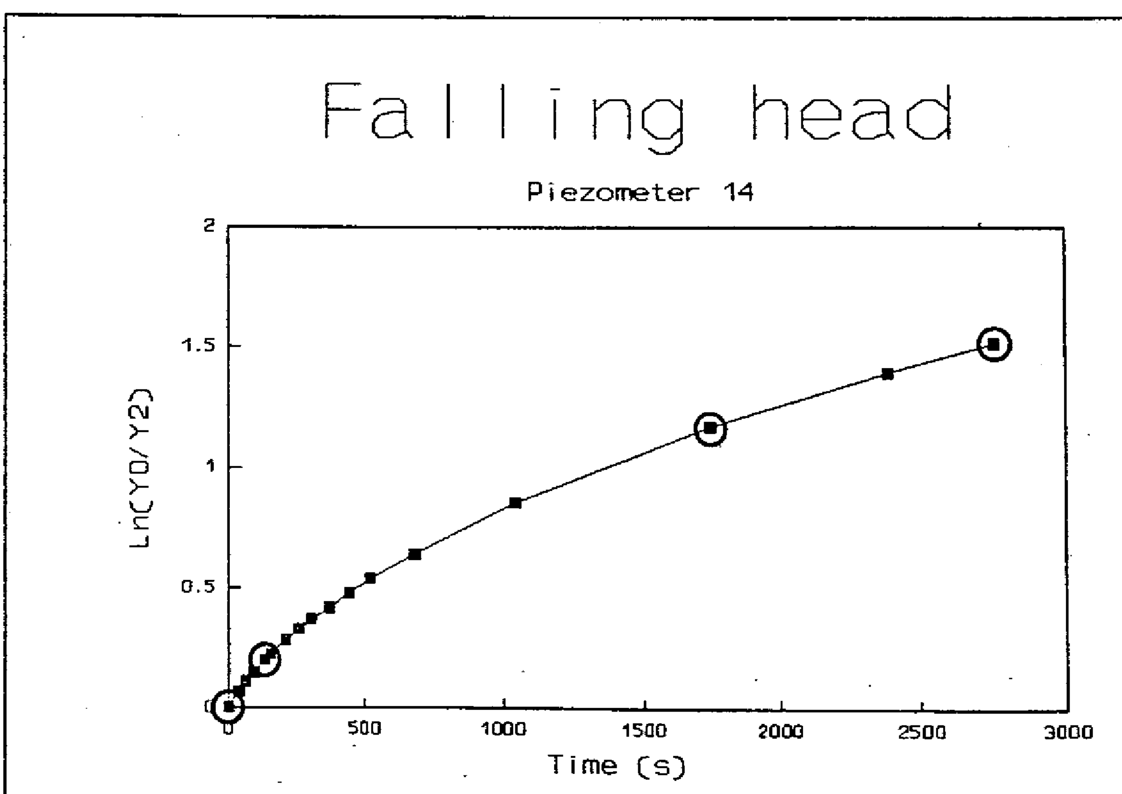

Falling head
Piezometer 10*
Ln(Y0/Y2)
Thousands
Time (s)

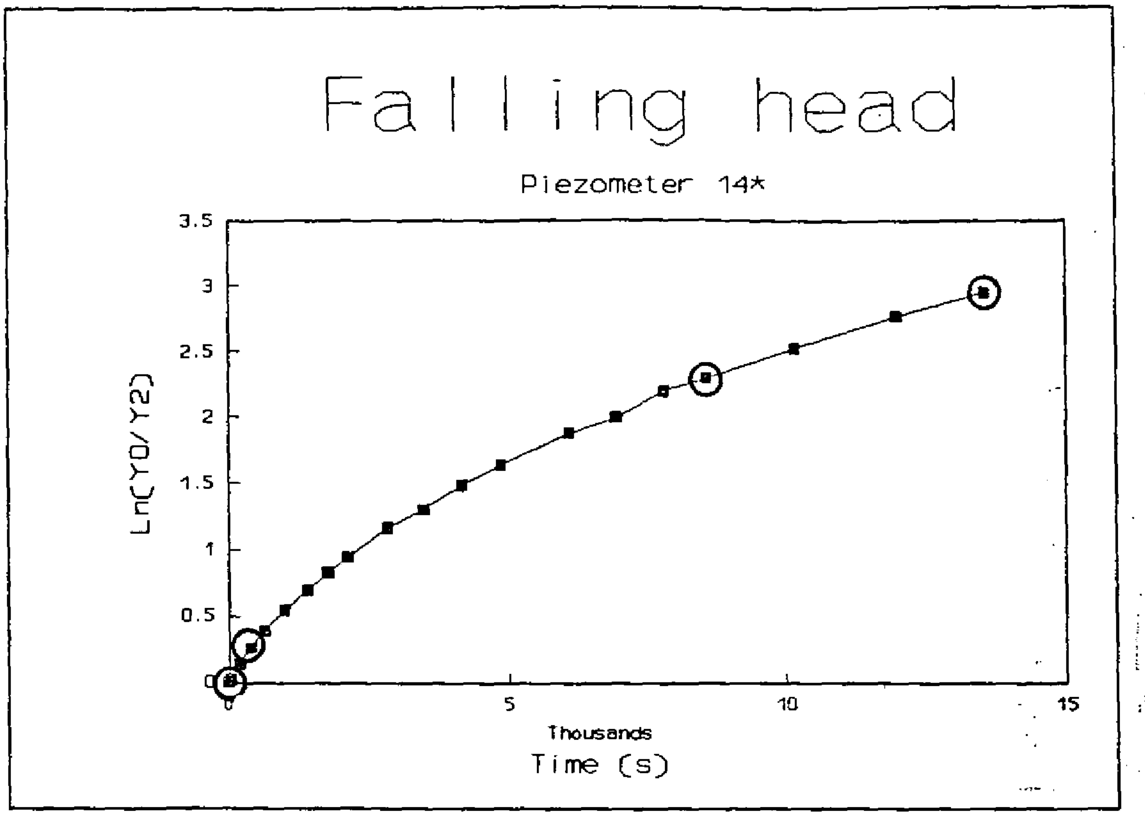

Falling head
Piezometer 11
Ln(Y0/Y2)
Thousands
Time (s)

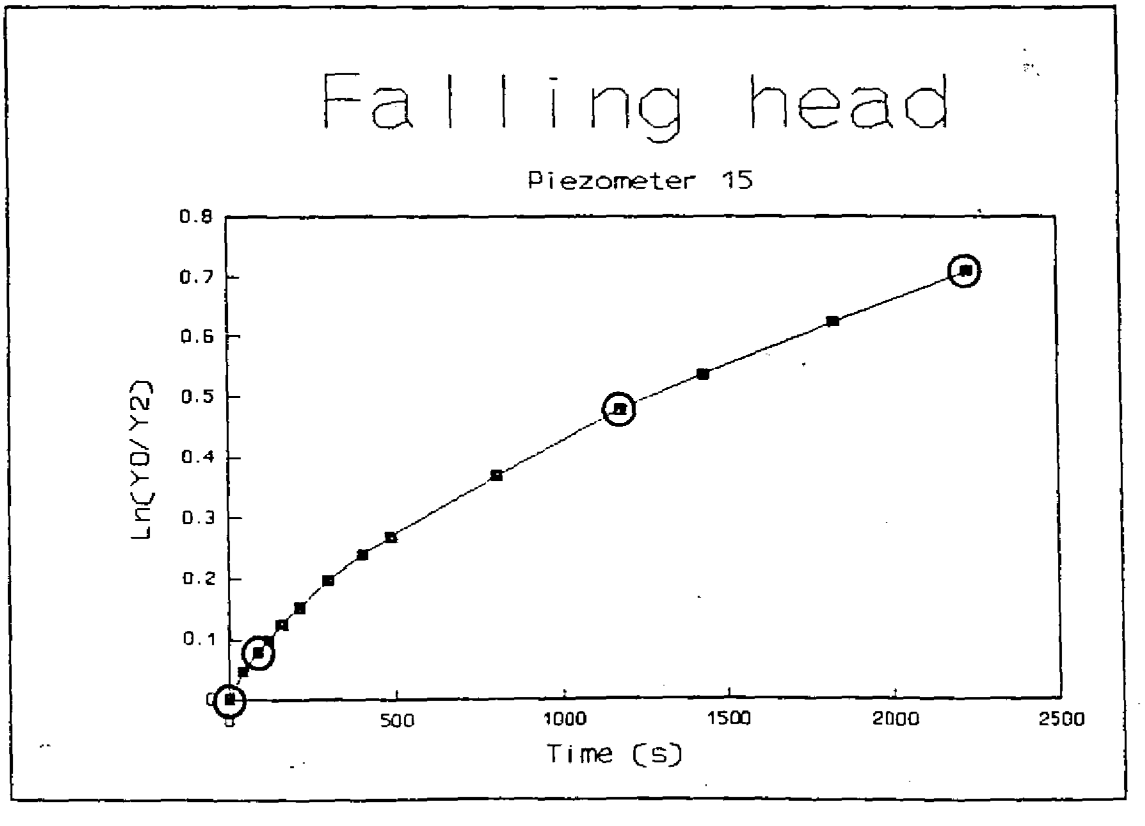

Falling head
Piezometer 12
Ln(Y0/Y2)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
Thousands
Time (s)

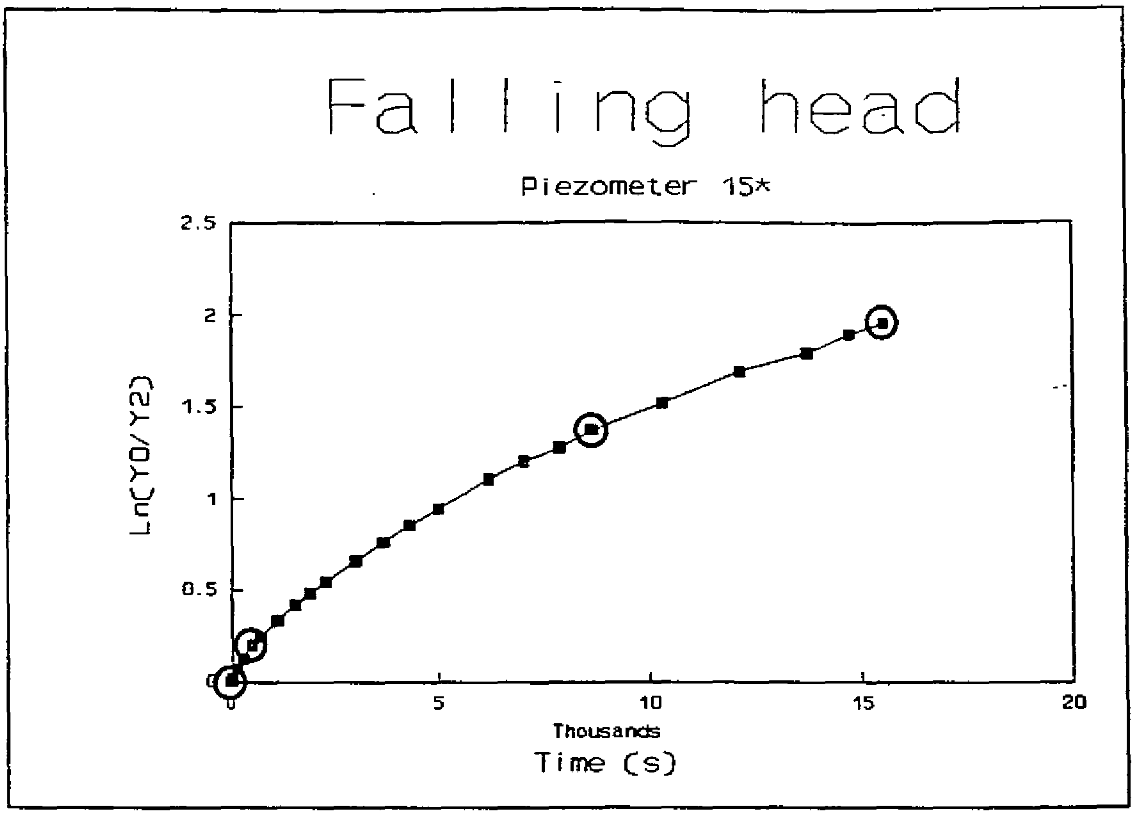

Falling head
Piezometer 12*
Ln(Y0/Y2)
2.5
2
1.5
1
0.5
0
0
5
10
15
20
Thousands
Time (s)

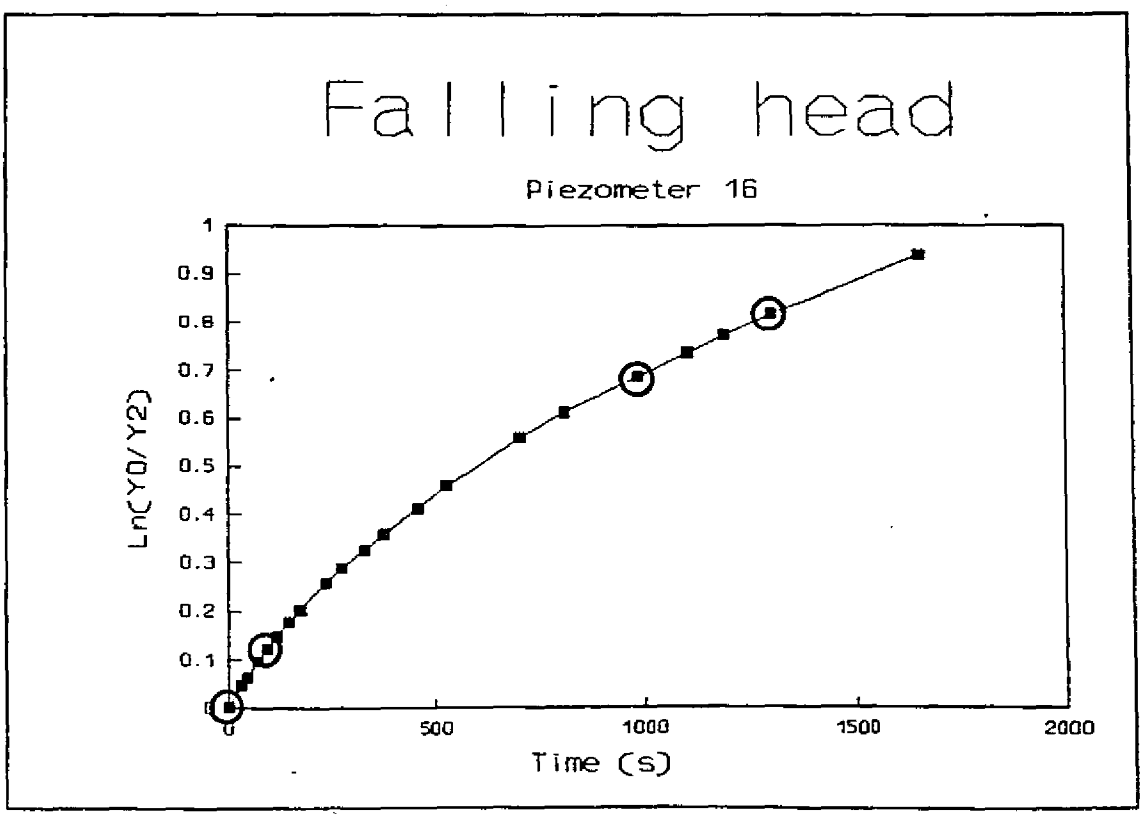

Falling head
Piezometer 13
Ln(Y0/Y2)
0
0.5
1
1.5
2
2.5
3
0
1
2
3
4
Thousands
Time (s)


Falling head
Piezometer 14
Ln(Y0/Y2)
0
0.5
1
1.5
2
0
500
1000
1500
2000
2500
3000
Time (s)


Falling head
Piezometer 14*
Ln(Y0/Y2)
0
0.5
1
1.5
2
2.5
3
3.5
0
5
10
15
Thousands
Time (s)

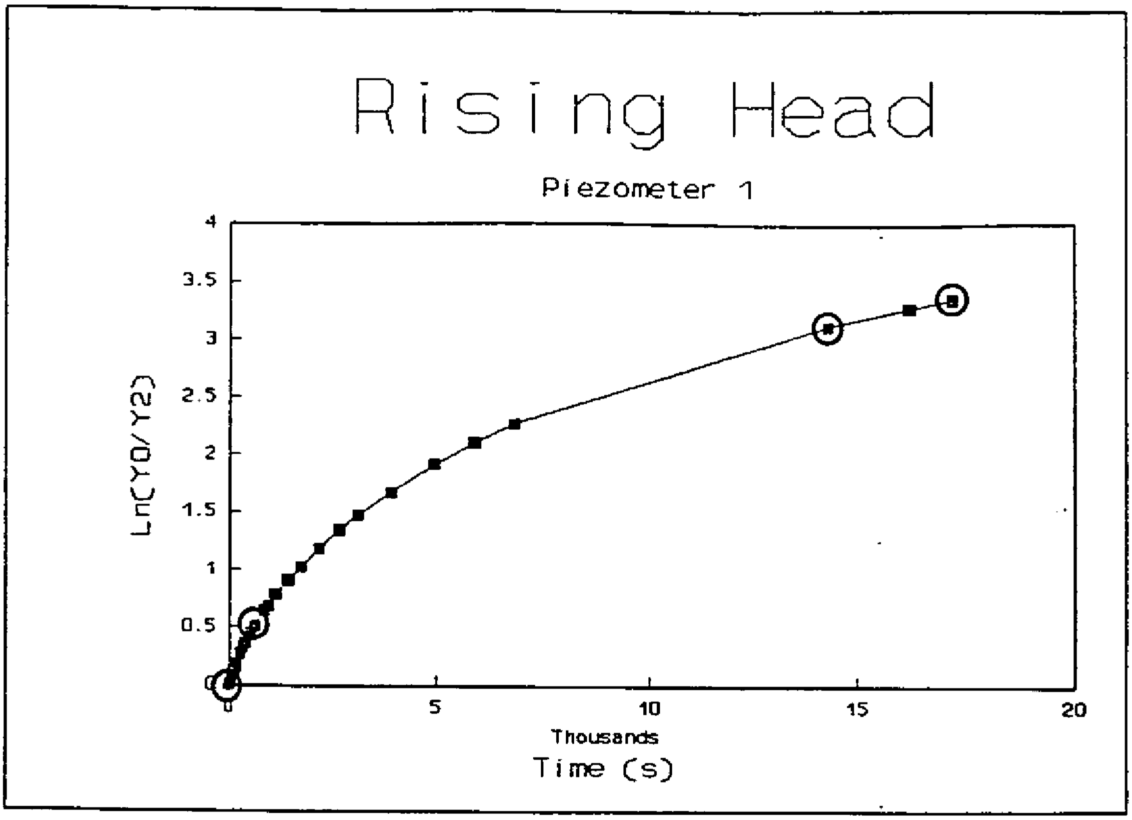

Falling head
Piezometer 15
Ln(Y0/Y2)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
500
1000
1500
2000
2500
Time (s)

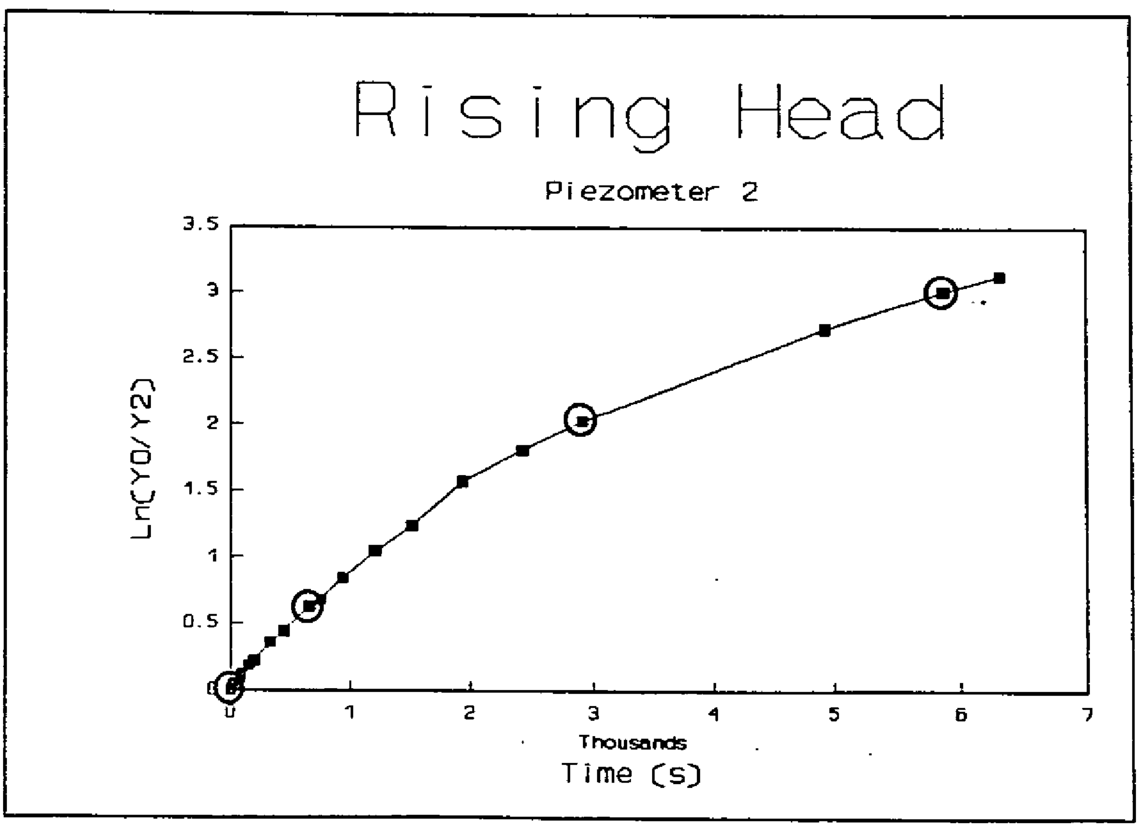

Falling head
Piezometer 15*
Ln(Y0/Y2)
Thousands
Time (s)
0
0.5
1
1.5
2
2.5
5
10
15
20

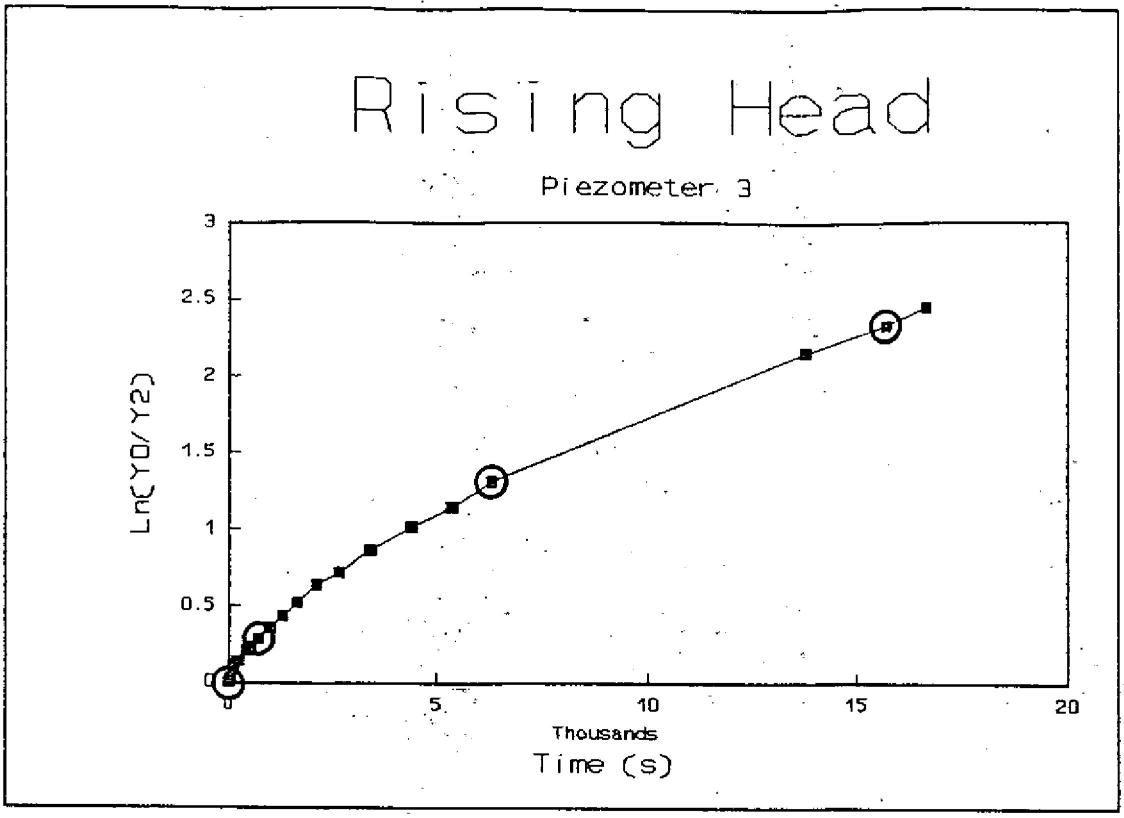

Falling head
Piezometer 16
Ln(Y0/Y2)
Time (s)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
500
1000
1500
2000

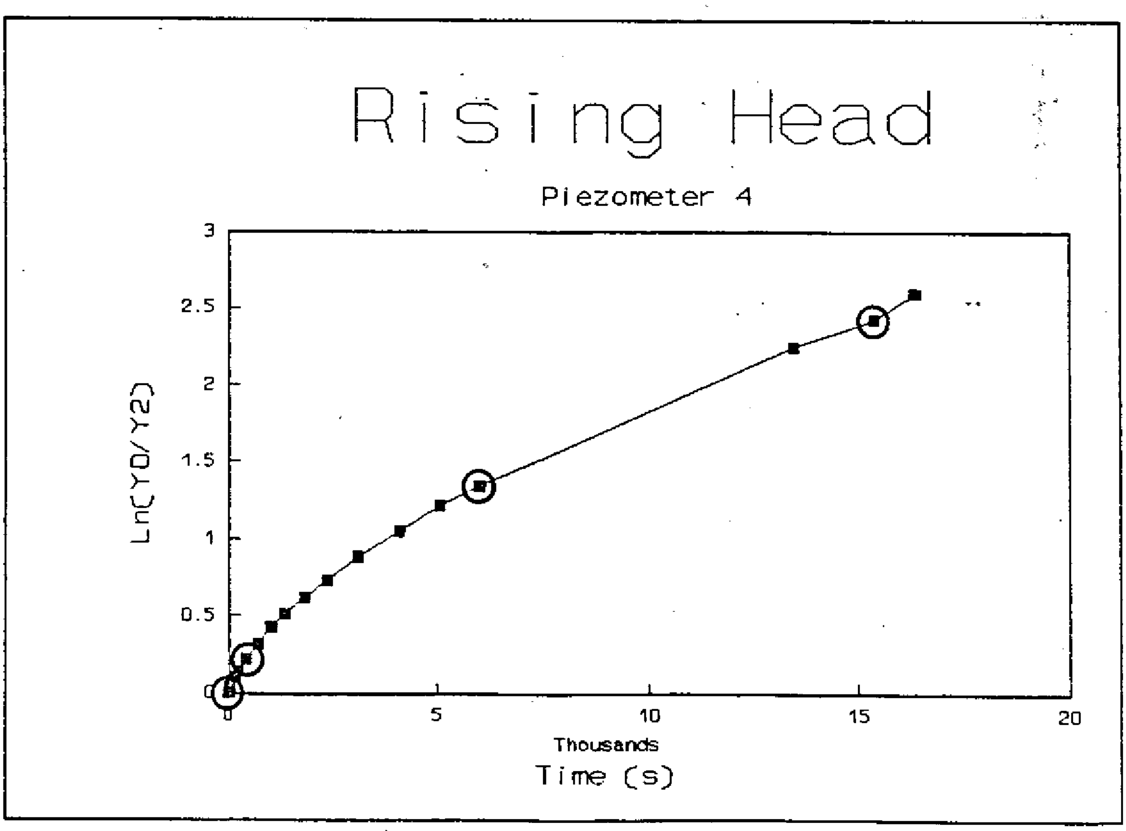
APPENDIX 6.2

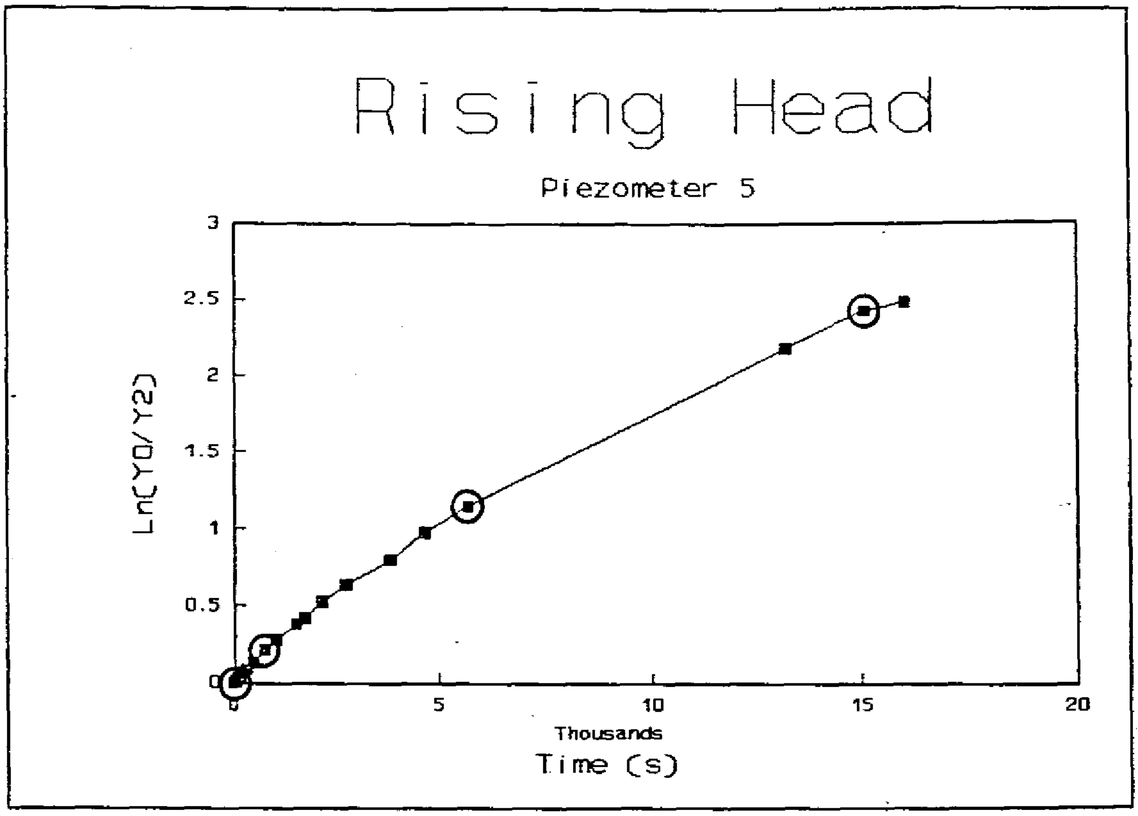
Rising Head

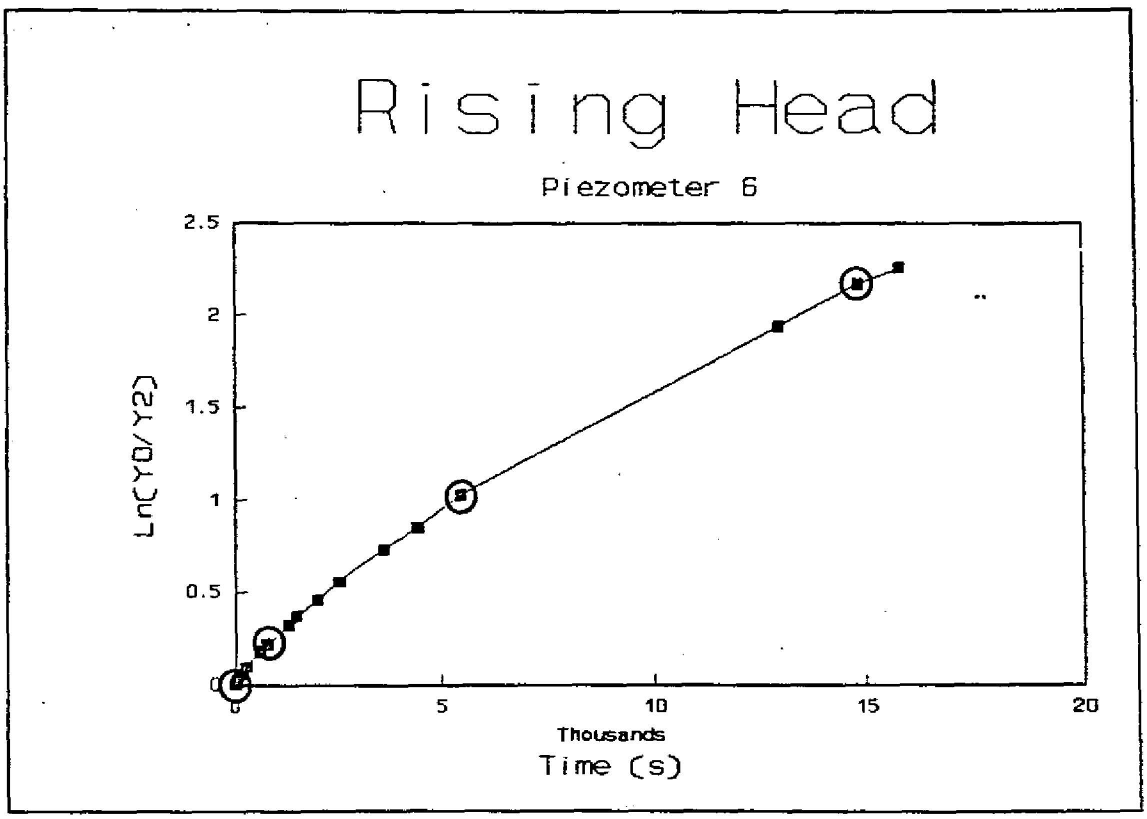

Rising Head
Piezometer 1
Ln(Y0/Y2)
Thousands
Time (s)

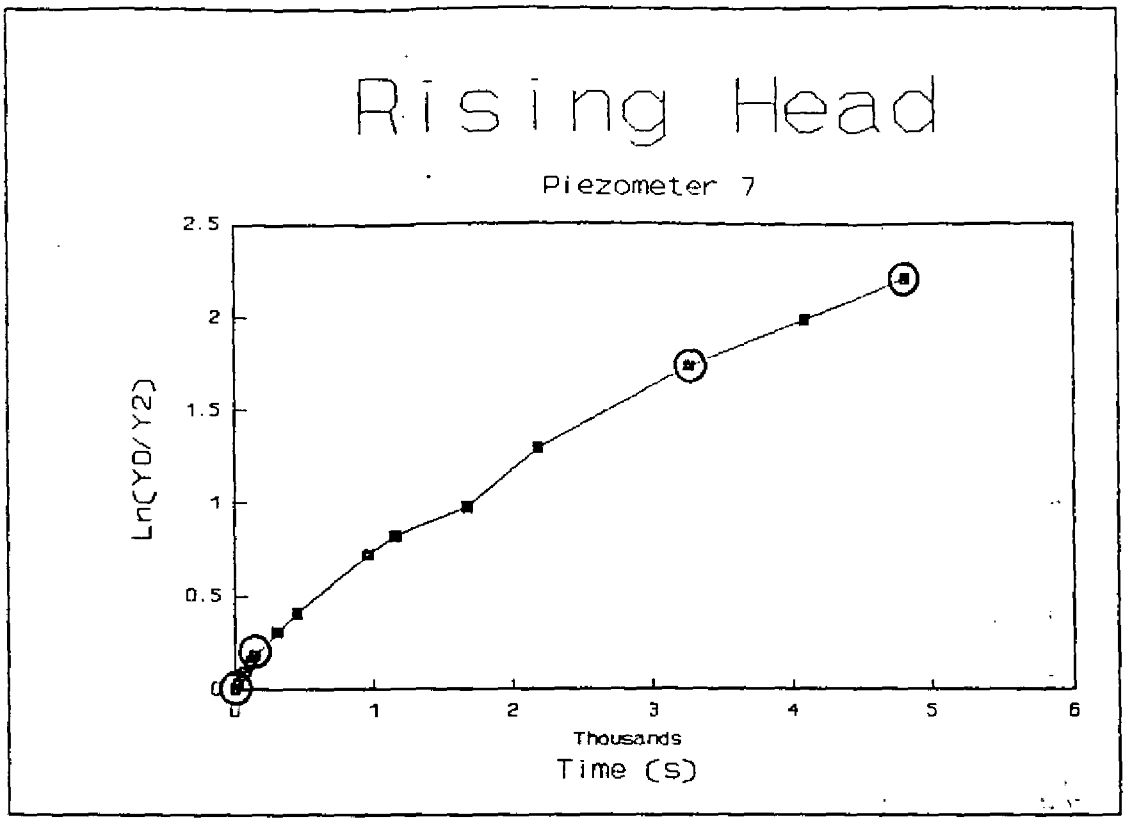

Rising Head
Piezometer 2
Ln(Y0/Y2)
Thousands
Time (s)

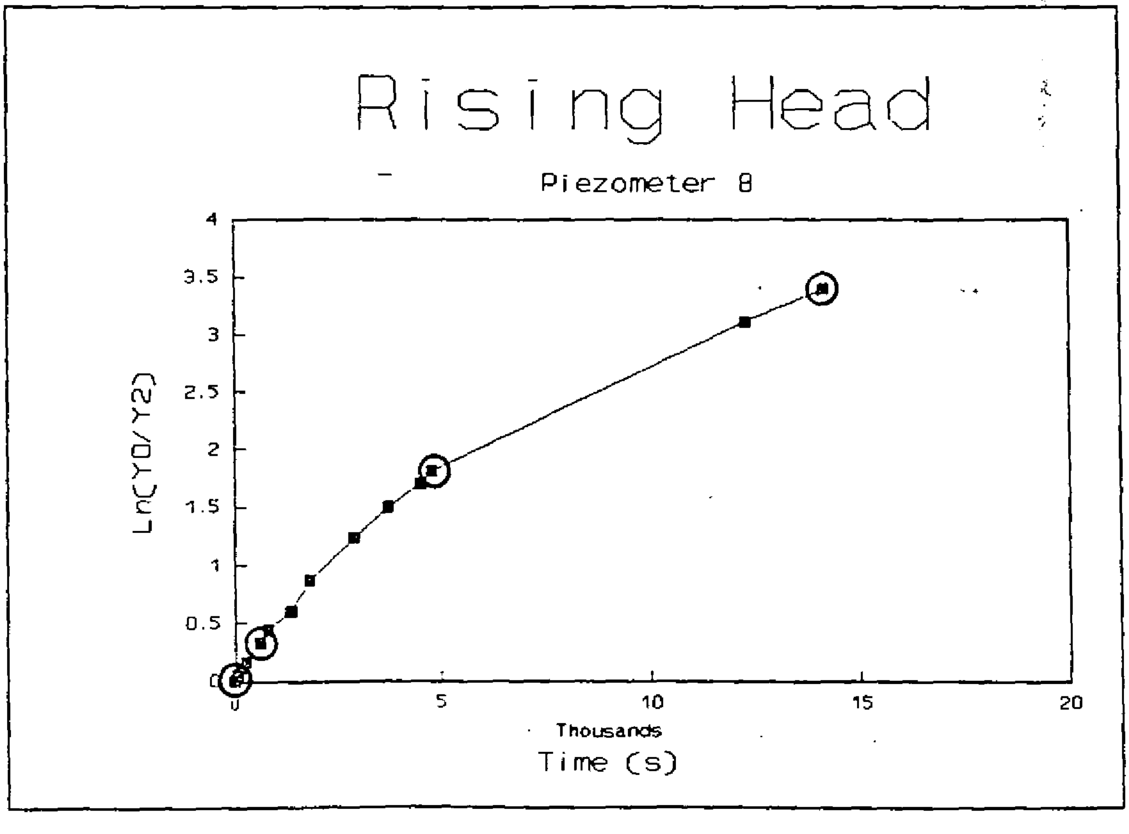

Rising Head
Piezometer 3
Ln(Y0/Y2)
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
Thousands
Time (s)

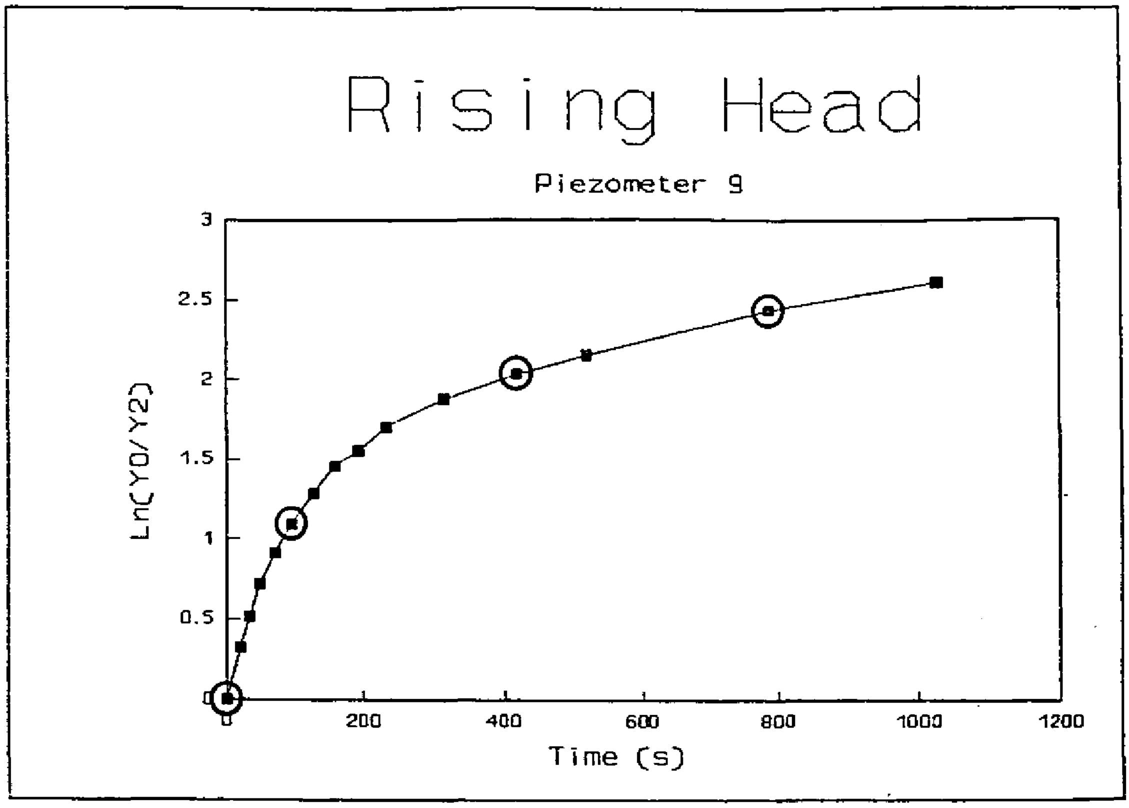

Rising Head
Piezometer 4
Ln(Y0/Y2)
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
Thousands
Time (s)

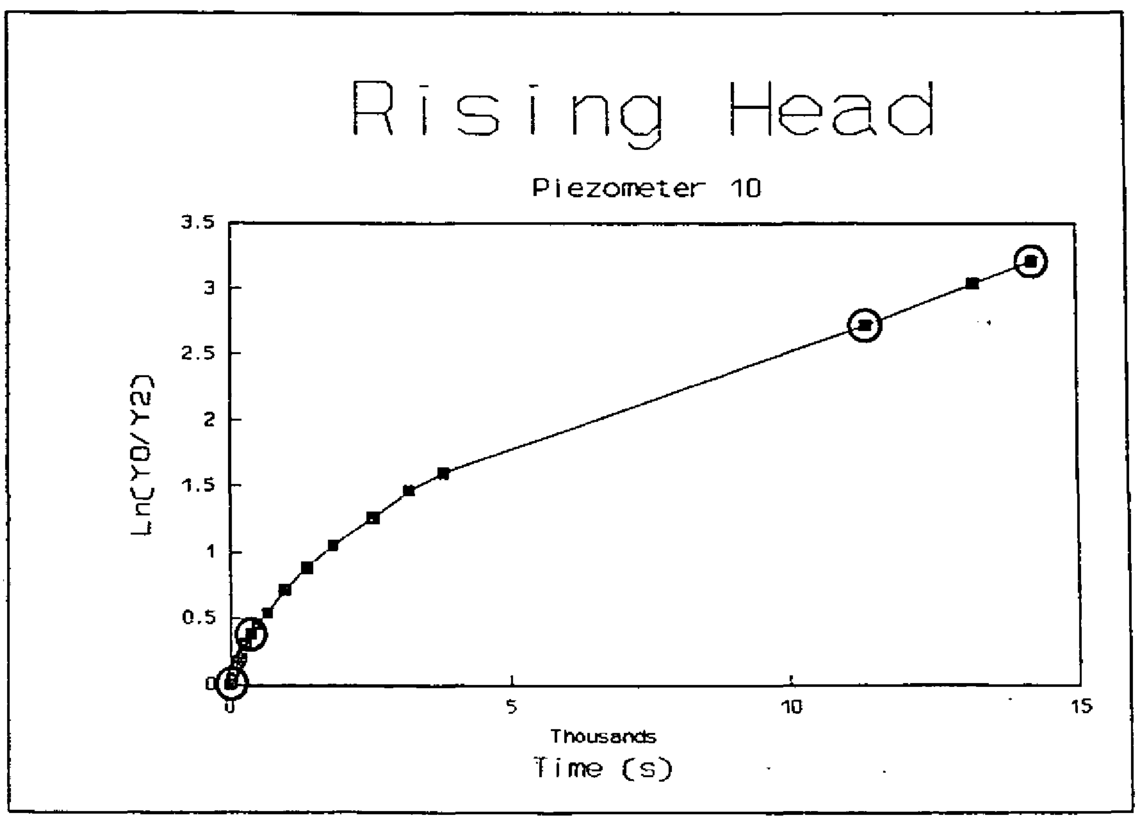

Rising Head
Piezometer 5
Ln(Y0/Y2)
Thousands
Time (s)
0
0.5
1
1.5
2
2.5
3
5
10
15
20

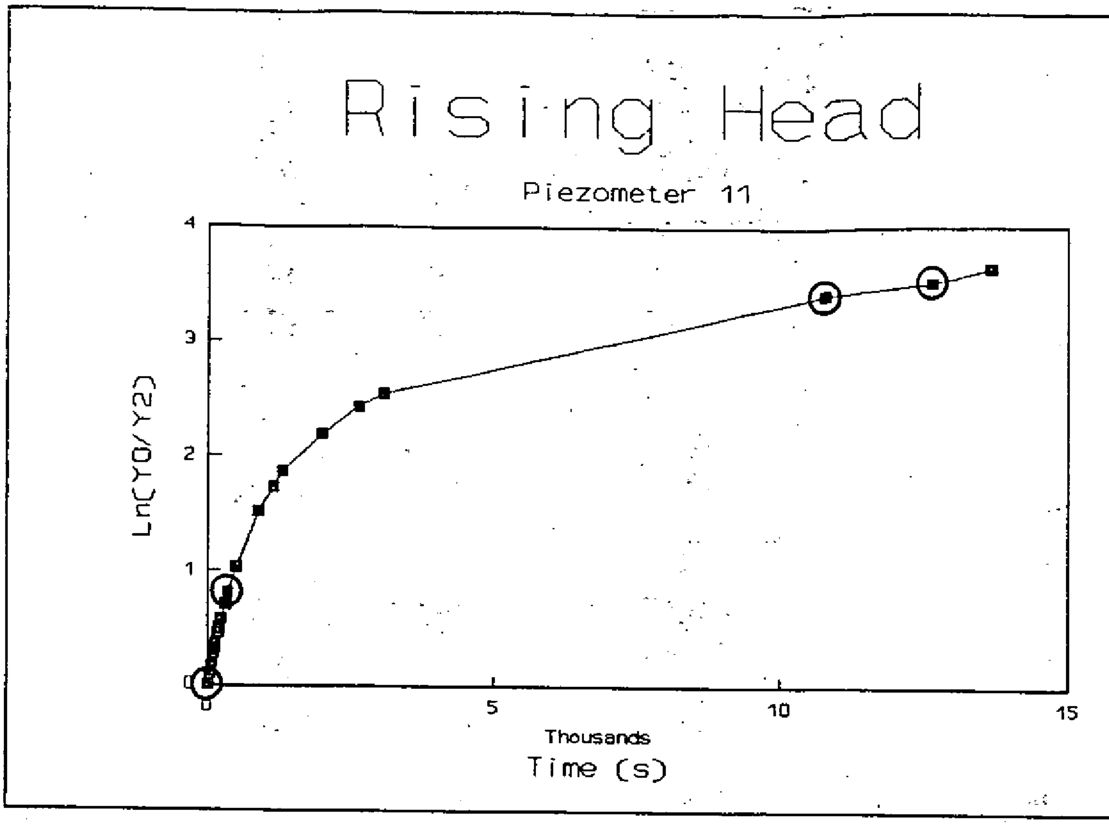

Rising Head
Piezometer 6
Ln(Y0/Y2)
Thousands
Time (s)
0
0.5
1
1.5
2
2.5
5
10
15
20


Rising Head
Piezometer 7
2.5
2
1.5
1
0.5
0
Ln(Y0/Y2)
0
1
2
3
4
5
6
Thousands
Time (s)

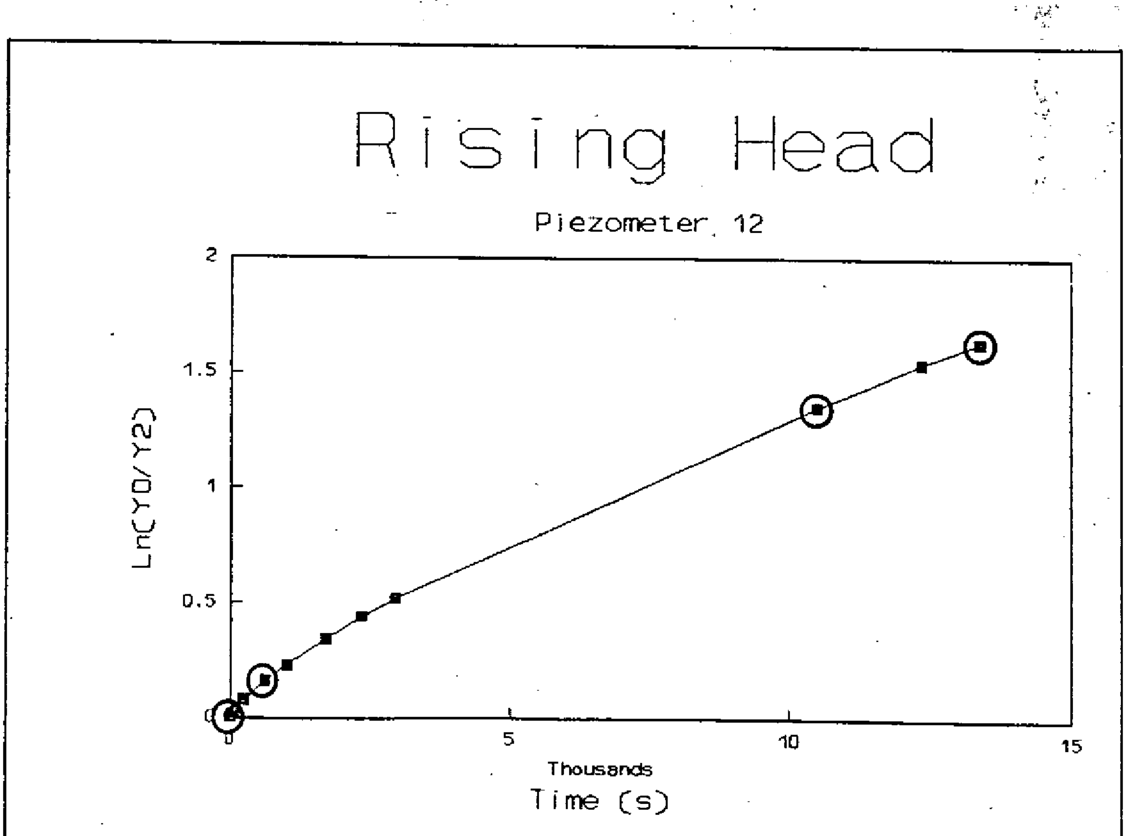

Rising Head
Piezometer 8
4
3.5
3
2.5
2
1.5
1
0.5
0
Ln(Y0/Y2)
0
5
10
15
20
Thousands
Time (s)


Rising Head
Piezometer 9
Ln(Y0/Y2)
3
2.5
2
1.5
1
0.5
0
200
400
600
800
1000
1200
Time (s)

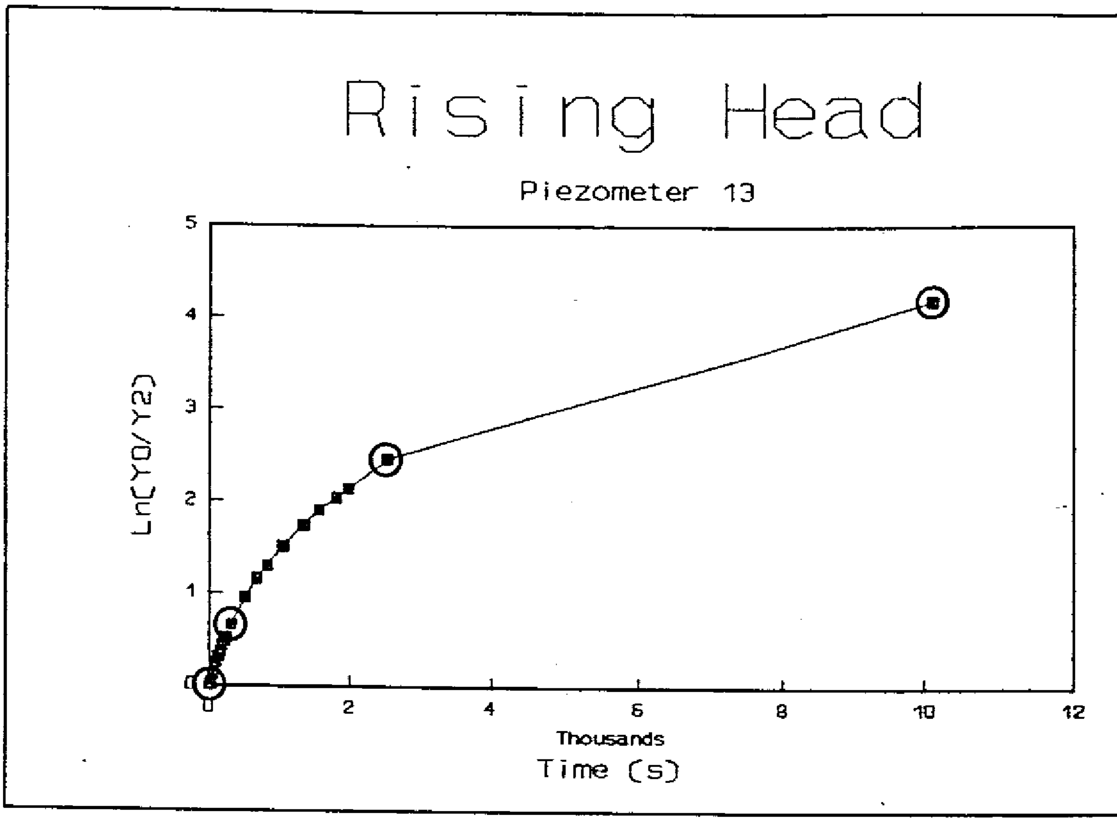

Rising Head
Piezometer 10
Ln(Y0/Y2)
3.5
3
2.5
2
1.5
1
0.5
0
5
10
15
Thousands
Time (s)

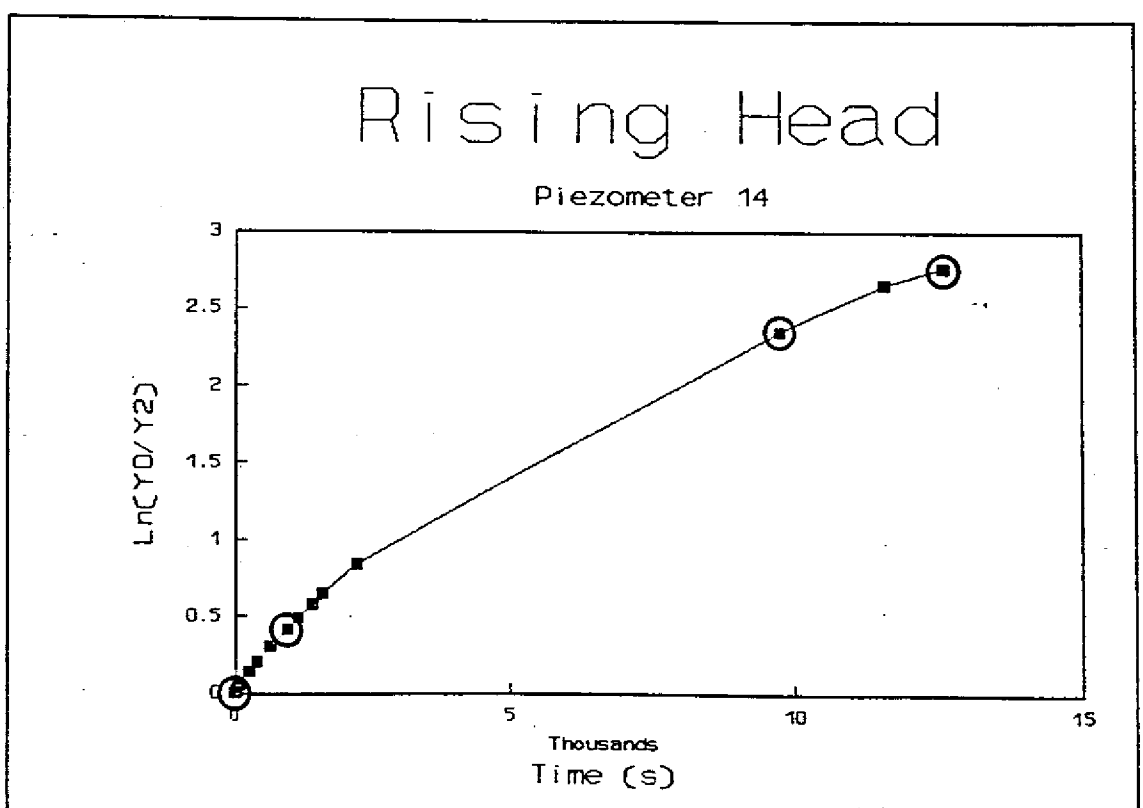


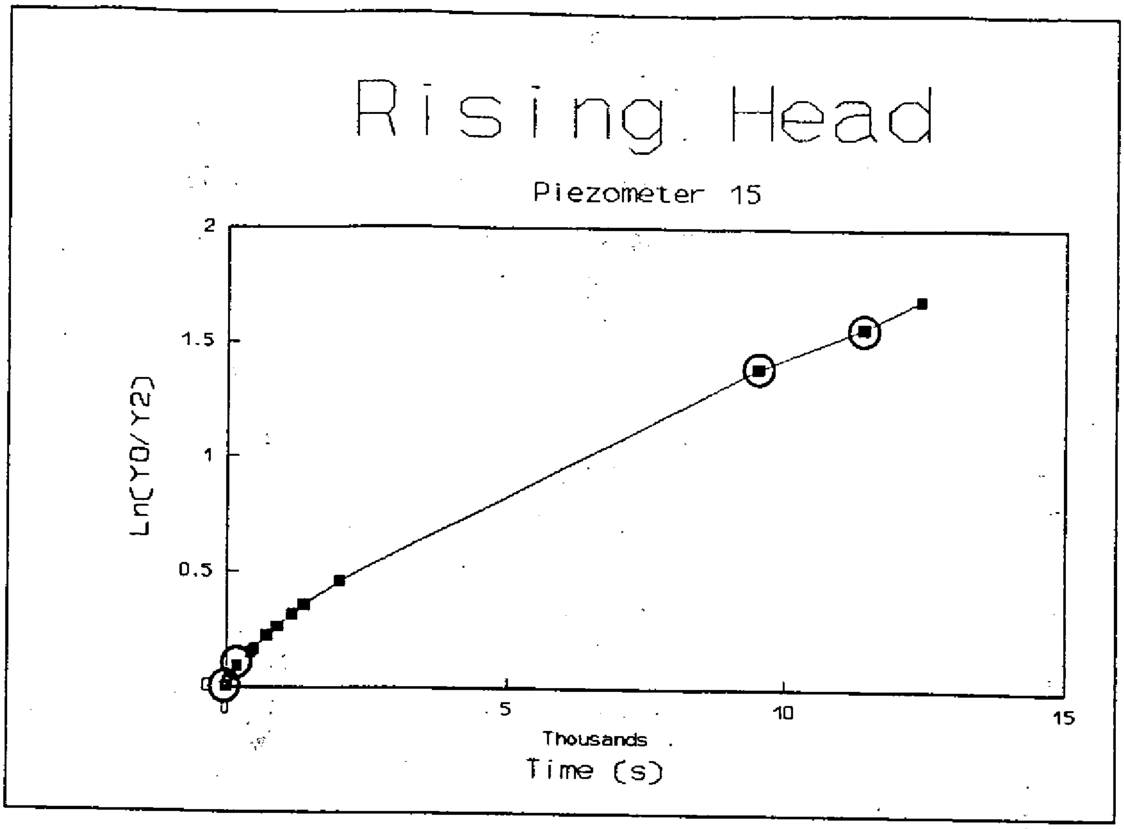
Rising Head
Piezometer 11
Ln(Y0/Y2)
0
1
2
3
4
0
5
10
15
Thousands
Time (s)

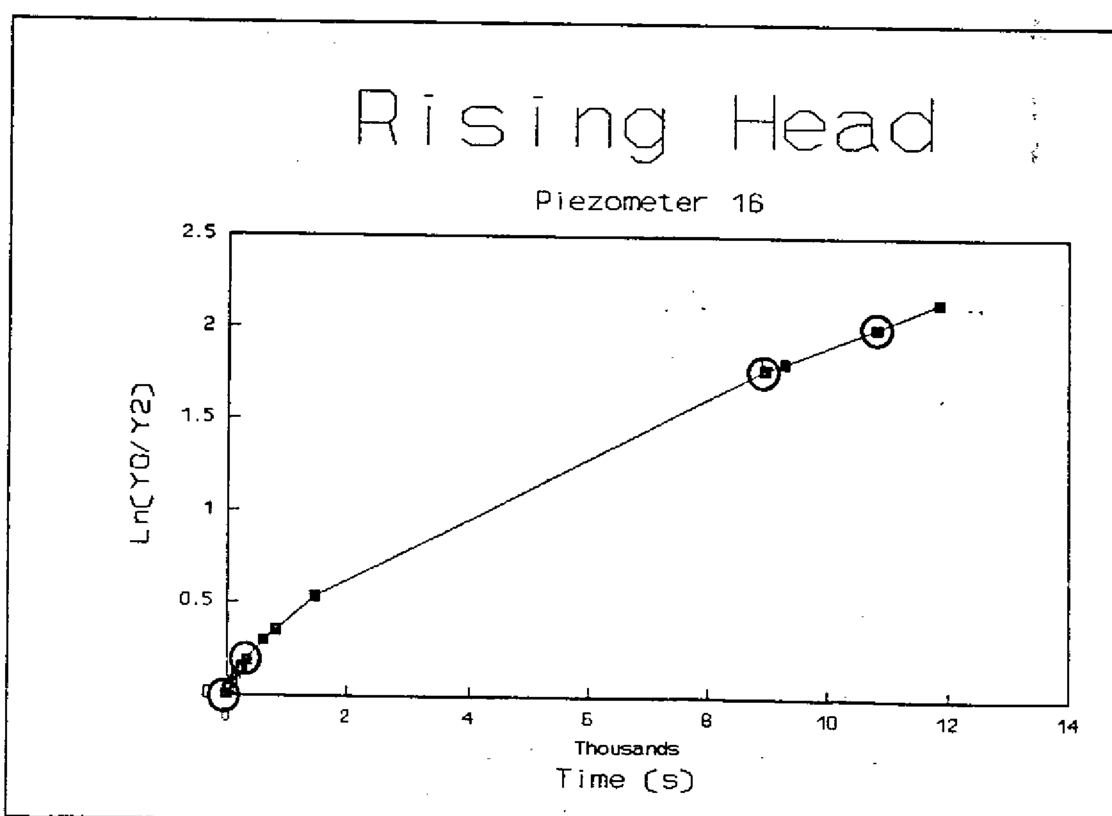


Rising Head
Piezometer 12
Ln(Y0/Y2)
0
0.5
1
1.5
2
0
5
10
15
Thousands
Time (s)


Rising Head
Piezometer 13
Ln(Y0/Y2)
Thousands
Time (s)


Rising Head
Piezometer 14
Ln(Y0/Y2)
Thousands
Time (s)

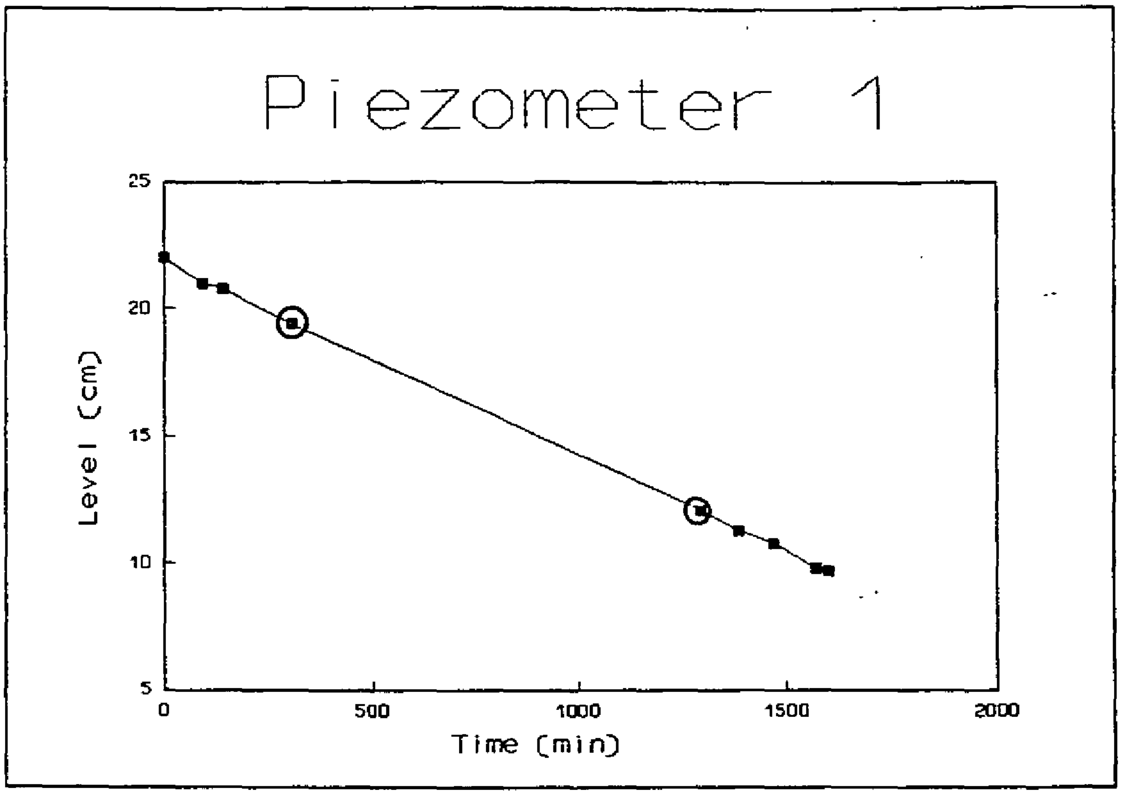

Rising Head
Piezometer 15
Ln(Y0/Y2)
Thousands
Time (s)
0
0.5
1
1.5
2
5
10
15

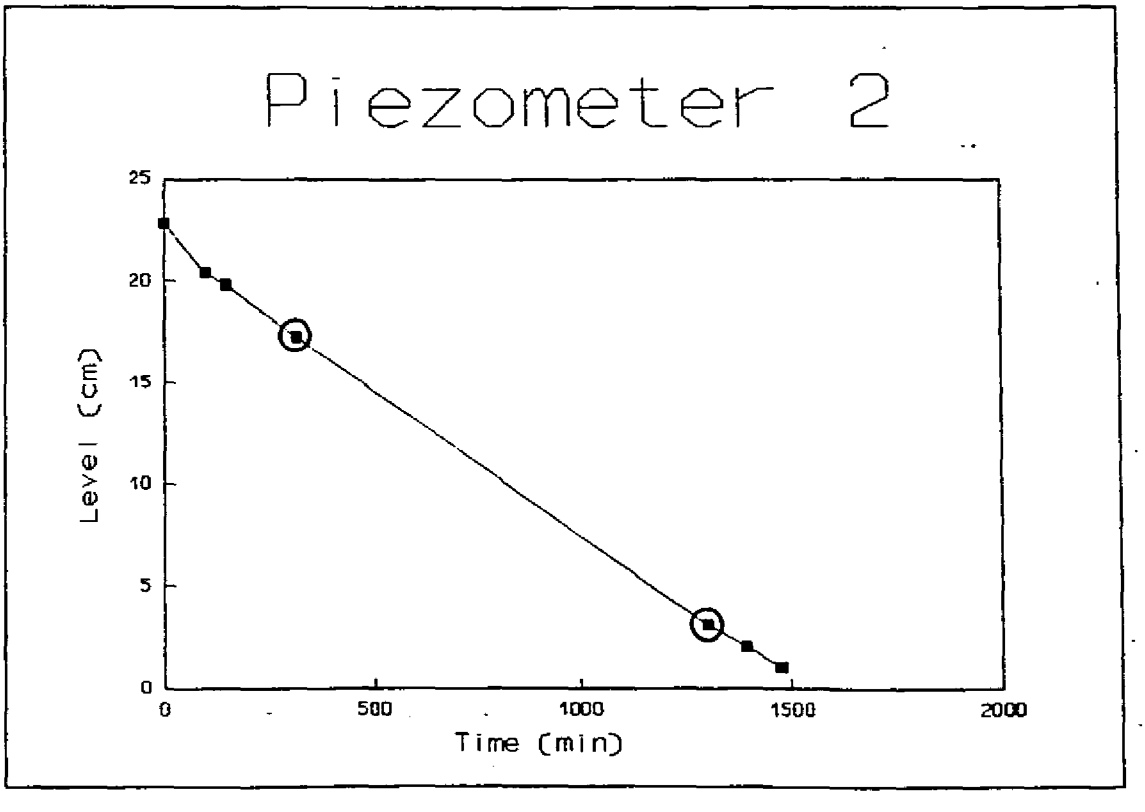

Rising Head
Piezometer 16
Ln(Y0/Y2)
Thousands
Time (s)
0
0.5
1
1.5
2
2.5
2
4
6
8
10
12
14

APPENDIX 6.3

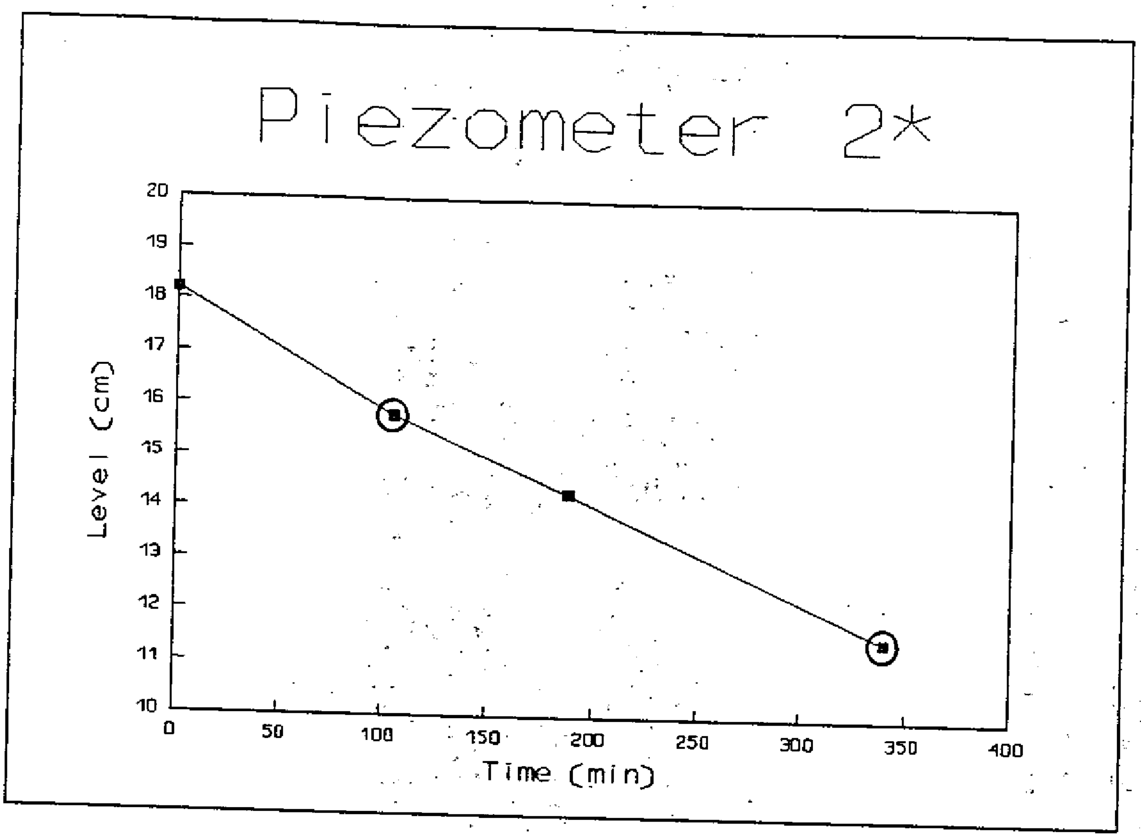
Constant Head

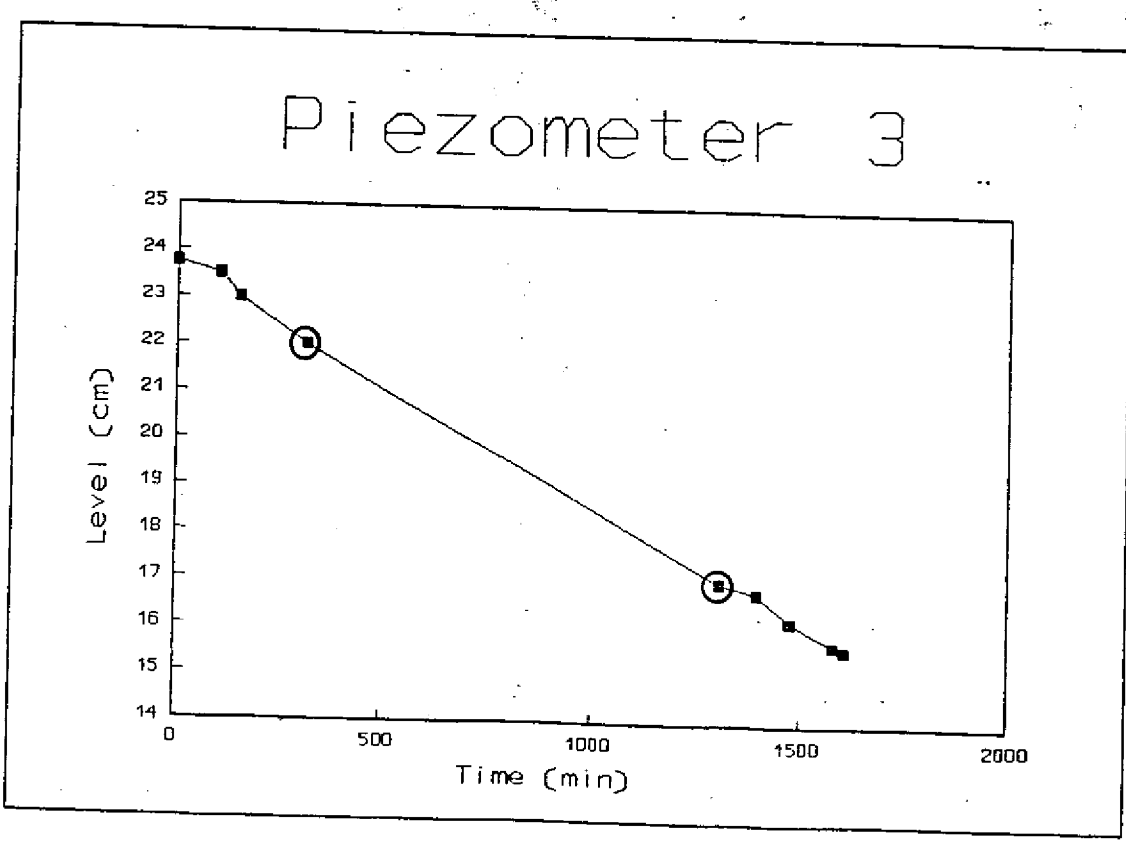
CONSTANT HEAD



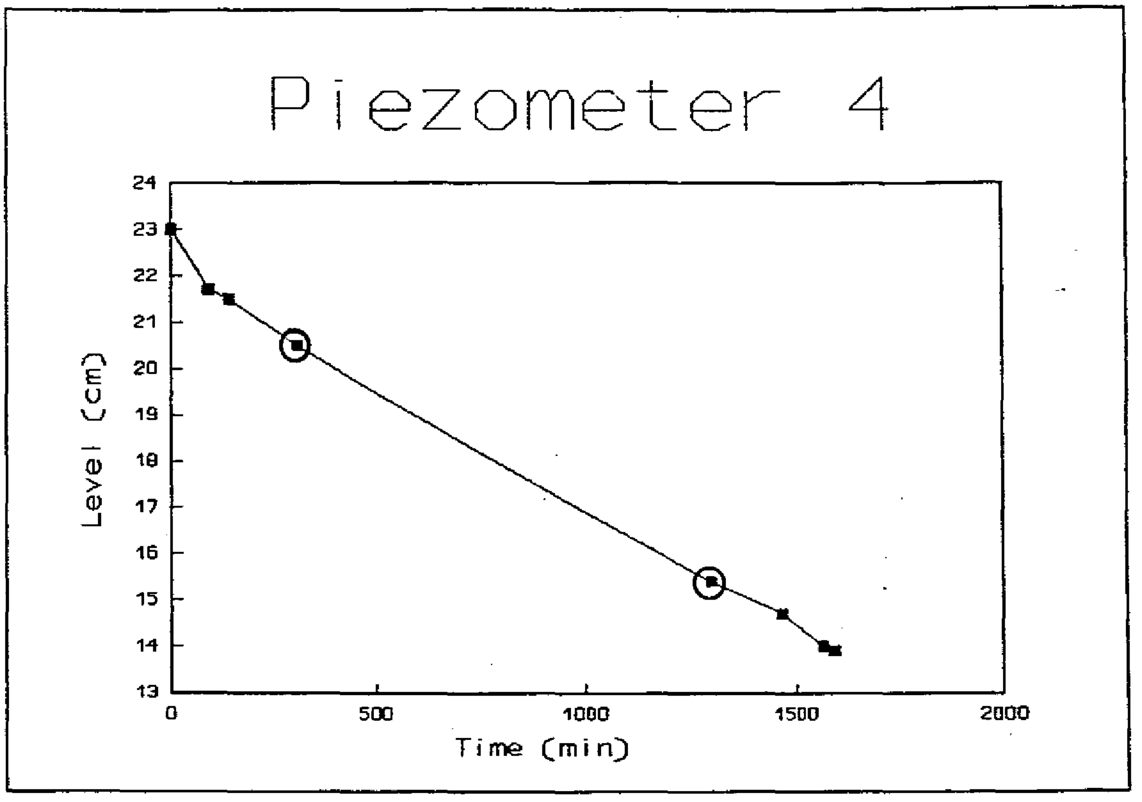


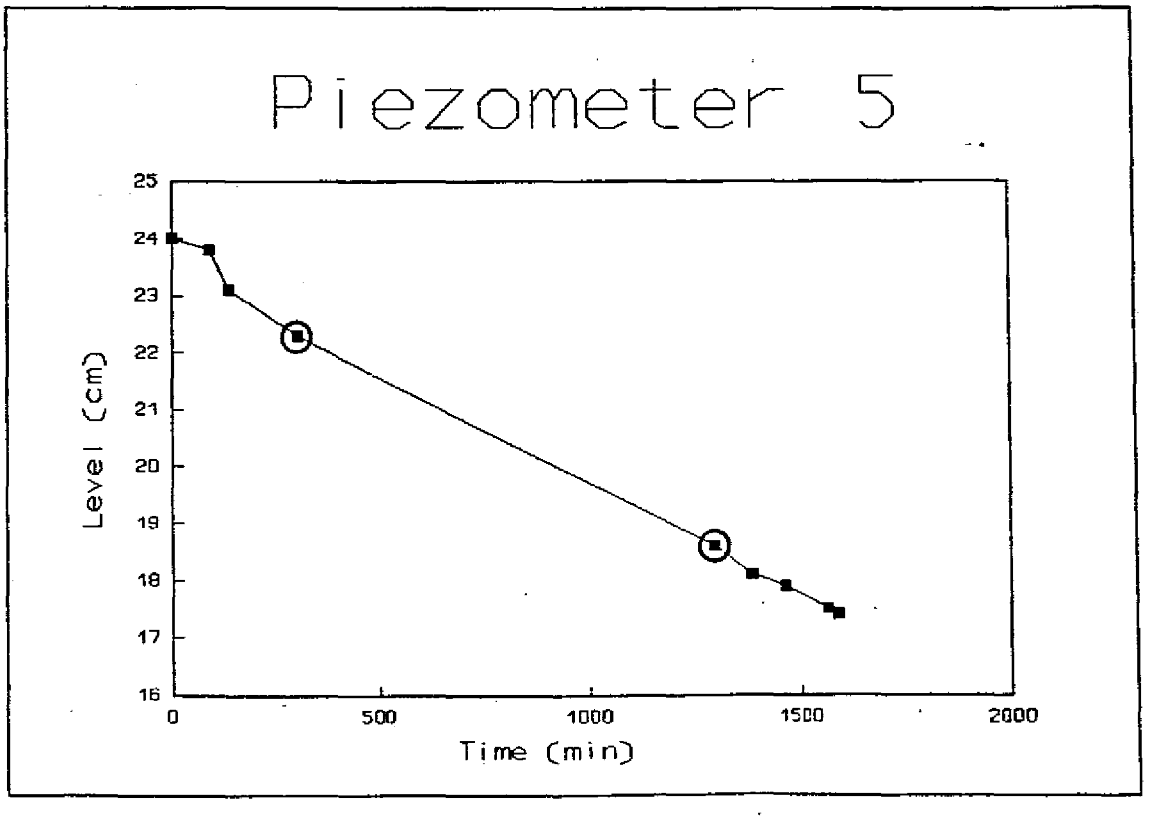
CONSTANT HEAD



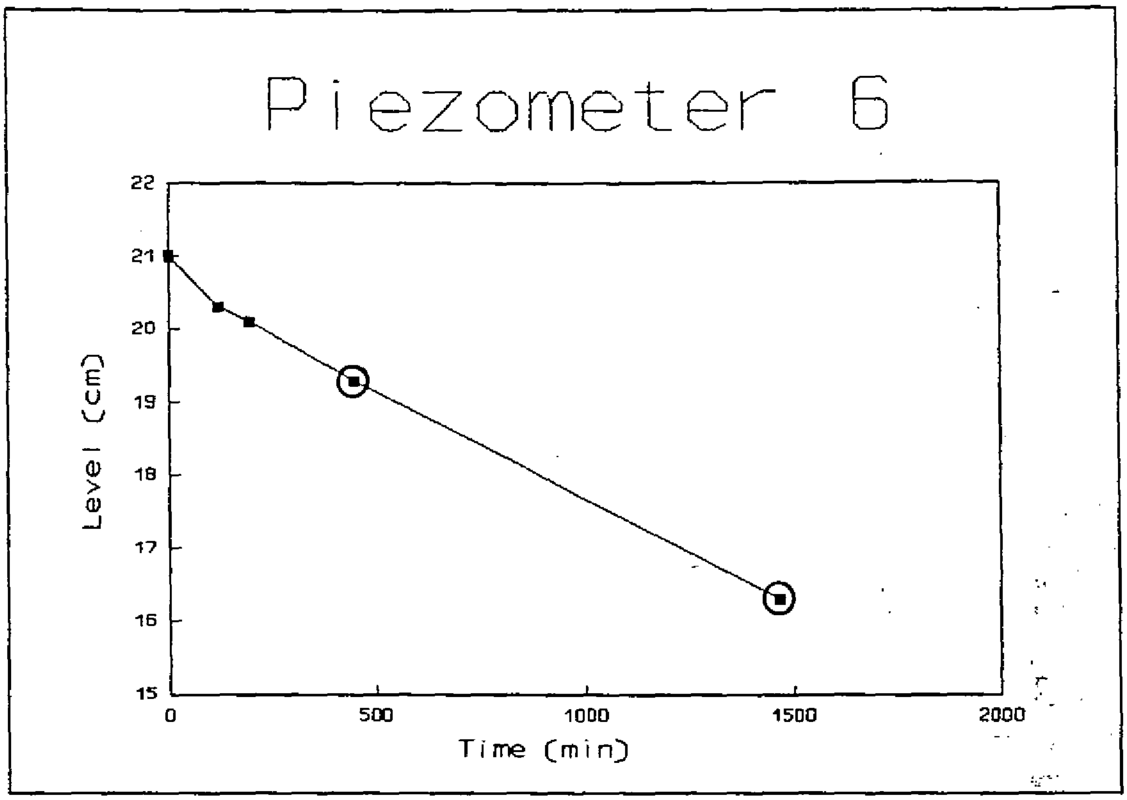


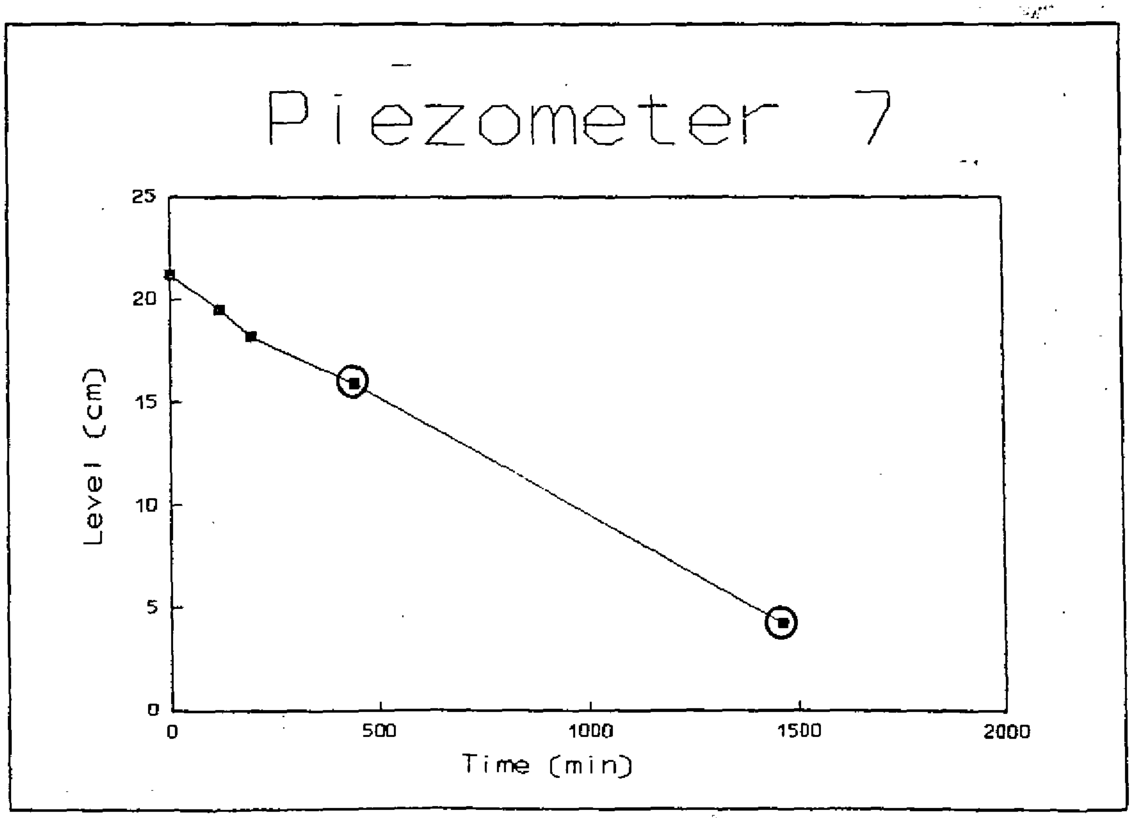
CONSTANT HEAD



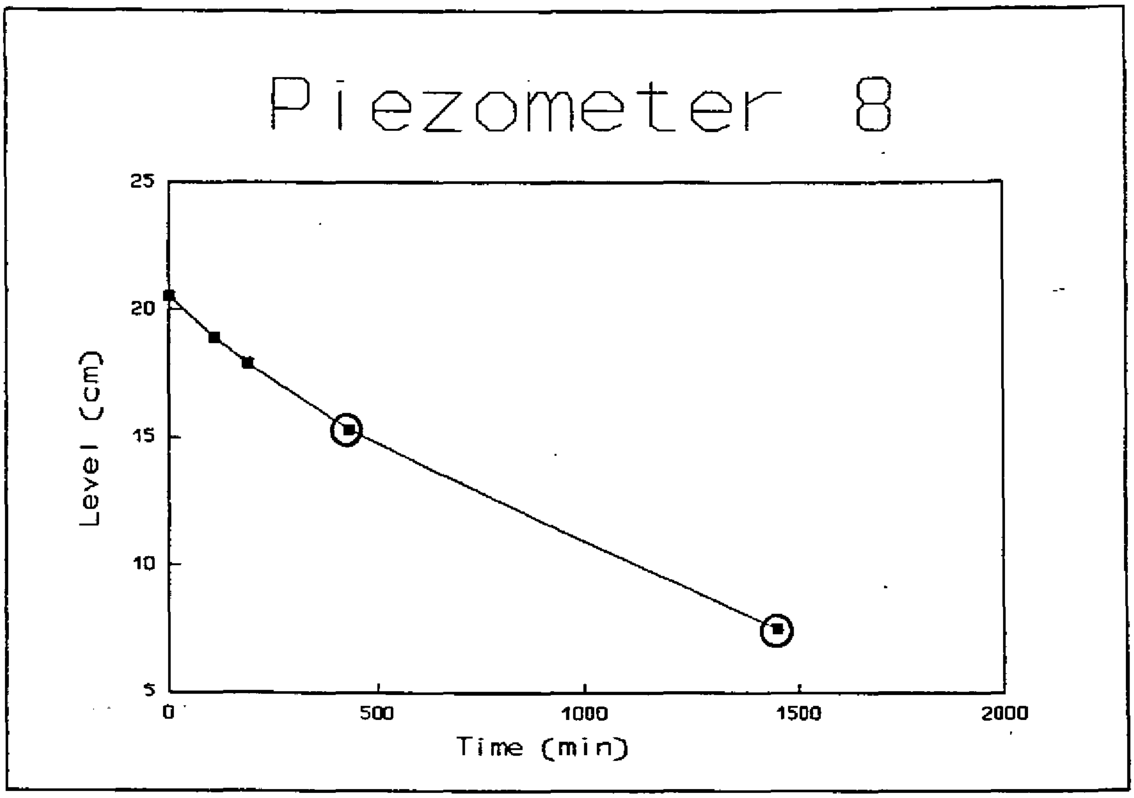


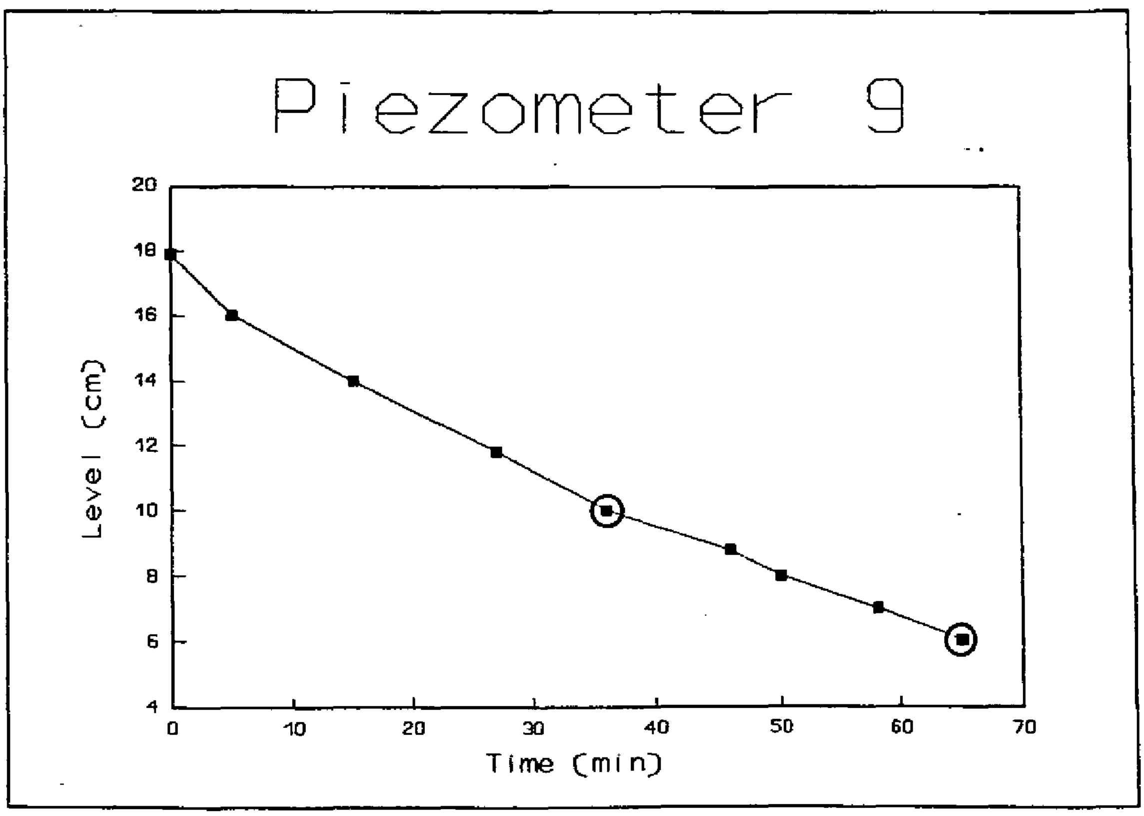
CONSTANT HEAD



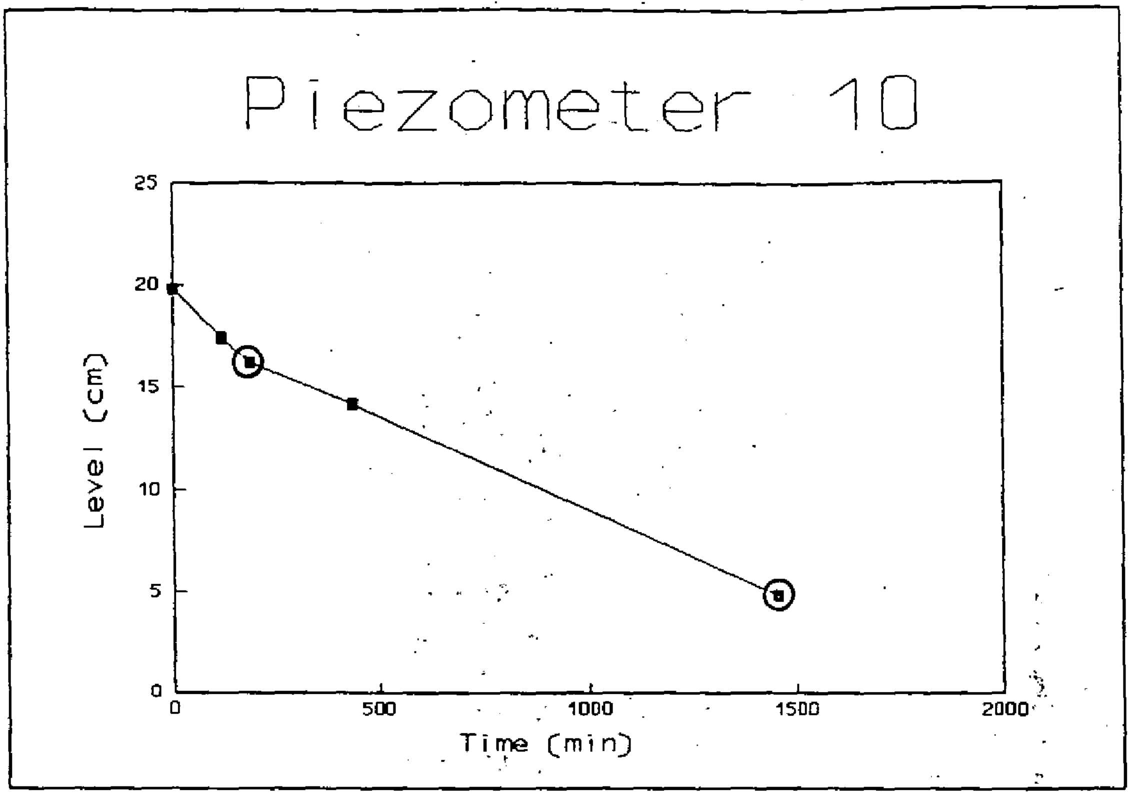


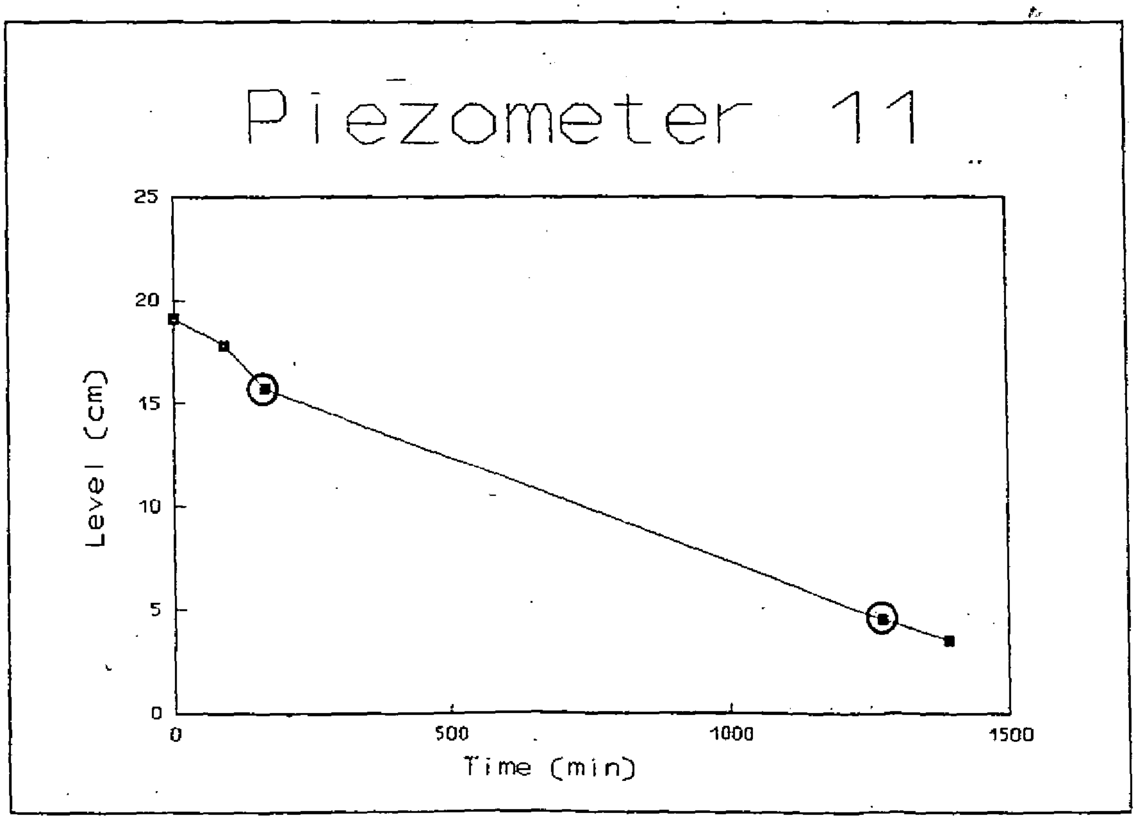
CONSTANT HEAD



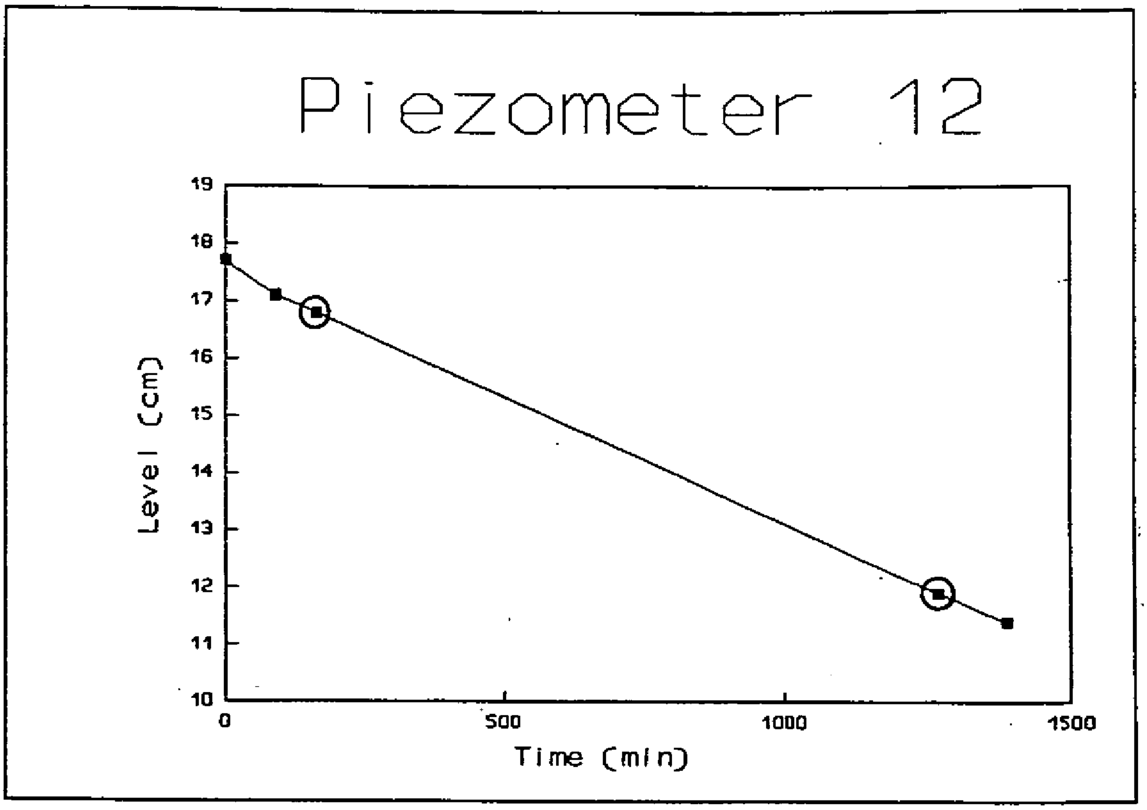


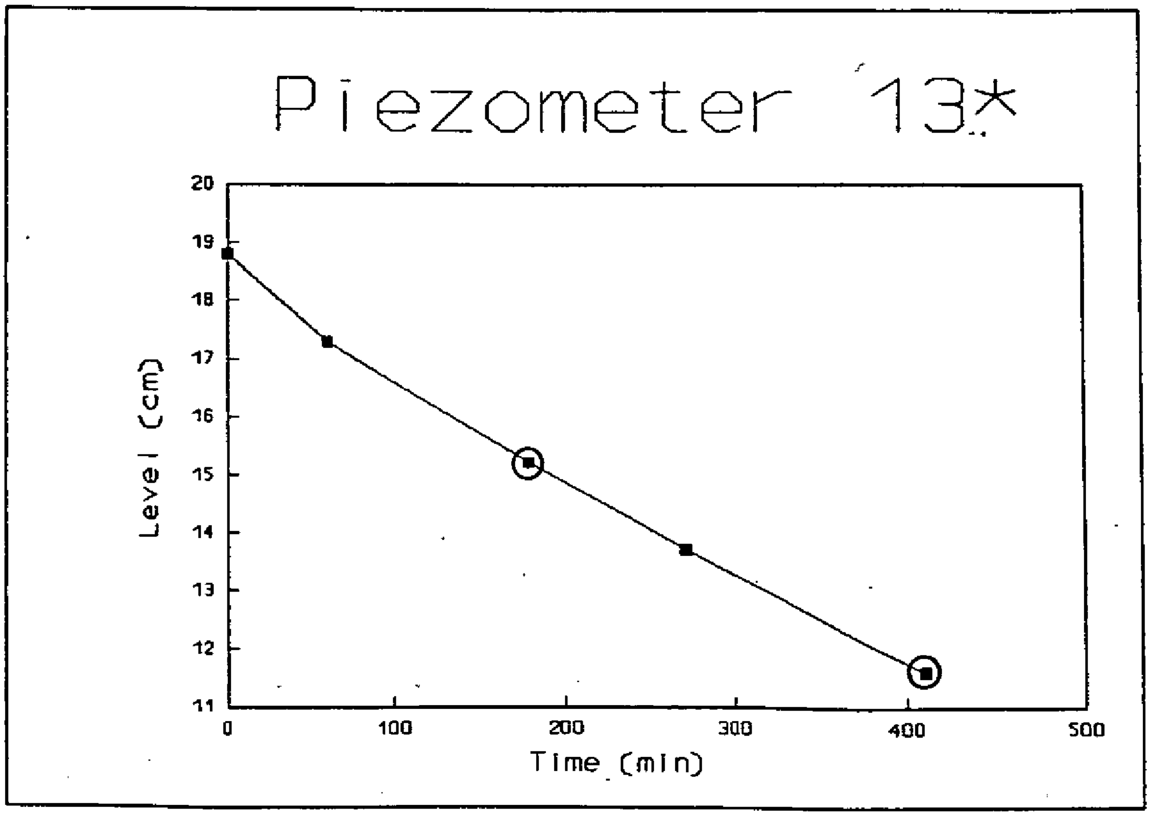
CONSTANT HEAD



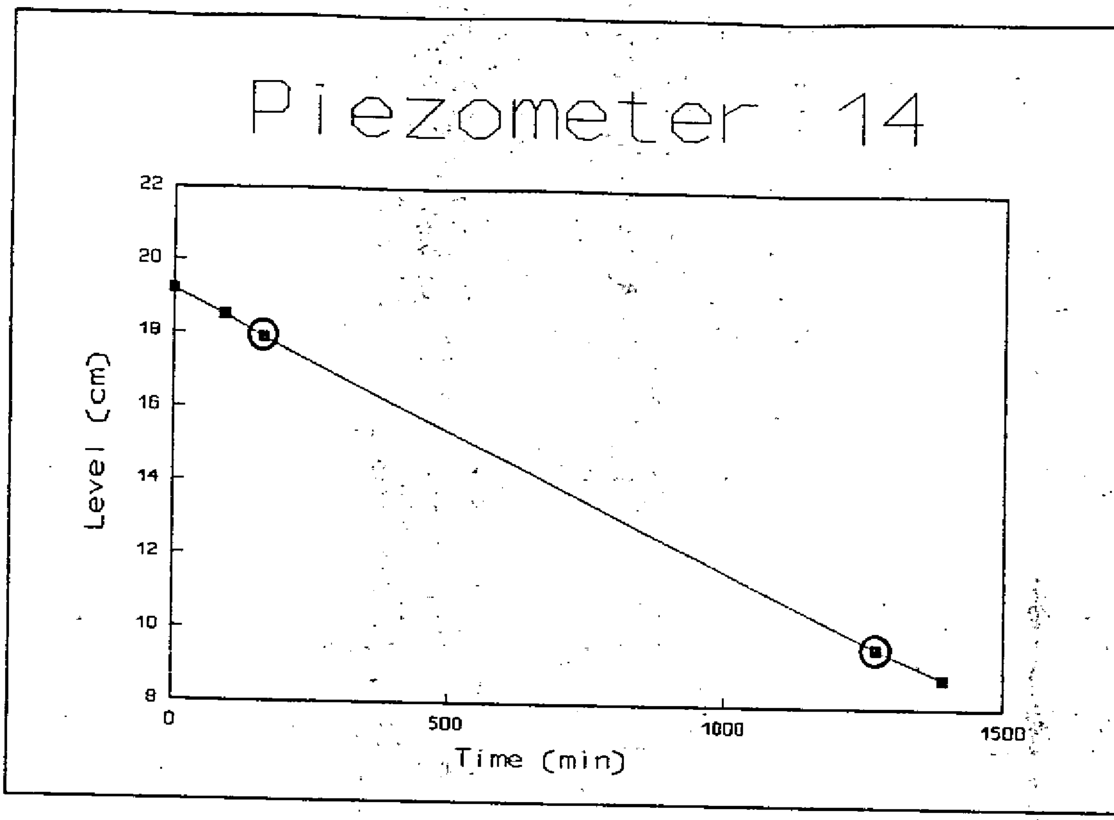


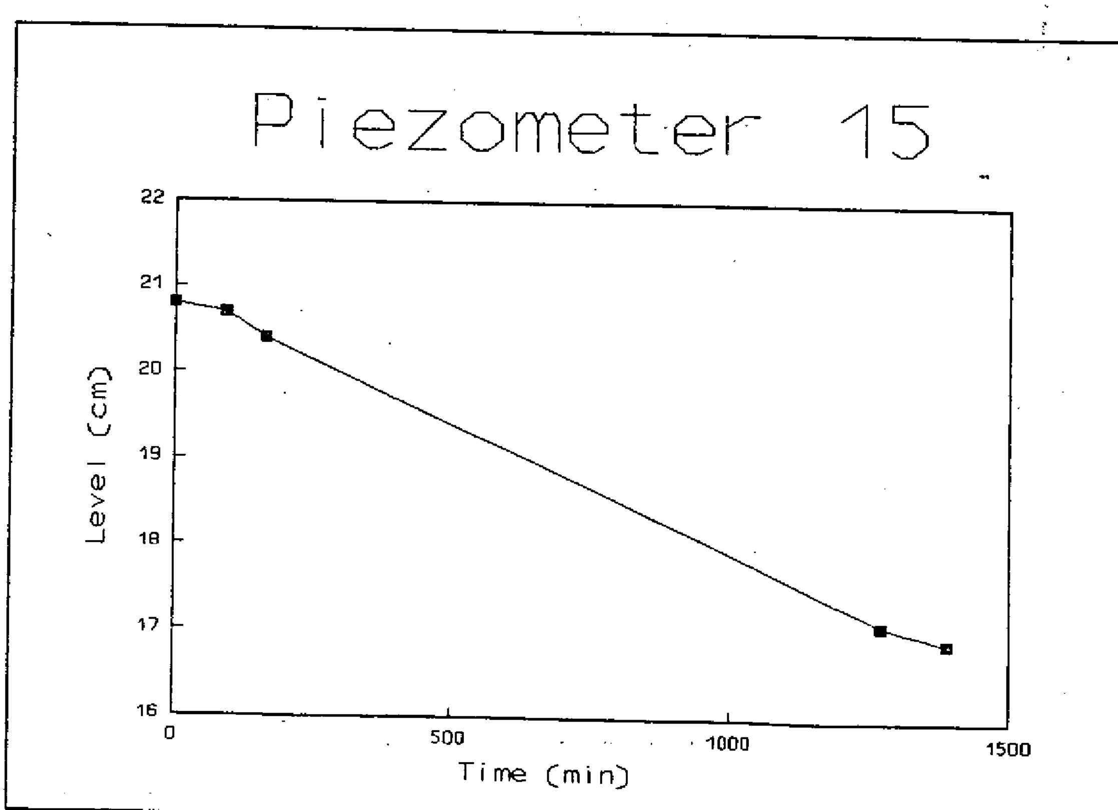
CONSTANT HEAD



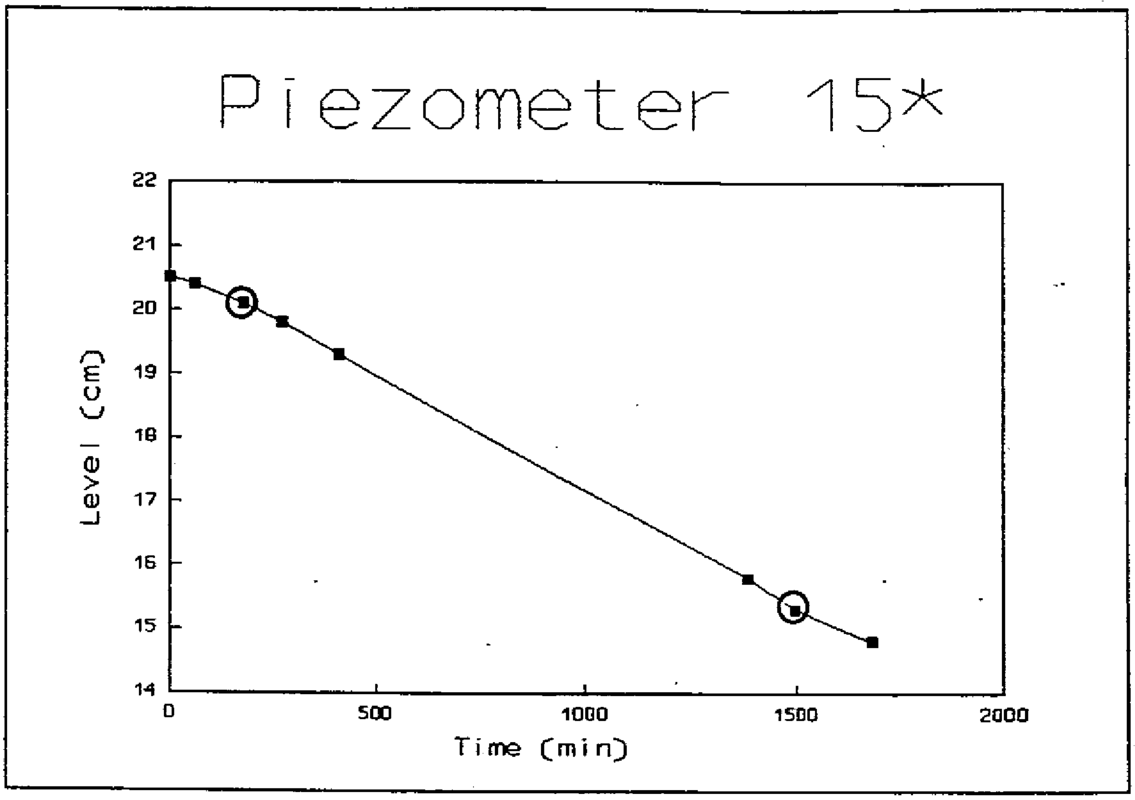


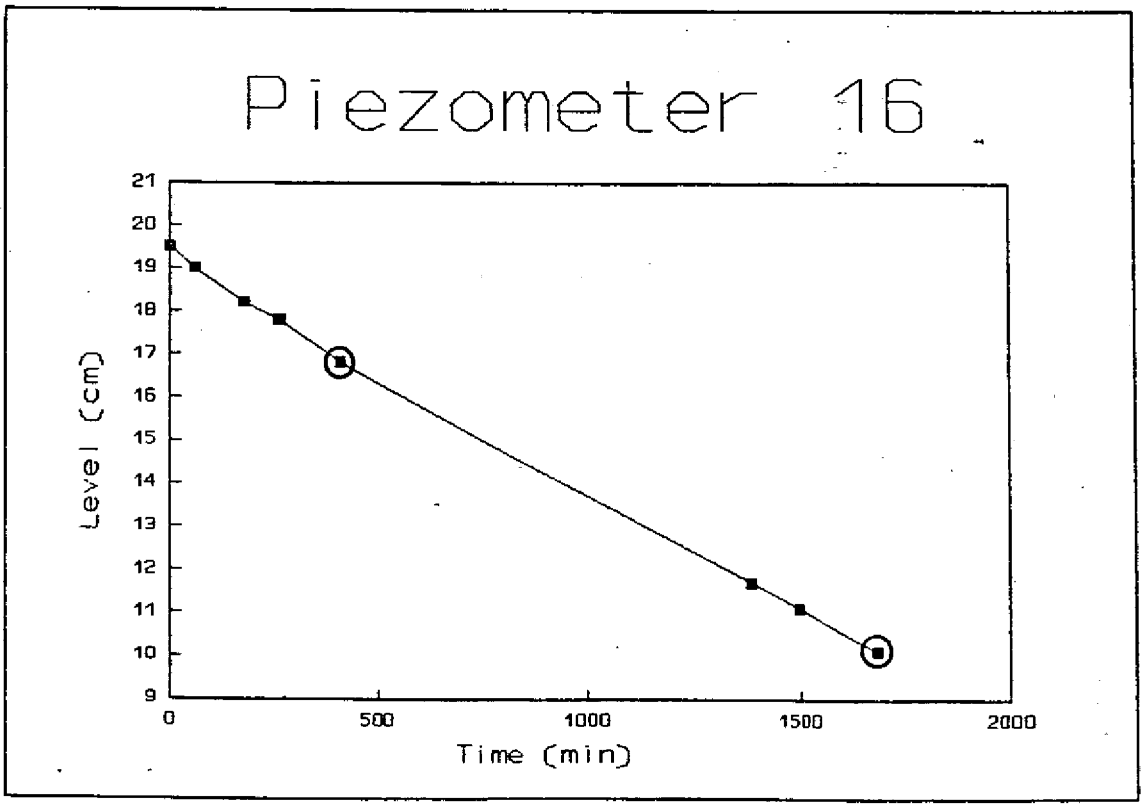
CONSTANT HEAD





CONSTANT HEAD





APPENDIX 6.4

Calculated permeability with Falling Head

FALLING HEAD
uitwerking volgens Kirkham

k={(864*pi*R^2)/A(t2-t1)}ln(h1/h2)

A bij 20 cm filter 43 cm A uit formule van "Gibson"
A bij 10 cm filter 28 cm

constante 864*pi*R^2 2992.555

FALLING HEAD

piezometer 1	20 cm & 20%		piezometer 2	10 cm & 10%		piezometer 3	20 cm & 10%		piezometer 4	10 cm & 20%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	60		0	53.4		0	41.6		0	49.7	
183	46.8	0.094489	159	39.2	0.207794	240	36.4	0.038721	206	42.2	0.084871
time	head		time	head		time	head		time	head	
7775	7.6		5737	5		6142	11.3		5482	15.9	
11445	5	0.00794	10692	2.2	0.017708	9872	7.6	0.007401	9242	11.7	0.008719

piezometer 5	20 cm & 20%		piezometer 6	20 cm & 10%		piezometer 7	10 cm & 20%		piezometer 8	10 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	42.3		0	41.5		0	41.1		0	59.1	
169	37.7	0.047409	291	37.6	0.023602	158	35.6	0.097179	262	40.4	0.155176
time	head		time	head		time	head		time	head	
5669	11.1		5027	16.1		4650	8.6		6614	5.5	
8600	7.5	0.009309	7962	11.3	0.008394	7583	5.5	0.016289	7214	3.1	0.102129

piezometer 9	20 cm & 20%		piezometer 10	20 cm & 10%		piezometer 11	10 cm & 20%		piezometer 12	10 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	25.7		0	49.3		0	43.6		0	57.3	
88	12.2	0.589223	118	43.3	0.076537	95	28.6	0.474366	66	55.3	0.057532
time	head		time	head		time	head		time	head	
5327	0.6		2640	18.7		2070	5.2		1884	33.6	
6062	0.5	0.017263	5540	11.9	0.010847	4963	3	0.020321	4238	22.3	0.018612

piezometer 13	20 cm & 20%		piezometer 14	20 cm & 10%		piezometer 15	10 cm & 20%		piezometer 16	10 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	61.5		0	62.3		0	63		0	65.1	
62	47.5	0.289947	130	51	0.107141	87	58.2	0.097356	91	57.6	0.143758
time	head		time	head		time	head		time	head	
1928	8.5		1742	19.4		1179	39.1		985	32.8	
3269	5.3	0.024514	2752	13.7	0.023971	2228	31	0.023651	1301	28.8	0.043986

piezometer 3*	20 cm & 10%		piezometer 4*	10 cm & 20%		piezometer 5*	20 cm & 20%		piezometer 6*	20 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	21.8		0	25.4		0	34.1		0	32.8	
863	16.3	0.023446	210	22	0.073138	257	28.1	0.052406	587	27.5	0.020895
time	head		time	head		time	head		time	head	
7642	4.9		7922	5.3		7235	5.2		9637	6.8	
12407	2.9	0.007661	12717	3.2	0.011246	11285	2.8	0.010637	14977	3.9	0.007245

---

piezometer 9*	20 cm & 20%		piezometer 10*	20 cm & 10%		piezometer 12*	10 cm & 10%		piezometer 14*	20 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	11.9		0	29.9		0	35.4		0	28.8	
90	5.3	0.625445	431	19.7	0.067372	503	30.5	0.031656	398	22.2	0.045513
time	head		time	head		time	head		time	head	
1190	1.3		5804	4.2		8388	8.9		8565	2.9	
2800	0.8	0.020987	13144	1.8	0.008034	14413	4.5	0.012097	13550	1.5	0.009204

---

piezometer 15*	10 cm & 20%		piezometer 1*	20 cm & 20%	
time	head	k (m/d)	time	head	k (m/d)
0	31.9		0	14.3	
497	26.2	0.042331	437	9.8	0.060179
time	head		time	head	
8665	8.1		6805	1.6	
15540	4.5	0.009138	12310	0.9	0.007274

APPENDIX 6.5

Calculated permeability with Rising Head

Rising head

piezometer test rising head 9-5-91

According to Kirkham

k=((864*pi*R^2)/A(t2-t1))ln(h1/h2)

A bij 20 cm filter 43 cm A from Appendix 6.13
A bij 10 cm filter 28 cm

constante 864*pi*R^2 2992.555

piezometer 1	20 cm & 20%		piezometer 2	10 cm & 10%		piezometer 3	20 cm & 10%		piezometer 4	10 cm & 20%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	77.3		0	18.3		0	26.7		0	28.2	
650	46.8	0.053728	653	9.8	0.102215	706	20.1	0.02799	243	24.5	0.061861
time	head		time	head		time	head		time	head	
4309	3.4		2913	2.4		6302	7.2		5989	7.4	
17182	2.7	0.005584	5866	0.9	0.035499	15714	2.6	0.007532	15397	2.5	0.012328

piezometer 5	20 cm & 20%		piezometer 6	20 cm & 10%		piezometer 7	10 cm & 20%		piezometer 8	10 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	20.5		0	30.6		0	25.4		0	26.8	
762	16.6	0.019273	775	24.7	0.019235	137	21.3	0.137335	593	19.3	0.059169
time	head		time	head		time	head		time	head	
5675	6.5		5454	11		3260	4.5		4760	4.4	
15085	1.8	0.005924	14856	3.5	0.005364	4805	2.8	0.032821	14144	0.9	0.018074

piezometer 9	20 cm & 20%		piezometer 10	20 cm & 10%		piezometer 11	10 cm & 20%		piezometer 12	10 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	13.7		0	27.3		0	30.7		0	27.1	
95	4.6	0.799484	368	18.6	0.072568	341	13.7	0.25289	649	23.1	0.026299
time	head		time	head		time	head		time	head	
419	1.8		11345	1.8		10798	1		10516	7	
787	1.2	0.035855	14217	1.1	0.002411	12658	0.9	0.006054	13398	5.3	0.010317

piezometer 13	20 cm & 20%		piezometer 14	20 cm & 10%		piezometer 15	10 cm & 20%		piezometer 16	10 cm & 10%	
time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)	time	head	k (m/d)
0	32.8		0	27.1		0	29.3		0	34.9	
294	17	0.155573	938	17.9	0.030771	210	26.8	0.04539	346	29	0.057204
time	head		time	head		time	head		time	head	
2524	2.8		9721	2.6		9515	7.3		9273	5.7	
10106	0.5	0.011864	12626	1.7	0.002342	11395	6.1	0.010209	10819	4.7	0.013336

APPENDIX 6.6

Calculated permeability with Constant Head

$$k = Q_{infin} / (A * y_0)$$

k = hydraulic conductivity (m/s)
Q infin = steady flow rate (m3/s)
y0 = constant imposed head (m)
A = shape factor (m) (see Appendix 6.13)

$$S = 2 * pie * L / \ln (L/d + (1 + (L/d)^2)^{1/2})$$

L = filter lenght of tube (m)
d = internal diameter of tube (m)

location: near lysimeterspot at Raheenmore

tube number	1	2	2*	3	4	5	6	7	8
filterlenght (cm)	20	10	10	20	10	20	20	10	10
perforation percentage	20	10	10	10	20	20	10	20	10
head in piez. (cm)	79.9	76.3	76	76	79.8	70.4	79.1	69.8	80
diff. head vessel and top piez. (cm)	51.6	54.5	47.2	38.3	42.2	40.3	50.5	30.5	39.5
imposed head y0 (m)	0.283	0.218	0.288	0.377	0.376	0.301	0.286	0.393	0.405
lenght open section L (m)	0.2	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.1
internal diameter d (m)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
shape factor A (m)	0.426025	0.277448	0.277448	0.426025	0.277448	0.426025	0.426025	0.277448	0.277448
waterlevel vessel t1 (cm)	19.4	17.2	15.8	22	20.5	22.3	19.3	15.9	15.3
waterlevel vessel t2 (cm)	12.1	3.1	11.5	17	15.4	18.6	16.3	4.2	7.5
time difference (min)	990	990	235	990	990	990	1018	1015	1020
discharge Q infin (l/s)	0.000043	0.000083	0.000107	0.000029	0.00003	0.000022	0.000017	0.000067	0.000045
hydraulic conduct. (cm) k (m/day)	0.030825	0.11868	0.115414	0.015849	0.024888	0.014689	0.01219	0.053282	0.0343

tube number	9	10	11	12	13	14	15*	16
filterlenght (cm)	20	20	10	10	20	20	10	10
perforation percentage	20	10	20	10	20	10	20	10
head in piez. (cm)	74	84.4	72	76.4	79.8	76	81.1	81.8
diff. head vessel and top piez. (cm)	46.5	48.2	48.3	40.5	52.2	44.7	52	48.6
imposed head y0 (m)	0.275	0.362	0.237	0.359	0.276	0.313	0.291	0.332
lenght open section L (m)	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1
internal diameter d (m)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
shape factor A (m)	0.426025	0.426025	0.277448	0.277448	0.426025	0.426025	0.277448	0.277448
waterlevel vessel t1 (cm)	10	16.2	15.7	16.8	15.2	17.9	20.1	16.8
waterlevel vessel t2 (cm)	6	4.8	4.5	11.9	11.6	9.6	14.8	10.1
time difference (min)	29	1268	1107	1105	232	1105	1508	1276
discharge Q infin (l/s)	0.000805	0.000052	0.000059	0.000026	0.000091	0.000044	0.000021	0.000031
hydraulic conduct. (cm) k (m/day)	0.593369	0.029381	0.077548	0.022438	0.066512	0.02839	0.02194	0.02873

APPENDIX 6.7

Results and ANOVA-tables

Explanation of the numbers:

	S	F	P	T
1	Cork	10 cm	10 %	Rising Head
2	Furl	20 cm	20 %	Falling Head
3				Constant Head

RESULTS

OBS	TUBE	S	F	P	T	k [mm/d]	LOG(k)
1	1	1	2	2	1	5.6	0.74819
2	1	1	2	2	2	7.3	0.86332
3	1	1	2	2	3	30.8	1.48855
4	2	1	1	1	1	35.5	1.55023
5	2	1	1	1	2	17.7	1.24797
6	2	1	1	1	3	118.7	2.07445
7	3	1	2	1	1	7.5	0.87506
8	3	1	2	1	2	7.7	0.88649
9	3	1	2	1	3	15.8	1.19866
10	4	1	1	2	1	12.3	1.08991
11	4	1	1	2	2	11.2	1.04922
12	4	1	1	2	3	24.9	1.39620
13	5	1	2	2	1	5.9	0.77085
14	5	1	2	2	2	10.6	1.02531
15	5	1	2	2	3	14.7	1.16732
16	6	1	2	1	1	5.4	0.73239
17	6	1	2	1	2	7.2	0.85733
18	6	1	2	1	3	12.2	1.08636
19	7	1	1	2	1	32.8	1.51587
20	7	1	1	2	2	16.3	1.21219
21	7	1	1	2	3	53.3	1.72673
22	8	1	1	1	1	18.1	1.25768
23	8	1	1	1	2	102.1	2.00903
24	8	1	1	1	3	34.3	1.53529
25	9	2	2	2	1	35.9	1.55509
26	9	2	2	2	2	21.0	1.32222
27	9	2	2	2	3	593.4	2.77335
28	10	2	2	1	1	2.4	0.38021
29	10	2	2	1	2	8.0	0.90309
30	10	2	2	1	3	29.4	1.46835
31	11	2	1	2	1	6.1	0.78533
32	11	2	1	2	2	20.3	1.30750
33	11	2	1	2	3	77.5	1.88930
34	12	2	1	1	1	10.3	1.01284
35	12	2	1	1	2	12.1	1.08279
36	12	2	1	1	3	22.4	1.35025
37	13	2	2	2	1	11.9	1.07555
38	13	2	2	2	2	24.5	1.38917
39	13	2	2	2	3	66.5	1.82282
40	14	2	2	1	1	2.3	0.36173
41	14	2	2	1	2	9.2	0.96379
42	14	2	2	1	3	28.4	1.45332
43	15	2	1	2	1	10.2	1.00860
44	15	2	1	2	2	9.1	0.95904
45	15	2	1	2	3	21.9	1.34044
46	16	2	1	1	1	13.3	1.12385
47	16	2	1	1	2	44.0	1.64345
48	16	2	1	1	3	28.7	1.45788

STATISTICAL ANALYSES

ALL DATA
ANOVA-table of Log(k)

Source	Dimensions of Freedom	Sum of Squares	Mean Square	F-value	Pr > F
Level	1	74.48724			
S	1	0.02365	0.02365	0.29	>0.05
F	1	0.62051	0.62051	7.70	0.0240
P	1	0.15980	0.15980	1.98	>0.05
S*F	1	0.87273	0.87273	10.82	0.0118
S*P	1	0.58172	0.58172	7.21	0.0291
F*P	1	0.99197	0.99197	12.30	0.0085
F*P*S	1	0.14927	0.14927	1.85	>0.05
ERROR 1	8	0.64505	0.08063		
T	2	2.89014	1.44507	25.79	0.0001
S*T	2	0.30443	0.15221	2.72	0.0864
F*T	2	0.22228	0.11114	1.98	0.1595
P*T	2	0.19733	0.09867	1.76	0.1934
ERROR 2	24	1.34463	0.05603		
Total	48	9.00352			

REDUCED MODEL
ANOVA-table of Log(k)

Source	Dimensions of Freedom	Sum of Squares	Mean Square	F-value	Pr > F
Level	1	74.48724			
S	1	0.023654	0.023645	0.27	>0.05
F	1	0.620511	0.620511	7.03	0.0272
P	1	0.159803	0.159803	1.81	>0.05
S*F	1	0.872733	0.872733	9.89	0.0130
S*P	1	0.581717	0.581717	6.59	0.0324
F*P	1	0.991972	0.991972	11.24	0.0089
ERROR 1	9	0.794325	0.088258		
T	2	2.890138	1.445069	20.96	0.0001
ERROR 2	30	2.068789	0.068956		
	48	2.644667			

FILTERLENGTH = 10 CM
ANOVA–table of Log(k)

Source	Dimensions of Freedom	Sum of Squares	Mean Square	F–value	Pr > F
Level	1				
S	1	0.304536	0.304536	3.82	>0.05
P	1	0.177742	0.177742	2.23	>0.05
S*P	1	0.070818	0.070818	0.89	>0.05
ERROR 1	4	0.318679	0.079670		
T	2	0.758561	0.379281	5.4	0.0183
ERROR 2	14	0.983698	0.070264		
Total	24	9.00352			

FILTERLENGTH = 20 CM
ANOVA–table of Log(k)

Source	Dimensions of Freedom	Sum of Squares	Mean Square	F–value	Pr > F
Level	1				
S	1	0.591842	0.591842	7.25	0.095
P	1	0.974033	0.974033	11.94	0.027
S*P	1	0.660173	0.660173	8.09	0.048
ERROR 1	4	0.326373	0.081593		
T	2	2.353859	1.176930	19.10	0.0001
ERROR 2	14	0.862699	0.061621		
Total	24	9.00352			

APPENDIX 6.8

Spearman Test

SPEARMAN TEST

	Rank numbers					
	Rising		Falling		Constant	
	K		K		K	
1	0.0056	4	0.0073	2	0.0308	10
2	0.0355	15	0.0177	11	0.1187	15
3	0.0075	7	0.0077	3	0.0158	3
4	0.0123	11	0.0112	8	0.0249	6
5	0.0059	5	0.0106	7	0.0147	2
6	0.0054	3	0.0072	1	0.0122	1
7	0.0328	14	0.0163	10	0.0533	12
8	0.0181	13	0.1021	16	0.0343	11
9	0.0359	16	0.0210	13	0.5934	16
10	0.0024	2	0.0080	4	0.0294	9
11	0.0061	6	0.0203	12	0.0775	14
12	0.0103	9	0.0121	9	0.0224	5
13	0.0119	10	0.0245	14	0.0665	13
14	0.0023	1	0.0092	6	0.0284	7
15	0.0102	8	0.0091	5	0.0219	4
16	0.0133	12	0.0440	15	0.0287	8

	Differences		
	Ris.&Fal.	Fal.&Con.	Ris.& Con.
	4	64	36
	16	16	0
	16	0	16
	9	4	25
	4	25	9
	4	0	4
	16	4	4
	9	25	4
	9	9	0
	4	25	49
	36	4	64
	0	16	16
	16	1	9
	25	1	36
	9	1	16
	9	49	16
Test criterion			
$d^2=$	186	244	304

H0: No rankcorrelation
H1: Rankcorrelation
Critical area: {x<388,x>1022}

All test criterions are in the left critical area. The Spearman test definitly shows a positive rankcorrelation. High values with all tests are measured at the same tubes.

APPENDIX 6.9

Wilcoxon Test

WILCOXON-TEST

W= The smallest sum of rank numbers of both groups.
Critical area: {x<55, x>81}
uncertainty is 10%
N=16 m=n=8

SEALING

Ho: The sealing of the tubes has no influence on the hydraulic conductivity

	Falling		*Rising*		*Constant*	
	CORK	*FURL*	*CORK*	*FURL*	*CORK*	*FURL*
	2	*13*	*4*	*16*	*10*	*16*
	11	*4*	*15*	*2*	*15*	*9*
	3	*12*	*7*	*6*	*3*	*14*
	8	*9*	*11*	*9*	*6*	*5*
	7	*14*	*5*	*10*	*2*	*13*
	1	*6*	*3*	*1*	*1*	*7*
	10	*5*	*14*	*8*	*12*	*4*
	16	*15*	*13*	*12*	*11*	*8*
W=	*58*			*64*	*60*	

The W-values are not in the critical area, so there is no reason to assume that the sealing has an influence on the hydraulic conductivity.

PERCENTAGE

Ho: The percentage of the holes in the filters of the the tubes has no influence on the hydraulic conductivity

	Falling		*Rising*		*Constant*	
	20 %	*10 %*	*20 %*	*10 %*	*20 %*	*10 %*
	2	*11*	*4*	*15*	*10*	*15*
	8	*3*	*11*	*7*	*6*	*3*
	7	*1*	*5*	*3*	*2*	*1*
	10	*16*	*14*	*13*	*12*	*11*
	13	*4*	*16*	*2*	*16*	*9*
	12	*9*	*6*	*9*	*14*	*5*
	14	*6*	*10*	*1*	*13*	*7*
	5	*15*	*8*	*12*	*4*	*8*
W=		*65*		*62*		*59*

The W–values are not in the critical area, so there is no reason to assume that the percentage of the holes in the filters has an influence on the hydraulic conductivity.

FILTERLENGTH

Ho: The filterlength of the tubes has no influence on the hydraulic conductivity.

	Falling		*Rising*		*Constant*	
	20 cm	*10 cm*	*20 cm*	*10 cm*	*20 cm*	*10 cm*
	2	*11*	*4*	*15*	*10*	*15*
	3	*8*	*7*	*11*	*3*	*6*
	7	*10*	*5*	*14*	*2*	*12*
	1	*16*	*3*	*13*	*1*	*11*
	13	*12*	*16*	*6*	*16*	*14*
	4	*9*	*2*	*9*	*9*	*5*
	14	*5*	*10*	*8*	*13*	*4*
	6	*15*	*1*	*12*	*7*	*8*
W=	*50*		*48*		*61*	

The W–values are not in the critical area for the Constant Head, so there is no reason to assume that the filterlength has an influence on the hydraulic conductivity.
For the Falling– & Rising Head however the test criterion W is in the critical area, hence the filterlength has an influence on the hydraulic conductivity with a certainty of 90%.

APPENDIX 6.10

Sign Test

THE SIGN TEST

Ho= The test has no influence on the result
Critical area: {0,1,2,14,15,16}

Differences between the tests.

	Rising	Falling		Rising	Constant		Falling	Constant	
1	0.0056	0.0073	+	0.0056	0.0308	+	0.0073	0.0308	+
2	0.0355	0.0177	–	0.0355	0.1187	+	0.0177	0.1187	+
3	0.0075	0.0077	+	0.0075	0.0158	+	0.0077	0.0158	+
4	0.0123	0.0112	–	0.0123	0.0249	+	0.0112	0.0249	+
5	0.0059	0.0106	+	0.0059	0.0147	+	0.0106	0.0147	+
6	0.0054	0.0072	+	0.0054	0.0122	+	0.0072	0.0122	+
7	0.0328	0.0163	–	0.0328	0.0533	+	0.0163	0.0533	+
8	0.0181	0.1021	+	0.0181	0.0343	+	0.1021	0.0343	–
9	0.0359	0.0210	–	0.0359	0.5934	+	0.0210	0.5934	+
10	0.0024	0.0080	+	0.0024	0.0294	+	0.0080	0.0294	+
11	0.0061	0.0203	+	0.0061	0.0775	+	0.0203	0.0775	+
12	0.0103	0.0121	+	0.0103	0.0224	+	0.0121	0.0224	+
13	0.0119	0.0245	+	0.0119	0.0665	+	0.0245	0.0665	+
14	0.0023	0.0092	+	0.0023	0.0284	+	0.0092	0.0284	+
15	0.0102	0.0091	–	0.0102	0.0219	+	0.0091	0.0219	+
16	0.0133	0.0440	+	0.0133	0.0287	+	0.0440	0.0287	–
			11 times +			16 times +			14 times +

11 is not in the critical area. The tests have no influence.

16 is in the critical area. The tests have influence

14 is in the critical area. The tests have influence

APPENDIX 6.11

Correlation between the permeabilities in the beginning and in the end of the test

RISING HEAD k [m/d]				
Tube	First k	Second k	k1/k2 (x)	1st Head (y)
1	0.0537	0.0056	9.59	77.3
2	0.1022	0.0355	2.88	18.3
3	0.0280	0.0075	3.73	26.7
4	0.0619	0.0123	5.03	28.2
5	0.0193	0.0059	3.27	20.5
6	0.0192	0.0054	3.56	30.6
7	0.1373	0.0328	4.19	25.4
8	0.0592	0.0181	3.28	26.8
9	0.7995	0.0359	22.27	13.7
10	0.0726	0.0024	30.25	27.3
11	0.2529	0.0061	41.46	30.7
12	0.0263	0.0103	2.55	27.1
13	0.1556	0.0119	13.08	32.8
14	0.0308	0.0023	13.39	27.1
15	0.0454	0.0102	4.45	29.3
16	0.0572	0.0133	4.30	34.9
		Mean:	10.45	29.79

RISING HEAD

	cov(x,y)	var.x	var.y
1	-41.107	0.749	2256.844
2	87.073	57.391	132.106
3	20.794	45.175	9.571
4	8.641	29.399	2.540
5	66.761	51.601	86.374
6	-5.562	47.597	0.650
7	27.543	39.296	19.305
8	21.493	51.540	8.963
9	-190.157	139.609	259.009
10	-49.365	391.858	6.219
11	28.098	961.274	0.821
12	21.284	62.429	7.256
13	7.880	6.870	9.038
14	-7.911	8.624	7.256
15	2.964	36.043	0.244
16	-31.423	37.870	26.074
Mean:	-2.062	122.958	177.017

$r = -0.014$

FALLING HEAD k[m/d]				
Tube	First k	Second k	k1/k2 (x)	1st Head (y)
1	0.0601	0.0073	8.23	14.3
2	0.2078	0.0177	11.74	53.4
3	0.0234	0.0077	3.04	21.8
4	0.0731	0.0112	6.53	25.4
5	0.0524	0.0106	4.94	34.1
6	0.0209	0.0072	2.90	32.8
7	0.0972	0.0163	5.96	41.1
8	0.1552	0.1021	1.52	59.1
9	0.6254	0.0210	29.78	11.9
10	0.0674	0.0080	8.43	29.9
11	0.4744	0.0203	23.37	43.6
12	0.0317	0.0121	2.62	35.4
13	0.2900	0.0245	11.84	61.5
14	0.0455	0.0092	4.95	28.8
15	0.0423	0.0091	4.65	31.9
16	0.1438	0.0440	3.27	65.1
		Mean:	8.36	36.88

FALLING HEAD

	cov(x,y)	var.x	var.y
1	2.873	0.016	509.913
2	55.833	11.424	272.869
3	80.250	28.315	227.444
4	21.049	3.361	131.819
5	9.503	11.674	7.735
6	22.273	29.783	16.657
7	-10.112	5.745	17.798
8	-151.987	46.792	493.673
9	-535.119	458.852	624.063
10	-0.453	0.004	48.738
11	100.844	225.280	45.142
12	8.503	32.951	2.194
13	85.590	12.087	606.083
14	27.593	11.659	65.307
15	18.489	13.777	24.813
16	-143.688	25.928	796.298
Mean:	-25.535	57.353	243.159

$r = -0.216$

APPENDIX 6.12

Augerings at the piezometertest

METHOD: DRILLING WITH A PEAT AUGER
PLACE: PIEZOMETERTEST

PIEZOMETER: 1

DEPTH	PEAT	HUMIFICATION DEGREE	COLOUR
2.50–2.60	reedpeat with many thick orange roots	4/5	3/2 7.5YR
2.60–2.80	reedpeat with alder	4/5	2/4 5YR
2.80–2.90	reedpeat	4	2/3 7.5YR
2.90–3.00	reedpeat with alder	4	2/3 7.5YR
	(and a lot of tiny yellow roots)	5/6	7.5 YR
3.00–3.05	reedpeat and alder	5	3/2 5YR
3.05–3.15	reedpeat and alder	5	3/4 7.5YR
3.15–3.25	reedpeat	4/5	3/2 7.5YR
3.25–4.00	reedpeat with birch and alder	4	3/2 7.5YR

PIEZOMETER: 2

DEPTH	PEAT	HUMIFICATION DEGREE	COLOUR
2.50–2.66	reedpeat	5	2/2 5YR
2.66–2.76	alder		6/6 2.5YR
2.76–3.00	reedpeat	5	2/4 5YR
3.00–3.17	reedpeat & alder	5	3/2 5YR
3.17–3.38	reedpeat	5	3/2 5YR
3.38–3.50	reedpeat & alder	5	2/3 5YR

PIEZOMETER: 5

DEPTH	PEAT	HUMIFICATION DEGREE	COLOUR
2.50–2.55	reedpeat	4/5	2/3 7.5YR
2.55–2.70	reedpeat and alder	4	2/4 5YR
2.70–2.88	reedpeat and yellow roots	4	2/2 5YR
2.88–2.96	reedpeat and leaves	3	2/1 5YR
2.96–3.00	reedpeat and alder	4	2/2 5YR
3.00–3.25	reedpeat	5	2/3 7.5YR
3.25–3.45	reedpeat	4	3/3 7.5YR
3.45–3.50	reedpeat and alder and leaves	4	2/2 7.5YR

PIEZOMETER: 6

DEPTH	PEAT	HUMIFICATION DEGREE	COLOUR
2.50–2.60	reedpeat	6	3/2 7.5YR
2.60–3.00	reedpeat & alder	5	3/3 7.5YR
3.00–3.20	reedpeat	6	2/2 5YR
3.20–3.30	reedpeat	6	2/3 7.5YR
3.30–3.47	reedpeat	6	2/3 7.5YR
3.47–3.50	alder		

PIEZOMETER: 9

DEPTH	PEAT	HUMIFICATION DEGREE	COLOUR
2.50–2.60	reedpeat	5	3/2 5YR
2.60–2.70	reedpeat & alder	5	3/3 5YR
2.70–2.83	reedpeat & alder	6	2/2 5YR
2.85–3.00	reedpeat	5	3/3 7.5YR
3.00–3.10	reedpeat	6	3/4 7.5YR
3.10–3.25	reedpeat	5	3/3 7.5YR
3.25–3.50	reedpeat	5	3/2 7.5YR

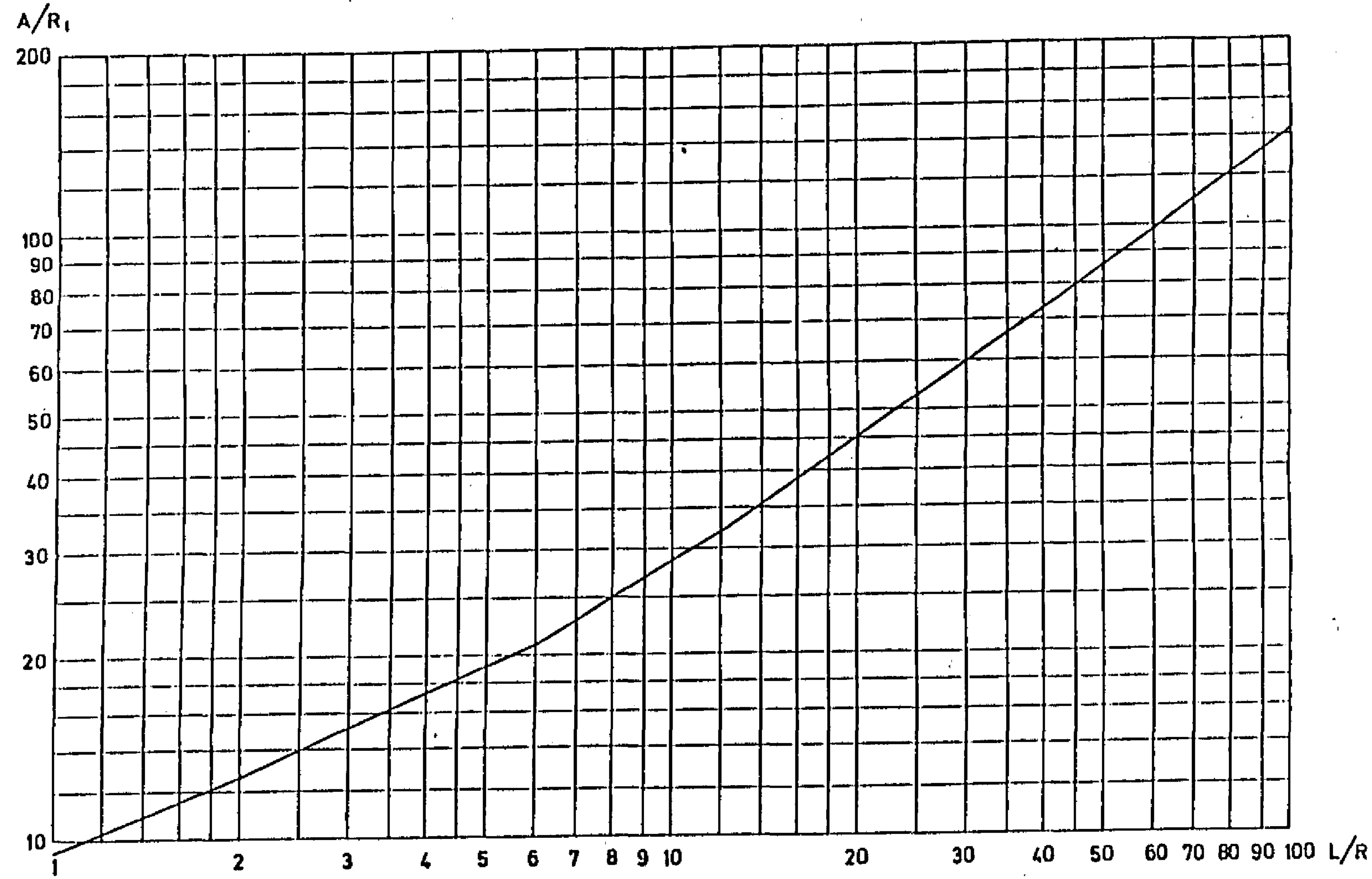
METHOD: DRILLING WITH A PEAT AUGER
PLACE: PIEZOMETERTEST

DEPTH	PEAT	HUMIFICATION DEGREE	COLOUR
PIEZOMETER: 10			
2.50-2.60	reedpeat	5	3/2 5YR
2.60-2.75	reedpeat & alder	5	3/4 7.5YR
2.75-2.90	reedpeat & alder	5/6	3/2 7.5YR
2.90-2.98	reedpeat & alder	5/6	2/2 7.5YR
2.98-3.00	birch		2/2 7.5YR
3.00-3.07	reedpeat & alder	6	3/1 5YR
3.07-3.50	reedpeat	5	3/2 7.5YR
PIEZOMETER: 13			
2.50-2.58	reedpeat	6	3/3 7.5YR
2.58-2.66	reedpeat and birch and thick red roots	5	3/3 5YR
2.66-2.75	reedpeat and alder	4	2/4 5YR
2.75-2.80	reedpeat and birch	5	2/3 5YR
2.80-2.85	reedpeat and alder	3/4	2/3 5YR
2.85-3.00	reedpeat and many yellow roots	4	2/3 7.5YR
3.00-3.07	reedpeat and alder	4	2/4 5YR
3.07-3.25	reedpeat	4	3/2 7.5YR
3.25-3.35	reedpeat	4	2/3 7.5YR
3.35-3.50	reedpeat	4	3/2 7.5YR

APPENDIX 6.13

Relation between L/R_1 and A/R_1 for the piezometer method

Relation between L/R_1 and A/R_1 for the piezometer method.



APPENDIX 7.1

Structure of the fixed files

Field	Fieldname	Type	Width	Dec.
1	TUBENUMBER	TEXT	5	0
2	GEONUMBER	TEXT	12	0
3	X_COORDINA	NUMERIC	4	0
4	Y_COORDINA	NUMERIC	4	0
5	TOP_FILTER	NUMERIC	5	2
6	BOTTOM_FIL	NUMERIC	5	2
7	TUBEDIAMET	NUMERIC	8	3
8	MATERIAL	TEXT	20	0
9	INSTALLATI	DATE	8	0
10	REMOVAL	DATE	8	0
11	REMARKS	TEXT	254	0
12	TOPPING	NUMERIC	4	2
		*** Total ***	337	9

APPENDIX 7.2

Pascal program to convert monitoring data to MOD.

```
(*************************************************************************)
(* Program:     LEVELS                                                   *)
(* Purpose:     To create real piezometric heads MOD from monitoring     *)
(*              measurements, levelling data and fixed data              *)
(* Interface:   Information is read in from the files containing the    *)
(*              needed data. The real levels are written to outputfiles *)
(* Date:        February 1992                                            *)
(* Author:      Ab Veldhuizen                                            *)
(*************************************************************************)
Program LEVELS (INPUT, OUTPUT, READINGS, LEVELS1, LEVELS2, FIXED, OUTFILE);

CONST
    N          = 125;   (* Maximum number of tubes in a file *)

TYPE
    MATRIX     = ARRAY [1..25,1..N] OF REAL;
    LIST8      = ARRAY [1..N] OF STRING[8];
    LIST9      = ARRAY [1..N] OF STRING[9];

VAR
   READINGS    ,       (* Inputfile with water level readings              *)
   LEVELS1     ,       (* Inputfile with levelling data                    *)
   LEVELS2     ,       (* Inputfile with levelling data                    *)
   FIXED       ,       (* Inputfile with fixed data                        *)
   OUTFILE     : TEXT; (* Output file                                      *)
   FILENAME    : STRING[12];
   DAY         ,
   MONTH       ,
   YEAR        ,
   TOPDATE     ,        (* Date of topping tubes                           *)
   MARKTOP     ,        (* Memorizes row number of topping influence       *)
   I,J         ,
   NROFTUBES   ,        (* Total number of tubes                           *)
   NROFDATES   ,        (* Number of monitoring dates                      *)
   LDATE1      ,        (* Levelling date                                  *)
   LDATE2      : INTEGER; (*idem*)
   FILENAM     : ARRAY [1..24] OF STRING [12];
   K,L         ,
   NROFLINES   ,
   NROFFILES   : INTEGER;
   CHOICE      ,
   YESNO       ,
   SLASH       : CHAR;
   X,Y         : STRING[9];
   MON_DATE    : LIST9; (* Monitoring dates                                *)
   TUBENR      : LIST9; (* Tube codes                                      *)
   LEV1        ,        (* Levelling data begin period                     *)
   LEV2        ,        (* Levelling data end period                       *)
   TOPPING     ,        (* Topping data                                    *)
   WEIGHT1     ,        (* Weight of first levelling                       *)
   WEIGHT2     : ARRAY[1..N] OF REAL;  (* Weight of second levelling       *)
   DATENR      : ARRAY[1..24] OF INTEGER;
   WATLEV      ,         (* Matrix with water level data                   *)
   TUBELEV     : MATRIX; (* Matrix with tube level data                    *)
   GO_ON       ,
   FIRSTTIME   : BOOLEAN;
```

```
(***********************************************************************)
(* Function    : CALCDATE                                              *)
(* Purpose     : Gives a date a number                                 *)
(***********************************************************************)
FUNCTION CALCDATE(DAY,MONTH,YEAR:INTEGER):INTEGER;
BEGIN
   CALCDATE:=DAY+(MONTH-1)*30+(YEAR-85)*365;
END(*CALCDATE*);

(***********************************************************************)
(* Function     : NR                                                   *)
(* Purpose      : Calculates day, month and year number                *)
(***********************************************************************)
FUNCTION NR (NR1,NR2:CHAR):INTEGER;
BEGIN
    NR:=10*(ORD(NR1)-48)+ORD(NR2)-48;
END;(*NR*)

(***********************************************************************)
(* Function     : MEASUR                                               *)
(* Purpose      : Decides whether a water level is measured or not     *)
(***********************************************************************)
FUNCTION MEASUR(WAT_LEV:REAL):BOOLEAN;
BEGIN
    MEASUR:=TRUE;
    IF (WAT_LEV=9999.0) OR (WAT_LEV=999.9) OR (WAT_LEV=8888.0) OR
    (WAT_LEV=888.8) OR (WAT_LEV=7777.0) OR (WAT_LEV=777.7) THEN
        MEASUR:=FALSE;
END(*MEASUR*);

(***********************************************************************)
(* Procedure   : INIREAD                                               *)
(* Purpose     : Opens the file with readings                          *)
(***********************************************************************)
PROCEDURE INIREAD;
VAR
   MEASURED ,
   FOUND     : BOOLEAN;
   X         : STRING[10];
   D1,D2     ,
   M1,M2     ,
   Y1,Y2     : CHAR;
   WATERL    : REAL;

BEGIN
    WRITE ('Give name READINGS-file: ');
    READLN (FILENAME);
    FILENAME:=FILENAME+'.PRN';
    ASSIGN (READINGS,FILENAME);
    RESET (READINGS);

    READ(READINGS,X);
    I:=1;
    WHILE NOT EOLN(READINGS) DO
    BEGIN
        (* Read the monitoring dates *)
        READ (READINGS,MON_DATE[I]);
        I:=I+1;
    END(*WHILE*);
    READLN (READINGS);
    NROFDATES:=I-1;
    I:=1;
```

```
    WHILE NOT EOF(READINGS) DO
    BEGIN
        (* Read tube codes *)
        READ (READINGS,TUBENR[I]);
        READLN(READINGS);
        I:=I+1;
    END(*WHILE*);
    RESET (READINGS);
    READ(READINGS,X);
    NROFTUBES:=I-1;
    I:=0;
    FOUND:=FALSE;
    FOR I:=1 TO NROFDATES DO
    BEGIN
        READ(READINGS,D1,D2,SLASH,M1,M2,SLASH,Y1,Y2,SLASH);
        DAY:=NR(D1,D2);
        MONTH:=NR(M1,M2);
        YEAR:=NR(Y1,Y2);
        (* Assign an integer value to the monitoring date *)
        DATENR[I]:=CALCDATE(DAY,MONTH,YEAR);
        IF (FOUND=FALSE) THEN
        BEGIN
            (* Find the date of "topping")
            IF (DATENR[I]>TOPDATE) THEN
            BEGIN
                MARKTOP:=I;
                FOUND:=TRUE;
            END(*IF*)
        END(*IF*);
    END(*FOR*);
    RESET (READINGS);
    READLN(READINGS);
    I:=1;
    WHILE NOT EOF(READINGS) DO
    BEGIN
        READ(READINGS,X);
        FOR J:=1 TO NROFDATES DO
        BEGIN
            (* Read the water level data, check whether it is measured *)
            (* and store it into a matrix in meters *)
            READ (READINGS,WATERL);
            MEASURED:=MEASUR(WATERL);
            IF MEASURED THEN
                WATLEV[J,I]:=WATERL/100
            ELSE
                WATLEV[J,I]:=9999.0;
        END(*FOR*);
        READLN(READINGS);
        I:=I+1;
    END(*WHILE*);
    CLOSE(READINGS);
END(*INIREAD*);
```

```
(**************************************************************************)
(* Procedure  : INILEV1                                                  *)
(* Purpose    : Opens the file with levels                               *)
(**************************************************************************)
PROCEDURE INILEV1;
VAR
    X,Y,Z   : STRING[9];                              (* dummy's*)
    D1,D2   ,
    M1,M2   ,
    Y1,Y2   : CHAR;

BEGIN
    WRITE ('Give name LEVELS1-file: ');
    READLN (FILENAME);
    FILENAME:=FILENAME+'.PRN';
    ASSIGN (LEVELS1,FILENAME);
    RESET (LEVELS1);
    READLN (LEVELS1);
    (* Determine the levelling date and calculate the integer value *)
    READ(LEVELS1,X,Y,Z,D1,D2,SLASH,M1,M2,SLASH,Y1,Y2);
    DAY:=NR(D1,D2);
    MONTH:=NR(M1,M2);
    YEAR:=NR(Y1,Y2);
    LDATE1:=CALCDATE(DAY,MONTH,YEAR);
    RESET (LEVELS1);
    READLN(LEVELS1);
    I:=1;
    WHILE NOT EOF (LEVELS1) DO
    BEGIN
        (* Read the levels *)
        READ (LEVELS1,X,LEV1[I]);
        I:=I+1;
        READLN(LEVELS1);
    END(*WHILE*);
    CLOSE (LEVELS1);
END(*LEVELS1*);

(**************************************************************************)
(* Procedure  : INILEV2                                                  *)
(* Purpose    : Opens the second file with levels                        *)
(**************************************************************************)
PROCEDURE INILEV2;
VAR
    X,Y,Z   :STRING[9];
    D1,D2   ,
    M1,M2   ,
    Y1,Y2   : CHAR;

BEGIN
    WRITE ('Give name LEVELS2-file: ');
    READLN (FILENAME);
    FILENAME:=FILENAME +'.PRN';
    ASSIGN (LEVELS2,FILENAME);
    RESET (LEVELS2);
    READLN (LEVELS2);
    READ(LEVELS2,X,Y,Z,D1,D2,SLASH,M1,M2,SLASH,Y1,Y2);
    DAY:=NR(D1,D2);
    MONTH:=NR(M1,M2);
    YEAR:=NR(Y1,Y2);
    LDATE2:=CALCDATE(DAY,MONTH,YEAR);
    RESET (LEVELS2);
    READLN(LEVELS2);
```

```
    I:=1;
    WHILE NOT EOF (LEVELS2) DO
    BEGIN
        READ (LEVELS2,X,LEV2[I]);
        (* If topping has taken place, then correct the leveling data
temperarily *)
        IF (CHOICE='3') THEN
        BEGIN
            LEV2[I]:=LEV2[I]+TOPPING[I];
        END(*IF*);
        I:=I+1;
        READLN(LEVELS2);
    END(*WHILE*);
    CLOSE(LEVELS2);
END(*LEVELS2*);

(***************************************************************************)
(* Procedure  : INIFIXED                                                  *)
(* Purpose    : Opens the file with FIXED DATA                            *)
(***************************************************************************)
PROCEDURE INIFIXED;
VAR
    D1,D2   ,
    M1,M2   ,
    Y1,Y2   :CHAR;

BEGIN
    WRITE ('Give name FIXED-file: ');
    READLN (FILENAME);
    FILENAME:=FILENAME+'.PRN';
    ASSIGN (FIXED,FILENAME);
    RESET (FIXED);
    WRITE ('On what date did the topping take place: (DD/MM/YY) ');
    READLN (D1,D2,SLASH,M1,M2,SLASH,Y1,Y2);
    DAY:=NR(D1,D2);
    MONTH:=NR(M1,M2);
    YEAR:=NR(Y1,Y2);
    TOPDATE:=CALCDATE(DAY,MONTH,YEAR);
    I:=1;
    READLN(FIXED);
    WHILE NOT EOF (FIXED) DO
    BEGIN
        (* Read the topping values *)
        READLN (FIXED,X,TOPPING[I]);
        I:=I+1;
    END(*WHILE*);
END(*INIFIXED*);
```

```
(***********************************************************************)
(* Procedure  : RLWEIGHT                                               *)
(* Purpose    : Calculates weights of levelling data on liniair basis   *)
(***********************************************************************)
PROCEDURE RLWEIGHT;
VAR
   DIFF1    ,
   DIFF2    ,
   TOTDIFF  :INTEGER;

BEGIN
    TOTDIFF:=LDATE2-LDATE1;
    FOR I:=1 TO NROFDATES DO
    BEGIN
        DIFF1:=DATENR[I]-LDATE1;
        DIFF2:=LDATE2-DATENR[I];
        WEIGHT1[I]:=DIFF2/TOTDIFF;
        WEIGHT2[I]:=DIFF1/TOTDIFF;
    END(*FOR*);
END(*RLWEIGHT*);

(***********************************************************************)
(* Procedure  : MKLEVEL                                                *)
(* Purpose    : Makes matrix with tube levels for monitoring dates     *)
(***********************************************************************)
PROCEDURE MKLEVEL;
VAR
    WATERL  : REAL;
    MEASURED: BOOLEAN;

BEGIN
    FOR I:=1 TO NROFDATES DO
    BEGIN
        FOR J:=1 TO NROFTUBES DO
        BEGIN
            IF (CHOICE='2') OR (CHOICE='3') THEN
                TUBELEV[I,J]:=WEIGHT1[I]*LEV1[J]+WEIGHT2[I]*LEV2[J];
            IF (CHOICE='1') THEN
                TUBELEV[I,J]:=LEV1[J];
            WATERL:=WATLEV[I,J];
            MEASURED:=MEASUR(WATERL);
            IF MEASURED THEN
            BEGIN
                WATLEV[I,J]:=TUBELEV[I,J]-WATLEV[I,J];
                IF (CHOICE='3') THEN
                BEGIN
                    (*  Correct  the  water  levels  after  topping  has  taken
                              place*)
                    IF (MARKTOP>=I) THEN
                        WATLEV[I,J]:=WATLEV[I,J]-TOPPING[J];
                END(*IF*);
            END(*IF*);
        END(*FOR*);
    END(*FOR*);
END(*MKLEVEL*);
```

```
(***********************************************************************)
(* Procedure  : MKOUTPUT                                              *)
(* Purpose    : Writes "real" waterlevels to output file              *)
(***********************************************************************)
PROCEDURE MKOUTPUT;
VAR
    CHOICE    : CHAR;
    TEMP      : ARRAY [1..100] OF STRING [54];

BEGIN
    (* When the program is started the output files have to be given *)
    IF FIRSTTIME THEN
    BEGIN
    WRITELN ('To be able to use the quality check program, it is necessary');
    WRITELN ('to write the output to files with only 6 columns.');
    NROFFILES:=TRUNC(NROFTUBES/5-0.1)+1;
    WRITELN ('You need ',NROFFILES:2,' output files.');
    FOR I:=1 TO NROFFILES DO
    BEGIN
        WRITE ('Give a name for output file ',I:2,':');
        READLN (FILENAM[I]);
        FILENAM[I]:=FILENAM[I]+'.PRN';
    END(*for*);
    WRITELN ('The results will be written to the following files:');
    FOR I:=1 TO NROFFILES DO
    BEGIN
        WRITELN (FILENAM[I]);
    END;
    REPEAT
    BEGIN
    WRITE ('Do you want to change any of the filenames(y/n): ');
    READLN (YESNO);
    IF (YESNO='Y') OR (YESNO='y') THEN
    BEGIN
        WRITE('Give file number: ');
        READLN(I);
        WRITE('What is the new filename: ');
        READLN(FILENAM[I]);
    END(*IF*);
    END(*REPEAT*);
    UNTIL (YESNO='N') OR (YESNO='n');
    FIRSTTIME:=FALSE;
    END (*IF*);

    REPEAT
    BEGIN
        WRITELN ('Do you want to add the waterlevel data to the files and');
        WRITE('do the files already exist? (Y/N) ');
        READLN (CHOICE);
    END(*REPEAT*);
    UNTIL (CHOICE = 'Y') OR (CHOICE ='y') OR (CHOICE = 'N') OR (CHOICE='n');
    FOR K:=1 TO NROFFILES DO
    BEGIN
    IF ((CHOICE='Y') OR (CHOICE ='y')) THEN
    BEGIN
        ASSIGN(OUTFILE,FILENAM[K]);
        RESET (OUTFILE);
        L:=0;
        (* The data in the file are stored temperarily *)
        WHILE NOT EOF(OUTFILE) DO
        BEGIN
            L:=L+1;
```

```
            READ(OUTFILE,TEMP[L]);
            READLN(OUTFILE);
        END(*WHILE*);
        NROFLINES:=L;
        CLOSE(OUTFILE);
        ASSIGN(OUTFILE,FILENAM[K]);
        REWRITE(OUTFILE);
        (* The data are are written back again *)
        FOR L:=1 TO NROFLINES DO
        BEGIN
            WRITE (OUTFILE, TEMP[L]);
            WRITELN(OUTFILE);
        END(*WHILE*);
    END(*IF*)
    ELSE
    (* The data in the output file (if any) are lost *)
    BEGIN
        ASSIGN (OUTFILE,FILENAM[K]);
        REWRITE (OUTFILE);
        WRITE (OUTFILE,'DATE        ');
        (* Write the rigth number of tube codes to the output file *)
        IF (K*5<=NROFTUBES) THEN
        BEGIN
            FOR I:=((K-1)*5+1) TO K*5 DO
                WRITE(OUTFILE,TUBENR[I]);
        END(*IF*)
        ELSE
        BEGIN
            FOR I:=((K-1)*5+1) TO NROFTUBES DO
                WRITE (OUTFILE,TUBENR[I]);
        END(*ELSE*);
        WRITELN (OUTFILE);
    END(*ELSE*);
    FOR I:=1 TO NROFDATES DO
    BEGIN
        WRITE (OUTFILE, MON_DATE[I]);
        IF (I=NROFDATES) THEN
            WRITE(OUTFILE,' ');
        IF (K*5<=NROFTUBES) THEN
        BEGIN
            FOR J:=((K-1)*5+1) TO K*5 DO
                WRITE(OUTFILE,WATLEV[I,J]:9:3);
        END(*IF*)
        ELSE
        BEGIN
            FOR J:=((K-1)*5+1) TO NROFTUBES DO
                WRITE (OUTFILE,WATLEV[I,J]:9:3);
        END(*ELSE*);
        WRITELN (OUTFILE);

    END(*FOR*);
    CLOSE(OUTFILE);
    END(*FOR*);
END(*MKOUTPUT*);
```

```
BEGIN(* Main Program *)

    WRITELN ('This program is written to convert water level readings of');
    WRITELN ('Raheenmore and Clara to "real" water levels in MOD.');
    WRITELN ('Topping of tubes as well as levelling data are taken into');
    WRITELN ('The output is formatted in such a way that the quality ');
    WRITELN ('control of Lensen can be applied.');
    WRITELN;
    GO_ON:=TRUE;
    FIRSTTIME:=TRUE;
    (* This program is continued until it is stopped *)
    WHILE (GO_ON=TRUE) DO
    BEGIN
    WRITELN ('You have the following options:');
    WRITELN ('1: The readings are before the first levelling');
    WRITELN ('2: The readings are between 2 levellings');
    WRITELN ('3: 2 and topping has taken place');

    REPEAT
    BEGIN
          WRITE ('What is your choice? (1,2,3)  ');
          READLN (CHOICE);
    END(*REPEAT*)
    UNTIL (CHOICE='1') OR (CHOICE='2') OR (CHOICE='3');

    TOPDATE:=0;
    CASE CHOICE OF
     '1': BEGIN
            INIREAD;
            INILEV1;
            MKLEVEL;
            MKOUTPUT;
          END;
     '2': BEGIN
               INIREAD;
               INILEV1;
               INILEV2;
               RLWEIGHT;
               MKLEVEL;
               MKOUTPUT;
          END;
     '3': BEGIN
               INIFIXED;
               INIREAD;
               INILEV1;
               INILEV2;
               RLWEIGHT;
               MKLEVEL;
               MKOUTPUT;
          END;
     END(*CASE*);
     (* You can decide whether to stop or continue *)
     WRITE('Do you want to continue(y/n): ');
     READLN (YESNO);
     IF (YESNO='n') OR (YESNO='N') THEN
         GO_ON:=FALSE;
     END(*WHILE*);
 END(*Program*).
```

APPENDIX 7.3

Structure of input files for LEVELS.PAS

(a) File with monitoring data

DATE	24/01/91	07/02/91	21/02/91	08/03/91	22/03/91	04/04/91	19/04/91
NR201A	48.8	42.8	39.4	39.3	41.0	42.3	42.5
NR201B	69.2	69.4	66.0	65.4	70.9	70.3	74.6
NR201C	132.2	131.5	131.0	128.8	129.3	134.2	139.2
NR201D	137.2	137.5	137.0	134.5	135.1	139.0	141.1
NR202A	26.4	28.7	25.8	23.2	26.1	24.0	27.6
NR202C	45.6	45.0	41.4	38.2	36.5	40.4	40.9
NR202D	55.9	56.2	54.5	51.7	51.2	49.6	54.2
NR203A	17.3	17.8	15.0	13.9	16.0	14.7	16.5
NR204A	26.0	27.6	23.1	21.7	23.1	22.6	26.8
NR204E	23.8	25.0	21.5	18.4	18.1	22.7	22.2
NR204C	28.1	29.0	25.1	23.9	23.4	23.5	26.3
NR204D	28.6	30.3	27.0	24.4	24.6	24.6	26.4
NR205A	30.2	31.4	28.7	26.0	28.9	27.9	34.1
NR206A	20.7	21.7	19.1	17.0	18.5	18.1	23.2
NR206E	39.0	40.0	38.1	35.5	35.3	36.0	37.0
NR206C	35.2	34.0	30.5	29.6	30.5	27.3	31.1
NR206D	39.2	39.2	37.0	35.0	35.8	33.8	37.0
NR206S	43.0	42.2	39.0	37.5	37.7	35.8	39.1
NR207A	21.1	21.4	20.0	17.7	18.8	19.1	22.5
NR208A	25.0	26.0	24.5	21.7	23.2	23.8	26.6
NR209A	25.0	24.0	23.1	21.8	21.4	23.7	25.5
NR209E	34.1	34.0	23.1	32.5	31.8	32.5	32.6
NR209C	30.0	29.8	28.4	27.0	27.5	27.0	28.6
NR209D	34.5	34.8	23.3	32.8	32.4	32.6	33.3
NR209F	45.5	47.0	45.6	43.0	43.0	44.6	43.2
NR210A	28.5	29.5	27.6	24.5	24.5	28.2	28.7
NR210E	28.5	28.8	28.3	26.5	25.0	28.2	27.2
NR210C	29.2	29.5	28.6	26.9	26.5	27.6	28.1
NR210D	28.1	28.5	28.1	26.5	25.0	27.6	27.1
NR211A	26.0	25.2	24.5	21.7	21.4	24.0	24.6
NR211E	38.5	38.5	38.3	36.2	36.0	38.5	37.8
NR211C	29.0	29.2	27.2	25.2	26.2	26.5	27.8
NR211D	35.0	35.2	33.0	31.8	31.6	33.8	33.8
NR211F	113.0	115.0	112.6	40.0	107.0	109.1	108.3
NR212A	30.0	31.0	30.4	27.7	27.7	29.8	30.6
NR212E	38.0	38.0	37.0	35.6	35.5	36.8	37.6
NR212C	39.9	33.4	32.1	30.5	30.9	31.6	33.0
NR212D	36.2	36.2	34.9	33.6	33.4	35.2	36.1
NR213S	43.3	43.7	44.2	40.0	41.0	0.0	44.9

<8 CHAR><9 CHAR ><9 CHAR > etc.

(b) File with levelling data

Tubenr.	Top_tube	Surface	Date
201A	100.59	100.37	25/04/91
201B	100.59	100.37	25/04/91
201C	100.59	100.37	25/04/91
201D	100.59	100.37	25/04/91
202A	101.35	101.17	25/04/91
202C	101.35	101.17	25/04/91
202D	101.31	101.13	25/04/91
203A	102.08	101.84	25/04/91
204A	102.52	102.29	25/04/91
204E	102.48	102.29	25/04/91
204C	102.50	102.29	25/04/91
204D	102.48	102.29	25/04/91
205A	103.35	103.15	25/04/91
206A	104.17	103.98	25/04/91
206E	104.15	103.98	25/04/91
206C	104.16	103.98	25/04/91
206D	104.15	103.98	25/04/91
206S	104.17	103.98	25/04/91
207A	104.35	104.18	25/04/91
208A	104.84	104.63	25/04/91
209A	105.21	104.98	25/04/91
209E	105.20	104.98	25/04/91
209C	105.20	104.98	25/04/91
209D	105.20	104.98	25/04/91
209F	105.20	104.98	25/04/91
210A	105.86	105.61	25/04/91
210E	105.85	105.61	25/04/91
210C	105.85	105.61	25/04/91
210D	105.85	105.61	25/04/91
211A	106.06	105.76	25/04/91
211E	106.06	105.76	25/04/91
211C	106.06	105.76	25/04/91
211D	106.06	105.76	25/04/91
211F	106.06	105.76	25/04/91
212A	106.54	106.24	25/04/91
212E	106.54	106.24	25/04/91
212C	106.54	106.24	25/04/91
212D	106.54	106.24	25/04/91
213S	99.60	99.60	25/04/91

<8 CHAR><9 CHAR ><9 CHAR ><9 CHAR >

(c) File with "topping" data

Tubenr	Topping
201A	0.04
201B	0.00
201C	0.03
201D	0.03
202A	0.02
202C	0.03
202D	0.00
203A	0.00
204A	0.00
204E	0.03
204C	0.03
204D	0.01
205A	0.00
206A	0.00
206E	0.02
206C	0.00
206D	0.00
206S	0.00
207A	0.00
208A	0.00
209A	0.00
209E	0.01
209C	0.01
209D	0.00
209F	0.00
210A	0.00
210E	0.02
210C	0.02
210D	0.00
211A	0.00
211E	0.03
211C	0.09
211D	0.06
211F	0.00
212A	0.01
212E	0.00
212C	0.01
212D	0.00
213S	0.00

<8 CHAR><9 CHAR >

APPENDIX 7.4

Output file of LEVELS.PAS

DATE	NR206C	NR206D	NR206S	NR207A	NR208A
16/11/89	103.590	103.560	103.550	103.830	103.960
27/11/89	103.610	103.560	103.530	103.830	103.940
11/12/89	103.610	103.549	103.550	103.800	103.940
19/12/89	103.629	103.578	103.570	103.870	103.980
04/01/90	103.627	103.576	103.570	103.850	103.980
21/01/90	103.636	103.594	103.580	103.840	103.960
31/01/90	103.655	103.633	103.630	103.870	103.990
15/02/90	103.664	103.641	103.640	103.910	104.030
01/03/90	103.673	103.639	103.650	103.920	104.050
16/03/90	103.652	103.608	103.620	103.830	103.970
29/03/90	103.641	103.576	103.580	103.800	103.940
12/04/90	103.650	103.584	103.590	103.800	103.940
26/04/90	103.649	103.573	103.580	103.800	103.940
10/05/90	103.627	103.551	103.560	103.780	103.910
24/05/90	103.606	103.520	103.530	103.720	103.870
07/06/90	103.615	103.538	103.540	103.800	103.930
21/06/90	103.614	103.516	103.530	103.810	103.940
05/07/90	103.613	103.545	103.540	103.880	104.000
19/07/90	103.582	103.513	103.520	103.740	103.890
01/08/90	103.571	103.492	103.490	103.740	103.890
15/08/90	103.570	103.480	103.480	103.740	103.880
29/08/90	103.666	103.589	103.551	103.965	104.251
12/09/90	103.687	103.618	103.585	103.949	104.418
26/09/90	103.683	103.612	103.582	103.952	104.436
09/10/90	103.706	103.635	103.611	104.047	104.513
24/10/90	103.741	103.690	103.665	104.103	104.545
06/11/90	103.709	103.666	103.645	104.054	104.524
20/11/90	103.755	103.701	103.682	104.109	104.548
04/12/90	103.733	103.690	103.667	104.061	104.503
18/12/90	103.748	103.688	103.670	104.068	104.474
11/01/91	103.780	103.741	103.729	104.117	104.546
24/01/91	103.763	103.722	103.704	104.094	104.528
07/02/91	103.782	103.727	103.717	104.098	104.526
21/02/91	103.824	103.755	103.755	104.119	104.551
08/03/91	103.841	103.782	103.777	104.150	104.591
22/03/91	103.839	103.779	103.780	104.146	104.585
04/04/91	103.877	103.804	103.804	104.149	104.588
19/04/91	103.846	103.778	103.777	104.122	104.570
03/05/91	103.845	103.781	103.777	104.135	104.575
17/05/91	103.835	103.759	103.758	104.025	104.525
31/05/91	103.811	103.728	103.718	103.955	104.439
14/06/91	103.817	103.743	103.728	104.049	104.519
28/06/91	103.812	103.737	103.724	104.074	104.548
11/07/91	103.815	103.743	103.721	104.064	104.519
31/07/91	103.809	103.717	103.703	104.005	104.476
09/08/91	103.806	103.726	103.707	104.098	104.536
23/08/91	103.810	103.719	103.701	104.000	104.476
06/09/91	103.762	103.671	103.646	103.875	104.387
20/09/91	103.757	103.662	103.633	103.949	104.437
03/10/91	103.762	103.684	103.656	104.100	104.555
17/10/91	103.788	103.732	103.698	104.119	104.565
01/11/91	103.813	103.753	103.720	104.162	104.615
15/11/91	103.812	103.781	103.741	104.161	104.612

<9 CHAR ><9 CHAR ><9 CHAR ><9 CHAR ><9 CHAR ><9 CHAR >