Donal Daly

IRISH - DUTCH

GEOHYDROLOGY AND ECOLOGY STUDY

- *O. P. W. Wildlife Service, Dublin*
- *Department of Nature Conservation, Environmental Protection and Wildlife Management, The Hague*
- *Geological Survey of Ireland, Dublin*
- *National Forest Service, Utrecht*

A STUDY OF THE HYDROLOGICAL EFFECTS OF A BOG ROAD

CLARA BOG, COUNTY OFFALY

by

JUDITH BELL

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DEPARTMENT OF CIVIL ENGINEERING
IMPERIAL COLLEGE LONDON

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

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CONTENTS

1. INTRODUCTION

This project took place as part of the Irish-Dutch Peatland Geohydrology and Ecology Study, which is a multidisciplinary study into the eco-hydrology of raised bogs. Two raised bogs are being studied in Ireland: Clara Bog and Raheenmore Bog, both owned by the Irish Wildlife Service. Ireland is one of the few countries in Western Europe to still have intact bogs as many countries, such as the Netherlands, drained their wetlands before realising the ecological consequences. The flora on boglands have to survive very nutrient-poor conditions and have therefore developed in a particular way with species found there that are unique to a bog habitat. Some of these plants include bog asphodel and the insectiferous sundews and butterworts. Peat is cut on a large scale in Ireland, both by individuals and commercially by Bord na Mona (the Irish Peat Board). With the development in the last fifty years of efficient peat-cutting machinery, the bogs are being destroyed at an increasing rate, and for this reason the Irish Wildlife Service has begun a strategic purchase of bog areas in order to conserve an endangered environment. To conserve a bog and to sustain its growth, a management strategy needs to be developed. The main aim of such a strategy is to preserve a high water table which is necessary for the bog moss to grow. The Irish-Dutch Peatland Study hopes to be able to produce such a strategy by studying the hydrology, geology and ecology of bogs and the impact man has had on them. A bog is a living entity and to preserve it involves conserving its dynamics which are essentially hydrological and assessing to what degree should sustainable development be allowed in such areas.

This project concentrated on Clara Bog which is in County Offaly in the Midlands of Ireland. Figure 1.1 shows the most recent (1910) Ordnance Survey map of the bog. Clara Bog is recognised internationally as an important nature reserve as it is one of the largest raised bogs remaining in Western Europe, with an area of 665 Ha, and the only one left in Ireland with a well-developed soak system. The bog is noted as being relatively intact but it is not (and has not been) free from human influence. The edge of the south-west area of the bog is still under private ownership and is being actively cut for use as fuel. The rest of the bog was previously owned by Bord na Mona. In 1983 they cut a series of parallel ditches into the bog surface on the eastern side in order to initiate drainage preparatory to commercial harvesting. These drains remained in operation until declaration of the bog as a nature reserve in 1987 and they have since been blocked by damming. The third human influence is a road that traverses the bog running from the town of Clara to Rahan dividing the bog into eastern and western portions, and which has been in place for over 150 years.

1.1 AIM OF THE PROJECT

The aim of this project was to assess the hydrological

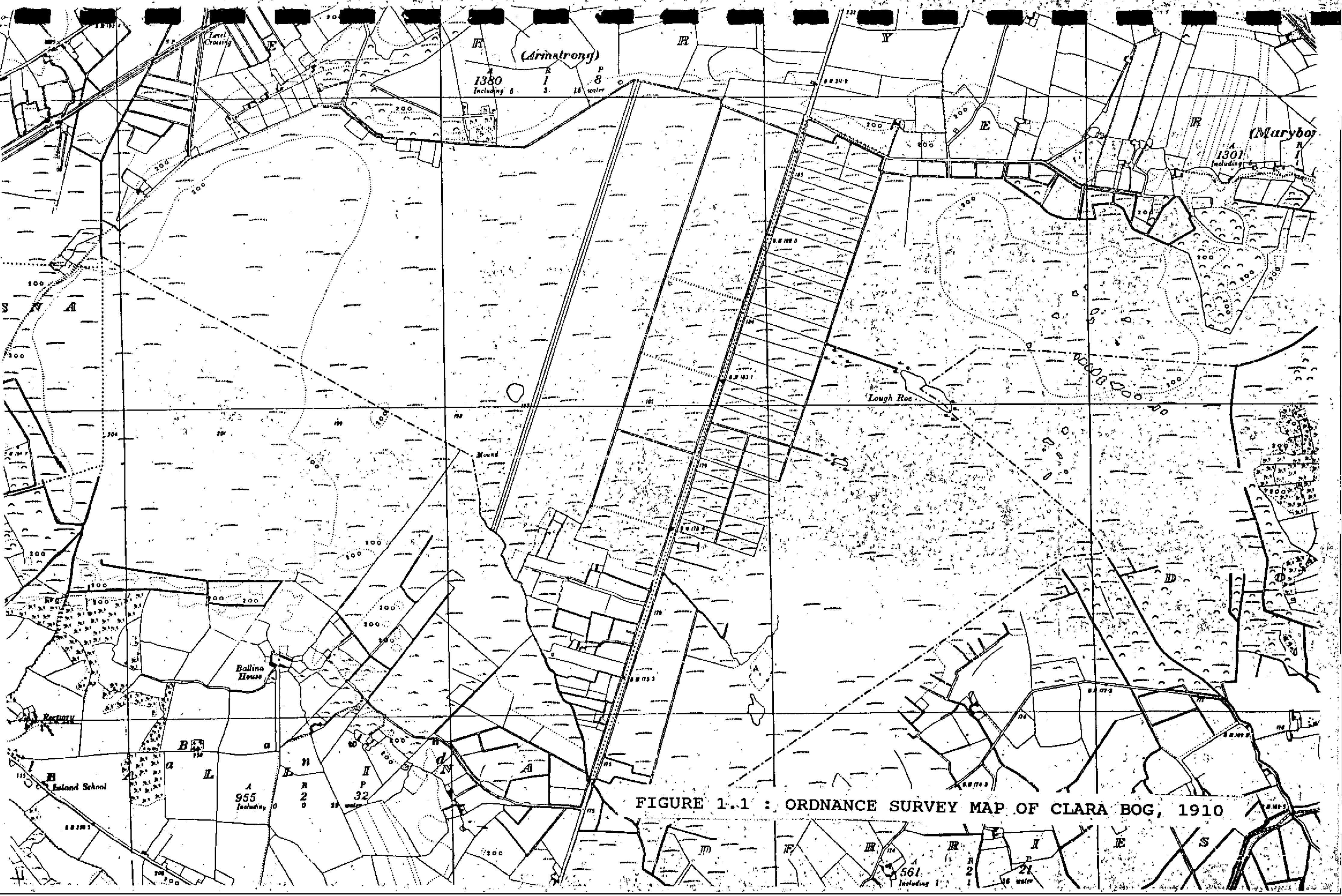


FIGURE 1.1 : ORDNANCE SURVEY MAP OF CLARA BOG, 1910

effects of one of these human influences - the road traversing Clara Bog. The road is known locally as the New Road though it is marked on Ordnance Survey maps of 1840 suggesting it was constructed earlier, and many bog roads of its type are known from historical evidence to have been built in the 1700's. Two drains run parallel to the road on its eastern and western edge. The road runs along a depression on the bog's surface so that the tarmac surface is up to 6 metres lower than the highest part of the bog on either side of it. Figure 1.2 shows a map of the surface topography of the bog converted from original Bord na Mona survey data into metres above sea-level by M. Smyth, 1991. This map shows the road to be lying along the axis of a valley that plunges to the south across the bog. Three theories had been put forward to explain this morphology:

1. The road was built in a natural depression through the middle of a twin-domed bog. This theory suggests that the road has had little impact on the bog.

2. The road was built across the middle of a single-domed bog and has itself (or by virtue of its drains) created the valley through subsidence. This theory suggests that the road has had a major impact on the bog and its hydrological regime.

3. The road was built across a single-domed bog and the depression was created by peat cutting along the roadside.

This third theory can almost immediately be rejected by simple observation of the slopes of the bog surface at the roadside which are largely too smooth to have been caused by cutting. In a few areas where cutting has occurred the face bank is steep and the cause is clear. Nevertheless there appears to be little residual evidence of any substantial cutting.

Thus, only the first two theories need to be considered and the objective of this project is to try and discover which came first: the road or the valley and how the road is now affecting the flow of water through the bog.

The approach taken has been essentially one of field investigation in order to assess the nature of the problem followed by some analytical/numerical modelling of the hydrology. The field work for this study included:

1. Measuring water table levels and hydraulic heads in the peat using piezometers.
2. Measuring permeabilities of the peat.
3. Drilling and sampling the peat in order to observe the changes in vegetation type, the degree of humification and for measurements of density for the assessment of the amount of any subsidence.
4. A geophysical survey (undertaken as part of another project) to investigate the hydrogeological stratification in the vicinity of the road.

The following chapters include a review of some background information relevant to bogs and this project, a description of the methods and materials used in the field work, a description of the geology and geophysics of Clara, a presentation of the results together with a discussion of which of the two theories outlined above are supported by the data, an analysis and modelling of the hydrology near to the road and finally some consequent conclusions and recommendations.

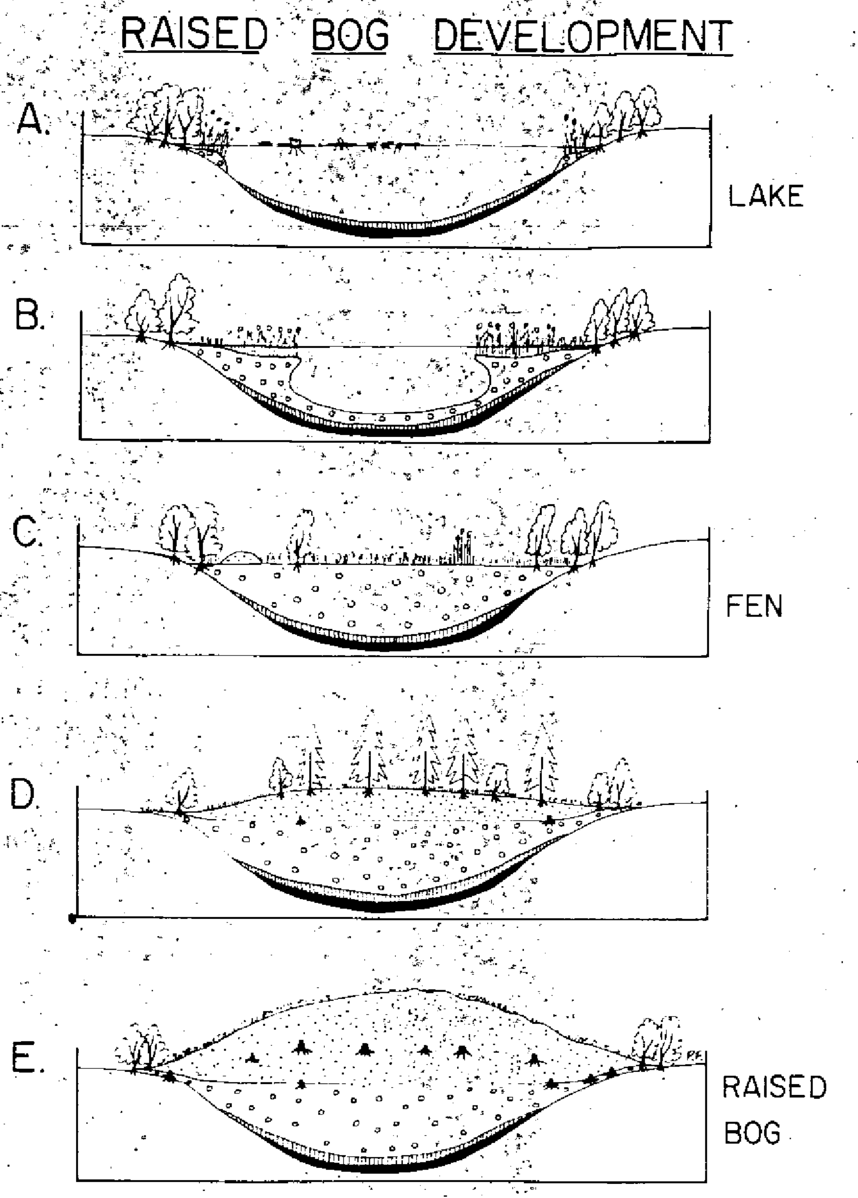
2. PEAT AND PEAT BOGS

2.1 WHAT IS PEAT?

Peat consists of the dead remains of plants that have accumulated over thousands of years in areas where the rate of plant production exceeds the rate of plant decomposition. Peatlands are composed of deep layers of waterlogged peat (the catotelm) and a surface layer of living vegetation (the acrotelm). Peat is physically a very heterogeneous deposit and can have very low permeabilities. There are four main types of peatland found in Ireland and Britain. Blanket bogs form where precipitation is very high, for example on upland plateaux. Here peat accumulation can spread or even start directly over level mineral ground. Where the prevailing geology is of sandstones or hard igneous rocks ground waters may almost be as poor in nutrients as is rain water and lakes may be colonised directly by oligotrophic (mineral poor) vegetation to form basin bogs. Valley bogs form alongside stream courses in lowland heaths. The fourth type of peatland found is the raised bog an example of which is Clara Bog.

2.2 WHAT IS A RAISED BOG?

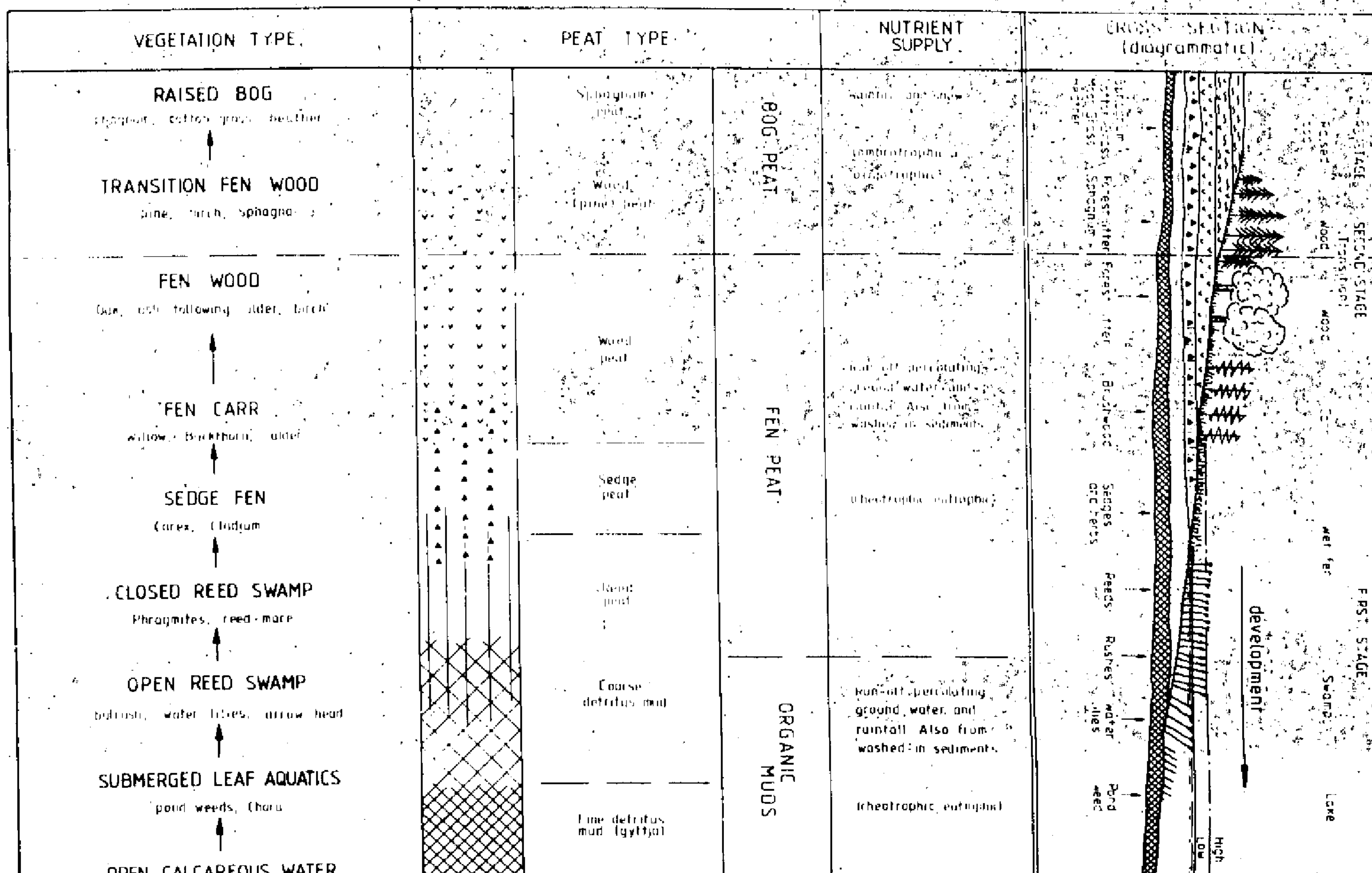
Raised bogs occur in areas where the average rainfall is 800-900 mm/year. They are termed raised bogs because of their domed topography. Current raised bog formation started at the end of the last glaciation some 10 thousand years ago when the glaciers had retreated northwards. At this time much of central Ireland was covered by shallow lakes left behind by melting ice. Lakes also formed where glacial ridges such as eskers impeded free drainage of the melt water. Bogs formed by the gradual infilling of these lakes under anaerobic conditions that prevented the decay of the dead vegetation. The hydroseral development of a raised bog has three main stages, depicted in figures 2.1 and 2.2. The first type of peat to form is known as a fen peat. This is made of the remains of eutrophic (mineral-rich) vegetation such as reed, sedge, alder and birch. The succession then undergoes a transitional stage until the mire has become a proper raised bog where only oligotrophic vegetation can grow such as sphagnum moss, cotton grass and heather. Figure 2.3 shows a cross-section of a raised bog and the different peat layers. As the lake begins to fill, peat accumulation begins in the lowest parts of the relief or the depression from the remains of eutrophic vegetation, the reservoir within the peat itself gradually raising the water level within the surrounding land, (Hobbs, 1986). Accumulation is more rapid at the centre of the depression than at the margins where the nutrient rich seepage waters encourage rapid decomposition of the dead vegetation. As a result of this differential rate of accumulation and the very low permeability of the peat, the concave peat surface gradually becomes raised above the surroundings, and, with the central parts of the mire having to rely to an increasing extent on atmospheric moisture, the eutrophic fen vegetation gives way to transition vegetation, basin



The developmental stages from a lake to a raised bog. A represents a lake with an open body of water and marginal reedbeds. The lake has thin layers of marl and lake peat (for an explanation of the symbols, see previous figure). B represents a lake which is being infilled with fen reed peat. C is the fen stage. D is the raised bog woodland phase and E is a profile through a present raised showing a Pine stump layer buried in acid peat.

FIGURE 2.1 : FROM HOBBS, 1986

FIGURE 2.2 : FROM HOBBS, 1986



Notes 1 There will be some natural overlapping of the various stages
2 Layers of silt brought in during flooding may be present in the fen stages
3 Conditions will be particularly rich in calcareous regions, rich in species

Vegetation and peat succession (after Godwin 1978)

Lake filling—the hydroseral succession. Note that bog raising normally starts at the centre of the old lake after filling is complete but is shown in the lake margin here for convenience.

bog or poor fen conditions, better able to survive under oligotrophic conditions (Hobbs, 1986). A developed, raised bog is fed solely by rainfall. Much of the rainwater collects on or is held close to the surface of the bog through the sponge-like action of sphagnum moss, but a considerable amount of water runs off the bog's surface either directly or via an internal drainage system known as a soak (O'Connell, 1987). The soak on Clara Bog consists of a series of lakes interconnected by natural drains with an exit drain leading to the bog margin (O'Connell, 1987). The lake water is rich in minerals and the source of this water is currently under investigation.

2.3 SOME HYDROLOGICAL PROPERTIES OF PEAT

Sphagnum peats are built up in a lenticular fashion due to the fact that a sphagnum bog is built up as a mosaic of alternating hollows and hummocks in which the hollows are gradually replaced by hummocks and vice versa as vegetation growth and decay continues (Dooge, 1972). This type of regeneration results in a deposit which is neither homogeneous nor random and which therefore may exhibit marked changes in hydrological behaviour at different levels in the bog or in different parts of the bog, (Dooge, 1972).

One of the most striking characteristics of peat is its ability to hold water. It has porosities in excess of 90 %. Five metres of fibrous peat may contain 4.7 m of water and as little as 300 mm of solid plant matter and yet

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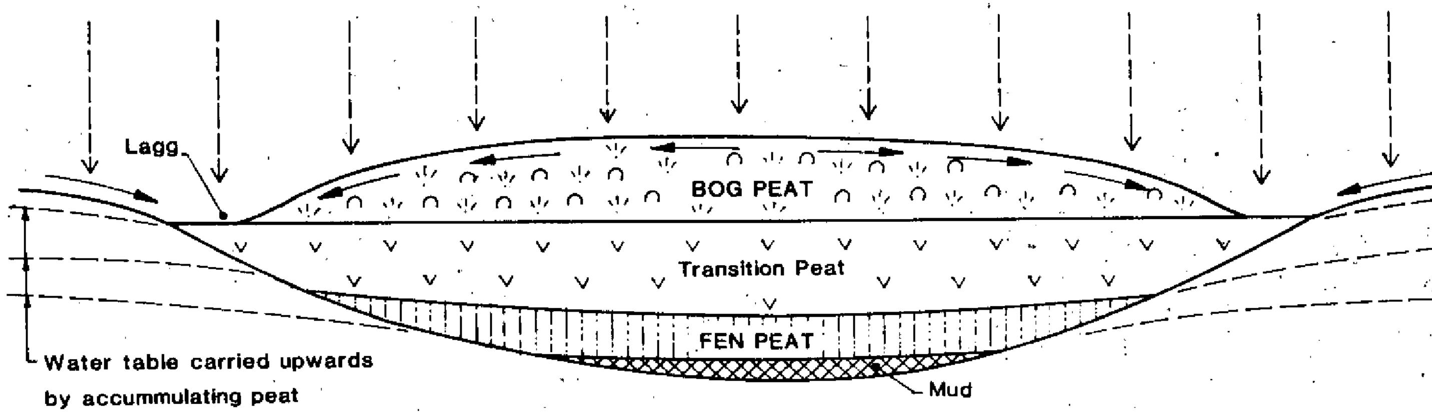
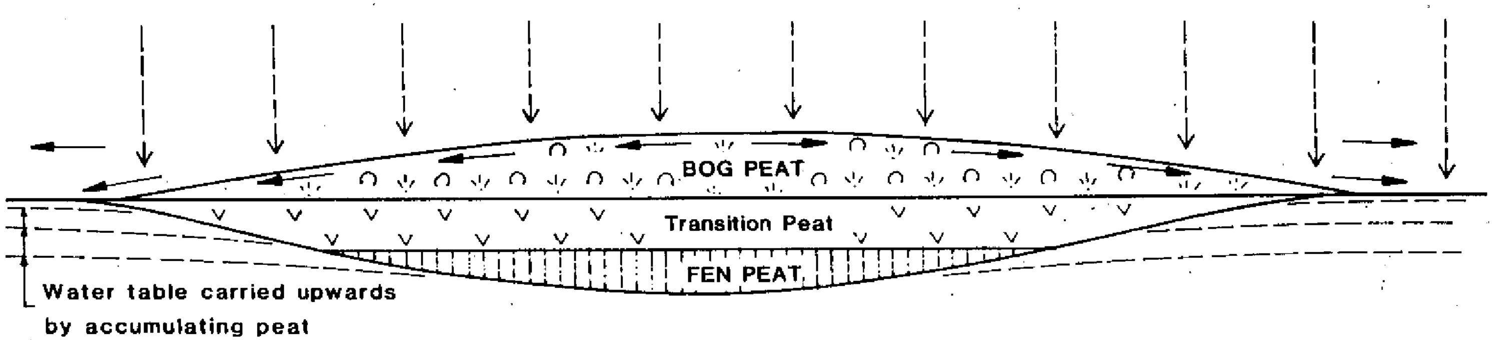


(a) Raised bog confined in deep basin



(b) Raised bog spreading outwards from shallow basin

Raised bogs in deep and shallow basins (after Ivanov 1981).

FIGURE 2.3 : FROM HOBBS, 1986

possess a significant shear strength and behave in many respects like normally consolidated clay (Hobbs, 1986). Three states of water can be recognised:

1. Free water in large cavities of the peat.
2. Capillary water in the narrower cavities.
3. Water bound physically, chemically, colloidally and osmotically.

2.3.1 THE PERMEABILITY OF PEAT

The permeability of a peat bog is very variable. The acrotelm is the most permeable part of the bog. Romanov (1968) has quoted seepage velocities in the acrotelm as high as 2.5 cm/s. The permeabilities in the catotelm are generally lower and can be quite variable. Ingram (1983) quotes results from near the top of the catotelm that range from 10^{-10} to 10^{-3} m/s. Permeability depends on: (after Ingram,1983)

1. the botanical composition - sphagnum, least permeable, sedge, most permeable,
2. the degree of humification - the least humified peats of given botanical composition are the most permeable,
3. the bulk density - permeability varies inversely with bulk density,
4. fibre content - permeability positively correlated with fibre content,
5. porosity - the higher the porosity the higher the permeability,

7. the surface loading - this decreases the permeability by decreasing the porosity.

There is some evidence that peat may not act as a Darcian medium to water flow. A full review of work done to investigate the hydraulic properties of peat has been made by Ingram, 1983. Relatively undecomposed peats have a high hydraulic conductance and Ingram et al. (1974) and Rycroft et al. (1975) found water flow through them to follow Darcy's law quite closely. However, the same workers found that flow in humified peats does deviate from Darcy's law as they found that the hydraulic conductivity varied with the potential gradient under which it was measured. This result was also found by Flynn (1990) during work on Clara Bog. One reason for Darcy's law breaking down in peat is because of a dual porosity that may exist where macropores are present.

2.4 SOME ENGINEERING PROPERTIES

The drainage and cultivation of peat soils brings about irreversible changes in their physical and chemical characteristics (Dooge, 1972). It removes the excess water, stops peat accumulation, causes peat subsidence and changes physical properties, such as the permeability, of the peat (Daly, 1981). The causes of subsidence are as follows:

1. Shrinkage due to drying. After desiccation the volume of the peat is reduced causing a lowering of the peat surface.

2. Consolidation by loss of buoyant force. Peat is formed in and under water. As the specific weight of organic material is only slightly greater than 1.0, its weight under water is very low. The pressure of overlying layers on underlying ones is only slight due to the buoyant force of the water. If the water table is lowered this buoyant force is lost and the relative pressure increases to a greater degree than for normal soils. This can be expressed simply in terms of the principle of effective stress where

$$d\sigma T = d\sigma e + dp$$

where σT is the total vertical stress downward (peat and water), p is the fluid pressure and σe is the effective stress which is that portion of total stress not borne by fluid pressure. Peat is less able to sustain an increase in σe (due to a loss of p under drainage) than other soils. Thicker peat areas will compress more than thin areas.

3. Contraction by capillary force. Peat has a high pore volume. After drainage the peat dries and the resulting capillary forces cause compression of the soil skeleton and a decrease in pore volume. Vertical contraction causes subsidence whilst horizontal contraction causes crack formation.

4. Biochemical Oxidation. This actually causes peat wastage as air enters the peat and material is lost which does not happen with the mechanical effects mentioned above.

5. Other factors such as wind erosion, burning and

compaction by machines and of course compaction by roads. Typical subsidence rates in Ireland are quoted as being 4 cm/year for the first few years after drainage, decreasing to 2.5 cm/year for the next seven years and later to 0.9 cm/year (Daly, 1982).

Of the three states of water found in peat only the free water and capillary water can be expelled by consolidation, whereas most of the water can be removed by oven drying at 105 degrees Celsius.

The permeability of peat is an important engineering property since it controls the rate of consolidation of peat under load and therefore its strength (Hobbs, 1986). A striking characteristic of peat is the remarkable decline in permeability with reduction in void ratio or water content, falling by some three orders against a change in void ratio of half an order (Hobbs, 1986). Based on laboratory tests with a Rowe cell, Hobbs reported that the pressure causing compression does not appear to be important but the significant factor is the initial void ratio, reflecting the natural state of the peat, and the void ratio attained under loading.

3. METHODS AND MATERIALS

3.1 INTRODUCTION

The hydrology of peat is unique due to its highly heterogeneous nature and peculiar physical characteristics which were discussed in section 2. Nevertheless, the basic investigative approach in the field is similar to other hydrogeological investigations but adapted to peat conditions - determination of the 3-D pressure field in order to evaluate flow directions, measurement ofpermeabilities and assessment of relevant hydrogeological profiles. Additional information on peat densities and their variation with depth is required in order to assess the degree of compaction.

The fieldwork carried out for this project consisted of:

1. Making, installing and monitoring piezometers to determine equipotential contours.
2. Drilling in the peat to note peat type, take samples for density measurements and to estimate any subsidence caused by the road.
3. Permeability measurements in the peat to assess the effect of the road and for use in modelling.
4. A dipole-dipole survey in the vicinity of the road carried out with a team of geophysicists from University College Galway as part of their study of both Clara Bog and Raheenmore Bog.

The Irish Office of Public Works (O.P.W.) have installed wooden stakes over the bog which has established

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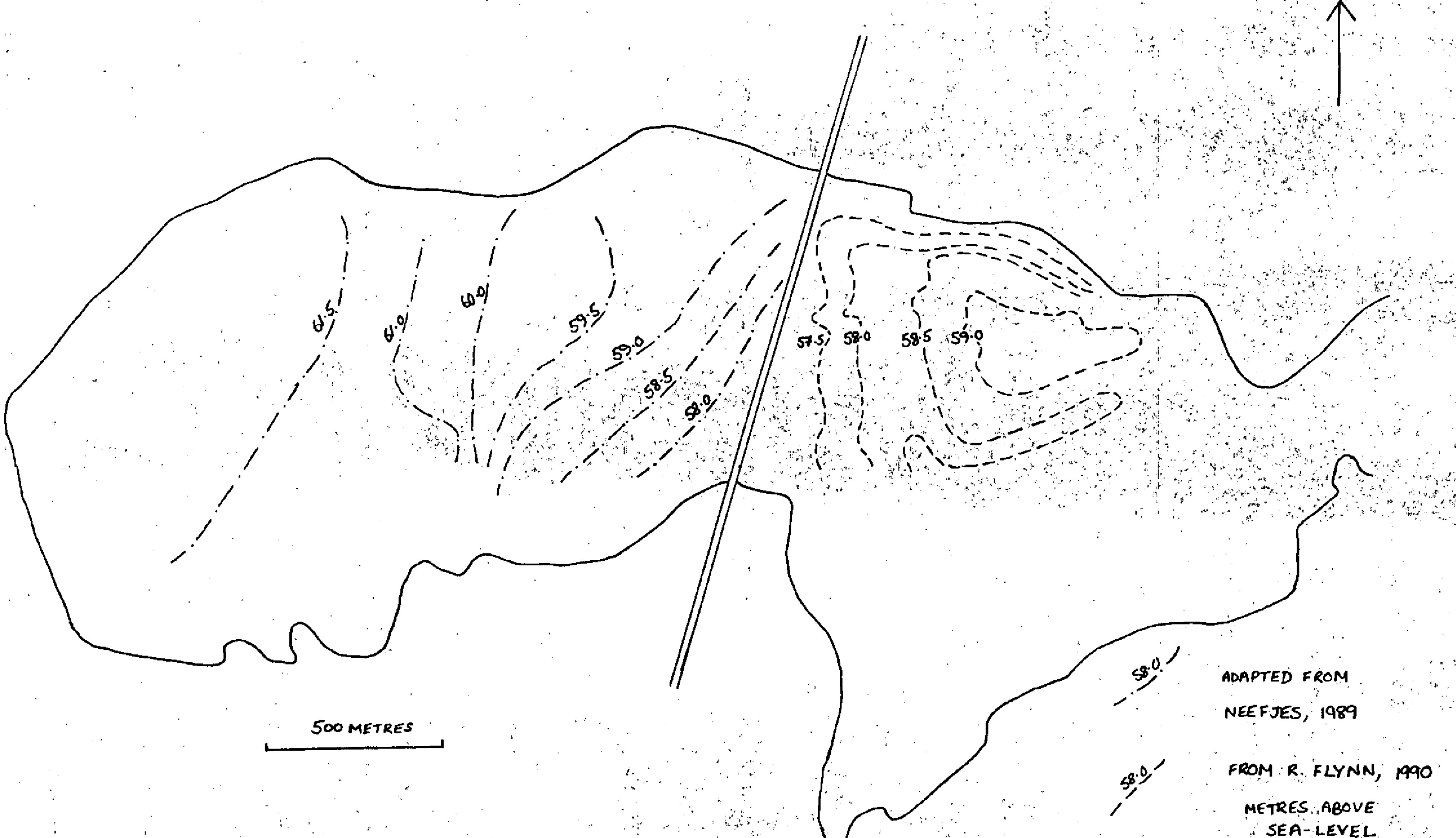
a surveyed grid reference system to which locations can be related. The grid has a 100 metre interval and uses a combination of letters for eastings and numbers for northings. The origin is at the northern end of the New road - a map of the grid can be found in appendix A13. The O.P.W. also placed benchmark studs at 100 metre intervals along the road and some benchmarks out on the bog itself. These were used during levelling. The elevations of the benchmark studs are listed in appendix A1.

3.2. THE PIEZOMETERS AND PHREATIC TUBES

In order to study the effect of the road on the flow of water through the bog four transects of piezometers were installed; labelled as NE, NW, SE and SW. After examining water table maps from reports by Flynn (1990) and Neefjees (1989) - figure 3.1 shows a diagram with these maps combined - and the peat surface contour map produced by Bord na Mona in 1982 (see figure 1.2), the transects were aligned at 60 degrees to the road in order to follow flow lines as closely as possible. Figure 3.2 shows the location of the transects. It was intended that, in addition to showing the effects of the road, the southern transects would show what effects, if any, the cut-away area at the south west margin is having on the bog. There are five piezometer stations along each transect, installed as part of this project except for stations 108 and 113 on Clara East which were already installed as part of a different transect by Henderson and Flynn in 1990. The

FIGURE 3.1 : WATER TABLE CONTOURS, CLARA BOG



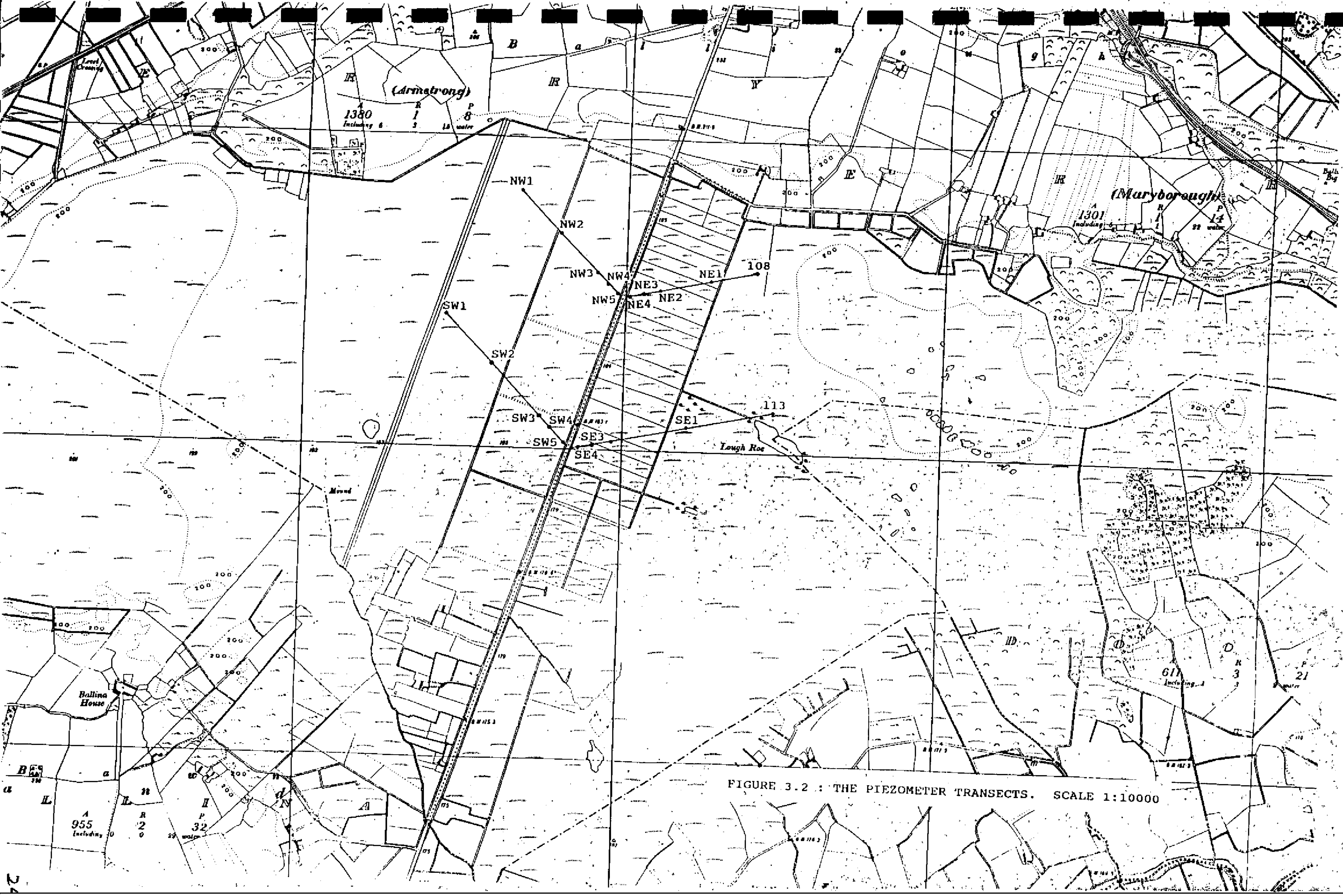


FIGURE 3.2 : THE PIEZOMETER TRANSECTS. SCALE 1:10000

location of the piezometer nests are shown in figure 3.2 and their national grid co-ordinates given in appendix A2.

Piezometers (simple devices for measuring the hydraulic head at a point in the ground) were made from one inch diameter P.V.C. tubes. Holes of 5mm diameter were drilled in to the bottom 15cm of the tubes to give an open area of approximately 10% and a rubber ferrule placed over the end to prevent peat entering the tube during installation. The holes were then covered with a fine mesh geotextile stocking to prevent blockage.

Each prospective piezo-station site was drilled with a hand auger in order to ascertain the total depth of the peat. Three piezometers were installed at each station at different depths, (shallow, intermediate and deep). The piezometers were numbered with the station number and then a prefix of A for the phreatic tube, B for the shallowest piezometer, C for the next deepest and D for the deepest. The depths of each piezometer are shown in appendix A3. They were installed by driving them into the peat. The piezometers could be set at any depth by adding tube extensions using PVC couplings and solvent cemented joints. About 40cm of tube was left above the ground surface. The piezometers were then filled with bog water from the drains and left to equilibrate for a week.

A phreatic tube (effectively a shallow piezometer) was also installed at each station. These consist of 1.5 metre lengths of the same P.V.C. tubing with holes drilled over

1 metre. They are used to measure the height of the water table.

Monitoring of the water levels in the tubes took place every two weeks during the field season (first monitoring 16/6/1991, last 7/8/1991). The tubes were levelled using the O.P.W.'s benchmark studs along the road and benchmark E on Clara East. This allowed the head in each tube to be calculated relative to Ordnance Datum by subtracting the distance to the water from the top of the tube from the levelled value of the top of the tube. Hence hydraulic heads at different depths for a certain date were obtained and equipotential contour maps could be drawn (see section 5).

Four wooden stakes were hammered into the drains by the road at the end of each transect. These were also levelled in and the water level from the top of the stake measured during monitoring in order to determine the changing storage role of the drain with time. Stakes were also hammered into the shallow drains on Clara East along the transects and the water levels in them also monitored.

3.3. DRILLING IN THE PEAT

Detailed drilling of the peat was undertaken at eight of the piezometer stations and at pegs 5D (west) and 5E (east) on the O.P.W. grid. A hand auger with a 50cm long semi-cylindrical chamber at the end was used. This allowed an almost undisturbed peat sample to be obtained. Drilling stopped once the clay was reached or sometimes earlier if an impenetrable layer was encountered. Two people were necessary for the drilling. A detailed log was made noting the humification degree of the peat and the vegetation types present. The degree of humification was assessed using the criteria outlined in Von Post's Humification Index (see appendix A4). This is a scale of humification from 1 (hardly humified plant remains) to 10 (totally humified plant remains) based on the structure of the peat, the degree to which it can be squeezed between the fingers and the colour of the squeezed water. By its nature it is a very subjective method and an assessment together with the results achieved can be found later in section 5.

A 5 cm long peat sample was taken from every fifty centimetre long core. These were used for density measurements. The density was calculated from the wet weight and dry weight of the sample and the sample volume. The samples were dried in an oven for at least 24 hours at 105 degrees Celsius. Any higher temperature is likely to cause charring or oxidation of the sample Hobbs, 1986). The volume of the sample is known by the diameter of the drill chamber (4.68 cm.) as is the length of peat core cut, (usually 5cm). Water contents of peat are high, ranging from 75% to 98% by volume. Occasionally a sample would indicate a water content of over 100% probably due to errors in determination of sample volume occurring whilst taking the sample. Fibrous peat is difficult to cut cleanly and measuring in field conditions can be difficult. Hobbs (1986), indeed, reported that the cutting resistance of fibrous matter to tube or piston sampling can cause a considerable compression of the peat, affecting the water content, permeability, compressibility and strength. Stronger, less decomposed peat is more susceptible to compression than softer more highly decomposed peat. This effect would mean that the volume used in the calculations could be smaller than the real volume leading to the error in the percentage volume of water.

The sample containers were also weighed so that the weight of the organic matter could be calculated.

3.4 PERMEABILITY TESTS

Permeability tests were carried out in the field using the constant head piezometer method. This method uses Marriote vessels which are water containers designed to produce a fixed imposed head irrespective of the water level in the container, see figure 3.3. The containers are filled with bog water from the drains and sealed with vaseline to be air-tight. Bog water must be used because the permeability of peat also depends upon the chemistry of the percolating water, since the adsorption complex will be affected by any change in chemistry (Hobbs, 1986). Plastic tubing is used to connect the containers to the water in the piezometers. To initiate the test the vessel is raised so that water runs into the piezometer. Care must be taken that no air bubbles are left in the tubes and that the end of the tube is below the water level so that water is not just running freely into air. The initial water

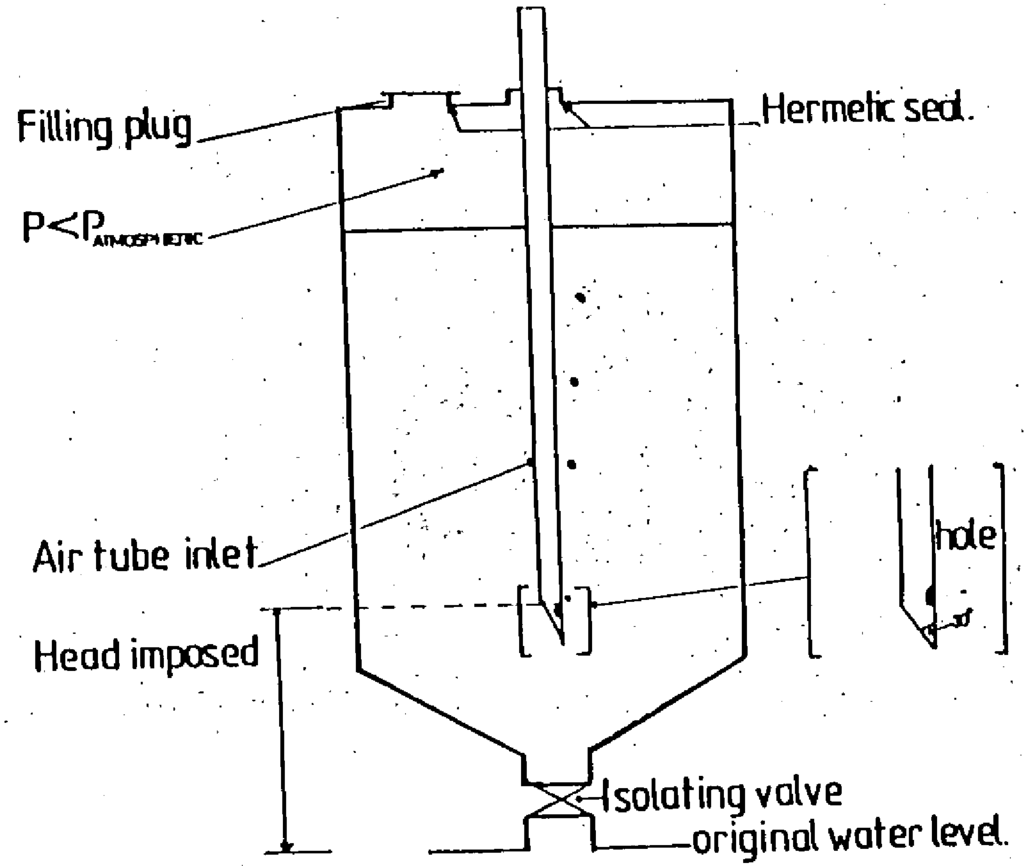


FIGURE 3·3 **Marriote Constant Head Appartus**

FROM FLYNN, 1990

level in the container is noted and its drop is measured at intervals.

According to Kirkham (1945),

$$K = q/(S*h)$$

where K is the hydraulic conductivity, q is the rate of outflow from the Marriote vessel which is necessary to maintain a constant water level in the piezometer under an imposed head of h. h is the difference between the water level in the piezometer before the test and the constant water level in it at the end of the test. The piezometer is therefore dipped at the beginning and the end of the test in order for this to be calculated. S is the shape factor which is,

$$S = (2\pi L)/\ln\{(L/d)+(1+(L/d)2)1/2\}$$

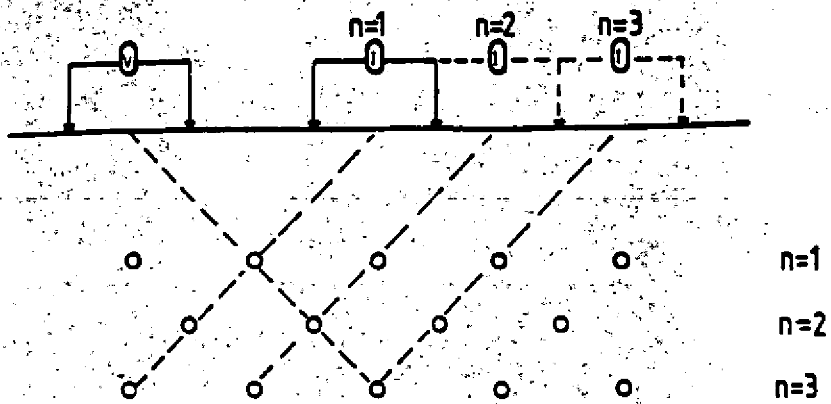
after Hvorslev, where L is the length of open section and d is the internal diameter of the tube. For the piezometers in this project S is 0.354 metres. S has the dimensions of length.

The tests were carried out over various time intervals depending on the conditions of the peat at each piezometer. During some tests it was found that the Marriote vessels emptied very slowly and these were then left for a few days with a measurement being taken two or three times a day. When the drop in water level is so slow it is more accurate to measure a drop over a longer period. It was also discovered that the rate of outflow often decreased markedly with time. This phenomenon is noted by Dooge (1972) in his review paper. Sometimes the flow would appear to become constant but was actually still changing slowly so that at a later stage a smaller flow was measured, see, for example, piezometer SE4D, appendix A5. Some of the vessels emptied at a much faster rate taking only a few hours. For these tests it is hard to be sure that a constant water level in the piezometers is achieved. Unfortunately it was not possible to monitor the water levels in the tubes during the tests as the diameter of the piezometers is too small. The values obtained are a measure of the horizontal hydraulic conductivities in the peat, under the specified head.

The constant head test was used rather than other piezometer tests such as the falling or rising head methods because there is some evidence that peat may not act as a Darcian medium to water flow and permeabilities would vary with the head. A constant head test would therefore seem the appropriate method to use, with as low an imposed head as possible to resemble natural conditions in the peat.

3.5 SURFACE GEOPHYSICS - DIPOLE-DIPOLE SECTIONING

The dipole-dipole method is a geo-electrical technique used to produce a resistivity pseudo-section. This pseudo-section can not be considered to directly reflect the sub-surface geology, but can be interpreted to indicate the general configuration of sub-surface features such as bedrock, layering, faults, etc, (Smyth, 1991). Figure 3.4 shows the electrode arrangement. The apparent resistivity (pa) is calculated as follows:



DIPOLE-DIPOLE PSEUDO-SECTION CONSTRUCTION TECHNIQUE.

The three current-dipole positions correspond to three different multiples of the basic spacing. The measured values are plotted at the intersections of 45° slope lines from the centres of the current voltage dipoles.
(Milsom, 1989)

FIGURE 3.4 : FROM FLYNN, 1990

$$pa = n * (n+1)*(n+2) * a * R$$

where the current-voltage spacing is increased in multiples of a, n is the multiple of 'a' separating the nearest current and potential electrodes and R is the resistance read from the instrumentation. The results are plotted as shown in figure 3.4, these values being contoured to produce the resulting pseudo-sections.

The dipole-dipole technique was used along six transects in the vicinity of the road; four traversing it and two along its length. Figure 3.5 shows the locations of the transects. The pseudo-sections were produced by M. Dowling, D. Keohane and E. Naughton, University College Galway.

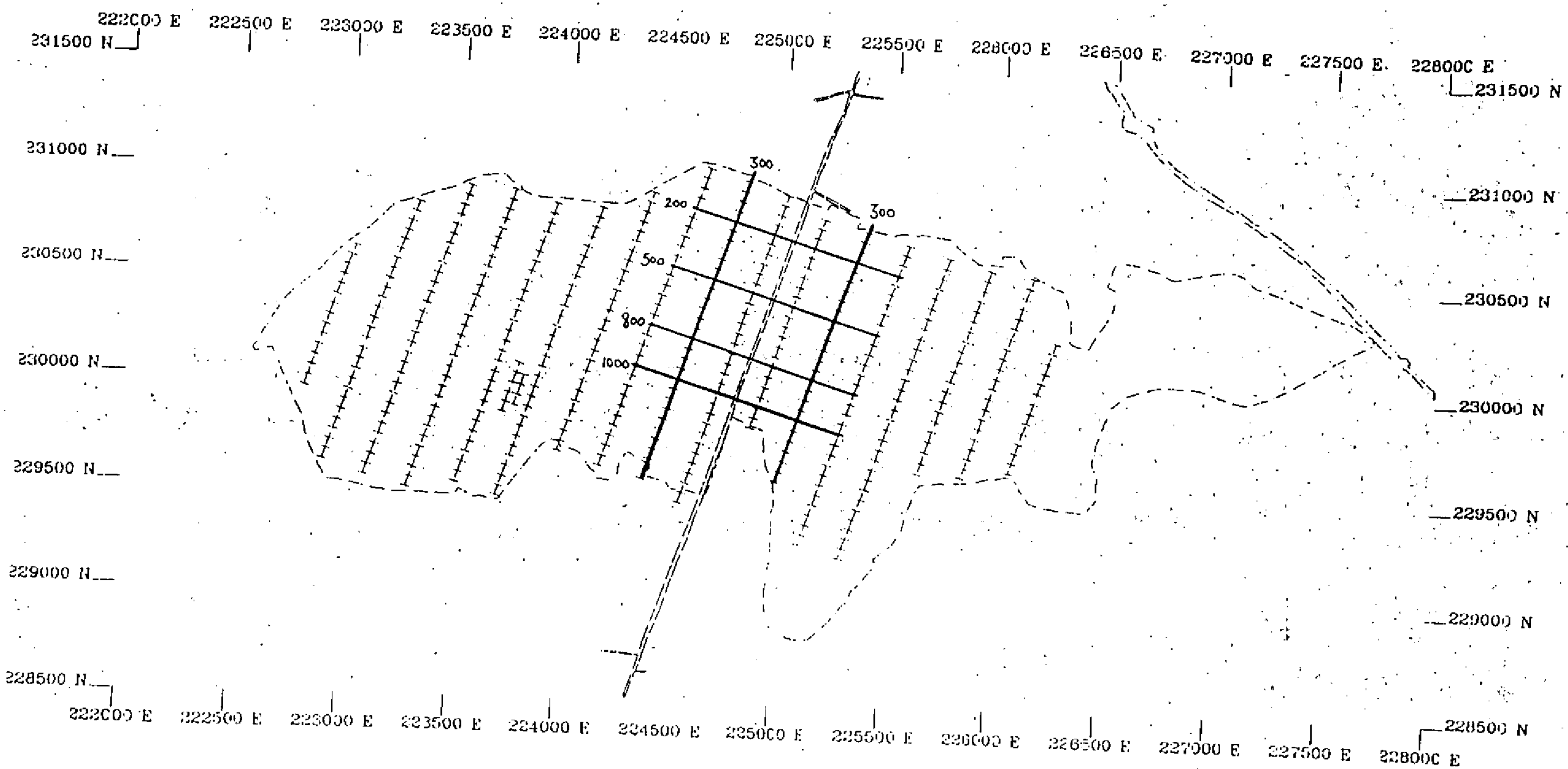


FIGURE 3.5 : THE DIPOLE-DIPOLE SURVEY LINES. SCALE 1:20000

4. GEOLOGY AND GEOPHYSICS

4.1 REGIONAL GEOLOGY

The geology of north County Offaly is dominated by Pleistocene and recent deposits, the former having a glacial origin (Flynn, 1990). The region is traversed by a series of east-west trending eskers with subsequent Holocene deposits lying inbetween, predominantly of organic or alluvial/lacustrine origin. Bedrock exposure in the area is rare but borehole data shows it to be Carboniferous limestone.

Clara Bog lies south of the Esker Riada which separates it from the River Brosna catchment to the north. The Silver River lies to the south of the bog. The deposits in the esker are exposed in numerous local quarries. They are dominated by medium sands; well-sorted and sub-angular to sub-rounded in shape. There are also lenticular units of predominantly cobble and boulder-sized material (Flynn, 1990).

4.2 THE GEOLOGY BENEATH CLARA BOG

Bedrock drilling was carried out by the Geological Survey of Ireland at three sites in the study area in 1990 and at four sites in 1991. A full account of the drilling investigations from 1990 is covered in reports by Henderson (1991) and Smyth (1991). Drilling at the carpark off the New Road in the centre of the bog was carried out both in 1990 and 1991. During the 1990 drilling it was discovered that artesian conditions existed in the limestone there which hindered the emplacement of piezometers. A new borehole was drilled in 1991 and because artesian conditions were expected precautions could be taken in installing the piezometers. A detailed log of this borehole can be found in appendix A12.

Drilling through the bog has shown the general geological succession to be peat (Holocene), underlain by blue-grey clay (Holocene), underlain by glacial till (Pleistocene), underlain by massive to lightly fissured, clean, blue-grey limestone (L. Carboniferous).

The depth of the peat varies spatially over the bog. Figure 4.1 shows a peat thickness contour map converted to metres from Bord na Mona survey data by M. Smyth, 1991. It shows that the peat is at its thickest (over 8 metres) in the areas in Clara east and west that coincide with the surface topographic highs. The map also shows that the peat thins out towards the margins of the bog. Hand-augering in the peat during the course of this project revealed that the peat thins near the road. Peat depths along the road were also found to be variable, ranging from 6 metres at the carpark to 3.75 metres at piezometer nest NW5. This variation is partly due to the undulating nature of the peat-clay interface. The deepest peat found during the augering was at O.P.W. peg 5E on Clara east, where the peat was 9.5 metres deep. In the middle of Clara west the peat has been reported as being as deep as 10 metres (Flynn, 1990).

Hand-augering at each piezometer nest consistently showed clay to underlie the peat. The nature of the top of this unit was observed to vary from a smooth, plastic, blue-grey clay, to a gravelly clay, to a silty clay with shell fragments. The thickness of the clay unit has been found to vary over the bog from 1 metre up to 5.5 metres at the carpark. The clay is sticky with a very low permeability although the peat-clay interface may be relatively permeable. The nature of the clay is such that it effectively seals the peat off from the underlying layers. Hand-augering showed the peat-clay interface to undulate as was found by Flynn, 1990, see figure 4.2.

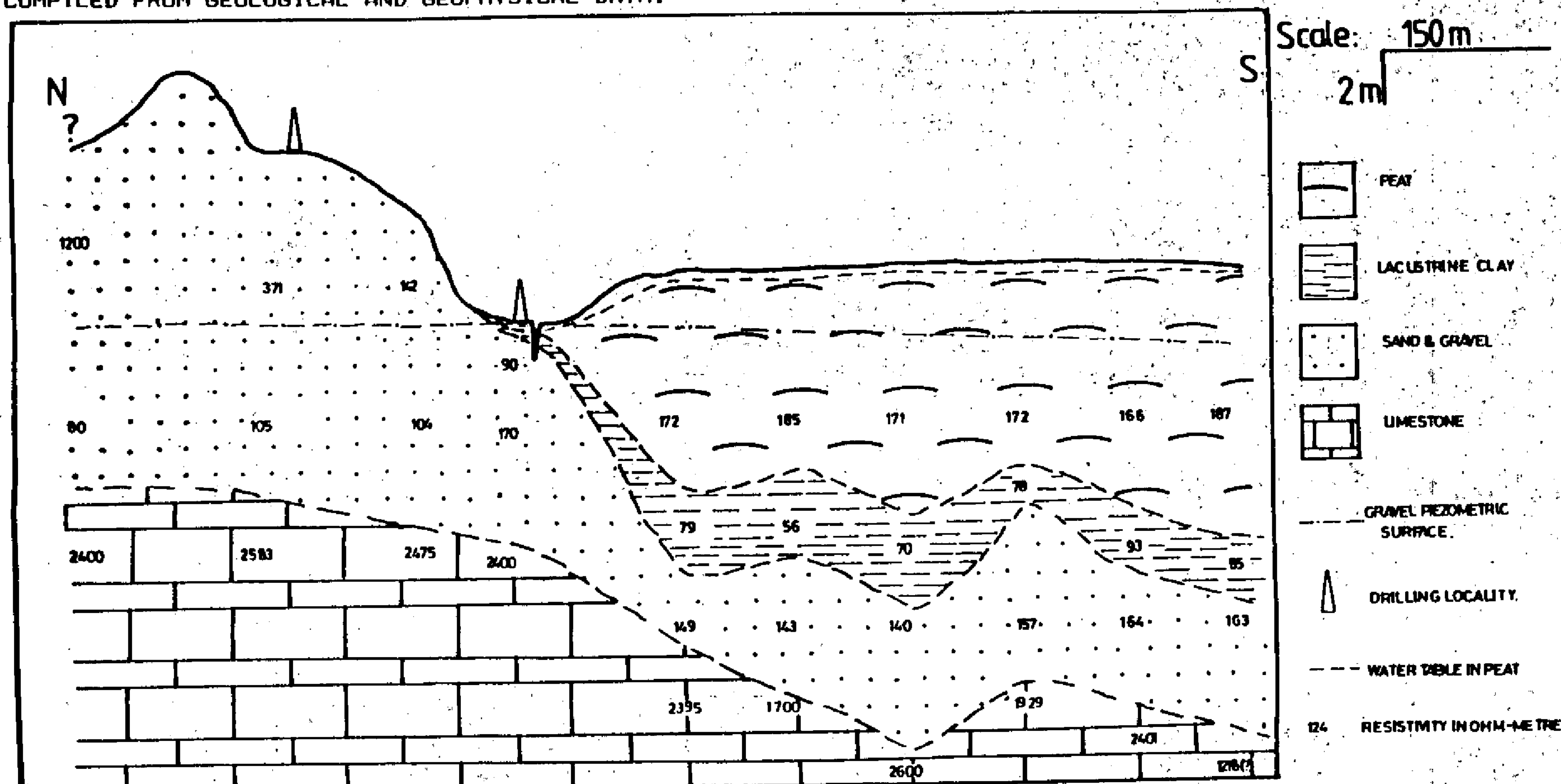
Figure 4.3 shows a contour map of the peat-base topography, again converted to metres from Bord na Mona survey data by M. Smyth, 1991. This map shows the pre-peat topography of the area. It can be seen that a basin existed with the lowest part (less than 50 M.O.D.) in the centre. The shape of the contours suggests that the basin continues further south than the southern margin of the existing bog. The bog probably extended further but has since been cut-away.

4.3 SOME GEOPHYSICAL DATA ON CLARA BOG

Figure 4.4 shows a contoured resistivity map from a VLF-R survey taken from M. Smyth, 1991. Areas of high resistivity (resistivity values greater than 450 ohm-m) indicate bedrock is likely to be closer to the surface (Smyth, 1991). Following this criteria it can be seen that bedrock is deep under the central area of the bog where the

A CROSS SECTION OF CLARA BOG AND ADJACENT ESKER

COMPILED FROM GEOLOGICAL AND GEOPHYSICAL DATA.



SECTION COMPILED FROM GEOLOGICAL & OFFSET WENNER GEOPHYSICAL DATA.

FIGURE 4.2 : FROM FLYNN, 1990

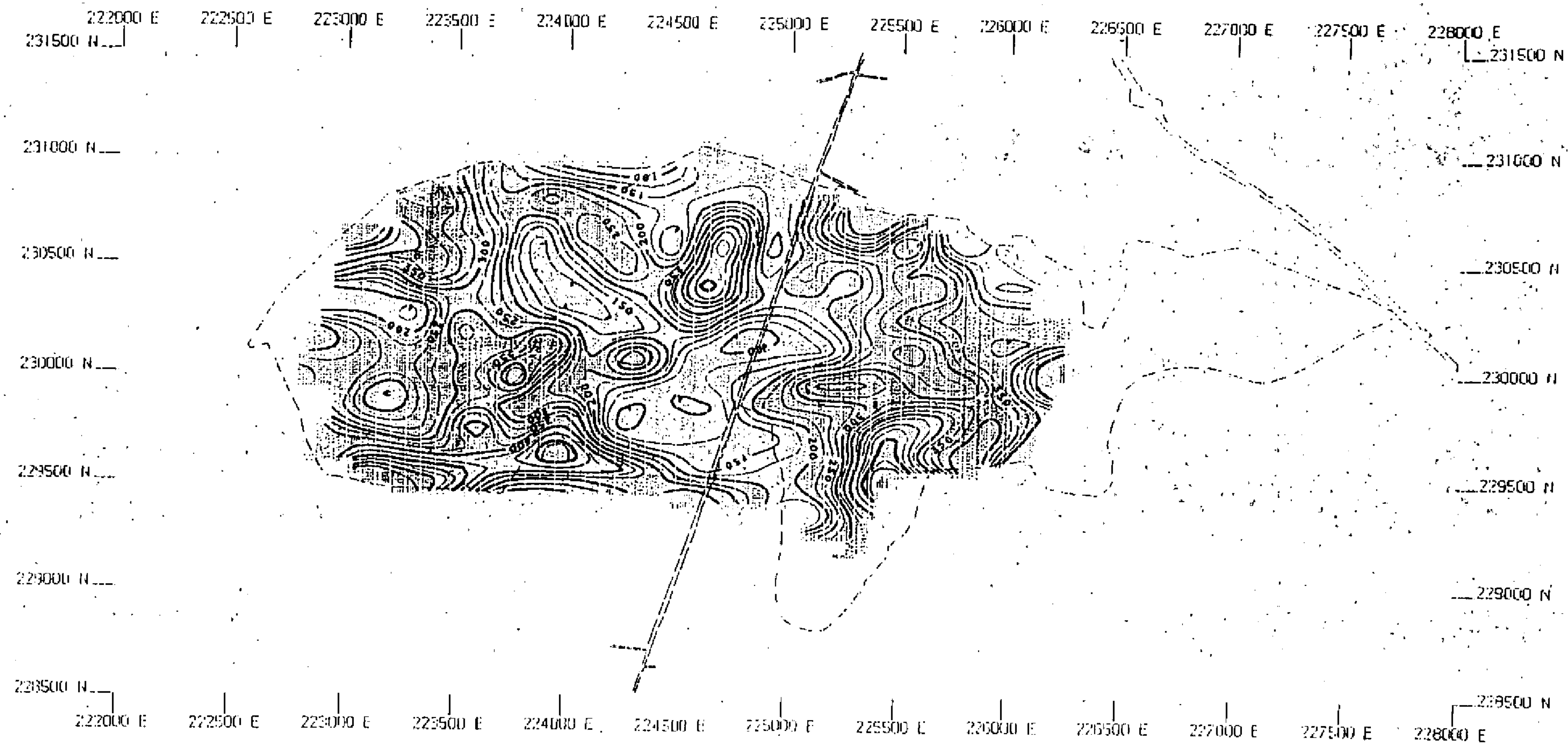


FIGURE 4.4 : SMOOTHED RESISTIVITY CONTOUR MAP. SCALE 1:20000
FROM M. SMYTH, 1991.

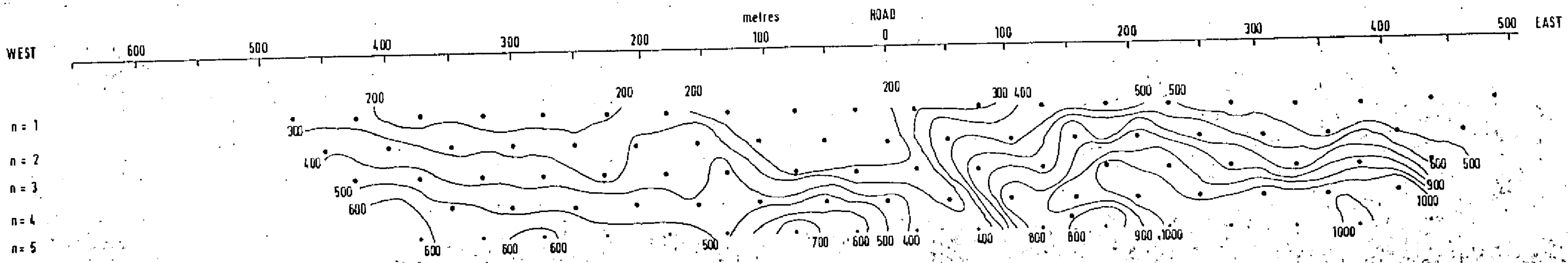
resistivities are less than 200 ohm-m. Bedrock can be seen to rise towards the edges of the bog where higher resistivities are found. This would indicate that a basin exists in the bedrock under the bog and this correlates well with the conclusions from the peat-base Bord na Mona data. The subsurface topography of the basin is very irregular.

The pseudo-sections from the dipole-dipole profiles are shown in figure 4.5 with permission from M. Dowling. A detailed description of them and other geophysical work done on Clara Bog in June, 1991 can be found in the MSc thesis of M. Dowling, 1991. The following criteria has been used in interpreting the sections:

0-300 ohm-m	peat/clay
300-600 ohm-m	boulder clay
600-1000 ohm-m	bedrock

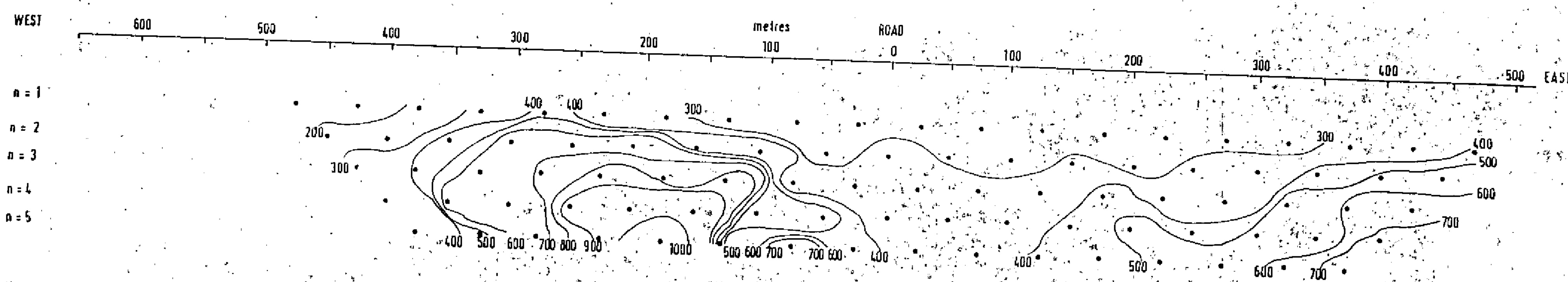
The pseudo-sections can then be seen to correlate well with the VLF-R contour map in figure 4.4. The east-west sections 200, 500 and 800 all show the bedrock to be deep underneath the road. Section 200 shows the bedrock to be shallower to the east while section 500 shows it to be shallower in the west. The east-west line 1000 shows high resistivities beneath the road indicating that the bedrock is near to the surface at this point. This fits in well with the VLF-R contour map and could be due to the effect of the basin. Some mineral company maps of the area show a fault in the southern region of the bog but there is some uncertainty over its actual position. The north-south line

300 in the west shows a resistivity high that correlates with the anomalous high to the north-west of the road in figure 4.4. The north-south line 300 in the east shows the bedrock to be relatively shallow in the north, which again correlates with the VLF-R map.



KEY:
Contours 100m intervals
Resistivity contours 100 ohm-metres

FIGURE 4.5
DIPOLE-DIPOLE PSEUDO-SECTION, CLARA STATION 200

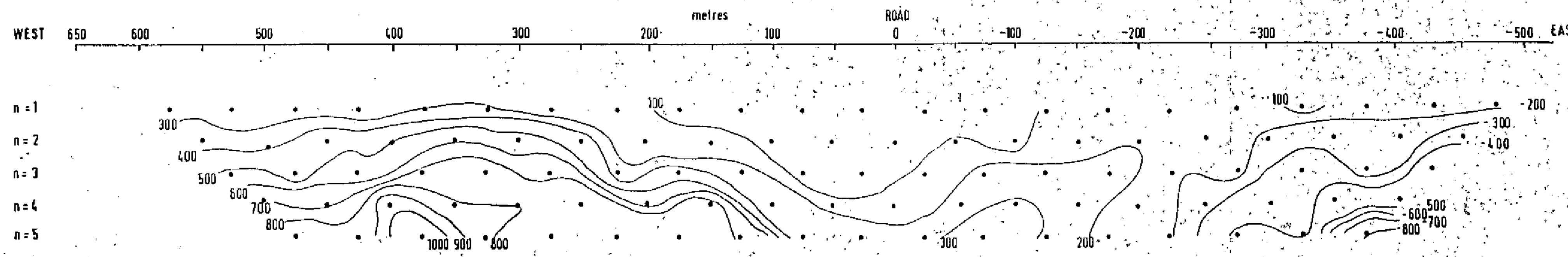


KEY

Contours 100m. intervals

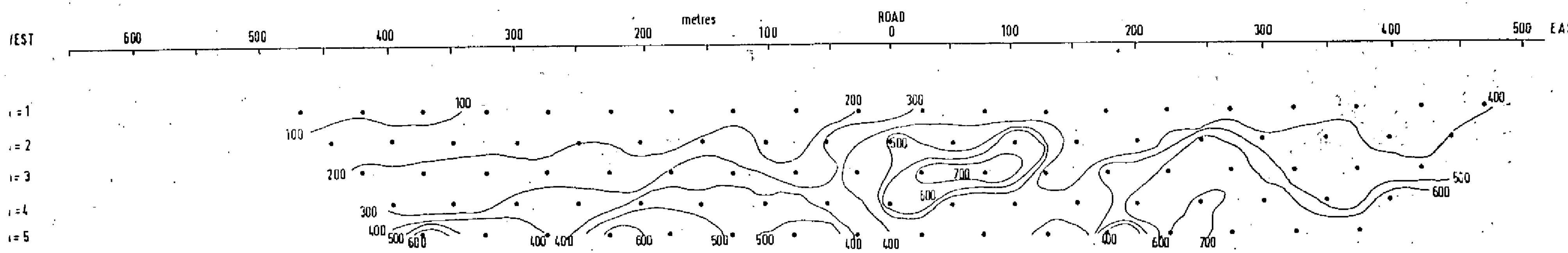
Resistivity contours 100 ohm-metres

DIPOLE-DIPOLE PSEUDO-SECTION, CLARA STATION 500



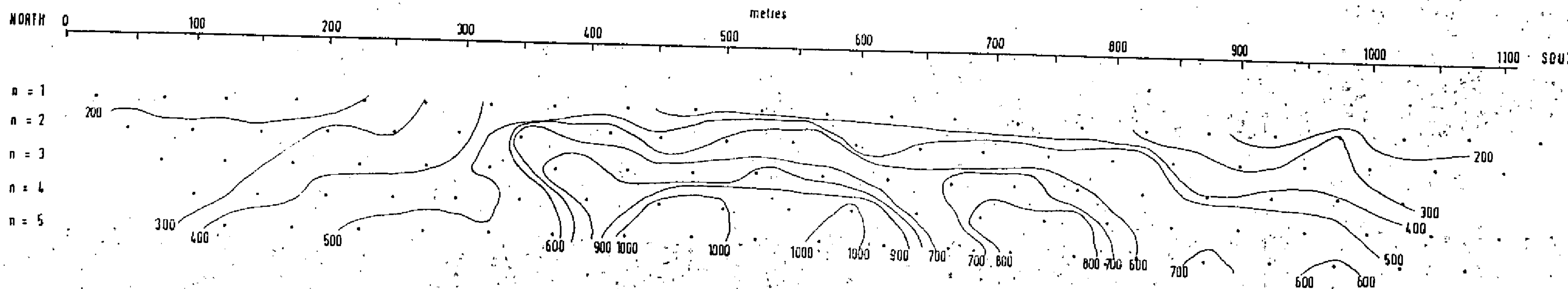
KEY:
Contours 100 m intervals
Resistivity contours 100 ohm - metres

DIPOLE - DIPOLE PSEUDO-SECTION, CLARA STATION 800



KEY:
Contours 100m intervals
Resistivity contours 100 ohm – metres

DIPOLE - DIPOLE PSEUDO - SECTION, CLARA STATION 1000

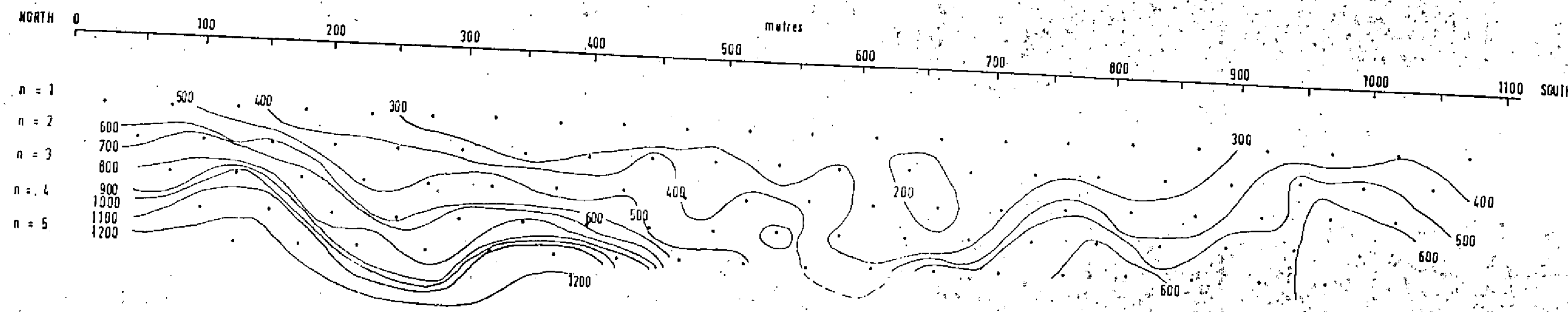


KEY

Contours 100 m intervals

Resistivity contours 100 ohm.-metres

DIPOLE - DIPOLE PSEUDO - SECTION, CLARA WEST LINE 300



KEY

Contours 100m intervals

Resistivity contours 100 ohm - metres

DIPOLE - DIPOLE PSEUDO - SECTION, CLARA EAST LINE 300

5. ANALYSIS AND RESULTS

5.1 HYDRAULIC HEAD DATA

Figure 5.1 shows the equipotential contours through the peat for the northern and southern piezometer transects from data collected on the 10/7/91. All of the monitoring data collected during the fieldwork period showed a similar pattern with heads differing only by a few centimetres, if at all, and showing the same trends. The equipotential cross-sections for the 26/6/91, 24/7/91 and 7/8/91 can be found in appendix A6 with the raw data listed in appendix A7. The data collected can be considered as being representative of the hydrological situation during the summer season. The transects have been drawn as cross-sections but it must be remembered that the angle between the two northern transects and the angle between the two southern transects is 120 degrees, not 180 degrees because the piezometers were located along flowlines. The underlying clay has been assumed to be a no-flow boundary so that the equipotential contours cut it at right-angles. Although in reality flow will occur through the clay its sticky nature would indicate that it has a very low permeability and that these flows would be very small.

If a basic assumption is made that the peat is homogeneous at the regional scale, flow in 2 dimensions can be considered as occurring perpendicular to the equipotential contours from areas of high hydraulic head to areas of low hydraulic head. Both the northern and

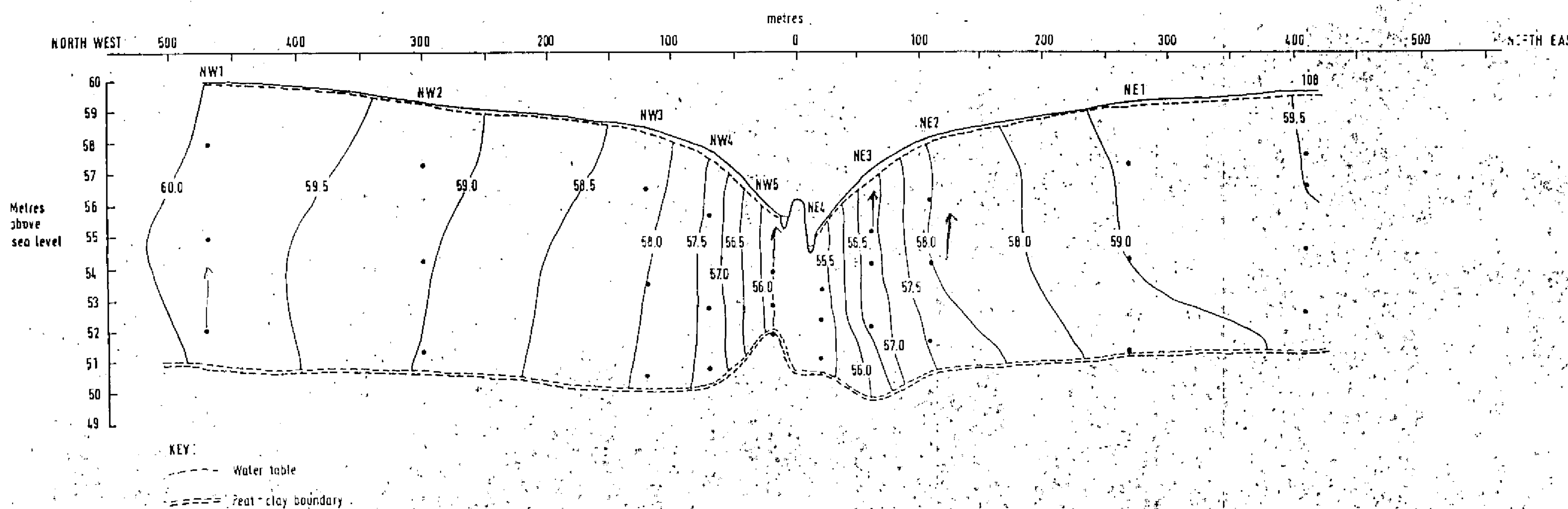


FIGURE 5.1
EQUIPOTENTIAL CONTOURS THROUGH THE PEAT
NORTHERN TRANSECTS Date 10/7/91
Contour interval 0.5m

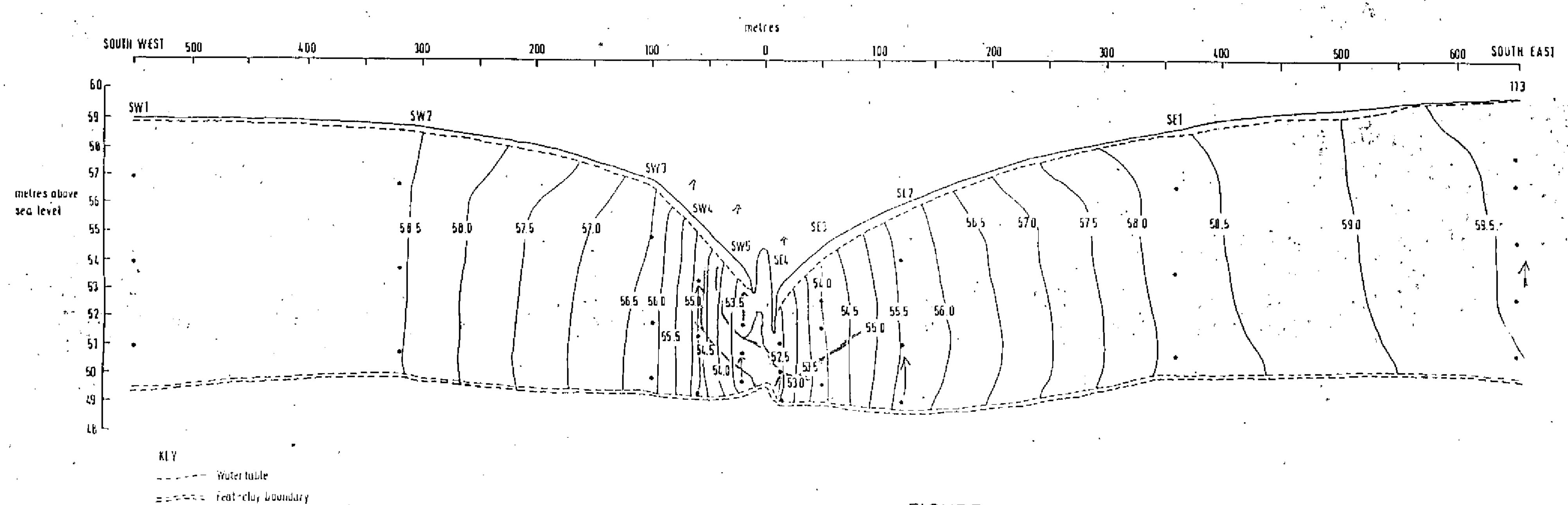


FIGURE 5.1
EQUIPOTENTIAL CONTOURS THROUGH THE PEAT, SOUTHERN TRANSECTS. Date 10/7/91
Contour interval 0.5m

southern transects show that the drains along the road affect the flow of water in the bog considerably. Water flows towards the drains from up to 650 metres away. The spacing of the equipotential contours becomes very close near to the drains because there is a rapid decrease in head governed by the position of the water table, which is in turn governed by the topography and the water level in the drains.

The vertical hydraulic gradients are mostly downwards. Only very near to the drains (less than 10 metres away) are any upwards gradients found.

In the north-east section, at a distance of more than 250 metres from the road, the equipotential contours bend as if the flow is downwards into the underlying clay layer. As mentioned above the clay is assumed to have a very low permeability so an explanation for the bending may be a high permeability layer in the peat or a high permeability peat-clay boundary in that area.

The heads in the northern transects are higher than those in the southern ones as would be expected from the their topographic differences. The heads in the western transects are higher than those in the eastern transects by approximately 1 metre. This is because the water levels in the western drains are higher and the drains in the east are deeper at stations 400 and 900 where the transects meet.

As the flowlines are at 60 degrees to the road the road cannot be the sole influence. The angled flow is due to the lower topography in the south which is probably caused by the cut-away area in the south.

5.2 RESULTS FROM THE PEAT DRILLINGS

The data from the peat drilling is listed in appendices A8 and A9.

5.2.1 HUMIFICATION

Because the method of assigning a humification degree to peat is so subjective, there is some doubt as to its worth. The humification degrees found ranged from H2 to H8. Figure 5.2 shows an attempted cross-section of humifications for the northern transect. Although the humification is very variable some general points can be made. The peat at the top tends to be of low humification degree, H3 or less. The lower peat tends to be composed of layers of variable humification until the bottom layer, with a humification of H5/H6, is reached. Near to the road the peat at the top is of H5 and not the poorly humified material found further away. This would indicate that some disturbance has occurred and the top layer has been greatly compressed.

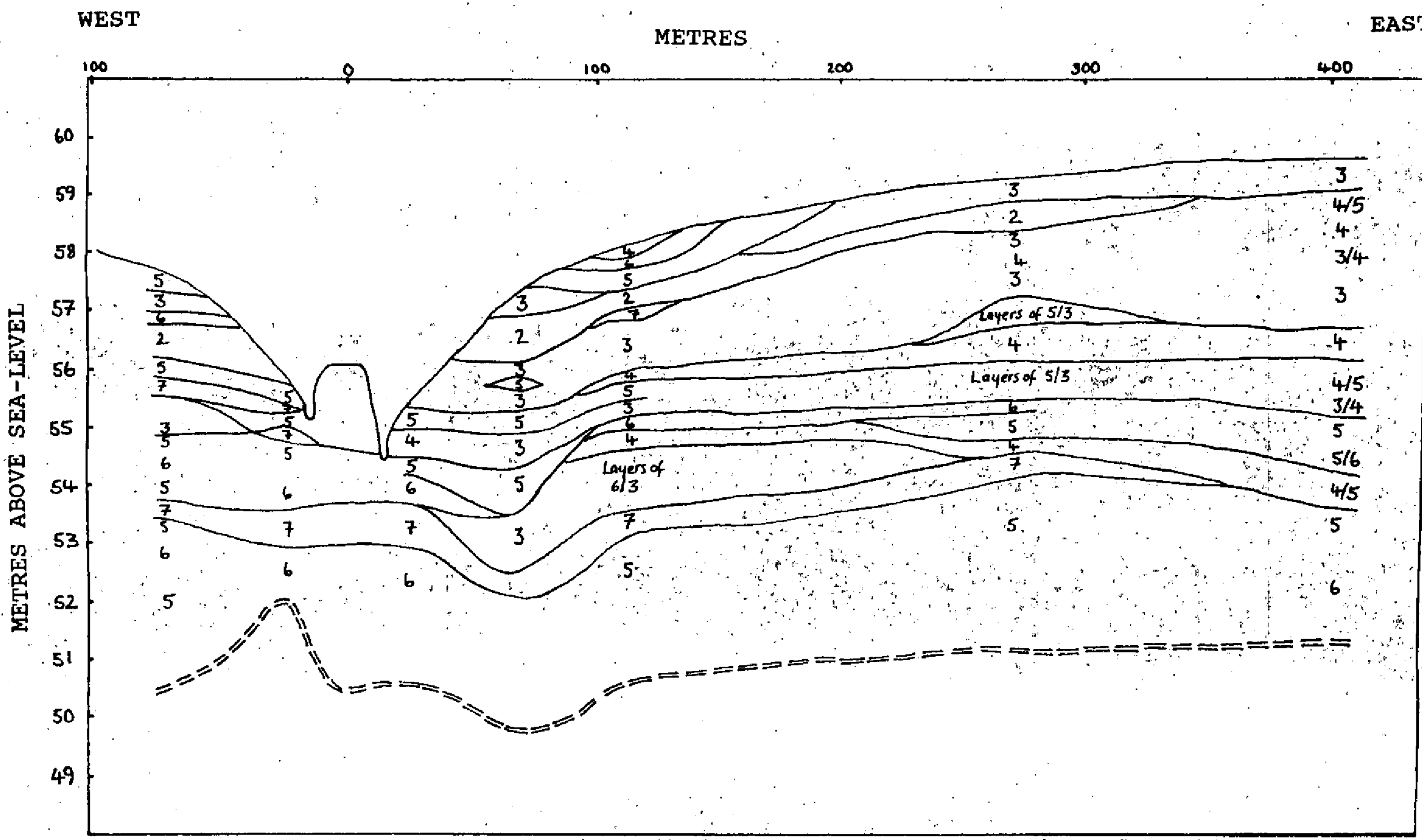


FIGURE 5.2 : CROSS-SECTION OF NORTHERN TRANSECTS SHOWING HUMIFICATION DEGREE (AFTER VON POST)

5.2.2 VEGETATION TYPE

The vegetation can be divided into the following categories, after Hobbs (1986):

Raised Bog	sphagnum, cotton grass, heather
Transition Peat	sphagnum, cotton grass, heather, wood, sedge, reed
Fen Peat	wood, sedge, reed

Figure 5.3 shows a cross-section of the northern transect with the vegetation divided into these categories. It can be seen that the transition peat and raised bog layers tend to be thinner near to the road probably as a result of compression.

5.2.3 DENSITY MEASUREMENTS

Graphs of density versus depth for the 10 drillings made are shown in appendix A10. It would be expected that density increases with depth. This trend is found in most of the curves, though they are not very smooth. The drilling made at piezometer nest SW5 has the opposite trend. The effect of the road may account for some of the irregularities in the curves. Density also varies with vegetation type and humification degree. The least irregular curves are those furthest from the road. It can be seen that the densities found in the peat near to the road are higher than the densities found in the peat away from the road even though the peat is much thicker there therefore the peat nearest to the road has been compressed.

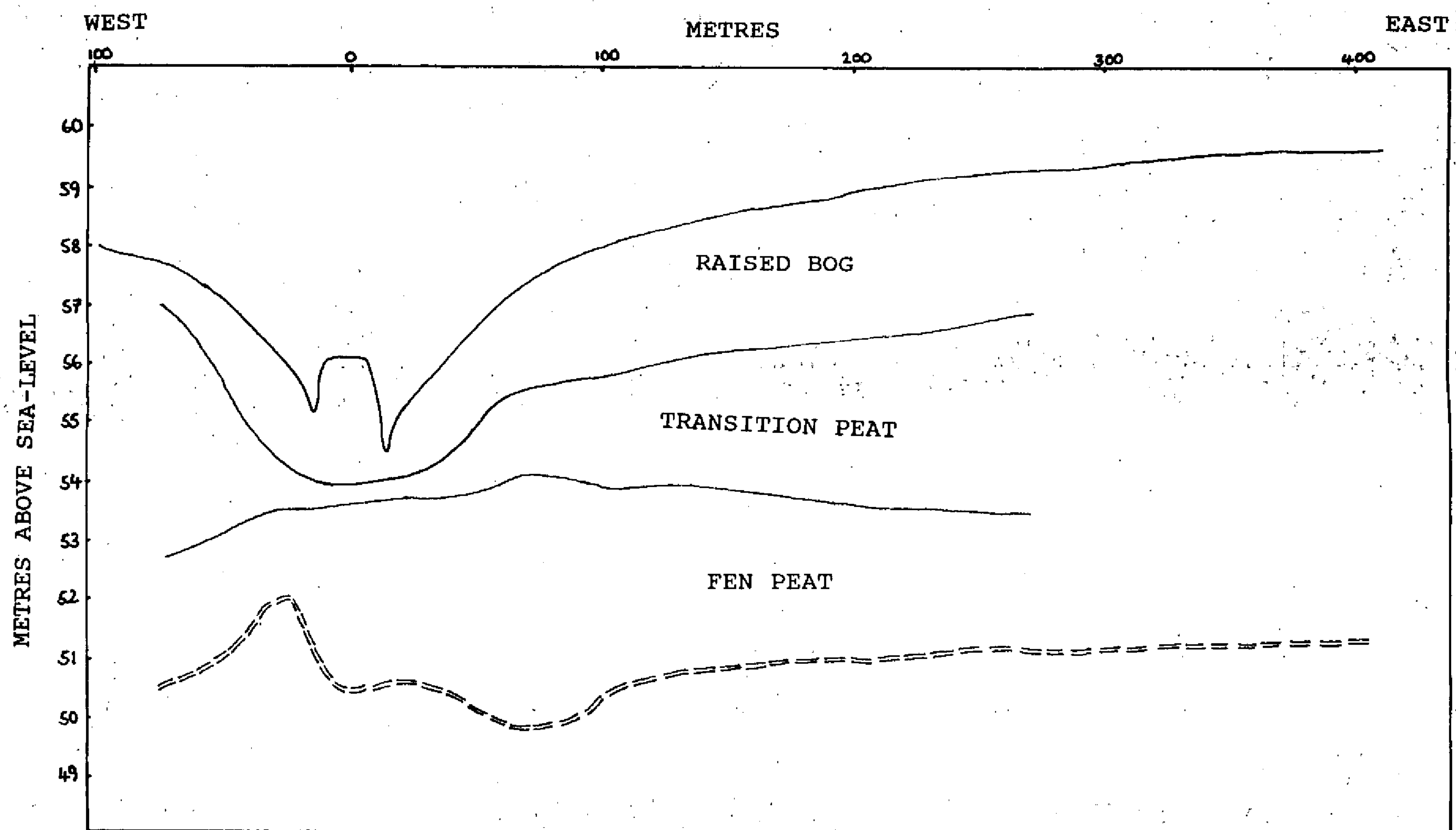


FIGURE 5.3 : CROSS-SECTION OF NORTHERN TRANSECTS SHOWING PEAT TYPE BASED ON VEGETATION

5.2.4 ESTIMATING THE AMOUNT OF SUBSIDENCE

The amount of subsidence can be estimated using density measurements or the weight of organic matter in a fixed volume. In order to calculate the amount of subsidence density/organic matter measurements must be made with reference to peat in an "undisturbed" area. An average density per metre or average weight of organic matter (in a fixed volume) per metre is then calculated for the peat column. Three such drillings were made on Clara Bog; at piezometer nest NE1, at the O.P.W. peg 5D on Clara west and at the O.P.W. peg 5E on Clara east. Then the amount of subsidence at a location can be calculated from:

$$pa/(l + x) = Zp$$

or

$$wa/(l + x) = Zw$$

where pa/wa is the average density/weight of organic matter (in a fixed volume) in the peat column at that location, Zp/Zw is the average density/weight of organic matter (in a fixed volume) per metre in the undisturbed column, l is the length of the peat column at that location and x is the amount of subsidence.

For NE1, $Zp = 7.5 * 10^{-3}$ g/cm^3/m

$Zw = 0.32$ g/m

For 5D, $Zp = 6.73 * 10^{-3}$ g/cm^3/m

$Zw = 0.29$ g/m

For 5E, $Zp = 5.75 * 10^{-3}$ g/cm^3/m

$Zw = 0.25$ g/m

Results:-

Using NE1, Zp

	NE1	NE2	NE3	NE4	NW4	NW5	SW3	SW5
x(m)	0.00	0.90	3.02	5.78	2.08	5.72	2.10	7.22

Using NE1, Zw

	NE1	NE2	NE3	NE4	NW4	NW5	SW3	SW5
x(m)	0.00	1.00	3.06	5.84	2.16	5.81	2.22	7.31

Using 5D west, Zp

	NE1	NE2	NE3	NE4	NW4	NW5	SW3	SW5
x(m)	0.92	1.86	4.19	6.99	3.15	6.80	3.20	8.53

Using 5D west, Zw

	NE1	NE2	NE3	NE4	NW4	NW5	SW3	SW5
x(m)	0.83	1.88	4.13	6.94	3.13	6.80	3.22	8.51

Using 5E east, Zp

	NE1	NE2	NE3	NE4	NW4	NW5	SW3	SW5
x(m)	2.43	3.46	6.14	8.99	4.92	8.60	5.02	10.71

Using 5E east, Zw

	NE1	NE2	NE3	NE4	NW4	NW5	SW3	SW5
x(m)	2.24	3.38	5.95	8.81	4.79	8.49	4.94	10.55

The x values calculated using Zp and Zw are very close for each drilling.

Figure 5.4 is a diagram of the reconstructed bog surface using density measurements and the Zp values for the three drillings in undisturbed areas. It can be seen that column 5E east consistently gives a greater value of subsidence followed by column 5D west and then NE1. The three reconstructed profiles have a very similar shape. From the position of NE1 on the bog it is possibly still

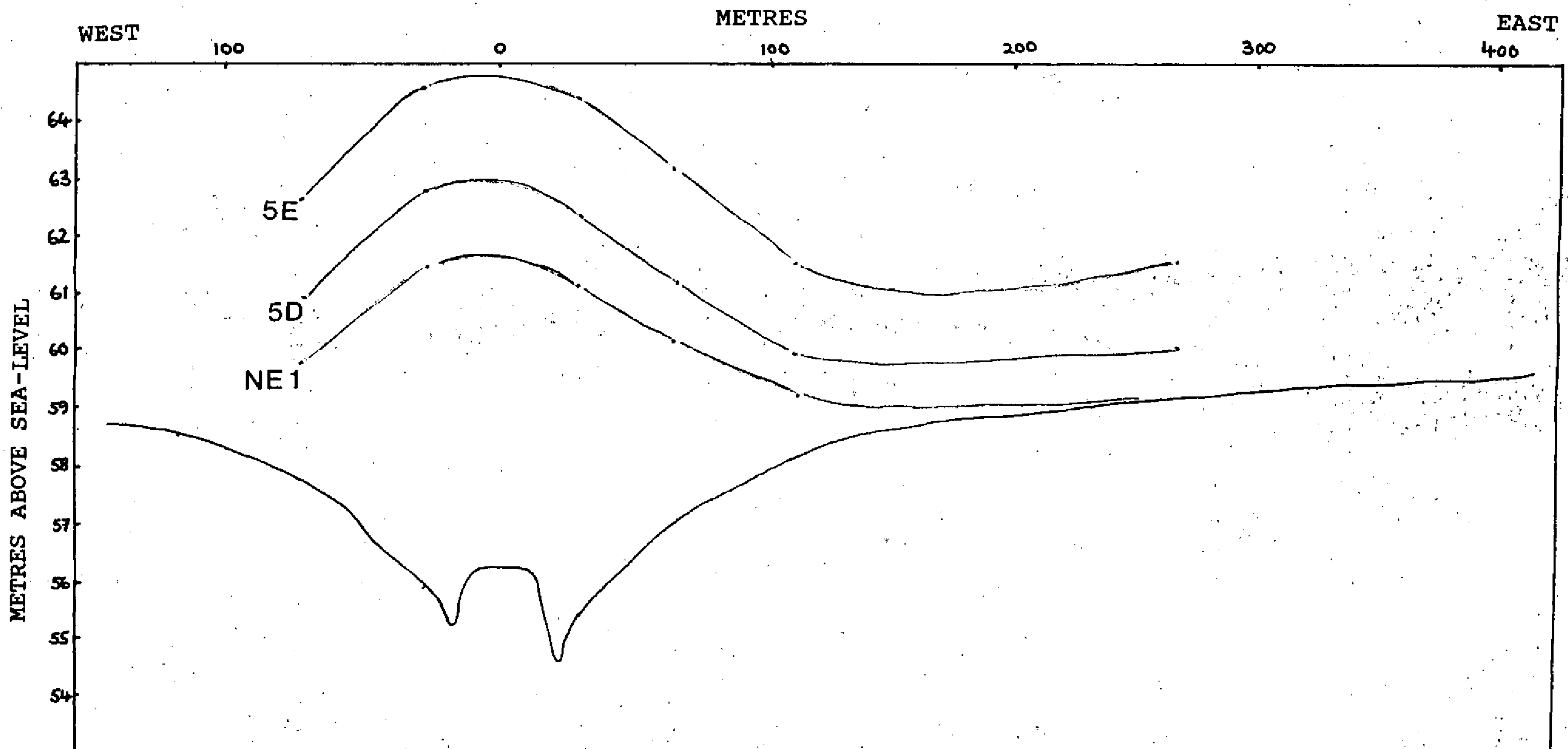


FIGURE 5.4a : RECONSTRUCTED BOG SURFACE, NORTHERN TRANSECTS

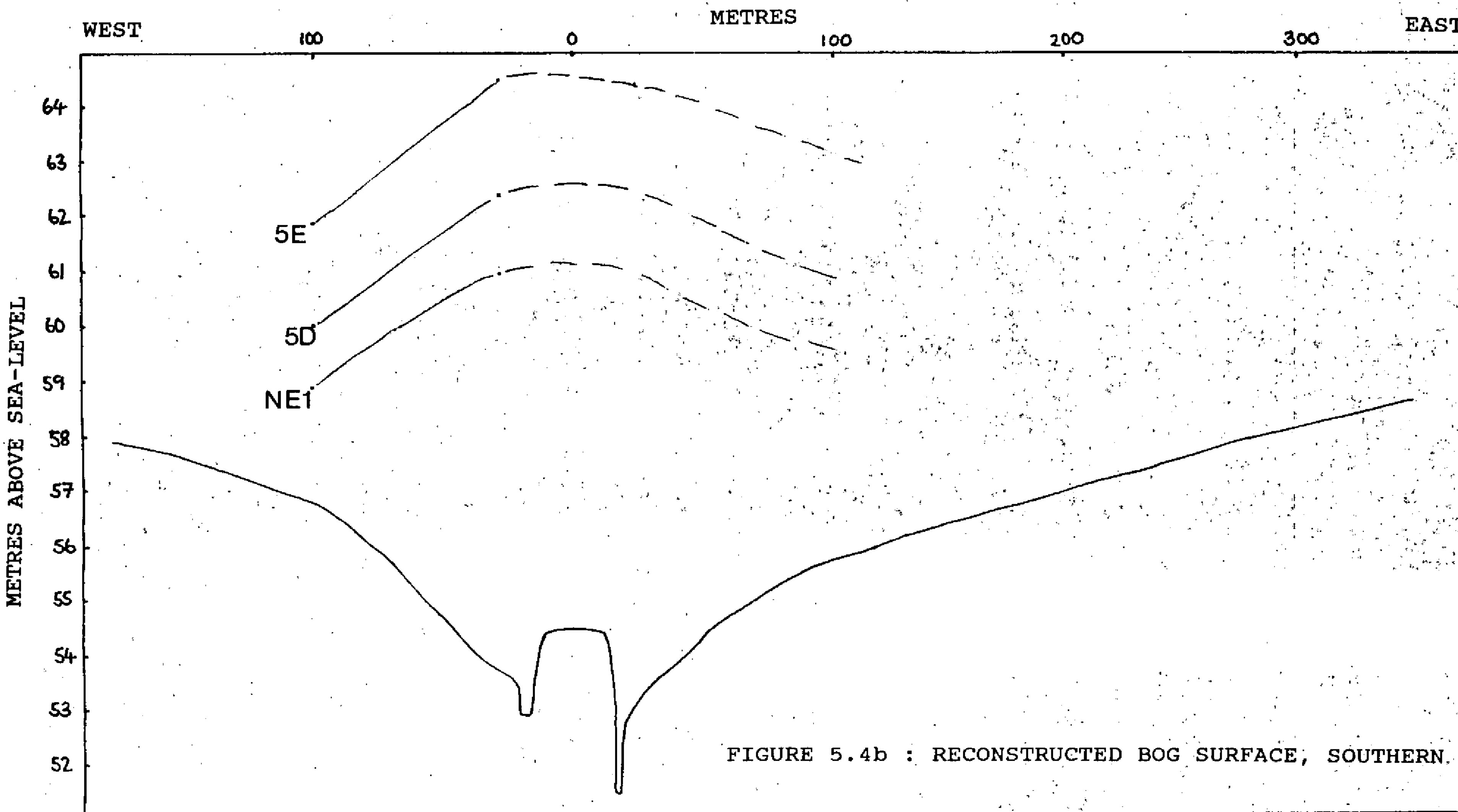


FIGURE 5.4b : RECONSTRUCTED BOG SURFACE, SOUTHERN TRANSECTS

slightly disturbed by the road and so the subsidences calculated using it will be an under-estimate. However the x values it produces are the most similar to those one would expect from looking at the topography of the present bog surface. More subsidence has occurred in the south of the area. The reconstructed profiles bring the altitude of the bog surface in the south to the same as that in the north. The extra subsidence in the south is probably associated with the cutting of peat in that area.

The method used above assumes that the same depths of peat of the same type are found every where on the bog, as different vegetation types will have different densities.

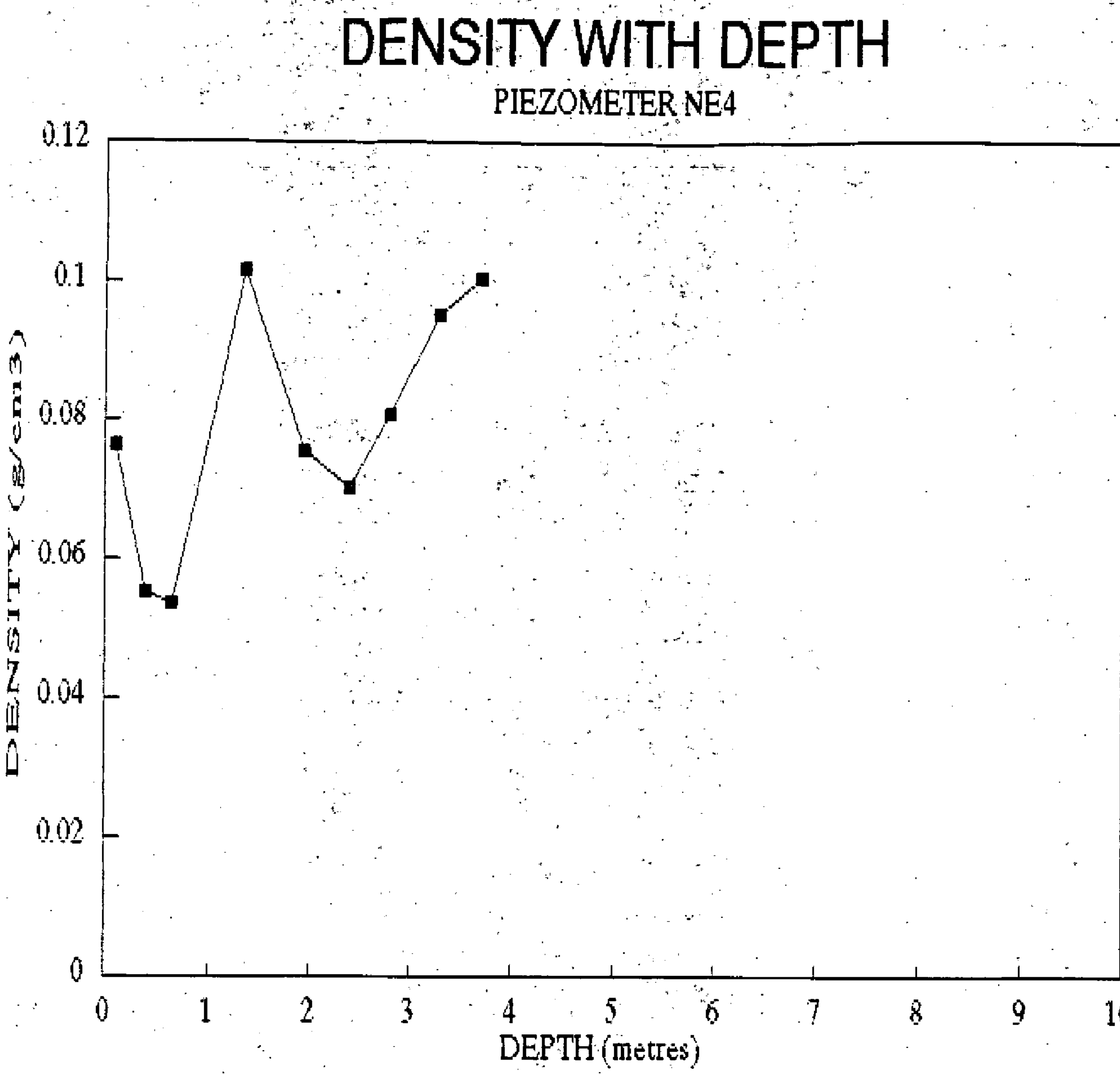
If the above method is applied to the layers of peat type based on vegetation (see section 5.2.2) all of the subsidence is found to occur in the top two layers; the raised bog and transition layers. For example using 5D west with the following Zp values for each layer:

	Zp
Raised bog	0.0194
Transition	0.0134
Fen	0.0395

the following x values are found at piezometer site NE4:

	x(m)
Raised bog	1.98
Transition	7.16
Fen	-0.96

The negative value for the fen vegetation occurs because that layer is actually thicker at NE4 than it is at peg 5D



DENSITY WITH DEPTH
PIEZOMETER NE4
0.12
0.1
0.08
0.06
0.04
0.02
0
DENSITY (g/cm3)
0
1
2
3
4
5
6
7
8
9
10
DEPTH (metres)

FIGURE 5.5

west. That the subsidence has occurred in the top two layers is also verified by looking at the actual values of density and weight of dry matter for the different layers. Both values are much higher for the transition layer at NE4. Figure 5.5 shows the density versus depth graph for NE4. The value of 0.102 g/cm^3 at 1.35 metres occurs in the transition type peat layer. The thickness of the layers in the cross-section of vegetation types in figure 5.3 would also indicate that most subsidence has occurred in the top layers. The fact that the subsidence has occurred in the top layers reinforces the hypothesis that the subsidence is due to surface drainage, as drainage caused, for example, by a permeable sub-stratum would result in subsidence in the lower layers.

5.3 RESULTS OF THE PERMEABILITY TESTS

The results of the constant head tests are listed in appendix A4. As can be seen from figure 5.6, the results are very varied with values of permeability found differing by two orders of magnitude. However the general trend found was for the permeabilities to be lower nearer to the road. Drainage causes a drop in permeability.

A plot of density versus permeability is shown in figure 5.7. It shows a clear linear trend with higher density peat having a lower permeability. A plot of humification versus permeability is shown in figure 5.8. Although not so clear, a trend exists such that the higher the humification degree the lower the permeability. Figure

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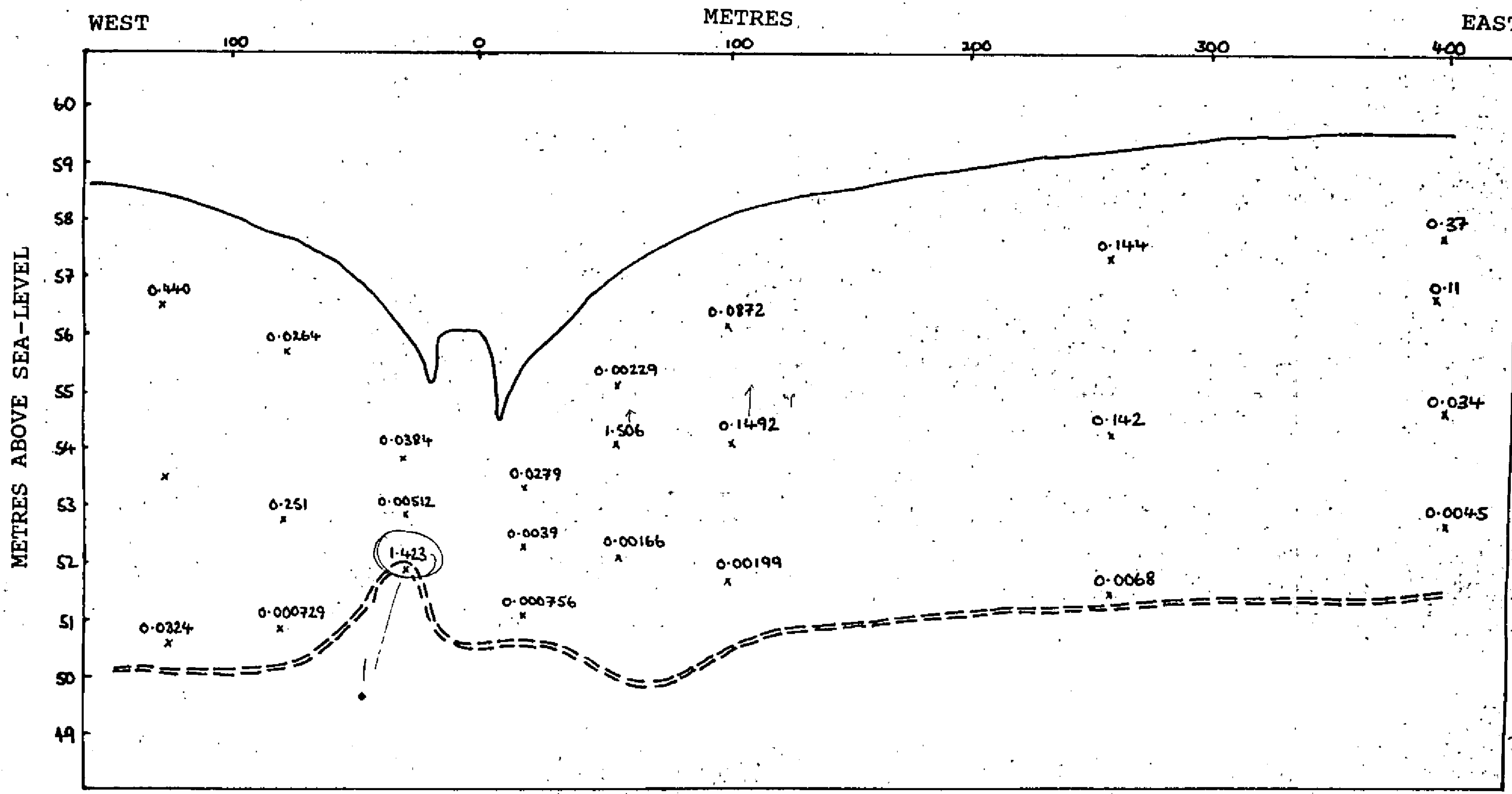


FIGURE 5.6a : PERMEABILITY VALUES (M/DAY) MEASURED WITH THE CONSTANT HEAD METHOD, NORTHERN TRANSECTS

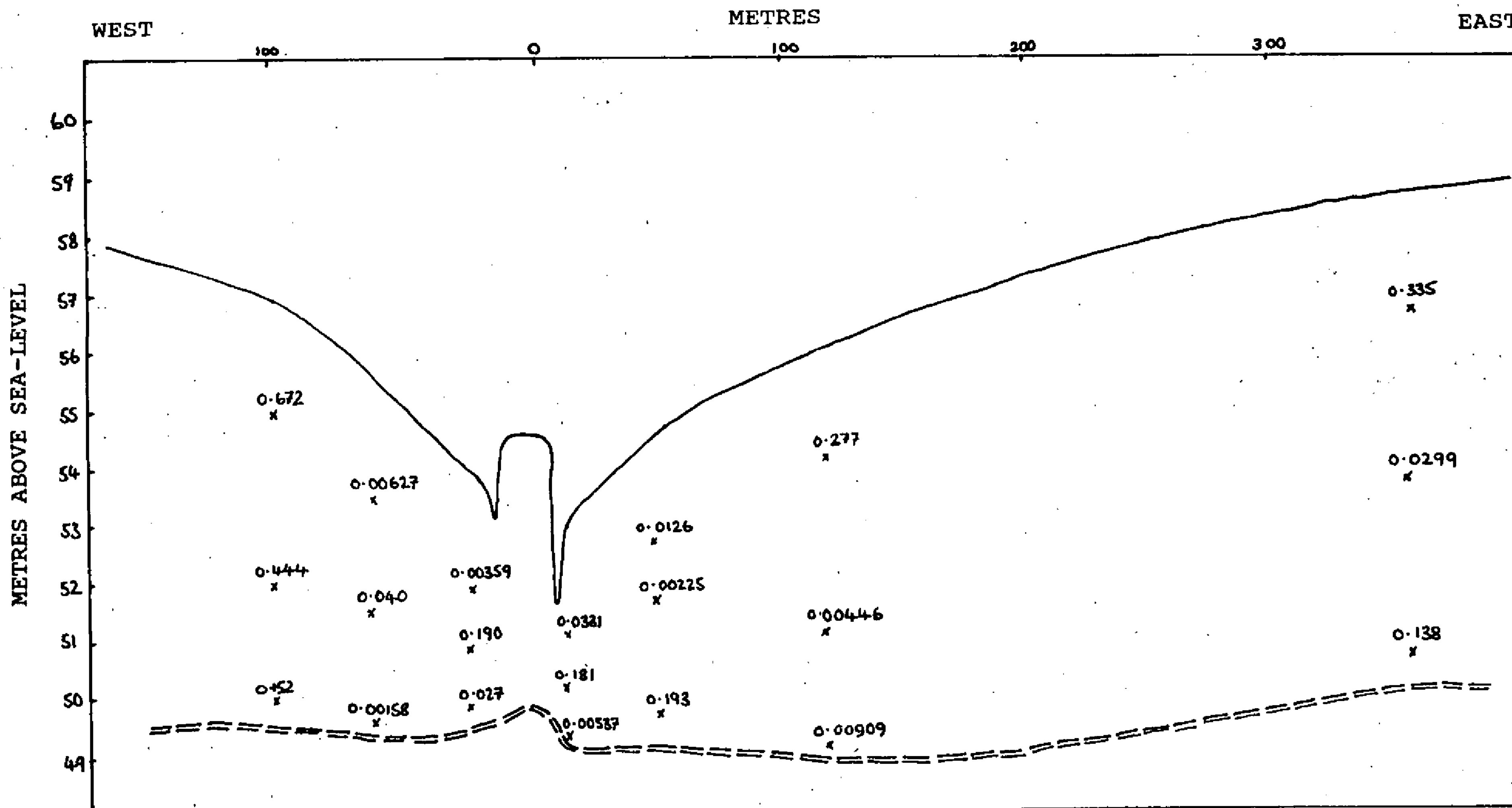


FIGURE 5.6b : PERMEABILITY VALUES (M/DAY) MEASURED WITH THE CONSTANT HEAD METHOD, SOUTHERN TRANSECTS

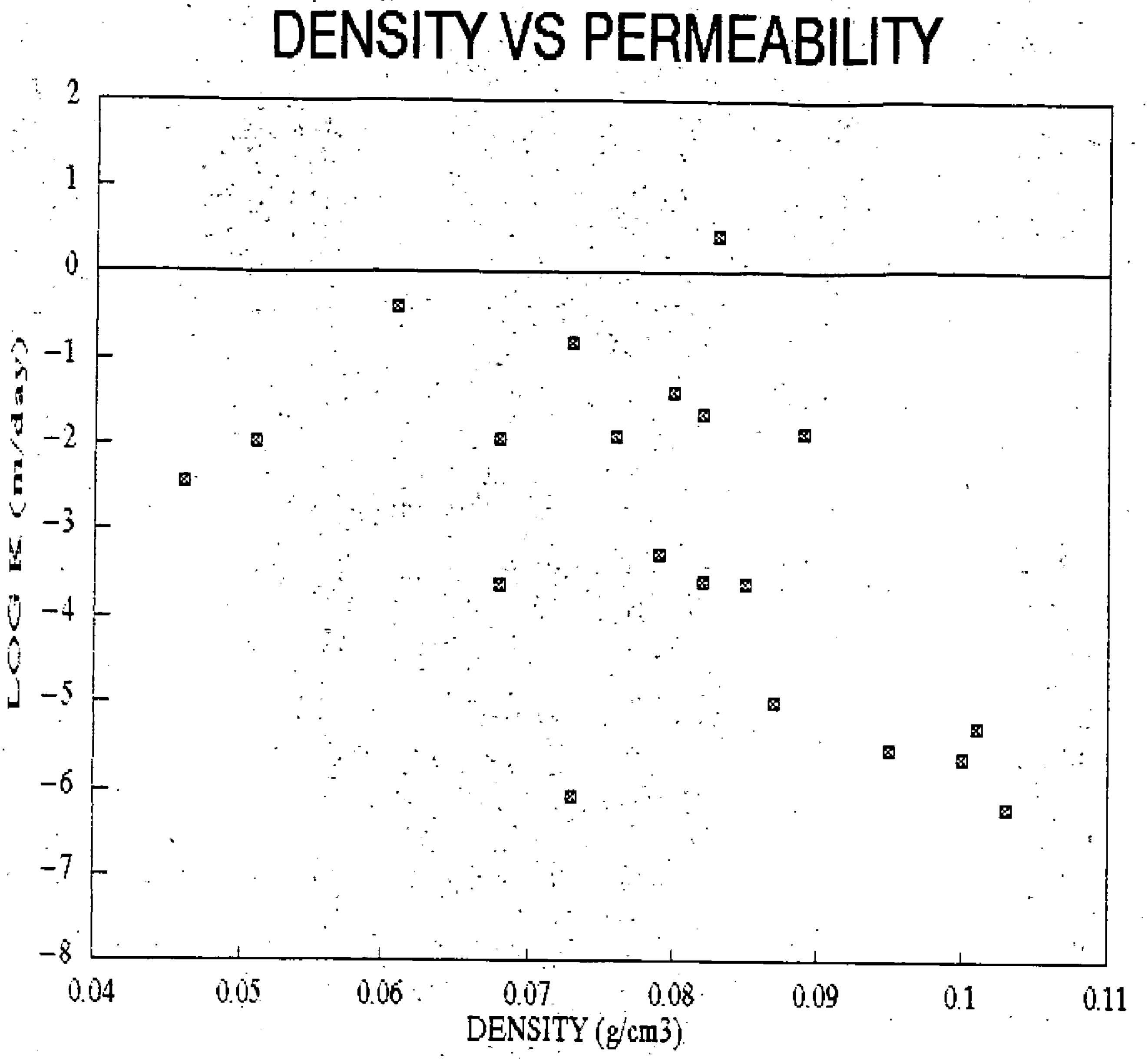

DENSITY VS PERMEABILITY
LOG K (m/day)
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
DENSITY (g/cm3)

FIGURE 5.7

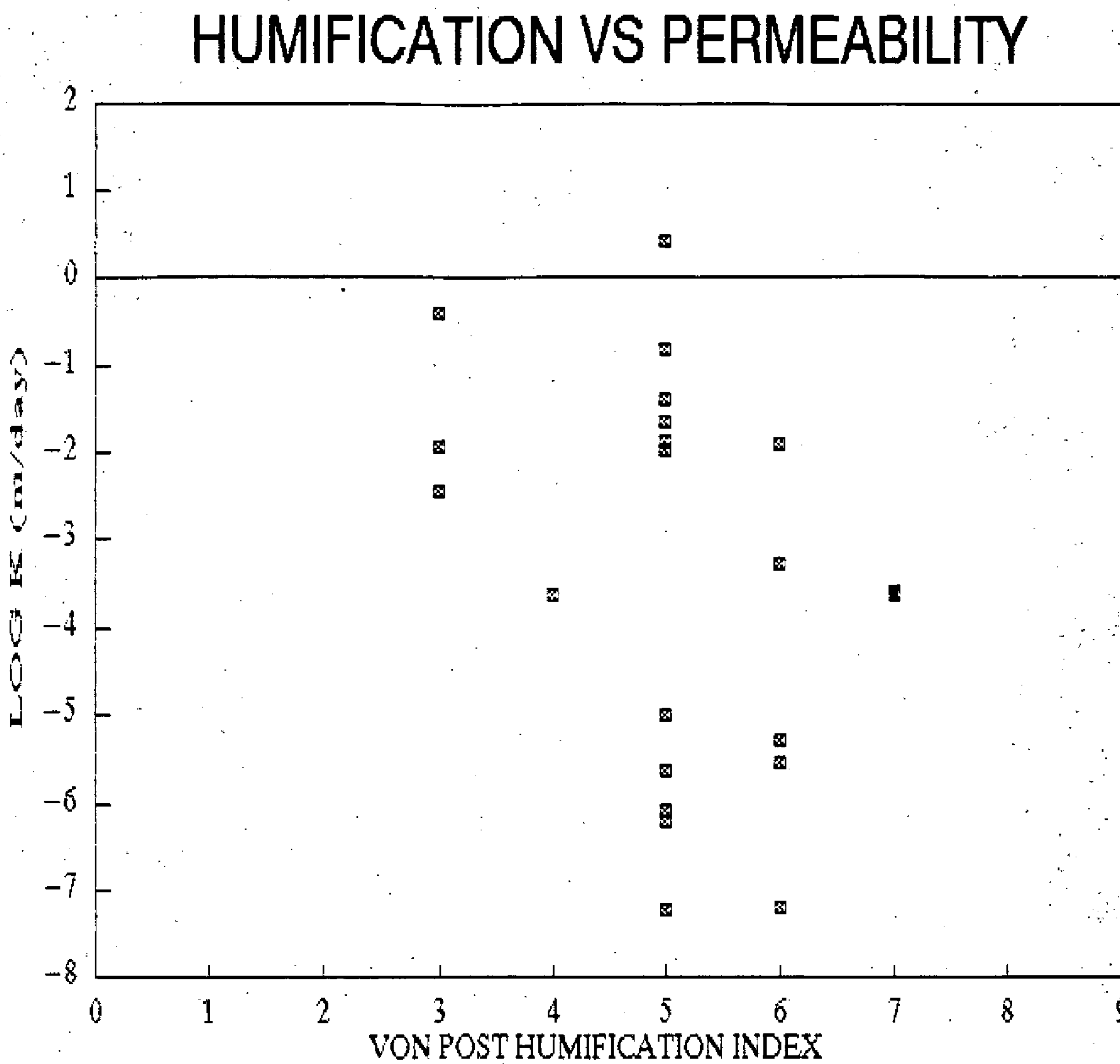

HUMIFICATION VS PERMEABILITY
LOG K (m/day)
VON POST HUMIFICATION INDEX
2
1
0
-1
-2
-3
-4
-5
-6
-7
-8
0
1
2
3
4
5
6
7
8
9

FIGURE 5.8

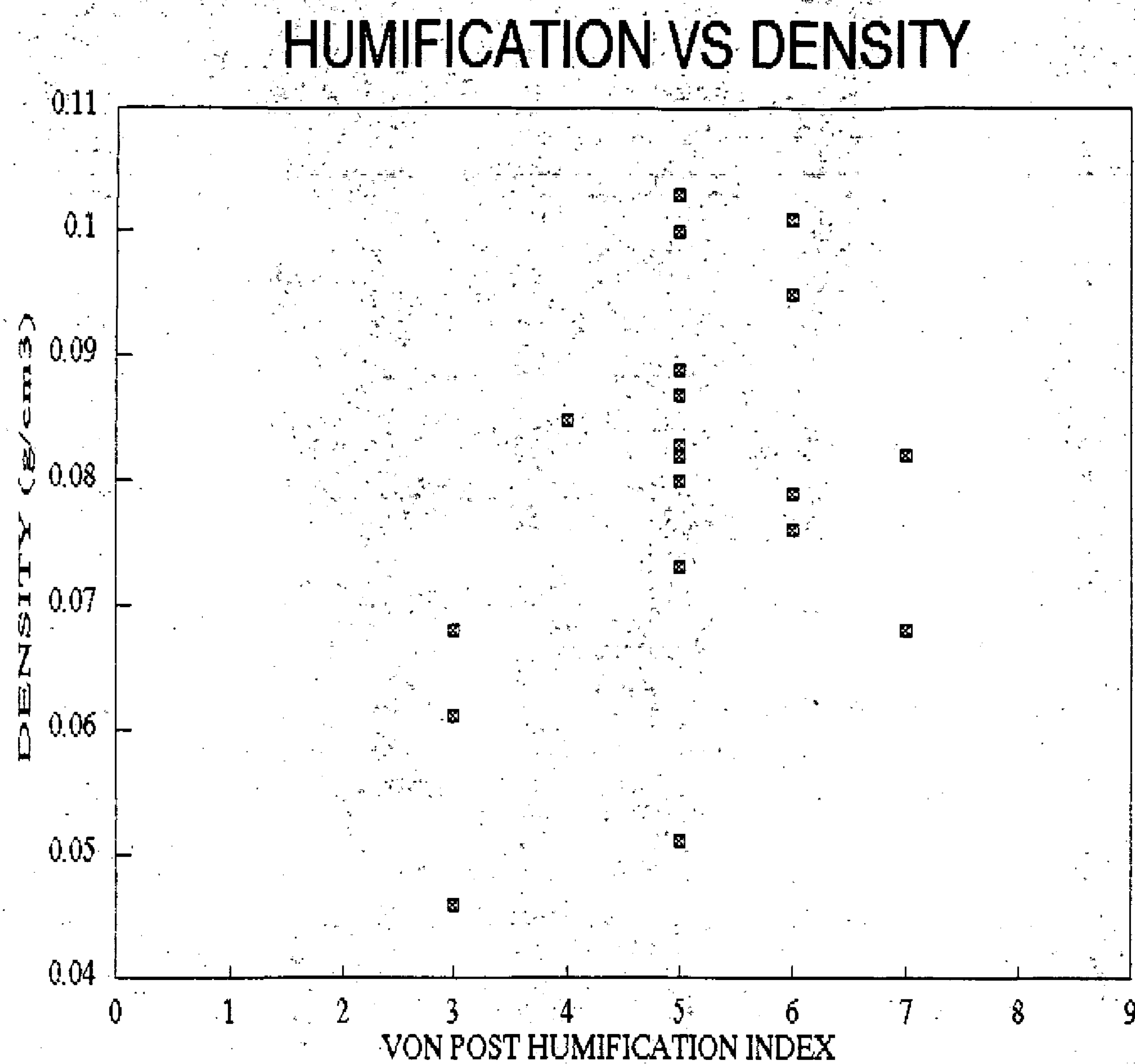

HUMIFICATION VS DENSITY
DENSITY (g/cm3)
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0
1
2
3
4
5
6
7
8
9
VON POST HUMIFICATION INDEX

FIGURE 5.9

5.9 shows humification versus density and shows that the density increases with an increase in humification. As compaction of peat produces an increase in density it will also cause a decrease in permeability and so affect the fluid flow through the bog.

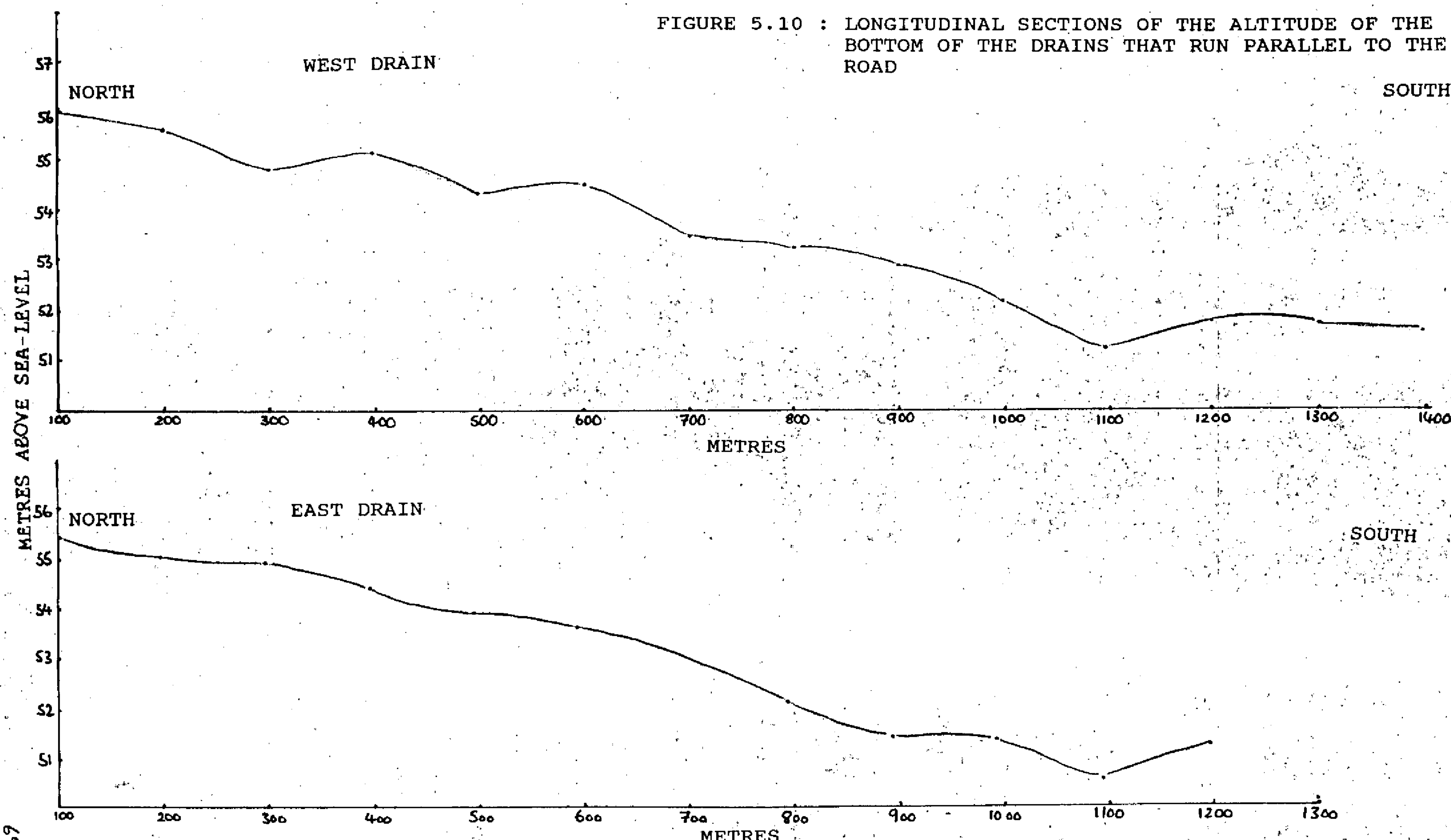
5.4 ASSESSMENT OF THE DRAINS

5.4.1 THE DRAINS BY THE ROAD

A survey of the two drains running parallel to the road was made at 100 metre intervals starting from the O.P.W.'s benchmark stud 100 to stud 1400. The height above sea-level of the bottom of the drains and their width was measured. The survey data is listed in appendix A11. The width of the drains varied from 0.4 metres to 2.5 metres. On the whole the east drain is deeper than the western one.

Figure 5.10 shows the longitudinal sections of the drains. The difference in altitude between the northern and southern end of the drains is 4.614 metres for the west drain and 4.525 metres for the east drain, so that water flows from north to south. The difference in altitude of the bottom of the drains between the middle of the northern and southern piezometer transects (at benchmark studs 400 and 900) is 2.311 metres for the west drain and 2.683 metres for the east drain. The water in the west drain is almost stagnant in places especially north of benchmark 400 due to the local topography of the drain in this area. Flows in both drains will be affected by the amount of

FIGURE 5.10 : LONGITUDINAL SECTIONS OF THE ALTITUDE OF THE BOTTOM OF THE DRAINS THAT RUN PARALLEL TO THE ROAD



vegetation growing in them and also other debris such as litter and even a discarded three-piece suite!

Using the relationship

$$v = 1/n \ (R^{2/3} \ S^{1/2})$$

where v is water velocity, n is Manning's coefficient, R is the hydraulic radius and S is the slope of the energy line, a value of v can be calculated between stations 400 and 900. Using a value of n of 0.1, v = 0.22 m/s for the west drain and 0.25 m/s for the east drain. An estimate of the cross-sectional area of the water in the drains at station 900 is 0.08 m^2 in the west and 0.1 m^2 in the east. This together with the velocities gives an estimated discharge of 0.0176 m^3/s for the west drain and 0.025 m^3/s for the east drain. If the area of the bog that drains towards the road is estimated very roughly as 2 km^2 in the west and 1 km^2 in the east, it is possible to estimate a depth of water across the bog that can be drained by the road in a chosen time period. For the western drain this estimate is 0.28 metres in one year and for the eastern drain it is 0.79 metres in one year. i.e. Have catchment area & outflow discharge to calc ppt on ground that can seep to drain in a year. Problem – for period of low flows: probably minimal estimate. Also assumes no surface R.O. cpt.

5.4.2 THE SHALLOW DRAINS ON CLARA EAST

An extensive set of shallow drains was cut on Clara east by Bord na Mona in 1983. Figure 5.11 shows the extent of this drainage. The drains have since been blocked with peat which appears to have been effective as the water levels on either side of the dams can often be seen to be significantly different. If the water levels in the drains

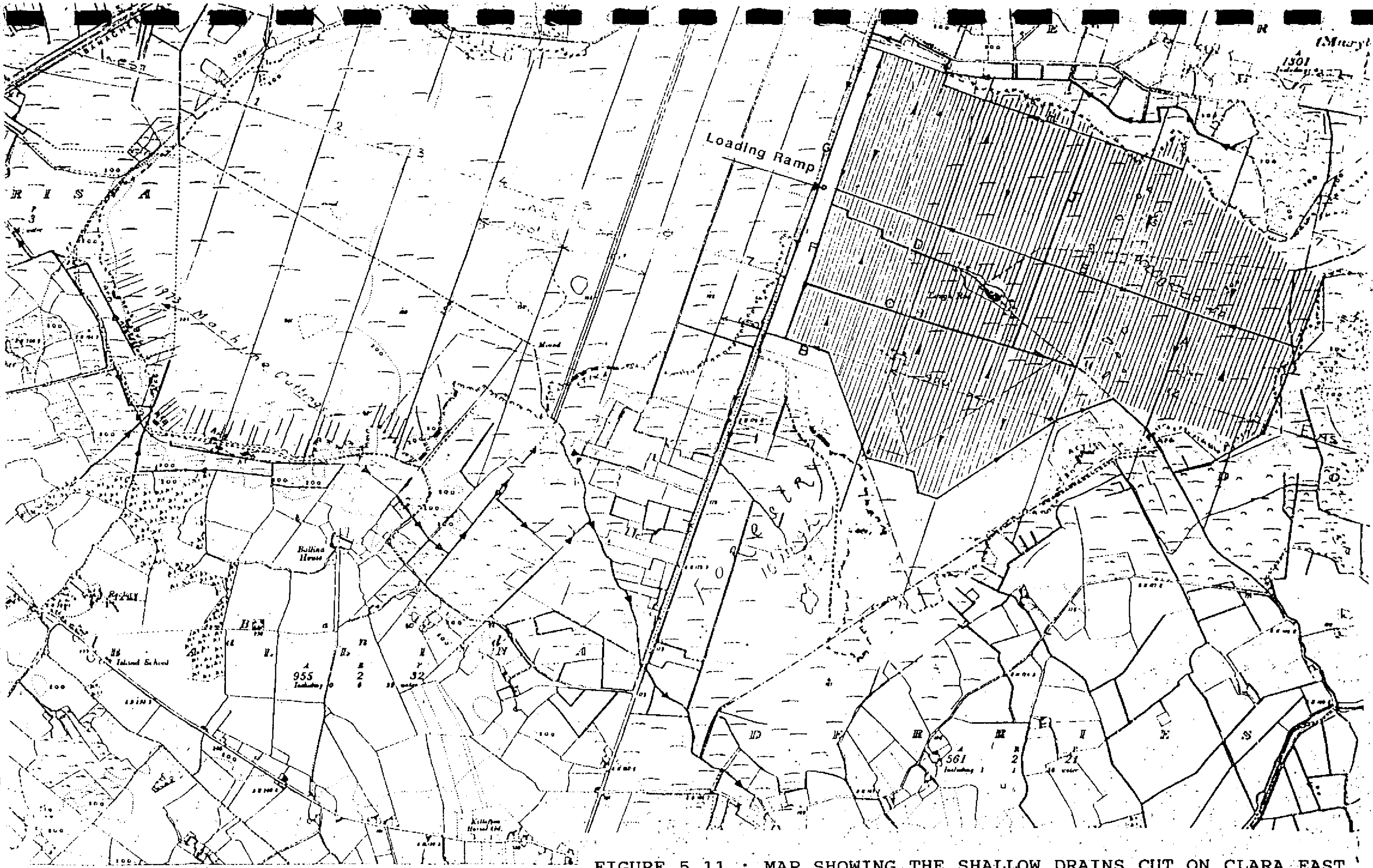


FIGURE 5.11 : MAP SHOWING THE SHALLOW DRAINS CUT ON CLARA EAST BY BORD NA MONA, 1983

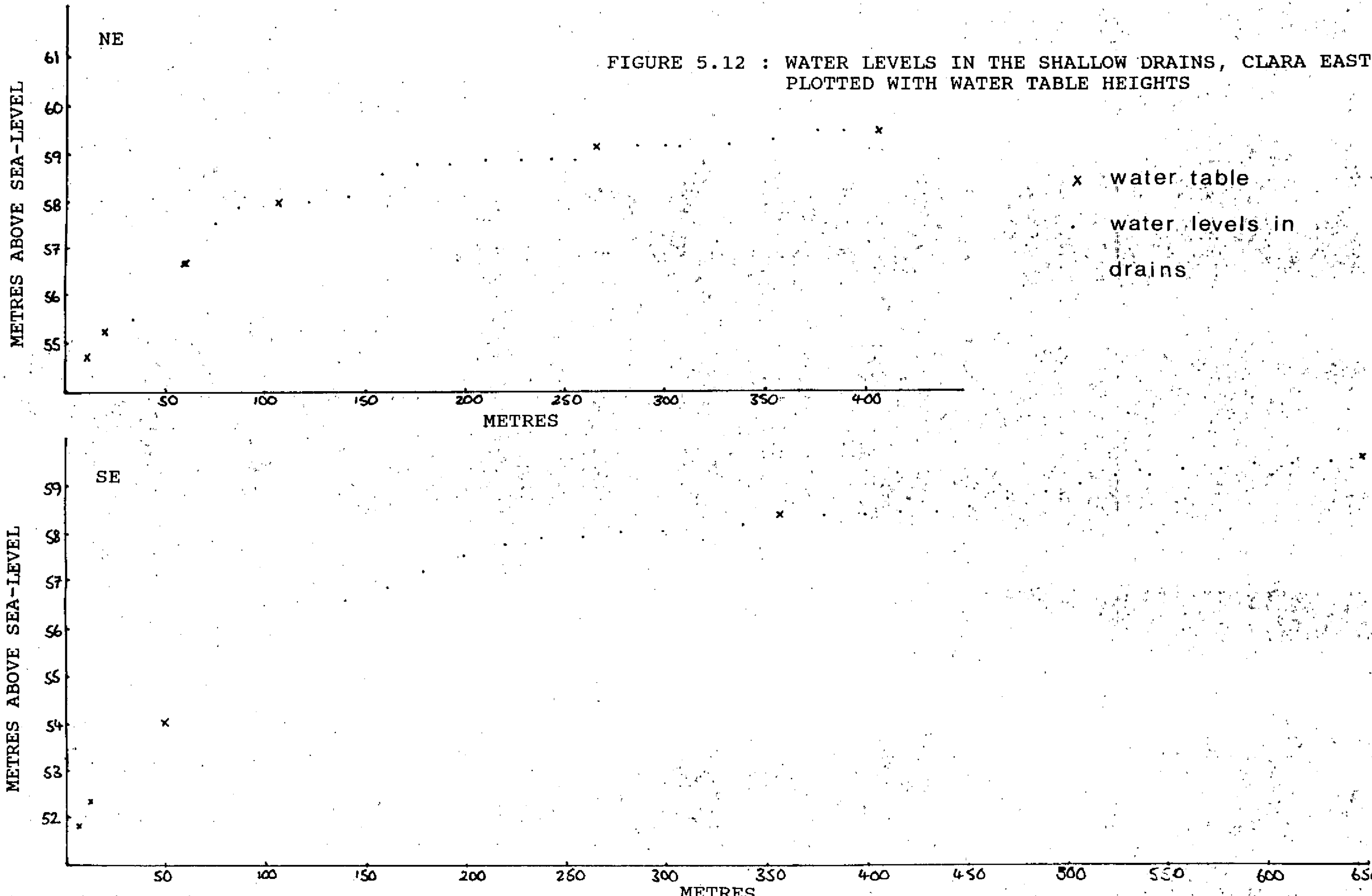


FIGURE 5.12 : WATER LEVELS IN THE SHALLOW DRAINS, CLARA EAST PLOTTED WITH WATER TABLE HEIGHTS

are plotted with the water table heights along the piezometer transects (see figure 5.12) it can be seen that the northern profile has more of a stepped appearance than the southern one. This might suggest that the damming has had more success in the north and that the water levels are affected by the dams.

Vegetation has begun to regrow in the drains which is another sign that the damming is having the desired effect. The greatest regrowth has take place in the drains furthest from the road. The drains nearest to the road were dry or nearly dry during the summer which explains the lack of sphagnum regrowth. The drains were dry because the water table was below their base drawn down by the water table, the topography and the water level in the drains parallel to the road, so that the subsidence caused by these drains is hindering the regrowth of vegetation in the shallow drains on Clara east.

5.5 EVIDENCE FOR THERE BEING ORIGINALLY ONE DOME

Two domed bogs are known to exist; figure 5.13 shows a cross-section and plan view of such a bog taken from Bellamy, 1986. It can be seen from this diagram that in order for two domes to form a ridge must exist in the basin. From the Bord na Mona map of peat-base topography (figure 4.3) and the geophysical work carried out on Clara Bog, it is clear that there is just one basin beneath it.

The decrease in permeability and increase in density in the peat near to the road indicates that subsidence due

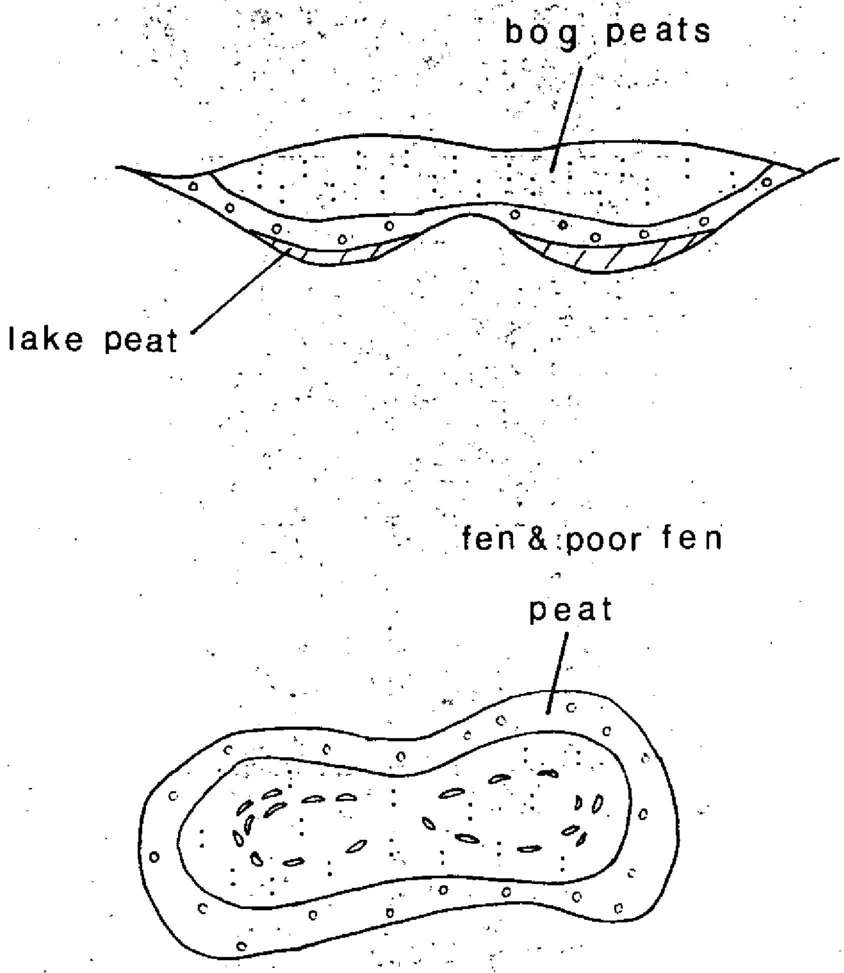


FIGURE 5.13 : RIDGE-RAISED BOG - TENSION POOLS ALIGNED ALONG MAIN SLOPES. FROM BELLAMY, 1986

to drainage has occurred. Using the density or weight of dry matter measurements, values of subsidence can be calculated that easily account for the present difference in altitude between the bog surface near the road and that in an undisturbed area.

If the subsidence rates quoted in section 2.4 are applied to Clara Bog the drains would have had to be cut at least 500 years ago. Although the age of the road is not known a common estimate is about 200 years. Either the road is older than assumed or the subsidence rates there are higher.

If one plots the spot-heights along the road from the 1910 Ordnance Survey map against the heights of the benchmark studs emplaced by the O.P.W. in 1990 (figure 5.14) the difference in altitude gives some indication of the amount of subsidence that has occurred during this time interval. The maximum subsidence has occurred between benchmark 800 and 900. Here the difference in altitudes is 1.3 metres which gives a subsidence rate of 1.625 cm/year over the period between 1910 and 1990. This is higher than the values quoted in section 2.4, but still is not high enough to account for the subsidence if the road is only 200 years old. However the rate of subsidence is known to decrease with time.

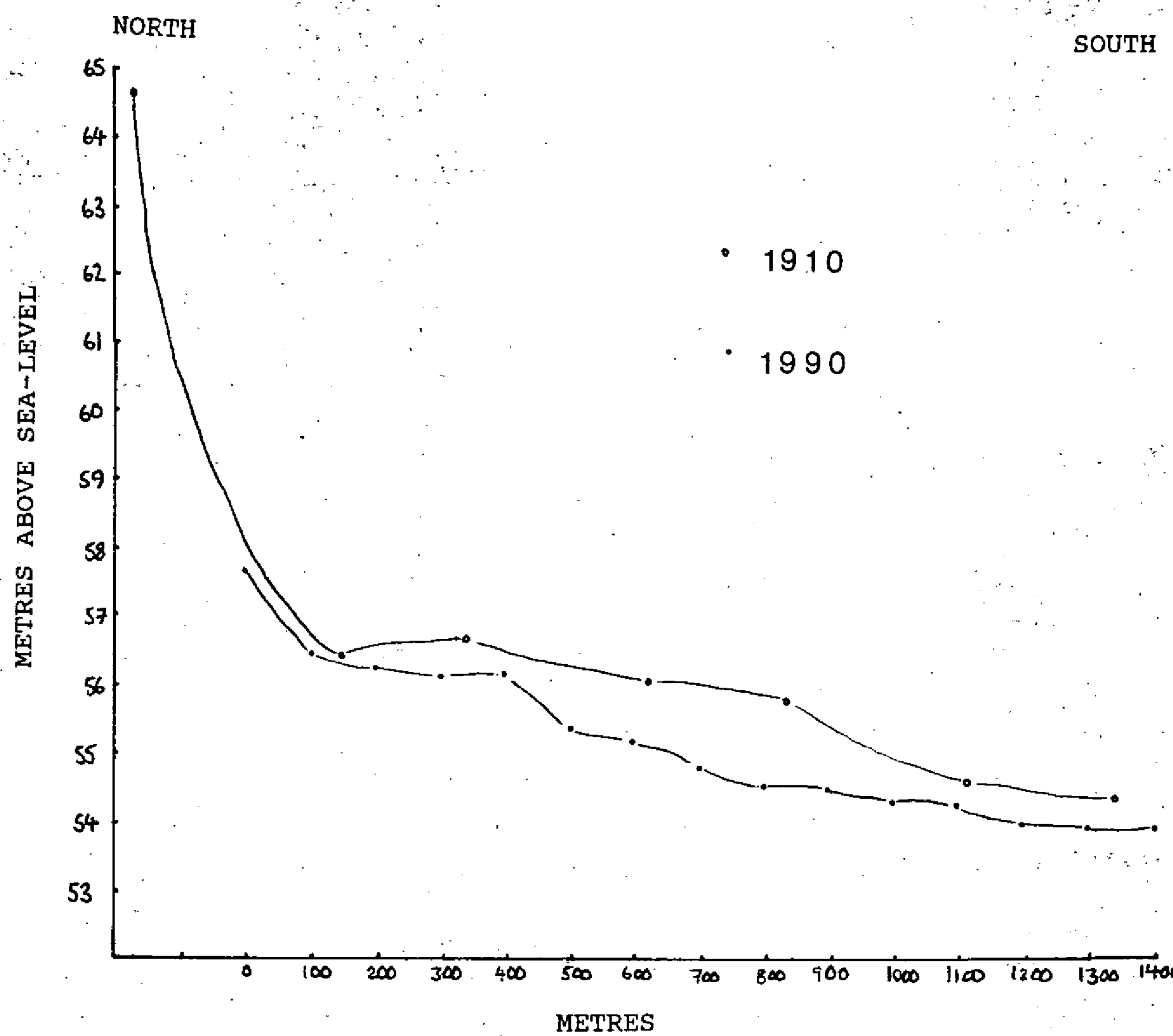


FIGURE 5.14 : SPOT HEIGHTS ALONG THE ROAD FROM THE 1910 O.S. MAP (CONVERTED FROM FEET TO METRES) PLOTTED WITH THE O.P.W. 1990 BENCHMARK VALUES

6. MODELLING THE HYDROLOGY

The computer package FLOWNET (van Elburg et al, 1989) was used to model the flow to the drains by the road. It models two dimensional, steady state, saturated groundwater flow in a rectangular, inhomogeneous, anisotropic section of the subsoil. The pattern of flowlines and equipotential lines is obtained by using the finite difference method and a regular grid.

The topography of the bog surface was difficult to simulate due to its curved nature. A compromise had to be reached between the accuracy of the topography and the number of nodes used. For the model of the northern transects 74 columns and 20 rows were used while the model of the southern transects used 98 columns and 22 rows.

The data input to the package includes the hydraulic heads along the top of the model and down the right and left hand sides and permeability values at every node. The permeability values from the constant head tests were contoured and values interpolated from them. The model did not work with the actual permeability values obtained because they were too low for the calculations it uses. To combat this problem the permeabilities were all increased by one order of magnitude. The peat-clay interface was modelled as a straight line for simplicity and as a no-flow boundary.

Figures 6.1a and b show the model with the present data for the northern and southern transects respectively. The boxes at the top and sides of the diagrams give an

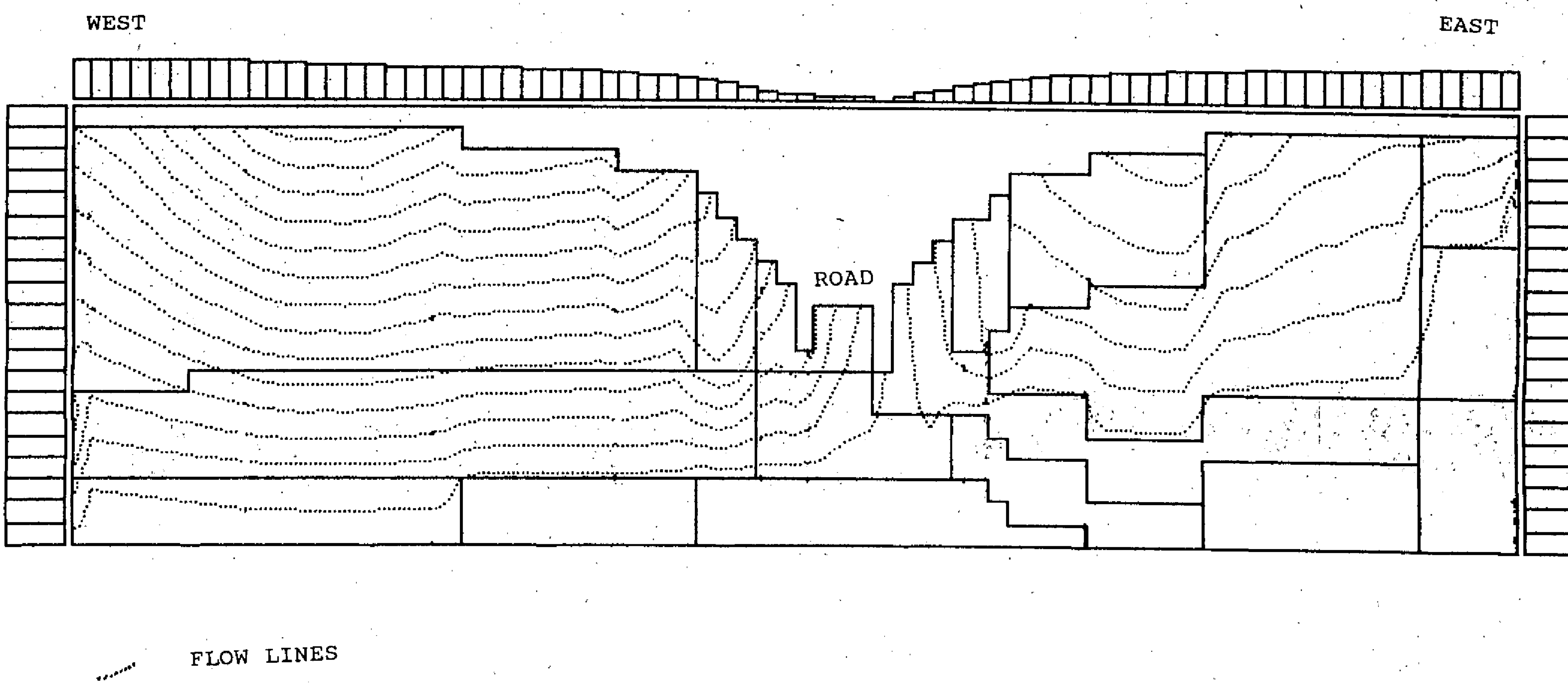


FIGURE 6.1a : FLOWNET MODEL OF THE PRESENT SITUATION, NORTHERN TRANSECTS. VERTICAL TO HORIZONTAL SCALE IS 40.

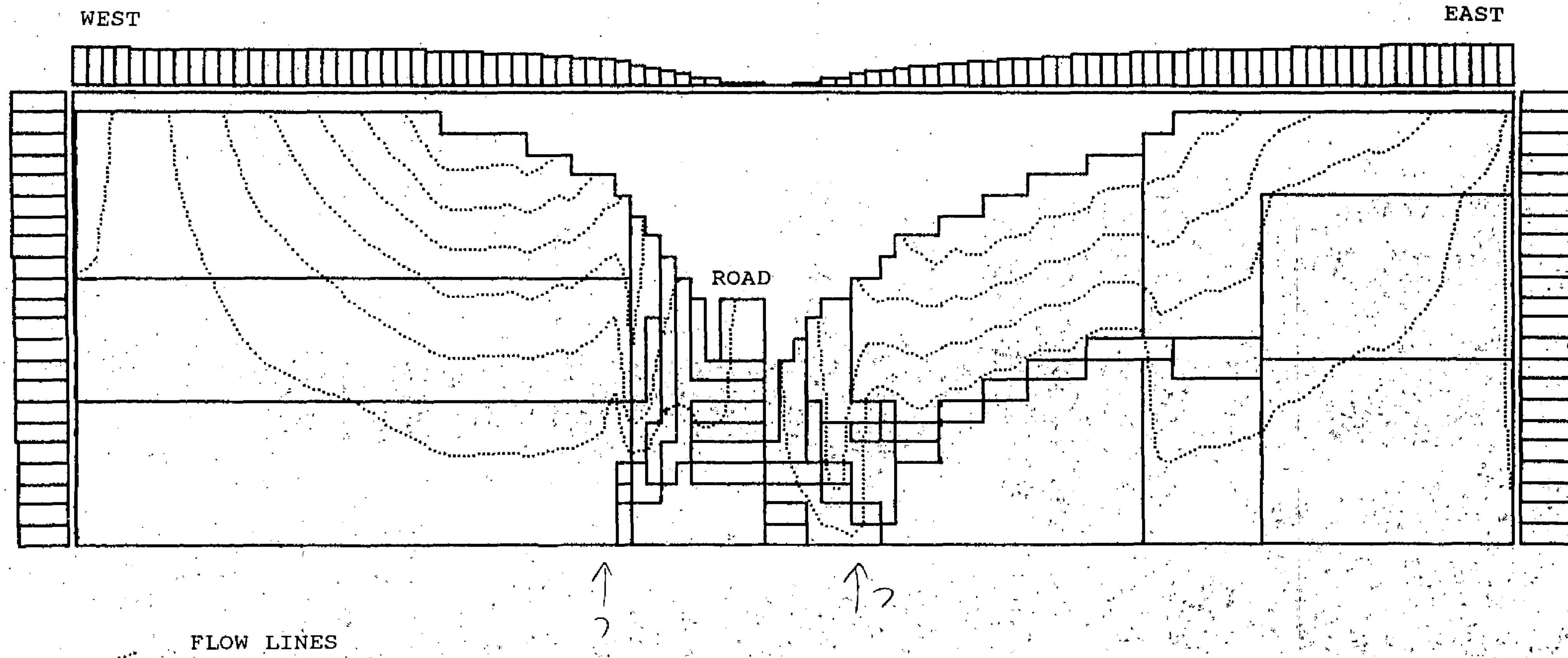


FIGURE 6.1b : FLOWNET MODEL OF THE PRESENT SITUATION, SOUTHERN TRANSECTS. VERTICAL TO HORIZONTAL SCALE IS 100.

indication of the hydraulic head. Most flow occurs in the top half of the sections where the permeabilities are higher. Many of the flowlines in both sections come to the surface before reaching the drains. This may be an artifact of the model or could represent seepage faces. During the field season for this project overland flow was observed on Clara east near to the carpark. Both sections show that more flow occurs to the drains from Clara west than Clara east.

The model was then changed to see what effect damming the drains would have on the flow. Figures 6.2a and b show the models for the northern and southern transects respectively with the drains dammed. For the northern model the water level in the drains was raised to 56 metres M.O.D. and so any water levels less than this were also raised to 56 metres M.O.D. For the southern model the water level was raised to 54 metres M.O.D. These levels were chosen because they were just under the height of the road at each location. If damming did occur the water levels would probably not be made so high because the road would then be in danger of flooding. Figures 6.2a and b show that raising the water levels in the drains does affect the pattern of flowlines. Most change in flow occurs in the northern profile. The FLOWNET package allows the flow rate in a chosen area to be calculated. Since the permeabilities used in the model are not the real ones the flow rates obtained can only be used relatively. The flow rate to the road was found to decrease slightly in the

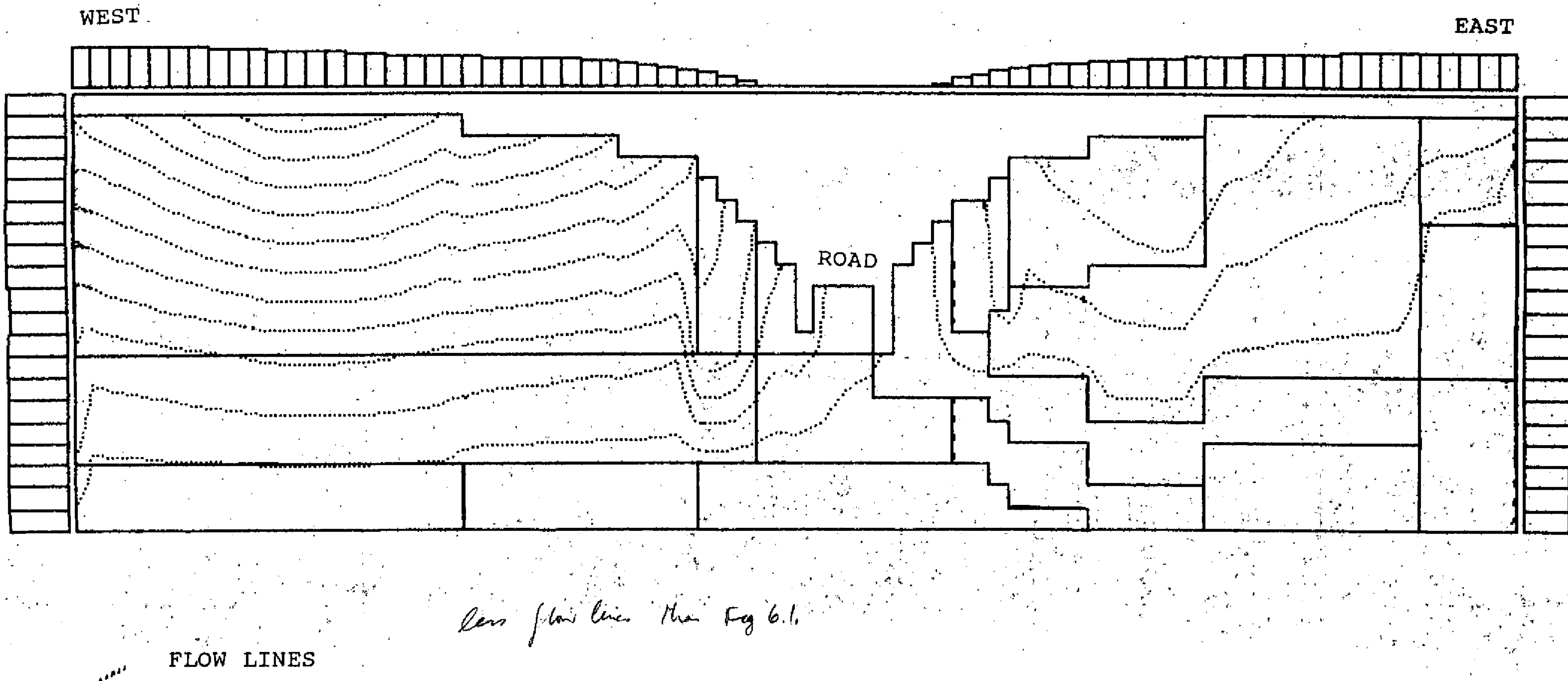


FIGURE 6.2a : FLOWNET MODEL WITH THE WATER LEVEL IN THE DRAIN RAISED TO 56 M.O.D., NORTHERN TRANSECTS. VERTICAL TO HORIZONTAL SCALE IS 40.

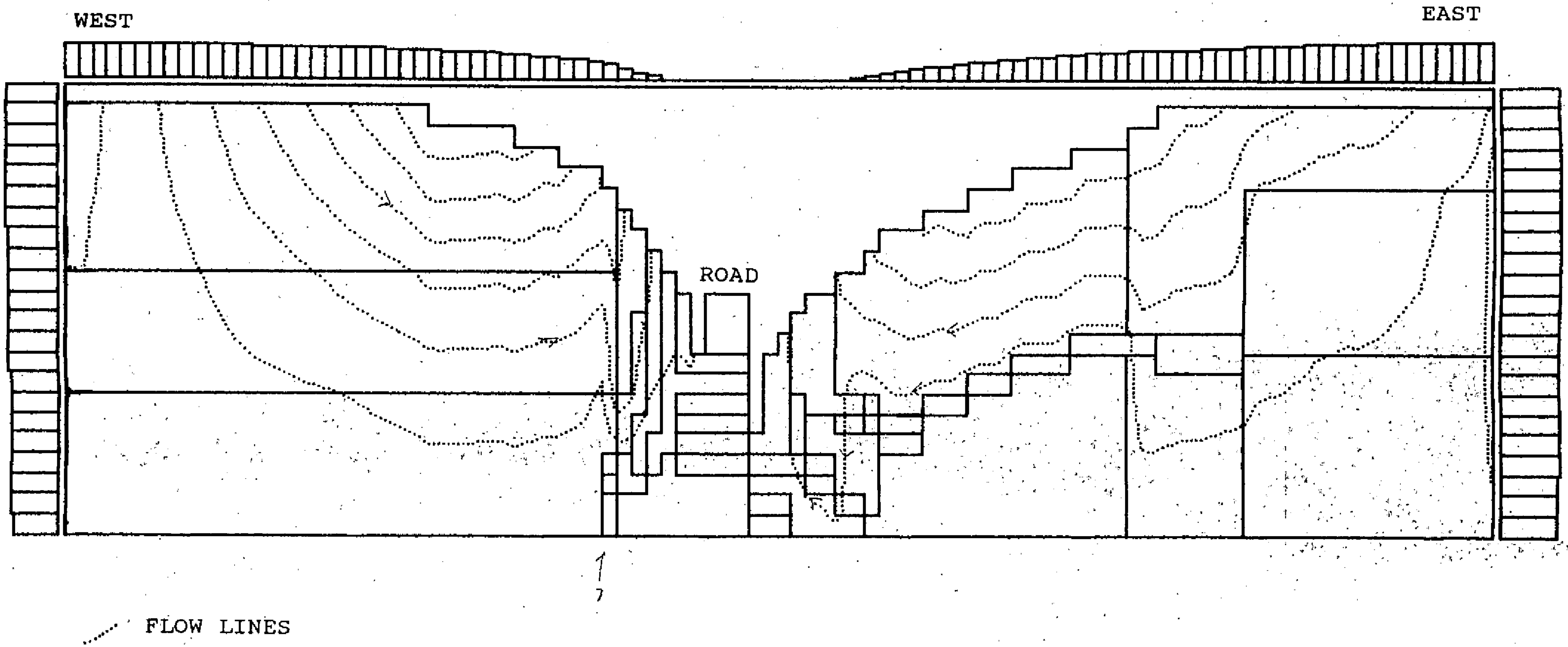


FIGURE 6.2b : FLOWNET MODEL WITH THE WATER LEVEL IN THE DRAIN RAISED TO 54 M.O.D., SOUTHERN TRANSECTS. VERTICAL TO HORIZONTAL SCALE IS 100.

northern model after raising the water levels in the drains. However no improvement was found in the southern model.

Compare with own equip't. lines !!

7. CONCLUSIONS AND RECOMMENDATIONS

The 'New' road running through Clara Bog and the two drains running parallel to it have had a major impact on the hydrology of the bog. The bog was originally one raised dome. The road and its drains have caused more than six metres of subsidence and have in effect caused two domes. The subsidence has increased the density and decreased the permeability of the peat near the road. Water flows towards the road from Clara east and west and it acts as a major drain on the bog.

The effect of peat-cutting in the south of the area has increased the subsidence due to the road. This makes the flow lines approach the road at an angle (60 degrees) rather than perpendicularly.

If the drains by the road were dammed, the water level would increase and the effect of the drains would be slightly decreased especially in the northern half of the bog. However such damming may produce problems with flooding which would affect the road and farms with land north of the bog which presently drain into these outlets. Before any dams are placed in the drains a thorough investigation of their effects should be made. Weir should be placed in the drains. More time should be spent on modelling the situation to see to what height the water level would have to be raised to make any substantial improvement and whether this level is practical to implement. The maximum water level possible is constrained by the height of the road. It would also be interesting to find out the present rate of subsidence in the area. The difference in altitude of the road between 1910 and 1990 (see figure 5.14) would indicate that subsidence is still actively happening. If this is the case it would be even more worthwhile to block the drains as this would decrease the subsidence. Blocking the drains may in fact be more important in stopping any further subsidence than actually restoring the previous hydrological regime.

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APPENDIX: A1

O.P.W. CLARA BOG SURVEY ALONG THE NEW ROAD, 1990

STATION NUMBER	BOLT LEVEL M.O.D.
0	57.62
100	56.47
200	56.22
300	56.14
400	56.13
500	55.35
600	55.20
700	54.82
800	54.53
900	54.41
1000	54.29
1100	54.22
1200	53.96
1300	53.89
1400	53.87

APPENDIX: A2

PIEZOMETER STATION	NATIONAL GRID CO-ORDINATES	
	EASTING	NORTHING
108	225410	230580
NE1	225280	230550
NE2	225120	230520
NE3	225060	230510
NE4	225020	230500
NW1	224680	230840
NW2	224800	230710
NW3	224910	230570
NW4	224950	230530
NW5	224980	230500
113	225470	230140
SE1	225190	230080
SE2	224960	230030
SE3	224890	230020
SE4	224850	230010
SW1	224810	230020
SW2	224780	230060
SW3	224750	230090
SW4	224590	230260
SW5	224440	230420

APPENDIX: A3

DATA OBTAINED AT EACH PIEZOMETER
CLARA BOG

PIEZO	DEPTH	H	DENSITY (g/cm3)	K (m/day)	LOG K
108B	2	3			
108C	3	3			
108D	5	5			
108E	7	6			
NE1B	2	3	0.068	0.144	-1.938
NE1C	5	5	0.051	0.142	-1.952
NE1D	8	5	0.087	0.0068	-4.991
NE2B	2	3	0.046	0.0872	-2.44
NE2C	4	6	0.076	0.149	-1.904
NE2D	6.5	5	0.103	0.002	-6.215
NE3B	2	5	0.073	0.0023	-6.07
NE3C	3	5	0.083	1.506	0.409
NE3D	5			0.00166	-6.401
NE4B	2	7	0.082	0.0279	-3.579
NE4C	3	6	0.095	0.0039	-5.547
NE4D	4.25	6		0.000756	-7.187
NW1B	2				
NW1C	5				
NW1D	8				
NW2B	2				
NW2C	5				
NW2D	8				
NW3B	2			0.44	-0.821
NW3C	5			6.129	1.813
NW3D	8			0.0324	-3.43
NW4B	2	7	0.068	0.0264	-3.634
NW4C	5	5	0.080	0.251	-1.382
NW4D	7	5		0.000729	-7.224
NW5B	2	6	0.079	0.0384	-3.26
NW5C	3	6	0.101	0.005122	-5.274
NW5D	3.97	CLAY		1.423	0.353
113B	2	5			
113C	3	6			
113D	5	7			
113E	7	8			
113F	9	8			
SE1B	2			0.335	-1.094
SE1C	5			0.0299	-3.51
SE1D	8			0.138	-1.981
SE2B	2			0.277	-1.284
SE2C	5			0.004457	-5.388
SE2D	7			0.00909	-4.7
SE3B	2			0.0126	-4.374
SE3C	3			0.00225	-6.097
SE3D	5			0.1925	-1.648
SE4B	2			0.03309	-3.409
SE4C	3			0.181	-1.709
SE4D	4			0.00537	-5.227
SW1B	2				
SW1C	5				

SW1D	8				
SW2B	2				
SW2C	5				
SW2D	8				
SW3B	2	3	0.061	0.672	-0.397
SW3C	5	5	0.073	0.444	-0.812
SW3D	7	5	0.089	0.1522	-1.883
SW4B	2			0.006268	-5.072
SW4C	4			0.04	-3.219
SW4D	6			0.001584	-6.448
SW5B	2	5	0.100	0.00359	-5.63
SW5C	3	5	0.082	0.191	-1.655
SW5D	4	4	0.085	0.027	-3.613

APPENDIX: A4

THE VON POST HUMIFICATION INDEX

H1 Completely unhumified plant remains from which almost colourless water can be squeezed.

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

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

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

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

H6 Fairly highly humified plant remains; the structure (texture) is unclear. About a 1/3 of peat escapes between fingers.

H7 Highly humified plant remains; about 1/2 escapes through fingers when squeezed. Squeeze water is dark brown.

H8 Very highly humified plant remains. About 2/3 escapes through fingers; only left with resistant wood, roots, etc.

H9 Almost completely humified; almost all peat escapes through fingers on squeezing. Structure is absent.

H10 Totally humified and amorphous. All peat escapes through fingers. No free water visible.

APPENDIX: A5

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE1B
DATE: 1991/7/11

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	20.3						
2.05	17.0	3.3	1.584	0.012925	0.163	0.354	0.224003
4.25	13.6	3.4	1.457	0.011889	0.163	0.354	0.206043
7.10	10.8	2.8	1.018	0.008307	0.163	0.354	0.143962

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE1C
DATE: 1991/7/11

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.5						
2.05	20.1	1.4	0.672	0.005484	0.078	0.354	0.198592
4.25	18.8	1.3	0.557	0.004545	0.078	0.354	0.164607
7.10	17.4	1.4	0.509	0.004153	0.078	0.354	0.150422
23.25	8.8	8.6	0.529	0.004317	0.078	0.354	0.156332
25.35	7.5	1.3	0.600	0.004896	0.078	0.354	0.177314
29.30	5.4	2.1	0.536	0.004374	0.078	0.354	0.158401
32.25	4.0	1.4	0.480	0.003917	0.078	0.354	0.141851

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE1D
DATE: 1991/7/12

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	16.0						
2.00	15.0	1.0	0.500	0.004080	0.502	0.354	0.022959
5.55	13.5	1.5	0.383	0.003125	0.502	0.354	0.017587
8.50	12.8	0.7	0.240	0.001958	0.502	0.354	0.011020
94.35	0.1	12.7	0.148	0.001208	0.502	0.354	0.006796

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE2B
DATE: 1991/7/11

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.5						
2.15	18.0	1.5	0.667	0.005443	0.17	0.354	0.090441
4.35	16.5	1.5	0.643	0.005247	0.17	0.354	0.087186
4.50	16.4	0.1	0.400	0.003264	0.17	0.354	0.054237
7.20	14.9	1.5	0.600	0.004896	0.17	0.354	0.081356
23.25	7.4	7.5	0.466	0.003803	0.17	0.354	0.063186
25.45	5.9	1.5	0.643	0.005247	0.17	0.354	0.087186

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE2C
DATE: 1991/7/12

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	20.8						
0.20	19.9	0.9	2.700	0.022032	0.175	0.354	0.355642
2.10	16.6	3.3	1.800	0.014688	0.175	0.354	0.237094
6.00	11.9	4.7	1.226	0.010004	0.175	0.354	0.161488
9.00	8.5	3.4	1.133	0.009245	0.175	0.354	0.149238

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE2D
DATE: 1991/7/11

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	23.5						
1.55	23.5						
4.15	23.2	0.3	0.129	0.001053	0.302	0.354	0.009846
7.00	22.9	0.3	0.109	0.000889	0.302	0.354	0.008320
23.55	20.5	2.4	0.142	0.001159	0.302	0.354	0.010838
26.15	20.4	0.1	0.043	0.000351	0.302	0.354	0.003282
30.05	20.3	0.1	0.026	0.000212	0.302	0.354	0.001985

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE3B
DATE: 1991/7/11

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.0						
1.10	22.0						
3.00	22.0						
5.20	22.0						
8.05	22.0						
24.05	22.0						
24.40	22.0						
26.30	21.9	0.1	0.055	0.000449	0.21	0.354	0.006037
30.20	21.8	0.1	0.026	0.000212	0.21	0.354	0.002854
33.20	21.8	0.0	*		0.21	0.354	
119.05	20.6	1.2	0.014	0.000114	0.21	0.354	0.002290

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE3C
DATE: 1991/7/9

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.5						
0.19	20.0	1.5	4.74	0.038678	0.032	0.354	3.414407
2.50	12.5	7.5	2.98	0.024317	0.032	0.354	2.146610
5.51	6.2	6.3	2.09	0.017054	0.032	0.354	1.505508

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE3D
DATE: 1991/7/9

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.0						
0.29	20.9	0.1	0.207	0.001689	0.362	0.354	0.013181
3.00	20.8	0.1	0.040	0.000326	0.362	0.354	0.002547
6.01	20.5	0.3	0.099	0.000808	0.362	0.354	0.006304
21.40	20.4	0.1	0.006	0.000049	0.362	0.354	0.000382
26.17	20.2	0.2	0.043	0.000351	0.362	0.354	0.002738
29.40	20.2	0.0	0.000	0.000000	0.362	0.354	0.000000
45.20	19.8	0.4	0.026	0.000212	0.362	0.354	0.001656

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE4B
DATE: 1991/7/9

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	20.0						
1.10	18.5	1.5	1.286	0.010494	0.105	0.354	0.282318
3.32	17.5	1.0	0.423	0.003452	0.105	0.354	0.092862
6.45	16.0	1.5	0.466	0.003803	0.105	0.354	0.102302
22.25	11.9	4.1	0.262	0.002138	0.105	0.354	0.057517
27.05	10.4	1.5	0.321	0.002619	0.105	0.354	0.070470
30.20	10.4	0.0	0.000	0	0.105	0.354	0.000000
46.05	8.4	2.0	0.127	0.001036	0.105	0.354	0.027881

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE4C
DATE: 1991/7/9

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.9						
1.00	21.9						
3.22	21.9						
6.35	21.9						
22.15	21.9						
26.55	21.8	0.10	0.021	0.000171	0.112	0.354	0.004322
30.10	21.8	0.00		0	0.112	0.354	0.000000
45.55	21.5	0.30	0.019	0.000155	0.112	0.354	0.003910

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NE4D
DATE: 1991/7/9

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	23.0						
2.22	22.7	0.3	0.127	0.001036	0.183	0.354	0.015997
5.35	22.4	0.1	0.031	0.000253	0.183	0.354	0.003905
21.15	22.4	0.0	0.000	0	0.183	0.354	0
25.55	22.4	0.0	0.000	0	0.183	0.354	0
29.10	22.3	0.1	0.031	0.000253	0.183	0.354	0.003905
44.55	22.2	0.1	0.006	0.000049	0.183	0.354	0.000756

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW3B
DATE: 1991/7/18

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	23.0						
3.15	11.0	12.0	3.69	0.03011	0.14	0.354	0.607554
7.00	1.0	10.0	2.67	0.021787	0.14	0.354	0.439613

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW3C
DATE: 1991/7/20

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.5						
0.02	17.0	2.5	75.0	0.612000	0.176	0.354	9.822804
0.04	15.0	2.0	60.0	0.489600	0.176	0.354	7.858243
0.07	12.0	3.0	60.0	0.489600	0.176	0.354	7.858243
0.12	7.8	4.2	50.4	0.411264	0.176	0.354	6.600924
0.27	3.9	3.9	46.8	0.381888	0.176	0.354	6.129430

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW3D
DATE: 1991/8/1

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.1						
6.02	11.0	8.1	1.343	0.010959	0.351	0.354	0.088197
24.52	1.7	9.3	0.494	0.004031	0.351	0.354	0.032442

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW4B
DATE: 1991/7/18

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.0						
3.35	21.2	0.8	0.223	0.001820	0.041	0.354	0.125374
7.15	20.7	0.5	0.136	0.001110	0.041	0.354	0.076461
25.22	18.2	2.5	0.138	0.001126	0.041	0.354	0.077586
30.05	17.5	0.7	1.148	0.009368	0.041	0.354	0.645424
50.00	15.0	2.5	0.126	0.001028	0.041	0.354	0.070839
56.25	14.4	0.6	0.094	0.000767	0.041	0.354	0.052848
95.50	9.9	4.5	0.047	0.000384	0.041	0.354	0.026424

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW4C
DATE: 1991/7/18

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.6						
0.20	17.7	1.9	5.700	0.046512	0.354	0.354	0.371158
3.30	5.5	12.2	3.853	0.031440	0.354	0.354	0.250890

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW4D
DATE: 1991/7/18

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.3						
3.20	22.0	0.3	0.090	0.000734	0.253	0.354	0.008200
7.00	22.0	0.0	0.000	0	0.253	0.354	0.000000
25.22	21.9	0.1	0.005	0.000041	0.253	0.354	0.000456
30.05	21.8	0.1	0.020	0.000163	0.253	0.354	0.001822
49.45	21.5	0.3	0.015	0.000122	0.253	0.354	0.001367
56.10	21.5	0.0	0.000	0	0.253	0.354	0.000000
95.35	21.2	0.3	0.008	0.000065	0.253	0.354	0.000729

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW5B
DATE: 1991/7/16

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	18.4						
1.30	17.9	0.5	0.333	0.002717	0.12	0.354	0.063966
3.55	17.4	0.5	0.207	0.001689	0.12	0.354	0.039763
6.50	16.7	0.7	0.240	0.001958	0.12	0.354	0.046102
23.20	13.1	3.6	0.218	0.001779	0.12	0.354	0.041876
27.30	12.0	1.1	0.264	0.002154	0.12	0.354	0.050712
47.32	8.0	4.0	0.200	0.001632	0.12	0.354	0.038418
51.22	7.2	0.8	0.209	0.001705	0.12	0.354	0.040147
55.02	6.4	0.8	0.218	0.001779	0.12	0.354	0.041876
71.00	3.2	3.2	0.200	0.001632	0.12	0.354	0.038418

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW5C
DATE: 1991/7/16

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.0						
0.55	18.9	0.1	0.109	0.000889	0.045	0.354	0.055834
1.45	18.8	0.1	0.120	0.000979	0.045	0.354	0.061469
4.10	18.5	0.3	0.124	0.001012	0.045	0.354	0.063518
7.05	18.3	0.2	0.069	0.000563	0.045	0.354	0.035345
23.35	18.0	0.3	0.018	0.000147	0.045	0.354	0.00922
27.45	17.8	0.2	0.048	0.000392	0.045	0.354	0.024588
47.47	17.4	0.4	0.020	0.000163	0.045	0.354	0.010245
51.37	17.1	0.3	0.078	0.000636	0.045	0.354	0.039955
55.17	17.0	0.1	0.027	0.000220	0.045	0.354	0.013831
71.15	16.6	0.4	0.025	0.000204	0.045	0.354	0.012806
76.00	16.2	0.4	0.084	0.000685	0.045	0.354	0.043028
95.55	16.0	0.2	0.010	0.000082	0.045	0.354	0.005122

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER NW5D
DATE: 1991/7/16

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.2						
0.55	20.4	0.8	0.873	0.007124	0.035	0.354	0.574954
1.45	19.4	1.0	1.200	0.009792	0.035	0.354	0.790315
4.10	11.8	7.6	3.145	0.025663	0.035	0.354	2.071283
7.05	5.5	6.3	2.160	0.017626	0.035	0.354	1.422567

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE1B
DATE: 1991/8/1

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.5						
0.50	16.9	4.6	5.52	0.045043	0.38	0.354	0.334844

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE1C
DATE: 1991/8/1

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.2						
0.50	20.8	0.4	0.480	0.003917	0.198	0.354	0.055881
7.20	16.1	4.7	0.723	0.005900	0.198	0.354	0.084171
25.37	9.1	7.0	0.383	0.003125	0.198	0.354	0.044588
31.50	7.5	1.6	0.257	0.002097	0.198	0.354	0.029920

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE1D
DATE: 1991/8/1

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	18.0						
0.50	14.3	3.7	4.440	0.03623	0.341	0.354	0.300134
7.20	1.0	13.3	2.046	0.016695	0.341	0.354	0.138305

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE2B
DATE: 1991/7/29

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	15.9						
4.10	4.7	11.2	2.688	0.021934	0.224	0.354	0.276610

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE2C
DATE: 1991/7/29

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	23.0						
4.10	22.3	0.7	0.168	0.001371	0.331	0.354	0.011700
22.20	19.8	2.5	0.138	0.001126	0.331	0.354	0.009610
29.06	19.0	0.8	0.118	0.000963	0.331	0.354	0.008218
45.58	17.5	1.5	0.089	0.000726	0.331	0.354	0.006198
52.35	16.9	0.6	0.091	0.000743	0.331	0.354	0.006337
69.52	15.8	1.1	0.064	0.000522	0.331	0.354	0.004457

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE2D
DATE: 1991/7/30

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.8						
6.50	16.0	3.8	0.556	0.004537	0.322	0.354	0.039802
23.42	12.4	3.6	0.213	0.001738	0.322	0.354	0.015248
30.19	11.4	1.0	0.151	0.001232	0.322	0.354	0.010810
47.38	9.2	2.2	0.127	0.001036	0.322	0.354	0.009091

METHOD: CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE3B
DATE: 1991/7/29

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.0						
4.15	19.0	2.0	0.471	0.003843	0.341	0.354	0.031839
22.20	14.1	4.9	0.271	0.002211	0.341	0.354	0.018319
29.05	12.6	1.5	0.222	0.001812	0.341	0.354	0.015007
45.56	9.0	3.6	0.214	0.001746	0.341	0.354	0.014466
52.35	7.8	1.2	0.180	0.001469	0.341	0.354	0.012168
69.50	4.6	3.2	0.186	0.001518	0.341	0.354	0.012573

METHOD: CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE3C
DATE: 1991/7/29

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.0						
4.15	18.5	0.5	0.118	0.000963	0.502	0.354	0.005418
22.20	17.0	1.5	0.083	0.000677	0.502	0.354	0.003811
29.05	16.5	0.5	0.074	0.000604	0.502	0.354	0.003398
45.56	15.4	1.1	0.065	0.000530	0.502	0.354	0.002985
52.35	15.2	0.2	0.030	0.000245	0.502	0.354	0.001378
69.50	14.6	0.6	0.035	0.000286	0.502	0.354	0.001607
76.35	14.4	0.2	0.030	0.000245	0.502	0.354	0.001378
95.54	13.3	1.1	0.057	0.000465	0.502	0.354	0.002617
102.05	13.0	0.3	0.049	0.000400	0.502	0.354	0.002250

METHOD: CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE3D
DATE: 1991/7/29

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.4						
4.15	3.3	19.1	4.494	0.036671	0.538	0.354	0.192547

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE4B
DATE: 1991/7/28

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.5						
4.05	17.4	5.1	1.249	0.010192	0.535	0.354	0.053814
22.50	3.0	14.4	0.768	0.006267	0.535	0.354	0.033090

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE4C
DATE: 1991/7/28

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	19.0						
4.05	4.6	14.4	3.527	0.02878	0.448	0.354	0.181474

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SE4D
DATE: 1991/7/29

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.9						
4.25	21.3	0.6	0.136	0.001110	0.352	0.354	0.008906
22.25	18.5	2.8	0.156	0.001273	0.352	0.354	0.010216
29.12	17.7	0.8	0.118	0.000963	0.352	0.354	0.007727
46.05	15.8	1.9	0.113	0.000922	0.352	0.354	0.007400
53.02	15.0	0.8	0.115	0.000938	0.352	0.354	0.007531
69.56	13.7	1.3	0.077	0.000628	0.352	0.354	0.005042
76.45	13.2	0.5	0.073	0.000596	0.352	0.354	0.004780
96.02	11.5	1.7	0.088	0.000718	0.352	0.354	0.005763
102.10	11.0	0.5	0.082	0.000669	0.352	0.354	0.005370

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW3B
DATE: 1991/7/28

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	21.5						
0.35	18.4	3.1	5.314	0.043362	0.136	0.354	0.900678
4.40	2.2	16.2	3.967	0.032371	0.136	0.354	0.672373

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW3C
DATE: 1991/7/28

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	18.8						
0.35	15.0	3.8	6.514	0.053154	0.338	0.354	0.44424

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW3D
DATE: 1991/7/28

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.9						
0.35	21.0	1.9	3.257	0.026577	0.367	0.354	0.204568
4.40	11.1	9.9	2.424	0.019780	0.367	0.354	0.152249

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW4B
DATE: 1991/7/23

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.0						
5.40	20.9	1.1	0.194	0.001583	0.456	0.354	0.009807
24.15	18.4	2.5	0.135	0.001102	0.456	0.354	0.006824
48.45	14.9	3.5	0.143	0.001167	0.456	0.354	0.007229
119.45	6.1	8.8	0.124	0.001012	0.456	0.354	0.006268

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW4C
DATE: 1991/7/28

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.4						
4.35	18.9	3.5	0.764	0.006234	0.411	0.354	0.042849
23.40	5.3	13.6	0.713	0.005818	0.411	0.354	0.039988

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW4D
DATE: 1991/7/23

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	17.9						
5.40	17.2	0.7	0.124	0.001012	0.553	0.354	0.005169
24.15	16.0	1.2	0.065	0.000530	0.553	0.354	0.002709
48.45	14.6	1.4	0.057	0.000465	0.553	0.354	0.002376
119.45	11.9	2.7	0.038	0.000310	0.553	0.354	0.001584

METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW5B
DATE: 1991/7/22

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.8						
2.27	22.4	0.4	0.163	0.001330	0.34	0.354	0.011051
6.25	22.0	0.4	0.101	0.000824	0.34	0.354	0.006847
24.40	20.1	0.9	0.049	0.000400	0.34	0.354	0.003322
31.10	19.6	0.5	0.077	0.000628	0.34	0.354	0.005220
49.30	18.5	1.1	0.060	0.000490	0.34	0.354	0.004068
73.57	17.2	1.3	0.053	0.000432	0.34	0.354	0.003593

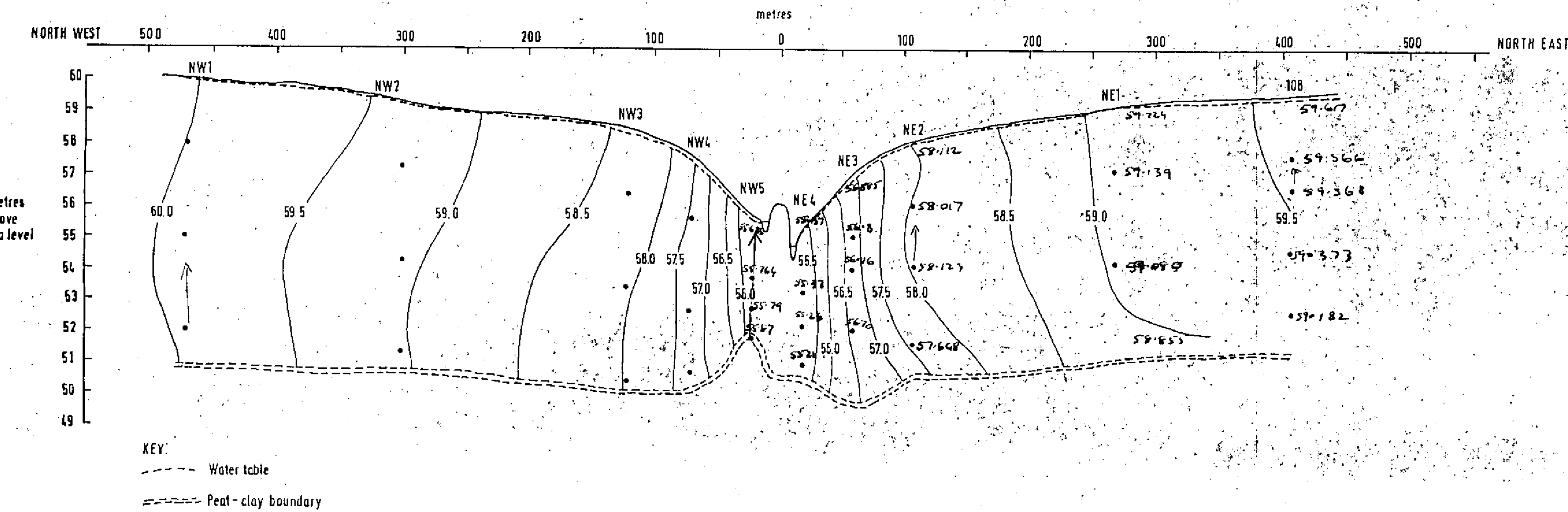
METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW5C
DATE: 1991/7/22

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	20.6						
2.27	10.9	9.7	3.959	0.032305	0.479	0.354	0.190518

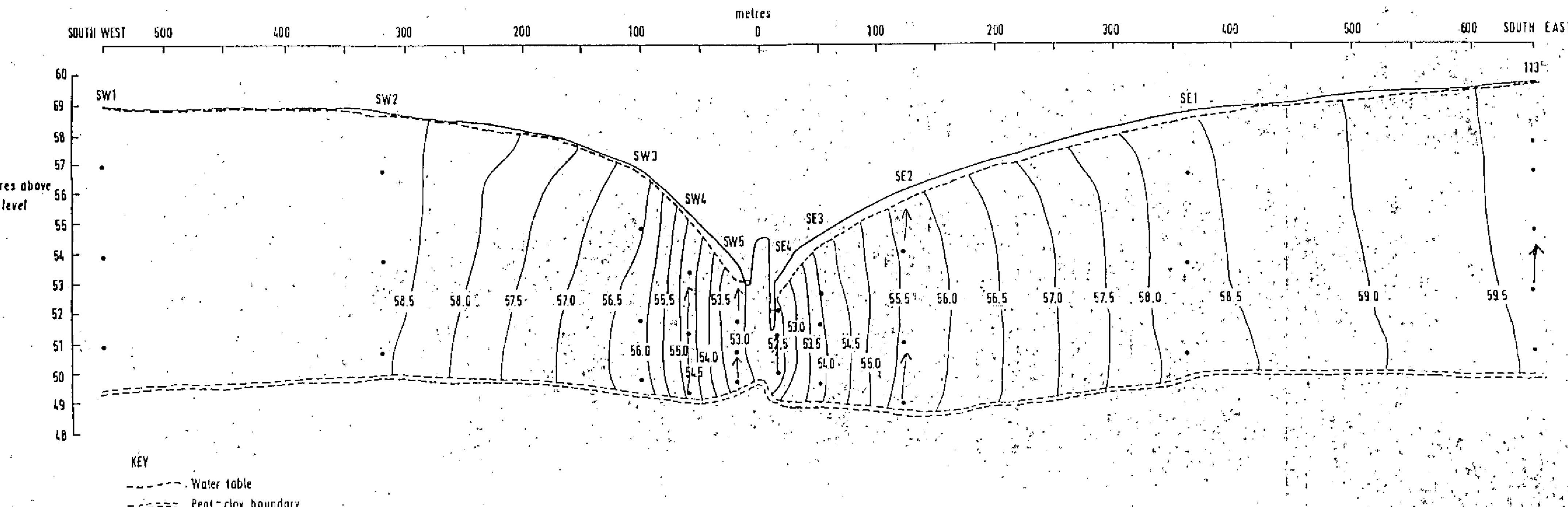
METHOD:CONSTANT HEAD PERMEABILITY TESTS
PLACE: CLARA, PIEZOMETER SW5D
DATE: 1991/7/22

TIME (HRS)	VESSEL LEVEL(cm)	DROP (cm)	RATE (cm/h)	Q (m3/day)	IMPOSED HEAD (m)	SHAPE FACTOR	K (m/day)
0.00	22.5						
2.27	19.4	3.1	1.265	0.010322	0.276	0.354	0.10565
6.25	16.4	3.0	0.756	0.006169	0.276	0.354	0.063139
24.40	8.6	7.8	0.427	0.003484	0.276	0.354	0.035662
31.10	6.5	2.1	0.323	0.002636	0.276	0.354	0.026976

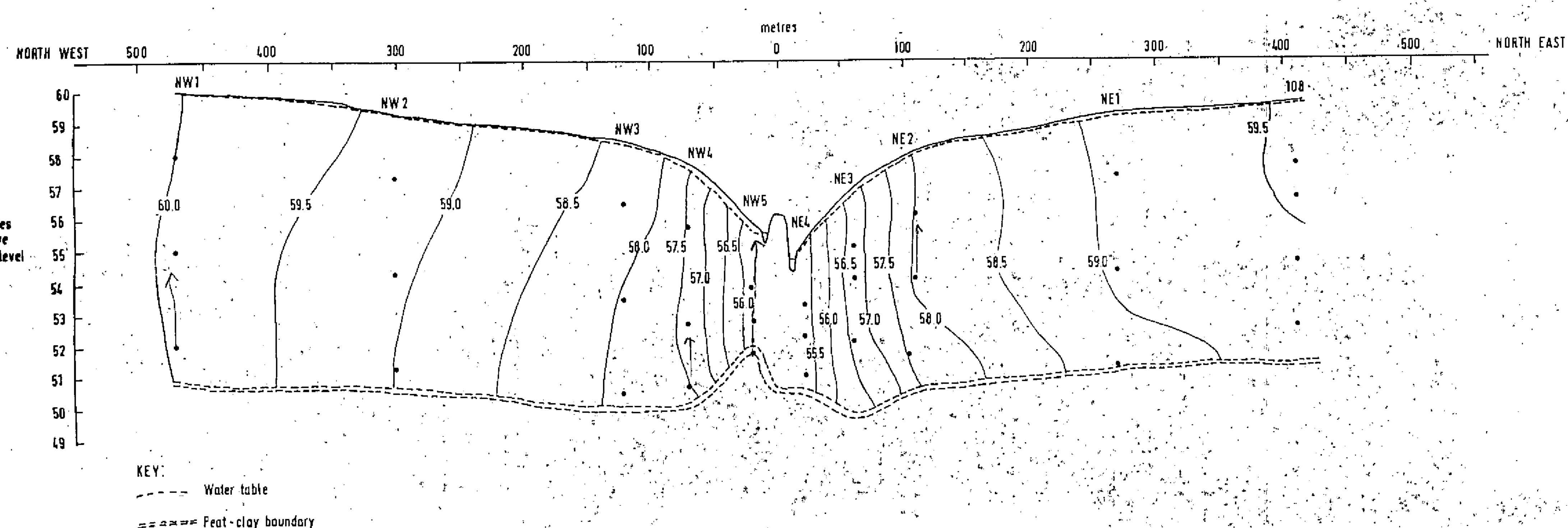
APPENDIX: A6



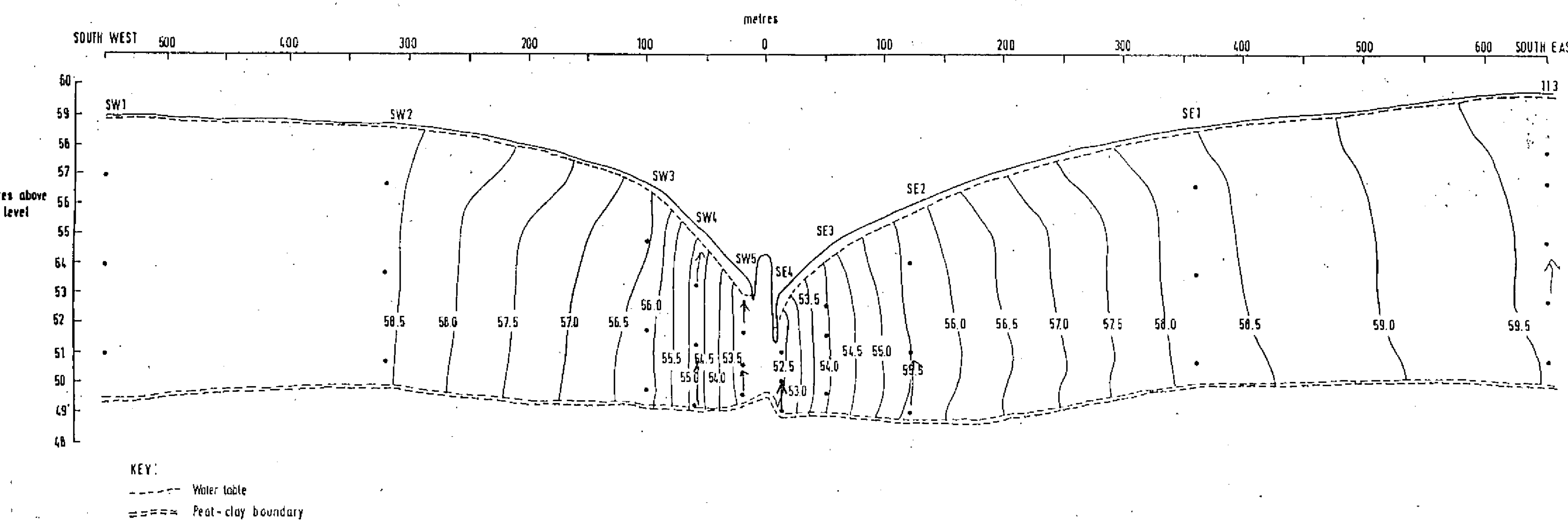
EQUIPOTENTIAL CONTOURS THROUGH THE PEAT
NORTHERN TRANSECTS Date 26/6/91
Contour interval 0.5 m



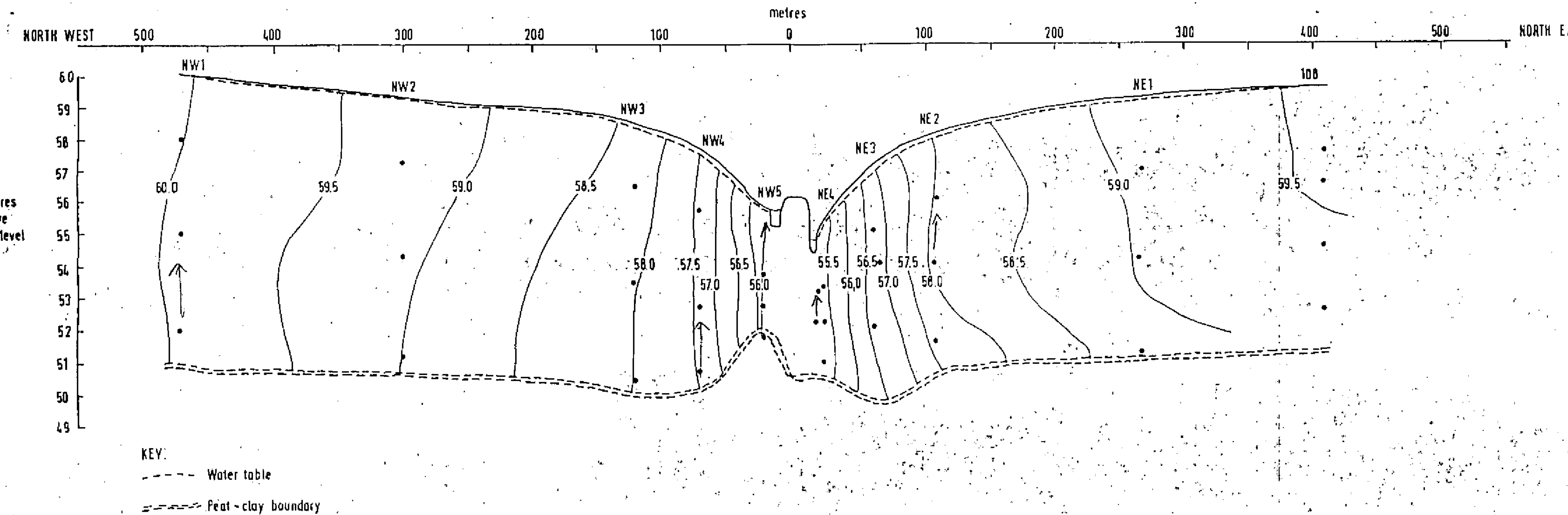
EQUIPOTENTIAL CONTOURS THROUGH THE PEAT
SOUTHERN TRANSECTS. Date 26/6/91
Contour interval 0.5m



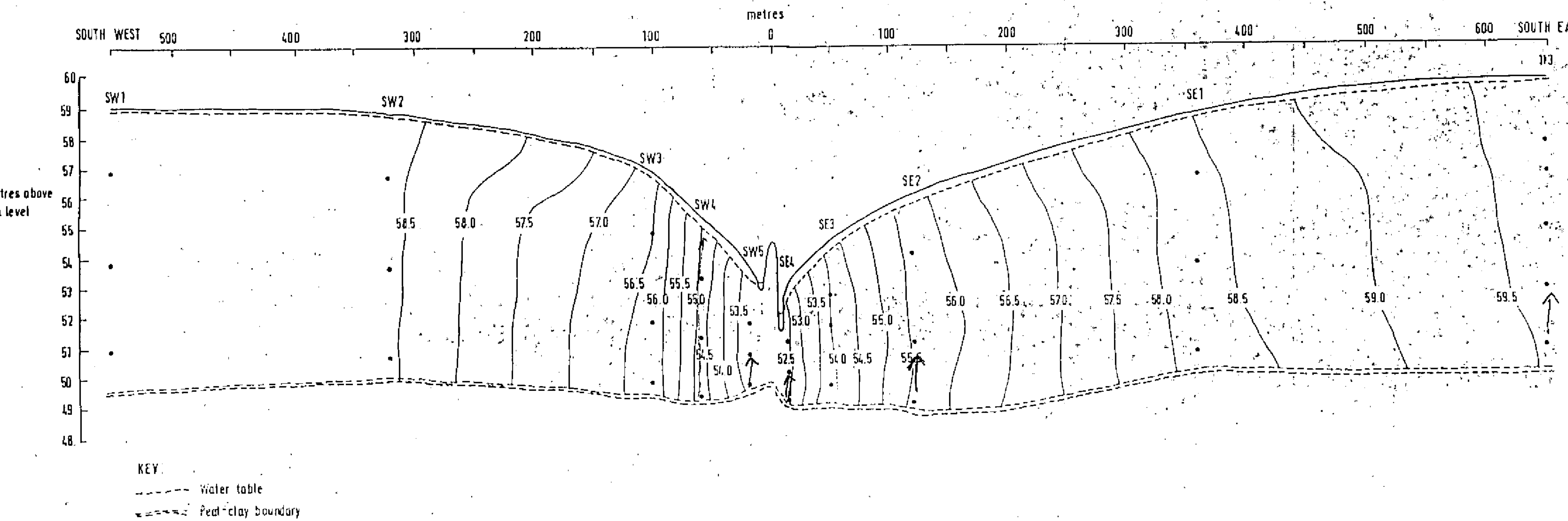
EQUIPOTENTIAL CONTOURS THROUGH THE PEAT
NORTHERN TRANSECTS Date 24/7/91
Contour interval 0.5m



EQUIPOTENTIAL CONTOURS THROUGH THE PEAT,
SOUTHERN TRANSECTS, Date 24/7/91
Contour interval 0.5m



EQUIPOTENTIAL CONTOURS THROUGH THE PEAT
NORTHERN TRANSECTS. Date 7/8/91
Contour interval 0.5 m



EQUIPOTENTIAL CONTOURS THROUGH THE PEAT,
SOUTHERN TRANSECTS date 7/8/91
Contour interval 0.5m

APPENDIX: A7

HEAD DATA
CLARA
DATE: 1991/6/19

PIEZO	DEPTH (m)	TOP TUBE M.O.D	BOT. TUBE M.O.D.	WATER LEVEL(m)	HEAD (m)
108A	phreatic	60.160	59.655	0.568	59.592
108B	2	60.160	59.650	0.596	59.564
108C	3	60.155	59.660	0.597	59.558
108D	5	60.145	59.700	0.781	59.364
108E	7	60.150	59.675	0.981	59.169
NE1A	phreatic	59.670	59.280	0.481	59.189
NE1B	2	59.665	59.255	0.540	59.125
NE1C	5	59.675	59.260	0.602	59.073
NE1D	8	59.660	59.240	0.835	58.825
NE2A	phreatic	58.575	58.165	0.501	58.074
NE2B	2	58.570	58.160	0.566	58.004
NE2C	4	58.580	58.165	0.495	58.085
NE2D	6.5	58.575	58.175	0.950	57.625
NE3A	phreatic	57.565	57.155	0.713	56.852
NE3B	2	57.550	57.130	0.768	56.782
NE3C	3	57.565	57.145	0.801	56.764
NE3D	5	57.543	57.140	0.834	56.709
NE4A	phreatic	55.750	55.340	0.382	55.368
NE4B	2	55.775	55.360	0.459	55.316
NE4C	3	55.770	55.370	0.537	55.233
NE4D	4.25	55.765	55.375	0.558	55.207
NW1A	phreatic	60.480	60.065	0.455	60.025
NW1B	2	60.495	60.070	0.511	59.984
NW1C	5	60.505	60.070	0.667	59.838
NW1D	8	60.490	60.070	0.564	59.926
NW2A	phreatic	59.715	59.310	0.419	59.296
NW2B	2	59.725	59.310	0.458	59.267
NW2C	5	59.730	59.315	0.645	59.085
NW2D	8	59.750	59.305	0.708	59.042
NW3A	phreatic	58.853	58.435	0.520	58.333
NW3B	2	58.840	58.427	0.574	58.266
NW3C	5	58.830	58.430	0.798	58.032
NW3D	8	58.815	58.400	0.824	57.991
NW4A	phreatic	58.125	57.710	0.588	57.537
NW4B	2	58.115	57.705	0.651	57.464
NW4C	5	58.120	57.720	0.733	57.387
NW4D	7	58.130	57.720	0.771	57.359
NW5A	phreatic	56.220	55.795	0.531	55.689
NW5B	2	56.215	55.790	0.462	55.753
NW5C	3	56.205	55.790	0.423	55.782
NW5D	3.97	56.200	55.795	0.344	55.856
113A	phreatic	60.233	59.763	0.474	59.759
113B	2	60.213	59.743	0.519	59.694
113C	3	60.233	59.743	0.542	59.691
113D	5	60.183	59.743	0.565	59.618
113E	7	60.243	59.758	0.610	59.633
113F	9	60.183	59.738	0.644	59.539
SE1A	phreatic	59.038	58.633	0.575	58.463
SE1B	2	59.053	58.628	0.679	58.374
SE1C	5	59.053	58.633	0.700	58.353

SE1D	8	59.078	58.618	0.848	58.230
SE2A	phreatic	56.428	56.028	0.715	55.713
SE2B	2	56.418	56.008	0.700	55.718
SE2C	5	56.413	55.998	0.877	55.536
SE2D	7	56.438	55.998	0.721	55.717
SE3A	phreatic	54.963	54.553	0.818	54.145
SE3B	2	54.958	54.553	0.933	54.025
SE3C	3	54.973	54.558	0.996	53.977
SE3D	5	54.992	54.573	1.070	53.922
SE4A	phreatic	53.438	53.013	0.976	52.462
SE4B	2	53.443	53.033	1.019	52.424
SE4C	3	53.463	53.033	1.083	52.380
SE4D	4	53.468	53.038	0.892	52.576
SW1A	phreatic	59.405	58.945	0.503	58.902
SW1B	2	59.440	58.990	0.580	58.860
SW1C	5	59.455	59.020	0.794	58.661
SW1D	8	59.470	59.025	1.015	58.455
SW2A	phreatic	59.135	58.710	0.501	58.634
SW2B	2	59.155	58.725	0.513	58.642
SW2C	5	59.165	58.720	0.538	58.627
SW2D	8	59.150	58.720	0.583	58.567
SW3A	phreatic	57.200	56.790	0.581	56.619
SW3B	2	57.190	56.785	0.664	56.526
SW3C	5	57.210	56.795	0.918	56.292
SW3D	7	57.215	56.805	0.958	56.257
SW4A	phreatic	55.765	55.360	0.764	55.001
SW4B	2	55.770	55.365	0.958	54.812
SW4C	4	55.780	55.350	0.945	54.835
SW4D	6	55.780	55.330	0.930	54.850
SW5A	phreatic	54.090	53.675	1.020	53.070
SW5B	2	54.100	53.675	0.959	53.141
SW5C	3	54.100	53.685	0.974	53.126
SW5D	4	54.120	53.705	0.928	53.192

HEAD DATA
CLARA
DATE: 1991/6/26

PIEZO	DEPTH (m)	TOP TUBE M.O.D	BOT. TUBE M.O.D.	WATER LEVEL(m)	HEAD (m)
108A	phreatic	60.160	59.655	0.543	59.617
108B	2	60.160	59.650	0.594	59.566
108C	3	60.155	59.660	0.587	59.568
108D	5	60.145	59.700	0.772	59.373
108E	7	60.150	59.675	0.968	59.182
NE1A	phreatic	59.670	59.280	0.446	59.224
NE1B	2	59.665	59.255	0.526	59.139
NE1C	5	59.675	59.260	0.595	59.080
NE1D	8	59.660	59.240	0.805	58.855
NE2A	phreatic	58.575	58.165	0.463	58.112
NE2B	2	58.570	58.160	0.553	58.017
NE2C	4	58.580	58.165	0.457	58.123
NE2D	6.5	58.575	58.175	0.927	57.648
NE3A	phreatic	57.565	57.155	0.680	56.885
NE3B	2	57.550	57.130	0.753	56.797
NE3C	3	57.565	57.145	0.802	56.763
NE3D	5	57.543	57.140	0.840	56.703
NE4A	phreatic	55.750	55.340	0.379	55.371
NE4B	2	55.775	55.360	0.447	55.328
NE4C	3	55.770	55.370	0.531	55.239
NE4D	4.25	55.765	55.375	0.556	55.209
NW1A	phreatic	60.480	60.065	0.450	60.030
NW1B	2	60.495	60.070	0.497	59.998
NW1C	5	60.505	60.070	0.660	59.845
NW1D	8	60.490	60.070	0.557	59.933
NW2A	phreatic	59.715	59.310	0.404	59.311
NW2B	2	59.725	59.310	0.445	59.280
NW2C	5	59.730	59.315	0.635	59.095
NW2D	8	59.750	59.305	0.701	59.049
NW3A	phreatic	58.853	58.435	0.488	58.365
NW3B	2	58.840	58.427	0.560	58.280
NW3C	5	58.830	58.430	0.789	58.041
NW3D	8	58.815	58.400	0.819	57.996
NW4A	phreatic	58.125	57.710	0.548	57.577
NW4B	2	58.115	57.705	0.636	57.479
NW4C	5	58.120	57.720	0.724	57.396
NW4D	7	58.130	57.720	0.755	57.375
NW5A	phreatic	56.220	55.795	0.535	55.685
NW5B	2	56.215	55.790	0.451	55.764
NW5C	3	56.205	55.790	0.415	55.790
NW5D	3.97	56.200	55.795	0.333	55.867
113A	phreatic	60.233	59.763	0.475	59.758
113B	2	60.213	59.743	0.517	59.696
113C	3	60.233	59.743	0.544	59.689
113D	5	60.183	59.743	0.566	59.617
113E	7	60.243	59.758	0.607	59.636
113F	9	60.183	59.738	0.645	59.538
SE1A	phreatic	59.038	58.633	0.528	58.510
SE1B	2	59.053	58.628	0.671	58.382
SE1C	5	59.053	58.633	0.699	58.354

SE1D	8	59.078	58.618	0.851	58.227
SE2A	phreatic	56.428	56.028	0.718	55.710
SE2B	2	56.418	56.008	0.698	55.720
SE2C	5	56.413	55.998	0.881	55.532
SE2D	7	56.438	55.998	0.756	55.682
SE3A	phreatic	54.963	54.553	0.760	54.203
SE3B	2	54.958	54.553	0.911	54.047
SE3C	3	54.973	54.558	0.999	53.974
SE3D	5	54.992	54.573	1.074	53.918
SE4A	phreatic	53.438	53.013	0.954	52.484
SE4B	2	53.443	53.033	0.997	52.446
SE4C	3	53.463	53.033	1.061	52.402
SE4D	4	53.468	53.038	0.875	52.593
SW1A	phreatic	59.405	58.945	0.491	58.914
SW1B	2	59.440	58.990	0.565	58.875
SW1C	5	59.455	59.020	0.784	58.671
SW1D	8	59.470	59.025	1.011	58.459
SW2A	phreatic	59.135	58.710	0.491	58.644
SW2B	2	59.155	58.725	0.510	58.645
SW2C	5	59.165	58.720	0.545	58.620
SW2D	8	59.150	58.720	0.584	58.566
SW3A	phreatic	57.200	56.790	0.501	56.699
SW3B	2	57.190	56.785	0.655	56.535
SW3C	5	57.210	56.795	0.910	56.300
SW3D	7	57.215	56.805	0.950	56.265
SW4A	phreatic	55.765	55.360	0.701	55.064
SW4B	2	55.770	55.365	0.964	54.806
SW4C	4	55.780	55.350	0.940	54.840
SW4D	6	55.780	55.330	0.929	54.851
SW5A	phreatic	54.090	53.675	0.991	53.099
SW5B	2	54.100	53.675	0.951	53.149
SW5C	3	54.100	53.685	0.965	53.135
SW5D	4	54.120	53.705	0.917	53.203

HEAD DATA
CLARA
DATE: 1991/7/10

PIEZO	DEPTH (m)	TOP TUBE M.O.D	BOT. TUBE M.O.D.	WATER LEVEL(m)	HEAD (m)
108A	phreatic	60.160	59.655	0.619	59.541
108B	2	60.160	59.650	0.637	59.523
108C	3	60.155	59.660	0.644	59.511
108D	5	60.145	59.700	0.825	59.320
108E	7	60.150	59.675	1.037	59.113
NE1A	phreatic	59.670	59.280	0.525	59.145
NE1B	2	59.665	59.255	0.577	59.088
NE1C	5	59.675	59.260	0.656	59.019
NE1D	8	59.660	59.240	0.865	58.795
NE2A	phreatic	58.575	58.165	0.569	58.006
NE2B	2	58.570	58.160	0.601	57.969
NE2C	4	58.580	58.165	0.567	58.013
NE2D	6.5	58.575	58.175	0.980	57.595
NE3A	phreatic	57.565	57.155	0.792	56.773
NE3B	2	57.550	57.130	0.700	56.850
NE3C	3	57.565	57.145	0.800	56.765
NE3D	5	57.543	57.140	0.842	56.701
NE4A	phreatic	55.750	55.340	0.458	55.292
NE4B	2	55.775	55.360	0.464	55.311
NE4C	3	55.770	55.370	0.546	55.224
NE4D	4.25	55.765	55.375	0.561	55.204
NW1A	phreatic	60.480	60.065	0.520	59.960
NW1B	2	60.495	60.070	0.550	59.945
NW1C	5	60.505	60.070	0.719	59.786
NW1D	8	60.490	60.070	0.619	59.871
NW2A	phreatic	59.715	59.310	0.451	59.264
NW2B	2	59.725	59.310	0.499	59.226
NW2C	5	59.730	59.315	0.694	59.036
NW2D	8	59.750	59.305	0.784	58.966
NW3A	phreatic	58.853	58.435	0.589	58.264
NW3B	2	58.840	58.427	0.615	58.225
NW3C	5	58.830	58.430	0.838	57.992
NW3D	8	58.815	58.400	0.878	57.937
NW4A	phreatic	58.125	57.710	0.662	57.463
NW4B	2	58.115	57.705	0.691	57.424
NW4C	5	58.120	57.720	0.771	57.349
NW4D	7	58.130	57.720	0.780	57.350
NW5A	phreatic	56.220	55.795	0.616	55.604
NW5B	2	56.215	55.790	0.512	55.703
NW5C	3	56.205	55.790	0.476	55.729
NW5D	3.97	56.200	55.795	0.390	55.810
113A	phreatic	60.233	59.763	0.536	59.697
113B	2	60.213	59.743	0.568	59.645
113C	3	60.233	59.743	0.600	59.633
113D	5	60.183	59.743	0.628	59.555
113E	7	60.243	59.758	0.669	59.574
113F	9	60.183	59.738	0.706	59.477
SE1A	phreatic	59.038	58.633	0.611	58.427
SE1B	2	59.053	58.628	0.721	58.332
SE1C	5	59.053	58.633	0.752	58.301

SE1D	8	59.078	58.618	0.904	58.174
SE2A	phreatic	56.428	56.028	0.772	55.656
SE2B	2	56.418	56.008	0.760	55.658
SE2C	5	56.413	55.998	0.915	55.498
SE2D	7	56.438	55.998	0.773	55.665
SE3A	phreatic	54.963	54.553	0.892	54.071
SE3B	2	54.958	54.553	0.969	53.989
SE3C	3	54.973	54.558	1.048	53.925
SE3D	5	54.992	54.573	1.126	53.866
SE4A	phreatic	53.438	53.013	1.063	52.375
SE4B	2	53.443	53.033	1.075	52.368
SE4C	3	53.463	53.033	1.114	52.349
SE4D	4	53.468	53.038	0.935	52.533
SW1A	phreatic	59.405	58.945	0.535	58.870
SW1B	2	59.440	58.990	0.618	58.822
SW1C	5	59.455	59.020	0.839	58.616
SW1D	8	59.470	59.025	1.063	58.407
SW2A	phreatic	59.135	58.710	0.543	58.592
SW2B	2	59.155	58.725	0.563	58.592
SW2C	5	59.165	58.720	0.597	58.568
SW2D	8	59.150	58.720	0.626	58.524
SW3A	phreatic	57.200	56.790	0.591	56.609
SW3B	2	57.190	56.785	0.686	56.504
SW3C	5	57.210	56.795	0.935	56.275
SW3D	7	57.215	56.805	0.997	56.218
SW4A	phreatic	55.765	55.360	0.824	54.941
SW4B	2	55.770	55.365	1.004	54.766
SW4C	4	55.780	55.350	0.970	54.810
SW4D	6	55.780	55.330	0.963	54.817
SW5A	phreatic	54.090	53.675	1.069	53.021
SW5B	2	54.100	53.675	0.999	53.101
SW5C	3	54.100	53.685	1.021	53.079
SW5D	4	54.120	53.705	0.969	53.151

HEAD DATA
CLARA
DATE: 1991/7/24

PIEZO	DEPTH (m)	TOP TUBE M.O.D	BOT. TUBE M.O.D.	WATER LEVEL(m)	HEAD (m)
108A	phreatic	60.160	59.655	0.547	59.613
108B	2	60.160	59.650	0.577	59.583
108C	3	60.155	59.660	0.586	59.569
108D	5	60.145	59.700	0.767	59.378
108E	7	60.150	59.675	0.967	59.183
NE1A	phreatic	59.670	59.280	0.454	59.216
NE1B	2	59.665	59.255	0.529	59.136
NE1C	5	59.675	59.260	0.597	59.078
NE1D	8	59.660	59.240	0.830	58.830
NE2A	phreatic	58.575	58.165	0.481	58.094
NE2B	2	58.570	58.160	0.553	58.017
NE2C	4	58.580	58.165	0.477	58.103
NE2D	6.5	58.575	58.175	0.922	57.653
NE3A	phreatic	57.565	57.155	0.709	56.856
NE3B	2	57.550	57.130	0.746	56.804
NE3C	3	57.565	57.145	0.816	56.749
NE3D	5	57.543	57.140	0.872	56.671
NE4A	phreatic	55.750	55.340	0.384	55.366
NE4B	2	55.775	55.360	0.457	55.318
NE4C	3	55.770	55.370	0.549	55.221
NE4D	4.25	55.765	55.375	0.564	55.201
NW1A	phreatic	60.480	60.065	0.439	60.041
NW1B	2	60.495	60.070	0.493	60.002
NW1C	5	60.505	60.070	0.659	59.846
NW1D	8	60.490	60.070	0.568	59.922
NW2A	phreatic	59.715	59.310	0.406	59.309
NW2B	2	59.725	59.310	0.443	59.282
NW2C	5	59.730	59.315	0.637	59.093
NW2D	8	59.750	59.305	0.761	58.989
NW3A	phreatic	58.853	58.435	0.481	58.372
NW3B	2	58.840	58.427	0.566	58.274
NW3C	5	58.830	58.430	0.801	58.029
NW3D	8	58.815	58.400	0.910	57.905
NW4A	phreatic	58.125	57.710	0.498	57.627
NW4B	2	58.115	57.705	0.639	57.476
NW4C	5	58.120	57.720	0.734	57.386
NW4D	7	58.130	57.720	0.572	57.558
NW5A	phreatic	56.220	55.795	0.531	55.689
NW5B	2	56.215	55.790	0.457	55.758
NW5C	3	56.205	55.790	0.422	55.783
NW5D	3.97	56.200	55.795	0.336	55.864
113A	phreatic	60.233	59.763	0.471	59.762
113B	2	60.213	59.743	0.516	59.697
113C	3	60.233	59.743	0.545	59.688
113D	5	60.183	59.743	0.569	59.614
113E	7	60.243	59.758	0.618	59.625
113F	9	60.183	59.738	0.654	59.529
SE1A	phreatic	59.038	58.633	0.519	58.519
SE1B	2	59.053	58.628	0.673	58.380
SE1C	5	59.053	58.633	0.701	58.352

SE1D	8	59.078	58.618	0.857	58.221
SE2A	phreatic	56.428	56.028	0.722	55.706
SE2B	2	56.418	56.008	0.719	55.699
SE2C	5	56.413	55.998	0.908	55.505
SE2D	7	56.438	55.998	0.759	55.679
SE3A	phreatic	54.963	54.553	0.781	54.182
SE3B	2	54.958	54.553	0.942	54.016
SE3C	3	54.973	54.558	1.011	53.962
SE3D	5	54.992	54.573	1.086	53.906
SE4A	phreatic	53.438	53.013	1.022	52.416
SE4B	2	53.443	53.033	1.033	52.410
SE4C	3	53.463	53.033	1.092	52.371
SE4D	4	53.468	53.038	0.900	52.568
SW1A	phreatic	59.405	58.945	0.480	58.925
SW1B	2	59.440	58.990	0.569	58.871
SW1C	5	59.455	59.020	0.787	58.668
SW1D	8	59.470	59.025	1.021	58.449
SW2A	phreatic	59.135	58.710	0.471	58.664
SW2B	2	59.155	58.725	0.511	58.644
SW2C	5	59.165	58.720	0.550	58.615
SW2D	8	59.150	58.720	0.593	58.557
SW3A	phreatic	57.200	56.790	0.511	56.689
SW3B	2	57.190	56.785	0.643	56.547
SW3C	5	57.210	56.795	0.922	56.288
SW3D	7	57.215	56.805	0.984	56.231
SW4A	phreatic	55.765	55.360	0.757	55.008
SW4B	2	55.770	55.365		55.770
SW4C	4	55.780	55.350	0.960	54.820
SW4D	6	55.780	55.330		55.780
SW5A	phreatic	54.090	53.675	1.032	53.058
SW5B	2	54.100	53.675		54.100
SW5C	3	54.100	53.685	0.963	53.137
SW5D	4	54.120	53.705		54.120

HEAD DATA
CLARA
DATE: 1991/8/7

PIEZO	DEPTH (m)	TOP TUBE M.O.D	BOT. TUBE M.O.D.	WATER LEVEL(m)	HEAD (m)
108A	phreatic	60.160	59.655	0.546	59.614
108B	2	60.160	59.650	0.577	59.583
108C	3	60.155	59.660	0.578	59.577
108D	5	60.145	59.700	0.772	59.373
108E	7	60.150	59.675	0.965	59.185
NE1A	phreatic	59.670	59.280	0.432	59.238
NE1B	2	59.665	59.255	0.519	59.146
NE1C	5	59.675	59.260	0.590	59.085
NE1D	8	59.660	59.240	0.826	58.834
NE2A	phreatic	58.575	58.165	0.449	58.126
NE2B	2	58.570	58.160	0.556	58.014
NE2C	4	58.580	58.165	0.434	58.146
NE2D	6.5	58.575	58.175	0.931	57.644
NE3A	phreatic	57.565	57.155	0.616	56.949
NE3B	2	57.550	57.130	0.764	56.786
NE3C	3	57.565	57.145	0.822	56.743
NE3D	5	57.543	57.140	0.877	56.666
NE4A	phreatic	55.750	55.340	0.365	55.385
NE4B	2	55.775	55.360	0.441	55.334
NE4C	3	55.770	55.370	0.526	55.244
NE4D	4.25	55.765	55.375	0.545	55.220
NW1A	phreatic	60.480	60.065	0.433	60.047
NW1B	2	60.495	60.070	0.482	60.013
NW1C	5	60.505	60.070	0.653	59.852
NW1D	8	60.490	60.070	0.563	59.927
NW2A	phreatic	59.715	59.310	0.378	59.337
NW2B	2	59.725	59.310	0.428	59.297
NW2C	5	59.730	59.315	0.627	59.103
NW2D	8	59.750	59.305	0.761	58.989
NW3A	phreatic	58.853	58.435	0.479	58.374
NW3B	2	58.840	58.427	0.555	58.285
NW3C	5	58.830	58.430	0.797	58.033
NW3D	8	58.815	58.400	0.825	57.990
NW4A	phreatic	58.125	57.710	0.566	57.559
NW4B	2	58.115	57.705	0.650	57.465
NW4C	5	58.120	57.720	0.724	57.396
NW4D	7	58.130	57.720	0.657	57.473
NW5A	phreatic	56.220	55.795	0.526	55.694
NW5B	2	56.215	55.790	0.440	55.775
NW5C	3	56.205	55.790	0.396	55.809
NW5D	3.97	56.200	55.795	0.309	55.891
113A	phreatic	60.233	59.763	0.466	59.767
113B	2	60.213	59.743	0.514	59.699
113C	3	60.233	59.743	0.544	59.689
113D	5	60.183	59.743	0.563	59.620
113E	7	60.243	59.758	0.615	59.628
113F	9	60.183	59.738	0.652	59.531
SE1A	phreatic	59.038	58.633	0.486	58.552
SE1B	2	59.053	58.628	0.666	58.387
SE1C	5	59.053	58.633	0.697	58.356

SE1D	8	59.078	58.618	0.836	58.242
SE2A	phreatic	56.428	56.028	0.707	55.721
SE2B	2	56.418	56.008	0.708	55.710
SE2C	5	56.413	55.998	0.926	55.487
SE2D	7	56.438	55.998	0.766	55.672
SE3A	phreatic	54.963	54.553	0.715	54.248
SE3B	2	54.958	54.553	0.926	54.032
SE3C	3	54.973	54.558	1.000	53.973
SE3D	5	54.992	54.573	1.098	53.894
SE4A	phreatic	53.438	53.013	0.942	52.496
SE4B	2	53.443	53.033	1.015	52.428
SE4C	3	53.463	53.033	1.069	52.394
SE4D	4	53.468	53.038	0.888	52.580
SW1A	phreatic	59.405	58.945	0.465	58.940
SW1B	2	59.440	58.990	0.556	58.884
SW1C	5	59.455	59.020	0.772	58.683
SW1D	8	59.470	59.025	1.017	58.453
SW2A	phreatic	59.135	58.710	0.468	58.667
SW2B	2	59.155	58.725	0.511	58.644
SW2C	5	59.165	58.720	0.557	58.608
SW2D	8	59.150	58.720	0.586	58.564
SW3A	phreatic	57.200	56.790	0.478	56.722
SW3B	2	57.190	56.785	0.637	56.553
SW3C	5	57.210	56.795	0.933	56.277
SW3D	7	57.215	56.805	0.982	56.233
SW4A	phreatic	55.765	55.360	stolen!	55.765
SW4B	2	55.770	55.365	0.981	54.789
SW4C	4	55.780	55.350	0.952	54.828
SW4D	6	55.780	55.330	0.952	54.828
SW5A	phreatic	54.090	53.675	0.851	53.239
SW5B	2	54.100	53.675	0.945	53.155
SW5C	3	54.100	53.685	0.967	53.133
SW5D	4	54.120	53.705	0.916	53.204
NW5B	2	55.936	55.533	0.764	55.172
NW5C	3	55.928	55.532	0.696	55.232

APPENDIX: A8

DRILLING AT PEG 5E EAST

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.35	H5	MOSS, HEATHER
0.35-0.50	H3	MOSS, HEATHER
0.50-0.95	H3	MOSS, COTTON GRASS
0.95-1.00	H5	MOSS, HEATHER
1.00-1.75	H3	MOSS, HEATHER, COTTON GRASS
1.75-2.00	H8	MOSS, SEDGE
2.00-2.10	H6	MOSS, SEDGE, HEATHER
2.10-2.70	H3	MOSS, SEDGE
2.70-2.85	H5	MOSS, SEDGE, REED, COTTON GRASS
2.85-2.90	H7	MOSS, SEDGE
2.90-3.25	H4	MOSS, SEDGE, REED
3.25-3.50	H7	MOSS, SEDGE, HEATHER
3.50-3.58	H6	MOSS, SEDGE
3.58-3.70	H7	MOSS, COTTON GRASS, SEDGE
3.70-4.20	H5	MOSS, SEDGE
4.20-4.23	H8	REED, SEDGE
4.23-4.25	H3	MOSS, HEATHER
4.25-4.27	H8	REED, SEDGE
4.27-4.50	H5	MOSS, HEATHER
4.50-5.75	H5	MOSS, HEATHER, COTTON GRASS, REED, SEDGE
5.75-6.00	H6	MOSS, REED, SEDGE, HEATHER
6.00-6.20	H6	REED, SEDGE

6.20-6.50	H6	REED, SEDGE, ALDER
6.50-6.70	H6	SEDGE, REED
6.70-7.00	H6	ALDER, REED, SEDGES, HEATHER
7.00-7.50	H6	REED, SEDGE
7.50-9.50	H7	REED, SEDGE, ALDER
9.50		CLAY

DRILLING AT PEG 5D WEST

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.25	H4	MOSS
0.25-0.75	H5	MOSS
0.75-1.00	H4	MOSS
1.00-1.50	H3	MOSS
1.50-2.30	H3	MOSS, HEATHER
2.30-2.55	H3	MOSS, REED
2.55-3.00	H4	MOSS, HEATHER, SEDGE
3.00-3.45	H3	MOSS, REED
3.45-3.50	H8	MOSS, REED
3.50-3.70	H3	MOSS, REED
3.70-3.80	H8	MOSS, SEDGE
3.80-4.00	H4	MOSS, HEATHER
4.00-4.30	H5	MOSS, C.GRASS, REED
4.30-4.32	H7	MOSS, REED
4.32-4.37	H5	MOSS, C.GRASS, REED
4.37-4.40	H8	MOSS, REED, SEDGE
4.40-4.58	H4	MOSS, HEATHER
4.58-4.70	H8	MOSS, REED, SEDGE
4.70-5.25	H4	MOSS, REED, SEDGE
5.25-6.00	H6	MOSS, REED, HEATHER, SEDGE, COTTON GRASS
6.00-6.50	H6	ALDER, REED, SEDGE, BIRCH
6.50-6.70	H6	ALDER, REED, SEDGE, BIRCH, C.GRASS
6.70-7.25	H5	REED, SEDGE, ALDER
7.25-7.40	H5	REED, SEDGE, ALDER

DRILLING AT PIEZO NE1

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.35	H3	MOSS, COTTON GRASS
0.35-0.80	H2	MOSS
0.80-1.20	H3	MOSS, REED
1.20-1.30	H4	MOSS, HEATHER, C.GRASS
1.30-2.55	H3	MOSS, HEATHER, REED, SEDGE
2.55-2.65	H5	SEDGE, REED, MOSS
2.65-2.69	H3	MOSS, HEATHER, REED, SEDGE
2.69-2.79	H5	SEDGE, REED
2.79-2.89	H3	MOSS, HEATHER, REED, SEDGE
2.89-3.00	H5	SEDGE, REED, COTTON GRASS, HEATHER
3.00-3.70	H4	SEDGE, HEATHER, MOSS
3.70-3.80	H3	MOSS, C.GRASS, REED
3.80-4.05	H5	MOSS, COTTON GRASS
4.05-4.10	H3	MOSS
4.10-4.20	H5	REED, SEDGE
4.20-4.40	H3	MOSS,C.GRASS,HEATHER
4.40-4.50	H6	COTTON GRASS, REED
4.50-5.20	H5	MOSS, HEATHER
5.20-5.60	H7	SEDGES, HEATHER
5.60-7.00	H5	ALDER, REED, SEDGE
7.00-8.00	H5	SEDGE, REED, ALDER, BIRCH
8.00		CLAY

DRILLING AT PIEZO NE2

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.30	H4	MOSS
0.30-0.50	H6	MOSS
0.50-0.85	H5	MOSS, HEATHER
0.85-1.20	H2	MOSS, HEATHER
1.20-1.30	H7	MOSS, HEATHER
1.30-1.50	H3	MOSS
1.50-1.58	H3	MOSS, HEATHER
1.58-1.64	H5	MOSS, HEATHER
1.64-2.20	H3	MOSS, HEATHER
2.20-2.35	H4	MOSS, HEATHER, REED, SEDGE
2.35-2.37	H8	SEDGES
2.37-2.41	H4	MOSS, HEATHER, REED, SEDGE
2.41-2.55	H5	SEDGE
2.55-2.70	H5	HEATHER, SEDGE, COTTON GRASS
2.70-2.90	H3	MOSS, HEATHER
2.90-3.13	H6	REED, SEDGE
3.13-3.50	H4	MOSS, HEATHER, REED, COTTON GRASS
3.50-3.65	H6	SEDGE, REED, HEATHER
3.65-3.80	H3	MOSS
3.80-3.90	H6	COTTON GRASS, MOSS, SEDGE
3.90-4.00	H3	COTTON GRASS, MOSS
4.00-4.05	H6	REED, SEDGE

4.05-4.20	H6	COTTON GRASS, HEATHER
4.20-4.25	H5	REED, SEDGE, HEATHER
4.25-4.90	H6	ALDER, HEATHER, REED, SEDGE, COTTON GRASS
4.90-5.00	H7	COTTON GRASS, SEDGE, HEATHER
5.00-5.20	H5	REED, SEDGE, HEATHER
5.20-7.50	H5	ALDER, REED, SEDGE
7.50		CLAY

DRILLING AT PIEZO NE3

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.25	H3	MOSS
0.25-1.00	H2	MOSS
1.00-1.30	H3	MOSS, HEATHER
1.30-1.40	H5	MOSS, REED, SEDGES
1.40-1.70	H3	MOSS
1.70-1.74	H8	SEDGE
1.74-1.77	H3	MOSS, SEDGE
1.77-2.10	H5	SEDGE, HEATHER, COTTON GRASS
2.10-2.15	H8	SEDGES
2.15-2.75	H3	COTTON GRASS, MOSS
2.75-2.80	H4	SEDGE, REED
2.80-3.00	H5	HEATHER, REED, SEDGE, COTTON GRASS
3.00-3.20	H5	COTTON GRASS, SEDGE, MOSS, HEATHER
3.20-3.50	H5	ALDER, REED, SEDGE, HEATHER
3.50-7.25	H5	REED, ALDER, SEDGES
7.25		CLAY

DRILLING AT PIEZO NE4

DEPTH, (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.35	H5	MOSS
0.35-0.50	H4	MOSS
0.50-0.90	H4	MOSS, COTTON GRASS
0.90-1.20	H5	MOSS, HEATHER
1.20-1.65	H6	HEATHER, MOSS, COTTON GRASS
1.65-2.35	H7	ALDER, REED
2.35-2.90	H6	SEDGE, REED
2.90-4.75	H6	REED, SEDGE, ALDER
4.75		CLAY

DRILLING AT PIEZO NW4

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.30	H5	MOSS
0.30-0.50	H3	MOSS, HEATHER
0.50-0.70	H3	MOSS
0.70-0.80	H6	REED, SEDGE, MOSS, HEATHER
0.80-1.00	H2	MOSS
1.00-1.50	H2	MOSS, SEDGE
1.50-1.75	H4	MOSS, COTTON GRASS
1.75-2.00	H7	ALDER, MOSS
2.00-2.25	?	MOSS
2.25-2.50	?	MOSS, COTTON GRASS
2.50-2.65	H3	MOSS
2.65-2.75	H7	SEDGE, REED
2.75-2.95	H5	C.GRASS, ALDER, MOSS
2.95-3.00	H6	COTTON GRASS
3.00-3.35	H6	SEDGE, MOSS
3.35-3.50	H5	COTTON GRASS, REED, HEATHER
3.50-3.60	H5	HEATHER, MOSS
3.60-3.75	H5	COTTON GRASS
3.75-4.15	H5	HEATHER, MOSS, REED
4.15-4.50	H7	MOSS, HEATHER, SEDGE
4.50-4.60	H5	MOSS
4.60-5.00	H6	ALDER, MOSS, REED, SEDGE
5.00-7.25	H5	REED, SEDGE, ALDER
7.25		CLAY

DRILLING AT PIEZO NW5

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.30	H5	MOSS
0.30-0.50	H7	MOSS, COTTON GRASS
0.50-0.70	H5	MOSS
0.70-0.85	H7	MOSS, HEATHER
0.85-1.30	H5	MOSS, COTTON GRASS
1.30-1.50	H6	MOSS, COTTON GRASS
1.50-2.25	H6	MOSS, HEATHER, ALDER, COTTON GRASS
2.25-2.85	H7	ALDER, BIRCH, SEDGE, REED
2.85-3.45	H6	REED, SEDGE
3.45-3.75	?	VERY WET, AMORPHOUS PEAT
3.75		CLAY

DRILLING AT PIEZO SW3

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.20	H3	MOSS
0.20-0.40	H3	MOSS, COTTON GRASS
0.40-0.60	H3	MOSS
0.60-0.80	H5	MOSS, C.GRASS, REED, ALDER
0.80-1.00	H3	MOSS
1.00-1.10	H3	MOSS, REED, HEATHER
1.10-1.25	H6	MOSS, SEDGE, HEATHER
1.25-1.30	H3	MOSS, HEATHER
1.30-1.40	H5	MOSS, COTTON GRASS, HEATHER, REED
1.40-1.50	H3	MOSS, SEDGES
1.50-2.03	H3	MOSS, COTTON GRASS
2.03-2.08	H6	REED, SEDGE, MOSS, HEATHER
2.08-2.18	H4	MOSS, SEDGE, HEATHER, REED
2.18-2.55	H3	MOSS, HEATHER
2.55-2.95	H7	SEDGE, REED, MOSS, HEATHER
2.95-3.00	H3	MOSS, HEATHER
3.00-3.25	H6	MOSS,C.GRASS, HEATHER
3.25-3.30	H5	MOSS, HEATHER
3.30-3.35	H7	MOSS, HEATHER,C.GRASS
3.35-3.70	H5	MOSS, HEATHER
3.70-4.22	H6	MOSS, HEATHER, REED
4.22-4.32	H6	REED, SEDGE, MOSS

4.32-4.60	H7	REED, SEDGE, MOSS
4.60-5.00	H6	ALDER, SEDGE, REED
5.00-7.50	H5	REED, SEDGE, ALDER
7.50		CLAY

DRILLING AT PIEZO SW5

DEPTH (METRES)	HUMIFICATION DEGREE	VEGETATION TYPE
0.00-0.55	H3	MOSS, HEATHER
0.55-0.85	H3	REED, COTTON GRASS, HEATHER
0.85-1.00	H6	HEATHER, REED
1.00-1.35	H5	COTTON GRASS, HEATHER, REED
1.35-1.50	H6	SEDGE, REED
1.50-3.50	H5	REED, SEDGE, ALDER
3.50-3.80	H4	REED, SEDGE, ALDER
3.80-4.25	H4	SEDGE, REED WITH SILTY LAYERS AND SHELLS
4.25		CLAY

APPENDIX: A9

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA EAST, PEG 5E
DATE: 1991/8/15

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.25-0.30	43	70.34	31.82	28.82	3.00	38.52	92.775	89.581	0.070
0.80-0.85	43	65.96	30.94	28.73	2.21	35.02	94.064	81.442	0.051
1.25-1.30	43	61.77	30.05	28.45	1.60	31.72	95.198	73.767	0.037
1.80-1.85	43	71.65	31.28	28.28	3.00	40.37	93.083	93.884	0.070
2.30-2.35	43	70.81	30.54	28.32	2.22	40.27	94.775	93.651	0.052
2.80-2.85	43	71.10	29.75	27.12	2.63	41.35	94.020	96.163	0.061
3.30-3.35	43	66.82	30.68	28.49	2.19	36.14	94.286	84.047	0.051
3.75-3.80	43	70.31	29.95	28.08	1.87	40.36	95.572	93.860	0.043
4.30-4.35	43	68.93	30.05	27.98	2.07	38.88	94.945	90.419	0.048
4.70-4.75	43	71.42	29.57	27.79	1.78	41.85	95.920	97.326	0.041
5.20-5.25	43	73.56	31.28	28.70	2.58	42.28	94.249	98.326	0.060
5.75-5.80	43	69.87	30.52	28.43	2.09	39.35	94.957	91.512	0.049
6.20-6.25	43	72.73	30.93	28.81	2.12	41.80	95.173	97.209	0.049
6.75-6.80	43	68.08	30.44	28.53	1.91	37.64	95.171	87.535	0.044
7.20-7.25	43	71.37	30.59	28.08	2.51	40.78	94.202	94.837	0.058
7.70-7.75	43	76.11	32.89	30.21	2.68	43.22	94.161	100.512	0.062
8.40-8.45	43	71.06	31.68	28.62	3.06	39.38	92.790	91.581	0.071
8.70-8.75	43	71.82	30.56	27.53	3.03	41.26	93.159	95.953	0.070
9.20-9.25	43	70.83	30.71	28.58	2.13	40.12	94.959	93.302	0.050

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA WEST, PEG 5D
DATE: 1991/8/15

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.30-0.35	43	71.33	30.96	28.45	2.51	40.37	94.146	93.884	0.058
0.75-0.80	43	67.99	29.82	27.70	2.12	38.17	94.738	88.767	0.049
1.20-1.25	43	66.56	30.29	28.83	1.46	36.27	96.130	84.349	0.034
1.85-1.90	43	68.84	29.27	27.61	1.66	39.57	95.974	92.023	0.039
2.10-2.15	43	66.48	29.95	28.09	1.86	36.53	95.155	84.953	0.043
2.75-2.80	43	67.03	29.80	28.05	1.75	37.23	95.511	86.581	0.041
3.20-3.25	43	67.53	31.20	29.34	1.86	36.33	95.130	84.488	0.043
3.70-3.75	43	68.59	29.76	27.33	2.43	38.83	94.111	90.302	0.057
4.25-4.30	43	68.27	30.74	28.83	1.91	37.53	95.157	87.279	0.044
4.75-4.80	43	66.66	30.04	28.25	1.79	36.62	95.340	85.163	0.042
5.20-5.25	43	68.63	31.05	28.97	2.08	37.58	94.755	87.395	0.048
5.65-5.70	43	71.06	32.35	29.21	3.14	38.71	92.497	90.023	0.073
6.25-6.30	43	72.58	31.84	28.52	3.32	40.74	92.465	94.744	0.077
6.75-6.80	43	76.46	33.16	29.52	3.64	43.30	92.245	100.698	0.085
7.25-7.30	43	68.55	31.19	27.96	3.23	37.36	92.042	86.884	0.075

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER NE1
DATE: 1991/7/17

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.25-0.30	43	67.73	31.38	28.70	2.68	36.35	93.133	84.535	0.062
0.85-0.90	43	68.71	30.61	28.31	2.30	38.10	94.307	88.605	0.053
1.40-1.45	43	69.41	30.45	28.03	2.42	38.96	94.152	90.605	0.056
1.70-1.75	43	70.08	31.39	28.44	2.95	38.69	92.915	89.977	0.069
2.20-2.25	43	68.03	30.52	28.11	2.41	37.51	93.963	87.233	0.056
2.75-2.80	43	71.59	29.98	27.33	2.65	41.61	94.013	96.767	0.062
3.20-3.25	43	70.76	28.27	25.57	2.70	42.49	94.025	98.814	0.063
3.85-3.90	43	68.32	30.57	28.47	2.10	37.75	94.730	87.791	0.049
4.35-4.40	43	68.88	29.98	27.69	2.29	38.90	94.440	90.465	0.053
4.75-4.80	43	72.64	30.90	29.35	1.55	41.74	96.419	97.070	0.036
5.25-5.30	43	72.72	31.71	29.22	2.49	41.01	94.276	95.372	0.058
5.75-5.80	43	70.85	30.33	27.98	2.35	40.52	94.518	94.233	0.055
6.25-6.30	43	71.52	30.88	28.35	2.53	40.64	94.139	94.512	0.059
6.70-6.75	43	72.01	31.07	28.09	2.98	40.94	93.215	95.209	0.069
7.20-7.25	43	73.09	31.90	28.84	3.06	41.19	93.085	95.791	0.071
7.75-7.80	43	75.13	33.30	29.83	3.47	41.83	92.340	97.279	0.081

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER NE2
DATE: 1991/7/16

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.35-0.40	43	72.93	30.72	28.10	2.62	42.21	94.156	98.163	0.061
0.60-0.65	43	68.07	31.16	29.05	2.11	36.91	94.593	85.837	0.049
1.30-1.35	43	66.34	29.69	27.80	1.89	36.65	95.096	85.233	0.044
1.65-1.70	43	67.62	29.84	27.99	1.85	37.78	95.332	87.860	0.043
2.45-2.50	43	66.90	31.03	28.72	2.31	35.87	93.950	83.419	0.054
2.65-2.70	43	71.89	30.41	28.33	2.08	41.48	95.225	96.465	0.048
3.07-3.12	43	74.91	30.79	28.50	2.29	44.12	95.066	102.605	0.053
3.70-3.75	43	73.14	31.83	29.53	2.30	41.31	94.726	96.070	0.053
4.10-4.15	43	73.21	31.54	28.51	3.03	41.67	93.221	96.907	0.070
4.70-4.75	43	76.20	31.73	28.63	3.10	44.47	93.483	103.419	0.072
5.15-5.20	43	72.83	31.80	28.26	3.54	41.03	92.057	95.419	0.082
5.72-5.77	43	71.60	30.72	27.86	2.86	40.88	93.461	95.070	0.067
6.25-6.30	43	77.10	32.58	28.85	3.73	44.52	92.269	103.535	0.087
6.70-6.75	43	75.82	32.03	27.60	4.43	43.79	90.813	101.837	0.103

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER NE3
DATE: 1991/7/16

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.15-0.20	43	68.87	30.56	27.16	3.40	38.31	91.848	89.093	0.079
0.70-0.75	43	73.83	30.86	28.08	2.78	42.97	93.923	99.930	0.065
1.20-1.25	43	79.31	33.63	30.22	3.41	45.68	93.054	106.233	0.079
1.75-1.80	43	74.07	32.03	28.77	3.26	42.04	92.804	97.767	0.076
2.25-2.30	43	68.58	31.34	28.84	2.50	37.24	93.709	86.605	0.058
2.80-2.85	43	72.81	32.31	28.84	3.47	40.50	92.108	94.186	0.081
3.25-3.30	43	74.28	31.73	28.60	3.13	42.55	93.148	98.953	0.073
3.70-3.75	43	77.60	33.07	28.63	4.44	44.53	90.933	103.558	0.103

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER NE4
DATE: 1991/6/24

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT (g)	DRY MATTER	WATER (g)	WATER % WT
0.10-0.15	43	60.46	31.85	28.57	3.28	28.61	89.715
0.40-0.45	43	62.16	30.24	27.87	2.37	31.92	93.088
0.65-0.70	43	64.70	30.94	28.63	2.31	33.76	93.596
1.35-1.40	43	76.67	32.35	27.98	4.37	44.32	91.025
1.95-2.00	43	72.70	32.02	28.76	3.26	40.68	92.581
2.40-2.45	43	71.14	32.84	29.81	3.03	38.30	92.669
2.80-2.85	43	75.10	31.94	28.47	3.47	43.16	92.558
3.30-3.35	43	75.02	32.59	28.50	4.09	42.43	91.208
3.70-3.75	43	78.23	33.33	29.02	4.31	44.90	91.242

WATER % VOL	DENSITY (g/cm3)
66.535	0.076
74.233	0.055
78.512	0.054
103.070	0.102
94.605	0.076
89.070	0.070
100.372	0.081
98.674	0.095
104.419	0.100

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER NW4
DATE: 1991/7/8

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.35-0.45	86	138.38	62.14	56.66	5.48	76.24	93.294	88.651	0.064
0.70-0.80	86	130.73	62.45	57.88	4.57	68.28	93.727	79.395	0.053
1.20-1.30	86	134.71	61.99	57.04	4.95	72.72	93.627	84.558	0.058
1.70-1.80	86	142.39	61.99	56.61	5.38	80.40	93.728	93.488	0.063
2.70-2.80	86	149.57	62.67	56.20	6.47	86.90	93.071	101.047	0.075
3.20-3.30	86	153.27	64.91	58.21	6.70	88.36	92.952	102.744	0.078
3.70-3.80	86	150.45	63.26	57.17	6.09	87.19	93.471	101.384	0.071
4.20-4.30	86	152.25	65.66	58.47	7.19	86.59	92.333	100.686	0.084
4.70-4.80	86	141.74	63.00	57.03	5.97	78.74	92.952	91.558	0.069
5.20-5.30	86	147.90	63.70	57.06	6.64	84.20	92.690	97.907	0.077
5.70-5.80	86	147.24	63.40	56.62	6.78	83.84	92.518	97.488	0.079

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER NW5
DATE: 1991/6/24

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT (g)	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.15-0.20	43	66.87	31.65	28.78	2.87	35.22	92.465	81.907	0.067
0.40-0.45	43	72.44	32.09	28.81	3.28	40.35	92.482	93.837	0.076
0.60-0.65	43	72.70	32.74	30.20	2.54	39.96	94.024	92.930	0.059
1.05-1.10	43	72.94	30.50	28.29	2.21	42.44	95.050	98.698	0.051
1.93-1.98	43	68.83	30.91	27.77	3.14	37.92	92.353	88.186	0.073
2.35-2.40	43	70.95	31.63	28.26	3.37	39.32	92.106	91.442	0.078
2.70-2.75	43	75.20	32.08	28.06	4.02	43.12	91.472	100.279	0.093

METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER SW3
DATE: 1991/7/23

DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.30-0.35	43	71.27	31.23	28.32	2.91	40.04	93.225	93.116	0.068
0.70-0.75	43	70.44	31.62	28.81	2.81	38.82	93.250	90.279	0.065
1.15-1.20	43	76.33	31.38	28.51	2.87	44.95	93.998	104.535	0.067
1.75-1.80	43	71.63	31.74	29.52	2.22	39.89	94.728	92.767	0.052
2.25-2.30	43	70.35	31.61	28.97	2.64	38.74	93.620	90.093	0.061
2.75-2.80	43	74.06	32.50	28.80	3.70	41.56	91.825	96.651	0.086
3.20-3.25	43	76.84	31.89	28.30	3.59	44.95	92.604	104.535	0.083
3.85-3.90	43	71.74	30.84	27.11	3.73	40.90	91.642	95.116	0.087
4.35-4.40	43	71.08	31.46	27.98	3.48	39.62	91.926	92.140	0.081
4.75-4.80	43	70.53	31.55	28.74	2.81	38.98	93.276	90.651	0.065
5.22-5.27	43	69.72	31.01	28.07	2.94	38.71	92.941	90.023	0.068
5.90-5.95	43	67.73	31.61	28.49	3.12	36.12	92.049	84.000	0.073
6.25-6.30	43	72.91	31.34	27.79	3.55	41.57	92.132	96.674	0.083

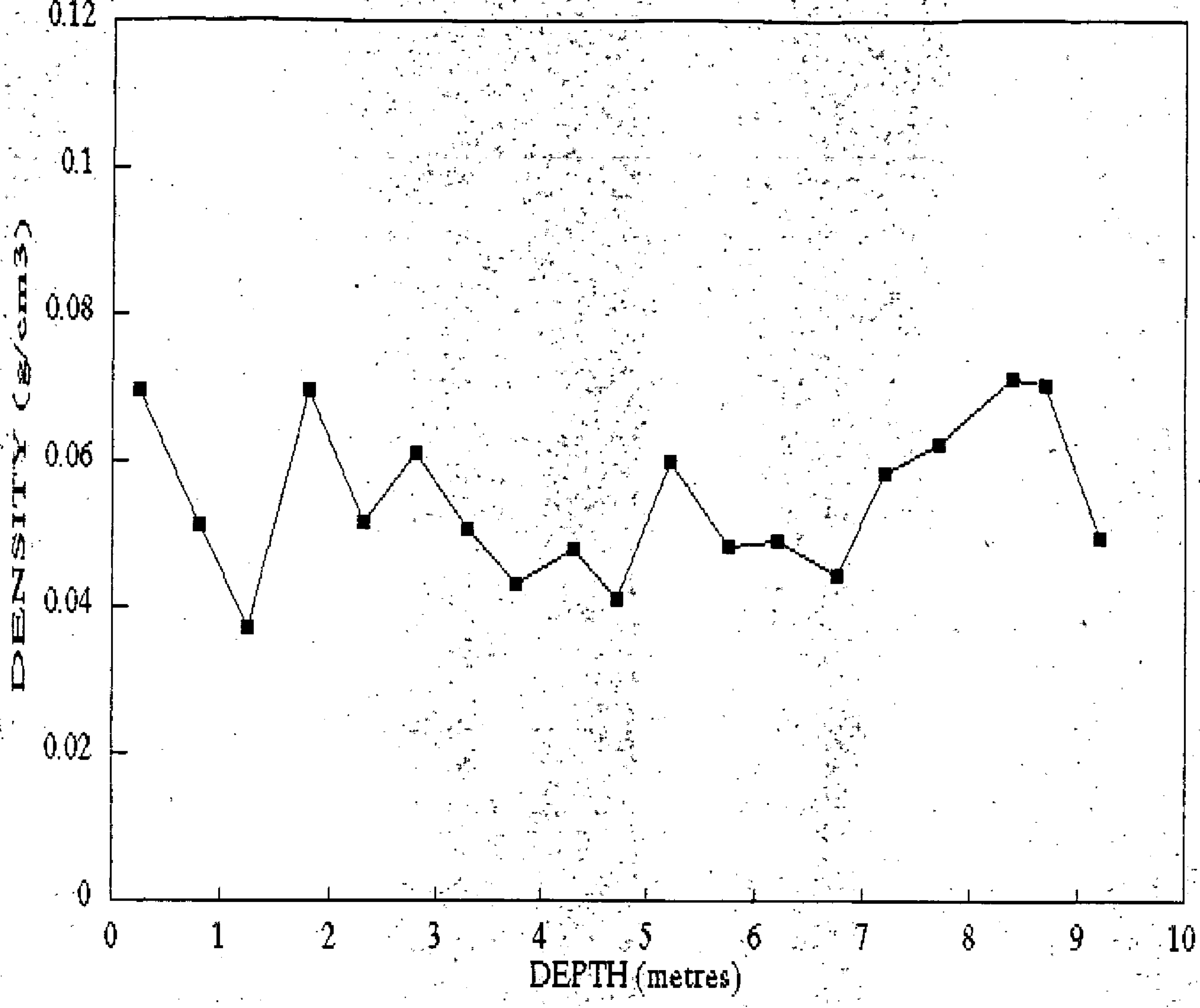
METHOD: DRILLING WITH A PEAT AUGER
PLACE: CLARA, PIEZOMETER SW5
DATE: 1991/7/9

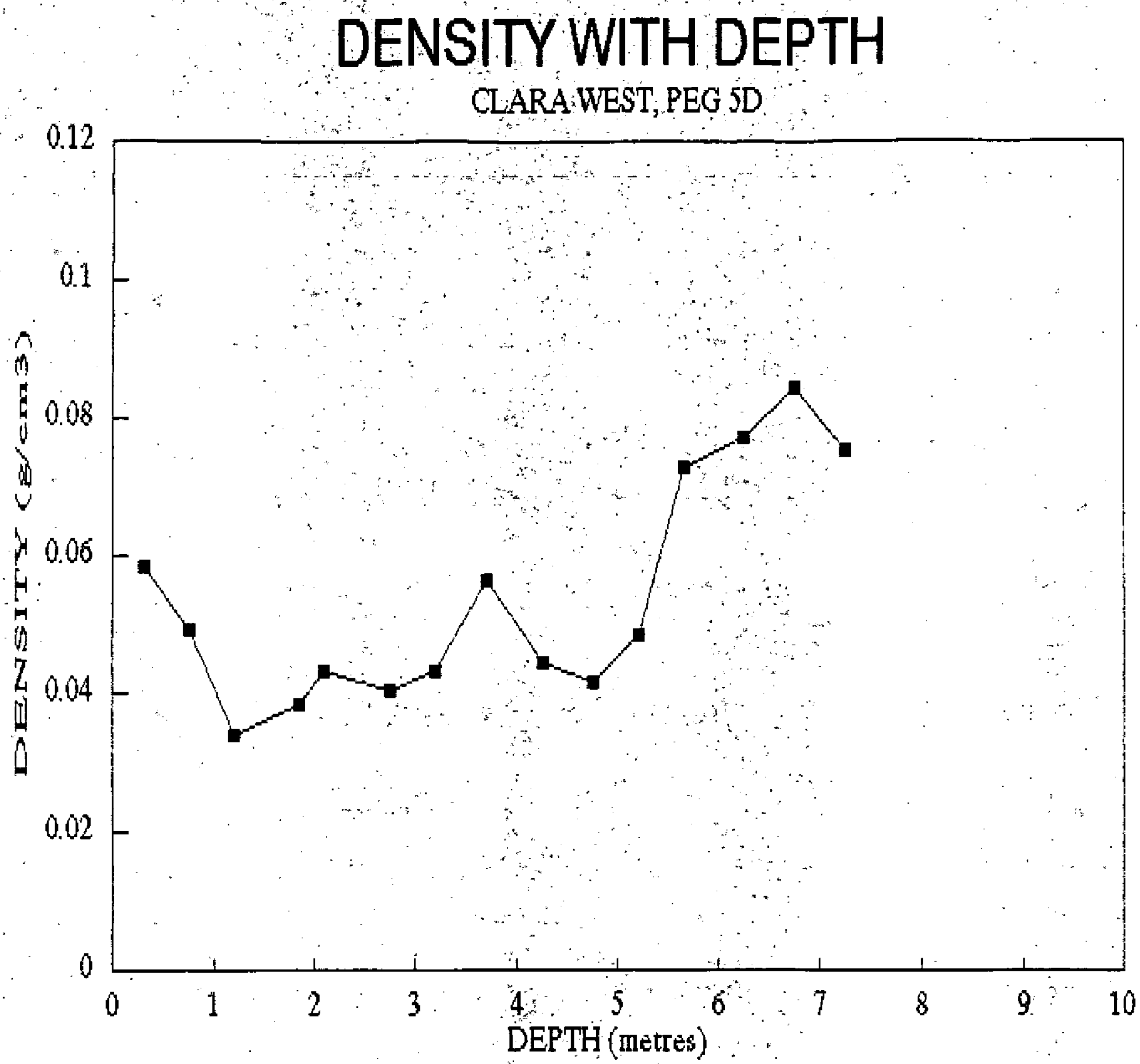
DEPTH (M)	VOLUME (cm3)	WET WT (g)	DRY WT (g)	BOX WT	DRY MATTER	WATER (g)	WATER % WT	WATER % VOL	DENSITY (g/cm3)
0.80-0.90	86	143.54	65.41	57.20	8.21	78.13	90.491	90.849	0.095
1.40-1.48	69	125.27	63.56	57.11	6.45	61.71	90.537	89.435	0.093
1.65-1.75	86	148.59	62.70	54.12	8.58	85.89	90.918	99.872	0.100
2.15-2.25	86	147.86	63.99	56.76	7.23	83.87	92.064	97.523	0.084
2.75-2.85	86	144.70	63.44	57.49	5.95	81.26	93.177	94.488	0.069
3.15-3.25	86	141.65	64.48	57.37	7.11	77.17	91.564	89.733	0.083
3.85-3.95	86	144.68	64.26	57.53	6.73	80.42	92.278	93.512	0.078

APPENDIX: A10

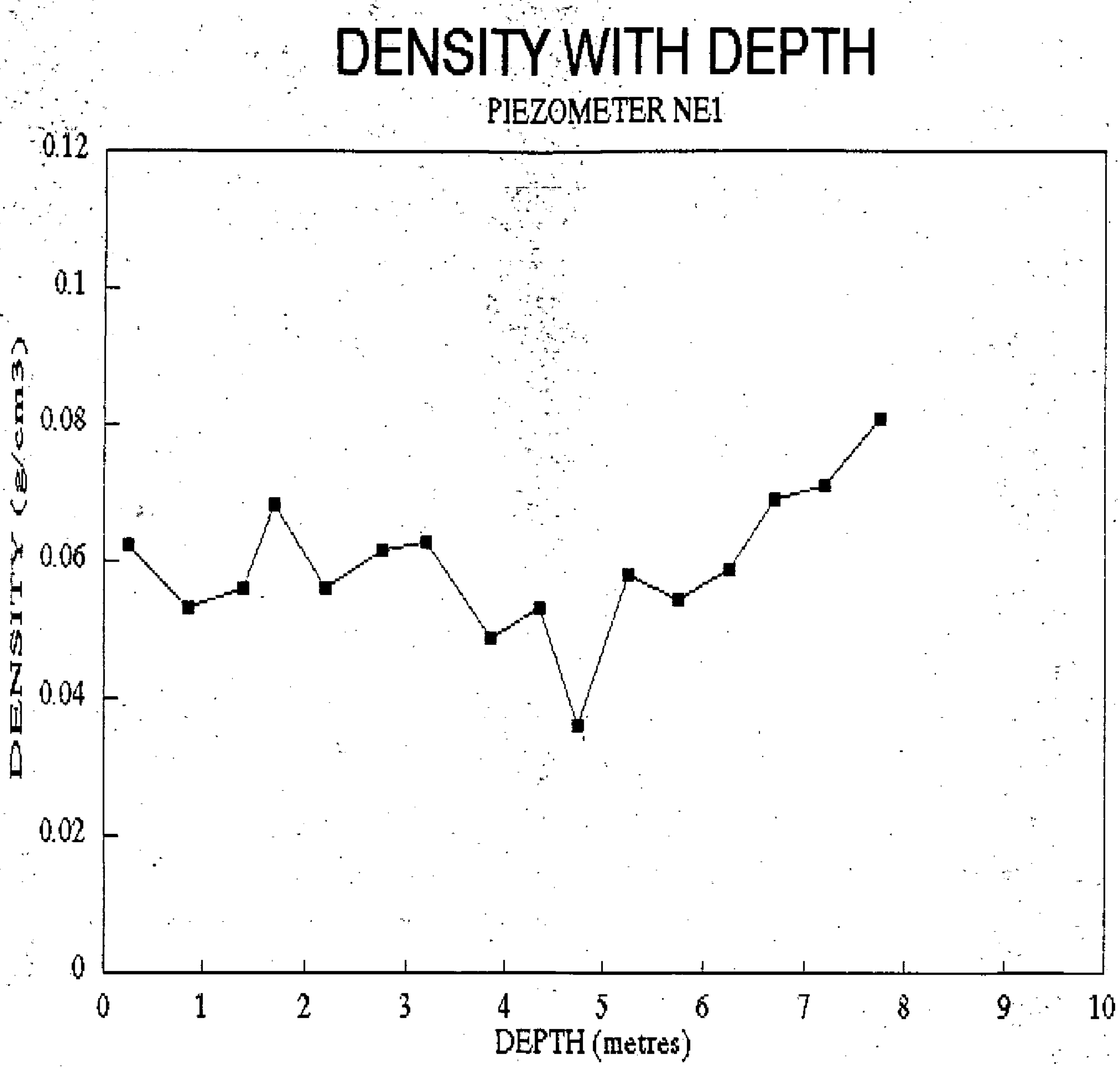
DENSITY WITH DEPTH

CLARA EAST, PEG 5E





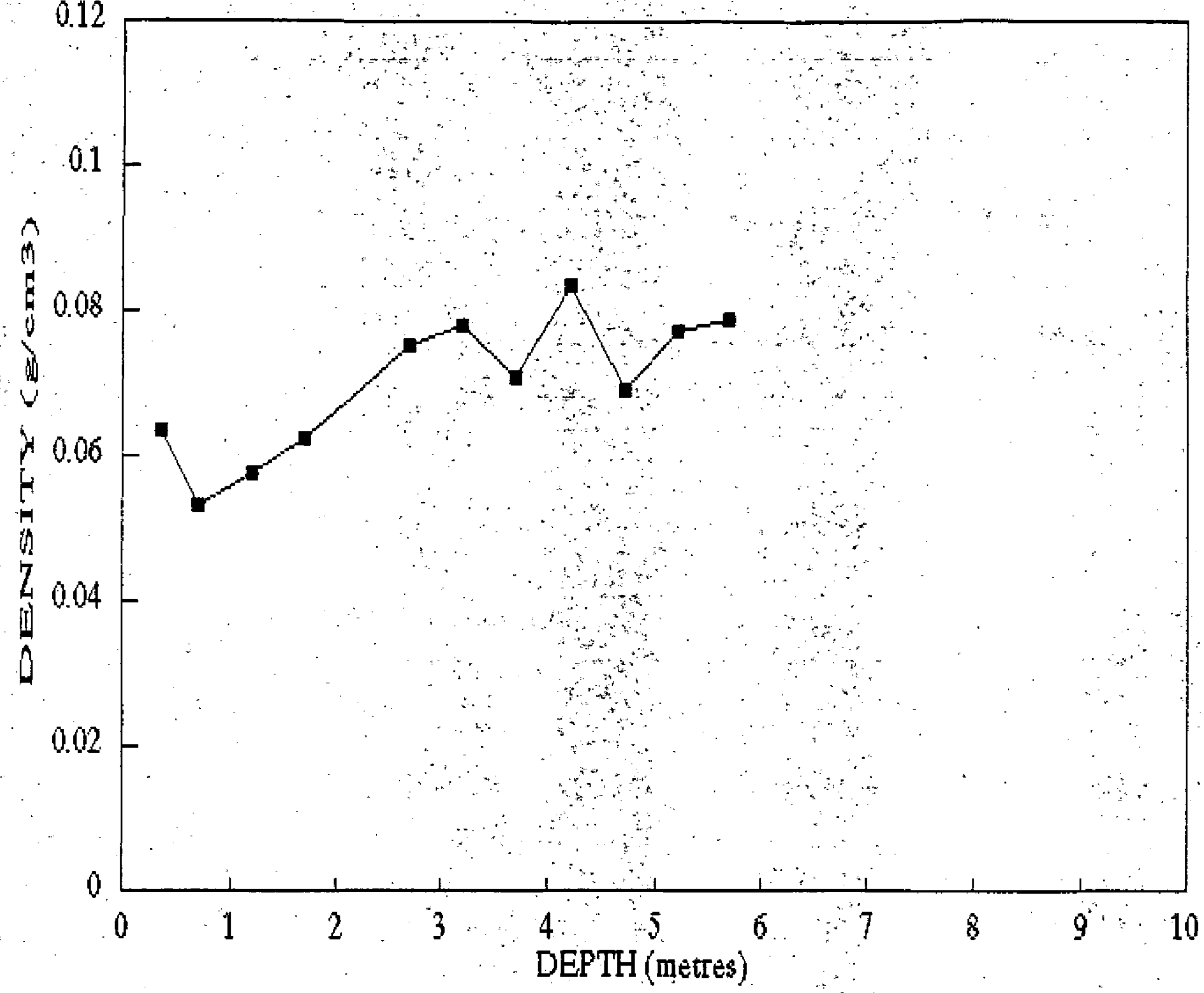
DENSITY WITH DEPTH
CLARA WEST, PEG 5D
DENSITY (g/cm3)
0.12
0.1
0.08
0.06
0.04
0.02
0
0
1
2
3
4
5
6
7
8
9
10
DEPTH (metres)

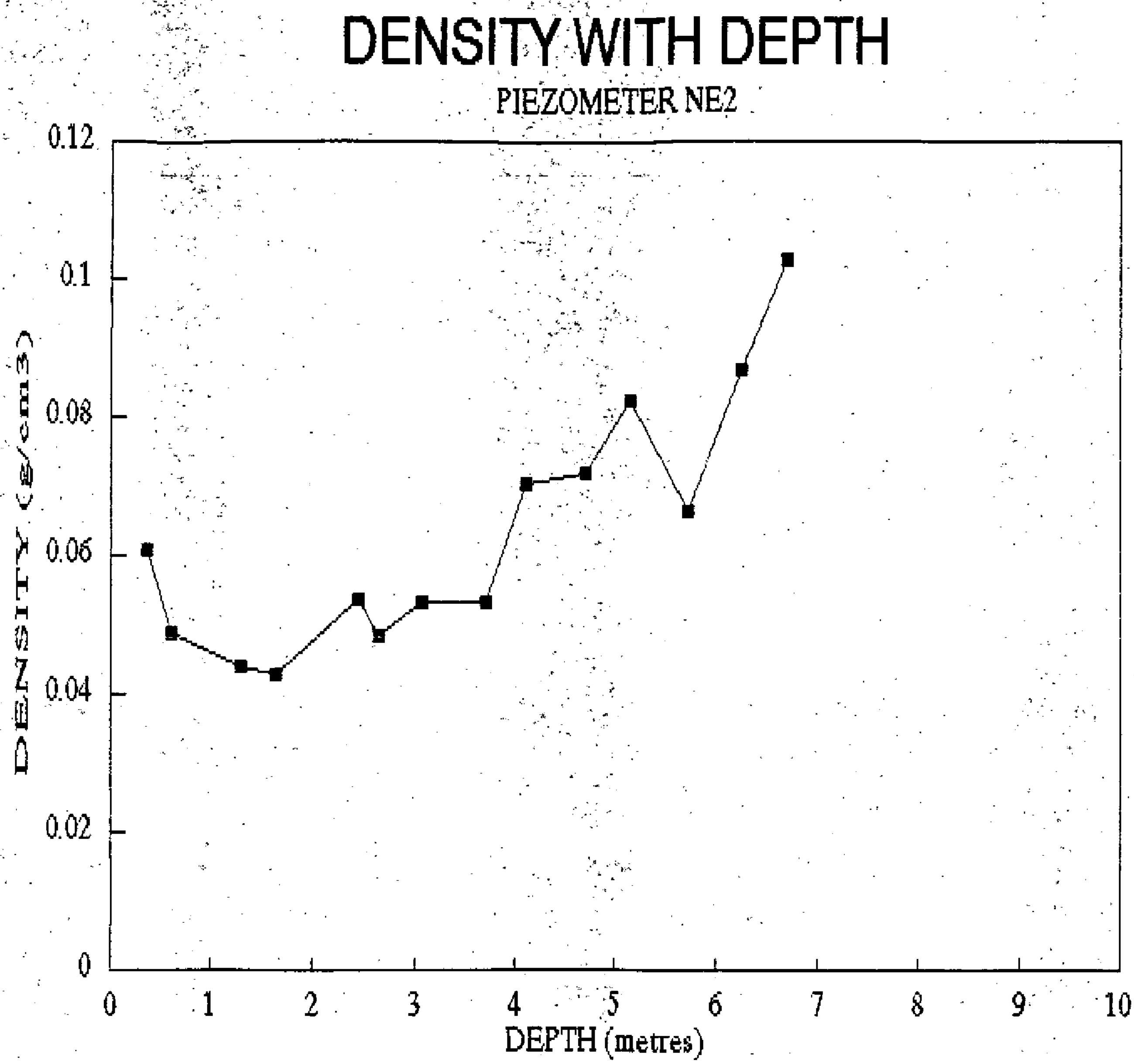


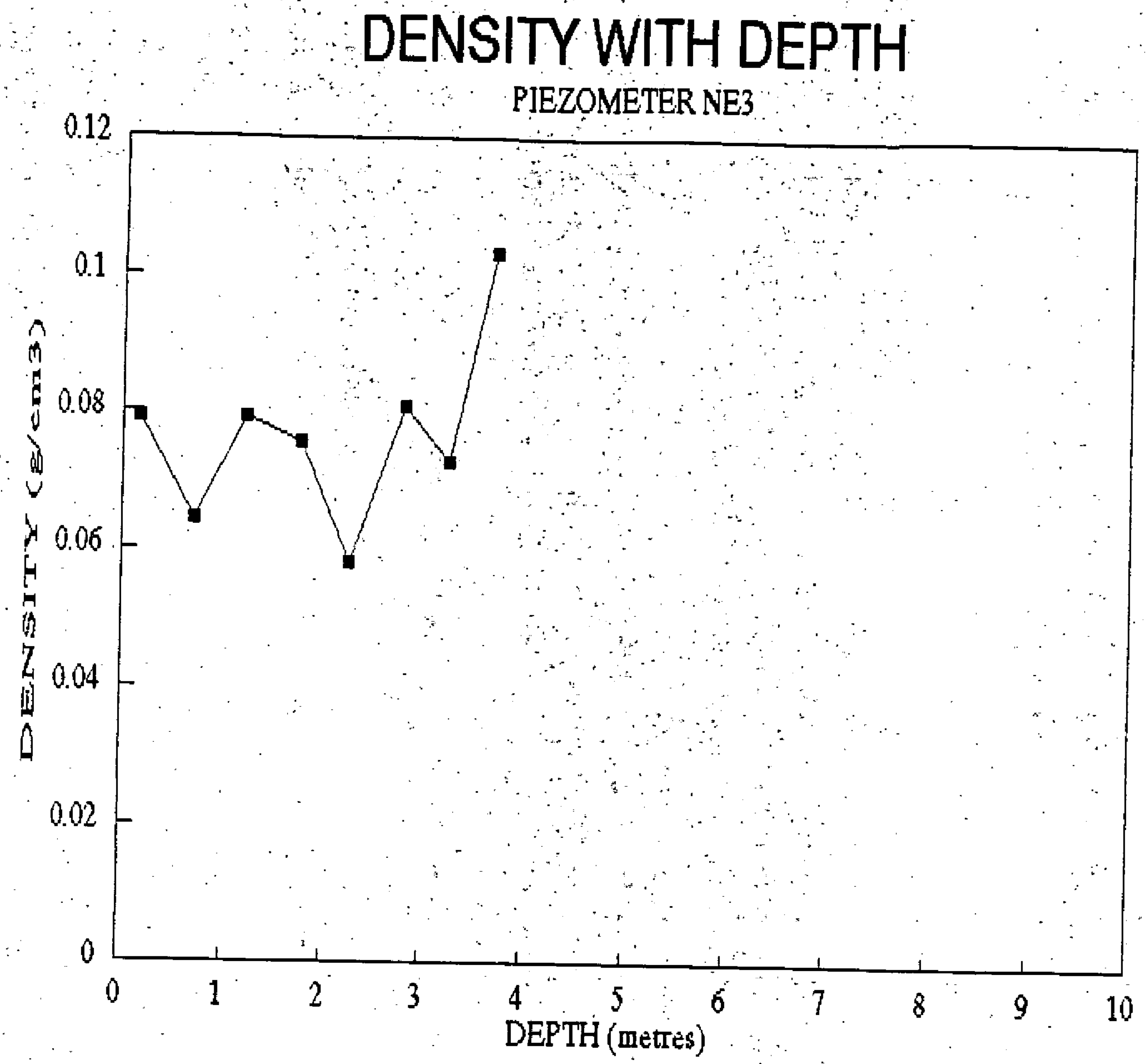
DENSITY WITH DEPTH
PIEZOMETER NE1
DENSITY (g/cm3)
0.12
0.1
0.08
0.06
0.04
0.02
0
0
1
2
3
4
5
6
7
8
9
10
DEPTH (metres)

DENSITY WITH DEPTH

PIEZOMETER NW4

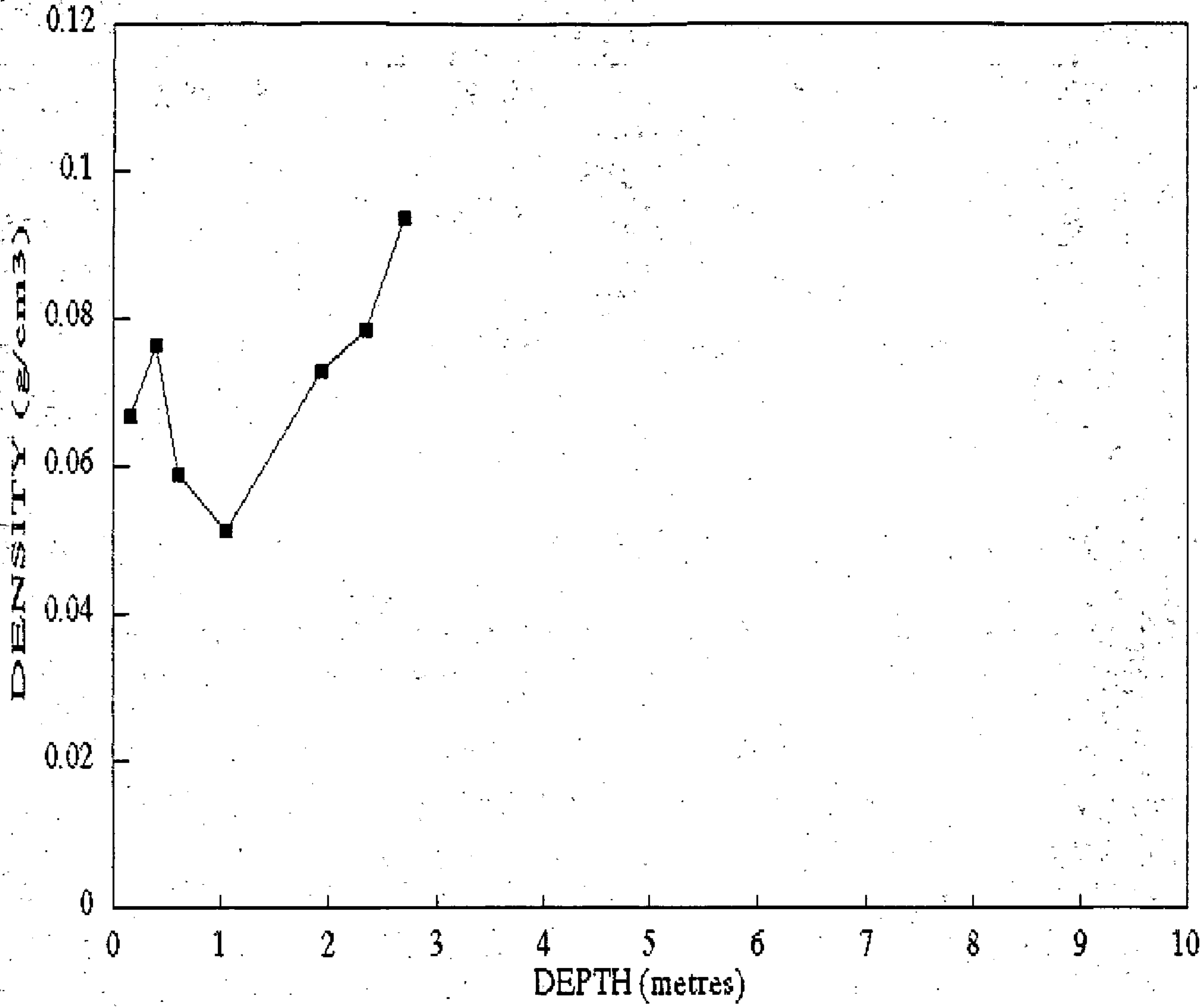



DENSITY WITH DEPTH
PIEZOMETER NE2
0.12
0.1
0.08
0.06
0.04
0.02
0
DENSITY (g/cm3)
0
1
2
3
4
5
6
7
8
9
10
DEPTH (metres)


DENSITY WITH DEPTH
PIEZOMETER NE3
DENSITY (g/cm3)
0.12
0.1
0.08
0.06
0.04
0.02
0
0
1
2
3
4
5
6
7
8
9
10
DEPTH (metres)

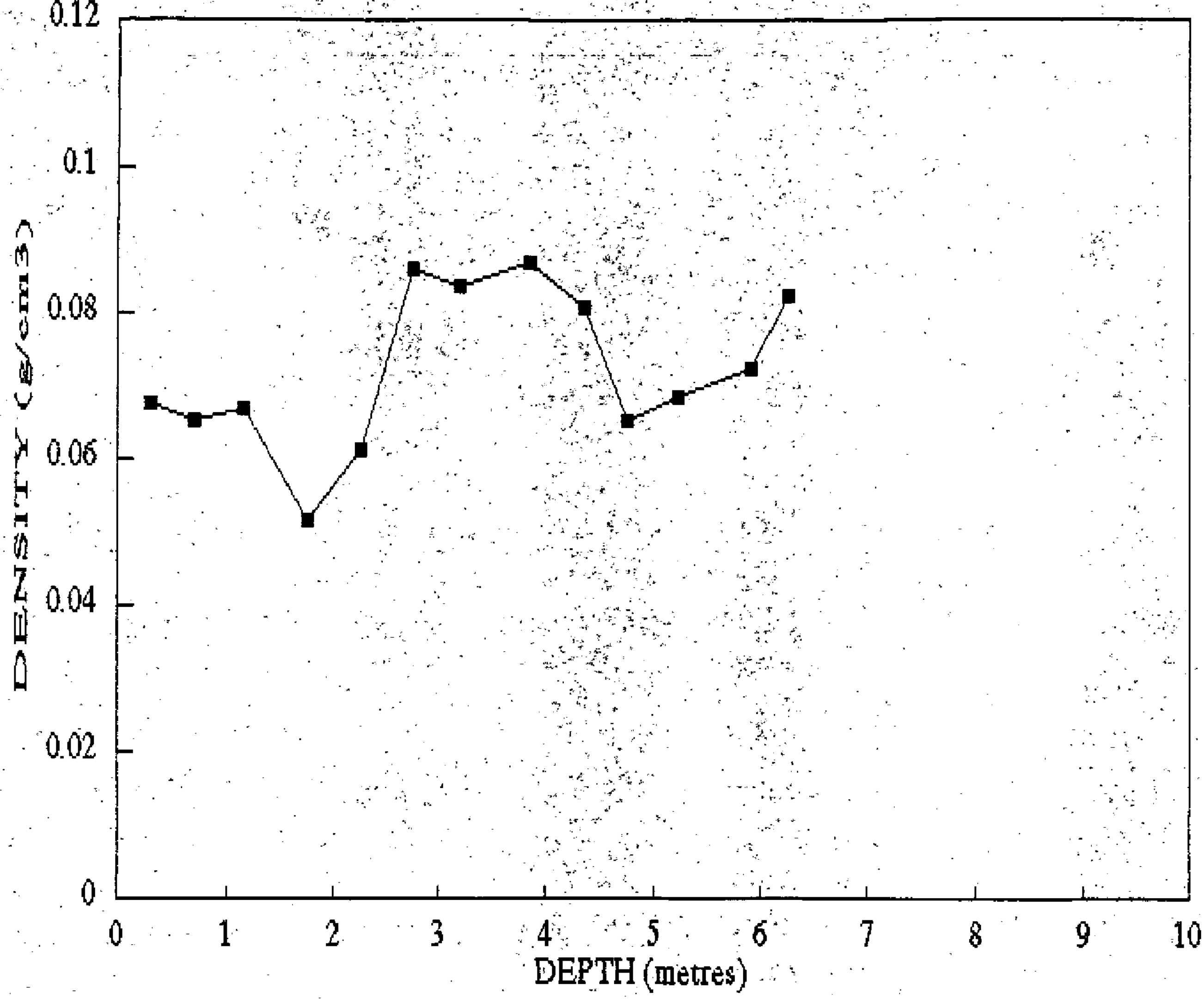
DENSITY WITH DEPTH

PIEZOMETER NW5



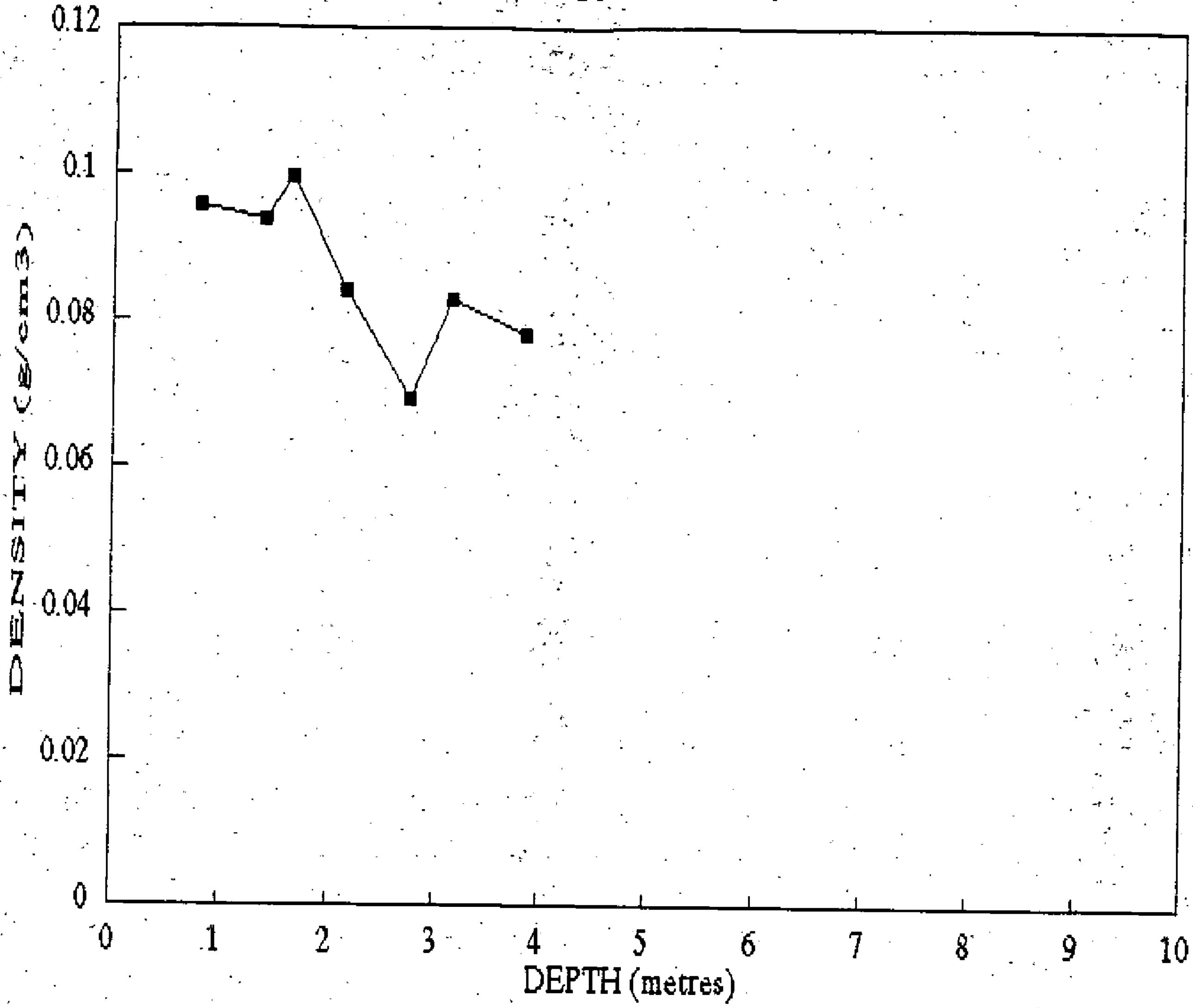
DENSITY WITH DEPTH

PIEZOMETER SW3



DENSITY WITH DEPTH

PIEZOMETER SW5



APPENDIX: A11

SURVEYING THE DRAINS BY THE NEW ROAD, 1991
(M.O.D.)

STATION NUMBER : 100

WEST DRAIN WIDTH: 1.2 m			EAST DRAIN WIDTH: 0.7 m		
WEST	MIDDLE	EAST	WEST	MIDDLE	EAST
56.147	56.082	56.172	55.932	55.447	55.797

STATION NUMBER : 200

WEST DRAIN WIDTH: 1.6 m			EAST DRAIN WIDTH: 1.0 m		
WEST	MIDDLE	EAST	WEST	MIDDLE	EAST
56.02	55.715	55.815	55.75	55.08	55.385

STATION NUMBER : 300

WEST DRAIN WIDTH: 1.5 m			EAST DRAIN WIDTH: 0.7 m		
WEST	MIDDLE	EAST	WEST	MIDDLE	EAST
55.635	54.855	55.68	55.343	54.945	55.685

STATION NUMBER : 400

WEST DRAIN WIDTH: 1.2 m			EAST DRAIN WIDTH: 1.0 m		
WEST	MIDDLE	EAST	WEST	MIDDLE	EAST
55.61	55.23	55.61	55.188	54.425	54.98

STATION NUMBER : 500

WEST DRAIN WIDTH: 0.7 m			EAST DRAIN WIDTH: 0.6 m		
WEST	MIDDLE	EAST	WEST	MIDDLE	EAST
55.127	54.45	55.105	54.333	53.895	54.37

STATION NUMBER : 600

WEST DRAIN WIDTH: 0.5 m			EAST DRAIN WIDTH: 0.6 m		
WEST	MIDDLE	EAST	WEST	MIDDLE	EAST
55.08	54.618	54.955	54.37	53.582	54.538

STATION NUMBER : 700

WEST DRAIN WIDTH: 0.6 m			EAST DRAIN INACCESSIBLE		
WEST	MIDDLE	EAST			
54.22	53.53	54.345			

STATION NUMBER : 800

WEST DRAIN WIDTH: 0.7 m

WEST	MIDDLE	EAST
53.868	53.227	54.003

EAST DRAIN WIDTH: 0.5 m

WEST	MIDDLE	EAST
52.953	52.01	53.258

STATION NUMBER : 900

WEST DRAIN WIDTH: 0.4 m

WEST	MIDDLE	EAST
53.292	52.919	53.356

EAST DRAIN WIDTH: 0.5 m

WEST	MIDDLE	EAST
53.022	51.442	52.972

STATION NUMBER : 1000

WEST DRAIN WIDTH: 0.9 m

WEST	MIDDLE	EAST
53.115	52.208	52.936

EAST DRAIN WIDTH: 1.0 m

WEST	MIDDLE	EAST
52.838	51.364	52.24

STATION NUMBER : 1100

WEST DRAIN WIDTH: 0.7 m

WEST	MIDDLE	EAST
51.818	51.162	51.79

EAST DRAIN WIDTH: 1.0 m

WEST	MIDDLE	EAST
52.136	50.431	52.657

STATION NUMBER : 1200

WEST DRAIN WIDTH: 1.0 m

WEST	MIDDLE	EAST
52.37	51.743	52.514

EAST DRAIN WIDTH: 1.5 m

WEST	MIDDLE	EAST
52.005	51.181	51.973

STATION NUMBER : 1300

WEST DRAIN WIDTH: 0.8 m

WEST	MIDDLE	EAST
52.123	51.64	52.443

EAST DRAIN WIDTH: 2.5 m

WEST	MIDDLE	EAST
51.864	50.922	51.494

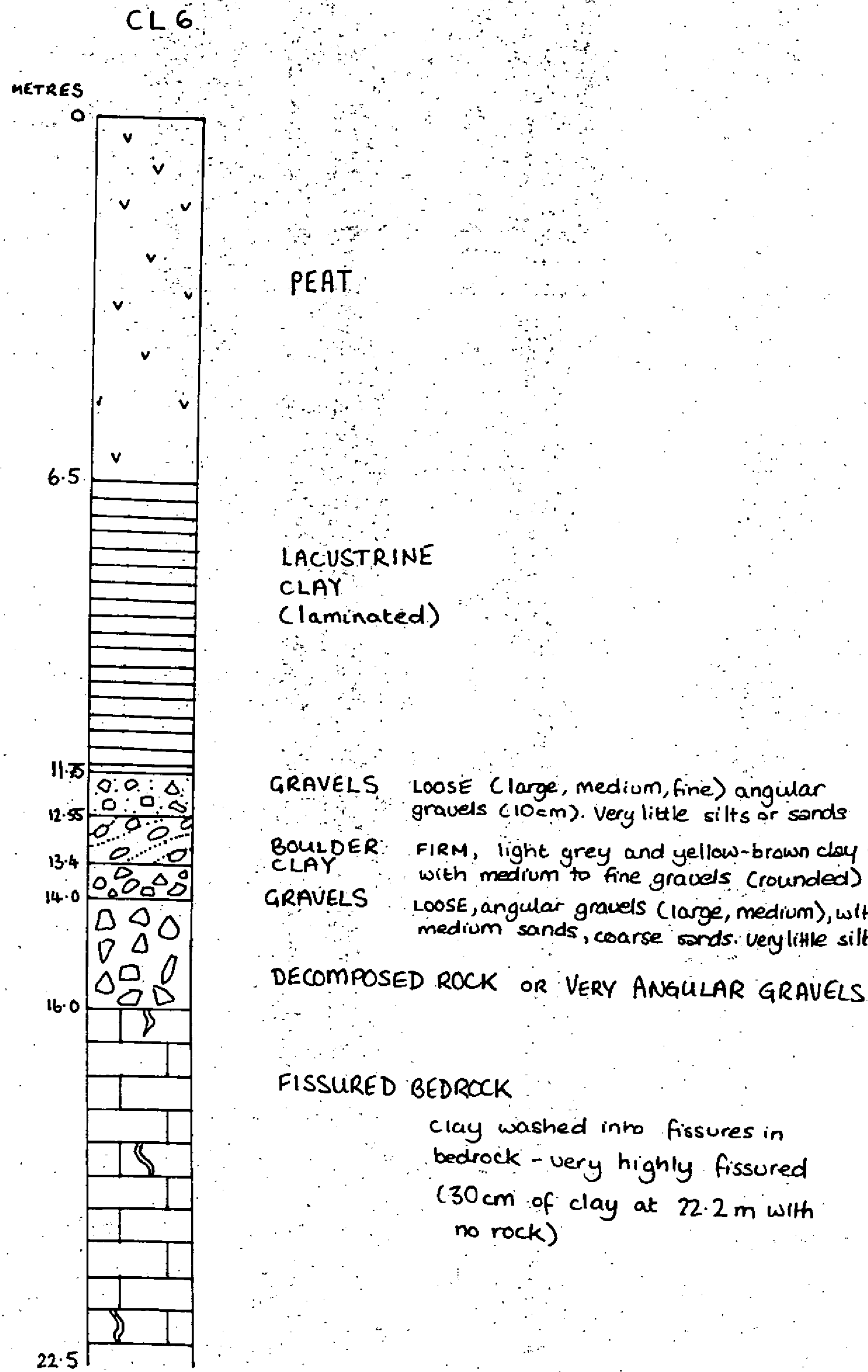
STATION NUMBER : 1400

WEST DRAIN WIDTH: 1.4 m

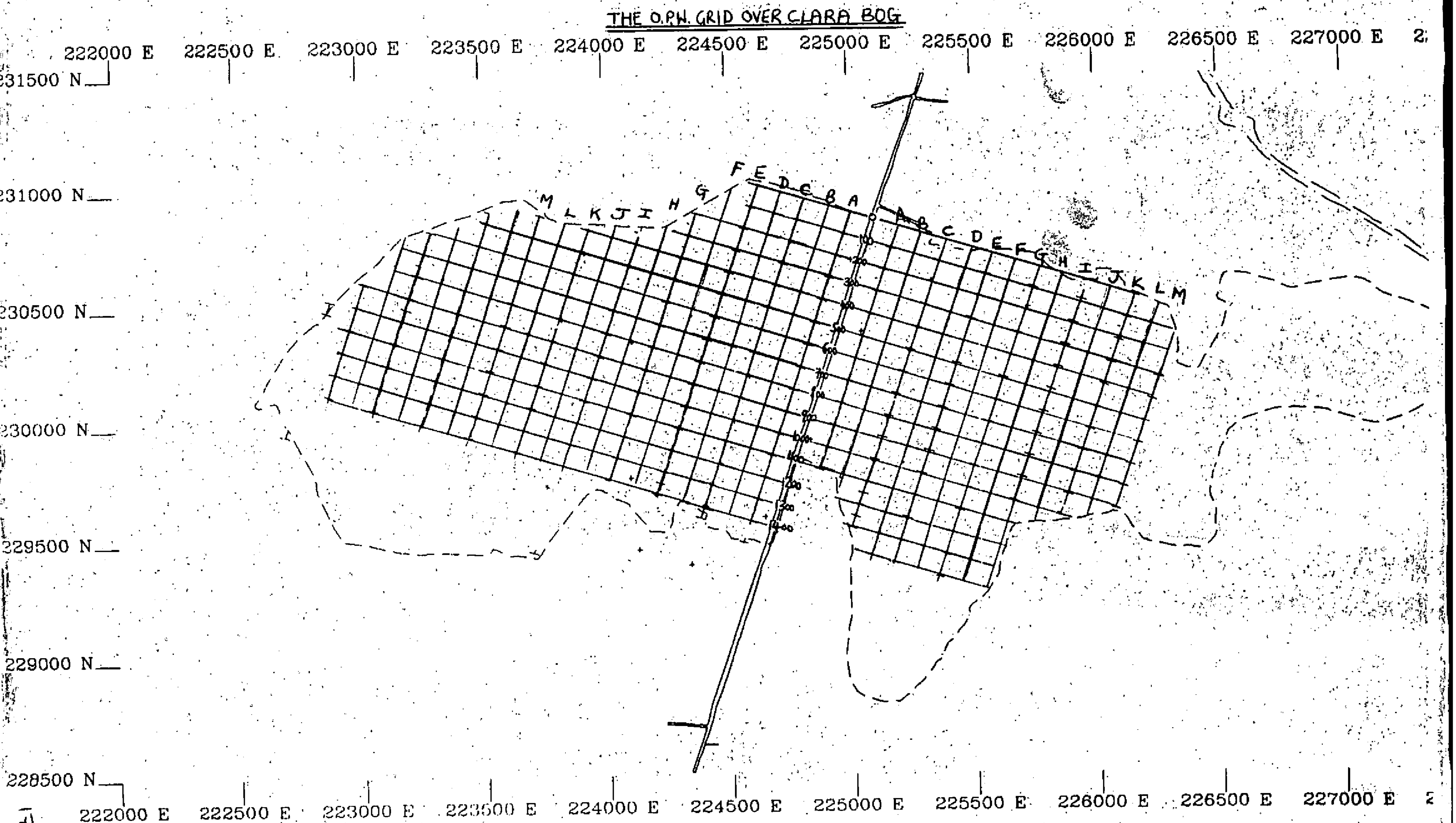
WEST	MIDDLE	EAST
52.37	51.468	52.366

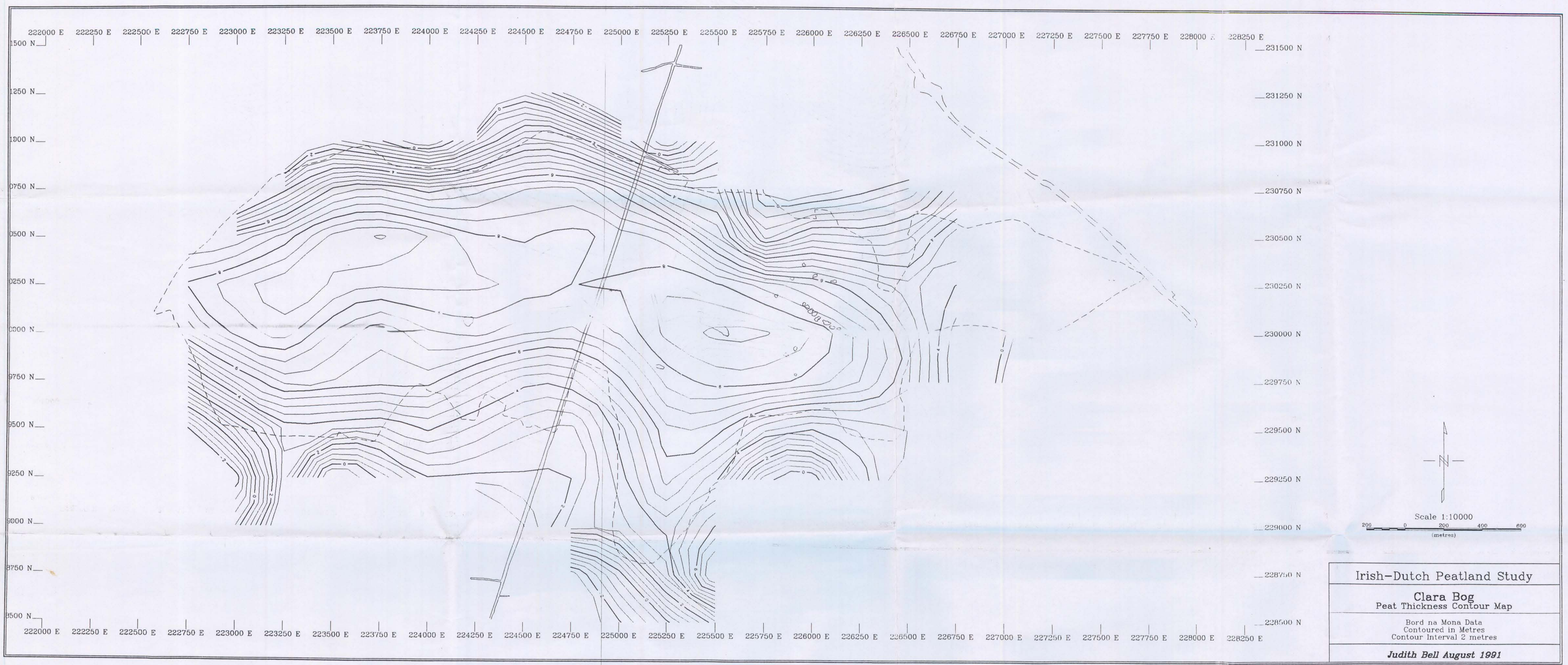
EAST DRAIN INACCESSIBLE

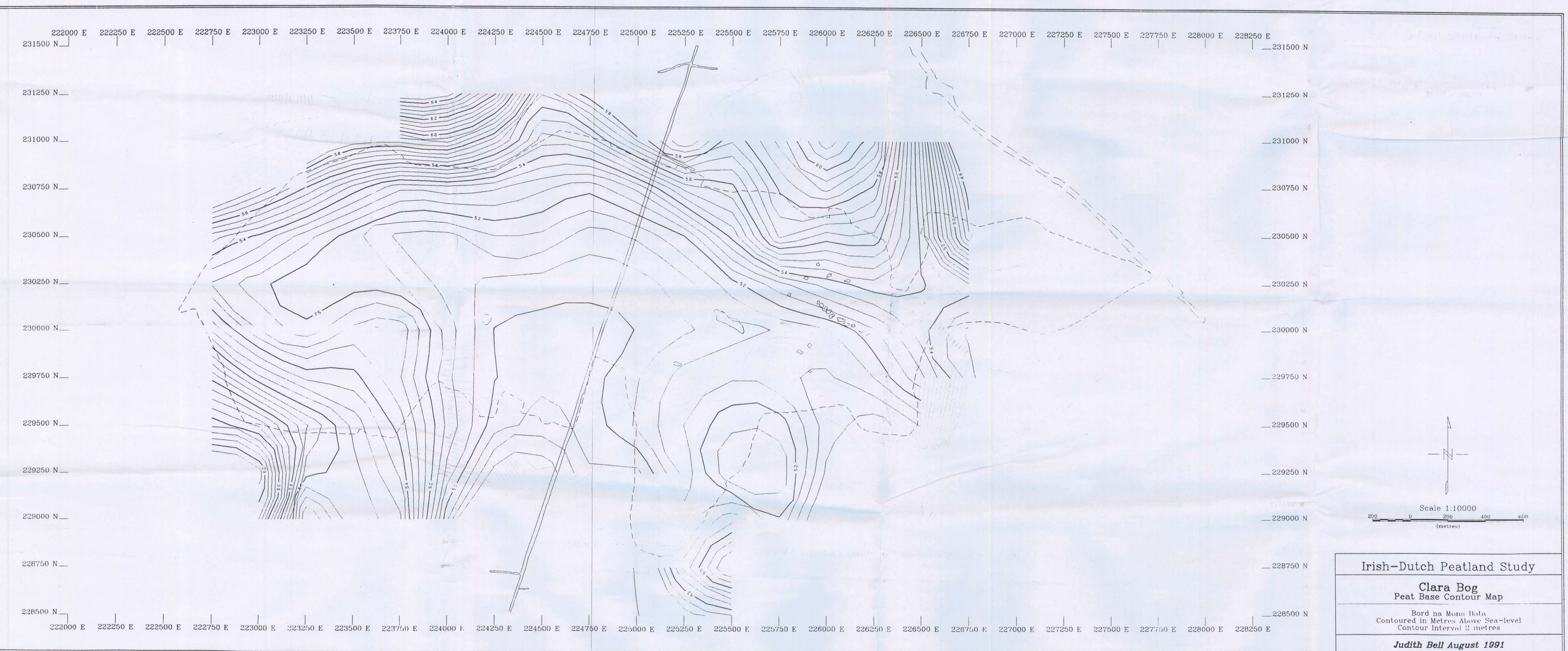
APPENDIX:A12

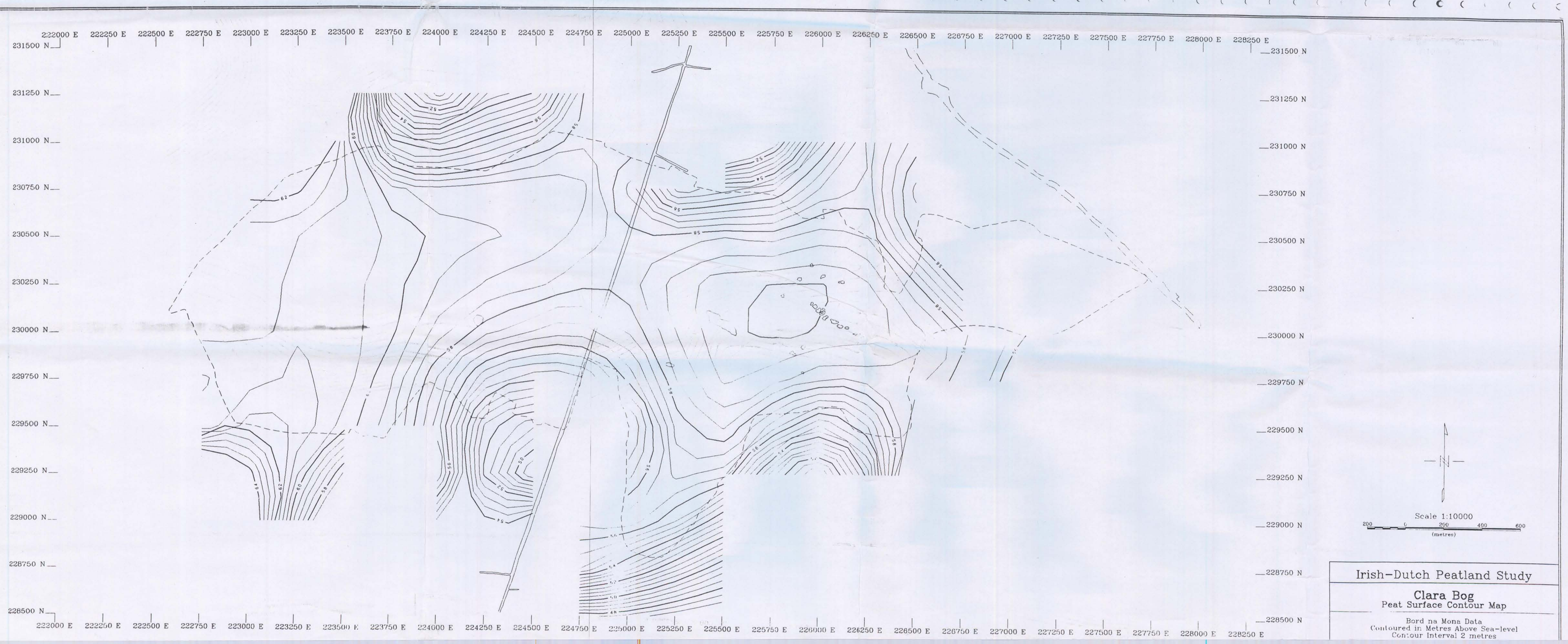

CL 6
METRES
0
6·5
11·75
12·55
13·4
14·0
16·0
22·5
PEAT
LACUSTRINE CLAY (laminated)
GRAVELS
LOOSE (large, medium, fine) angular gravels (10cm). Very little silts or sands
BOULDER CLAY
FIRM, light grey and yellow-brown clay with medium to fine gravels (rounded)
GRAVELS
LOOSE, angular gravels (large, medium), with medium sands, coarse sands. Very little silt
DECOMPOSED ROCK OR VERY ANGULAR GRAVELS
FISSURED BEDROCK
Clay washed into fissures in bedrock - very highly fissured (30cm of clay at 22·2m with no rock)

APPENDIX: A13


THE O.P.W. GRID OVER CLARA BOG
222000 E
222500 E
223000 E
223500 E
224000 E
224500 E
225000 E
225500 E
226000 E
226500 E
227000 E
231500 N
231000 N
230500 N
230000 N
229500 N
229000 N
228500 N
F E D C B A
M L K J I H G
A B C D E F G H I J K L M


Scale 1:10000
Irish–Dutch Peatland Study
Clara Bog
Peat Thickness Contour Map
Bord na Mona Data
Contoured in Metres
Contour Interval 2 metres
Judith Bell August 1991


Scale 1:10000
Irish–Dutch Peatland Study
Clara Bog
Peat Base Contour Map
Bord na Mona Data
Contoured in Metres Above Sea-level
Contour Interval 2 metres
Judith Bell August 1991


Scale 1:10000
Irish–Dutch Peatland Study
Clara Bog
Peat Surface Contour Map
Bord na Mona Data
Contoured in Metres Above Sea-level
Contour Interval 2 metres