

**Flood Risk Management Research Consortium  
Land Use and Management  
Multi-Scale Experimental Programme  
Pontbren Catchment Study Database Catalogue**



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## **Introduction to the Database Catalogue**

This provides a description of the Pontbren Database including details of the instrumentation used to provide the data.

Data files are ordered into directories, the framework of which is provided below. Where Quality assured data is provided, each point will have a quality assurance code, details of which are provided in the Appendices. Most data are provided in .txt files generally split into 6 month blocks, January-June and July-December. However, there are times when the data is split differently, at the start or end of data set or when the sampling frequency is such that the number of rows exceeds what can be opened in excel. The name of the text file will generally indicate the dates between which the data has been collected from.

Where necessary a description of the folder and its contents are provided in this catalogue.

Appendices are also included providing supplementary information which may be of use for the database user.

## **Database framework**

This simply illustrates how the folders and subfolders are laid out within the data base.

## **Quality Assured**

### **AWS**

#### **Bowl study site runoff and soil water tension data**

*Bowl runoff*

Bowl runoff weir box

Bowl drain flow weir box

Bowl overland flow weir box

Bowl drain flow tipping bucket

Bowl overland flow tipping bucket

*Bowl Tensiometers*

#### **Groundwater**

*Borehole1*

*Borehole2*

*Borehole3*

*Borehole4*

*Borehole5*

#### **Hillslope study site runoff soil water tension data**

*Hillslope runoff weir box*

Hillslope drain flow weir box

Hillslope overland flow weir box

*Hillslope tensiometers*

*Tree shelterbelt overland flow*

#### **Llyn Hir study site soil water tension data**

#### **Land use manipulation plot data**

*Manipulation plot1*

Manipulation plot1 tensiometer

Manipulation plot1 overland flow

*Manipulation plot2*

Manipulation plot2 tensiometer

Manipulation plot2 overland flow

*Manipulation plot3*

Manipulation plot3 tensiometer  
Manipulation plot3 overland flow

*Manipulation plot4*

Manipulation plot4 tensiometer  
Manipulation plot4 overland flow

**Neutron probe soil moisture data**

**Rain gauge data**

*Bowl*  
*Hirrhos Uchaf*  
*Llyn\_Hir*  
*Penllwyn*  
*Quarry*  
*Rhos1*

**Field Diaries**

**Streamflow**

*Site1*  
*Site2*  
*Site3*  
*Site4*  
*Site5*  
*Site6*  
*Site7*  
*Site8*  
*Site9*  
*Site10*  
*Site11*  
*Site12*  
*Site13*

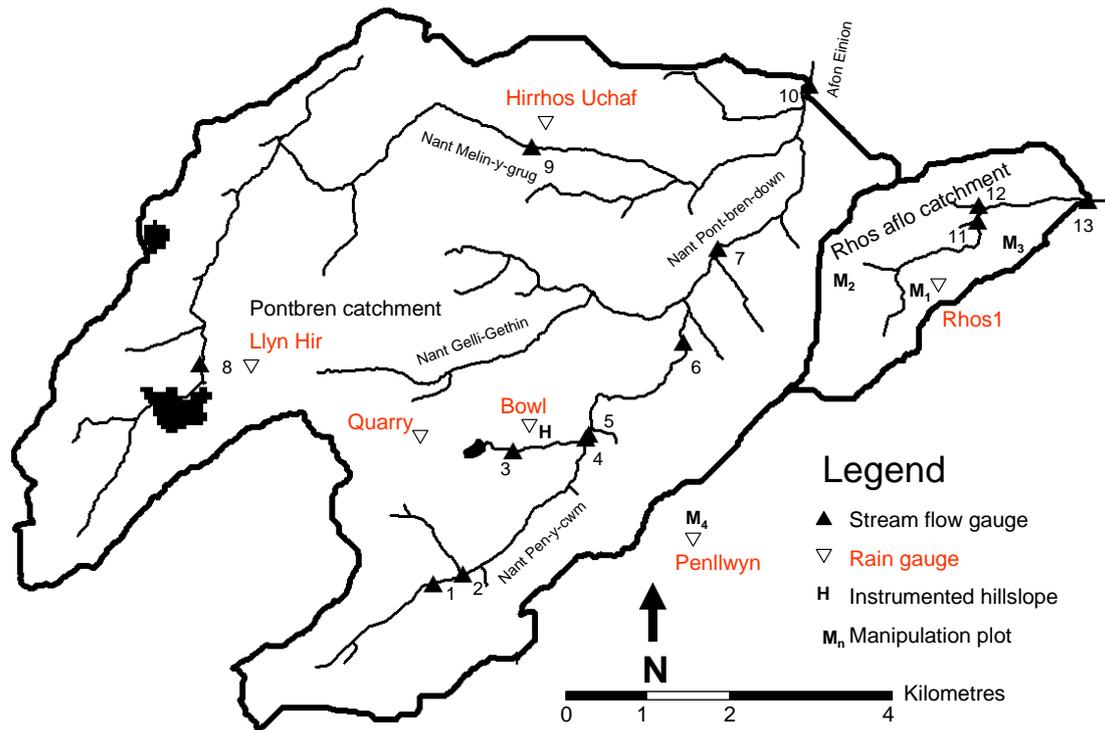


Figure 1. Showing the instrument locations across the Pontbren study site.

## 1. AWS

The data in this folder are from the automatic weather station, AWS, located at the bowl within the instrumented hillslope (See Figs. 1 and 2). All sensors are sampled every 1 minute and provided in the form of daily and 10 minute averages. Table 1 details headings and measurement readings. In the daily data files daily maximum and daily minimum values are given for some measurements as well as the daily average. Standard deviation is also given for the wind direction.

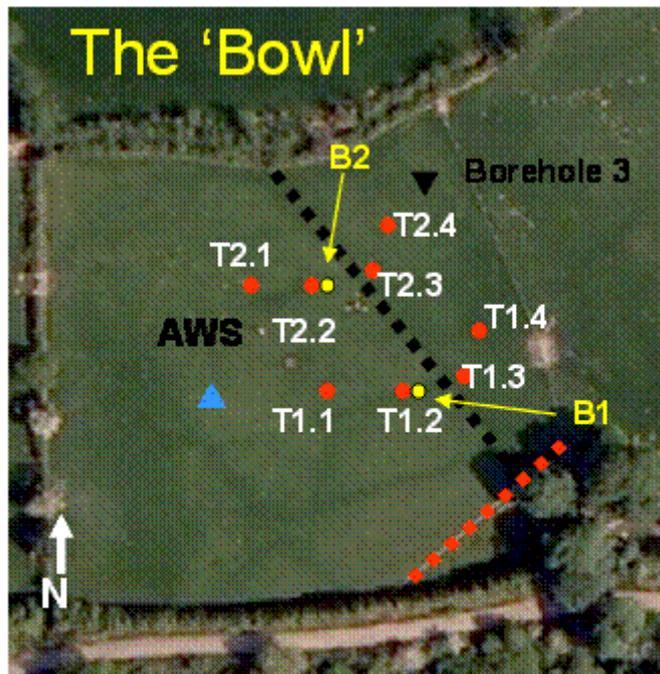
Table 1. AWS data file headings.

Column heading	Measurement	Units
Incident rad.	Incident radiation	$\text{Wm}^{-2}$
Wind speed	Wind speed	$\text{ms}^{-1}$
Wind dir.	Wind direction	Degrees (0 – 359)
Soil Temp.	Soil temperature	$^{\circ}\text{C}$
Rel. Humidity	Relative humidity	%
Air Temp.	Air temperature	$^{\circ}\text{C}$
Net. Rad.	Net Radiation	$\text{Wm}^{-2}$

Note in AWS files from 2009 extra columns appear titled ‘Ave. Rel Humidity 2’ and ‘Ave. Air Temp. 2’. These extra columns exist because a new temp. / relative humidity sensor was installed at the same time as the original because of concerns that the original was not measuring the relative humidity correctly.

## 2. Bowl study site runoff and soil water tension data

The data in this folder includes all data collected from the bowl study site except that from the AWS, tipping bucket rain gauge, borehole and neutron probe monitoring. Figure 2 details the instrumentation set up. The data are divided into runoff and tensiometer data. The runoff data are further divided into that collected using the weir boxes and the tipping buckets.



Key: **AWS** Automatic weather station; ▲  
Rain gauge; ■■■ Overland flow trap;  
--- Instrumented drain; ● Tensiometer array;  
● neutron probe access tube; ▼ borehole;

Figure 2. Showing the Bowl study site instrumentation locations.

### 2.1 Bowl runoff

This folder includes all runoff data from the bowl study site within the instrumented hillslope.

#### 2.1.1 Bowl runoff weir box

This contains data collected from the weir box systems at the bowl study site. Both weir boxes have pressure transducers installed in stilling wells connected to the weir box system and the height of water above a 90° weir was measured. Pressure transducers are both connected to a central logger and measurements were initially sampled every 10 seconds and the average logged every 1 minute. Latterly measurements were sampled every 10 seconds and averaged every 5 minutes. Because of evaporation, water within the weir boxes sometimes drops below the level of the weir. When estimates of water height in relation to the bottom of the weir become increasingly negative it is assumed that no flow is occurring. When there is an increase in the water height but it still below the bottom of the weir, the change in volume within the weir box/unit time is used as an estimate of flow.

Flow is given in litres/second,  $l s^{-1}$ .

### 2.1.1.1 Bowl drain flow weir box

This folder contains data from the weir box for which drain water from a 0.44 ha estimated drainage area of the bowl study site flows through.

### 2.1.1.2 Bowl overland flow weir box

This folder contains data from the weir box for which overland flow water collected from an estimated 0.36 ha area of the bowl study site flows through.

### 2.1.2 Bowl drain flow tipping bucket

This folder contains data collected from a tipping bucket system for which drain water from a 0.44 ha estimated drainage area of the bowl study site flows through. Once water has flowed through the weir box system described in 2.1.1.1 it is routed through the tipping bucket system which provides another estimate of drain flow.

Flow is given in litres/second. However, differences in sampling time occurred throughout the monitoring period due to logger limitations. Changes in sampling time can be found by examining specific data files. Changes in the size of the bucket also occurred during the monitoring period. It is considered that the weir boxes provide a more accurate prediction of the highest flows, however there are times when they are not operation.

### 2.1.3 Bowl overland flow tipping bucket

This folder contains data collected from a tipping bucket system for which overland flow water from a 0.36 ha estimated drainage area of the bowl study site flows through. Once water has flowed through the weir box system described in 2.1.1.2 it is routed through the tipping bucket system which provides another estimate of overland flow.

Flow is given in litres/second. However, differences in sampling time occurred throughout the monitoring period due to logger limitations. Changes in sampling time can be found by examining specific data files. Changes in the size of the bucket also occurred during the monitoring period. It is considered that the weir boxes provide a more accurate prediction of the highest flows. However, there are times when they are not operation.

## *2.2 Bowl tensiometers*

This folder contains tensiometer data collected from the bowl study site. Tensiometers are located in arrays installed at 10 cm, 30 cm, and 50 cm depth. Figure 2 shows the location of the tensiometer arrays, T1.1 –T2.4. All array locations shown were monitored until March 2008 when all tensiometers apart from those located at T1.3 and T2.3 were removed. Up until this point all data are presented in one file for each monitoring period. Initially tensiometers were all connected to one central logger. After March 2008, when tensiometer array numbers were reduced to 2, each array data logged on separate loggers. From March 2008 onwards data are separated; data files beginning with 'Bowl\_Tensio\_Bot' contains the data from tensiometer array T1.3 and files beginning with 'Bowl\_Tensio\_Top' contains the data from tensiometer array T2.3.

Tensiometer data are given in cm H<sub>2</sub>O.

### **3. Groundwater**

This folder includes all data collected from the groundwater monitoring locations at the instrumented hillslope at Tyn y Bryn farm. Groundwater has been monitored at 5 locations. Groundwater is measured using Diver pressure transducers installed in boreholes with a BaroDiver pressure transducer used to account for the effects of variations in barometric pressure. Data are presented in terms of height of water (cm) in relation to the soil surface. Groundwater temperature (°C) is also given.

Groundwater height was initially sampled every 10 minutes until October 2006 when it was changed to sampling every 30 minutes. Details of the boreholes are given in the appendix.

#### *3.1 Borehole1*

Borehole 1 is located in the field immediately above the bowl study site adjacent to Borehole 2.

#### *3.2 Borehole2*

Borehole 2 is located in the field immediately above the bowl study site adjacent to Borehole 1.

#### *3.2 Borehole3*

Borehole 3 is located in the bowl study site and is shown in Figure 2.

#### *3.4 Borehole4*

Borehole 4 is located above the tree shelterbelt in the tree shelterbelt hillslope as indicated in Figure 3.

#### *3.5 Borehole5*

Borehole 5 is located below the tree shelterbelt in the tree shelterbelt hillslope as indicated in Figure 3.

#### 4. Hillslope study site runoff and soil water tension data

This folder includes all data collected from the tree shelterbelt hillslope except that collected from the boreholes and neutron probe monitoring. Data are divided into runoff data collected from the overland flow traps within the tree shelterbelt, drain flow and overland flow (from the hillslope above the tree areas) and tensiometer data.

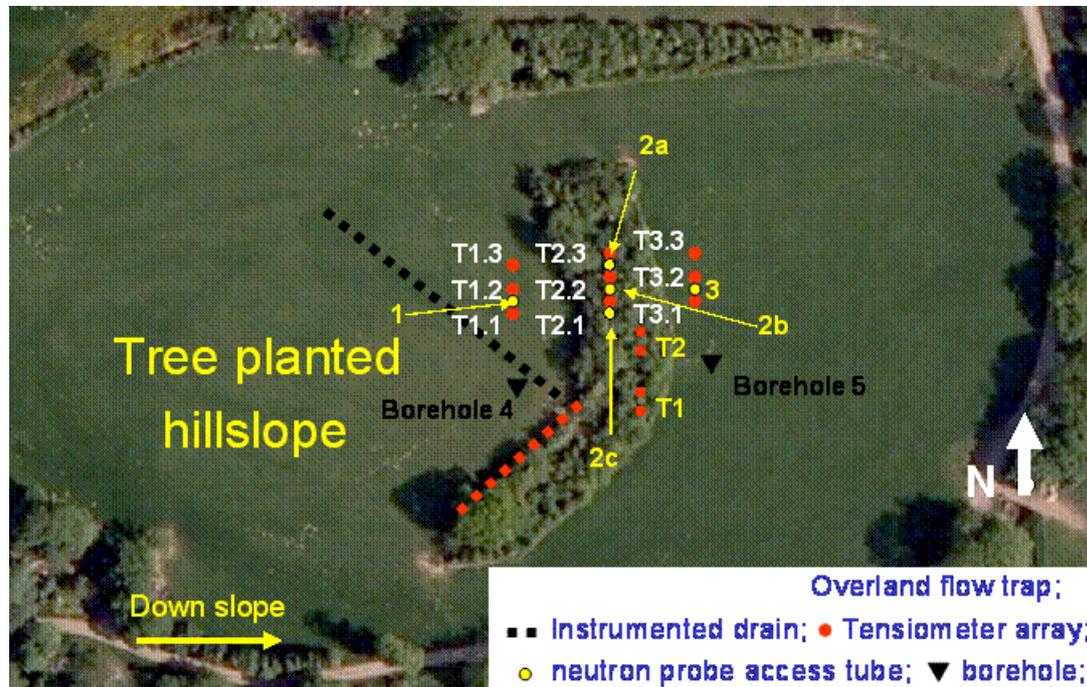


Figure 3. Showing the tree shelterbelt hillslope instrumentation locations.

##### 4.1 Hillslope runoff weir box

This contains data collected from the weir box systems at the hillslope study site. Both weir boxes have pressure transducers installed in stilling wells connected to the weir box system and the height of water above a 90° weir was measured. Pressure transducers are both connected to a central logger and measurements were sampled every 1 minute and averaged and logged every 5 minutes. Because of evaporation, water within the weir boxes sometimes dropped below the level of the weir. When estimates of water height in relation to the bottom of the weir become increasingly negative it is assumed that no flow is occurring. When there is an increase in the water height but it still below the bottom of the weir, the change in volume within the weir box/unit time is used as an estimate of flow.

Flow is given in litres/second,  $l s^{-1}$ .

#### 4.1.1 Hillslope drain flow weir box

This folder contains data from the weir box for which drain water from an area of hillslope above the tree shelterbelt flows through. At the time of producing this catalogue it was not known the extent of the contributing drainage area.

#### 4.1.2 Hillslope overland flow weir box

This folder contains data from the weir box for which overland flow water collected from an area of hillslope above the tree shelterbelt flows through. Figure 3 shows the location of the overland flow trap 32m in length. The data is patchy and there are some questions over the quality in the data collected from this system because of continuous problems with rodents (voles and moles) causing damage to the collection system. This is reflected in the quality assurance codes assigned to a considerable amount of the data.

#### *4.2 Hillslope tensiometers*

This folder includes tensiometer data collected from the tree shelterbelt hillslope. Tensiometers are located in arrays as shown in Figure 3. At all arrays apart from those located within the tree planted area (T2.1-T2.3) are installed at 10 cm, 30 cm, and 50 cm depth. Within the tree areas tensiometers are installed at 10 cm and 30 cm. All array locations shown were monitored until April 2008 when tensiometers located at T1.1, T1.3, T2.3, T3.1 and T3.3 were removed. Tensiometers are all connected to one central logger.

#### *4.3 Tree shelterbelt overland flow*

This folder contains data from the 2 overland flow traps installed within the tree shelterbelt (see Fig. 3 for location). Traps are installed to collect data from two 5 m x 5 m isolated plots. Initially plots were set up so that the cumulative overland flow volume (mm) occurring between site visits could be measured. This setup was then replaced by tipping bucket systems connected to data loggers (logging every 10 minutes) to provide continuous data in litres/ second ( $l s^{-1}$ ).

### **5. Llyn Hir study site soil water tension data**

This folder contains data from the tensiometer array installed at the Llyn Hir site adjacent to the Llyn Hir rain gauges and close to Site 8 streamflow gauging site (see Fig. 1). Three tensiometers are installed at 10 cm, 30 cm, and 50 cm depth and sampled every 10 minutes. In September 2009 the sample time was increased to every 15 minutes to reduce the number of times/month required for site visits.

Tensiometer data are given in cm H<sub>2</sub>O.

## 6. Land use manipulation plots

This folder contains tensiometer and overland flow data from each of the 4 manipulation plot sites. The location of each of the manipulation plots sites is shown in Figure 1. Each manipulation plot site has 3 replicate plots as shown in Figure 4. Replicate plots are labelled 1, 2, and 3 from left to right when looking up hill. Following initial baseline monitoring up until January 2007, treatments were applied at each of the 4 sites. The 3 treatments are: Grazed (i.e. control), Ungrazed (removal of sheep), and Trees (removal of sheep and planting of trees). Within each manipulation plot the treatments were randomly allocated to the replicate plots 1-3. Table 2 shows the treatment location within each plot.

Within each replicate plot three tensiometers are installed at 10 cm, 30 cm, and 50 cm depth and sampled every 10 minutes. Tensiometer data are given in cm H<sub>2</sub>O. Overland flow from a 10m x 2.5m isolated plot is also measured within each replicate plot. Overland flow data from the manipulation plots are given in millimetres/hour (mmh<sup>-1</sup>).

Table 2. Manipulation plot treatment location.

Manipulation plot	Replicate plot		
	1	2	3
1 (Rhos1)	Ungrazed	Trees	Grazed
2 (Rhos2)	Grazed	Ungrazed	Trees
3 (Tyn Fron)	Trees	Grazed	Ungrazed
4 (Penllwyn)	Ungrazed	Grazed	Trees

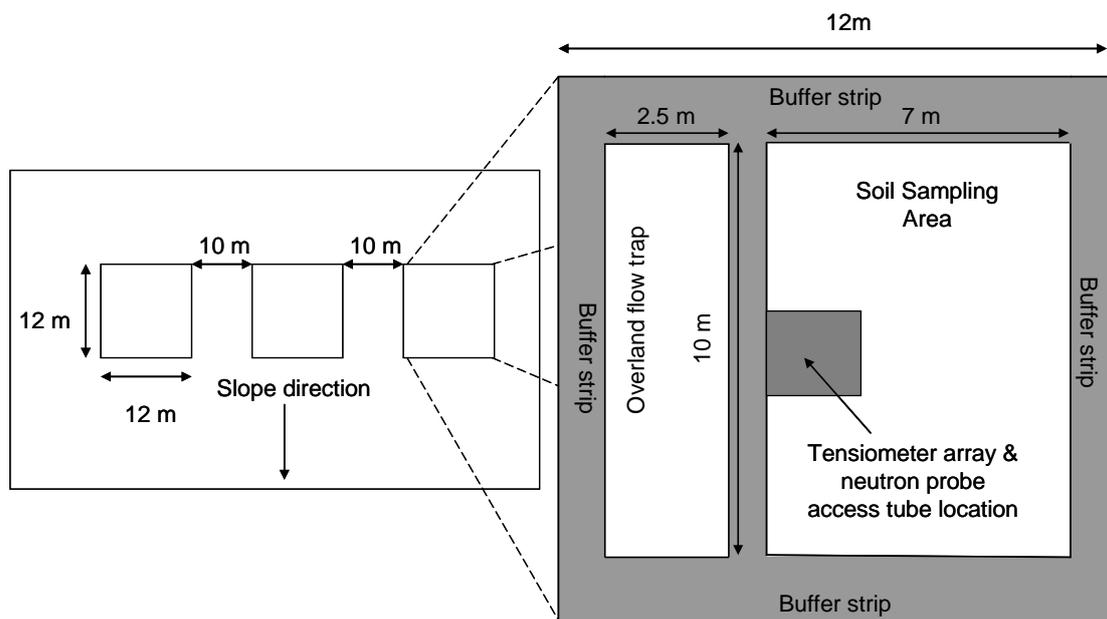


Figure 4. Manipulation plot layout design.

### *6.1 Manipulation plot 1*

This folder contains the pore water pressure data and overland flow data for manipulation plot 1. Manipulation plot 1 is also known as Rhos1.

[6.1.1 Manipulation plot 1 tensiometer](#)

[6.1.2 Manipulation plot 1 overland flow](#)

### *6.2 Manipulation plot 2*

This folder contains the pore water pressure data and overland flow data for manipulation plot 2. Manipulation plot 2 is also known as Rhos2.

[6.2.1 Manipulation plot 2 tensiometer](#)

[6.2.2 Manipulation plot 2 overland flow](#)

### *6.3 Manipulation plot 3*

This folder contains the pore water pressure data and overland flow data for manipulation plot 3. Manipulation plot 3 is also known as Tyn y Fron.

[6.3.1 Manipulation plot 3 tensiometer](#)

[6.3.2 Manipulation plot 3 overland flow](#)

### *6.4 Manipulation plot 4*

This folder contains the pore water pressure data and overland flow data for manipulation plot 4. Manipulation plot 4 is also known as Penllwyn.

[6.4.1 Manipulation plot 4 tensiometer](#)

[6.4.2 Manipulation plot 4 overland flow](#)

## 7. Neutron probe soil moisture data

This folder contains the neutron probe data measured at the bowl study site, instrumented hillslope site, manipulation plot sites, tree areas and Llyn Hir. Where possible, profile measurements are made every 10cm to a depth of down to 120cm.

Figure 2 and 3 show the locations of the neutron probe access tubes within the bowl and hillslope study site respectively.

Within the manipulation plot neutron probe data file, plot i.d. M1-M4 refer to manipulation plots 1-4 respectively. In the plot column the number 1-3 following the decimal place refers to the treatment plot 1-3. For example Plot 2.1 refers to manipulation to treatment plot 1 in manipulation plot 2 (the grazed treatment at Rhos2). The data from the access tube at Llyn Hir are included in the manipulation plot neutron probe data file.

The details regarding the tree area locations are given in the FRMRC Research report UR16 impacts of upland land management on flood risk: multi-scale modelling methodology and results from the Pontbren experiment.

The data presented in these files is the raw count data (16 second) as measured by the neutron probe along with the shield (1 x 64 second) and water count (Average 5 x 64 second).

The straight line equation

$$y = \alpha \frac{\text{Soil\_count}}{\text{Water\_count}} + \beta$$

is used to determine the moisture content where  $y$  is the volumetric moisture content,  $y$  ( $\text{cm}^3\text{cm}^{-3}$ ), and  $\alpha$  and  $\beta$  are the slope and intercept parameters respectively. *Soil\_count* is the neutron probe count as measured within the soil profile and *Water\_count* is the neutron probe count as measured within water.

At the time of putting this catalogue together, parameters values used for all sites were based on the clay calibration as determined by the Centre for Ecology and Hydrology, where  $\alpha = 0.96$  and  $\beta = -0.01$ . It may be that an alternative parameter set is used, especially for the top 30cm of the Llyn Hir profile as there is a layer of peat present at this site. There is also a relatively high organic matter content in the surface layer of the soil found at manipulation plot 4.

## 8. Rain gauge data

This folder includes data collected from the rain gauges located across the Pontbren study site. Where storage gauge data are available, this is also included in a separate file in the respective subfolders. The location of the rain gauges is given in Figure 1.

Tipping bucket data are given mm/day ( $\text{mmd}^{-1}$ ) and storage gauge data are given in mm.

### 8.1 Bowl

This folder includes data from the tipping bucket rain gauge located at the bowl study site. The rain gauge here sits ~ 300mm above ground level. A ditch with a rain gauge grid surrounds the gauge. Height above Ordnance datum (AOD) = 311m.

### 8.2 Hirrhos Uchaf

This folder includes data from the tipping bucket and storage rain gauge located at the Hirrhos Uchaf site. The rain gauges here sit above ground level. A ditch with a rain gauge grid surrounds each gauge. Height AOD = 293m.

### *8.3 Llyn\_Hir*

This folder includes data from the tipping bucket and storage rain gauge located at the Llyn Hir site. The rain gauges here sit above ground level. A ditch with a rain gauge grid surrounds each gauge. Height AOD = 383m.

### *8.4 Penllwyn*

This folder includes data from the tipping bucket and storage rain gauge located at the Penllwyn site (M4 manipulation plot site). The rain gauges here sit ~ 300mm above ground level. A ditch with a rain gauge grid surrounds each gauge. Height AOD = 312m.

### *8.5 Quarry*

This folder includes data from the tipping bucket and storage rain gauge located at the Quarry site. The rain gauges here sit at ground level. A ditch with a rain gauge grid surrounds each gauge. Height AOD = 373m.

### *8.6 Rhos1*

This folder includes data from the tipping bucket and storage rain gauge located at the Rhos1 site (M4 manipulation plot site). The rain gauges here sit ~ 300mm above ground level. A ditch with a rain gauge grid surrounds each gauge. Height AOD = 221m.

## **9. Field Diaries**

This folder contains a series of word documents of field notes for each of the monitoring locations/instrumentation. The field notes describe some of the issues that may have occurred and maybe used in reference to explain data issues.

## 10. Streamflow

This folder includes data from the stream flow monitoring sites located across the Pontbren study sites (see Figure 3). Sites 1-9 and Site 13 are monitored using bed-mounted acoustic Doppler monitoring systems (Starflows). At Site 10 changes in stage height is measured using a pressure transducer and Sites 10 and 11 are monitored use v-notch weir plates with pressure transducers.

Starflow monitoring: stage height and velocity are measured every minute and averaged every 15 minutes. For each 15 minutes water depth (mm), water temperature (°C), battery status (V), cross-sectional area (cm<sup>2</sup>), Velocity (mms<sup>-1</sup>), and flow rate (ls<sup>-1</sup>). Because of discrepancies between manual spot measurements of flow and that estimated by the starflow, site specific straight line equations have been created relating starflow estimates with manual spot measurements (a table of spot measurements made are included in the appendix).

$$y = \alpha x + \beta$$

$y$  is the calibrated estimate of flow in litres/second (ls<sup>-1</sup>),  $x$  is the starflow estimate of flow (ls<sup>-1</sup>) and  $\alpha$  and  $\beta$  are site specific parameters, details of which are provided in table 3. Because of limitations in the starflow's ability to accurately measure low flows, data where the depth of water is < 50 mm is deemed unacceptable for calibration purposes.

Table 3. Calibration parameters for the starflow streamflow gauging sites.

Streamflow gauging site	$\alpha^*$	$\beta^*$
1	0.62 (0.43)	0.02 (0.05)
2	0.57 (0.04)	-0.01 (0.01)
3	0.88 (0.33)	0.02 (0.01)
4	0.87 (0.09)	0.02 (0.003)
5	1.20 (0.03)	0.01 (0.01)
6	1.07 (0.05)	-0.03 (0.02)
7	0.89 (0.21)	0.06 (0.19)
8	0.65 (0.21)	0.00 (0.04)
9	0.85 (0.04)	0.04 (0.03)
13	1.20 (0.17)	0.03 (0.02)

\*Standard deviations of  $\alpha$  and  $\beta$  estimated from the regression analysis, are in parentheses

### 10.1 Site1

This folder contains the stream flow data as measured by the installed starflow at gauging site 1.

### 10.2 Site2

This folder contains the stream flow data as measured by the installed starflow at gauging site 2.

### 10.3 Site3

This folder contains the stream flow data as measured by the installed starflow at gauging site 3.

#### *10.4 Site4*

This folder contains the stream flow data as measured by the installed starflow at gauging site 4.

#### *10.5 Site5*

This folder contains the stream flow data as measured by the installed starflow at gauging site 5.

#### *10.6 Site6*

This folder contains the stream flow data as measured by the installed starflow at gauging site 6.

#### *10.7 Site7*

This folder contains the stream flow data as measured by the installed starflow at gauging site 7.

#### *10.8 Site8*

This folder contains the stream flow data as measured by the installed starflow at gauging site 8.

#### *10.9 Site9*

This folder contains the stream flow data as measured by the installed starflow at gauging site 9.

#### *10.10 Site10*

This folder contains the stream flow data as measured by the installed pressure transducer installed at gauging site 10.

#### *10.11 Site11*

This folder contains the stream flow data as measured by the installed v-notch weir and pressure transducer installed at gauging site 11.

#### *10.12 Site12*

This folder contains the stream flow data as measured by the installed v-notch weir and pressure transducer installed at gauging site 12.

#### *10.13 Site13*

This folder contains the stream flow data as measured by the installed starflow at gauging site 13.

**Appendix A: Quality assurance coding system.**

Instrument	Description	Code
General	Good quality data - no problems	1x
	Some questions over data quality	2x
	Data not suitable for calibration purposes	3x
	Data exceeds a maximum threshold value	4x
	Data less than minimum threshold value	5x
	Logger failure	6x
	No additional information	x0
Tensiometers	Tensiometers de-gassed	x1
	Sheep damage or loose in ground	x2
	Tensiometer not installed	x3
	Vents Blocked	x4
	Unexplained fault	x5
	Tensiometer re-installation	x6
	Tensiometer is reading <-800cm (potential for cavitation)	x7
	No power source	x8
	Wire cut	x9
Rain Gauges	Gauge blocked	x1
	Pit flooded	x2
	Snowfall	x3
	Gauge out of balance	x4
	Undetermined Problem	x5
	Gauge under-catching (installed above ground level)	x6
	frozen tipping bucket system	x7
	monthly total > 10 % different from storage gauge if monthly total > 50 mm - does not necessarily = bad data	x8
Tipping Buckets (Drain and Overland Flow)	Multiple Tips	x1
	Overwhelmed (>255 Tips)	x2
	TB guide bolts loose	x3
	Tipping mechanism impeded e.g. ice formation	x4
	Not all flow being captured	x5
	Collection system damaged or blocked	x6
	out of operation	x7
	Calibration	x8
	Divergence from WB data during high flow events (>0.5 ls-1 difference)	x9
weir box	Pressure transducer voltage jump (requires adjustment)	x1
	Snow	x2
	Frozen weir box or stilling well	x3
	Not all flow being captured	x4
	Collection system damaged or blocked	x5
	logger problem	x6
	unexplained problem	x7
	calibration process	x8
	damaged pressure transducer	x9
Groundwater monitoring	reading taken when pressure transducer is removed from borehole	x1
	> 10 % diff. between manual dip (taken at the end of the measurement period) and pressure transducer value. This does not necessarily mean problems with data.	x2
Starflow data	Requires calibration using flow rating curve	x1
	Assume no flow	x2
	Depth reading < 50 mm	x3
	unexplained fault	x4
	starflow off its mountings	x5
	starflow out of action	x6
	Velocity < 21 mms-1	x7
	Velocity > 4500 mms-1	x8
	flat line velocity trace	x9
	Frozen conditions	xa
weir plate	Weir plate under cut or water flowing round the side	x1
	unexplained fault	x2
Tipping buckets (manipulation plots)	Water filled pits or blocked gutter	x1
	Disturbance or removal	x2
	Tipping bucket problem	x3
	Delta T problem	x4
AWS	Sensor calibration	x1
	Sensor (pyronometer) set at wrong sensitivity	x2
	Damaged sensor/out of operation	x3
	lost data	x4
Tree shelterbelt OLF	Collection system damaged or blocked	x1
	Issue regarding the amount of water collected - Too much (unknown reason)	x2
	Collection vessel full	x3

**Appendix B:** Groundwater monitoring Borehole logs.

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No 3	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> TechnoDrill MiniTech rig 125 cfm compressor 90 mm power auger 0-0.4 m 75 mm DTH & drag bit 0.4 – 5.92		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION  The Bowl <b>Borehole 3</b>		
<b>Water</b> Water struck at 3.9 m BGL on 06/07/05 RWL = 0.91 m BGL after completion on 07/07/05 RWL = 1.59 m BGL after completion on 15/07/05		<b>Grid Reference</b>  <b>Datum level</b>		
<b>Carried out for</b> Imperial College		<b>Date</b> 06/07/05		<b>Ground level</b>
<b>Description</b>		<b>Thickness</b>	<b>Depth mBGL</b>	<b>Reduced level</b>
SOIL		0.40	0.40	
Strong, grey (N6), ROCK (boulder)		0.30	0.70	
Firm-stiff, dry, light olive grey (2.5YR5/4) gravelly silty CLAY, becoming very gravelly below 1.70		1.30	2.00	
Strong, grey (N6), ROCK (boulder)		0.40	2.40	
Stiff, dry, olive grey (5Y5/2) very gravelly silty CLAY		1.50	3.90	
Stiff, slightly moist, dark brownish grey (2.5Y4/2) very gravelly CLAY		0.50	4.40	
Stiff, grey (5Y5/1) very gravelly silty CLAY		0.25	4.65	
Stiff, slightly moist, dark brownish grey (2.5Y4/2) very gravelly CLAY		0.95	5.60	
<b>Completion</b> Polyurethane foam surface seal NW steel casing (89mm OD) c/w nutty crunch shoe Open hole 75mm (no pack / no seal) 2" Triloc PVC casing (60mm OD) 2" Triloc PVC screen (60mm OD) 2" Triloc PVC casing (60mm OD) – no cap at base			0.30 1.03 5.92 4.50 5.70 5.92	
<b>Samples</b> 0.40-0.70 0.70-1.70 1.70-2.00 2.00-2.40 2.40-3.90 3.90-4.90 4.40-4.65				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No 1	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> TechnoDrill MiniTech rig 125 cfm compressor 90 mm power auger 0- 4.10 m 75 mm DTH & drag bit 4.10 – 5.9		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION  Top of transect <b>Borehole 1</b>		
<b>Water</b> Water not struck 07/07/05 or 08/07/05 RWL = 5.20 m BGL after completion on 12/07/05 RWL = 4.01 m BGL after completion on 15/07/05		<b>Grid Reference</b>		
		<b>Datum level</b>		
<b>Carried out for</b> Imperial College		<b>Date</b> 06/07/05 – 07/07/05		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level	
SOIL	0.30	0.30		
Soft-firm, brownish yellow (10YR6/6) CLAY with some strong brown (7.5YR5/8) and grey (N6) mottling	0.6	0.9		
Firm-stiff, dry, light olive grey (2.5YR5/4) gravelly silty CLAY, becoming very gravelly below 1.70	1.30	2.00		
Strong, grey (N6), ROCK (boulder)	0.40	2.40		
Stiff, dry, olive grey (5Y5/2) very gravelly silty CLAY	1.50	3.90		
Stiff, slightly moist, dark brownish grey (2.5Y4/2) very gravelly CLAY	0.50	4.40		
Stiff, grey (5Y5/1) very gravelly silty CLAY	0.25	4.65		
Stiff, slightly moist, dark brownish grey (2.5Y4/2) very gravelly CLAY	0.94	5.59		
<b>Completion</b> Surface seal probably sufficient with surface casing tight 90 mm OD PVC casing Open hole 75mm (no pack / no seal) 42 mm OD PVC casing 42 mm OD PVC screen 42 mm OD PVC casing			4.11 5.46 4.69 5.54 5.59	
<b>Samples</b> 0.30-0.90 0.90-1.80 1.80-2.20 2.20-3.60 3.60-4.65		4.65-5.60		

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No 2	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Pilcon Traveller T30 rig 90 mm power auger 0- 3.00m 125 / 130 cfm compressor 75 mm DTH & drag bit & rock roller bit 3.00 – 11.6 m		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION  Top of transect <b>Borehole 2</b>		
<b>Water</b> Dry at 7.00 on 13/07/05 Water struck at 9.75 m BGL on 13/07/05 RWL = 8.61 m BGL after completion on 15/07/05		<b>Grid Reference</b>		
		<b>Datum level</b>		
<b>Carried out for</b> Imperial College		<b>Date</b> 12/07/05 – 13/07/05		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level	
SOIL	0.40	0.40		
Firm, dry, light yellowish brown (2.5Y6/4) gravelly silty CLAY	1.30	1.7		
Firm, dry, greyish brown (2.5Y5/2) gravelly silty CLAY	0.90	2.60		
Firm-stiff, dry, light grey (2.5Y5/2) slightly gravelly silty CLAY	0.40	3.00		
Strong, grey (N6), ROCK (boulder)	0.20	3.20		
Stiff, dark grey (5Y4/1) gravelly silty CLAY, more gravelly between 5.5-6.0 m and less gravelly between 6.5–7.0 m	4.65	7.85		
Strong, grey (N6), ROCK (boulder)	0.40	8.25		
Stiff, wet, dark grey (5Y4/1) gravelly silty CLAY	3.34	11.64		
<b>Completion</b> Polyurethane foam surface seal NW steel casing (89mm OD) c/w nutty crunch shoe Open hole 75mm (no pack / no seal) 42 mm OD PVC casing 42 mm OD PVC screen 42 mm OD PVC casing			0.30 2.76 11.65 9.59 11.59 11.64	
<b>Samples</b> 0.40-1.70 1.70-2.60 2.60-3.00 3.00-3.20 3.20-4.50	4.50-5.50 5.50-6.50 6.50-7.50 7.85-8.25 8.25-11.60			

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No 5	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Pilcon Traveller T30 rig 130 cfm compressor 90 mm power auger 0- 4.10m 75 mm DTH & rock roller bit 4.10 – 10.5 m		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION  Bottom of transect <b>Borehole 5</b>		
<b>Water</b> Water struck at 9.50 m BGL on 14/07/05. Good yield. RWL = 7.58 m BGL after completion on 15/07/05		<b>Grid Reference</b>		
		<b>Datum level</b>		
<b>Carried out for</b> Imperial College		<b>Date</b> 14/07/05		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Firm, dry, light olive brown (2.5Y6/4) slightly gravelly silty CLAY		1.10	1.10	
Firm, dry, light olive brown (2.5Y6/4) gravelly silty CLAY		3.00	4.10	
Stiff, dry, greyish brown (2.5Y4/2) very gravelly silty CLAY		0.90	7.30	
Strong, grey (N6), ROCK (boulder)		0.30	7.60	
Medium dense, dark greyish brown (10YR4/2) very clayey fine GRAVEL		2.90	10.5	
<b>Completion</b> Surface seal probably sufficient with surface casing tight 90 mm OD PVC casing Open hole 75mm (no pack / no seal) 50 mm ID MGS PVC casing 50 mm ID Demco Terraline screen			3.65 ? 5.73 9.65	
<b>Samples</b> 0.40-1.70 1.70-2.60 2.60-3.00 3.00-3.20 3.20-4.50 4.50-5.50		5.50-6.50 6.50-7.50 7.85-8.25 8.25-11.60		

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No 4	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Pilcon Traveller T30 rig 85 cfm compressor 90 mm power auger 0- 4.00 m 75 mm DTH & rock roller bit 4.00 – 12.00		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION  Between PB1 and PB4 <b>Borehole 4</b>		
<b>Water</b> RWL=11.04 BGL		<b>Grid Reference</b>		
		<b>Datum level</b>		
<b>Carried out for</b> Imperial College		<b>Date</b> 14/07/05 – 20/07/05		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level	
SOIL	0.30	0.30		
Soft - firm, moist, light light olive brown (2.5Y5/4) silty CLAY	1.00	1.00		
Firm, dry, light olive brown (2.5Y5/4) silty CLAY	0.50	1.50		
Firm, dry, dark greyish brown (2.5Y4/2) slightly gravelly silty CLAY	0.50	2.00		
Firm - stiff, dry, dark greyish brown (2.5Y4/2) slightly gravelly silty CLAY	1.00	3.00		
Stiff, very dark greyish brown gravelly silty CLAY	2.00	5.00		
Olive grey (5Y4/2) gravelly CLAY, becoming olive (5Y3/2) at 7.5 m and olive brown (2.5Y4/4) at 7.85 m.	3.75	8.75		
Strong, grey (N5) ROCK (boulder?)	0.20	8.95		
Dark greyish brown (2.5Y3/2) gravelly CLAY / clayey GRAVEL	2.05	12.00		
<b>Completion</b> Polyurethane foam surface seal NW steel casing (89mm OD) c/w nutty crunch shoe Open hole 75mm (no pack / no seal) 42 mm OD PVC casing 42 mm OD PVC screen			0.30 4.32 11.96 9.96 11.96	
<b>Samples</b>	4.00-5.00 5.00-6.00 6.00-7.00 7.00-7.50 7.50-7.85 7.85-8.10	8.10-8.75 8.75-8.95 8.95-9.45 9.45-9.80 9.80-11.50 11.50-12.00		

**Appendix C:** Neutron probe access tube logs.

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP1	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube	<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Hillslope 3</b> Below Half Moon Shelter Belt near PB4			
<b>Water</b> Not struck	<b>Grid Reference</b> SJ 04760 05725			
	<b>Datum level</b>			
<b>Carried out for</b> Centre for Ecology and Hydrology	<b>Date</b> 10/05/06		<b>Ground level</b>	
<b>Description</b>	Thickness	Depth mBGL	Reduced level	
Dark brown (10YR4/3) silty clay loam SOIL with some slight (2.5YR3/6) mottling and grey fine-medium grained sandstone stones. Becoming brown (10YR5/3) with depth	0.45	0.45		
Firm dry light brownish grey (2.5Y6/2) slightly gravelly silty CLAY with yellowish red (5YR5/8) mottling	0.55	1.00		
Firm-stiff dry greyish brown (2.5Y5/2) and light grey (N7) mottled slightly gravelly silty CLAY	0.45	1.45		
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing		1.40		
<b>Samples</b> 1.40				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG	BOREHOLE No NP2	
		Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Atlas Copco RAB hand held air flush rotary drill	<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Hillslope 2a</b> Half Moon Shelter Belt		
<b>Water</b> Not struck	<b>Grid Reference</b> SJ 04745 05718		
	<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology	<b>Date</b> 10/05/06		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level
Soft moist brown (10YR5/3) clay SOIL	0.20	0.20	
Firm-stiff dry light grey slightly gravelly silty CLAY with some reddish yellow (7.5YR6/8) mottling	1.36	1.56	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing		?	
<b>Samples</b> 1.56			

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG	BOREHOLE No NP3	
		Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube	<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Cae Drains Trees</b> Stream Birch Nr Half moon		
<b>Water</b> Not struck	<b>Grid Reference</b> SJ 04734 05761		
	<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology	<b>Date</b> 10/05/06		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level
Soft moist brown (10YR4/5) silty CLAY	0.65	0.65	
Soft moist greyish brown (10YR5/2) silty CLAY with very dark greyish brown (10YR3/2) mottling	0.15	0.80	
Soft – firm moist grey (10YR6/1) and reddish yellow (7.5YR6/8) mottled silty CLAY	0.65	1.45	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing		?	
<b>Samples</b> 1.45			
Groundwater Monitoring	BOREHOLE LOG	BOREHOLE No NP4	

<b>and Drilling Ltd</b>		<b>Sheet 1 of 1</b>	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Pant-powsi Trees</b> Nant Pen-y-cwm	
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 04727 05633	
		<b>Datum level</b>	
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 10/05/06	<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level
Soft moist light brownish grey (10YR6/2) CLAY	0.30	0.30	
Soft – firm moist light olive brown (2.5Y6/4) and olive grey (N7) mottled slightly gravelly silty CLAY	0.70	1.00	
Stiff dry dark greyish brown (2.5Y4/2) gravelly silty CLAY Gravel: SA-SR	0.40	1.40	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			?
<b>Samples</b> 1.40			

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP5	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Hillslope 1</b> Near PB5		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 04725 05715		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 10/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Soft – firm moist dark brown (10YR3/3) clay SOIL		0.50	0.50	
Soft – firm moist brownish yellow (10YR6/6) silty CLAY		1.40	0.90	
Firm – stiff dry yellowish brown (10YR5/6) and light grey (10YR7/1) mottled gravelly CLAY. Gravel: subrounded		0.60	1.50	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing				?
<b>Samples</b> 1.40-1.50				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP6	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Bowl B1</b> Bowl lower		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 04594 05682		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 11/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Brown (10YR4/3) SOIL		0.30	0.30	
Firm – stiff moist light olive brown (2.5YR6/4) slightly gravelly silty CLAY with strong brown (7.5YR5/6) mottling becoming dry with depth		1.09	1.39	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.39	
<b>Samples</b> No sample				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP7	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube		<b>Location</b> TYN-Y-BRYN LLANFAIR CAEREINION <b>N-probe Bowl B2</b> Bowl upper		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 04577 05704		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 11/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Dark greyish brown (10YR4/2) SOIL		0.30	0.30	
Soft – firm moist light yellow brown (2.5YR6/4) and yellowish red (5YR5/6) mottled slightly gravelly silty CLAY		0.55	0.85	
Light grey (N6) moist stone		0.05	0.90	
Stiff, dry and light yellow brown (2.5YR6/4) and yellowish red (5YR5/6) mottled gravelly silty CLAY gravelly. Gravel: subangular - subrounded		0.30	1.20	
Stiff light olive brown (2.5YR5/4) with grey (N5) mottled gravelly silty CLAY. Gravel: sub-angular – sub-rounded		0.35	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.48	
<b>Samples</b> 1.40-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP11	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> PEN-Y-RHOS LLANFAIR CAEREINION <b>N-probe Manipulation plot 4.1</b> Site S4 (westernmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 05607 04852		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 12/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Brown (10YR4/3) SOIL		0.40	0.40	
Soft – firm moist brownish yellow (10YR6/6) CLAY becoming light grey (10YR6/1) mottled with depth and becoming drier at 1.3		0.40	0.80	
Stiff dark grey (5Y4/1) and grey (N5) with slight yellowish red (5YR5/8) mottling gravelly CLAY Gravel: fine – coarse subangular – subrounded. Coarse gravel: fine – medium grained sandstone		0.75	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.52	
<b>Samples</b> 1.30-1.50				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP12	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> PEN-Y-RHOS LLANFAIR CAEREINION <b>N-probe Manipulation plot 4.2</b> Site S4 (central)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 05626 04872		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 12/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Brown (10YR4/3) SOIL		0.40	0.40	
Soft – firm moist brownish yellow (10YR6/6) CLAY		0.30	0.70	
Becoming light grey (10YR7/1) CLAY		0.20	0.90	
Stiff grey (N5) and greyish brown (2.5Y5/2) gravelly CLAY Gravel: strong fine – medium grained sandstone		0.65	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.52	
<b>Samples</b> 1.30-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP13	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> PEN-Y-RHOS LLANFAIR CAEREINION <b>N-probe Manipulation plot 4.3</b> Site S4 (easternmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 05630 04883		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 11/05/06		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level	
Brown (10YR4/3) SOIL	0.40	0.40		
Soft – firm moist brownish yellow (10YR6/6) CLAY with light brown grey (2.5Y6/2) at depth	0.60	1.0		
Stiff grey (N5) and gravelly CLAY with some strong brown (7.5YR5/8) mottling Gravel: fine – coarse sandstone	0.40	1.50		
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.46	
<b>Samples</b> 1.30-1.50				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP14	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> RHOSAFLO LLANFAIR CAEREINION <b>N-probe Manipulation plot 1.3</b> Site S1 (westernmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 06873 06703		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 13/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Yellowish brown (10YR5/4) clay loam SOIL		0.50	0.50	
Soft moist brownish yellow (10YR5/6) gravelly CLAY		0.50	1.00	
Strong light grey (N7) fine grained sandstone cobbles / boulders becoming stiff olive (5Y5/3) very gravelly CLAY with reddish yellow (7.5YR6/6) mottling with depth		0.45	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.50	
<b>Samples</b> 1.00 -1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP15	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> RHOSAFLO LLANFAIR CAEREINION <b>N-probe Manipulation plot 1.2</b> Site S1 (central)		
<b>Water</b> Water level = 1.12		<b>Grid Reference</b> SJ 06899 06704		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 13/05/06		<b>Ground level</b>
<b>Description</b>	Thickness	Depth mBGL	Reduced level	
Yellowish brown (10YR5/4) clay LOAM	0.45	0.45		
Soft moist light yellowish brown (10YR5/4) gravelly sandy CLAY with brick	0.25	0.70		
Soft – Firm brownish yellow (10YR6/6) gravelly sandy CLAY	0.20	0.90		
Strong light grey (N7) fine grained sandstone cobbles becoming stiff light yellow brown (2.5Y6/4) and strong brown (7.5YR5/6) mottled CLAY	0.65	1.55		
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.51	
<b>Samples</b> 0.90-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP16	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> RHOSAFLO LLANFAIR CAEREINION <b>N-probe Manipulation plot 1.1</b> Site S1 (easternmost)		
<b>Water</b> Water struck at c. 0.65 – 0.85		<b>Grid Reference</b> SJ 06921 06704		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 13/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Greyish brown (10YR5/2) silty clay SOIL		0.45	0.45	
Soft brownish yellow (10YR6/6) silty CLAY with strong brown (7.5YR6/8) mottling		0.10	0.55	
Firm brownish yellow (10YR6/6) and reddish yellow (7.5YR6/8) mottled CLAY		0.10	0.65	
Stiff light olive brown (2.5Y5/4) very gravelly CLAY with strong brown (7.5YR5/6) and grey (N6) mottling. More gravelly at top (fine grained sandstone)		0.95	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.53	
<b>Samples</b>				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP17	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> RHOSAFLO LLANFAIR CAEREINION <b>N-probe Manipulation plot 2.1</b> Site S2 (westernmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 06430 06837		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 13/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Yellowish brown (10YR5/4) silty clay loam SOIL		0.50	0.50	
Soft – Firm brownish yellow (10YR6/6) CLAY with some light grey (N7) mottling		0.20	0.70	
Becoming stiff light grey (5Y7/1) and reddish yellow (7.5YR6/6) mottled very gravelly CLAY. Gravel: fine – coarse. Coarse gravel: fine grained sandstone		0.85	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.55	
<b>Samples</b> 0.70-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP18	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> RHOSAFLO LLANFAIR CAEREINION <b>N-probe Manipulation plot 2.2</b> Site S2 (central)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 06452 06848		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 13/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Yellowish brown (10YR5/4) silty clay loam SOIL		0.30	0.30	
Soft – firm brownish yellow (10YR6/6) gravelly CLAY with light grey (N7) mottling		0.40	0.70	
Becoming stiff light yellowish brown (2.5Y6/4) very gravelly CLAY with light grey (N7) and mottling and black coatings.		0.90	1.600	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.56	
<b>Samples</b> 1.00-1.60				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP19	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> RHOSAFLO LLANFAIR CAEREINION <b>N-probe Manipulation plot 2.3</b> Site S2 (easternmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 06472 06858		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 13/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Light yellowish brown (10YR6/4) silty clay loam SOIL		0.50	0.50	
Soft – firm light yellowish brown (2.5Y6/4) and reddish yellow (7.5YR6/6) mottled slightly gravelly CLAY		0.20	0.70	
Stiff grey (N6) and reddish yellow (7.5YR6/6) very gravelly CLAY. Coarse gravel mainly fine grained sandstone		0.85	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.51	
<b>Samples</b> 0.90-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP20	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> PEN-TAL-Y-CEIN LLANFAIR CAEREINION <b>N-probe Manipulation plot 3.1</b> Site S3 (easternmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 07360 06833 <b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 14/05/06		<b>Ground level</b>
<b>Description</b>		<b>Thickness</b>	<b>Depth mBGL</b>	<b>Reduced level</b>
Dark yellow brown (10YR4/4) silty clay SOIL		0.40	0.40	
Soft – firm yellowish brown (10YR5/6) CLAY		0.40	0.80	
Stiff olive brown (2.5Y4/4) gravelly CLAY with yellowish brown (10YR5/4) and grey (N5) mottling		0.80	1.60	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.58	
<b>Samples</b> 0.80-1.60				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP21	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill		<b>Location</b> PEN-TAL-Y-CEIN LLANFAIR CAEREINION <b>N-probe Manipulation plot 3.2</b> Site S3 (central)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 07341 06821		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 14/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Dark yellowish brown (10YR4/4) silty clay SOIL with some slight yellowish red (5YR5/6) mottling		0.25	0.25	
Soft – firm moist olive yellow (2.5YR6/6) slightly gravelly silty CLAY with strong brown (7.5YR5/8) mottling		0.35	0.60	
Stiff olive brown (2.5Y4/4) very gravelly CLAY with yellowish brown (10YR5/8) and grey (N5) mottling. Gravel: fine-coarse subangular – subrounded sandstone and mudstone		1.00	1.60	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.58	
<b>Samples</b> 1.20-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP22	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube Pneumatic hammer Atlas Copco RAB hand held air flush rotary drill Atlas Copco Leopard rotary/percussive air flush drill		<b>Location</b> PEN-TAL-Y-CEIN LLANFAIR CAEREINION <b>N-probe Manipulation plot 3.3</b> Site S3 (westernmost)		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 07323 06807		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 14/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Greyish brown (10YR5/2) silty CLAY with yellowish red (5YR5/6) mottling		0.35	0.50	
Soft – firm moist brownish yellow (10YR6/6) and grey (N7) mottled CLAY becoming stiff and greyer at 0.60		0.55	1.05	
Strong dark grey fine grained sandstone boulder		0.15	1.20	
Stiff greyish brown (2.5Y5/2) very gravelly CLAY with strong brown (7.5YR5/8) and light brownish grey (2.5YR6/2) mottling. Gravel: fine–coarse sandstone and mudstone		0.30	1.55	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.38	
<b>Samples</b> 1.20-1.55				

Groundwater Monitoring and Drilling Ltd	BOREHOLE LOG		BOREHOLE No NP23	
			Sheet 1 of 1	
<b>Equipment &amp; Methods</b> Hand auger with AQ drill rod / guide tube		<b>Location</b> COED CWM-Y-LLWYNOG LLANFAIR CAEREINION <b>N-probe Tyn y Fron Trees</b> Edge of wood		
<b>Water</b> Not struck		<b>Grid Reference</b> SJ 07426 06920		
		<b>Datum level</b>		
<b>Carried out for</b> Centre for Ecology and Hydrology		<b>Date</b> 14/05/06		<b>Ground level</b>
<b>Description</b>		Thickness	Depth mBGL	Reduced level
Dark brown (10YR3/3) humic soil with roots and leaf litter		0.25	0.25	
Soft – firm brownish yellow (10YR6/6) with reddish yellow (7.5YR6/8) and light grey (2.5Y7/2) mottling		0.6	0.85	
Stiff greyish brown (2.5Y5/2) gravelly CLAY with light grey (N7) and yellowish brown (10YR5/8) mottling		0.65	1.50	
<b>Completion</b> 16 gauge 44.5mm diameter aluminium access tubing			1.50	
<b>Samples</b> 0.85-1.50				

**Appendix D: Streamflow gauging sites flow metered spot measurements.**

Flow gauging site	Start time dd/mm/yyyy hh:mm	Finish time dd/mm/yyyy hh:mm	Flow metered estimate ls-1
Site 10	19/11/2009 11:35	19/11/2009 11:53	918.1
	09/03/2006 13:25	09/03/2006 14:05	778.3
	29/03/2006 15:00	29/03/2006 15:30	651.9
	03/05/2006 11:50	03/05/2006 12:11	51.0
	18/05/2006 11:10	18/05/2006 11:35	352.4
	06/10/2006 10:44	06/10/2006 11:28	1423.5
	22/11/2006 15:50	22/11/2006 16:18	691.1
	29/11/2006 09:32	29/11/2006 10:02	688.2
Site 8	22/11/2006 09:05	22/11/2006 09:32	0.0687
	28/11/2006 15:25	28/11/2006 16:00	0.1286
	13/12/2006 14:12	13/12/2006 14:48	0.2129
	06/03/2007 10:05	06/03/2007 10:35	0.1519
Site 7	22/11/2006 14:44	22/11/2006 15:01	360.9
	23/11/2006 13:26	23/11/2006 13:47	880.7
	27/02/2007 13:58	27/02/2007 14:30	1064.6
	05/12/2007 11:55	05/12/2007 12:18	685.2
	05/12/2007 15:14	05/12/2007 15:32	657.6
	06/12/2007 11:50	06/12/2007 12:15	1248.1
Site 6	29/03/2006 12:53	29/03/2006 12:53	159.1
	18/05/2006 10:22	18/05/2006 10:41	92.8
	22/11/2006 14:13	22/11/2006 14:29	161.7
	05/12/2006 12:00	05/12/2006 12:34	858.3
	27/02/2007 14:57	27/02/2007 15:24	586.0
	28/02/2007 15:00	28/02/2007 15:49	314.3
Site 9	09/03/2006 14:30	09/03/2006 14:30	390.7
	15/03/2006 14:00	15/03/2006 14:23	673.3
	18/05/2006 07:57	18/05/2006 08:18	176.1
	06/10/2006 10:10	06/10/2006 10:27	511.4
	22/11/2006 15:15	22/11/2006 15:33	313.5
	05/12/2006 10:03	05/12/2006 10:40	1349.4
	19/11/2009 13:34	19/11/2009 14:00	514.9
Site 4	09/03/2006 11:43	09/03/2006 12:10	31.4
	15/03/2006 12:03	15/03/2006 12:37	42.8
	29/03/2006 14:00	29/03/2006 14:14	20.1
	22/11/2006 13:24	22/11/2006 13:36	15.9
	23/11/2006 12:00	23/11/2006 12:20	50.1
	05/12/2006 14:17	05/12/2006 14:34	89.1
	27/02/2007 16:20	27/02/2007 16:37	56.9
	06/12/2007 11:00	06/12/2007 11:20	64.2
Site 13	23/11/2006 09:15	23/11/2006 09:50	196.7
	05/12/2007 11:20	05/12/2007 11:40	177.3
	05/12/2007 15:51	05/12/2007 16:09	148.9
	06/12/2007 12:44	06/12/2007 12:44	264.9
	06/10/2006 07:35	06/10/2006 07:50	90.2
Site 3	09/03/2006 12:20	09/03/2006 12:20	13.3
	15/03/2006 12:59	15/03/2006 13:09	32.2
	29/03/2006 14:25	29/03/2006 14:25	10.8
	22/11/2006 12:56	22/11/2006 13:08	6.7
	23/11/2006 11:48	23/11/2006 12:05	32.3
Site 5	05/12/2005 16:30	05/12/2005 16:30	270.4
	09/03/2006 11:15	09/03/2006 11:15	110.1
	15/03/2006 11:33	15/03/2006 11:56	429.0
	29/03/2006 13:40	29/03/2006 13:55	121.9

	22/11/2006 13:40	22/11/2006 13:55	116.1
	23/11/2006 12:40	23/11/2006 13:02	350.3
	05/12/2006 13:05	05/12/2006 14:09	654.9
	27/02/2007 15:56	27/02/2007 15:56	489.5
Site 1	15/03/2006 10:40	15/03/2006 11:01	113.7
	29/03/2006 10:55	29/03/2006 11:15	34.2
	23/11/2006 10:58	23/11/2006 11:17	123.9
	05/12/2006 16:02	05/12/2006 16:22	158.4
Site 2	09/03/2006 09:50	09/03/2006 09:50	67.2
	15/03/2006 10:00	15/03/2006 10:35	228.0
	29/03/2006 10:20	29/03/2006 10:49	53.8
	02/05/2006 14:00	02/05/2006 14:20	7.4
	18/05/2006 08:38	18/05/2006 08:57	41.8
	06/10/2006 08:05	06/10/2006 08:31	181.4
	23/11/2006 10:15	23/11/2006 10:50	154.0
	28/02/2007 11:32	28/02/2007 11:32	86.2