FLOOD RISK ASSESSMENT

TO SUPPORT THE PLANNING APPLICATION FOR THE PROPOSED SITING OF PERMENANT POLYTUNNELS IN ASSOCIATION WITH "TABLE TOP" STRAWBERRY PRODUCTION

LAND AT HOMME FARM, HOM GREEN, ROSS ON WYE, HEREFORDSHIRE, HR9 7TF

for

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HOMME FARM POLYTUNNELS FLOOD RISK ASSESSMENT
NON TECHNICAL SUMMARY

Planning consent for 54ha of "Spanish" polytunnels at Homme Farm, Herefordshire was granted in 2008. The consent was for rotational polytunnels that incorporated the "in ground" soft fruit growing system.

A new planning application for 48.6ha of polytunnel development at Homme Farm, Herefordshire is being submitted on behalf of E C Drummond & Son by Davies Light Associates Ltd. The application is to erect fixed, permanent (i.e. non-rotating) "Spanish" polytunnels that incorporate the "Table Top" soft fruit growing system that would replace the existing consented polytunnels.

This Flood Risk Assessment (FRA) has been undertaken to support the application and has written and submitted in accordance with guidelines laid out in the technical guidance for the National Planning Policy Framework (NPPF) and incorporates FRA1 Guidance Note "Development greater than 1 hectare in Flood Zone 1".

The principal objective of this appraisal is to demonstrate that the amount of water running off the site for the polytunnel development will not exceed the amount running off in a "Greenfield" scenario. This report has been prepared by Envireau Water, a specialist independent water management consultancy. The approach taken duplicates that taken in other areas, which have been approved by the Environment Agency.

The "Table Top" polytunnel application represents a 10% reduction in the existing, consented polytunnel coverage. The whole farm catchment is approximately 356ha of which the "Table Top" polytunnel planning application area represents 13.7% of the land coverage

The "Table Top" method of growing soft fruit under the polytunnels uses growing trays are located in a frame at approximately waist to chest height and are trickle fed with water and nutrients. Because the irrigation is applied to the growing trays, there is no wetting of the natural soils. The irrigation of the soft fruit plants within the growing trays can also be controlled and implemented more efficiently. No soft fruit plants are planted directly into the ground.

Noticeable benefits of the "Table Top" system will be the elimination of soil mobilisation, better soil drainage between polytunnels and improved humidity levels in the polytunnels. The irrigation system for the "Table Top" growing system will be completely separated from natural runoff.

The standard quantitative approach normally undertaken for FRA's is that detailed in DEFRA/Environment Agency document "Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision D, re-published June 2007". This utilises an analysis based on a 1 in 100 year storm and takes into account a 20% climate change surcharge in accordance with NPPF guidelines, and in turn, calculates the relevant storage requirement to attenuate additional runoff generated by the development.

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A key technical issue is that the calculations outlined in the DEFRA/Environment Agency document are dependent on using a value for the percentage of the development area that is impervious. Inherent to the design, construction and development of the "Table Top" growing method is that rainfall is allowed to follow its natural course and dissipate over grassland beneath the entire area of the polytunnel covers as if it were a "Greenfield" scenario. Therefore, the net impervious area for the development is essentially zero percent. Therefore, a qualitative approach has been undertaken for the polytunnel areas as it has been deemed that a valid quantitative approach is unattainable and/or inappropriate.

It is important to recognise that the polytunnel growing system is characterised by rural hydrology and not urban hydrology. While the polytunnels themselves form a high runoff cover, the drainage from the farm is controlled by the processes at ground level, which is generally grassed soil. Because the "Table Top" growing methods will be employed and runoff dispersed beneath the polytunnel covers, the net effect is that no additional rainfall runoff volume or increase in rainfall runoff rate is generated. This is different from an urban setting, where development generally leads to high runoff surfaces, with drainage controlled by pipes, resulting in high runoff velocities.

When identifying potential areas for the polytunnel development, the proposed polytunnel locations were identified to be available within Flood Zone 1. Under guidelines laid out in NPPF, the polytunnel development has been classified as "less vulnerable" and the development is considered appropriate for Flood Zone 1. The Exception Test is not relevant to this development.

This assessment has demonstrated that the development at Homme Farm will not have a detrimental impact on drainage and flooding on or off the farm site. The farm will remain safe during times of flood; will result in no net loss of floodplain storage; will not impede water flows and will not increase the flood risk elsewhere.

HOMME FARM POLYTUNNELS FLOOD RISK ASSESSMENT

1 INTRODUCTION

Planning consent for 54ha of "Spanish" polytunnels at Homme Farm, Herefordshire was granted in 2008. The consent was for rotational polytunnels that incorporated the "in ground" soft fruit growing system.

A new planning application for 48.6ha of polytunnel development at Homme Farm, Herefordshire is being submitted on behalf of E C Drummond & Son by Davies Light Associates Ltd. The application is to erect fixed, permanent (i.e. non-rotating) "Spanish" polytunnels that incorporate the "Table Top" soft fruit growing system that would replace the existing consented polytunnels.

This Flood Risk Assessment (FRA) has been undertaken to support the application and has written and submitted in accordance with guidelines laid out in the technical guidance for the National Planning Policy Framework (NPPF) and incorporates FRA1 Guidance Note "Development greater than 1 hectare in Flood Zone 1".

The principal objective of this appraisal is to demonstrate that the amount of water running off the site for the polytunnel development will not exceed the amount running off in a "Greenfield" scenario.

The Flood Risk Assessment (FRA) includes:

a) Location plans showing geographical features, watercourses, the existing farm site and the development proposals.
b) Topographic data showing surface water flow routes from polytunnels to receiving watercourses.
c) Details of how runoff is collected, stores and transferred off the farm.

The "Table Top" method of growing soft fruit under the polytunnels will be employed at the farm. By using this method, growing trays are located in a frame at approximately waist to chest height and are trickle fed with water and nutrients. Because the irrigation is applied to the growing trays, there is no wetting of the natural soils and therefore, the natural soil moisture content under the polytunnels will be the same or less than that outside the polytunnel. The irrigation of the growing trays or pots of the soft fruit plants can also be controlled and implemented more efficiently. No soft fruit plants are planted directly into the ground. As a result the ground is covered by a grass sward, much the same as in a meadow. No soft fruit plants are planted directly into the ground.

This report has been prepared by Envireau Water, a specialist, independent water resources and water management consultancy. The lead consultant was James Dodds, the Managing Director of Envireau Water, who has some 25 years experience in water management consulting.

The approach taken for this study duplicates that taken in other areas, which have been reviewed and accepted by the Environment Agency.

2 FARM DESCRIPTION

Homme Farm is located at Hom Green, approximately 1.5km to the southwest of Ross-on-Wye (Figure 1). The farm is centred at grid reference SO 580 215 covering an area of 356ha and elevations across the farm site vary between 28 and 62mAOD.

Based on Ordnance Survey mapping at a scale of 1:10000, the topography of the farm site consists of four small drainage catchments and natural drainage courses that have gradients ranging from 0.2% to 10% with the majority of gradients less than 5%. The four drainage catchments are spurs that project into the Wye Valley with the natural farm drainage courses eventually flowing into the River Wye at the farm boundary.

The geology of the site has been taken from British Geological Survey (BGS) 1:50000 sheet 215 (Ross-on-Wye) and comprises of the Brownstones Formation of the Lower Old Red Sandstones of Devonian age. These are drab, red-brown pebbly sandstones with minor red-brown mudstones and calcretes.

According to the Soil Survey of England and Wales map and classification, the Brownstones Formation at Homme Farm are overlain by either:

- Sub-group 541c: Well drained, reddish, coarse loamy soils that shallows in places, especially on brows

  or

- Sub-group 541w: Well drained reddish, coarse and fine loamy soils over gravels that are locally deep.

Additional, flat lying land adjacent to the River Wye is described as:

- Sub-group 561b: Deep stoneless permeable silty soils with gravely subsoils in places.

The farm is relatively well drained with groundwater levels at the farm expected to be greater than 5m below ground level.

3 QUANTITATIVE DATA ANALYSIS

Although developed for urban runoff settings, the approach normally taken by Envireau Water in compiling a FRA for a site is to incorporate the calculation detailed in DEFRA/Environment Agency document "Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision D, re-published June 2007". This is then normally combined with runoff calculations using the Revitalised FSR/FEH rainfall runoff method (ReFH).

Inherent to the calculations used in this approach is the use of a PIMP value (Percentage of Impervious Area) in relation to the development site, excluding "greenfield" areas. However, the nature and considerate design of the "Table Top" growing method allows the polytunnel area to replicate that of an open meadow scenario by allowing runoff to flow, undisturbed by the polytunnel erection, beneath the polytunnel covers. Therefore, it is considered that the PIMP value is essentially zero percent and hence, a quantitative approach has been deemed both inappropriate and invalid.

This being the case, this FRA has been assessed qualitatively with experience gained from previous FRAs undertaken by Envireau Water for a variety of polytunnel sites and growing methods around UK.

4 QUALITATIVE ASSESSMENT OF PROPOSED POLYTUNNEL DEVELOPMENT

4.1 Hydrological Characterisation

Based upon a combination of Ordnance Survey topographic mapping and a detailed walk-over survey of the site undertaken by Envireau Water on 24th May 2012, the farm area has been considered as four sub catchments, which are shown on Figure 1.

Figure 2 compliments Figure 1 and shows the areas of polytunnel development, together with the direction of overland runoff, the location of drainage channels and ponded areas. The polytunnel areas illustrated in Figure 2 forms the basis of the qualitative assessment of runoff from the site. The planning application is for a 48.6ha of the land covered by polytunnels spread out across the whole farm with polytunnel blocks sited in all four sub-catchments. Figure 3 shows photographs of drainage channels and land form taken around the farm relative to where polytunnels will be placed

Homme Farm currently use polytunnels to grow soft fruits in the ground. It is proposed that this method will no longer be employed and that the "Table Top" growing method be utilised instead.

It is important to recognise that the hydrological characteristics of the polytunnel growing system is characterised by rural hydrology and not urban hydrology. While the polytunnels themselves form a high runoff cover, the drainage from the site is controlled by the processes at ground level, which is generally grassed and vegetated soil. Inherent to the design, implementation and success of the "Table Top" growing method is the control of the rainfall runoff, the nutrient feed management and water management across the site. This results in an overall low runoff velocity system without generation of additional runoff volume. This is different from an urban setting, where development generally leads to high runoff surfaces, with drainage controlled by pipes, resulting in high runoff velocities.

As previously mentioned the concept of the "Table Top" method of growing soft fruit under the polytunnels is summarised in pictorial examples in Figure 4 and schematically on Figure 5. Growing trays are located in a frame at approximately waist to chest height and are trickle fed with water and nutrients. No wetting of the natural soils occurs and no soft fruit plants are planted directly into the ground. As a result the ground cover is grassed, much the same as in a meadow.

This conceptualisation is important, as the drainage system following the establishment of the polytunnels is an agricultural drainage system and not an urban drainage system. It is therefore important that the analysis approach and technique reflects this.

Excess irrigation water from the growing trays will be collected via a closed pipe system that will be incorporated into sub-terranean trenching located at the end of each polytunnel block. This closed pipe system is independent from the surface water drainage system. Excess irrigation water will be directed to a collection sump. Therefore, this method of soft fruit growing encourages the optimum efficiency for water/nutrient use and management saving on both cost and resources. This method also negates the need for specialised fertilisers associated with "in ground" growing methods thereby benefiting the general environment.

The irrigation system and surface water drainage will be completely separate systems and will NOT interact.

Runoff and drainage from the farm eventually finds its way to the River Wye. The River Wye has large relatively flat lying floodplain partially located within the farm boundary. This floodplain has been characterised by the Environment Agency (EA) as a flood risk zone and is illustrated in Figure 1. The flood risk zone has been classified by the EA as a Flood Zone 3 and represents a 1 in 100 year flooding event. No polytunnels are located within this zone with land use being small grain crops, turf or grazing.

4.2 Proposed Polytunnel Erection

A key consideration and design factor in using the "Table Top" growing method is that the erection of the polytunnel stands and the legs for the "Table Top" trays leaves the topography of the farm unaffected.

The polytunnel stands are driven into the ground and no channel generation or earth moving takes place. Therefore, the surface characteristics of the fields remain unaffected, no new preferential flow paths that encourage rilling are generated and runoff flows are maintained as overland flow.

4.3 Polytunnel Layout

Figure 2 shows the proposed location and layout of the polytunnels on the farm.

The total farm land ownership area within which the polytunnels are located extends to approximately 365ha of which the proposed polytunnels represent 48.6ha.

The polytunnels will only be covered / sheeted for approximately 8 months of the year and will not be covered in winter and when strong winds are forecast.

Under "general" agricultural conditions, it is likely that the farm will have exposed soils at some point between cropping cycles. This can lead to increased rainfall runoff rates and volumes and in turn, leads to the potential for greater erosion and sediment mobilisation. A key benefit of the "Table Top" growing methods is that the areas beneath the polytunnel covers are permanently grassed. By permanently maintaining a grass cover in the fields all year round, the "Table Top" is in fact an improvement over the existing scenario by maintaining runoff attributable to a "Greenfield" runoff rate.

4.4 Polytunnel Orientation and Drainage

Drainage from the proposed polytunnels will be in two stages. The first stage covers the interception by the polytunnel covers and in the leg row areas. The second stage is the generation of overland flows across the ground surface and ultimately to drainage ditches on the farm and watercourses off the farm. This is shown schematically in Figure 5.

Rainfall hits the polytunnels with the assumption of instantaneous and total run-off to ground surface. Rainfall intercepted by polytunnels accumulates at the legs and is then spread by overland flow over the meadow area following the natural topographic contours.

The orientations of the proposed polytunnels are carefully considered in relation to the topographic contours. Where practicable, the polytunnels are placed across or at an angle to the topographic contour. This eliminates the potential for runoff channels to be generated along the legs of the polytunnel and encourages runoff to naturally flow and be dispersed over the whole area beneath the polytunnel covers.

The combination of the grassed land surface below the tunnels together with the dispersion of the runoff between the leg rows, results in the runoff characteristics of the polytunnel area replicating

that of a meadow with the exception that the losses in the system due to meadow rainfall interception is limited. However, evapotranspiration beneath the polytunnel cover will be greater while the soil moisture will be moderately lower than without the covers allowing greater infiltration and take up of runoff, counter balancing the effect of limited interception. Conceptually therefore, it can be considered that in the case of this development, the polytunnels will have little net effect on the runoff characteristics and replicate that of an open meadow.

In all four hydrological sub-catchments, overland runoff is allowed to leave the polytunnel area as it would in an open meadow scenario. Generally, after passing over wide grassed headlands, rainfall runoff will then pass through established hedge or tree lined field boundaries or drainage ditches before finally leaving the farm to ultimately enter into the local watercourse.

The net result of the "Table Top" growing method is that irrigation and nutrient rich waters are efficiently controlled and kept separated from the natural hydrology. Also, with active management and considerate planning the hydrological characteristics of the polytunnel areas replicate that of an open meadow scenario.

For Area A, runoff from polytunnels generally reaches the low point and is dispersed by grassed headlands. Runoff then moves through hedgerows at the River Wye floodplain levee and enters the River Wye floodplain. Runoff then leaves the site along the reach of the River Wye to the west of Homme Farm by entering drainage ditches or as overland flow or by infiltration to ground.

For Area B, the majority of runoff is not from polytunnel areas. Runoff from polytunnels generally accumulates and flows through grassed drainage channels and ponds. Runoff then leaves the site along the reach of the River Wye to the south of Homme Farm via drainage ditches or as overland flow or by infiltration to ground.

For Area C, runoff from polytunnels generally accumulates in grassed drainage channels constructed for the polytunnels and then follows the natural topographic gradient into drains running through a marshland area. The marshland area has a low topographic gradient and the drainage channels are deep and heavily vegetated. Runoff then generally leaves the site via channel flow at the site boundary before entering the River Wye to the south.

For Area D, runoff from polytunnels follows the natural topographic gradient into the drainage ditch running along the southern boundary of the site. The drainage ditch flows through a ponded area before discharging into a drainage pipe. The drainage pipe emerges some 300m to the north into a small watercourse that then flows onto the River Wye floodplain before entering the River Wye.

Overall, Homme Farm is actively engaged in providing and maintaining a water management system at the site.

4.5 Sediment Mobilisation

The use of the "Table Top" growing methods and the grassed areas beneath the polytunnels has a significant positive effect on the reduction of soil erosion and sediment mobilisation.

Overland flow velocities >1cm/s have the potential to start mobilising soil particles and therefore initiate erosion; and velocities >10cm/s will almost certainly transport soil particles and initiate erosion, if the water is flowing over bare soil (Reading, 1986).

By utilising largely grassed areas, the runoff is dispersed over the ground surface and flow velocities are greatly reduced due to the resistance of the grass. As a result soil stability is greatly increased. Soil stability is increased further by the binding effects of the roots.

As mentioned previously, the potential for sediment mobilisation is greatly reduced due to the farm being permanently grassed for the "Table Top" scenario as opposed to the soils being periodically exposed.

5 SEQUENTIAL TEST AND EXCEPTION TEST

Land characterised by the Environment Agency (EA) as a flood risk zone that is located in the vicinity of Homme Farm are illustrated in Figure 1. The flood risk zone is split into three areas that are classified by the EA as Flood Zone 1 (Lowest Probability) Flood Zone 2 (Medium Probability – representing a 1 in 1000 year flooding event) and Flood Zone 3 (High Probability - representing a 1 in 100 year flooding event).

The Sequential Test from the technical guidance to the National Policy Planning Framework (NPPF) guides development to areas at the lowest probability of flooding (Flood Zone 1).

When identifying potential areas for the polytunnel development, the proposed siting of polytunnels was identified to be available within Flood Zone 1.

Under the technical guidance laid out in the NPPF, the polytunnel development has been classified as "less vulnerable"" and the development is considered appropriate for Flood Zone 1.

The technical guidance to the NPPF indicates that the Exception Test is not relevant to this development.

The polytunnels located at the application area will remain operational and safe during times of flood, will result in no net loss of storage from the floodplain and will not increase the flood risk elsewhere.

6 DISCUSSION

It is important to place the "Table Top" growing methods of polytunnel development into the correct context. This type of development by its very nature is rural. While the polytunnels themselves generate essentially 100% runoff, as soon as the water hits the ground, then soil and vegetation surface processes such as infiltration, evapotranspiration and dispersion will start to attenuate the runoff over the whole of the grassed area beneath the polytunnel cover. The polytunnels will be purposely designed, orientated and constructed to follow the natural topographic surface and encourage dispersion of runoff beneath the polytunnel cover. Increases and decreases to evaporation, infiltration, interception and soil moisture will occur for the development, however, the net effect will replicate that of an open meadow scenario.

At the end of the polytunnels, discharge into and over grassed headlands will further attenuate flow rate and volumes by resistance in the grass sward as well as the other processes.

Therefore, there is little drainage modification over that which would be present in an agriculturally drained grass field. This means that increase in runoff rate or runoff volume will NOT be generated.

It is important to consider that a no polytunnel scenario does not mean that the land would be meadow. This is very different to urban development, where it is reasonable to compare the developed land (usually hard surface and high runoff) with a "Greenfield runoff" rate. Economically viable alternatives crops to the polytunnels could and often does lead to soils being exposed during certain times of the year between cropping cycles, particularly in the winter. This can lead to increased runoff rates and volumes and also erosion potential. The "Table Top" growing method will generate fields that are permanently grassed all year round and will therefore improve the hydrological characteristics of the fields between cropping cycles.

The successful management of rainfall runoff and drainage from the polytunnels is therefore, dependent on the pro-active water and nutrient management at the farm site. This not only benefits the hydrological characteristics of the farm but is also inherent to the success of the "Table Top" growing method making growing, water use and nutrient use more efficient and cost effective. This method of growing results in a reduction in the use of agro-chemicals when compared to standard agricultural practices and eliminates the use of agro-chemical or fertiliser application to surface soils for crop growing.

7 OTHER POTENTIAL SOURCES OF FLOODING.

7.1 Flooding from streams and rivers

As previously discussed runoff from the polytunnel areas gravitates towards the River Wye or its tributaries. The flood zone of these watercourses does not encroach into the application boundary and will not generate flooding for the polytunnel area.

There are no watercourses up gradient of Homme Farm that will generate direct surface runoff to the planning application area during flood events.

7.2 Flooding from the sea

There is no risk from flooding from sea.

7.3 Flooding from groundwater

Groundwater levels are estimated to be around 5 to 30m below ground level. These estimates are based on topography and the geology of the area.

This range of groundwater level will not pose a risk to the development or access to the farm.

In the unlikely event of flooding, groundwater flooding will be that associated with the EA Flood Zone 3. It is unlikely that groundwater will be raised sufficient to induce flooding of Homme Farm.

7.4 Sewers and road drainage

The farm site is a rural, agricultural development and as such there are no sewer systems or road drainage associated with the polytunnels areas.

The local housing sewerage systems are by means of soakaway or small, domestic package treatment plants that discharge into the local unnamed watercourse. These dwellings are located in EA Flood Zone 1 and any flooding of the sewage systems will not, by nature of their development, affect or be affected by the polytunnel development.

7.5 Reservoirs and canals

There are no reservoirs and canals up gradient of farm boundary.

8 ENVIRONMENT AGENCY CONSENTS

The polytunnels will NOT be located within 8m of the banks of the local watercourses.

There is no requirement for a land drainage, impoundment or flood defence consent.

9 DRY ACCESS ROUTES

Based on the location of the farm in Flood Zone 1, a dry access route during the 1 in 100 year +20% event will always be available.

10 DRY ISLANDS

In the event of flooding, EA Flood Zones 2 and 3 do not surround the farm area and therefore, no dry islands will be produced.

11 CONCLUSIONS

The planning application for Homme Farm is to move away from the permitted development of "in ground" growing method polytunnels, to be replaced with the "Table Top" growing method polytunnels. The application is for 48.6ha of "Table Top" polytunnels, a net reduction of 10% of total polytunnel area in relation to the permitted polytunnel development.

This qualitative assessment has demonstrated that the polytunnel development at Homme Farm will not have a detrimental impact on drainage and flooding by incorporating the "Table Top" soft fruit growing method. In fact, the polytunnel development will improve the drainage and erosion at the farm between cropping cycles when compared to standard agricultural practices.

An important element of the planning of the proposed polytunnel development to both the hydrological characteristics of the farm and the successful and efficient growing of soft fruits is that the drainage system is carefully considered. By incorporating the "Table Top" growing method the net effect is that the hydrological characteristics at the farm replicates that of an open meadow scenario so that runoff rates and runoff volumes do not increase.

Based on Envireau Waters' experience of producing FRAs for several other polytunnel developments around the UK, it is considered that attempting to quantitatively assess runoff using the DEFRA/Environment Agency document "Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision D, is both inappropriate and invalid for the "Table Top" growing method proposed for this site. The principal reason for this is that the development will not detract from the permeable areas already existing at the site, i.e. the PIMP value for the development is essentially zero percent.

Overall, Homme Farm will be actively engaged in providing and maintaining a water management system at the proposed farm site.

Under the technical guidance laid out in the NPPF, the polytunnel development has been classified as "less vulnerable"" and the development is considered appropriate for Flood Zone 1. This FRA has demonstrated that the proposed development will be located within Flood Zone 1.

With the current and recommended water management systems at the farm, the farm area will remain operational and safe during times of flood; will result in no net loss of floodplain storage; will not impede water flows and will not increase the flood risk elsewhere.

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Director

Bibliography

Butler, D., and Davies, J.W. (2004). Urban Drainage 2nd Ed. Spon Press, London.

Chambers, B.J., Garwood, T.W.D. and Unwin, R.J., (2000). Controlling soil water erosion and phosphorus losses from arable land in England and Wales. Journal of Environmental Quality 29, 145-150.

Chow, V.T., Maidment, D.R. and Mays, L.W. (1988). Applied Hydrology. McGraw-Hill, Ltd

DEFRA/Environment Agency. (2007). Preliminary rainfall runoff management for developments. R&D Technical Report W5-074/A/TR/1 Revision D.

Environment Agency. (2007). FRA Guidance Note 1: Development greater than 1 hectare in Flood Zone 1.

National Planning Policy Framework. 2012

National SUDS working group. 2004. Interim code of practice for sustainable drainage systems.

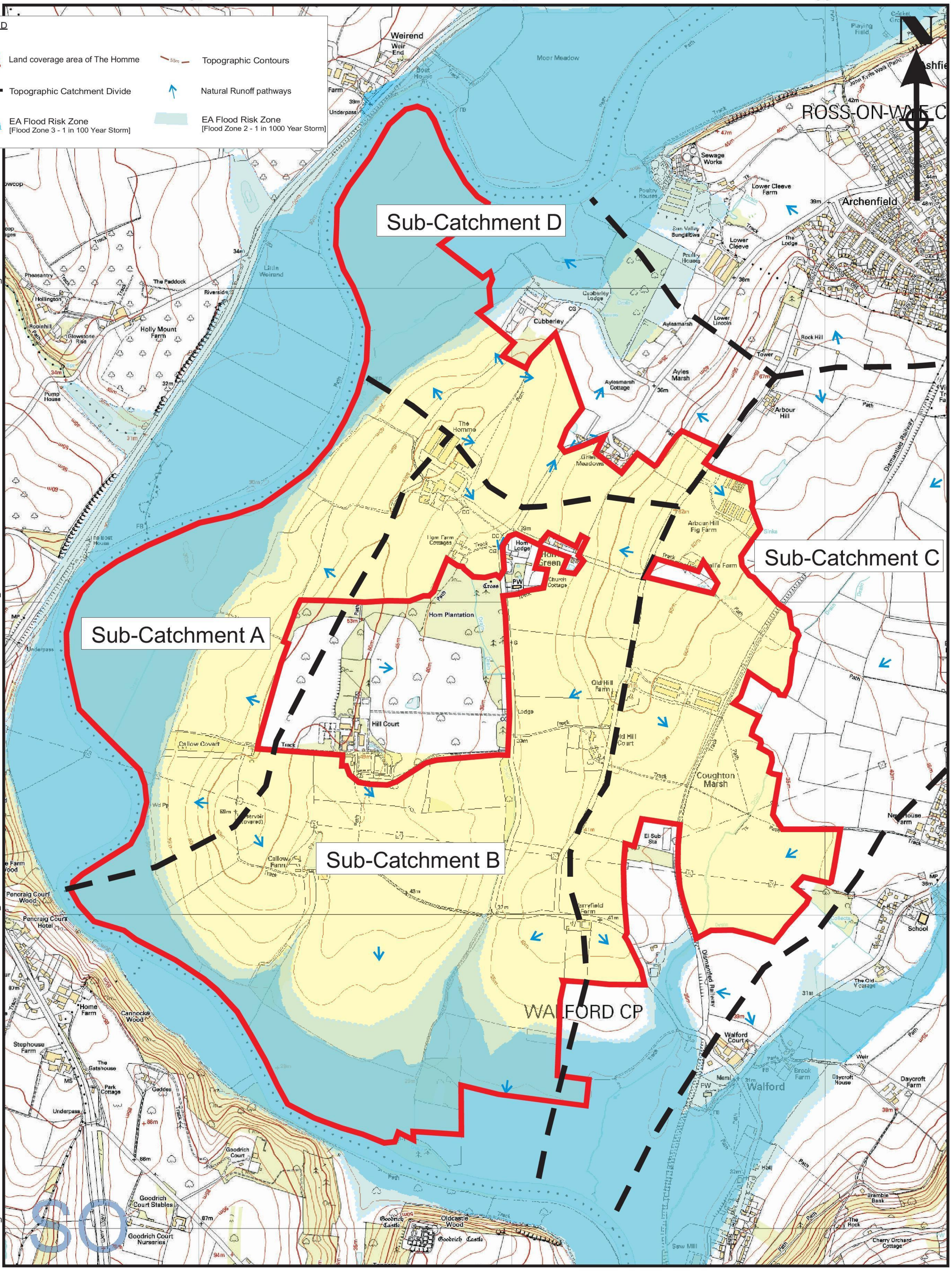
NERC (1999) Flood Estimation Handbook, with WIN-FAP FEH software and FEH CD-ROM 3 (2010) for catchment descriptors. Centre for Ecology and Hydrology, Wallingford.

Reading, (1986). Sedimentary Environments & Facies, Second Edition, edited by H.G. Reading. Blackwell Scientific Publications, Oxford. 1986. From Figure 12.2 D, p-400 (after McCave, 1984).

Technical Guidance to the National Planning Policy Framework. 2012

Quinton, J.N. and Catt, J.A., (2004). The effects of minimal tillage and contour cultivation on surface run-off, soil loss and crop yield in the long-term Woburn Erosion Reference Experiment on sandy soil at Woburn, England. Soil Use and Management, 20, 343-349

FIGURES



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Ref: P:\Drummond TT Poly FRA (1364)\Fig 1 Date: 30/10/2012	**Homme Farm - FRA**
Figure 1	Site Location and Hydrological Catchments

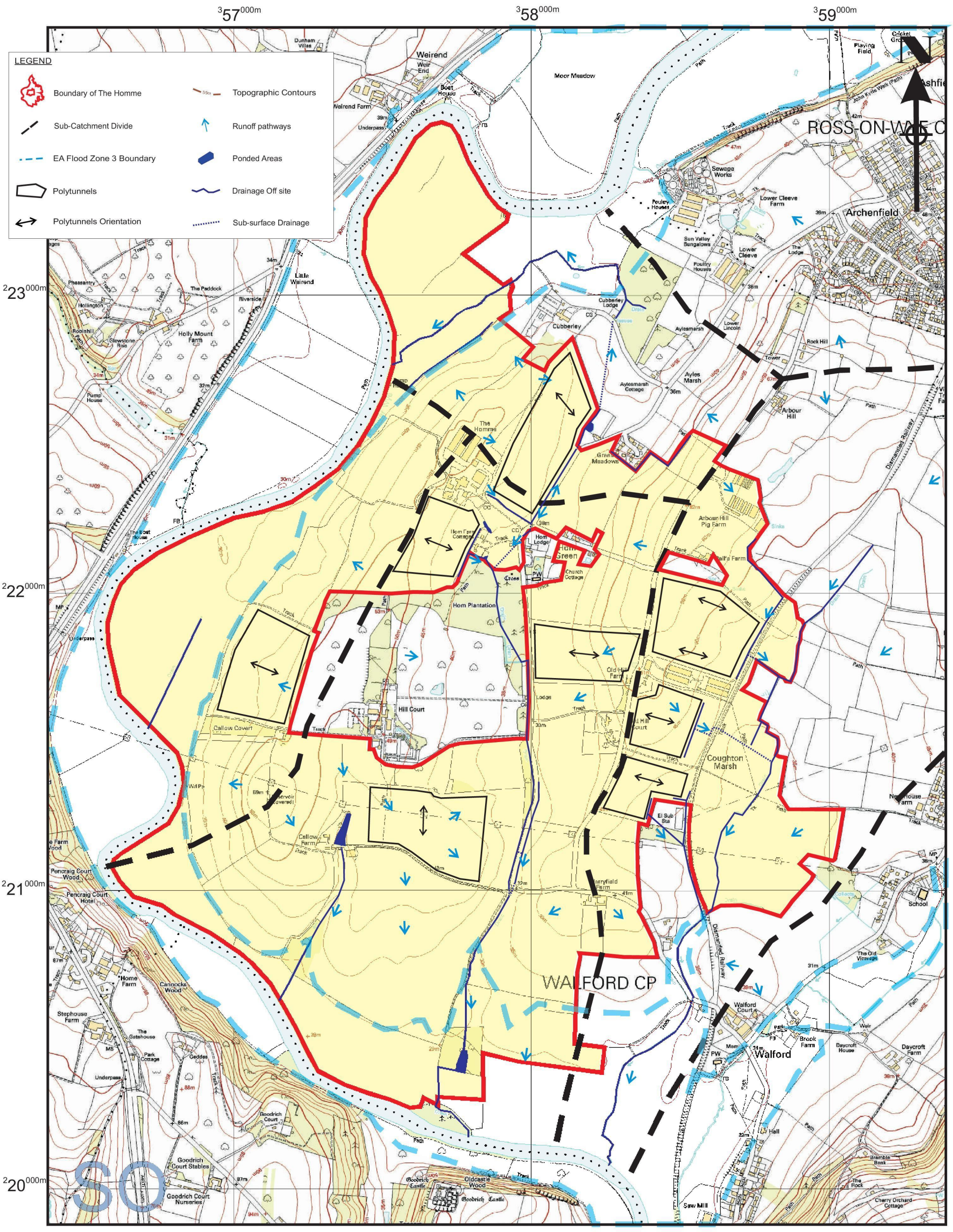

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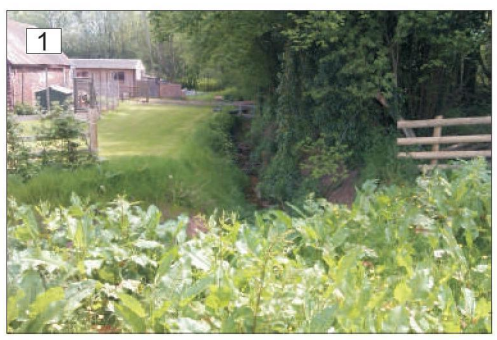
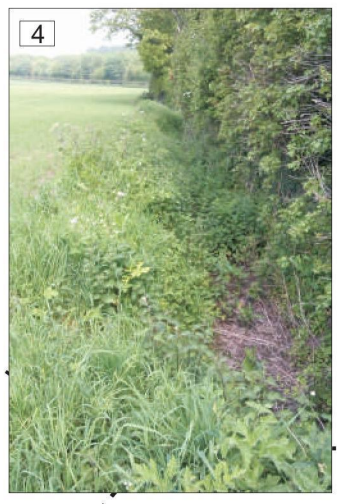
Figure 2	Polytunnel Placement, Orientation and Drainage Pathways





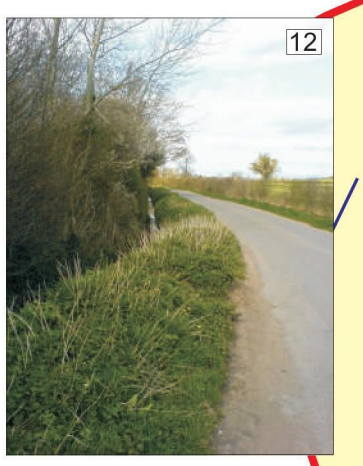


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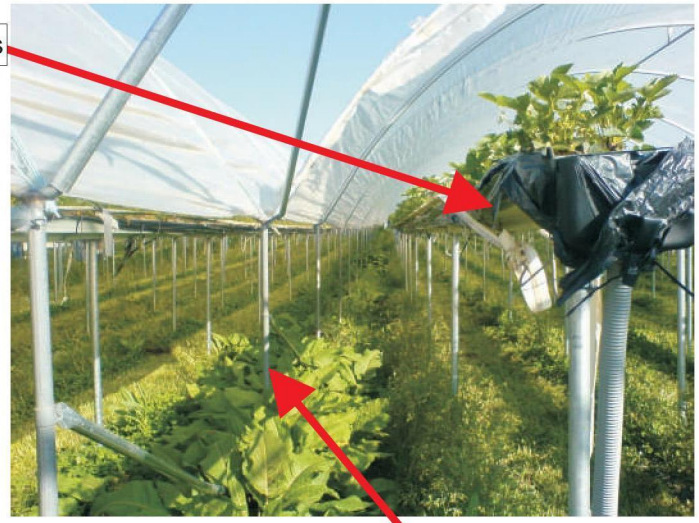
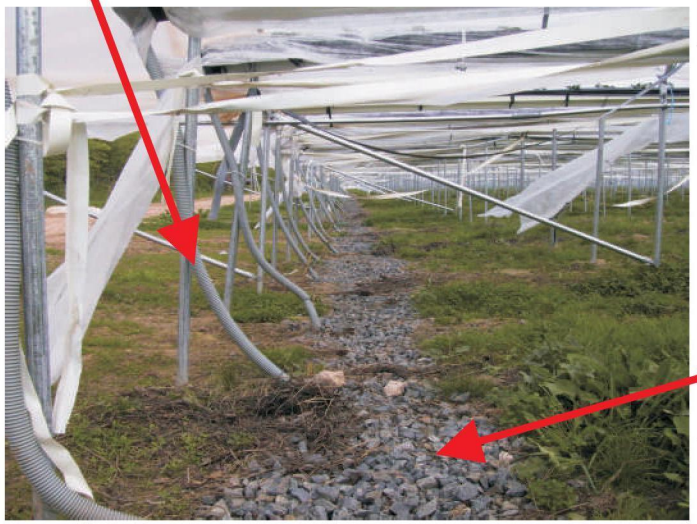
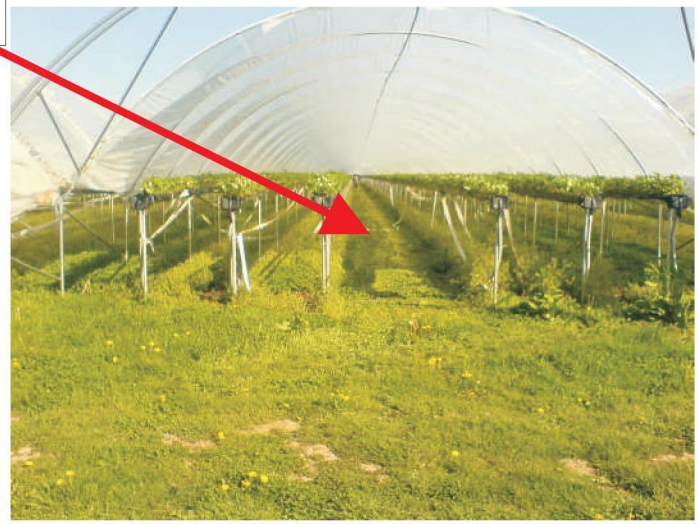
Figure 3	Photographs of Land Use

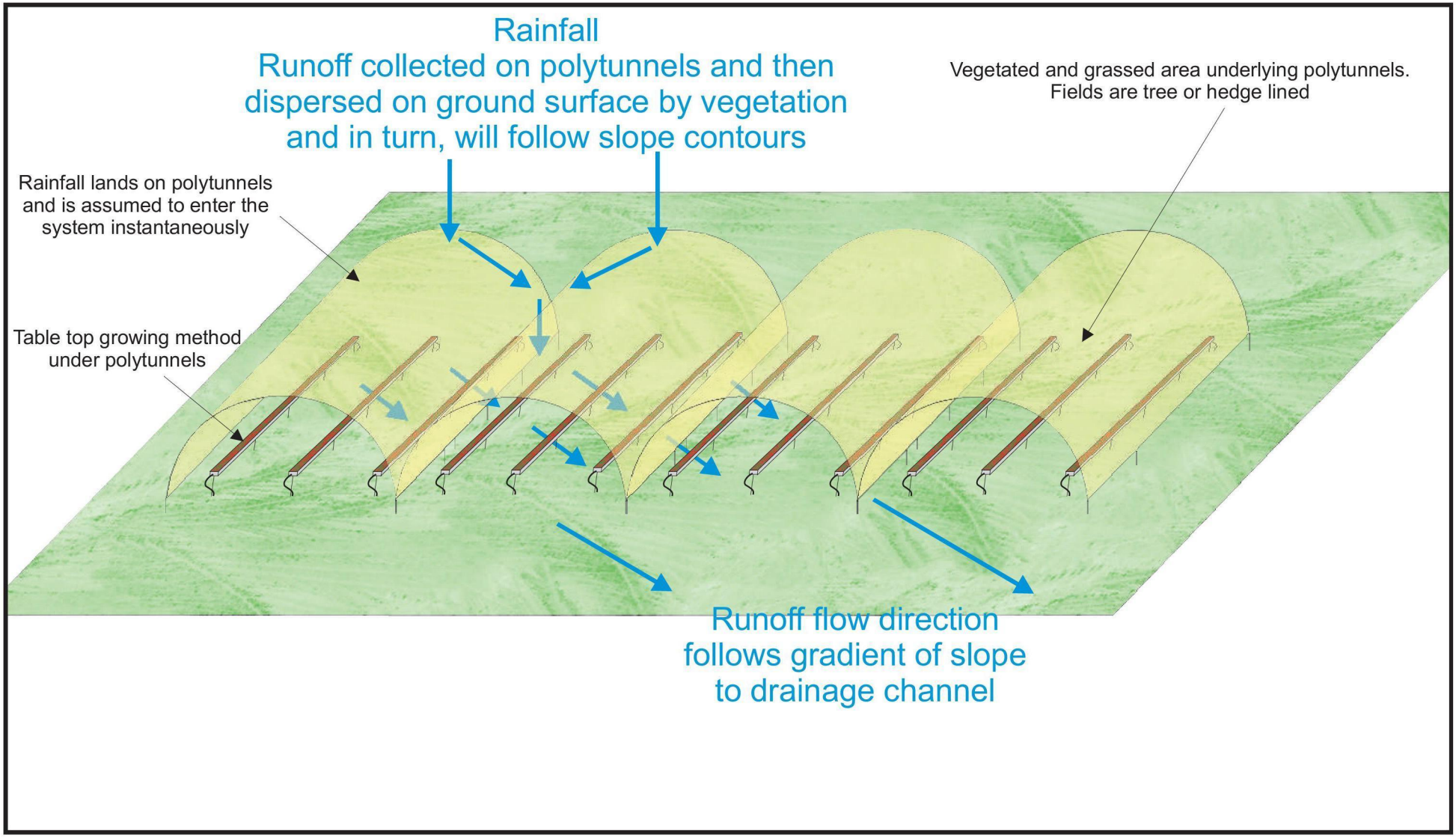






envireau WATER

Ref: P:\Drummond TT Poly FRA (1368) \Fig 4 .cdr Date: 30/10/12	**Homme Farm - FRA**
Figure 4	Pictorial Representation of the Proposed Polytunnel Development Incorporating the "Table Top" Growing Method



envireau WATER

Ref: P:\Drummond TT Poly FRA (1368) \Fig 5 .cdr Date: 30/10/12	**Homme Farm - FRA**
Figure 5	Schematic Diagram of Polytunnel Runoff and Drainage for the "Table Top" Growing Method