Forestry Commission **Proposal for funding Agreement Number CFS 10-2011-15**

FORESTRY COMMISSION
Description of the Research Project or Services

1.	**Research Purchasing Manager (C&FS)**	**Sallie Bailey**
	Relevant PAG	**Ecosystems and Biodiversity**

2.	**Name of FR Programme Manager (PgM) or Project Manager (PM) and staff**	**Dr Thomas R Nisbet (PgM)** **Dr Elena Vanguelova (PM, WP6,7)** **Dr Nadeem Shah (PM, WP3)** **Huw Thomas (PM, WP2)** **Dr Rona Pitman (PM WP6,7)** **Samantha Broadmeadow (PM WP4)**
	Name of Institution/company	**FR**
	Official address	Alice Holt Lodge, Wrecclesham Farnham Surrey, GU10 4LH
	Telephone No.	
	e-mail address	Tom.nisbet@forestry.gsi.gov.uk
	Programme Life (years)	**4 Years: Programme funding declining from £529k in FY11/12 to £451k in FY14/15**
	Start Date	**1st April 2011**
	Completion Date	**31st March 2015**
	Revision Dates	**31st March 2012/2013/2014**

3. Title of Research Project or Service

Protecting Soil and Water Resources

4. Abstract of proposed research (*Summary to be used on website/FRCC etc***) (200 words)**

At the core of the Government's policy on sustainable forest management is the need to safeguard soil and water resources. Human actions, from local scale forest operations to international scale climate change and air pollution may compromise forest soil sustainability with consequential impacts on the freshwater environment. Poorly planned and managed forests can severely degrade soil and water resources, making forests more vulnerable to climate change. Good management, in contrast, seeks to maintain and enhance the natural protective functions of forests and the benefits they provide for society, including carbon sequestration, clean water and reduced flood risk. The overall objective of this programme is to evaluate through measuring, modelling and mapping the impacts of forests, woodlands and management practices on soil and water resources under a changing climate and changing pollutant emissions. It also aims to quantify the benefits of woodland creation for soil, water and flood management and evaluate the role of woodland in integrated catchment management. The findings will

improve our understanding of the nature of these impacts and be used to help develop practices and guide future policy to secure the soil and water services that underpin the multiple benefits provided by forests.

5. Aims and objectives (word limit 500)

5.1 Aim of the research

The research programme has two main aims. The first is to support the development and implementation of sustainable forest management with respect to the protection of soil and water resources. The Forestry Commission's Science and innovation strategy for British forestry 2010-2013 identifies 'Working towards a sustainable future' as one of its key themes and highlights the need to protect soil and water for long term sustainability. The programme will also contribute to a number of other themes, including 'Counting the carbon' and 'Protecting what we have'. Forests and forestry management practices are a major influence on both soil and water resources. Poorly planned and managed forests can severely degrade soil and water, making forests more vulnerable to climate change. Good management, in contrast, seeks to maintain and develop the natural protective functions of forests and the benefits they provide to society. At the core of the programme is the need to provide a firm base of scientific evidence to help underpin and aid further development of the UK Forestry Standard Requirements for forest soils and water, together with the associated soil and water guidelines.

While the UK Forestry Standard and guidelines have achieved much in protecting forest soil and water resources, a number of challenges remain. The most important of these is managing the impacts of future climate change. Predictions of warmer, wetter winters and hotter, drier summers will have a fundamental effect on soil properties and processes, and a direct impact on water resources. For example, wetter soils will reduce trafficability and increase the risk of soil damage and erosion, while an increased incidence of waterlogging could have a serious impact on root mortality and tree stability. Changes to rainfall and evaporation are likely to increase the risk of floods and drought, while drier summers will increase soil water stress with implications for soil carbon and water quality. A related challenge stems from developments in forestry systems designed for carbon gain, particularly the increasing interest in energy forestry. An expansion of intensive forestry such as the planting of short rotation crops of Eucalyptus and the harvesting of forest residues present new threats to forest soils and water. There is a need to understand the impacts of climate change and new forestry systems:

- So that the Forestry Commission can continue to develop and refine policies and practical guideline measures to ensure compliance with UK and European legislation on water protection, including the EU Water Framework Directive and EU Floods Directive, as well as any future legislation that results from the European Thematic Programme on soil protection.
- To aid development of the woodland Carbon Code by incorporating changes in soil carbon stocks and to improve national carbon accounting.
- To aid development of soil carbon models simulating changes in forest soil functions under changing management and climatic conditions.
- To better predict tree growth and timber yield under a future climate to support forest planning and investment decisions.
- So that the Forestry Commission can develop appropriate policies and guidance on

choice of woodland type, species and provenance for adapting to increased summer soil water stress and winter waterlogging.
- So that the UK can meet Forest Europe's Warsaw Resolution 2 (November 2007) on 'Forests and water' concerning the sustainable management of forests in relation to water, better coordination of policies on forests and water, and addressing the impacts of climate change.
- To maximise the forestry sector's contribution to soil and water related targets set by UK government, the devolved administrations and the National Offices.
- To better manage and regulate the disposal of a range of waste materials to forest land.

The second main aim of the research programme is to quantify the benefits of woodland creation for soil, water and flood management. It is increasingly recognised that woodland creation could help mitigate a number of protracted problems associated with other land uses, such as reducing diffuse water pollution and flood risk. For example, the ability of woodland to protect soils, slow down runoff and retain pollutants can alleviate the large diffuse pollution pressure exerted by agriculture and urban activities, as well as aid flood management. There is significant potential for targeted woodland creation to tackle these issues through better land use integration at the catchment scale. This requires research and monitoring work to:

- Provide evidence of the beneficial role of forests in mitigating diffuse pollution and flood risk in order that other government departments, regulators and agencies include forestry-based measures in integrated catchment management plans.
- Identify where woodland creation would maximise soil and water services while minimising risks and disbenefits.
- Help quantify the contribution of woodland creation to carbon storage and sequestration.
- Support an economic valuation of soil and water-related forest services to underpin the case for additional funding contributions for woodland creation.

The programme will involve:

- Measuring the impact of forests, management practices and new planting on soil and water resources by conducting multi-scale (spatial and temporal) studies.
- Measuring and modelling the impact of climate change and air pollution on forest soils and water, and interactions with management practices.
- Aiding the development of best practice measures for soil and water protection through measurement, modelling, testing and demonstration.
- Developing mapping and modelling tools to promote integrated catchment management by guiding woodland creation to the most effective locations for maximising soil and water services while minimising risks and disbenefits.
- Building research partnerships and liaising with the forest industry, environmental regulators, government departments and other agencies to ensure outputs are understood and meet the needs of end users.
- Providing recommendations and guidance on forest policy and practice to ensure compliance with UK and European environmental legislation on soil and water protection, including developing and reviewing national and international guidelines and standards.

Added value will be provided by linking with relevant ongoing and planned FC, Government

agency and EC funded collaborative programmes. Programme outputs will range from publications, models, maps, guidance, the provision of seminars, workshops and training, to demonstration sites.

The main outcomes at the end of the four-year research programme are expected to be:

- Improved estimates of UK and country forest soil carbon stocks and carbon dynamics, including differences between forest types and species. This will generate improvements in soil and forest carbon modelling and reduce uncertainties in national carbon accounting.
- An improved Woodland Carbon Code incorporating soil carbon
- A better understanding of the impact of forest management practices on soil functions, including carbon stocks and the sensitivity of different soil types to disturbance. Improved guidance on management practices to secure or enhance forest carbon stocks over the longer-term.
- Improved knowledge of the likely impacts of climate change and interactions with air pollution on forest soil functions, including carbon stocks and the recovery of acidified forest soils and water, which will help to shape future policy on climate change and emission control.
- Improved knowledge of the risks and benefits presented by energy forestry to soil and water resources, which will help shape future policy on energy forestry and generate better guidance on site selection for energy forestry crops and the harvesting of forestry residues.
- Improved knowledge of the impact of upland forestry on the chemical and biological recovery of acidified soils and waters. Revised guidance on forest restocking to promote recovery and better relations with fishery groups.
- Improved knowledge of the contribution of forestry to flood risk management. Guidance on forest design and management to mitigate downstream flooding. A greater area of the UK covered by maps showing opportunities for woodland creation to reduce flood risk. An expansion of woodland planting leading to a reduction in local flood risk.
- Establishment of a catchment study to demonstrate and evaluate the contribution of targeted woodland creation to reduce diffuse pollution. Guidance on woodland placement, design and management for pollutant retention.
- A stronger case for integrated catchment management and greater financial support for woodland creation for soil and water services, supported by improved valuations of the economic benefit of these services.
- A better understanding of the threat posed by forests and woodlands to water supplies and ecological flows under a future climate and improved guidance on how to reduce the risk through forest design and management practices.
- Establishment of a catchment scale study to demonstrate and evaluate how to design and manage riparian woodland to mitigate the increasing risk of thermal stress to fish due to climate change.

5.2 Work Areas

Please list your work Areas as shown in the table below and show how they further sub-divide Work Areas should be individually costed and be time bound – see 13 below. Please state key desired outcomes from each work area. First two years should be detailed, the next two in outline. See also Note for this Section below.

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Work Area 1:	**Knowledge Exchange (T Nisbet, E Vanguelova, H Thomas, N Shah, R Pitman, Samantha Broadmeadow); Budget £177.0k (2011/12)**
Work package 1.1	Advice CFS
Work package 1.2	Liaison
Work package 1.3	PhD supervision
Work package 1.4	Programme development
Work package 1.5	Publications
Work Area 2:	**Sustainable Flood Management (H Thomas, T Nisbet, N Shah, Samantha Broadmeadow, Gregory Valatin, some TSU staff); Budget £44.8k (2011/12)**
Work package 2.1	Effect of semi-natural floodplain woodland on flood flows Continuation of river level and associated monitoring work at semi-natural floodplain woodland site at Great Triley Wood, near Abergavenny, Wales to capture the impact of the woodland and large woody debris (LWD) dam network on a wider range of flood flows; includes plan to assess the reverse impact of removing all constructed dams, after suitable baseline period. Purpose: to provide evidence base on contribution of floodplain woodland (focus on LWD dams) to managing flood risk.
Work package 2.2	Effect of planting new floodplain woodland on flood flows Continuation of river level and associated monitoring work on upper River Parrett in Somerset, SW England to capture the impact of the recently planted woodland on flood flows; site being used by new PhD student at Cardiff University. Purpose: to provide evidence base on contribution of newly planted/young floodplain woodland to managing flood risk.
Work package 2.3	Effect of planting riparian woodland on flood flows Installation of new water level recorders along Longcote Burn at Eddleston in the Borders to assess the impact of planned extensive planting of native riparian woodland on flood flows; linked to wider partnership funded study led by Dundee University. Also includes a contribution to monitoring work at Pickering, as part of the Slowing the Flow at Pickering project Purpose: to provide evidence base on contribution of riparian woodland planting to managing flood risk.
Work Area 3:	**Mitigating Diffuse Pollution (N Shah, T Nisbet, Samantha Broadmeadow, Andrew Peace, some TSU staff); Budget £103.2k (2011/12)**
Work package 3.1	Effectiveness of good forestry practice in reducing the impacts of conifer afforestation Continuation of long-term water quality and biology study at Halladale in N Scotland (established in 1993) to demonstrate the sustainability of upland conifer afforestation in a catchment supporting an important salmon fishery. Purpose: to demonstrate the effectiveness of good forestry practice and so underpin the Forests & Water Guidelines; also linked to a condition of planting approval that impacts are evaluated.
Work package 3.2	Long-term impact of forestry on acidification Continuation of long-term acid waters monitoring study in upland Wales (established in 1991) to evaluate the response of ten forest streams and

	two moorland controls to emission reductions and interactions with climate change. This is a joint funded project with EA(Wales) and supplements the UK Acid Waters Network with additional forest sites, as per recommendation of original Department of Environment/FC Darlington report. Purpose: to provide evidence to underpin Forests & Water Guidelines and new guidance on addressing impacts of forestry on acidification.
Work package 3.3	UK Upland Monitoring Network Support for continuation of UK Acid Waters Monitoring Network (proposal to change name to UK Upland Monitoring Network), including funding for three forested sites in Scotland (total of five forest sites in network). Purpose: to maintain forest sites in the partnership funded network (including Defra, WAG, SG, NERC, EA) to provide evidence to underpin Forests & Water Guidelines and new guidance on addressing impacts of forestry on acidification.
Work package 3.4	Long-term impact of forestry on acidification Continuation of long-term soil, rain, throughfall and soil water monitoring at original Level II site (established in 1994) at Llyn Brianne in mid-Wales to evaluate response of acidification processes to emission reductions and climate change; measurements contribute to understanding response of long-term stream water chemistry being monitored in catchment by EA(Wales)). Purpose: to understand soil and streamwater trends in acidification and help guide policy and practice to mitigate impacts as per Forests & Water and Soil Guidelines.
Work package 3.5	Impact of native woodland expansion To establish small catchment study at Loch Katrine to evaluate the impact of large-scale native woodland expansion on water quality and quantity. Purpose: to use opportunity to assess water benefits and risks from native woodland creation to provide evidence base for woodland water services and case for greater financial support for planting.
Work package 3.6	Ecological Change Network stream study Long-term monitoring of stream chemistry draining Alice Holt ECN site, established in 1994. Purpose: to contribute to long-term assessment of ecological change at woodland site in response to climate change and woodland management.
Work package 3.7	Impact of harvesting and peatland restoration Evaluation of the impact of tree removal and peatland restoration at Flanders Moss in mid-Scotland on nutrient (primarily phosphate linked to concern over effect of clearfelling on peatland on phosphate release) and carbon loss to water. Purpose: to help guide felling practice in sensitive catchments (e.g. those supporting freshwater pearl mussel) and test measures in Forests & Water Guidelines. Also to generate numbers for carbon loss to water to supplement wider GHG balance study
Work package 3.8	Impact of stump harvesting To establish new study to determine the impact on water quality of planned stump harvesting at Greskine Forest in S Scotland; part of wider study on environmental impacts of stump harvesting.

	Purpose: to inform future review of interim guidance on stump and brash harvesting.
Work Area 4:	**Sustaining Water Resources (T Nisbet, Samantha Broadmeadow, N Shah, some TSU staff); Budget £48.2k (2011/12)**
Work package 4.1	Long-term impact of upland afforestation Continuation of long-term forest hydrology study (established in 1967 – longest in UK) at Coalburn in N England to establish the impact of a full forest rotation on water quantity and quality. Purpose: to improve understanding of the contrasting effects of different phases of the forest cycle on water quantity and quality, to underpin Forests & Water Guidelines.
Work package 4.2	Impact of Short Rotation Forestry Evaluation of the impact of recently planted SRF native broadleaves at Alyth in E Scotland and planned planting of SRF eucalyptus at Squerryes Estate in Kent, E England on water resources. Purpose: to help guide policy and practice on expansion of SRF, including on site suitability.
Work package 4.3	Water use modelling To evaluate in-house use of the HYLUC model to assess the impact of future woodland creation and felling on water resources. Purpose: to help guide policy and practice on woodland expansion and management to reduce impacts on water resources under a future, potentially drier, climate.
Work package 4.4	Riparian shade for mitigating thermal stress Continuation of long-term monitoring of the effect of riparian shade on stream temperature in the New Forest in S England, evaluate water temperature models and upscale work to catchment level. Purpose: to help guide policy and practice on mitigating the impact of climate warming on salmonids and other sensitive freshwater species.
Work Area 5:	**Transnational Forestry Management Strategies in Response to Regional Climate Change Impacts (ForeStClim; this Programme only supports the hydrology component of this study) (T Nisbet, H Thomas, N Shah, Samantha Broadmeadow, Bill Mason, Duncan Ray. Bruce Nicoll, Barry Gardiner, Stephen Bathgate, John Fonweban, Colin Edwards, Stefania Pizzirani, Philip Taylor, Mitchal Petr, some TSU staff); Budget £25.0k (from this programme only, in 2011/12)**
Work package 5.1	Regional climate scenarios Downscaling of regional climate models to generate future climate predictions for regional case study site at Craik Forest in Scottish Borders. Purpose: to help guide evaluation of appropriate forestry management strategies to adapt to climate change (WP 5.3).
Work package 5.2	Development of tools and assessment of goods and services Application and testing of models and tools to assess site impacts and risks of climate change. Purpose: to guide the development of appropriate risk management strategies (WP5.3).
Work package 5.3	Ecological and economic sound management strategies As above.

Work package 5.4	Regional implementation of management and risk strategies Purpose: to test applicability of selected strategies at regional test site.
Work Area 6:	**Sustainable Soil Management (Elena Vanguelova, Rona Pitman, Andy Moffat, Andrew Peace, Peter Crow, Sue Benham, some TSU); Budget £64.0k (2011/12)**
Work package 6.1	Impact of whole-tree, brash and stump harvesting Evaluation of the impact of whole-tree, brash and stump harvesting on soil sustainability, including Bala stump harvesting site in Wales; new destumping experiment at Greskine Forest in S Scotland, and from long term brash removal experiment at Falstone, in Kielder Forest, N England. Purpose: to underpin guidelines for sustainable forest management for bioenergy
Work package 6.2	Impact of short rotation forestry Establishing a soil baseline for the recently planted network of SRF sites in Scotland and England. Evaluation of the impact of previously established "data mining" eucalyptus sites in England on soil quality. Support for PhD studentship with University of Central Lancashire, investigating the impact of SRF on soil biodiversity. Purpose: to help guide policy and practice on expansion of SRF, including on long term soil sustainability and site suitability.
Work package 6.3	Impact of afforestation Evaluation of the impact of afforestation on soil carbon and nutrient potential in a chronosequence study of Sitka spruce on peaty gley soils in Kielder forest. Includes support for PhD studentship study with Newcastle University investigating the impact of forest management on soil C pools. Purpose: to provide scientific evidence to support policy on GHG mitigation, land use change and long term C modelling.
Work Area 7:	**Soil Carbon and Function (Elena Vanguelova, Rona Pitman, Andy Moffat, Tom Nisbet, James Morison, Russell Anderson, Tim Randle, Samantha Broadmeadow, some TSU); Budget £66.8k (2011/12)**
Work package 7.1	Soil carbon and nutrients Evaluation of soil carbon stock, nutrient capacity and deadwood for BioSoil, Level I and Level II surveys. Soil C, nutrient changes from chronosequence studies and long term monitoring. Support for PhD studentship with Reading University on soil C fractionation (different soil C pools). Purpose: data input for soil C model development and testing, soil carbon national upscaling and reporting, and to underpin Woodland C Code.
Work package 7.2	Climate change and pollution impacts Evaluation of climate impact on soil solution chemistry from Level II and through spatial datasets from BioSoil survey. Evaluating N deposition impact on soil and forest C and biogeochemistry from Thetford and Alice Holt long term experiments. Support for PhD studentship with Essex University investigating the microbial communities associated with C and N processes in soils. Purpose: data input for soil and forest model development and testing. Scientific underpinning of sustainable forest management and pollution mitigation policies.
Work package 7.3	Soil monitoring

	Continuation of long term Level II monitoring site at Llyn Brianne. Testing soil C uncertainties at different scales, methodologies forest ecosystems from all forest soil monitoring network sites in UK and also some sites from EU COST action. Purpose: to guide development of protocols and underpin soil assessment in NFI and other national soil monitoring networks.

* Add new work areas and packages as required

6. Please indicate which of the FC's 6 Climate change priority actions this work fits into

Protect what we already have	X☐	Reduce deforestation	☐
Restore the world's forest cover	X☐	Use wood for energy	X☐
Replace other materials with wood	☐	Plan to adapt to our changing climate	X☐

7. Comment on how this research will address Country Strategy needs/targets (175 words)

The programme is closely aligned with all three Country Strategies/Corporate Plans. In England, the work will help achieve the main aim of protecting and enhancing water and soil resources and contribute to the objectives and actions on woodland provision of ecosystem services, and identifying priority catchments for testing how woodland creation could help meet the objectives of the Water Framework Directive. In Scotland, it will address the key objectives of helping to tackle climate change and protecting soil and water resources. In particular, the programme will contribute to several priority actions and indicators concerned with improving understanding of climate change impacts and the effect of woodland creation on soil carbon stocks and dynamics, increasing long-term carbon retention in woodlands, and avoiding/tackling diffuse pollution and morphological pressures. In Wales, the programme will contribute to a number of strategic outcomes, actions and indicators, including woodlands reducing the carbon footprint of Wales by protecting soil carbon storage, and the development of a more integrated approach to land use management for soil and water protection.

8. Identify and comment on any associated business risk of undertaking/not undertaking the research and how that will be managed

There are a number of risks of not undertaking the research programme:

- The Forestry Commission's UK Forestry Standard requirements and guidelines on protecting soil and water resources may become deficient in addressing the threats posed by climate change and developments in forestry systems and practice, such as energy forestry. There is also a significant risk of the requirements and guidelines not being correctly implemented due to the absence of planned guidance. This could lead to an increased incidence of forestry operators causing water pollution and non-compliance with legal requirements, including damage to freshwater life. It would also pose a risk of forestry causing long-term or irreparable damage to the soil, thereby jeopardising sustainable forest management. The case for energy forestry could be undermined by soil and water problems arising from inappropriate site selection, including resulting in net carbon loss, rather than gain.

- Lack of confidence in forest carbon models, the Woodland Carbon Code and national carbon accounting due to greater uncertainty regarding soil carbon dynamics and the impacts of forestry management practices. This could bring reputational damage to the Forestry Commission.
- Upland forestry delaying or reversing the recovery of acidified soils and waters, preventing the recovery of fish populations. This would further damage relations with fishery groups and result in pressure for excessive forest clearance with loss of wider benefits.
- Missed opportunities for forestry to help solve a range of protracted problems faced by society, including diffuse pollution and flood risk, both of which are expected to be accentuated by climate change. There is also a risk of the wrong type of woodland being planted in the wrong place, enhancing, rather than reducing flood risk and potentially threatening water supplies and ecological flows.
- Missed opportunity to mitigate the impact of climate warming on fish populations through appropriate riparian woodland planting and management, leading to a loss of priority fish species in vulnerable waters such as Atlantic salmon and damage to fisheries.
- A weaker case for woodland creation and integrated catchment management due to greater uncertainty over risks and benefits, and a lack of economic data on the value of soil and water services.

There are believed to be no significant business risks associated with undertaking the planned programme.

9. Research impact (economic, social, or biodiversity)

Who will benefit from this research?
The main beneficiaries are considered to be:

- The FC, UK Government and the devolved administrations, by helping to guide the development of policies and practices to secure sustainable forest management and meet international commitments, including on GHG reporting.
- Society, by improving understanding and demonstrating the water and soil services and potential disbenefits provided by forestry, and helping to ensure that policies and practices are tailored to delivering the former and minimising the latter.
- The environmental regulators, by demonstrating how woodland measures can assist them in delivering environmental objectives, assist flood risk management, promote carbon sequestration and help meet statutory targets.
- EU policy makers, by helping to shape appropriate land use and land management policies and support mechanisms to protect and enhance soil and water resources.
- Fishery groups, by improving confidence in forestry measures designed to protect fisheries and in so doing, enhance relations between fishery and forestry sectors.
- The forest industry, by developing and guiding best practice to secure sustainable forest management,
- The water industry, by demonstrating how woodland measures can assist them in reducing treatment costs and complying with environmental standards.

How will they benefit from this research?
See above – benefits will derive from the results of the planned research improving our understanding of the nature of the interactions between forestry and soil and water

resources, and the impacts of climate change. The knowledge gained will be used to help guide future policy and develop practices to secure and where possible extend the soil and water services that underpin the multiple benefits provided by forests

What will be done to ensure that they have the opportunity to benefit from this research?

The following actions will ensure that those identified will benefit from this research:

- Development and application of opportunity mapping and modelling tools to promote integrated catchment management.
- Providing demonstration sites and contributing to outreach seminars, workshops, conferences and training events to communicate project findings to practitioners, planners, policy informers, scientific community and the public.
- Building research partnerships and liaising with the forest industry, environmental regulators, government departments, international organisations and other agencies to ensure outputs are relevant, understood and meet the needs of end users.
- Providing recommendations and guidance on forest policy and practice to ensure soil and water protection, including developing and reviewing national and international guidelines and standards.
- Assisting in the provision of robust valuations of soil and water services for use in ecosystem service assessments.
- Using a wide array of publications to communicate findings and best practice to target groups, including FC Practice Guides and Information Notes, forestry and science journals, trade magazines and press articles, as well as through the project web site.

Potential for innovation and new markets?

Potential opportunities include:

- Developing new and improved woodland measures for reducing flood risk, including within sustainable urban drainage systems, supported by improved modelling tools.
- Extending work on flood risk management to develop woodland measures for reducing tidal surges.
- Developing and testing woodland measures for diffuse pollution control and mitigating thermal stress to fish.
- Contributing to the development of carbon accounting tools, including developing a DSS or tool for dating various forms of below ground carbon.
- Evaluating the potential for using biochar in forestry to promote carbon sequestration.
- Contributing to the development and application of an integrated DSS and/or opportunity mapping tools to aid targeting of woodland creation to maximise benefits and minimise risks.
- Contributing to the development of a tool for calculating the water footprint of different forest products.
- Evaluating the potential of using energy forestry to reduce pollution loading from landfill sites to the water environment.
- Contributing to the development of a woodland ‘data bank’ on economic valuations of soil and water services provided by different forest habitat types and forest systems, including possible accreditation.

10. Communication Strategy

Publications: See section 14 and below; a wide range of publications are planned,

including 4 FC Practice Guides, 2 updated guidance notes, one FC info Note and at least one trade journal article.
Reports: See section 14; 9 reports planned to inform CFS and wider FC
Seminars/training courses/conferences: Includes support for training courses on new soil and water guidelines, input to FC soil carbon workshops and regional or country seminars on managing flood risk; total of 10, not including participation and presentations at national and international conferences.
Decision support systems: No stand-alone systems envisaged but expect to contribute to proposed spatial evaluation and ecosystem service support systems led by other programmes.
Website: Will maintain existing project web pages on forest soils and hydrology and add new topics as appropriate.
Peer review papers: See section 14; plan to publish 12 peer review papers in science and forestry journals.

11. Under government survey control procedures, Ministerial approval must be sought before statistical surveys of businesses or local authorities can proceed. Please indicate any intention to carry out a survey.

Yes ☐ No X☐

- If yes please give brief details

1. **Details of support agreed or to be sought from funding bodies for project** (*including in-kind support)*

*Includes work in Climate Change Adaptation, Wood and Timber Properties, Alternative Management Approaches, Social Research, Tree Selection and Breeding, and Advice and Scientific Support for Tree Health Programmes.

Future external funding bids will be made in connection with the items listed in section 9 as opportunities arise. This includes a possible partnership (FR, EA, FC(E), NE) bid to EU LIFE+ for a demonstration or policy related study on increasing riparian woodland shade in WFD Priority catchments to help freshwater life adapt to climate change (expected to submit in 2012 funding round).

13. Resources (times and fees) requested from the Forestry Commission

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14. Deliverables and associated costs to Forestry Commission

Work* Area number	Output	Year 1				Year 2				Year 3				Year 4				Output	Total Cost
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Unique Identifier	
1.2/7	Contribution to four FC soil carbon workshops				X				X				X				X		
1.2/2	Organise regional or country seminars on woodland creation and management for flood mitigation		X				X				X								
1.2	Contribution to training courses on new soil and water guidelines				X	X													
1.2	Annual revision of website and web pages			X				X				X				X			
1.5	Contribution to FC Water and Soil Guidelines	X																	
1.5/3	FC Practice Guide on acidification and forestry		X																
1.5	FC Practice Guide on managing riparian woodland						X												
1.5/2/4	FC Practice Guide on managing water resources and flooding										X								
1.5/3	FC Practice Guide on managing forest operations (ground prep, fertiliser, pesticides, other chemicals, road construction and maintenance, and harvesting) for soil and water protection														X				
1.5/3.8/ 6.1	Revised/updated 2009 guidance: 'Stump Harvesting: Interim Guidance on Site Selection and Good Practice' and 'Guidance on Site Selection for Brash Removal'																X		
1.5	Report to FC(E) and EA: 'Woodland for Water: Woodland measures for meeting WFD objectives'	X																	
1.5/2	Final Report to Defra: 'Slowing the Flow at Pickering' plus seven appendices.	X																	
1.5	Report on ecosystem service evaluation	X																	
1.5/5.4	Report to EU INTERREG on the impact of							X											

	drain blocking and clearfelling on peak flows (based on ForeStClim study at Craik Forest)																		
1.5/6.2	Report to FC(S) on soil baseline conditions from study of the impact of SRF trials on soil sustainability in Scotland.				X														
1.5/3	Report to FC(S) on initial impact of planting SRF on streamwater quality (based on Sibster study).																X		
1.5/6.2	Report to FC(E) on soil baseline conditions from study of the impact of SRF trials on soil sustainability in England.				X														
1.5/6.1	Report summarising results from 10 year study of impacts of destumping on forest nutrition at Thetford.						X												
1.5/7	Final report to Defra on the Terrestrial Umbrella project.				X														
1.5/6	FC Information note reviewing impacts of energy forestry on soil sustainability (including results from on-going studies)																X		
1.5/7	Trade journal article: 'Impacts of climate change on forest soil carbon and sustainability'		X																
1.5/1.3	Scientific paper: 'Assessing the effect of broadleaved woodland expansion on acidic dry deposition and streamwater acidification'		X																
1.5/2.1	Scientific paper on evaluating the impact of large woody debris in watercourses on flood flows (based on Great Triley Wood modelling study)		X																
1.5/3.1	Scientific paper: 'Long-term impact of conifer afforestation on freshwater environment at Halladale'						X												
1.5/3.2	Scientific paper: 'Long-term impact of upland forestry on surface water acidification'										X								
1.5/3.7	Scientific paper: 'Impact of deforestation for peatland restoration on nutrient and carbon release to waters' (based on results from																X		

	Flanders Moss)																		
1.5/6.1	Scientific paper: 'Assessment of WTH impacts on long-term soil carbon and nutrient sustainability – tree belowground response' (based on results from various sites)							X											
1.5/6.1	Scientific paper: 'Belowground and aboveground carbon and nutrient balance modelling' (based on results from Kielder WTH site)															X			
1.5/6.1	Scientific paper: 'The effects of PAWS on soil quality' (based on results from Tugley site)				X														
1.5/7.1	Scientific paper on the impact of afforestation on soil carbon stocks (based on results from the Kielder chronosequence study)											X							
1.5/7.1	Scientific paper: 'Current status of forest soil carbon stocks in British Forests'			X															
1.5/7.2	Scientific paper: 'The impacts of N input on forest and soil biogeochemistry in GB'					X													
1.5/7.2	Scientific paper on the local and regional impact of N deposition on soil and forest biogeochemistry (based on results from Thetford study)											X							
All Work Areas	Provide a report to CFS on agreed knowledge exchange work				X			X				X				X			

***** Split numbers relate to relevant element of knowledge exchange (mainly publications; 1.5) and the research project Work Area.

Signed……..Research Provider/HOD
Date…….

Signed……..C&FS Advisor
Date…….

Proposal Approved CFS 31st August 2011

15. Agreed Changes

Description of change:
Signed……..Research Provider Date……. Signed……..C&FS Date…….
Signed……..Research Provider Date……. Signed……..C&FS Date…….
Signed……..Research Provider Date……. Signed……..C&FS Date…….

16. Detailed communications plan:
Year 1
Year 2
Year 3
Year 4