DEFRA FLOOD RISK MANAGEMENT AND MODELLING COMPETITION

Why are we holding a competition on this topic?

Recurrent flooding in the UK over recent years has catalysed a range of interesting academic work spanning catchment-scale hydrology, channel hydraulics (including geomorphology impacts), land use impacts (including new models based on EO data), and the relative potential of both hard engineered and natural flood defences to reduce risk in a cost-effective way. The Government's National Flood Resilience Review has made use of recent advances in Met Office weather and climate modelling to conduct a new and more sophisticated analysis of the risk of flooding from rivers and the sea in England over the next ten years, but has also highlighted the scope for further development of more integrated flood risk modelling.

The Department for Environment, Food & Rural Affairs (Defra) is keen to see this thinking crystallised into practical policy proposals, which build on the scientific and economic evidence base but focus on demonstrating a specific local application. In this way, we hope to achieve an intelligent consolidation of the evidence base, a deeper understanding of the practical applicability of the approaches which have been proposed, and a solid starting point for future work on catchment-based multi-objective flood risk management.

Defra is running a competition for flood risk management approaches to manage the River Eden in Cumbria. The competition is being sponsored by United Utilities, Aviva and the Natural Environment Research Council (NERC). The judging panel has representation from United Utilities and Aviva (as outlined in Annex A).

Why is the competition focused on the Eden?

Although we are ultimately interested in identifying tools and approaches that can influence other catchments facing different kinds of challenges, the Eden offers a particularly good case study for a variety of reasons:

1. It has experienced a material amount of flood-related damage over recent years and is therefore a key focus of the Government's current floods analysis. The Cumbria Floods Partnership has already brought together a number of local bodies to focus on the question of flood risk management, and their initial report provides a solid starting point for further discussions.

2. The Eden is also likely to feature strongly in further work on integrated catchment management. This will build on ongoing Demonstration Test Catchment work on the Eden and a variety of other broader local natural capital related initiatives.

3. The Eden has already been the focus of a number of previous academic studies, which provide a broad evidence base and suggestions of issues to address. In combination with a wide range of new data from the Defra Open Data Programme and from sources such as new Earth Observation Systems (EOS), there should be good scope for new model calibrations and evidence-based analysis.

4. The Eden is a relatively large catchment which encapsulates many of the same constituent challenges faced elsewhere in the country.

The Competition Question

The central competition question is formulated as follows:

> *If you were responsible for managing the Eden catchment in Cumbria, what flood risk management approaches would you recommend, and why?*

The context can be assumed to be the allocation of additional flood defence funding to the catchment, which needs to be employed in the most cost-effective way. Benefits should focus on expected flood damage avoided for various levels of spending, taking into account reliability, but may also reflect broader social, environmental and economic impacts, especially to the extent that these can be monetised. Practical constraints should be considered, and the likely perspective of the local community on different approaches should be taken into account. Any impact on visitors to the area may also be considered.

How will entries be assessed, and who should enter?

The principal aim of the competition is to generate evidence-based practical policy proposals on flood risk management in the Eden catchment. As such, we can imagine a wide variety of potential approaches, and for this reason we've decided to award two series of prizes, one for the overall practicality and quality of the proposals and one for innovation in a particular area. In this way, we hope that those entrants with strong data, analytic or modelling capabilities will be encouraged to use the results of new tools or recalibrations of existing approaches as part of their entries, while other entrants will be able to build on previously published science but bring new thinking to bear on practical application, economic frameworks, local community considerations and the like. The best entries may incorporate both these aspects, and we would like to encourage the formation of multi-disciplinary teams where appropriate – something we will seek to facilitate through the registered entrant group and launch event. However, we would encourage anyone who has a substantive, practical and evidence-based proposition to submit an entry – even those entries which don't ultimately win a prize may highlight some interesting approaches or evidence neglected by others, and we expect all entries to influence future work in some way, not just the leading submissions.

We would expect this competition to be of interest to individuals who have an interest in hydrology, channel hydraulics, geomorphology, land and water management, civil engineering, catchment management, environmental economics, and risk management. Responses may come from consultancy companies specialising in flood risk assessment and mitigation, from technology companies with relevant modelling frameworks or new data sources (such as EOS data), from insurance companies and flood risk underwriting specialists, from water companies, from forestry

experts, and from a wide range of NGOs (wildlife and rivers trusts, wildlife charities) with an interest in multi-objective catchment management.

Entries should consider the following issues:

(i) How to identify the range of options that can be applied on the catchment.

(ii) How we might go about scaling up natural flood management (NFM) measures for larger settlements like Appleby and Carlisle with the larger catchments above them while developing an approach for the Eden (beyond the 200km^2 that seems to be the accepted threshold at present for effectiveness).

(iii) Changing / modifying the combination of options on a catchment to look at the effect on flows etc.

(iv) An approach that identifies how to work with Environment Agency modelling for traditional flood defences. Approaches that can adapt to future technology as best as possible.

(v) A quantitative analysis of the distribution of ***flow and depth estimates*** at various points throughout the catchment system, including indications of sensitivity to precipitation intensity set within the context of historic experience and climate sensitivities.

(vi) A quantitative and spatially explicit assessment of the consequent ***risk of flooding from channel overtopping*** throughout the catchment system, including assessment of the likely spread and depth of any consequent fluvial flooding.

(vii) A similar assessment of the risks of ***surface water, groundwater and / or coastal / tidal flooding***, and an assessment of the cumulative consequences.

(viii) Analysis of the impact of ***sediment transfer and channel maintenance*** strategies on outcomes.

(ix) Quantitative observations on the principal ***exposed assets*** within the catchment, with an assessment of their apparent vulnerability or resilience to flood events.

(x) Quantitative and spatially explicit recommendations on ***potential NFM approaches*** which could be employed within the catchment to mitigate the risk of flooding in the most cost-effective way (balancing likely capital costs against expected damage reduction). These may include tree planting, associated woodland strategies, and permanent or contingent land use change including the creation of wetlands.

(xi) New thinking on ***local community engagement*** approaches, including measures relating to property level resilience, dealing with knowledge uncertainties, warning systems and flood response.

(xii) Elements of formal ***cost-benefit analysis*** for the principal proposed schemes.

(xiii) Spatially explicit and quantitative observations on ***multi-objective benefits*** associated with proposed schemes, such as economic impacts from land-use change, habitat and

biodiversity benefits, water quality and erosion control benefits, recreational and tourism impacts.

(xiv) Observations on the principal ***data gaps*** affecting the analysis, with thoughts on their likely materiality and options for cost-effective improvements.

(xv) Brief observations on the ***pros and cons of any modelling approach*** used, set within the context of other available approaches, including a discussion of the applicability to catchments with differing characteristics (geology, land use, drought, urbanisation).

(xvi) ***Innovative financing*** approaches, including potential payments to and from householders, insurers, landowners, community groups and multi-objective beneficiaries, or models to leverage public sector funding.

(xvii) A short discussion of ***potential extension work*** which might help to crystallise initial observations and modelling into more concrete and costed proposals.

(xviii) Some observations on the potential ***transferability*** of the approach demonstrated on the Eden to other catchments, and comments on any key data or evidence gaps which may be present in other areas.

Evaluation Criterion

The scoring framework is based on five evaluation criterion which are set out below. Each criterion will be scored on a scale of 1-7, and weighted in line with the percentages shown below.

Criterion 1	Catchment understanding
Criterion 2	Quantitative analysis
Criterion 3	Technical analysis
Criterion 4	Multi-objective approach
Criterion 5	Innovation

Understanding of Catchment 20%

This criterion will assess the proposal's use of evidence to demonstrate a thorough understanding of relevant aspects of the Eden catchment. A range of evidence could be drawn upon including published literature, data and policy documents.

Proposals should demonstrate how they will synthesise and apply relevant research findings, data and other material to the competition question.

Quantitative Analysis 20%

The criterion will assess the methods proposed for quantifying the impact of the proposed approach and measures, including NFM measures, in mitigating flood discharges and losses, including the use of pre-existing modelling results and analyses where appropriate.

Technical analysis 30%

The criterion will assess the suggested approach in terms of the evidence provided on engineering and logistical practicalities, including semi-engineered approaches and NFM measures. It will consider how far proposals have considered the strengths and weaknesses of the approach including any key evidence gaps, financing issues and the local community perspective.

Multi-objective approach 10%

The criterion will assess whether the proposal has considered broader economic social and environmental impacts and how environmental impacts could be valued. It will also assess how far solutions address multiple objectives particularly combining flood risk management with wider catchment management objectives.

Innovation 20%

The criterion will assess how far the proposal takes an innovative approach. This could be in relation to modelling, engineering and/or NFM approaches, financial innovation or community engagement mechanisms or other innovations.

Potential Areas of Focus

To date projects have been commissioned have had a NFM driver or provided NFM benefit as an added benefit. There are an estimated 30 communities at risk on the Eden. Many of these will sit on the smaller sub-catchment scale. We can imagine a variety of areas that may be addressed by a successful entry, and the winners are likely to be those which provide the best possible evidence context for a spatially focused, provisionally costed, and potentially implementable scheme. Entrants may wish to briefly review the salient features of the catchment, the concentrations of value at risk, the scope of existing defences, and the principal residual risks. Entries may draw on previously published material (suitably referenced) including published Environment Agency datasets and maps, but would be expected to incorporate some form of new thinking analysis or modelling.

Competition Instructions

Entries will take the form of a short briefing paper (maximum 5,000 words, plus references). The briefing paper should be written in English and presented as an A4 pdf document in Arial size 12 font or similarly sized typeface, and may incorporate maps, graphs, charts or tables as required. Only one paper per entrant is allowed. Once the paper is submitted, you will not have the opportunity to revise it. Please carefully check your entry before submitting the final copy, and also ensure that all

supplementary information is included on the cover sheet provided (name, contact details, paper title). References should be presented as endnotes, beginning on a separate page at the end of the document, and should ideally incorporate hyperlinks through to material available online. The cover page should include a short abstract (maximum 200 words) highlighting the principal areas of focus and any innovative approaches incorporated. If using existing material, do cite appropriately as plagiarism will not be permitted.

All entrants are expected to fully acknowledge and reference material drawn from other authors or sources, and any examples of plagiarism will be penalised. All entries must be submitted by 5pm (GMT) September 30th 2016. Route to entry for the competition and details of how to enter are via Citizen Space here. Any request for clarification regarding the Competition should be submitted at the earliest opportunity via Citizen Space or Floods-Competition@defra.gsi.gov.uk. Winners will be notified by the end of October 2016.

Competition Timeline

27 Jun 2016	Cumbria Floods Partnership report, release of additional background on competition prizes, sponsors, judges and potential target areas
20 Jul 2016	Competition launch event
3 August 2016	Competition opens on the citizen space portal via the associated website.
30 Sep 2016	Competition closes by 5pm. All entries must be uploaded to the Citizen Space portal. Entries submitted after this deadline may be rejected.
October 2016	Review of entries and judges panel.
End of Oct/early Nov	Awards ceremony (date TBC)

Competition Prizes

The competition will have two principal prize categories. The first will focus on the overall quality and practicality of entries, including the use of evidence, data or modelling, the breadth and applicability of analysis, and the degree to which the entry lays a foundation for subsequent work on the Eden or elsewhere. This prize category is designed to encourage broad-based entries.

The second category focuses on innovation in a particular area. This could be an applied use of recently released open data, a new scientific or economic model, or new thinking on community engagement or financing mechanisms. The prize is designed to reward entries which may be narrower-based but bring genuinely new thinking or analysis to bear.

The prizes for both the overall category and the innovation category will be £5,000 each. There will be runners up prizes for both categories of £2,000, making a total of £14,000 prize money.

In addition to these two prize categories, the judges will have the discretion to make a number of 'special award' prizes, which reward particular insights identified by the judges as deserving merit, even if the entry fails to win one of the main prizes. A panel of expert judges has been assembled (see Annex A), headed by Professor Keith Beven, Lancaster University. Defra reserves the right not to fully allocate the prize fund if the judges conclude that there are insufficient entries of a calibre to warrant the full award of prizes. Entrants accept that the decision of Defra and the judging panel on the award of prizes will be final.

Other matters

By submitting a proposal, entrants agree to be bound by the terms of the competition set out in this document. Defra reserves the right in its absolute discretion to vary, abandon, terminate, or suspend this competition. This invitation to participate in this competition should not be regarded as a commitment or representation on the part of the Defra to enter into a contractual arrangement. Entrants shall bear all their own costs and expenses incurred in the preparation and submission of their entries and Defra will in no case be responsible or liable for those costs, regardless of the outcome of the competition, even if the procurement is terminated or amended by the Defra.

By participating in the competition, entrants agree to Defra publishing their entry on the competition website. Entrants agree that the use and access of the winning and runner ups approach will be made available to the public. Defra may also use entries as part of internal analysis of options for future work in the Eden catchment and entrants agree to enter into any necessary royalty-free irrevocable, non-transferable, non-exclusive licence agreement with Defra if required to enable such use of the entries Entrants consent to Defra's use of their names, organisations and any competition-related photographs in publicity associated with the competition.

ANNEX A

Competition Judges

COMPETITON CHAIR OF JUDGES
Professor Keith Beven Lancaster University

Keith Beven has worked at Lancaster University for 26 years and is now a Distinguished Professor in the Lancaster Environment Centre. He is the most highly cited hydrologist and has published 10 books and over 350 papers. Recent books include Environmental Modelling: An Uncertain Future? (2009); a 4th Edition of Shaw's Hydrology in Practice (with Nick Chappell and Rob Lamb, 2011) and a 2nd Edition of Rainfall-Runoff Modelling: The Primer (2012).

His main research interests are in hydrological modelling and understanding the prediction uncertainties associated with environmental models (see www.uncertain-future.org.uk). He was the originator with Mike Kirkby of the TOPMODEL Concepts and the originator of the Generalised Likelihood Uncertainty Estimation (GLUE) methodology. GLUE has been applied to a wide variety of fields including rainfall-runoff modelling, flood inundation, water quality modelling, sediment transport, recharge and groundwater modelling, vegetation growth models, aphid populations, forest fire and tree death modelling. Current projects include leading the NERC/ScienceWise Catchment Change Management Hub project (ccmhub.net), novel modelling of flow and transport on hillslopes and in catchments, modelling the impacts of climate and land management on flood runoff and flood frequency, nonparametric estimation of the rainfall-flow nonlinearity, and flood forecasting.

His research has resulted in a number of awards including the Horton and Langbein Awards of the American Geophysical Union, the John Dalton Medal of the European Geophysical Union, and the IAHS/WMO/UNESCO International Hydrology Prize. He also still likes to try and find time to take some photographs (mostly of water, see www.mallerstangmagic.co.uk). Author/co-author for several water quality and pollution control books. Author and presenter of over 30 technical papers on a wide range of topics, including hydraulic modelling, water quality modelling, coastal studies, flood forecasting, flood risk management and decision support system.

ALISTAIR MALTBY
Operations Director, the Rivers Trust

Alistair has worked in the rivers trust movement since 1997. Beginning at Westcountry Rivers Trust he was part of the small team which implemented the Tamar2000 project, which developed the principles of achieving catchment improvements through economic savings on farms, and evolved into Defra's Catchment Sensitive Farming. Moving to Thames21 he delivered London Probation Service's Millennium Project to restore urban rivers through Community Service, and integrated environmental quality objectives for the river catchment with the canal network using the Single Regeneration Budget. Alistair moved to Eden Rivers Trust to deliver an ambitious whole catchment restoration, and initiated the first rivers trust programme of catchment modelling and monitoring to inform prioritisation of funding and restoration work.

Alistair was a founding trustee of the Association of Rivers Trusts in 2004 and moved to work for the umbrella body in 2005, now known as The Rivers Trust. Since then, Alistair and colleagues have facilitated the growth of the rivers trust movement from five founding trusts, to over 50 community-led organisations in England, Wales, Northern Ireland and now the Republic of Ireland. Alistair's most recent achievement has been as technical author of a €20M Life Integrated Project to deliver the NW River Basin Management Plan using principles of integrated water management. Alistair sits on United Utilities' "Your Voice" and Yorkshire Water's "Customer Forum", customer challenge groups for business planning and expenditure. Alistair is a Winston Churchill Travelling Fellow (2007) on the subject of managing rivers in a changing climate.

SUSAN PENWARDEN
Chief Underwriting Officer, Global Commercial Lines, Aviva

Susan is a highly accomplished senior executive with 7 years' experience operating at Board level in a variety of challenging roles both in the UK and globally. A seasoned executive with excellent communication, influencing and change management skills, she has solid track record of leading businesses through major transformational change resulting in exceptional results. She is a critical thinker, with a breadth of capability encompassing strategy, risk management and governance. Her motivational and engaging leadership style inspires her people to perform whilst maintaining an environment based on personal integrity, honesty and trust.

Susan reports to the MD, UK Commercial Lines and CEO, and is responsible for commercial underwriting and pricing across UK, Ireland and global business units. She has been with Aviva for 3 years and prior to that worked both in the UK and Canada for RSA. She also worked in Denmark in the insurance industry.

Aviva is the largest UK commercial lines insurers and continues to maintain our commitment to our business customers in areas at risk of flooding as well as protecting homes. Last winter's adverse weather affected a significant number of business premises flooding as well as homes.

Aviva has consistently been advocating for a more comprehensive approach that focuses on resilience across the system, not just flood defences, and believes SME's should a) know whether their properties are at risk, 2) receive support to become more resilient if indeed and 3) look at the ecosystem operating in the catchment areas to address the flood risk more broadly. This activity supports communities and local businesses, and therefore local economies and jobs. It also has particular impact for areas outside of London, where the government is keen to rebalance the economic activity.

JO HARRISON
Director of Asset Management, United Utilities

Jo Harrison is the Director of Asset Management at United Utilities, the regional Water and Sewerage Company in the North West of England. She has over 20 years of experience of working in the water industry and has worked for UU since joining the company in 1998.

In her current role she is accountable for setting the asset management strategy for the wholesale business for the next 25 years; including developing and strengthening the Company's approach to asset management and environmental regulation and quality as well as improving service to the customers.
Jo has a BSc in Geography and Ecology from the University of Sheffield and an MSc in Pollution and Environmental Control from Manchester University. She is a chartered member of the Institute of Water and Environmental Managers (CIWEM) and a Chartered Environmentalist. She is also a member of the UKWIR Board, a member of the North West Flood and Coastal Committee (RFCC), a Trustee of the Community Forest Trust and a Trustee of the Healthy Rivers Trust, covering Manchester, Liverpool and Cheshire.

GLYN VAUGHAN
Chairman of the Eden Rivers Trust

Glyn is a flood risk engineer, with almost 40 years' experience in a career that has been focussed on Flood Risk Management within the Environment Agency and predecessor organisations. From shortly after his retirement from the Environment Agency in 2011 until the present day, Glyn has been a trustee and, for the past three years, Chairman of the Eden Rivers Trust, where he has been involved in ensuring that the reduction of flood risk in rural communities has been placed high on the Trust's agenda. This has involved extensive partnership working with Cumbria County Council and the Environment Agency in order to maximise funding to carry out research plus extensive site work including river restoration and 'slow the flow' projects.

From 1986, Glyn worked in management roles, culminating in the Area Flood and Coastal Risk Manager (Cumbria and Lancashire) post from 1996 until retirement in 2011. Over this period, he gained extensive experience of working with professional partners, stakeholders, and community groups. Glyn completed an MBA in 1997 to compliment his technical qualifications. The two major Cumbrian flood events of 2005 and 2009 were testing times for the Environment Agency and Glyn, as the Area Flood and Coastal Risk Manager, was the main local Environment Agency manager for the event itself and the recovery phase. He was actively involved in creating the 'Making Space for Water' groups, and working with community groups to raise partner funding. The Cockermouth and Keswick Flood Alleviation schemes were only viable due to additional funding from the community groups and other partners. Glyn also worked closely with the private sector, including several large businesses that had suffered from the flooding. Glyn's experiences in the 2005 and 2009 Cumbrian floods were put to good use in the December 2015 floods, when he assisted the Environment Agency with the immediate aftermath of the event.

Glyn lives in the Eden Valley, and has witnessed the effects of the flooding first hand, including the on-going recovery process.

LYDIA BURGESS-GAMBLE
Principal Scientist Flooding and Communities Research Team, Environment Agency

Lydia has been at the Environment Agency for 14 years. Prior to this she worked on river restoration project appraisal procedures, developing a protocol for monitoring river restoration schemes as part of her PhD research.

Lydia is currently a Principal Scientist in a research team at the Environment Agency, where she manages the Working with Natural Process (WWNP) to reduce flood risk research theme. In this role she has developed a research and development framework, this is a programme of research projects which once implemented will provide the Environment Agency and our partners with the evidence needed to build flood risk management schemes which work with nature to reduce flood risk. The research she works on is funded by the DEFRA/EA Joint FCRM R&D programme.

Lydia is currently managing a suite of R&D projects which will develop a high quality evidence base, and subsequently, the technical guidance and tools needed by flood and coastal risk management authorities to help them understand, justify, develop and implement FCERM schemes which include WWNP to reduce flood risk. She is also working with the Natural Environment Research Council to help develop and shape a Natural Flood Management research call.

Dr BEN GROOM
Associate Professor in Environment and Development Economics, London School of Economics

Ben is an Associate Professor of Environment and Development Economics at the Department of Geography and Environment, London School of Economics. . He studied Economics at Sheffield University, Environmental

and Resource Economics at UCL, and completed his PhD in Economics at UCL in 2005 on empirical and theoretical aspects of social discounting for distant time horizons.

Prior to his academic career he worked for the Overseas Development Institute as an ODI fellow posted in the Department of Water Affairs. Since that time he has worked on a number of development, agricultural and water related projects in Pakistan, Benin, Bolivia and China. In addition Ben has served as a Consultant for numerous international organisations, including the World Bank, the Asian Development Bank, the OECD and the WWF. He has also advised government in the UK (Treasury and Environment Agency), USA (USEPA), Norway, The Netherlands, China and Pakistan on various aspects of environmental policy.