Sustainable Asset Management (SAM) - Theme Work Plan, 2005-2010
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1 Introduction

This Work Plan sets out the activities that have been or will be carried out to develop and undertake science projects within the Sustainable Asset Management (SAM) Theme of the joint Defra / Environment Agency Flood and Coastal Erosion Risk Management (FCERM) R&D programme over the five-year period 2005-2010. Key supporting documents associated with this work plan are the SAM Rationale & Objectives (RO) Statement and the FCERM Programme Definition Document (www.defra.gov.uk/environ/fcd/research/default.htm).

The Theme Work Plan provides an overview of the science (research and related development) programme needed to respond to the drivers, vision and objectives in the RO Statement. It sets out priority work areas and a schedule for delivery. It is a working document for use by those involved in managing, advising, reviewing and evaluating the programme. Theme work plans will be reviewed annually.

It would be unrealistic to expect the Theme Work Plan to set out a complete, detailed programme of projects for the next five years. Such a list of projects would be aspirational and perhaps inflexible in responding to changing user needs and opportunities arising from advances in scientific knowledge and technological capability, as well as fluctuations in funding streams. The Work Plan provides a vision, particularly of the outcomes via the theme objectives, and a logical framework of sub-themes and project areas with typical examples and user benefits. It provides a basis for determining the annual programme of projects.

The proposals for new projects for each financial year, together with an analysis of achievement against objectives for the past year, will be presented and recorded in detail in an Annual Work Plan. This will contain the budget and list of new starts, with supporting Short Form As/project proposals. Theme Advisory Groups will be consulted in the drafting of these lists, as well as other Themes and the programme management team. Projects to be procured through the Environment Agency will be subjected to further Project Appraisal Board (PAB) approval.

2 Setting the context of SAM R&D

The context of the SAM Theme within the overall FCERM R&D Programme is set out in the Programme Definition Document. This establishes the policy and operational context of the R&D Programme in relation to the Government’s ‘Making Space for Water’ Strategy for Flood Risk Management with its strategic and holistic approach. However, given the strong engineering and environmental aspects of asset management, the SAM Theme Programme necessarily supports the continuous improvement of best practice in (a) efficient and cost effective design, construction and management of flood management assets, and (b) their environmental performance. This applies to all Operating Authorities.

Critical success factors established in the Programme Definition Document that apply to the SAM Theme Programme are as follow:
• Timely provision of innovation in delivery of flood and coastal erosion risk management
• Evidence and innovation needs of flood and erosion risk management aligned with the pressures and opportunities created by the principal drivers for changes in flood and coastal erosion risk levels, namely climate change and socio-economic pressures
• Excellence in practical application of science and technology
• Successful partnerships with other policy areas and projects funded in collaboration with internal and external partners.

The Programme Definition Document states that the SAM Theme should cover all aspects of improved delivery of the FCERM asset management function where assets will include all physical measures that contribute to flood and coastal erosion risk management and are owned and operated by the Environment Agency or other operating authorities.

Thus the Theme Programme must encompass the overall process of planning and identification of flood or coastal erosion management interventions (i.e. physical measures to interact with flood or coastal erosion processes) as a appropriate means of risk management, together with the consequent design and construction of new works and the operation, maintenance, renewal, upgrading, removal and/or replacement of existing assets. Assets include conventional “defences” - such as embankments, revetment, walls, barriers and pumping stations; natural features – such as river channels, saltmarshes and beaches – that contribute to the flooding and erosion process; and temporary flood barriers.

While the SAM Theme Programme will naturally focus on the development of tools and techniques for good practice, the Programme Definition Document emphasises the need, where necessary, for Theme Programme to develop the evidence and information base to support innovation and improved methods.

The Environment Agency Asset Management Strategy was produced in Summer 2006 and now provides further context within the Environment Agency for the development of future SAM Theme Programme. The Theme Programme is already (2006/07) broadly aligned with the direction of the new strategy, since both have been informed by the systems, risk and performance-based approach to the assessment and design of assets and to their management and replacement. The Environment Agency has now designated approximately 3300 asset systems in England and Wales, all of which demand appropriate technical and environmental management in achieving the optimum balance of resource allocation, and management of risk and performance.

The SAM Theme inherited a programme of on-going projects in September 2005. This comprised of the former Engineering Theme Programme, the PAMS (performance based asset management system) project formerly under the Risk Evaluation & Understanding of Uncertainty (REUoU) Theme and several projects from the disbanded Fluvial, Estuaries & Coastal Processes (FECP) Theme. Also, in establishing the new SAM Theme Programme, efforts have been made to consider the future research issues identified under the former themes, as well as the issues identified in the Independent Review (Defra, 2005).
Objectives and Outcomes

The rationale for the SAM Theme is set out in the Rationale and Objective (RO) statement through the Theme Vision and a suite of Key Objectives for completion over the five-year period.

The Theme Vision is that sustainable asset management will:

- ensure that flood and coastal erosion risk management infrastructure remains appropriate to the changing conditions in which it must contribute to the management of flood or coastal erosion risk;
- over its service life minimise the loss of life due to flooding and provide best value;
- enable assets to perform in an optimal manner – both under normal service conditions, and resiliently and predictably under extreme storm or flood events; and
- achieve the best outcome for people and both the natural and built environment.

The Theme Programme should reduce the uncertainty surrounding flood and coastal erosion performance, particularly through the introduction of risk based techniques and decision support frameworks to assist in the decision making process and optimise the funding of asset management.

The Overall Objective of the SAM Theme is:

to help reduce the risk of flooding and coastal erosion through the application of sound science in developing sustainable asset management systems.

The Key Objectives in the RO Statement (see table overleaf), which establish the broad focus of the SAM Theme, have been developed through discussion with the Programme Board and Managers, the Theme Advisory Group and representative users of the Theme outputs. Broad evaluation criteria are also given in the RO Statement in order to evaluate our progress against the objectives.

The Independent Review and the Programme Definition Document emphasise the need to focus on delivery of the science to end users in order to secure the expected benefits. Making our outputs fit for purpose is therefore a major goal of the theme. Key beneficiary groups within Operating Authorities and the wider F&CERM industry are identified in the RO Statement. The process of implementation of the output following the successful completion of the science project (which of course needs to be considered in principle at the outset of the project) is a matter for joint planning between the SAM theme management and the end user (or representative). Not every science project will deliver directly to the policy or operational end-user; some projects will feed into further science projects (such as PAMS – see Section 5), into updates of good practice guidance (such as the Beach Manual), or into client development initiatives (such as Environment Agency Work Instructions).

The Outcomes (see table overleaf) indicate what the end user will do or have that is different as a result of the Theme Programme. In general this will be an improved tool or technique. The product will be in a form appropriate for specific
implementation and use by the end user within a recognised sector of business change. Implementation is an active planned process, as distinct from the more passive dissemination of science results through publication in journals or scientific reports.

<table>
<thead>
<tr>
<th>RO Key Objective</th>
<th>End-user Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Improve understanding of the concepts of sustainability as related to asset management. Develop approaches that are more adaptable to long term changes in site conditions, climate change, morphological change, hydraulic loading etc.</td>
<td><strong>1.1</strong> Sustainability concepts will be interpreted and techniques described from the viewpoint of FCERM asset management. These will cover basic engineering function, environmental and societal context, and life-cycle economics. Basic material utilised in education and professional training. <strong>1.2</strong> Concepts and techniques will be bedded into (a) planning and decision-support guidance for asset management interventions, and (b) recommended tools, good practice guidance and work instructions for FCERM asset management (detailed design and operations).</td>
</tr>
<tr>
<td><strong>2.</strong> Improve our understanding of asset condition (both components and systems) in order that our assets can be appropriately designed, constructed and maintained. Develop knowledge surrounding sustainability issues such as deterioration, resilience and flexibility.</td>
<td><strong>2.1</strong> Factors contributing to deterioration of component materials and overall asset condition, as well as how this affects the engineering, environmental and other functions, will be described from the viewpoint of the different tasks of asset management — asset monitoring; inspection; in-depth assessment; maintenance and upgrading; optimal design of new works. The descriptions will be bedded into relevant education and training material, work instructions, decision-support tools and good practice guidance. <strong>2.2</strong> The sensitivity of engineering performance (incl. resilience and risk of failure) to asset condition will be explicit in guidance on asset management.</td>
</tr>
<tr>
<td><strong>3.</strong> Improve our design and management techniques (including risk-based methods) in order to ensure that the condition and performance of assets is in line with their intended standard of service and loading conditions.</td>
<td><strong>3.1</strong> Risk-based methods (involving progressive shift from deterministic to probabilistic approaches) including fragility assessment of different asset types will be described and bedded into relevant training material and tools. <strong>3.2</strong> Design and assessment tools and techniques for establishing or adapting the performance and standard of service of asset, including overall methods for asset systems, will be progressively developed, piloted and implemented. <strong>3.3</strong> Effect of management intervention or “do nothing” will be quantifiable.</td>
</tr>
<tr>
<td><strong>4.</strong> Identify means of reducing the whole life costs of assets in order to improve their value and cost-effectiveness for given standard of service. Improve the whole systems approach to sustainable asset management using decision support tools to help underpin decision making processes.</td>
<td><strong>4.1</strong> Rational procedures for monitoring and archiving life-cycle costs of asset ownership (to include operation, maintenance, renewal, upgrading, removal and/or replacement) will be developed and implemented. <strong>4.2</strong> Cost models for different asset types and approaches to investment and/or asset management intervention will be available to support decision-making processes in asset management planning and detailed design. <strong>4.3</strong> Historic and life-cycle costs will be better linked into (a) whole system tools in 3.2 &amp; 3 above, and (b) good practice guidance for individual assets.</td>
</tr>
</tbody>
</table>
5. Improve our understanding of the construction process for assets in order to improve the quality and efficiency of delivery of the construction product and to minimise adverse environmental impact during construction and maintenance.

5.1 FCERM construction process will be screened against best practice in other comparable or relevant sectors of the construction industry for quality (engineering; environmental; costs; societal) of construction product.

5.2 Areas considered to benefit from improvements or new practice will be identified with involvement of FCERM stakeholders. Continuous improvement process initiated or modified accordingly (links to 1.2 above).

5.3 Guidance on the environmental (particularly WFD) and societal potential of selected FCERM assets will be improved (links to 6 below).

6. Contribute to the concepts of building sustainable communities and achieving wider benefits alongside flood risk management. Improve the interaction between asset systems and the local environment (e.g. operational staff / public H&S, landscape and amenity value).

6.1 Concepts of multi-functional performance and multiple benefits from the viewpoint of FCERM assets will be included in the planning and design process. Then utilised in education, training and good practice guidance.

6.2 Collaborative working on multiple benefits developed under science (including pilot) projects with other internal and external partners, including good practice on achieving “good ecological potential” for FCERM assets under WFD.

### 3 Programme Planning

This section of the Work Plan sets out the main considerations leading to the structure of the Theme Programme, the main subject areas that are planned to be covered, and the selection of the projects in the Annual Work Plan.

#### 4.1 Principal considerations

**Independent Programme Review – 2005**

The broad coverage of “all physical measures” envisaged for the SAM Theme by the Programme Review has been described in Section 3. The Programme Review expects the SAM Theme Programme to address both short and longer-term needs (sometimes referred to as tactical and strategic research). The short term focus should be on developing more efficient ways to deliver FCERM in today’s environment. At the same time, the SAM Theme must respond to the longer-term “new or increasing demands”. At the time of writing (January 2007) these drivers are already well recognised:

- Climate change and socio-economic development pressures
- Asset condition and management
- Urban flood risk
- Water Framework Directive (WFD) and the Habitats Directive
- Shortage of skills

The Programme Review identified the potential research issues listed in Appendix B. These arise from (a) the Foresight Future Flooding project, and (b) the User Workshop during the Programme Review
The Programme Review also requires the Theme Programme to focus on needs of practitioners and ensure the logical delivery of results in a useable form to those responsible for delivering FCERM. The Theme Programme is expected to include updating of existing tools and good practice guidance with new knowledge and know-how.

**Inherited and on-going research**

As explained in Section 2, the SAM Theme inherited a programme of on-going projects in September 2005 and builds its programme principally on the former Engineering and Processes Themes. The important PAMS (Performance-based Asset Management Systems) project was part-sponsored by the Engineering Theme.

The background, projects (past, on-going and potential) and outputs from the Engineering Theme are recorded in its Work Plan (updated in November 2004). The proposals or suggestions for research that had previously been identified in the Engineering Theme Work Plan have either been rolled forward into the planning of the SAM Annual Work Plans for 2005/06 and 2006/07, or are now reflected in the list of potential SAM research proposals.

The inherited on-going projects have been reviewed against the current Programme Definition Document, the Independent Programme Review, and the SAM RO Statement. In general these have been accepted into the SAM Theme Programme. Some projects have been varied to provide secure improved outputs from the viewpoint of delivery to current FCERM structures and business programmes.

These include (a) Conveyance and afflux estimation systems (CES / AES – for use in channel performance management); (b) Flood embankments – Good practice review (to link consistently with EA Asset Management); (c) PAMS (to include logical Measured Steps Forward and improved links to EA Asset Management); (d) Impact of maintenance of river sediments and habitats (to include channel classification and link to current good practice).

- **Understanding of current gaps in knowledge**

From the viewpoint SAM Programme planning, perhaps the key intellectual knowledge that has been inherited is the broad understanding of where the gaps in knowledge or in guidance and tools exist. This impacts on the type of research, development, demonstration or simply training that is, or isn’t, needed. Several of the issues for potential support from an Asset Management programme listed in Appendix B do not need research or development per se, but rather the better synthesis and presentation of existing knowledge and good practice.

- **Existing important collaborations**

The future SAM Programme should build on the following collaborations. These bring in significant funding and research resources as well as important interfaces with practitioners.
- **Flood Risk Management Research Consortium (FRMRC)** Lead funder EPSRC, with support funding from Defra / EA, Scottish Executive, Rivers Agency (NI) and UKWIR. Two Priority Areas relevant to SAM Programme – (a) Infrastructure Management (embankments, coastal) and (b) Urban Flood Management (integrated modelling).

- **FLOODsite** Lead funder EC Research, with support from national organisations including Defra / EA. Three key Tasks relevant to SAM Programme – (a) Understanding and predicting failure modes, (b) Reliability analysis of flood defence structures and (c) Pilot projects (including TE2100 asset risk attribution model). FLOODsite is quoted in the new Floods Directive as a contributor to collective EU understanding of flood risk management practice.

- **Thames Estuary (TE) 2100** The EA project team has worked with the Defra / EA Joint Programme to make appropriate use of improved flood risk management methods. Key areas relevant to SAM Programme as (a) asset deterioration and condition assessment, and (b) modelling for system risk attribution and management intervention.

- **EA Asset Management** Following the implementation of the EA’s Asset Management Strategy, SAM Theme management has worked closely with the EA Asset Management team to link outputs into their Implementation Programme (see 4.2 below).

- **Pilot and Demonstration projects** These have provided successful opportunities to test and develop tools and techniques with practitioners at specific locations, particularly with coastal authorities.

- **Partnerships with science contractors** The Environment Agency has a framework agreement with HR Wallingford and has a mutually beneficial arrangement for working through CIRIA on projects involving the wider FCERM industry.

### 4.2 Structure of SAM Programme

Obviously the on-going SAM Programme has been influenced in its first two year by the inherited research. Irrespective of the projects within the programme, it is important to establish a structure to the programme that reflects the SAM RO Statement, and the main direction of the Objectives and Outcomes in Section 3.

Four sub-themes have been identified under the SAM Programme to reflect the principles, framework and hierarchy within which Sustainable Asset Management can logically be considered. Key areas of science which can be associated with each of the sub-themes are listed in the following table. Notably, particular science projects can span between sub-themes.

<table>
<thead>
<tr>
<th>Sub-theme</th>
<th>Area of science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk and strategic planning (related to assets)</td>
<td>Sustainability concepts</td>
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<tr>
<td></td>
<td>Types of risk, including business risk</td>
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<td></td>
<td>Whole life / life cycle concepts</td>
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<td></td>
<td>Strategic planning (links to SAM – e.g. MDSF2)</td>
</tr>
<tr>
<td></td>
<td>Multi-functional schemes and multiple benefits</td>
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<tr>
<td>Environmental state and asset condition</td>
<td>Asset inspection and condition assessment</td>
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<tr>
<td></td>
<td>Asset deterioration</td>
</tr>
<tr>
<td></td>
<td>Morphological and ecological quality (incl Habitats /</td>
</tr>
<tr>
<td>Asset systems (planning and design of intervention)</td>
<td>Asset performance and failure modes</td>
</tr>
<tr>
<td>Asset improvement and operational delivery</td>
<td>Demonstration and pilot studies</td>
</tr>
</tbody>
</table>

The sub themes relationship with the objectives set out in the R&O Statement can be seen below.

<table>
<thead>
<tr>
<th>Objective*</th>
<th>Risk</th>
<th>Environmental State and Asset</th>
<th>Asset</th>
<th>Delivery Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Asset management Sustainability concepts.</td>
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<tr>
<td>2. Asset condition</td>
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<tr>
<td>3. Design and management techniques (including risk-based methods)</td>
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<tr>
<td>4. Whole life costs of a systems approach to sustainable asset management.</td>
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<tr>
<td>5. Construction Process and Maintenance</td>
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<tr>
<td>6. Asset systems and the local environment</td>
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</tr>
</tbody>
</table>

* Refer to R&O Statement for full objective descriptions

The time scales of projects will be influenced by delivery targets for the initiatives and strategies that the SAM Programme supports. The projects may also be influenced by other themes within the FCERM Programme, where a project overarches a number of programme areas.

5 Summary of activities

Whilst expanding on the summary of activities there is a need to remind ourselves that the Defra / EA Joint Programme has to address the interests of all Operating Authorities.

Continuing demand arises for the need of strong engineering and environmental aspects of asset management, providing best practice and appropriate tools for efficient and cost effective design, construction and management of flood management assets, and their environmental performance. The environmental drivers should be reflected in catchment-based, multi-functional and appropriately “soft” considerations within FCERM. An urban demand arises from both the increased EA interest (new Strategic Role) and Local Authorities, which see this as
an increasing concern to the public but an area in which generally their resources (and COWs role) have been cut back. Whilst a lot of research has been carried out on fluvial management the development of Shoreline Management Plans and future changes in coastal accountabilities have highlighted the need for increased research in the coastal area. There is no doubting that climate change has increased the hazard of pluvial flooding in relation to fluvial, and that further good practice is required in this area of considerable uncertainty. This in turn has a knock on effect for socio-economic scenarios.

The division of Programme areas has been influenced by the conclusions of the Review Team (Appendix 3), as well as a number of strategies and scientific thinking. A detailed summary of proposed, ongoing and completed projects can be found within the SAM Annual Work Plan. This annual plan importantly documents what the expected benefits of the research will be, as well as what benefits have been realised by completed research.

5.1 Urban Flood Management
This is an area of increasing concern driven by climate change and the policy need for a more strategic and integrated approach to flood risk management. Integration involves both different operating agencies and sources of flooding. Key needs are for integrated planning tools, particularly to clarify risk attribution between sewer and surface water systems and to assist in improving / optimising physical infrastructure. The research and evidence base to support this change now needs a substantial effort.

In relation to fluvial flood risk, urban flood risk is seen to be increasing both in incidence of flood generating events and in their consequence. Urban flood “infrastructure” (i.e. the complex “flooding system” of sewers, drains, storage, soakaways etc) is the responsibility of several different authorities.

The need to address complex urban flooding issues was highlighted in the ICE’s Learning to Live with Rivers (2002) and Foresight Future Flooding (2004). The Government is taking action under Making Space for Water via the Integrated Urban Drainage (IUD) Pilots initiative. This action will initially focus on a review of good practice and issues, and then proceed to pilot a range of different approaches to effective integrated urban drainage management. The IUD scoping study (done by MWH) will also help to establish the baseline for future research.

As a step towards clarifying the R&D issues, the former Engineering and Risk Themes actively supported an Urban Flood Risk Assessment Working Group. This comprised the main researchers and practitioners who are involved in current urban research initiatives and helped to draw together a consensus position on current science and new tools for the IUD initiative.

Ongoing urban flood management / drainage projects include a Dti led project on “SAM - System-based analysis and management of urban flood risks” (HR-W); Urban drainage interface with Operating Authorities (AUDACIOUS urban drainage management tool box; CIRIA ‘Designing for exceedance in urban drainage - good practice’); Flood Risk Management Research Consortium, Priority Area 6 – Urban Flood Management.
5.2 Asset condition and management
This topic area is driven by Government policy and the implementation of the Environment Agency strategy and operational changes (IFRM). The continuing move towards asset management, away from a compartmentalized “construct – operate – maintain” approach, was strongly reflected in the questionnaire responses received by the review team. Practitioners want more guidance on the assessment of performance and deterioration of FCERM assets, the management of risks/ cost/ performance, decision support tools particularly to examine risk attribution across asset systems and the effects of management interventions (including “do nothing”) on that. The EA Sustainable Asset Management Strategy and the scale of the existing asset base (£15 billion plus) highlights the value of such research.

The PAMS (Performance-based Asset Management System) framework below was developed under the previous Defra / EA R&D Joint Programme. The related principles of (a) asset condition assessment and (b) the prioritisation of management intervention (whether ‘maintenance’, ‘refurbishment’ or ‘replacement’ works) of asset systems is now embedded in the EA’s IFRM (Incident and Flood Risk Management) structure. Catchments and coastal cells have been subdivided into c.3000 “Asset Management Systems” for operational management.

Figure: The PAMS framework for decision support in asset management intervention

Phase 2 of PAMS (currently underway) identifies the desirable elements to a future asset management system. Since taking overall charge of this project in September 2006 (from the Modeling & Risk Theme (MAR)), the SAM Theme Management have worked with EA Process teams in Asset System Management and Operations Delivery and the contractor to restructure the research project to deliver so-called ‘Measured steps forward’ to operational staff in 2006. These ease implementation by ensuring that the user takes on new procedures in a measured step-by-step manner, focusing on the most appropriate issues first and recognising the major cultural and ownership issues involved in moving to a new approach. (This contrasts from seeking to implement a major step change later.)
SAM has also opened up a dialogue with the Association of Drainage Authorities via its Technical Group specifically on drain and watercourse management (involving IDBs and lead LA Operating Authorities).

Ongoing asset management projects include: Performance-based Asset Management Systems – Phase 2; Embankment vegetation management trials; Aquatic Plant Management Group (formerly CAPM) programme at CEH; Flood Risk Management Research Consortium, Priority Area 4 - Infrastructure Management; FLOODsite (EU project); Integration of geotechnical process into flood embankment management; Implementation – CES Standalone for channel management; Embankments – Good practice.

5.3 Environmental Asset Management
The Water Framework Directive (WFD) and the Habitats Directive act as constraints on the implementation of a range of potential solutions, as well as drivers for taking a catchment-based approach to planning and operational management. The WFD requires the integration of flood risk management into catchment management generally, with a focus on water protection, improvement and use. FCERM managers will need tools and techniques that enable them to use, or demonstrate that they are using, best practice for achieving good ecological potential for water bodies that are heavily modified by FCERM works. Ongoing projects in this area include the Environmental River Engineering Design Manual, The Fluvial Design Manual, The Aquatic Plant Management Group (APMG).

5.4 Coastal Processes
The SAM Programme to date has had a relatively good coverage of fluvial processes, however Coastal aspects still require particular consideration. This is highlighted through the development of Shoreline Management Plans. There is a concern that there is still inadequate linkage between coastal erosion and flood risk management (often largely technically, environmentally and economically driven) and the planning process when it comes to coastal processes. This is fundamental to sustainable management of the coast, particularly with regard to development control, but also in terms of the broad consideration of planning issues in managing the coast. Climate change impacts such as sea level rise and increased tidal surges have become of particular concern. Projects that are ongoing in this area include: Wave Overtopping, Beach Management Manual - an amalgamation of best practice, including the Lowering of Beaches, Beach permeability, Coastal protection methods (Dunwich), realignment of shoreline (Tollesbury, Freiston), Shingle Management – Coastal Demonstrations.

5.5 Climate Change & Socio-economic Scenarios
The Foresight Future Flooding report (OST, 2004) highlighted a number of key areas where we must consider adaptation to Climate Change uncertainties. These effectively drive the future scenarios covered in the Catchment and Shoreline Management Planning process, which in turn establish the future policies and strategies to which FCERM asset management must respond. The report highlighted that changes in tidal surges, waves, coastal sediment supply and morphology, and relative sea level rise are capable of increasing risk (average annual damages). River flow processes, such as vegetation and flood conveyance could also increase risks up to 6 times present levels under the community-oriented scenarios owing to the
effects. Restrictions on channel maintenance and the wish to re-naturalise rivers should be considered within this context. Changes in land use, such as urbanisation could see an increase in risk by up to 4 times than present levels. The uncertainty drives us to consider flexibility in our design, adapting sustainability to ensure appropriate resilience. We should define consequences using a probabilistic scenario, rather than a definitive, as we build on our understanding. Ongoing projects in this area include: Coastal Wave Overtopping, Conveyance Estimation System, Beach Management Manual and the Performance Based Asset Management System.

**Good Practice Guidance**

In response to the needs of practitioners, the maintenance of strong user focus was a recurring theme in both the questionnaire responses and the workshops held by this programme in 2005. There were consistent calls for practical guidance that would pull together existing good practice and new knowledge / know-how and make it available in a useable form to those responsible for delivering FCERM.

A range of ‘good research practice’ has emerged over the past four years relating to the best way to demonstrate the research product (called ‘proof of concept’ by EA Science) and then move on to implementation in practice. Also, some difficulties in implementation were highlighted in the Programme Review.

We hope that the use of pilot and demonstration projects will feature strongly in the SAM Theme Programme. We believe that complex issues like the development and implementation of performance-based asset management can only be effectively addressed via pilot work involving real sites and real users. We are pleased to see similar support for the pilot approach from the Government in the Making Space for Water consultation response on Integrated Urban Drainage Management (Project HA2 – see Section 4 below).

**Information Systems**

A separate delivery issue that must be addressed carefully in the future programme is the EA’s overall IS/IT framework into which the large potential number of new software and computer-based tools are not only developed, but subsequently used, supported and eventually upgraded or replaced. Unless a clearer generic approach is provided, individual projects will (a) be slow to approve and to implement, (b) be less consistent and potentially non-compliant, and (c) be potentially less effective and beneficial to users. We understand that such a framework will be highlighted in the EA’s FRM Modeling Strategy which is now at the consultation stage.
<table>
<thead>
<tr>
<th>Year</th>
<th>Management</th>
<th>Coastal</th>
<th>Asset condition / management</th>
<th>Environmental</th>
<th>Urban</th>
<th>Climate / Socio-Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/06</td>
<td>Adaptation from 'Engineering' &amp; 'Processes' theme to 'Sustainable Asset Management Theme'</td>
<td>Realignment Best Practice</td>
<td>Condition Assessment</td>
<td>Vegetation management / channel maintenance</td>
<td>Whole system understanding (pluvial, fluvial, sewage)</td>
<td>Sustainable Adaptation principles</td>
</tr>
<tr>
<td>2007/08</td>
<td></td>
<td>System Management (e.g. Saltmarsh)</td>
<td>Conveyance Estimation</td>
<td>Sustainable use of dredgings/vegetation</td>
<td></td>
<td>Carbon footprint of assets/management Performance specification</td>
</tr>
<tr>
<td>2008/09</td>
<td></td>
<td>Risk based adaptation tool for Coastal Protection</td>
<td>Whole Life Costing</td>
<td>Sustainable Fluvial, Environmental &amp; Landscape Design</td>
<td></td>
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<tr>
<td>2009/10</td>
<td></td>
<td></td>
<td>Criticality assessment (fragility)</td>
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</table>
6 Resource management

6.1 Human resource
The SAM Theme Champion is Brian Empson (Environment Agency) and the Theme Manager is Chrissy Mitchell (Environment Agency), assisted by a Theme Advisor, Mervyn Bramley (Independent).

The SAM Theme is one of four themes under the FCERM R&D Programme, working in close association with the Modelling & Risk theme (MAR), Strategy and Policy Development (SPD) and Incident Management and Community Engagement (IMCE). It reports directly to the Joint Programme Management Team (JPMT), who are steered by the Programme Board and advised by the Programme Advisory Group. Further details on the roles of each of these groups can be found in the Programme Definition Document.

Structure of the Joint Defra/EA FCERM Programme

The membership of the SAM TAG includes representatives of the major stakeholders, Defra and Environment Agency, and leading experts covering the theme topics. They are shown in Appendix A alongside their affiliations and associated topic areas.

The programme planning cycle can be found within the Programme Definition Document, but essentially comprises of
<table>
<thead>
<tr>
<th>Time</th>
<th>Planning cycle</th>
<th>Expectations</th>
</tr>
</thead>
</table>
| Pre June   | Proposals for future R&D collated                                              | 1. Review of completed projects from previous FY  
2. Review of progress on fulfilment of research area plans and scoping study recommendations generally, and against theme objectives.  
3. Review of need for update of research plans  
4. Identify gaps in the programme and new ideas for next FY  
5. Production of Short Forms outlining proposed projects.  
6. Prioritise projects and submit to Programme Management |
| June       | Themes present proposed annual plan, usually following a TAG meeting           |  
| July       | Programme Management Team discuss proposals and clarify issues                |  
| August     | Programme Advisory Group challenge programme proposed. Programme Management Team finalise plan |  
| End Sep    | Defra and Environment Agency seek authorisation for expenditure               | 1. Review of current programme  
2. Identify procurement / planning issues for individual projects and programmes  
3. Debate and discuss practical methodologies to carry out R&D proposed  
4. Preliminary consideration of the shape of theme programme for the following FY |
| Oct-Jan    | Procurement & Planning                                                         |  
| April      | Plan implemented                                                               |  

An essential component to the efficient running of the SAM programme, is appropriate resource at a project management level. It should be recognised that the level of Project Manager (PM) competency required varies from project to project. At a higher level, both a technically competent external project manager and internal (Defra/Environment Agency) PM may be required. At the lower end of the scale there is an expectation of a competent internal PM, or an competent external PM with a support internal PM to manage the internal systems (e.g. Science Management Information System (MIS), Joint Defra/EA FCERM R&D Web site etc.)

Appropriate resource is becoming a challenge due to a growing shortage of skills. This is influencing the ability of operating authorities (and their consultants) to deliver FCERM, which in turn highlights the need for the science programme to link into the provision of training, tools and guidance. (Identified by Reports within the EA and ICE examining engineering skills for FRM, 2005/6). This programme should continue to support the breach of this gap in experience. For example, through provision of updates to training courses/University material.

The SAM Theme has the ability to appoint Project Area Groups. These are flexible groups that can be formed, refocused and, where appropriate, disbanded as the emphasis of the programme changes. They essentially form a sub advisory group to
the Theme on a detailed area of research, informing SAM Theme where appropriate (e.g. coastal, urban).

An Annual Work plan will be developed and produced in the period April-September each year. It will be finalised upon approval of projects for the following FY by the programme management, Programme Board and, in the case of Agency-funded projects, by the PAB. The annual Work Plan will also hold information on completed projects, detailing the benefits that have been realised by the research, financial information (refer to next section) and proposals for future research.

This document (the 5-year Theme Work Plan) will be reviewed each year but is unlikely to be amended except in respect of any changing matters at a higher level.

6.2 Financial Resource

The proportion of budget for the SAM Programme is set on an annual basis by the Joint Programme Chairs. Details of budget forecasts and actual spend can be found in the Annual work plan.

The review of the joint programme carried out by an independent panel and focusing on the period between 2001-05 identified the percentage budget set for the Engineering Theme at 16% of the total Defra/EA Joint Programme. In 2006/07 this increased to 24% of the budget. This remains inconsistent with expenditure by Operating Authorities on FRM infrastructure. For example Operating Authorities expenditure on fluvial and coastal flood management in England and Wales accounted for over 60% of the budget in 2004. Further to this there are particularly strong reasons within the SAM Theme Programme to increase the amount of developmental science on fundamental issues for the effective risk management of infrastructure – e.g. embankment fragility, and material deterioration.

The SAM Theme continues to bid for a higher percentage cut of the budget for SAM R&D, in the hope that expenditure may reflect operating demand.
## Appendix A  TAG membership and representation

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
<th>Topic area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brian Empson</td>
<td>Environment Agency</td>
<td>Theme Champion</td>
</tr>
<tr>
<td>Chrissy Mitchell</td>
<td>Environment Agency</td>
<td>Theme Manager</td>
</tr>
<tr>
<td>Mervyn Bramley</td>
<td>Independent</td>
<td>Theme Advisor</td>
</tr>
<tr>
<td>John Horne</td>
<td>Defra</td>
<td>Governance of Delivery Programme</td>
</tr>
<tr>
<td>Jackie Banks</td>
<td>Environment Agency</td>
<td>Asset System Management &amp; Enforcement</td>
</tr>
<tr>
<td>Tim Kersley</td>
<td>Environment Agency</td>
<td>Head of Asset Management</td>
</tr>
<tr>
<td>Fola Ogunyoye</td>
<td>Royal Haskoning</td>
<td>Coasts &amp; Rivers Division</td>
</tr>
<tr>
<td>Paul Sayers</td>
<td>HR Wallingford</td>
<td>Group Manager</td>
</tr>
<tr>
<td>Dick Thomas</td>
<td>HR Wallingford</td>
<td>Coastal Consultant</td>
</tr>
<tr>
<td>Steve McFarland</td>
<td>Canterbury City Council</td>
<td>Coastal Authorities</td>
</tr>
<tr>
<td>John Gosden</td>
<td>Jacobs Babbies</td>
<td>Senior Consultant</td>
</tr>
<tr>
<td>Jo Murphy</td>
<td>Environment Agency</td>
<td>National Environmental Assessment Staff (NEAS)</td>
</tr>
<tr>
<td>Stuart Hemmings</td>
<td>Black Sluice IDB</td>
<td>Representing ADA Technical Committee</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Corresponding Member</strong></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brian Francis</td>
<td>Environment Agency</td>
<td>National Capital Programme Management Services (NCPMS)</td>
</tr>
</tbody>
</table>
Table IR1 – Requirements for future research in asset management specifically raised in Foresight Future Flooding

<table>
<thead>
<tr>
<th>Topic area</th>
<th>Summary of research requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>River vegetation and conveyance</td>
<td>Vegetation processes in rivers, and improvement of the way that hydraulic models represent resistance and estimate conveyance</td>
</tr>
<tr>
<td>Contribution of river and coastal maintenance activities to reducing risk</td>
<td>Asset management tools to monitor expenditure on maintenance activities, the condition of defences, their performance under extreme loadings and the resulting impact on flood risk</td>
</tr>
<tr>
<td>Enhanced database of flood-defence assets</td>
<td>Improve the accuracy and coverage of existing databases of flood and coastal defence infrastructure</td>
</tr>
<tr>
<td>Performance of defences during flood events</td>
<td>Monitoring and post-project appraisal studies on the type and severity of damage occurring to flood and coastal defences subjected to extreme events and increased environmental loadings</td>
</tr>
<tr>
<td>Vulnerability of coastal defences</td>
<td>Response of beach and shoreline profiles in front of existing defences will respond to climate change Establish how serious and widespread failures of coastal defence infrastructure are likely to be under each scenario in the 2050s and 2080s due to foreshore steepening and scour in front of coastal defences</td>
</tr>
<tr>
<td>Energy reduction and renewable energy extraction</td>
<td>Potential for energy to be extracted in multi-purpose schemes designed to manage coastal erosion and generate renewable energy.</td>
</tr>
<tr>
<td>Managed realignment of coastal defences</td>
<td>Methodological basis for assessment of the true costs and benefits of infrastructure relocation and managed realignment as a policy response to intensified coastal erosion</td>
</tr>
<tr>
<td>Sustainable beach recharge and recycling</td>
<td>Further research into sediment sourcing and recycling</td>
</tr>
</tbody>
</table>

Table IR2 – Issues for potential support by future Asset Management Programme identified at User Workshop during the Independent Review – January 2005

<table>
<thead>
<tr>
<th>Topic</th>
<th>Summary of issue potentially for Asset Management Programme</th>
</tr>
</thead>
</table>
| 1. Best practice and guidance             | - Best practice in construction  
- Best practice for communicating I.T. between project parties  
- Design guide for operational and public safety  
- Design guide for resilience of structures during exceedance events  
- Practical advice on flood defence design for sustainability  
- Health and safety guidance  
- Compendium of design guidance  
- Climate change and standard design  
- Impacts on structures/materials  
- Ensuring adaptability |
<table>
<thead>
<tr>
<th>Topic</th>
<th>Summary of issue potentially for Asset Management Programme</th>
</tr>
</thead>
</table>
| 2. Development of design techniques | - Sustainable design principles in river/coastal systems  
- Maximising the whole life of coastal structures / river defences  
- Design in flexibility/adaptability/reversibility  
- Maintainability of assets  
- Buildability of FCERM structures  
- Innovative methods  
- Breach repairs |
| 3. Asset inspection, assessment and management tools and techniques | - Asset inspection techniques, assessment and management  
- Asset performance and integrity  
- Non destructive testing  
- Visual inspection of structural integrity  
- Culvert conveyance, condition  
- MEICA asset management plans and testing  
- Appropriate condition monitoring (risk-based approach)  
- Asset performance and management (including failure recovery)  
- Residual life assessment of assets and risk-based maintenance  
- Rapid non-destructive structural condition tools |
| 4. Procurement and cost management issues | - Procurement process best practice  
- Appraisal of the merits of different approaches to procurement and risk in design and construction  
- Behavioural aspects of client – consultant – contractor (partnering)  
- Capital vs. revenue inconsistency  
- HEs (House Equivalents): estimating property damage from flooding  
- Allocation and prioritisation of Flood Defence GiA  
- Seeking other sources of funding + developing partnerships (guidance for staff)  
- How can FRM learn from other industries and sectors e.g. charities  
- Cost estimation of flood risk management. Operational and capital - national set of unit rates |
| 5. Urban design and rehabilitation | - Urban flood / drainage management (design and social implications etc) – accommodation of storage and flow – cross-cutting theme.  
- Culvert rehabilitation  
- Rehabilitation of old structures  
- Flow through defences – process and design and rehabilitation guidance |
| 6. Miscellaneous | - Demonstration and pilot studies in implementation  
- Software – how does the programme or client promote and support development / implement maintenance  
- Innovative engineering technology  
- FRM implementation efficiency – reduce time  
- “Future proofing” for climate in face of (extreme) uncertainty  
- Knowledge management  
- Capturing practical experience of design and construction  
- Typical details / specifications (science scoping done; delivery is non-science issue) |
Appendix C: Extract from Chapter 3 of Independent Review – Responding to the drivers of FCERM

3.4 Recommendations – the future directions

The proposed new thematic structure for the R&D Programme is designed to allow change in relation to new directions for FCERM and new user priorities, and indeed we feel strongly that if there is no change then opportunities are being wasted and the structure is not being used to its full potential.

An indication of the emphases for the new R&D Programme is contained in Table 3.2 (Table 1 in this TAG paper), which builds on the existing R&D agenda already in play. In drawing up this table we have not sought to identify particular projects, as that is not in the spirit of the thematic approach that has successfully developed over the last five years. Furthermore, no attempt has been made at prioritising the topics listed in Table 3.2. The more detailed information contained in the Appendices can be used by the Programme Board and its support staff to suggest priorities and thereby to steer the overall Programme in new directions in the initial stages of the new structure.

However, the following 10-point action plan list summarises what we believe to be the key areas for future emphasis in the R&D Programme, based on the wide range of sources consulted as part of our review. The list draws also on statements from Making Space for Water, and other key documents, where these are clearly reflecting or reinforcing the messages that we have received from all other sources. It should be noted that the list is not presented in order of priority:

One of the strongest messages to come out of the two workshops that we held was the need to get developing and established science into good practice tools and guidance for practitioners. The need for such tools and guidance is also reinforced by the knowledge that we are currently facing a growing skills shortage in FCERM. The availability of sound and approved guidance, and practical tools, in readily usable formats will help to overcome some of the problems created by the shortage of appropriately skilled personnel. This work has been part of the current Programme, but there is a clearly-voiced demand for more such outputs.

Another major theme in Making Space for Water is that of risk management, encompassing a range of subject areas from the appraisal of potential schemes to the delivery of effective solutions for groundwater and sewer flooding. This theme is, of course, also strongly represented in the Foresight Future Flooding report, in terms of assessing the range of risks and developing strategies to deal with them. Much of this is new work, and provides strong support for the continuation of the work of the Risk and Uncertainty Theme in the R&D Programme and its inclusion of greater attention to social issues.

The as yet unanswered question of the impact of rural land use management on flood risk also comes within the ambit of risk management. Until the current Programme of research is completed, there will continue to be heated debate about the connection between farming practices and floods and what steps should and
could be taken to reduce flood risk. Some initial work has been done, but the fundamental questions remain unanswered.

The important role of flood warning systems in managing risk is also emphasised in Making Space for Water, and it must be recognised that warning systems cannot operate without effective flood forecasting. There remains much to be done in the R&D Programme to improve our ability to generate accurate forecasts and deliver timely warnings.

The need to integrate drainage planning and management in urban areas has been identified in the existing R&D Programme and a number of initiatives have been pursued (e.g. AUDACIOUS). This same message is reinforced in both Making Space for Water and Future Flooding. This is clearly a rapidly evolving area which should be emphasised in the R&D Programme for the next five years, with appropriate levels of coordination with ongoing and proposed pilots and related initiatives (e.g. FRMRC), and cooperation with other research bodies with overlapping interests (e.g. UKWIR). This is critical and urgent work.

Making Space for Water also quite rightly raises the issue of public awareness, which is linked to the better understanding of risk, as well as to more informed decision-making. There is strong support for greater community engagement from many quarters, not least of all the ICE’s Learning to Live with Rivers (2001) and the Agency’s Strategy for Flood Risk Management (2003). This area of research is virtually untouched, and is clearly an area where the Defra/Agency R&D Programme would benefit from better coordination with ESRC (with the assistance of ODPM).

The impact of the Water Framework Directive (WFD) has yet to be felt in the delivery of FCERM, but there can be no doubt that this far-reaching piece of legislation presents both constraints and opportunities at all levels from policy to operations. There is a clear need for R&D over the next five years to explore the consequences and develop solutions, taking account of other more established legislation such as the Habitats Directive. Furthermore, there are particular questions to be answered in respect of coastal flooding and erosion management, not least of all in terms of the implementation of a policy of managed realignment and its social dimensions. This area of research is in its infancy.

Of course, one of the most fundamental drivers of change in the delivery of FCERM is climate change and all the implications thereof, as explored in the Foresight report. There can be no doubting that there is further work to do in the science of climate change. In the previous review, the focus on research related to climate change was low key, awaiting outputs from the international research at the necessary level of resolution. This level of information is now becoming available and there is a need to examine impacts but the focus of the Defra/Agency R&D Programme should be the development of appropriate responses and adaptations to the predicted changes. This is an R&D field that demands innovation, and recent scientific evidence suggests that it should be given a high priority.
In parallel with climate change are the ongoing social and demographic changes, which have to be reflected in the delivery of FCERM, but these changes to date have been the subject of very little systematic analysis. If solutions are to be developed that build on the three pillars of sustainability (social, economic and environmental), then evidence on such changes needs to be integral to policy-making and strategic planning, as identified in the Foresight report. The research required needs to link closely with similar work ongoing elsewhere within Defra and with the Agency unit for Social Policy. This is a new area of research for the Programme.

Although the focus in the delivery of protection to people and property has changed over the past decade, from the provision of flood defences to the wider concept of flood risk management, it is recognised that much of the management of risks comes from the continued functioning of flood defence assets. Therefore the calls for better approaches to asset management are well founded, and there is much more that the R&D Programme can deliver in this regard.

In summary, the Defra / EA R&D Joint Programme must make a substantial contribution to reducing flood risk for the people of England and Wales. The outcomes from the investment should be:

Better evidence-based policies;
Better allocation of resources;
Improved risk assessment and risk management, and
More timely solutions based on sound engineering, environmental and social sciences.

The Programme may also encourage academic excellence, accelerate research productivity, and add to the sum of human knowledge.

We do not have to draft another “vision” in order to provide direction for the R&D Programme. The Foresight and Making Space for Water initiatives have clearly defined the strategic framework, essential policy elements, and higher level targets for the next five years and beyond. However, in order to ensure that the next phase of the R&D Programme is set on the right course, we suggest that the Programme Board prepares a “route map” for consultation. This would involve considering the above ten point plan, and setting out achievable objectives that are required to support delivery of more effective and appropriate FCERM in the future.

Finally, the FCERM R&D Programme must include a much enhanced means of measuring its own performance (successes and failures), so that the benefits of this R&D effort can be evaluated much more systematically and the case for continued investment more clearly demonstrated in the future.

Independent Review team:
Edmund Penning-Rowsell, Peter Bye, Charlie Rickard, Ian Townend, Andrew Watkinso