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DEVELOPING A PERFORMANCE - BASED MANAGEMENT SYSTEM FOR FLOOD AND COASTAL DEFENCE ASSETS

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ABSTRACT
This paper provides an update on the on-going research and development to develop new methods and tools to support asset management. The new approaches aim to support the attribution of risk to particular assets within the flood system and quantify how this may change over time and how alternative whole life strategies of capital and maintenance interventions can be best directed to manage the changing risk. The research includes development of a revised methodology for asset inspection and ongoing studies into how the probability of defence failures can be modelled and represented in a scientifically robust way.

Introduction
Flood risk asset managers need to target spending in areas of greatest flood risk, whilst seeking to maximise the overall return on investment and achievement of other targets. This requires a move towards a more integrated and risk-based approach to asset management.

To build a 'robust' case for funding, managers must be provided with and be able to use the best assessment and management tools available. The Environment Agency currently employs a methodology which relies on event probability related to loadings and water levels. This does not take into account as well as it could the performance of structures, components, operational actions, whole flood defence systems, or the associated risks of failure of these. As described in Sayers et al (2004), the

Department for the Environment, Food and Rural Affairs (Defra) and the Environment Agency are attempting to address this issue by funding research and development of an improved management system. This 'Performance-based Asset Management System' – is building on and bringing to fruition previously relatively isolated research and development undertaken in the UK from initiatives such as the Flood Risk Management Research Consortium and the European FLOODsite project as well as from Defra Environment Agency funded R&D such as 'Risk Assessment for Strategic Planning' (RASP), 'Operations & Maintenance for Concerted Action', 'Embankment Failure Under Extreme Conditions'(IMPACT), 'The Conveyance Estimation System' (CES), the 'Performance and Reliability of Flood & Coastal Defences' and the 'Thames 2100' project.

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Management of asset performance

The project is aiming to provide a management framework, methodology, guidance, tools and operational infrastructure for more effective and reliable flood risk management, assessment and decision-making in the UK. Although primarily aimed at Environment Agency Flood Risk Management, Asset and Operations Delivery Managers, it should also be of benefit to Internal Drainage Boards and Local Authorities with flood risk management and reduction responsibilities.

Tools developed under the project should help the Environment Agency to realise its strategy for Flood Risk Management for 2004-08. Underpinning this strategy is the Agency's recent organisational change known as Incident and Flood Risk Management (IFRM). Each of the 3000 System Asset Management Systems in England and Wales will have a performance specification which the maintenance programmes will reflect. The aim is that by 2008 all FRM systems will have a System Asset Management Plan.

The R&D project has three phases. Phase 1 was the scoping stage, Phase 2, now underway, is developing the frameworks and methods and Phase 3 aims to provide the full suite of tools.

In addition to the integration of the R&D mentioned above, the project also aims to fill in some of the remaining gaps in the adopted approach not addressed in previous projects. Some of the outputs also require 'fleshing out' and/or further development and testing before full implementation of the system can be initiated. This is therefore not an overnight solution, and will take several years of concerted effort to deliver. Further refinement of the quality of the outputs will rely on improvements in data reliability and accuracy gathered as part of the 'day job' of flood risk and asset management. In the shorter term, useful and proven tools or methods will be introduced where appropriate as part of a programme of 'measured steps' toward improved asset management and flood risk appraisal. These

Measured Steps (see Box 1 below) should facilitate a gradual change in management practice, spreading the cost burden of introduction of the new methods of working over a longer period. This modular approach means that each module or development should fit into the overall framework as they are rolled out without the need for a 'step change' in existing practice. The key benefits expected to arise from implementation of the system are outlined in Box 2.

Several pilot schemes are currently underway to test and demonstrate modules (or elements) of the proposed performance-based asset management system on real systems involving asset and operational managers to ensure needs are met, stimulate interest and encourage uptake. These include pilots at sites on an estuary (Thames), coast (Lincshore) and rural river (Great Eau)

Box 1. Early 'Measured Steps' towards a performance-based asset management system

MSF 1: Interim update of the Sea and River Defence Visual Condition Assessment Manual (CAM). The Condition Assessment Manual is to be updated with a new narrative consistent with principles of performance-based asset management. Other amendments are also to be made including the replacement of poor photographs and more appropriate guidance in the 'percentage area defect tables.

MSF 2: Inclusion of images and text for condition inspection of channels within the Condition Assessment Manual
The limited existing guidance on the assessment of channels in the CAM is to be expanded with diagrams, photographs, checklists and narrative.

MSF 3: Development of guidance for setting channel management performance specifications
The guidance will be developed through explanation of how existing knowledge and tools, for example the CES, can be used to translate performance standards into performance specifications and maintenance.

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MSF 4: Development of guidance for exploring channel management options against performance specifications
This work will illustrate how the channel condition assessment approach can be utilised to determine intervention measures that raise performance standards.

MSF 5: Primary and Secondary Data Requirements
Accuracy and reliability of source data is important to reduce uncertainty in the results and increase confidence in decision-making. This task is to scope a guide to data requirements – primary and secondary.

MSF 6: Defence asset residual risk attribution
This task will outline how asset residual risk attribution can be obtained from a tiered hierarchy of modelling tools (National, regional and local scale models) and utilised within asset management maintenance planning and decision-making.
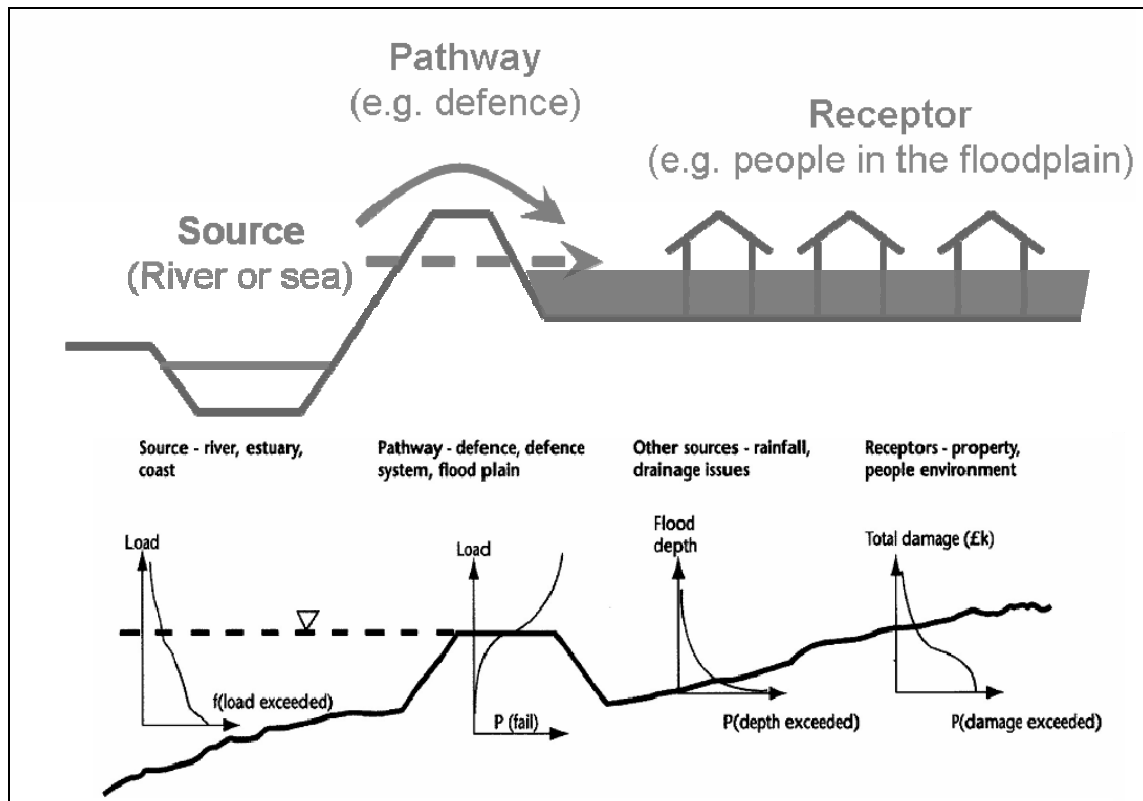
Box 2 Key benefits of a Performance-based Asset Management System

- **PRIORITIES** - Asset management can focus on priority areas in terms of flood risk reduction, which considers both flood probability and consequence.

- **OPTIONS** –Flood risk arising from a range of asset management options can be assessed, so that best value maintenance, repair and replacement options can be selected, in terms of flood risk reduction.

- **BEST VALUE** – Efficient maintenance planning methods and tools will be provided that help to justify maintenance works in terms of flood risk reduction and other requirements such as conservation.

- **EVIDENCE** - Assets will be managed based on evidence of their condition and contribution to reducing risk.

- **INFORMATION** – The system will steer the collection of relevant data for the NFCDD and hence develop improved risk information to enhance business decisions and benefit other Agency functions.

- **CONSISTENCY** - There will be a consistent approach to flood risk management throughout the Environment Agency; providing more consistent protection across the country; and bringing efficiencies and opportunities in terms of training, mobility and systems development management.

- **SCENARIOS** - Scenario testing of potential futures, including projected climate and socio-economic change, can be undertaken to enable whole-life costing and better planning for future uncertainties. (This is a longer-term benefit, rather than part of the initial measured step forward.)

- **REQUIREMENTS** - The Environment Agency will fulfil key requirements of its Strategy for Flood Risk Management and National Asset Management Strategy.

Principles and outputs of a performance-based asset management system

The basis of the management system is the widely accepted 'source-pathway-receptor-consequence' (s-p-r-c) model as illustrated in Figure 1. The source parameter is the water level or loading of the system; the pathway is the defence (e.g. embankment), component (e.g. pump) or operational activity (such as gate or sluice closure); the receptors are people and property in the floodplain and the consequences are the potential damages to those receptors at risk (normally expressed in fatality and monetary terms).

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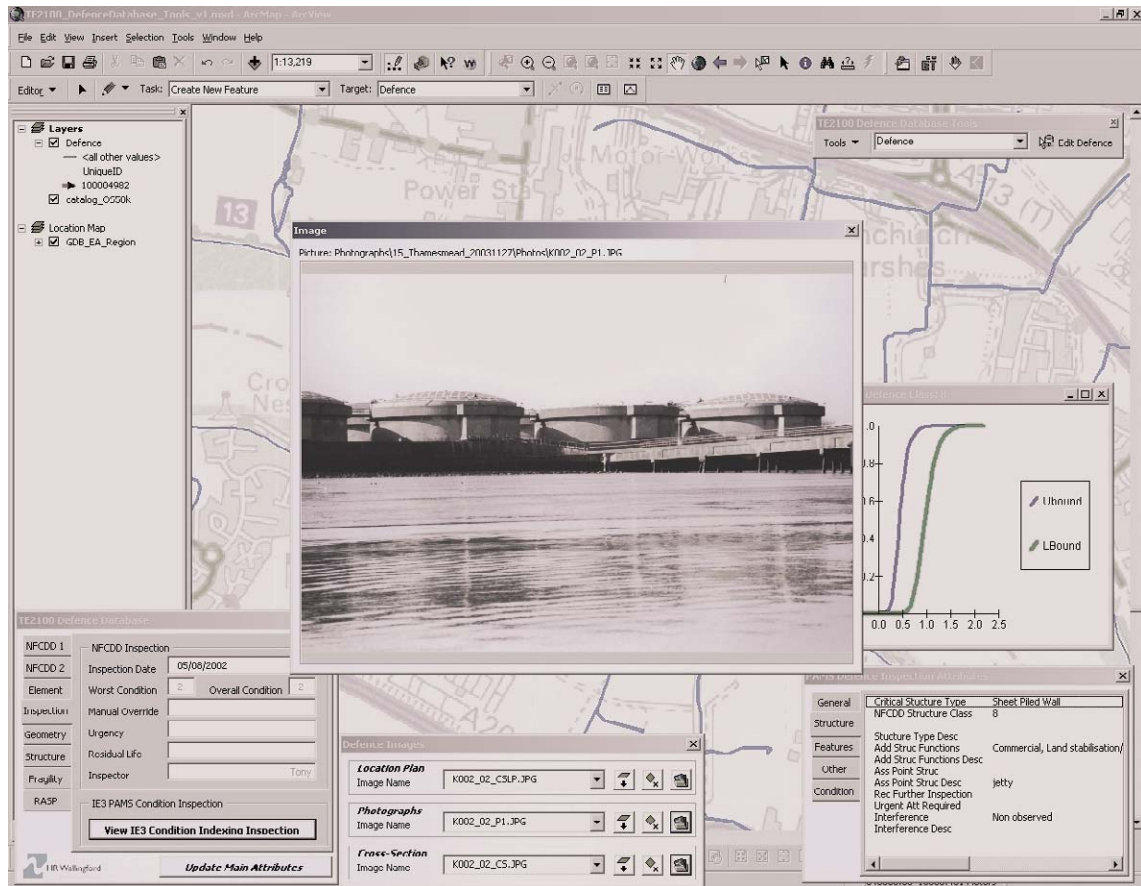HR Wallingford

Figure 1   SPRC model

The system will work by collating and processing all the relevant data from these s-p-r-c parameters in a GIS based computer system also equipped to run existing and accepted models for devising water levels and loading, event probability, defence fragility, breaching, and flood spreading. Tabular data such as the Middlesex University Flood Hazard Research Centre 'depth-damage' curves and the National Properties Dataset will be utilised to determine the consequence terms. The 'front end' packages are still to be fully developed. However Figure 2, a screenshot of the asset information and assessment part of the PAMS database, gives an impression of how they might look.

The output options will include present day and future scenario flood risk maps conditional for instance on, defence condition and deterioration, operational practice and management and climate change. This will enable the manager to assess the relative effect and impact of flood risk and asset

management decision-making today and in the future.

Defence cross sectional information will identify the components of an asset that contribute most to its likelihood of failing (often referred to as 'fragility'). This information will form the basis of decisions either to repair and maintain or to make more detailed investigations.

The system will also support every day decision-making for asset managers and operational staff undertaking their respective roles in systems assessment, asset inspection and asset management by integrating and providing tools such as the Conveyance Estimation System, and methods such as a Visual Asset Condition Assessment based on structural performance. Thus the elements of the system, whilst integral parts of the overall risk-based assessment framework, are also designed to help and improve intervention decision-making and actions within the lower tiers of the FRM structure.

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Figure 2 **Example performance-based asset management system database screenshot**

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HR Wallingford provides world-leading analysis, advice and support in engineering and environmental hydraulics, and in the management of water and the water environment. Created as the Hydraulics Research Station of the UK Government in 1947, the Company became a private entity in 1982, and has since operated as a independent, non profit distributing firm committed to building knowledge and solving problems, expertly and appropriately.

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