



Economic impact of NRFA peak flow database, new report

A key national flood data source hosted by CEH has been estimated to deliver over £5m per annum net benefit to the UK flood risk assessments sector, a new report¹ reveals.

The National River Flow Archive's (NRFA) Peak Flow database is calculated to provide net economic benefits of almost £5.4 million per year in terms of costs saved by environmental consultants and regulators. Over a 25-year term, it equates to a net present value of £95 million, according to the report author, Richard Blackmore of Research Impact Consulting.

"Up-to-date, accurate records of peak river flow are vital for developing understanding of flood events and improving the ability of regulators and the private sector to predict, manage and mitigate their impact," explains Dr Harry Dixon, Head of the NRFA.

He adds that, "the NRFA data underpins the full spectrum of flood risk activities from national strategic mapping through to flood risk assessments conducted when planning new housing or commercial developments."

Peak flow data were integrated into the NRFA – hosted by the Centre for Ecology & Hydrology – in April 2014. The move means that, for the first time since the national collation of hydrometric data was initiated in 1934, a single source of UK-wide data is available to support water resources and flood risk management.

NRFA data are used in a number of areas of UK water management, including water resources assessment, national situation monitoring and freshwater science. As the findings relate to just a small part of the database's uses in flood risk assessments, the calculated value represents only a fraction of the national archive's wider economic impact.

Dr Dixon, said, "The report highlights a significant economic contribution by the NRFA to the local flood risk assessment sector. The analysis demonstrates that the entire cost of maintaining the NRFA Peak Flow Database on an annual cycle is easily covered by the benefits of its use by consultants and regulators in preparing and assessing detailed flood risk assessments alone."

He added, "We are pleased to be able to demonstrate that investment by NERC, the Environment Agency, Scottish Environment Protection Agency, Natural Resources Wales and the Northern Ireland Rivers Agency in maintaining the NRFA Peak Flow Database represents extremely good value for money."

¹ Blackmore R (2015) The Economic Impact of the NRFA Peak Flow Database. Research Impact Consulting. 19pp

Notes:

The report, published in October 2015, was produced for the Centre for Ecology & Hydrology by Research Impacts Consulting. The report explores the economic impact of the UK National River Flow Archive's (NRFA) Peak Flow Database which was launched in April 2014 when responsibility for the provision of UK national flood peak data was transferred from the previous HiFlows-UK initiative hosted by the Environment Agency to the National River Flow Archive (NRFA), which is maintained by CEH working in partnership with the UK's hydrometric measuring authorities.

The economic analysis included in **this report considers only a small part of the NRFA's impact**, namely the savings for regulators and consultants in relation to conducting Flood Risk Assessments.

The NRFA user community includes water resources managers, environmental regulators, researchers, education establishments, Government and UN bodies and the general

public. Its impacts extend across all areas of water management and Flood Risk Assessment represents only a small proportion of the economic benefits derived from the NRFA. The collation of national peak flow data began with the release of the Flood Studies Report (FSR) in 1975 by the Institute of Hydrology (which subsequently became part of the Centre for Ecology & Hydrology). Further data updates to the FSR took place in the 1970s and 1990s culminating with the release of the Flood Estimation Handbook in 1999. Between 2004 and 2014 updated UK flood peak data were provided via the HiFlows-UK initiative, a partnership between the UK's hydrometric measuring authorities, and the data were hosted on the Environment Agency's previous website. The NRFA peak flow data service launched in 2014 replaced HiFlows-UK. The NRFA service is fully integrated into the existing NRFA website, allowing users to easily search, view and download data. Guidance on how to use the service can be found on the NRFA homepage.

Useful Information:

Cite the report: Blackmore R (2015) The Economic Impact of the NRFA Peak Flow Database. Research Impact Consulting.

NRFA contacts:

Web: <http://nrfa.ceh.ac.uk> **Email:** nrfa@ceh.ac.uk **Tel:** +44 (0) 1491 692599

Relevant links:

NRFA Peak Flows data via: <http://nrfa.ceh.ac.uk/peak-flow-data>

Flood Estimation Handbook: <http://www.ceh.ac.uk/services/flood-estimation-handbook>

CEH Natural Hazards Science: <http://www.ceh.ac.uk/science/natural-hazards.html>

CEH Environmental Informatics: <http://www.ceh.ac.uk/our-science/science-areas/environmental-informatics>

Flood risk assessment for planning applications guidance: <https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>

National Planning Policy Framework: <https://www.gov.uk/government/publications/national-planning-policy-framework--2>

The Economic Impact of the NRFA Peak Flow Database

Final Report

Richard Blackmore, Research Impact Consulting



Table of Contents

Executive Summary	3
1. Flooding in the UK	4
2. The Peak Flow Database	4
2.1 Historical development.....	4
2.2 Management of the Peak Flow Database by the NRFA	5
2.3 Peak Flow Database and FEH	6
3. Uses of the Peak Flow Database	6
3.1 Flood risk management strategy and planning.....	6
3.2 Flood risk maps	8
3.3 National Flood Risk Assessments	8
3.4 Catchment Flood Management Plans	9
3.5 Strategic Flood Risk Assessments.....	9
3.6 Flood Risk Assessments.....	10
3.7 Local Flood Risk Management Schemes	11
3.8 Other uses of the Peak Flow Database	12
4. Costs of maintaining the Peak Flow Database	12
5. Economic Benefits of the Peak Flow Database	13
5.1 Overview	13
5.2 Peak Flow Database and Flood Risk Assessments - Context	14
5.3 Cost Savings from use of Peak Flow Database in FRAs.....	15
5.4 Net Economic Benefit of the Peak Flow Database in FRAs.....	18
6. Summary & Conclusion	19

Report prepared for the Centre for Ecology and Hydrology
September 2015

Executive Summary

Flooding, and flood risk assessment, is of major economic importance in the UK:

- 2.4 million properties in England are at risk from flooding from rivers or the sea, of which nearly half a million are at significant risk. In Scotland, 73,000 properties are estimated to be at high to medium risk from river flooding.
- Annual flood damage costs in England have been estimated at around £1.1 billion per year but can be substantially greater in extreme flooding events.
- The Government expects to spend £2.3 billion on flood defence schemes in England over the period 2015-21, with 55% of this sum being allocated to defence against inland flooding. The Net Present Value (NPV) of the c250 flood defence schemes (of all types) currently under construction, or scheduled to start by March 2016, is c£215bn.
- The market value of new residential units to which the EA objects on flood risk grounds each year is in the range £8-12 billion.

In this context, the reliability of flood risk assessment methodologies and data is of critical importance. The National Audit Office has recommended that the EA *“build on the sophistication of flood modeling data, and ensure that both industry and the public have access, within data protection guidelines, so that its value is maximized.”*

The NRFA Peak Flow Database is key flood data source used by regulators, environmental consultants across the full spectrum of flood risk strategy and planning activities. Its uses include the development of flood risk maps; formulation of national, strategic and local flood risk strategies; preparation of flood risk assessments for specific planning proposals; and designing flood defence schemes.

The cost to NERC and the UK hydrometric Measuring Authorities of maintaining the NRFA Peak Flow Database and updating it annually (excluding the costs of raw data collection) is estimated to be around £185-235k/year.

Using conservative assumptions, and considering only its usage in preparing and assessing detailed Flood Risk Assessments, the net economic benefits of the database in terms of costs saved by environmental consultants and regulators are just under £5.4m/year. Over a 25-year term, and using a 3% discount rate, this equates to an NPV of £95m. However, since the NRFA Peak Flow Database is used for many other purposes, this underestimates its full value.

If the database were ‘frozen’ in its current format: the view of consultants and regulators alike is that the ‘frozen’ data would need to be updated after any new ‘flooding event’, and in any event within 3-5 years. However, updating the NRFA Peak Flow Database on a 5-yearly cycle would not save money, but could create significant operational problems and raise potential liability issues.

Investment in maintaining the NRFA Peak Flow Database by NERC and UK hydrometric Measuring Authorities represents extremely good value for money. Indeed, if it no longer existed, then the clear underlying message from consultants and regulators is that it would need to be re-created almost immediately.

1. Flooding in the UK

A recent House of Commons report highlighted that around 5.2 million properties in England, or one in six properties, are judged to be at risk from flooding.¹ In total, over 2.4 million properties are at risk from flooding from rivers or the sea, of which nearly half a million are at significant risk. One million of these properties are also vulnerable to surface water flooding, while a further 2.8 million properties are susceptible to surface water flooding alone. In Scotland, 73,000 properties are estimated to be at high to medium risk from river flooding².

Annual flood damage costs in England have been estimated at around £1.1 billion per year³, but can be substantially greater in extreme flooding events. The estimated insurance cost of direct damage caused by the flooding in June and July 2007 was approximately £3 billion. However, the wider costs of flooding are significantly greater, in terms of its impact on human lives: in 2007, 55,000 properties were flooded, around 7,000 people were rescued from the flood waters by the emergency services and 13 people died.⁴

The challenges posed by flooding are likely to increase in future, partly as a result of climate change but also as a consequence of changing patterns of land use, and increasing numbers of buildings in flood-prone areas. According to the Stern Review, annual UK flood losses could increase from 0.1% of GDP today to 0.2 - 0.4% of GDP if the increase in global average temperatures reaches 3 or 4°C⁵. The Environment Agency (EA) estimates that annual flood damage costs could exceed £27 billion across the UK by 2080.

Surveying the potential impacts of climate change, Sir Bob Watson, former chief scientist at Defra, has observed that *"if you had to pick one particular issue, I think the flooding issue is the most dominant."*⁶ adding that *"flooding will become increasingly more severe almost immediately."*⁷

In this context, there is a clear need for reliable data and methodologies for assessing flood risk, guiding planning policies and informing investment decisions, as discussed more fully in Section 3 below.

2. The Peak Flow Database

2.1 Historical development

The collation of national peak flow data began with the release of the Flood Studies Report (FSR) in 1975 by the Institute of Hydrology (which subsequently became part of the Centre for Ecology & Hydrology (CEH)). Further data updates took place in the 1980s and 1990s, culminating with the release of the Flood Estimation Handbook (FEH) in 1999. The FEH included flow data to around 1993/94, and its flood estimation methods made considerable use of recorded flood flow data. However, there was a widely agreed need to add additional years of data, to pick-up on the many analyses of station rating curves carried out in recent years, and to provide more detailed information about gauging stations.

¹ House of Commons Library: Flood defence spending in England, SN/SC/5755; November 2014

² Responsibilities for managing flood risk in Scotland www.gov.scot/Resource/Doc/921/0052798.doc

³ National Audit Office: Flood risk management in England, October 2011

⁴ Pitt Review: Learning the lessons from the 2007 floods, June 2008

⁵ Stern Review on the Economics of Climate Change (2006)

http://webarchive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/sternreview_index.htm

⁶ See www.guardian.co.uk/environment/2012/jan/26/floods-worst-climate-change-uk

⁷ See www.nature.com/news/flooding-is-the-united-kingdom-s-biggest-climate-threat-1.9906

In 2001, HiFlows-UK was established as a partnership between the various UK Measuring Authorities (the EA in England and Wales, Scottish Environment Protection Agency (SEPA) in Scotland, and the Rivers Agency in Northern Ireland (RANI) with grant funding from HM Treasury's Capital Modernisation Fund.⁸ The aim of the partnership was to bring together hydrometric data held by the project partners, with additional data being provided by CEH and the University of Dundee. The project objectives of the HiFlows-UK partnership were to:

- Review existing flood peak data to provide a single authoritative UK database
- Improve background information to assist users of the FEH to make valid decisions
- Add recent data and additional sites
- Make data widely available and easily accessible to everyone via the internet
- Establish structures and procedures for future updating⁹ and dissemination.

HiFlows-UK contained significantly more data than the FEH database, and incorporated the results of subsequent data reviews to improve data quality, together with additional information on each station, including the indicative suitability of the data. The data and website was initially released as a pilot for testing and feedback on both the website functionality and data in March 2004.

Between 2004 and 2014 the HiFlows-UK website (hosted by the EA, with support from JBA Consulting) provided peak flow data and station information from around 1000 river flow gauging stations throughout the UK, for use with the statistical flood estimation methods set out in the FEH. The first full version of the WINFAP-FEH data (version 1.1) were released on 1 August 2005, and JBA Consulting carried out a number of subsequent updates to the HiFlows-UK database between 2004 and 2014.

In April 2014, responsibility for the maintenance and public provision of the UK's national flood peak data was transferred to the National River Flow Archive (NRFA). The NRFA is maintained by the CEH in close collaboration with the UK hydrometric Measuring Authorities (primarily the EA, SEPA, RANI and Natural Resources Wales (NRW)). Provision of peak flow data is now being fully integrated with the NRFA's existing services for daily and monthly mean flow data. The move to fully integrate delivery of peak flow data with the NRFA's existing services means that, for the first time since the national collation of hydrometric data was initiated in 1934, a single source of UK wide data is available to support water resources and flood risk management.¹⁰

2.2 Management of the Peak Flow Database by the NRFA

River flow data is collected by a variety of hydrometric Measuring Authorities at c1500 river gauging stations around the UK, with the vast majority collected by regulatory bodies such as the EA, NRW, SEPA and RANI. Flood peak data for c900 of these stations (those deemed suitable for use in flood risk estimation) are provided to the NRFA for national archival. Data is provided to NRFA annually. The marginal cost to the regulators of data provision is low, since the data is already being collected for operational purposes.

⁸ See HiFlows-UK project website, accessed on 2 March 2015
<http://webarchive.nationalarchives.gov.uk/20091017175719/http://environment-agency.gov.uk/hiflowsuk/aboutus/?version=1&lang=e>

⁹ It was the intention of the HiFlows-UK partnership to update the data annually, with assistance from CEH Wallingford. Where appropriate, this would include the addition and removal of gauging stations, and the amendment of existing data.

¹⁰ Dixon, Harry, et al.. 2014 National peak flow data - what next? [Poster] In: *12th British Hydrological Society National Symposium, Birmingham, UK, 2-4 Sept 2014*. <http://nora.nerc.ac.uk/508319/>

The NRFA undertakes quality control of flood peak data before uploading to the national archive. The process followed mirrors the NRFA's quality control for daily river flow data which has been demonstrated to significantly improve the utility of the final database.¹¹

The NRFA promotes best practice on data collection at gauging stations and provides advice and guidance to the UK hydrometric Measuring Authorities in order to minimizing risk of data problems before they arise. These activities include an audit program, regular liaison between the NRFA and local gauging station operators and development of national and international standards.¹²

NRFA maintains a suit of database systems and data processing tools in order to manage, store and disseminate the national peak flow database. The NRFA then disseminates the national peak flow database to users. The primary dissemination route is via the NRFA website, where users are able to freely download data files for use in the WINFAP-FEH software and other flood estimation tools.

2.3 Peak Flow Database and FEH

The FEH is the standard approach for estimating flood size and frequency across the UK, and is used by the vast majority of hydrologists. It provides flooding specialists with guidance on rainfall and river flood frequency estimation, and also provides methods for assessing the rarity of notable rainfalls or floods, which are of interest to insurers and others. The main users of the FEH are hydrologists based at government regulatory agencies (EA, SEPA, NRW, RANI), environmental consultancies, local authorities and universities.

In order to use the FEH methodology, hydrologists need to download Peak Flow data from the NRFA website.¹³ In line with NERC policy on data provision, such data is supplied for free of charge to all users, except for large or complex requests where a handling charge may be applied to cover the cost of supply. Such charges are not normally applicable in the case of the flood peak data.¹⁴

The FEH methodology has been continuously developed and improved by CEH. Over 2001-2005, CEH undertook a major research project with support from Defra and the EA, resulting in the Revitalised Flood Hydrograph (ReFH) model. The software implementations of the FEH and ReFH methodologies are maintained and licensed to commercial users by Wallingford Hydrosolutions.¹⁵

3. Uses of the NRFA Peak Flow Database

3.1 Flood risk management strategy and planning

The NRFA Peak Flow Database is used for a wide variety of purposes, and to set these in context, it is helpful to consider overall hierarchy of flood risk management strategy and planning. This is summarized for England in Fig 1 overleaf¹⁶

¹¹ See **Muchan, K** and **Dixon, H.** (2014). Ensuring hydrometric data are fit-for-purpose through a national Service Level Agreement. In: Daniell, Trevor M., (ed.) *Hydrology in a changing world: environmental and human dimensions*. Wallingford, UK, International Association of Hydrological Sciences, 30-35. (IAHS Publication 363).

¹² See **Dixon, H., Hannaford, J.** and **Fry, M.J.** 2013. The effective management of national hydrometric data: experiences from the United Kingdom. *Hydrological Sciences Journal*, 58 (7). 1383-1399.

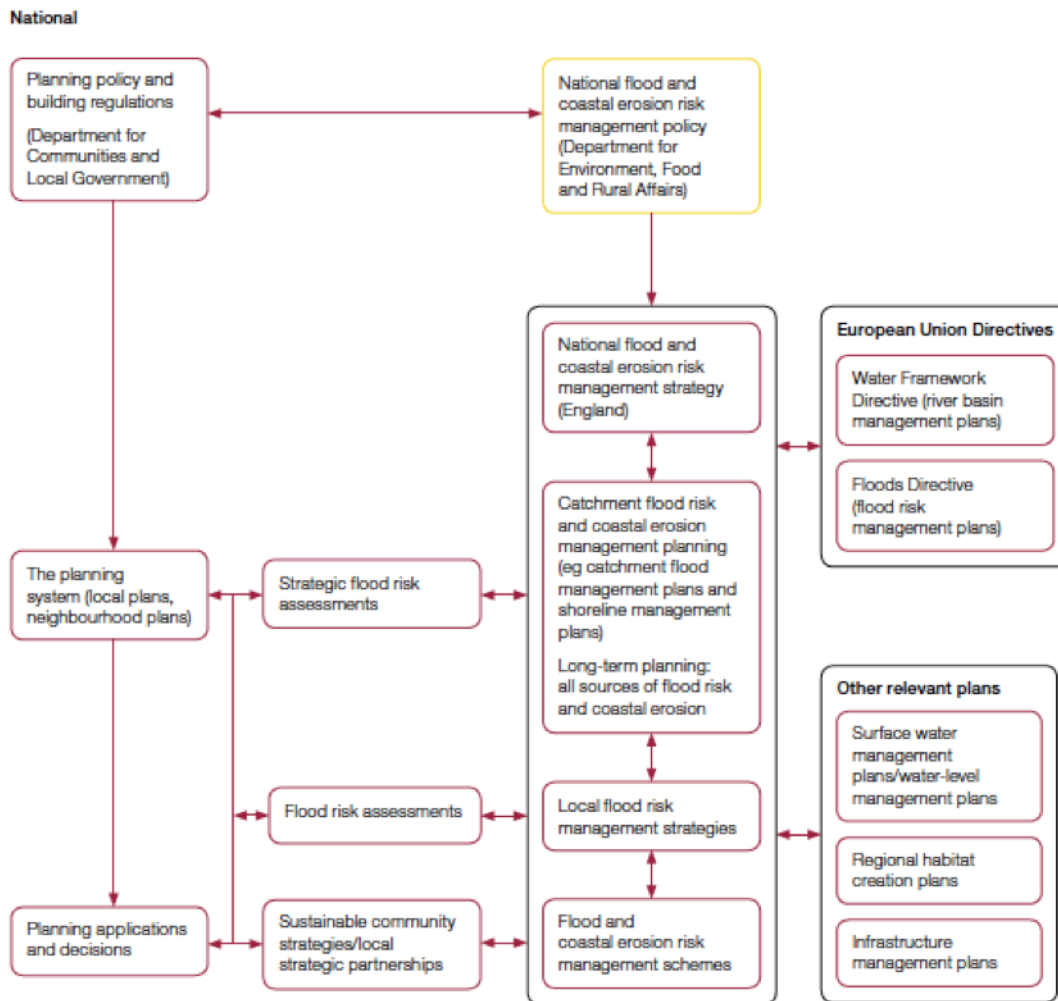
¹³ See NRFA website www.ceh.ac.uk/data/nrfa/peakflow_overview.html

¹⁴ NERC Policy on Licensing and Charging for Environmental Data and Information Products, Version 1.0 October 2012, <http://www.nerc.ac.uk/research/sites/data/policy/>

¹⁵ Wallingford Hydrosolutions www.hydrosolutions.co.uk

¹⁶ The formulation of flood risk strategies and planning will differ in some respects in Scotland, Wales and Northern Ireland

Fig 1. Flood and coastal erosion risk management strategy and relationship to planning



Source: National Audit Office

The entire architecture of flood risk strategy and planning is to a very large extent underpinned by hydrological flood models¹⁷ that are used to assess flood risks and develop flood risk maps. These models also provide the basis for planning policy (at the national, strategic or local level), and inform the design of flood alleviation and defence schemes. However, reliable peak river flow data sets are essential both for the development of these flood models, and for the generation of outputs. As one flood model developer observed:

“Flood models are critically dependent on high flow data, either for real events or return period flows. Without these you don’t have flood maps”

The importance of flood data was recognized by a recent NAO report, which noted that the Environment Agency “has improved the way it presents flood modelling data, and has committed to more improvements in both sophistication and ease of use”. The NAO further recommended that the EA should:

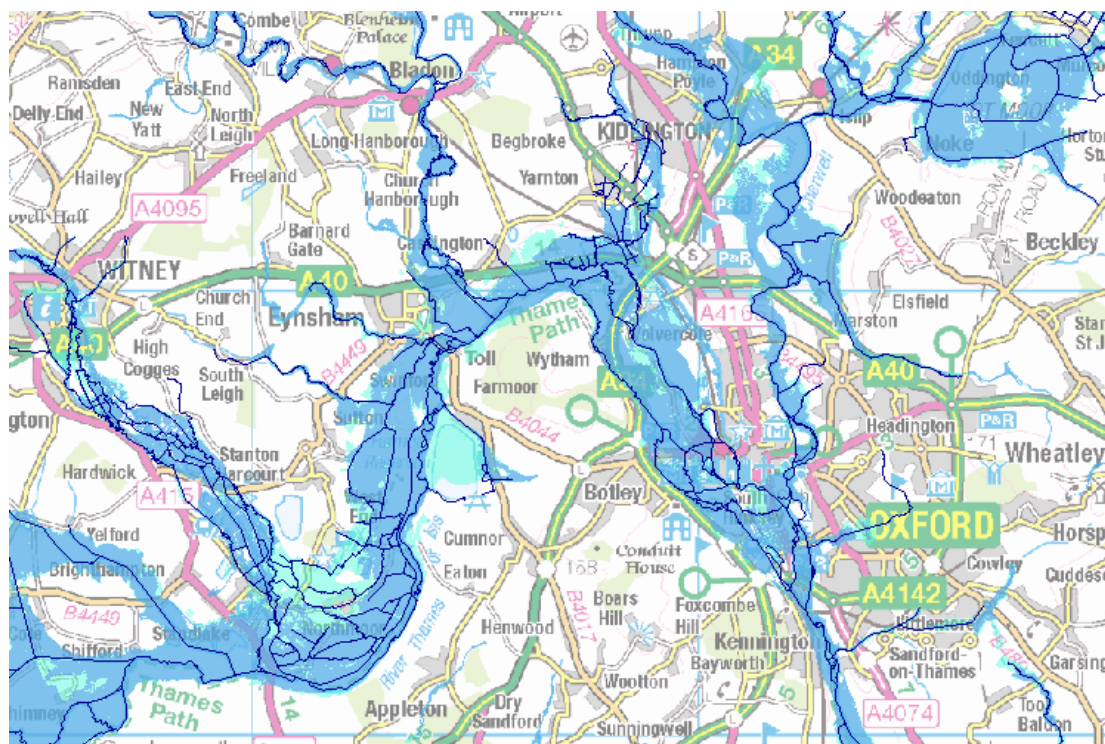
“Build on the sophistication of flood modeling data, and ensure that both industry and the public have access, within data protection guidelines, so that its value is maximized.”

¹⁷ FEH is the longest established model and is the industry standard. However, other models exist both in academia and the private sector, for example LISFLOOD-FP developed by the University of Bristol
www.bristol.ac.uk/geography/research/hydrology/models/lisflood/

3.2 Flood risk maps

The NRFA Peak Flow Database is an essential data source for the development of flood risk maps. These have now become an integral part of flood risk management and planning, and are a key source of information for a wide range of stakeholders, including planners and developers, insurance companies and the general public. An example, shown in Fig 2 below, is the flood risk map made freely available by the EA to the general public showing flood risk areas.

Fig 2: EA Flood Risk Map for the Oxford area



The first Indicative Flood Map for England and Wales was developed by the EA in 1999, and was essentially binary indicating a safe zone and areas exposed to a risk from river flooding with a 1% annual probability, or from coastal flooding with a 0.5% annual probability. Improvements in FEH methodology and the new HiFlows-UK database enabled a more sophisticated Flood Zone Map to be launched in 2004. This shows areas at high risk of river flooding (Flood Zone 3, ie a 1% annual probability) and at medium risk (Flood Zone 2, ie a 0.1%-1.0% annual probability). The EA maps have revised, most recently in 2013 to include surface water flood risks, and similar maps have been developed for Scotland by SEPA.

3.3 National Flood Risk Assessments

The first National Flood Risk Assessment (NaFRA) for England was published by the EA in 2008.¹⁸ In the words of the EA's Chief Executive, Paul Leinster, *"It underpins our future plans for investment in flood risk management as well as helping us to work together with our partners to protect the public and property from floods more effectively."*

¹⁸ Flooding in England: A national assessment of flood risk. Environment Agency, 2009. Accessed on www.gov.uk/government/uploads/system/uploads/attachment_data/file/292928/geho0609bqds-e-e.pdf

A similar exercise was carried out by SEPA, resulting in the National Flood Risk Assessment for Scotland, published in December 2011.¹⁹

According to SEPA, it would have been ‘*very difficult*’ to undertake the Scottish NaFRA without access to the Peak Flow Database, and this work will feed in to the Flood Risk Management Strategies and Local Flood Risk Management Plans that are currently under preparation in Scotland. If Peak Flow Database did not exist, then SEPA would still have had to revert to using the raw data, and this would have incurred significant additional costs.

3.4 Catchment Flood Management Plans

In England, Catchment Flood Management Plans (CFMPs) consider inland flood risk from rivers, surface water, groundwater and tidal flooding. CFMPs also include the likely impacts of climate change, the effects of how land is managed, and how areas could be developed to meet our present day needs without compromising the ability of future generations to meet their own needs.²⁰

The EA produced CFMPs for 69 main catchments in England during 2009. They are high-level planning tools and set out objectives for flood risk management across each river catchment and estuary. They also identify flood risk management policies that are economically practical, have a potential life of 50 to 100 years, and will help the EA work with others stakeholders to put these policies into place.

In Scotland, SEPA is responsible for producing a Flood Risk Management Strategy by the end of 2015 for each of the 14 districts that have been based on river catchments. These strategies will set out the most sustainable combination of actions to address flooding in the areas at greatest risk, where the benefits of intervention can have the greatest impact.²¹ As noted above, this work is being informed by the NRFA Peak Flow Database.

3.5 Strategic Flood Risk Assessments

The National Planning Policy Framework (NPPF)²² sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed. To assist in formulating overall planning policies, local planning authorities must carry out a Strategic Flood Risk Assessment (SFRA) to assess the risk from flooding from all sources, both now and in the future. An SFRA takes into account the impacts of climate change and the impact that land use changes and development in the area will have on flood risk,²³ and can be carried out at two levels:

- Level 1: where flooding is not a major issue, and development pressures are low.
- Level 2: where land outside flood risk areas cannot accommodate all necessary development, and the NPPF’s ‘exception test’ needs to be applied.

All local planning authorities must carry out a Level 1 SFRA, while a Level 2 SFRA is required if development is needed within flood zone 2 or 3.

¹⁹ National Flood Risk Assessment Scotland: accessed on www.sepa.org.uk/environment/water/flooding/flood-risk-management/national-flood-risk-assessment/

²⁰ See www.gov.uk/government/collections/catchment-flood-management-plans

²¹ See www.sepa.org.uk/environment/water/flooding/flood-risk-management

²² See National Planning Policy Framework, paragraphs 100-104

²³ Environment Agency: Strategic Flood Risk Assessments – Guidance to support the National Planning Policy Framework; July 2013

SFRAs, particularly at Level 2, involve substantial amounts of preparatory work, typically involving detailed flood risk modeling studies by professional environmental consultants. This in turn requires detailed flood models, and supported reliable data.

SFRAs are 'living documents and should therefore be reviewed and updated on a regular basis'²⁴ taking into account advances in the flood risk evidence base and changes in local development priorities. To take an example, Oxford City Council published its first SFRA in July 2008, which was revised by a Level 1 SFRA (produced by Atkins) published in March 2011, followed by a Level 2 SFRA (also produced by Atkins) in February 2012.

The NRFA Peak Flow Database is extensively used by environmental consultants engaged in the preparation of SFRAs. The total number of SFRAs is uncertain, as there is no central archive, but is likely to be in the hundreds.

3.6 Flood Risk Assessments

The Government's Planning Policy Statement 25 (PPS25) requires that flood risk be a consideration at all stages of a planning application. Local planning authorities in England must consult the Environment Agency on planning applications where the property is at risk from flooding. Developers must also produce a Flood Risk Assessment (FRA) to show that their development proposals comply with planning policy on flooding. Similar provisions apply in Scotland, Northern Ireland and Wales (where developers are required to produce a Flood Consequence Assessment, or FCA).²⁵

Data on the numbers of planning applications that are notified to the EA in England are shown in Table 1 below, and average around 10,000/year.

Table 1: LPA planning applications considered by the EA on flood risk grounds

Year	Consultations requiring detailed consideration on flood risk grounds	Total EA objections made on flood risk grounds	Rate of EA objections on flood risk grounds
2004-05	13,937	4,634	33.2%
2005-06	11,403	4,201	36.8%
2006-07	10,854	4,750	43.8%
2007-08	9,123	6,232	68.3%
2008-09	12,115	5,198	42.9%
2009-10	11,096	4,124	37.1%
2010-11	10,890	3,343	31.6%
2011-12	n/a	n/a	n/a
2012-13	8,760	2,638	30.0%
2013-14	9,868	2,885	29.2%

Sources:

Environment Agency: Development and flood risk in England report 2008-09; Development and flood risk in England report 2009-10; Development and flood risk in England report 2010-11;

Environment Agency: Flooding in England: A National Assessment of Flood Risk

Environment Agency: Managing flood and coastal erosion risks in England 2012 to 2013; Managing flood and coastal erosion risks in England 2013 to 2014

In Scotland around 2,000 FRAs are referred to SEPA each year, around 200-300 are notified annually to the RANI in Northern Ireland, and around 150 FCAs are submitted to the NRW in Wales.²⁶

²⁴ Oxford City Council: Strategic Flood Risk Assessment for Oxford City, Final Report; March 2011

²⁵ Planning Policy Statement 25: Development and Flood Risk Practice Guide. DCLG, Dec 2009. Accessed on www.gov.uk/government/uploads/system/uploads/attachment_data/file/7772/pps25guideupdate.pdf

²⁶ Private communications with regulatory agencies

The level of detail of an FRA is likely to depend upon the scale of development proposed and the flood risks involved. For minor developments, a consultant may use little more than information included in existing flood risk maps, but for larger projects a detailed FRA will involve site-specific flood risk modelling requiring use of the NRFA Peak Flow Database. Assessment of the FRA by the regulator will also require use of flood risk maps, models and peak river flow data. The issues relating to FRAs are discussed in greater detail in section 5 below.

3.7 Local Flood Risk Management Schemes

The Government provides significant financial support for flood defence schemes, amounting to £2.37 billion in England alone over the 4-year period 2007-11, and £2.34 billion over the period 2011-15.²⁷ The recently announced 6-year investment programme for flood and coastal erosion risk management envisages a capital investment of £2.3 billion, with a further £345m in additional funding being attracted through partnership contributions. Around 55% of this money will be spent on inland flood risk management, with 45% being spent on coastal flood and erosion management.²⁸

An analysis of flood defence schemes planned by the EA over the period 2015-21 is shown in Table 1. (These include defence schemes against all types of flooding and coastal erosion, since identification of schemes to protect against river flooding alone is not possible).

Table 2: Flood defence schemes planned by the EA 2015-21

Status of scheme	Number of schemes (all types)	Total project costs £m	Total economic benefits (NPV) £m	Households with better level of protection from flooding
Construction				
• Started before April 2015	213	1,474	18,098	200,570
• Scheduled to start by 31 March 2016	39	1,876	195,672	106,437
• Scheduled to start by 31 March 2016 subject to securing other funding	58	317	n/a	68,097
Development				
• Expected to start in future years subject to a full business case	574	650	8,763	176,135
• Expected to start in future years subject to a full business case AND securing other funding	545	1,642	12,418	159,192
Pipeline				
• May move into development subject to securing other funding contributions	43	156	n/a	10,140
TOTAL - ALL SCHEMES	1,472	6,115	>234,951	720,751

Source: Environment Agency Data

The planning of river flood defence schemes will require detailed flood risk modelling and data from the NRFA Peak Flow Database. This analytical work will typically be carried out by a specialist environmental consultant, and will vary in scale from resizing a culvert to the design of a major flood defence scheme.

²⁷ House of Commons Library: Flood defence spending in England, SN/SC/5755; November 2014

²⁸ Environment Agency: Programme of flood and coastal erosion risk management schemes. Accessed on www.gov.uk/government/publications/programme-of-flood-and-coastal-erosion-risk-management-schemes

3.8 Other uses of the Peak Flow Database

In addition to the uses outlined above, the NRFA Peak Flow Database is also used by regulators and environmental consultants for a wide range of other purposes. These include:

- Drainage plans and assessments
- Products for the insurance sector (eg flood risk maps and damage calculations)
- Water cycle studies for local authorities
- Projects for third sector clients including River Trusts and Wetland Trusts, eg wetland restoration schemes

4. Costs of maintaining the NRFA Peak Flow Database

The costs of maintaining the NRFA Peak Flow Database have been assessed under two different scenarios:

- Scenario 1: Annual maintenance cycle (ie. the *status quo*)
- Scenario 2: Five yearly upgrade cycle

Scenario 1: Annual database maintenance cycle

The annual cost of maintaining the Peak Flow Database as part of the NRFA is estimated to be in the range £140-190k per year.²⁹ Funding for this maintenance is currently (2015-2020) provided by NERC and the UK hydrometric Measuring Authorities (EA, SEPA, NRW, RANI).

The cost to the various regulators of providing data to the NRFA is smaller, since the data is already being collected for operational purposes (for example, monitoring of compensation releases, real-time flood forecasting). One regulator estimated that for 100 gauging stations, the costs of providing data to the NRFA would be

Activity	Annual time cost
Basic check and export of peak flow data for 100 sites	40 hours
Collate data and meta data corrections/updates (eg ratings, photos, new stations)	40 hours
Respond to queries relating to 20% of sites	40 hours
All activities (per 100 gauging stations)	120 hours

Using an hourly time cost (including overheads) of £30 would imply a total annual cost of £3600, or around £36/station/year.

Another regulator, covering 56 gauging stations, estimated that the time taken to validate data, visit stations to manually download any not on telemetry and to export data would equate to approximately £3000, or £53/station/year. Assuming that other regulators are in the same ballpark, and using an average of £50/station/year, implies a total cost to regulators across all 900 gauging stations of maybe £45,000/year.

On this basis, the total cost of maintaining the NRFA Peak Flow Database annually is:

Costs of database maintenance by the NRFA	£140-190k / year
Costs of data provision by regulators	£45k / year

²⁹ NRFA estimate

Total costs – annual cycle	£185 – 235k / year
<i>Scenario 2: 5-yearly database maintenance cycle</i>	

An alternative to an annual database maintenance cycle could be to ‘freeze’ the database in its current form, and only add fresh data once every 5 years. (As discussed in greater detail below, there was a general consensus between regulators and environmental consultants that updated data would be required after any significant ‘flood event’ had occurred, and the frequency of such events in recent years has tended to be around 5-yearly)

The costs of a 5-yearly maintenance cycle are less easy to estimate, but the NRFA does have current experience of updating peak flow data from one region after a hiatus of a few years. Based on this experience it has been concluded that an annual cycle enables database maintenance to be completed both more efficiently (by integrating with other work and maintaining skills, tools and regular procedures) and more effectively (as data problems are picked up prompt and resolved, skills and knowledge is constantly maintained leading to improved data/metadata quality).

If the database is not updated annually, then the costs to the NRFA of a 5-yearly maintenance cycle were estimated to be £820–1,135k. For the regulators, similar issues are likely to apply. If one assumes (probably conservatively) that the costs of data provision by regulators for a 5-yearly cycle are double those for an annual cycle, then the total cost of maintaining the NRFA Peak Flow Database on a 5-year cycle is:

Costs of database maintenance by the NRFA	£820-1,135k / 5 years
Costs of data provision by regulators	£90k / 5 years
Total costs – 5-yearly cycle	£910 – 1,225k / 5 years

In short, a 5-yearly update cycle is unlikely to save money in the long run, and may actually increase direct costs.

However, a 5-year update cycle also has the major disadvantage of reducing the ability to identify and remedy peak flow data quality control issues at individual gauging stations at an early date. In addition to the quality control conducted by hydrometric Measuring Authorities, part of the NRFA’s annual update programme includes assessment of the likely accuracy of flood peaks in the previous year. If a station were to develop issues with peak flow data capture that weren’t identified until the next 5 year update then in many cases it would be difficult to ‘reverse engineer’ the faulty data and correct it. As a result, the utility of that data for flood estimation would have effectively been lost permanently. This failure to identify data quality issues at an early date would also have wider implications for the operational uses of the data by regulators.

5. Economic Benefits of the NRFA Peak Flow Database

5.1 Overview

The full economic benefits of the NRFA Peak Flow Database are extremely hard to assess since, as discussed in Section 3 above, it is used for such a wide variety of purposes. These include:

- The development of flood risk maps
- Preparation of National, Strategic and local Flood Risk Assessments
- Preparation and assessment of Flood Risk Assessments for specific development proposals
- Preparation of flood prevention strategies

- Design of specific flood prevention schemes

In theory, raw data sourced from hydrometric Measuring Authorities could be used to substitute for the data contained in the NRFA Peak Flow Database, but in practice this would be a far from straightforward task. As SEPA noted in relation to the Scottish National Flood Assessment, there would have been costs in making raw data useable and these are hard to estimate. Concerns over the practicability of providing raw data to a wide range of users for multiple purposes were expressed by regulators in Northern Ireland, who noted that *‘given current and future staffing levels the Hydrometric Section would struggle to provide this service’*.

Even if regulators did use raw data from their own archives, undertaking all the quality assurance that would be required, this would not fully compensate for the absence of an over-arching national database. A distinct advantage of a national database is that it permits data pooling using the FEH’s regionalization methodologies. This enables similar catchments across the UK to be identified and compared when analyzing flood risk (eg Wales and Scotland share many characteristics, with extensive mountainous areas), which would not be possible in the absence of a national Peak Flow Database. As one regulator observed:

“if there is a national methodology for flood risk assessment [FEH] then there really does need to be a national dataset to go with it”.

Rather than attempt to estimate the economic benefits of the NRFA Peak Flow Database in all its applications, we focus below on one particular area of use: the preparation and assessment of Flood Risk Assessments in connection with planning applications for specific development proposals.

5.2 NRFA Peak Flow Database and Flood Risk Assessments - Context

The numbers of flood risk assessments received by regulators each year is summarised in table 3 below.

Table 3: Flood Risk Assessments submitted to Regulators each year

Country	Regulator	Flood Risk Assessments received
England	EA	Around 10,000 planning applications referred each year for detailed consideration on flood risk grounds – each should include an FRA
Scotland	SEPA	2000 – 2400 flood risk assessments received annually
Wales	NRW	Around 150 flood consequence assessments annually
N. Ireland	RANI	200-300 flood risk assessment annually
Total UK		Around 12,000 flood risk assessments each year

Source: EA data; communications with regulators

The level of detail of flood risk assessments is likely to vary depending upon the size of the development and its location. Environmental consultants working in this sector have stated that a significant number of FRAs will not require detailed peak flow data analysis, relying instead upon existing published information such as flood risk maps or modelling results from earlier studies. However, larger development proposals, and those in areas of greatest flood risk, are likely to be accompanied by detailed FRAs requiring use of Peak Flow data. On average, it is estimated that around 30-50% of FRAs are likely to require detailed hydrological modelling, and hence direct use of the NRFA Peak Flow Database.³⁰

³⁰ Private communications with environmental consultants

The wider economic importance of FRAs in the planning process is highlighted by data published by the EA on the number of residential units involved in planning applications to which they have objected on flood risk grounds. This is summarised in table 4 below:

Table 4: EA objections to proposed residential units in flood risk areas

	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014
Total residential units in planning applications where the EA objected on flood risk grounds,	57,294	68,350	54,236	46,721	n/a	68,903	58,161
Residential units permitted <u>against</u> EA advice*	543	573	519	262	n/a		
% of residential units permitted <u>against</u> EA advice*	<1%	<1%	<1%	<1%	n/a		
% of residential units determined <u>in line with</u> EA advice*					n/a	>99%	>99%

Sources:

Environment Agency: Development and flood risk in England report 2008-09; Development and flood risk in England report 2009-10; Development and flood risk in England report 2010-11; Managing flood and coastal erosion risks in England 2012 to 2013; Managing flood and coastal erosion risks in England 2013 to 2014

Planning outcomes are counted as being in line with the EA's advice when:

- applications with flood risk issues have been refused by the local planning authority (LPA);
- withdrawn by the applicant before an LPA decision could be made;
- found to be acceptable following further investigation, for example, when a suitable Flood Risk Assessment was provided by the developer;
- or redesigned by the developer to be more flood resilient following detailed discussions with the EA and other technical advisers.

The economic importance of these planning decisions is highlighted by the fact that average price for homes in England and Wales is now £180,000.³¹ The market value of the proposed new residential units to which the EA objects on flood risk grounds (between 46,000 and 68,000 a year) is thus in the range £8.2 billion - £12.2 billion/year.

Data from the Department of Communities and Local Government shows that the actual numbers of new homes built in flood risk areas since 2000 has averaged 12,000/year,³² compared with the proposed numbers of 58,000/year to which the EA has on average objected – a difference of around 46,000/year. The need for robust data and flood risk methodologies to underpin planning decisions of this magnitude is readily apparent.

5.3 Cost Savings from use of NRFA Peak Flow Database in FRAs

Environmental consultants and regulators were asked to assess the additional costs that would be incurred in preparing and assessing FRAs under two alternate scenarios:

- Scenario 1: Peak Flow Database does not exist
- Scenario 2: Peak Flow Database exists but is 'frozen'

³¹ Land Registry House Price Index, June 2015

³² Written answer by Nick Boles in House of Commons: Hansard, 10 February 2014. Accessed on www.publications.parliament.uk/pa/cm201314/cmhansrd/cm140210/text/140210w0002.htm#140210w0002.htm_spnwz

They were also asked to comment on wider issues that would arise, for example insurance and liability issues associated with the use of data that was either out of date or not quality-controlled. The two scenarios are discussed in detail below.

Scenario 1: NRFA Peak Flow Database does not exist

As noted above, a significant number of FRAs are prepared with a fairly 'light touch', or use results from earlier work. An estimated 30-50% require detailed hydrological analysis, and use of the NRFA Peak Flow Database. For the sake of argument we assume, conservatively, that just one third of the estimated 12,000 FRAs submitted each year, ie 4,000, are of this more detailed nature.

If the NRFA Peak Flow Database did not exist, then:

- *Consultants* would need to obtain the raw river flow data collected by the hydrometric Measuring Authorities on a case-by-case basis. The raw data would then require processing to get it into a form suitable for use with the FEH models used in preparing an FRA. It is estimated by consultants that this would probably take on average 2-3 days of effort. Assuming a charge rate of £300/day, and taking the lower estimate, the additional cost for the consultant is:

2 additional days consultant time per FRA in processing raw data
Cost per FRA @ £300/day = £600

- *Consultants* noted that FEH calculations often require 'data pooling', and that for detailed hydrological calculations multiple data requests across many hydrometric Measuring Authorities would be required, inevitably creating delays. The number of sites could be 15 per FRA, rising to 50 for a large and complex FRA.
- *Consultants* also expressed concern over the potential liability issues that could arise if they were forced to use raw data from hydrometric Measuring Authorities that had not been subject to quality control. This problem becomes more acute when large scale data pooling is required across regions, as different regions may well have different quality control practices. The cost implications of such liability issues are difficult to estimate. However, given the sums of money involved in large development proposals (in excess of £8-12 billion/year for residential units in flood risk areas alone), and the risks of legal actions and challenges, it is not surprising that as one consultant put it "*our clients would require our FRAs to be as robust as possible*".
- *Regulators* would incur costs in the provision of raw data to consultants for use in FRAs. One regulator replied that "*it would mean time to respond to individual requests and collate information, if available*", while another thought that the additional costs would be "*considerable*". In quantitative terms, a third regulator thought that providing data would require perhaps 2 hours of time per request. The cost implications are compounded by the data pooling issues raised by consultants. If an FRA were to require data for 15 sites (not the 50 that could be required for complex FRAs) then at an overheaded staff cost of £20/hour, the additional cost is:

Data requests for 15 sites at 2 hours per request = 30 hours regulator time
Cost per FRA: 30 hours @ £20/hour = £600

- *Regulators* expressed concern that if the NRFA Peak Flow Database did not exist then the accuracy of FRAs submitted by developers would be compromised. In the view of

one, “it would have a considerable impact if FRAs are not submitted with the most up to date and accurate data”, while another thought that “this would significantly affect the accuracy of flood calculations”.

- *Regulators’ concerns over the accuracy of FRAs submitted by consultants, combined with the fact that the regulators themselves would be hindered by the lack of the Peak Flow Database, means that additional costs would be incurred in assessing FRAs. One regulator believed that “where estimates differed significantly from ours, we would need to check what data each consultant was using and if it was correct and appropriate, this could add considerably to our review time.” Another argued that “there would be a considerable cost both in terms of time and resources if the Peaks Flow did not exist.”*

For simplicity, we ignore any time costs that may be involved in assessing ‘less detailed’ FRAs, and focus solely on the estimated 4,000 detailed FRAs. These are likely to relate to larger scale developments in areas of greater flood risk (ie Level 3). An additional 1 day to review each detailed FRA would seem conservative, given the risks for regulators that their decisions are subject to challenge and hence need to be robust. On this basis, and assuming a time cost of £200/day, the additional cost for the regulator is:

*1 additional day of regulator time per detailed FRA in assessment
Cost per FRA @ £200/day = £200*

The total additional costs incurred in preparation and assessment of detailed FRAs in the absence of the Peak Flow Database, both per FRA and annualised across the whole of the UK, are therefore:

<i>Consultant</i>	
• Additional costs of FRA preparation	<i>£600</i>
<i>Regulator</i>	
• Additional costs of data provision	<i>£600</i>
• Additional costs of FRA assessment	<i>£200</i>
<i>Total additional costs per detailed FRA</i>	<i>£1,400</i>
 Total costs saved per year by Peak Flow Database	
4,000 detailed FRAs @ £1,400	£ 5.6 million

Scenario 2: NRFA Peak Flow Database is ‘Frozen’

Consultants and regulators were asked to imagine a situation in which the NRFA Peak Flow Database existed, but was ‘frozen’ in its current form. The questions then is how long it would take before the lack of annual updating started to compromise the accuracy of FRAs and started to impose additional costs upon consultants and regulators alike.

Responses by both consultants and regulators were very similar. In essence, their views were that:

- It is unlikely that ‘freezing’ the database would have much noticeable effect in the short term (<2 years).
- After 2-3 years, or at the very most 5 years, the database would no longer be considered to be reliable. If a ‘flood event’ occurred before this time had elapsed, then there would be immediate concerns over data reliability.

One regulator suggested that if the database was frozen “a few years could make a difference, and five years would be an issue” while another thought that “between 2-3 years [we] would see the accuracy/usefulness start to tail off but [this] would of course be dictated by the flow regime and nature of flood timing in any location”. A third regulator believed that the database would need to be updated after each major ‘flood event’, arguing that the existing methodology and data are based on the assumption of zero change, but with climate change this is clearly not the case. In his opinion “the next big flood will typically exceed previous capacity and expectations” and hence “maintaining the dataset as up-to-date as possible is paramount”.

Consultants felt that while they would be driven by what the regulators demanded in terms of data accuracy, their clients would also be questioning whether the models and data being used took into account the implications of the most recent flood event. As one consultant put it “our clients more often than not insist upon using up-to-date hydrological databases. This is important where studies are carried out after a major flood event, for example the winter 2013-14 flooding.”

As table 5 below shows, the flood events have occurred in the UK since 2000 with considerable frequency.

Table 5: Recent flood events in the UK

Year	Flood event
2004	Flash floods in Boscastle and surrounding areas
2005	Cumbrian floods - 2000 properties flooded, causing >£250m damage
2007	Severe flash floods in many areas of the UK. (Pitt Review)
2009	Cumbrian floods - Cockermouth
2012	Series of floods affecting many areas of the UK
2014	Extreme flooding in Somerset Levels and Thames Valley

Consultants observed that liability issues could arise if they carried out an FRA for a client using models and data that they knew were likely to be inaccurate. As one consultant put it, “you cannot have a dynamic flood model with static data”, arguing that regular updating of quality-controlled data is absolutely essential. In effect, Scenario 2 is thus exactly the same as Scenario 1, but with a brief time delay of perhaps 2-3 years.

5.4 Net Economic Benefit of the NRFA Peak Flow Database in FRAs

The analysis demonstrates that the entire cost of maintaining the NRFA Peak Flow Database on an annual cycle is easily covered by the benefits of its use by consultants and regulators in preparing and assessing detailed flood risk assessments alone:

Costs and Benefits	Amount (£)
<i>Economic Benefit</i>	
Cost savings in preparation and assessment of FRAs	£5.6m/year
<i>Economic Costs</i>	
Maintenance of NRFA Peak Flow Database (annual cycle, highest cost estimate)	<u>£235k/year</u>
<i>Net Economic Benefit</i>	<u>£5.375m/year</u>
Net Present Value (25 years, 3% discount rate)	<u>£95 million</u>

Since freezing the database and adopting a 5-yearly upgrade cycle does not actually save money, and may also have a number of disbenefits, a comparable calculation for this option is not necessary.

6. Summary & Conclusion

The NRFA Peak Flow Database plays a central role in flood risk policy and planning in the UK. It is used for a wide range of purposes, in particular the preparation of flood risk maps, flood risk assessments (at a national, strategic and local level), and the design of flood defence and alleviation schemes.

The importance of accurate data to support flood risk planning and policy is highlighted by the facts that:

- 2.4 million properties in England are at risk from flooding from rivers or the sea, of which nearly half a million are at significant risk.
- In Scotland, 73,000 properties are estimated to be at high to medium risk from river flooding,
- Annual flood damage costs in England have been estimated at around £1.1 billion per year but can be substantially greater in extreme flooding events.
- The Government expects to spend £2.3 billion on flood defence schemes in England over the period 2015-21, with 55% of this sum being allocated to defence against inland flooding.
- The c250 flood defence schemes (of all types) currently under construction in England, or scheduled to start by March 2016, have a total cost of £3.3bn and are expected to provide greater flood protection to >300,000 homes. The NPV of total benefits is estimated at around £215bn.
- Flood risk assessments for around 60,000 new residential units in flood risk zones, with a marketable value of c£10bn, are reviewed by the EA each year.

In the context of the sums involved, the cost of maintaining the NRFA Peak Flow Database (around £185-235k/year) is extremely modest.

Using quite conservative assumptions, and considering only its usage in preparing and assessing detailed Flood Risk Assessments, of the net economic benefits of the database in terms of costs saved by environmental consultants and regulators are just under £5.4m/year. Over a 25-year term, and using a 3% discount rate, this equates to an NPV of £95m. However, since the NRFA Peak Flow Database is used for many other purposes, this significantly underestimates its full value.

There is no benefit from saving in freezing the database in its current format: the view of consultants and regulators alike is that while there would be no immediate negative impact, the 'frozen' data would need to be updated after any new 'flooding event', and in any event within 5 years. Also, adopting a 5-yearly update cycle does not actually save money when compared with the current annual update cycle.

Investment in maintaining the NRFA Peak Flow Database by NERC and UK hydrometric Measuring Authorities represents extremely good value for money. Indeed, if it no longer existed, then the clear underlying message from consultants and regulators alike is that it would need to be re-invented almost immediately.