NATIONAL TECHNICAL ADVISORY GROUP ON FLOODING ISSUES

INSTITUTION OF CIVIL ENGINEERS *LEARNING TO LIVE WITH RIVERS* REPORT

Purpose

1. This paper introduces the Institute of Civil Engineers' (ICE) *Learning to Live with Rivers* report and highlights the conclusions and recommendations reached.

Background

2. NTAG has been set up to offer expert advice to the Scottish Executive on how best to provide technical guidance on flood prevention schemes in Scotland. In doing so it is important that it considers relevant pieces of work already in the public domain. Members agreed to consider the ICE findings The *Learning to Live with Rivers* report and an extract from the report, highlighting the conclusions and recommendations is attached at Annex A to this paper.

Learning to Live with Rivers report

3. The *Learning to Live with Rivers* report was commissioned by the Government in January 2001 in light of experience from the autumn 2000 floods. An ICE Commission, chaired by Prof. George Fleming, was set up in February 2001 to review the technical aspects of flood risk management in England and Wales and consulted widely gathering both written and oral evidence from a range of interested parties.

4. In particular, the *Learning to Live with Rivers* report was set-up to review the following areas:

- current methods of estimating and reducing flood risk;
- whether a more strategic catchment-based approach to fluvial flood alleviation is appropriate;
- the impact of flood defences on the natural and build environment;
- whether flood risk management can make more use of natural processes;
- possible impact of climate change and
- experience in other countries.

5. The report was published in November 2001.

Conclusions

6. **Members are invited to discuss and advise the Executive on the relevance of the *Learning to Live with Rivers* report, to flood risk management in Scotland.**

NTAG Secretariat
January 2004

ANNEX 1

NATIONAL TECHNICAL ADVISORY GROUP ON FLOODING ISSUES

EXTRACT FROM *LEARNING TO LIVE WITH RIVERS* REPORT

Chapter 11 Conclusions and recommendations

11.1 Summary conclusions

The original terms of reference of the Commission have led to conclusions and recommendations for a wider range of issues, some of which span more than one of the terms of reference. As a result, the main conclusions relating directly to the original terms of reference are stated below and the recommendations are detailed in the following sections.

Current methods of estimating and reducing flood risk

The Commission concludes that while best practice for estimating flood flow remains based on the *Flood Studies Report (NERC, 1975)* and the *Flood Estimation Handbook (CEHW, 1999)*, there is a serious inadequacy in representing the dynamic effects of land use changes, catchment processes and climatic variability. There is also a reluctance to use available computer models to provide greater insight into the sensitivity of flood risk for a combination of conditions.

Whether a more strategic catchment-based approach to fluvial flood alleviation is appropriate

The Commission concludes that a more strategic catchment-based approach is essential in tackling fluvial flood alleviation.

The impact of flood defences on the natural and built environment

The evidence presented to the Commission clearly identifies the very significant impact of flood defences in both the natural and built environment. The impact has been to reduce the risk of flooding and, in most cases, flood defences have been sympathetic to the built environment and indeed have become an integral part of a sustainable built environment. The Commission recognises that in the natural environment, the impact of flood defences may in general terms have been less successful in alleviating rural flood risk. A clear need has been identified to provide capacity for rivers to respond to flooding in both the rural and built environment by the more careful balance of land use through redevelopment.

Whether flood risk management can make more use of natural processes

The Commission concludes that sustainable flood risk management can only be achieved by working with the natural response of the river basin and providing the necessary storage, flow reduction and discharge capacity. Floods can only be managed, not prevented, and the community must learn to live with rivers.

Possible impact of climate change

The Commission is of the opinion that there is evidence of the significant impact which climate change is having on the rainfall, evaporation, storage and runoff within catchments. The Commission is of the view that best practice in flood estimation must have the effects of climate change designed into it.

Experience in other countries

The Commission's review of best practice in a few selected countries supports the need for an integrated approach to flood risk management. It also revealed greater confidence in river basin modelling both for flood assessment and real-time flood management than in the UK.

11.2 Summary recommendations

Fluvial flood risk management needs to be a holistic process that considers flooding from the point rainfall hits the ground to the place it is finally discharged into the sea. It needs to recognise, evaluate and take into account the human dimension as well as the technical and economic cases for interventions, as well as the environmental impact of these. It requires a full understanding of all the physical processes involved and the ways in which these are changed by human activities, from agriculture to urban development. It needs a trained and motivated body of professionals at all levels, equipped with the necessary tools and resources. And finally it needs the understanding and co-operation of the people who will benefit. The detailed recommendations are set out in the following sections, together with references to emboldened text in the main body of the report. Table 3 shows how the recommendations relate to the Commission's original terms of reference.

11.3 Raising flood awareness

11.3.1 The recent periods of widespread and sustained flooding have raised awareness of the damage and distress that can occur. The Commission believes that it is crucial that we take advantage of this raised state of awareness to communicate the realities of flood risk and how we manage this risk. This communication process must be maintained indefinitely to ensure that time does not diminish the level of awareness that is of considerable help in reducing the impacts of flooding. (2.3)

11.3.2 The Commission supports the Environment Agency's initiatives in raising awareness of fluvial flooding, and believes that a long-term education initiative is required to stress that flood risks cannot be removed and to explain the uncertainties inherent in flood forecasting. With a sufficient level of knowledge, flood-prone members of the public could themselves become involved in the processes of emergency planning and flood risk management, bringing real engagement of those at risk. (2.3)

11.3.3 In terms of communicating the likelihood of flooding, the use of 'return period' is unhelpful to lay persons. However, understanding of odds is widespread, arising in many games and sports involving chance and gambling. The Commission therefore recommends that, instead of referring to the 100-year flood, we would say that the odds are 100 to 1 against such a flood occurring in any year (100-1 chance flood), regardless of any recent severe occurrences. (2.3)

11.3.4 The Commission supports the introduction of historical flood level marking as an effective means of raising flood awareness in communities. (2.3, 2.4)

11.3.5 The Commission recognises that flood risk maps are a valuable source of information for the public and for those involved in development control and flood risk management. The present maps are not accurate or detailed enough to give confidence in the guidance that they provide. The Environment Agency should give high priority to this initiative to ensure that the maps give accurate, up-to-date and reliable information. (6.3)

11.3.6 The Commission recommends that the Environment Agency, recognising the legal implications, should move ahead to refine flood plain mapping to indicate to the public which areas have some measure of flood defence with the associated quantifiable risk. (6.3)

11.3.7 There is a complex division of responsibilities in flood risk management and the Commission recommends the provision of a 'one-stop shop' for public access and information. (2.4, 10.1, 10.3)

11.4 Promoting the human dimension

11.4.1 The human distress and health damage caused by flooding has been overlooked in the strictly economic approach adopted to assess the benefits of flood mitigation interventions. The Commission believes that this human cost should be built-in to future benefit-cost assessments, so that the true worth of interventions is established. Preliminary research shows that the intangible costs of flooding are of the same order as the tangible costs. (2.5, 5.3)

11.5 Planning for floods

11.5.1 The Commission endorses the risk-based, sequential approach to development on flood plains advocated in *Planning Policy Guidance Note 25, Development and Flood Risk (DTLR, 2001)*. In particular, we support the need for flood risk assessments to accompany proposals for new development in flood plain locations linked, as appropriate, with models and data deriving from the process of preparing catchment flood management plans. (5.6)

11.5.2 The Commission supports the promotion of a more strategic-based catchment approach of which the initiative for catchment flood management plans is an important element. However, the time needed to develop catchment plans and the follow-up initiatives should not be used as a reason to delay the implementation of flood defences and other interventions that are already in the pipeline. (3.1)

11.5.3 While much effort is rightly going into establishing a sound methodology for preparing catchment flood management plans, producing the plans is not an end in itself. The Commission believes that more consideration needs to be given to the practical issues of ensuring that there are the leadership and professional skills, stakeholder commitment, partnership structures and financial resources to turn the plans into action on the ground. (3.1)

11.5.4 The Commission recommends action to identify flood storage areas as a recognised land use for inclusion in local plans. Agri-environmental schemes should be promoted where appropriate as elements in flood risk management, an attractive complement to farming in financial terms and a means of promoting biodiversity. (5.4)

11.5.5 Within the overall emergency planning framework, the Commission recommends detailed flood emergency plans should be prepared for all significant settlements at risk from flooding. This task should be used as an opportunity to engage with, and raise awareness of, flood risk management issues amongst flood plain communities. Involving people in preparing emergency plans and developing initiatives such as flood warden networks are good ways of raising flood awareness amongst householders and businesses at risk. This should also include planning and resourcing for recovery from flooding, which needs to be given a higher priority. (6.9)

11.5.6 The Commission considers that it is essential for the Environment Agency to have an effective, well-trained and well-equipped emergency work force for responding to emergency flood situations. (6.9)

11.5.7 The Commission supports *Planning Policy Guidance Note 25, Development and Flood Risk (DTLR, 2001)* for encouraging planning authorities to require a 'drainage impact assessment' for all new developments. This would cover all drainage related issues in sufficient depth to ensure that appropriate and sustainable solutions are incorporated into the development proposals. (4.3)

11.5.8 The Commission recommends that the performance indicators established to monitor the implementation of DEFRA's *High Level Targets for Flood and Coastal Defence (MAFF, 1999b)* should be expanded to include the number of households flooded each year. The present approach is too focused on economic benefit and needs to recognise the human distress and health effects of flooding. (5.3)

11.6 Designing for floods

11.6.1 The Commission recommends that a wider application of risk-based methods is encouraged by both clients and professionals involved in flood risk management. This will involve increased competency levels and adherence to best practice. (2.1)

11.6.2 For the future, the Commission considers it is no longer acceptable to design flood defence schemes on the basis of a single event (the design event). For the future, scheme design should extend the analysis to look at sensitivity to flows higher than the present design flow to take into account climatic and land use changes. (2.4)

11.6.3 The Commission urges that design engineers take advantage of the power of the *Flood Estimation Handbook (CEHW, 1999)* techniques to explore the sensitivity of the flood regime to climate change and land use. (6.2)

11.6.4 The link between stage (hydraulics) and discharge (hydrology) is of particular importance. Powerful methods such as the *Flood Estimation Handbook (CEHW, 1999)* lack a complementary approach in hydraulics and the Commission recommends this imbalance must be rectified if progress is to be made in designing and modelling for flooding events. (3.2)

11.6.5 The Commission recommends that all conveyance and storage options should be considered in every case where solutions are being sought for a fluvial flooding problem. This should include land use change such as the option of abandoning houses and other buildings that have been constructed in the flood plain. (5.2, 5.4, 5.5)

11.6.6 In circumstances where it is appropriate to provide engineered defences to protect significant numbers (i.e. hundreds) of people in a contiguous community, the Commission suggests the aim should be to provide a high standard of defence, even if the economic analysis reveals that a lower standard would yield a larger benefit-cost ratio. It is recommended that the target should be based on providing protection against the 100-1 chance flood in any year as a minimum. (5.3)

11.6.7 The Commission recommends that an assessment of the role of sustainable urban drainage systems and the impact of more frequent and longer duration river floods on sewers and sewage pumping stations is undertaken. Development of national standards for the infrastructure of sustainable urban drainage systems will allow easier adoption by the utility companies and local authorities. (4.3)

11.7 Asset management

11.7.1 The Commission received evidence of underinvestment in maintenance of flood defences over recent years and a lack of planning and programming of maintenance in accordance with need. This trend needs to be reversed so that existing flood alleviation schemes perform as designed, all interventions are planned with a full appreciation of operation and maintenance requirements and resulting whole-life costs. This process will be facilitated by the use of risk-based analytical techniques and regular condition surveys. (5.7. 5.8)

11.7.2 The Commission strongly supports the establishment of a national database of flood defence assets. This will be invaluable for future operation and maintenance activities and for planning the eventual replacement of existing flood defence infrastructure. To ensure that this initiative does not founder, consideration should be given to placing the responsibility for gathering information on all defences with a single agency, regardless of ownership. (4.3, 5.7)

11.7.3 In view of the high risk of flooding caused by blockages of culverts and trash screens, the Commission recommends that all critical culverts be assessed for this risk. In assessing the options for overcoming the flood risk posed by blockages, we should not shy away from reclaiming urban channels that have been culverted or encroached upon by development. (4.3)

11.7.4 The Commission recommends that the management of earthen flood defences is the subject of research and development so that future maintenance, repair and replacement programmes can proceed on the basis of sound knowledge. This research should proceed in parallel with research into the failure modes of earth embankments so that increased understanding can be used to inform flood risk management when embankments are subjected to high water levels. (5.7)

11.8 Research

11.8.1 The Commission commends the DEFRA / Environment Agency research and development programme and recommends the level of funding in research and development should be built up to the figure established in the Penning-Rowsell Report and maintained at that level, at least until the next review (viz £5.2 million each year). (5.9)

11.8.2 The present structure of the research councils (Natural Environment Research Council, Engineering and Physical Sciences Research Council, Social Research Council, Medical Research Council, Biological and Biomedical Sciences and Office of Science and Technology) has failed to nurture crossboundary projects in the area of flood risk management, especially with respect to technical, health, social and environmental impacts. The Commission recommends the structure of the research councils should be reviewed. (6.6, 6.7)

11.8.3 There should be consideration given to a long-term strategy for developing research skills within the UK for flood analysis. The Commission has identified there are considerable gaps in our knowledge and a move to a solution-orientated culture by all concerned with flood risk management will enable these gaps to be filled. Greater collaboration on research and development between the Environment Agency, DEFRA, academia and research institutes needs to be promoted. In particular, greater collaboration between the Natural Environment Research Council and the Engineering and Physical Sciences Research Council, which would join a 'pure science' approach with an 'engineering science' approach, is urgently needed for fluvial problems. (6.7, 6.8)

11.8.4 Recent competitive research contract practice in the Natural Environment Research Council and the Engineering and Physical Sciences Research Council has been to announce a multi-million pound theme and then let the spending be on a myriad of relatively disconnected topics loosely within that theme. The Commission believes that applied flood research, of key value to the community, needs a more managed approach. The success of the *Flood Studies Report (NERC, 1975)* is often over-looked. The next major target should be 'long-sequence flow simulation', covering river level-velocity-energy relationships, with full visualisation (as with building design). (6.7)

11.8.5 More research into the interaction of sewer and piped drainage systems and the rivers into which they discharge in flood events is needed. This is an area of research that inevitably falls between two stools. The Commission recommends that contact is established between the DEFRA / Environment Agency research and development programme and UK Water Industry Research to explore the possibilities for a jointly funded research programme. (4.3)

11.8.6 The Commission believes that further research is required into the impact of seasonal catchment conditions on flooding, including the effects of climate change. (7.2)

11.8.7 A particular area for further study is the link between land use and flooding, so as to have confidence in policy changes that could lead to significant reduction of flood risk. The Commission recommends that whole-catchment modelling be undertaken with greater vigour to address this issue. (5.3)

11.8.8 The Commission recommends that research be progressed to enable monetary values to be attributed to the cost of the health and social distress caused by flooding, or the benefit of its avoidance. (2.4)

11.8.9 Further research should be carried out into all the available options for improving the flood resistance of both existing and new buildings. The Commission suggests the aim should be to identify innovative and cost-effective solutions that will be readily adopted by the building industry. (5.4)

11.9 Model development

11.9.1 The Commission believes that modelling will allow not only the testing of flood scenarios based on current catchment conditions, but also a dynamic perspective through investigation of future scenarios with various climate change and development assumptions. (3.1)

11.9.2 The Commission recognises that models should be developed to match the scale and complexity of the problem. It should also be recognised that there is a distinction between the use of models for design and the use of models for operational, active risk management. (3.2)

11.9.3 The Commission recognises historical data is of significant value. However, we need to look at more innovative methods of flood estimation including modelling if we are to successfully manage flood risk. (3.2)

11.9.4 The Commission has identified a need to develop and further integrate hydro-dynamic modelling, examining channel change and sedimentation, with hydrological sensitivity analyses to improve the accuracy of flood level estimates. This model coupling should occur at both catchment and sub-catchment scales and there is a need to pool best use in their practice. (6.2)

11.9.5 Flood hydrograph forecasting is not yet being trusted by those who use it in flood emergencies in the UK. The Commission recommends that current methodologies be continually refined so that state-updating from catchment sensors is employed in forecasting models to the maximum extent that brings useful performance gains. (6.5)

11.9.6 The Commission recommends the development of regional flood response models should be progressed more urgently. Although complete standardisation may be unhelpful in all cases, core concepts and algorithms should be transparent enough to perceive why differences are needed. (6.5)

11.10 Skills shortage

11.10.1 The general conclusion of the Commission is that the appropriate technical skills are lacking within the industry, from drainage engineers in local authorities to river engineers in the Environment Agency and skilled hydraulic specialists in universities. This lack of skills resources requires urgent attention. (8.1)

11.10.2 With the increased technical demands of management, an improvement in staffing levels within the industry should be considered, particularly with regard to senior technical and managerial posts concerned with flood management. The Commission recommends that a policy is required for attracting, training and keeping staff to higher technical and management levels, with a thorough understanding of the processes involved and skills in advanced modelling techniques (hydrological and hydrodynamic). (8.1)

11.10.3 It is acknowledged that frequent movement of staff within the industry as part of the staff development programme has an adverse impact on the ability of the industry to respond to flood events. Local and detailed knowledge of rivers, flood defences, hydrology and flood forecasting systems is important. The Commission believes the industry needs to consider how to foster technical skills without undermining promotional prospects. (8.1)

11.10.4 The Commission believes that there is a critical need to develop a structure of flood risk management that ensures sustained leadership and professional skills are available as a high priority and that all stakeholders are brought together in partnership to promote the quality of service to the community in flood risk management. (3.1, 8.2)

11.10.5 There is evidence that there has been a disconnection between research in universities and research in consultancies and other organisations. The Commission promotes a partnering approach for the future that must include university departments. (5.9)

11.10.6 The Commission recommends a review of the skills required in flood risk management and an assessment of the skills shortage that is perceived to exist. (8.1)

11.11 Availability of data

11.11.1 The Commission recommends that publicly collected primary and processed data (topographical, meteorological, hydrological and hydraulic) should be made publicly available, as is the case in the United States. This would result in improved flood risk assessment and management. (6.3)

11.11.2 Ways of integrating knowledge between the disciplines of hydrology and hydraulics are required for effective flood risk management. The Commission recommends that impetus should be given to the establishment of a good database of flood events. This should include the provision of additional flood flow measuring stations and the development of reliable stage-discharge relationships for all existing stations and key hydraulic structures. It is suggested that as a first step stage discharge data and rating curves at all gauging locations should be added to the *Flood Estimation Handbook (CEHW, 1999)* as it is common to both disciplines. (6.3)

11.11.3 The Commission believes that consideration should be given to increasing the acquisition of primary data for catchment planning purposes, including the possibility of installing new telemetered rainfall, water level and soil moisture gauges. (6.5)

11.11.4 The Commission received evidence of the under-use of data series. Analysis of flooding probability could be improved if computerisation of the UK's archive of daily rainfalls at 1000+ sites was completed. (6.5)

11.11.5 There is a lack of reliable flood event data. The Commission recommends that greater emphasis should be placed on the collection of flood data during flood events – this should be done in a way that does not add to the burden already placed upon the Environment Agency and other staff during emergencies. (6.3)

11.11.6 The Commission recommends that data should be made available by transport authorities – such as highways, railways and airports – which should commission and publish flood risk surveys of flood-prone routes or locations, especially where these can be cut for long periods (as in chalk-bourne areas) or where heavily trafficked routes are capable of being severely affected. (6.5)

11.11.7 The Commission recommends utilising a wider range of catchment flood forecasting and warning tools and closer co-ordination of Met Office and Environment Agency functions

in this field. This should include a review of current practice and assessment of the beneficial use of real-time monitoring to manage the operation of flood defences. (5.7, 9.3)

11.12 Resourcing

11.12.1 From the evidence presented to the Commission, there is a strong case for significant increases in real terms in public spending on all aspects of flood risk management, from maintenance of existing flood defence assets to provision of new flood defences to flood warning and emergency planning procedures. (5.8)

11.12.2 If public expectations are to be met, increased public spending needs to be sustained over a long period and not cut back if the country enjoys some relatively flood-sparse years. The Commission recommends a two-headed strategy.

a) In the short term, priority in any increased public spending should be directed to improving maintenance of critical flood defence assets and action to tackle flood 'hot spots'. (5.7)

b) In the longer term, a clear linkage should be developed between the priorities emerging from the new catchment flood management plans and the allocation of available national funds. (10.3)

11.12.3 The technical review undertaken by the Commission has shown that flooding from urban drainage systems is a problem and, although the scale of such incidents is often not great, the number across the country is significant and warrants greater investment than has been made to date. Incidents such as the flooding of houses with sewage as a result of overloaded sewers are even more distressful than surface water flooding and pose a considerable health risk. (4.1)

11.12.4 The Commission recommends that the same rigour should be applied to investment decisions associated with flood preparedness and response measures as those to engineered flood defences. (2.4)

11.13 Responsibility for flooding

11.13.1 The Commission recommends that the responsibility for flood risk management should be consolidated around one executive agency with enhanced supervisory powers over the various operating authorities. This agency should have resources allocated directly from the Government and have responsibility for spending prioritisation, preparation and implementation of catchment flood management plans and delivery of DEFRA's *High Level Targets for Flood and Coastal Defence (MAFF, 1999b)*. (10.3)

Legislation

11.14.2 It is strongly recommended by the Commission that current sewerage legislation is reviewed with sewer flood control in mind. The review should include an assessment of the current low levels of investment in sewer improvement to reduce flood risk and the need for a more 'joined-up' approach to the whole issue of urban drainage. (4.1)

11.14.3 There has been a reluctance to accept responsibility for maintenance of sustainable urban drainage systems, which has constrained progress of these systems. The Commission

recommends that this reluctance is addressed by the Government and suitable measures taken to overcome it, if necessary by a change in the law. (4.3)

11.14.4 The categorisation of watercourses into 'main river', 'ordinary watercourses' and 'critical ordinary watercourses' is arbitrary and unhelpful. It adds more confusion in the minds of the public and emphasises the divided responsibility that has been raised as a cause for concern by many of the consultees. The Commission recommends that the need for these definitions is reviewed in the light of calls for singlepoint responsibility for flood risk management. (4.3)

11.14.5 The Commission recommends that any responsibility for riparian drainage maintenance should be added to registered land titles. This would most readily be achieved at re-registration of a land transfer. (5.7)

11.14.6 The Commission recommends that all surveys for future property sales should include an assessment of likely flood risk. (5.7)

11.15 Concluding remarks

The recommendations presented in this report will be of little value if there are not sufficient numbers of highquality skilled professionals available to implement them. The Institution of Civil Engineers recognises this and will use its influence to promote the Institution as the recognised training and professional qualification body at the forefront of flood risk management and river basin engineering. As indicated in the early sections of this report, the Institution of Civil Engineers has throughout the last century been the professional body involved in advancing the debate and introducing best practice in flood management and river basin engineering. This report is seen by the Institution of Civil Engineers as a contribution to a wider debate that must embrace the social and economic dimension of flooding and the issues of environment, land use, planning, infrastructure, development and emergency response. The debate will continue but the solution must be sustainable. With determination this can be done within the decade. We recommend we start now.

Learning to live with Rivers, published by the Institute of Civil Engineers (November 2001)