A feasibility study into a System for the Assessment of an Insurer's Flood risk Exposure (SAIFE)

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To

Jardine Thompson Graham Ltd

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IH/ICL collaboration

WIS is the product of a joint collaboration and investment programme by the Institute of Hydrology (IH) and International Computers Limited (ICL). IH has contributed the research, design, programming and development environment. ICL has provided the programme management, quality assurance, additional development funding, development hardware and design support. ICL acknowledges that the Intellectual Property Rights of WIS are vested in the Natural Environment Research Council.

Copyright and intellectual property rights

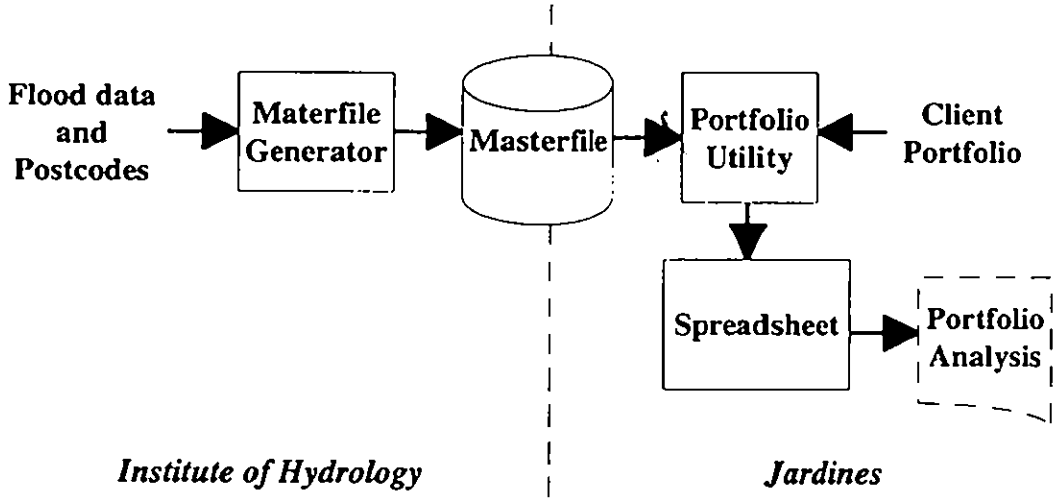
Contents

Executive Summary

Overview

This report discusses an approach which could be used to develop a computerised system to determine the extent to which a postcode is susceptible to flooding. The Flood Susceptibility System would be implemented as two sub-systems as shown in Figure 1.1. One sub-system, the Master File Generator, would be run by and at the Institute of Hydrology to produce a master file of all UK postcode sectors and their susceptibility to flooding. The other sub-system known as the Portfolio Utility would be installed at Jardines and would be run whenever Jardines wished to analyse the flood susceptibility of a client's portfolio.

Figure 1.1 - The SAIFE System



An important consideration is the availablity of data about flooding. The current situation is far from ideal: the basic data is incomplete and in many different formats, less exists in digital form than we were led to believe earlier, and some of what does exist may be denied to us (the ABI data in digital form is restricted to its members). Howdens are not as far on with their data collection as was first understood and there is as yet no reciprocal agreement between them and the NRA. The NRA have yet to begin on the data required for the boundaries of flooding for different return periods. The Institute of Hydrology's work for MAFF on computing flood plain boundaries is just beginning.

However there are other routes to the required data in digital form and these form the basis of this proposal. The first version of the system could use the digitised boundaries of historic river floods and coastal data. Later versions could provide estimates of the probability of flooding, extend the geographical areas covered and increase the completeness of the data.

Recommendations

From the research compiled for this study and the conclusions reached, it has been established that such a system is feasible to build. On the assumption that such a system will bring substantial benefits to Jardines, it is recommended that detailed program specifications and data acquisition procedures be prepared and costed.

It is proposed that the system should be produced in three phases as follows:

I based on historical river flood boundaries and the ABI coastal data

II further enhanced by the use of digital terrain data to achieve a greater degree of national coverage

III enhanced by the addition of return period river flood boundaries

It is suggested that the copyright and intellectual property rights of the Master File and the system should be held by the Institute of Hydrology and International Computers Ltd. Jardines would have the right to use the Master File for internal business purposes. This avoids the need for Jardines to purchase and maintain substantial NERC datasets which are otherwise of little interest to them.

From our discussions with the British Geological Survey, we are aware that there may be a market for the system or a service based upon it. It is suggested that IH/ICL and Jardines should discuss whether there is such a market and, if so, how to exploit it.

Project Summary

A detailed plan for Phase I starting in January 1995 will be completed in October 1995.

To prepare the detailed specifications is estimated at £17,350.

To build the proposed system to the point where it can at least handle the Phase I data is estimated at £74,750.

To acquire and process the Phase I data to populate the Master File is estimated at £57,600.

The annual ongoing charge is estimated at £8,300, including the suggested Data Consultancy service.

Phases II and III cannot be estimated accurately at this stage but Phase I is likely to exceed one hundred thousand pounds while Phase II could be several hundred thousand.

Glossary

ABI

The Association of British Insurers.

BGS

The British Geological Survey.

Client portfolio

In this context, the client's portfolio means a spreadsheet file supplied to Jardines by an insurer which contains data on the sums insured grouped by postcode sector.

CSV file

Comma separated variable file.

DTM

Digital terrain model, term for data describing ground elevations. Usually, the data are arranged on a square grid or triangular network.

GHASP

Geo-hazard susceptibility package, developed by BGS.

ICL

International Computers Limited.

IH

Institute of Hydrology.

ITE

Institute of Terrestrial Ecology

MAFF

Ministry of Agriculture, Fisheries and Food

Master File

The primary output of the Flood Susceptibility System is a Master File containing all postcode sectors for the UK and their associated susceptibility to flooding. The file is produced by and at the Institute of Hydrology and dispatched to Jardines for use in the Portfolio Utility.

NERC

Natural Environment Research Council

NGR

National Grid Reference

NRA

The National Rivers Authority.

NTF

National Transfer Format (NTF) is a national standard, developed by British Standards Institute (BSI) Technical Committee (BSI/IST/36) - Geographical Information. NTF is the main format for the input of spatial and time-series data to WIS.

PAF

Postcode Address File

Postcodes

Postcodes are used by the Royal Mail for sorting mail during the delivery process. They are also widely used by outside bodies as a crude form of spatial indicator when geographical coordinate data are unavailable. A postcode has a structure of the form:

AADD SSUU

where AA is the area
DD the district
SS the sector
UU the unit or sub-sector

RPB

The Scottish River Purification Boards.

SAIFE

SAIFE is the acronym for the System for the Assessment of an Insurer's Flood risk Exposure.

SDS

Sea Defence Survey

WIS

The Water Information System is the Institute of Hydrology's Geographical Information System for the storage and analysis of time-series and spatial data. WIS will be used to process and store the flood, geographical and hydrological data.

Chapter 1

Introduction

Purpose

This report presents the findings of the feasibility study conducted by the Institute of Hydrology into the design and costs of a system to allow insurance companies to better estimate their exposure to losses due to flooding. The study has been conducted in stages, starting with the required functions and outputs of the system. Having identified the required functionality, there were then two major areas to address, the sources and availability of the data necessary to underpin the system and the production of a workable system design. The results of both of these pieces of work are presented here.

Background

Insurers and re-insurers have a major interest in assessing the risks associated with policies or portfolios covering losses inflicted by environmental extremes. For example, an insurance company might be concerned about its liability for wind-induced damage at residential properties throughout England and Wales. The gales of October 1987 and February 1990 were exceptional events which inflicted extensive damage on the relatively densely populated parts of Southern and Central England. However, the fact that they happened and the magnitude of the loss, raises the questions:

'What is the probability of further such storms?'

'How severe could they be and how frequently could they occur?'

Wind damage is not the only problem of current concern to insurers. They also require an answer to these questions in relation to coastal and inland flooding so that they can quantify their risks, at least on a scale of high, medium or low or, better, some measure of return period. They can then assess their financial exposure by relating the risks to the sums insured. In the present context this is confined to domestic property and house contents.

While pursuing an answer to these problems, an MSc student working for Jardines saw the Water Information System (WIS). As it appeared to contain some of the elements of a solution, Mr Robert Pease of Jardine Thompson Graham Ltd approached IH/ICL with a view to developing a system for estimating such exposure. Over a period of two to three months, the requirement was refined, and the availability of suitable data and techniques investigated. Some sample data were assembled and loaded to gain a better understanding of the problems that might lie ahead. This work was done on an informal basis and the resources available were modest; nevertheless it was sufficient to suggest that such a system might be feasible and that a formal feasibility study was worth undertaking. Accordingly, IH/ICL were asked to undertake such a study and this report presents the conclusions.

Terms of reference

The terms of reference for the study have been:

> To produce a functional requirements specification, draft project plan and budgetary price for a computer based solution which will be used to make an assessment of an insurer's exposure to flood risk in both coastal and inland areas within the UK.

Activities

a) Confirm business and data requirements, identifying in particular preferences for analysis and presentation of flood risk data.

b) Discuss and relate Jardine's IT strategy to this project.

c) Produce a data model and data definitions.

d) Match business requirements and data model against the functionality of the Water Information System (WIS).

e) Identify and cost areas of bespoke software development, particularly reporting, presentation and options for file transfer.

f) Determine the sources of data, their format, quality, availability and conditions of use plus costs of acquisition.

g) If possible, identify and quantify any need to tidy and correct the data.

h) Determine the procedure for data conversion and loading onto WIS, identifying and costing any requirement for conversion software.

i) Determine the options for implementation, support, project management, training and on-going maintenance and their costs.

j) Identify and cost hardware, software and networking elements of the total solution.

k) Specify requirements for links to and from external software, e.g. MapInfo.

m) Produce an outline systems design.

n) Produce a draft project plan.

o) Produce a budgetary cost for the full solution.

p) Document the results of the study, in a form that can be used as a functional specification for a future deliverable.

Cross references

Initial enquiry from Jardines - 4th July 1994. Ref RPP/jas/1043G

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Chapter 2

Problem definition

Project objectives - overview

The objective of the project has been to assess the feasibility of creating a system of hardware, software and readily available data, that will allow an insurer to assess his exposure to losses as a result of coastal and river flooding. It should operate anywhere in the UK and provide results at the sector level of the postcode system. The system will be called SAIFE.

Technical requirements and constraints

Requirements

The flood susceptibility system SAIFE should be implemented in three phases. Phasing will enable Jardines to obtain a working system quickly, but then provide time for the developers to improve the quality of its output as better data and techniques become available from the NRA, IH and other sources.

At the end of Phase I the proposed system should:

- take as input a simple comma separated variable (CSV) file containing data on a client's portfolio. One of the columns in this file should contain postcodes.
- ask the user to define which column contains the postcodes.
- ask the user to define in which columns the results should be placed.
- ask the user which flood susceptibility parameters should be estimated:
  - known historic river flooding:

    {YES | NO}

  - dates of historic river flooding:

    {No known river flooding | Unknown | date}[,{Unknown | date}]...

  - fraction of postcode area known to have flooded at sometime.
  - similar parameters for coastal flooding, to be defined when the available data are known. ABI data has been assumed for costing purposes.

- compute the flood susceptibility characteristics based upon historic flood plain boundaries.

- output a new client portfolio file containing the input file with the flood susceptibility data added.

At the end of Phase II the proposed system should:

- perform all the Phase I functions but utilise additional data such as the IH digital terrain model to improve the quality and extent of flood characteristics.

At the end of Phase III the proposed system should:

- perform all the Phase I functions and in addition:

- compute flood susceptibility characteristics based upon return period flood plain boundaries as follows:

    - fractions of the postcode area at risk from the 50 year flood, 100 year flood and 200 year flood or whatever return period flood plain boundaries the NRA decides to compute, assuming this will be four or fewer.

- output a new file containing the input file with the flood susceptibility data added.

Constraints

The system should be designed within the following constraints:

- it should be based upon available data.

- it should be PC based at the user end.

- the client's portfolio will be available in a CSV file, one column of which will contain postcodes.

- the results should be returned by adding additional columns to the portfolio file.

- the 'insurance calculations' will then be made in a spreadsheet provided by Jardines.

- the system should be compatible with Jardine's IT policy and existing systems.

- the initial system is for multi-user single site access only.

Chapter 3

Proposed solution

Overview

The proposed system is shown in outline in Figure 3.1. It has two component sub-systems. One sub-system, the Master File Generator, is run by and at the Institute of Hydrology, processing raw flood and postcode data to produce a master file containing postcode sectors and their associated susceptibility to flooding. This file will be supplied to Jardines.

A new master file will be produced by the Institute of Hydrology only when it is requested to do so. This will usually be when significant benefits can be gained from updates to the raw data used to produce the master file. There are three elements to the cost of generating a master file: data gathering, system development and master file generation. The first dominates the costs and the time for its production.

The Master File Generator will be based on an extended version of the Water Information System. WIS will provide all the data entry and storage facilities. The extensions relate to the specialist processing required to generate the master file.

The second sub-system, the Portfolio Utility, will be used by Jardines to update a client's portfolio with the flood susceptibility data from the supplied master file. The Jardines sub-system can be used as and when new client portfolios require analysis.

Project phases

Phasing

The project has been split into three main phases to allow a quick initial implementation, followed by the development of additional features as and when data and techniques become available.

The first phase will involve historic flood plains, postcodes, postcode boundaries, watercourses, water bodies, gauging stations and urban areas. This will allow the first phase of SAIFE to produce a master file of postcode sectors and associated flood data.

The second phase will include the IH Digital Terrain Model and new techniques giving a greater geographical coverage.

The third phase will include the addition of return flood plain boundaries and introduce a measure of risk.

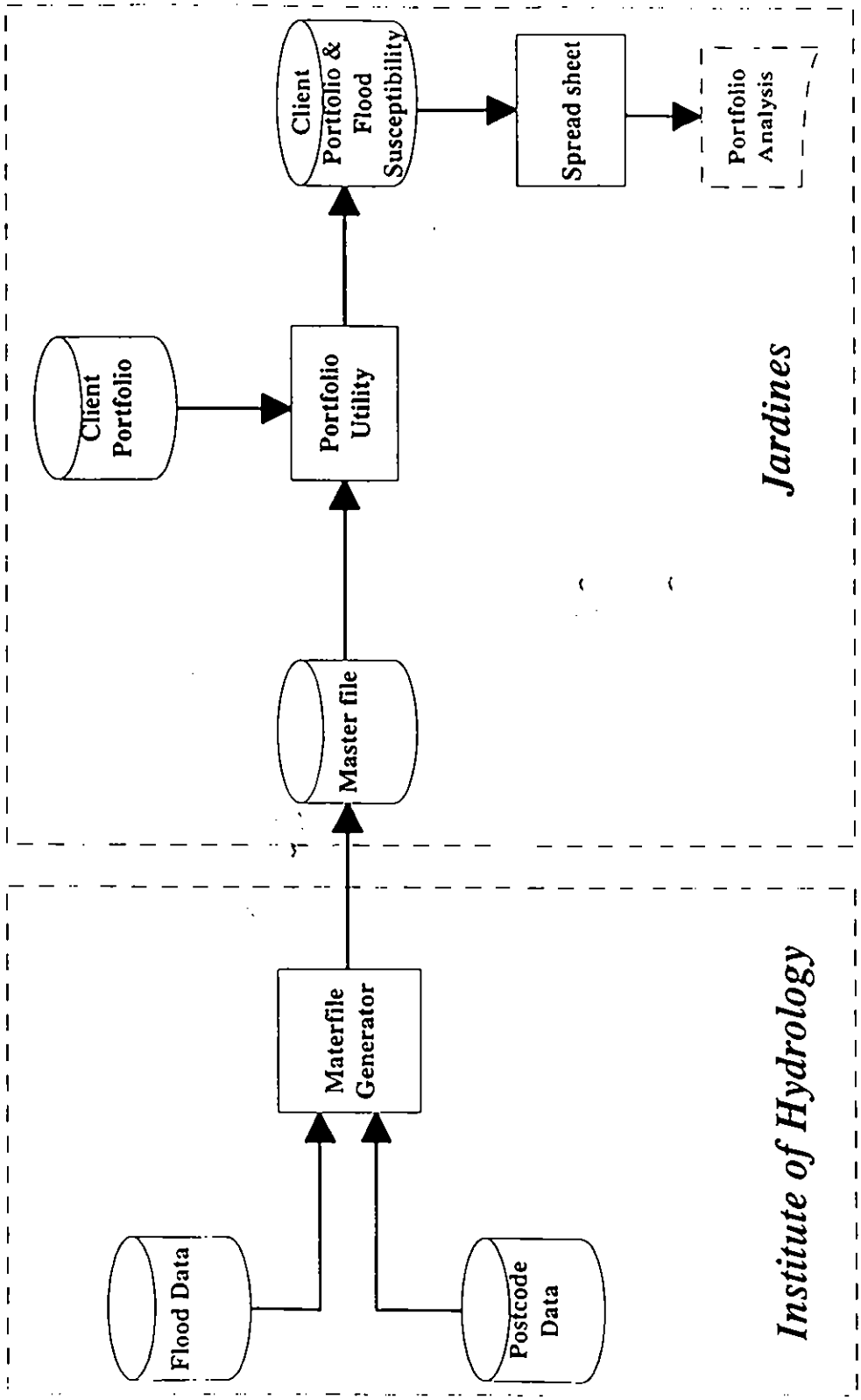


Figure 3.1 - Outline System Design

Data availablity and phasing

An important consideration in planning the phasing of the project is the availablity of data. The current situation is far from ideal. As the data survey will reveal later, less exists in digital form than we were led to believe earlier and some of what does exist appears to be denied to us. The ABI data in digital form is restricted to its members. Howdens are not as far on with their data collection as was first understood. They have only digitised the coastal historical flood boundaries, expected to be completed in April 1995, and do not propose to digitise the fluvial flooding until then. At least one region of the NRA has expressed reservations about the Howdens data, though these may arise from the two organisations having different objectives. There is as yet no reciprocal agreement between the NRA and Alexander Howden. Greig Fester have produced a 5x5m digital terrain model for the East coast. On the basis of our own work and our discussions with others, we believe the claims for it may be optimistic. Work has yet to begin on the data required for the boundaries of flooding for different return periods. The IH work for MAFF on computing flood plain boundaries using the IH DTM is just beginning.

However, all is not necessarily lost. Informal contact with the ABI suggests there may be other routes to their data in digital form. We have also had informal discussions with Chiltern Digitising Services, a small local company familiar with river mapping, and preliminary calculations suggest that it may be feasible to digitise the historic flood boundaries ourselves, though this would, of course, require NRA consent. However, for the data required by the later phases, we will be dependent on either the NRA or the current IH work being undertaken for MAFF being completed. It is these reasons that are the main justification for a phased approach.

Data Model

Before data can be loaded into WIS, the nature of the data must be described to the system. This description is called a 'data model' and it is stored in WIS's dictionaries. A prerequisite to establishing the data model and dictionaries is to list the types of data required and then reconcile the list with that which can actually be obtained within the available resources.

The result of that process identified the following data types:

- Postcode boundaries
- Postcode points
- Historic flood boundaries
- Return period flood boundaries
- Areas prone to coastal flooding
- Watercourses
- Water bodies
- Gauging stations
- Urban areas
- Digital terrain data

WIS has two main concepts in its data storage system; features (entities) and attributes. A feature is any object a user wishes to describe; its description is recorded as a set of values for the various attributes which make up its description.

Appendix 1 shows a first draft data model for flood susceptibility data.

Sources of data

Described below are the sources for each type of data outlined in the data model and required for estimating flood susceptibility.

Postcode boundaries

Geoplan (UK) Ltd operates in association with the Royal Mail to maintain accurate postcode boundary files, which are available at the area, district and sector levels in digital form.

The data are available in three resolutions (high, medium and low) at three different levels (area, district and sector), in three different forms. Boundaries are available as closed, single line polygons or as line segments; point data are in the form of centroids. The boundaries have been digitised on OS base maps at 1:50000 scale. The data is updated every quarter, in line with the Royal Mail's Post Office Address File (PAF). New postcodes in London and Manchester have been digitised at 1:5000 and 1:10000 respectively.

The resolution of the data is as follows :

- high resolution — digitised from 1:50K maps, and for urban areas from 1:10K maps, following landmarks such as roads and rivers
- medium resolution — points closer than 200m are stripped out, but the nodes are retained
- low resolution — contains nodes, and the mid point of each segment, i.e. each line has only 3 points

Only high resolution boundaries are suitable, as many flood plain areas are smaller than 200 metres wide.

The cost for high resolution postcode sector, district and area boundaries for the whole of the UK is £3250, including free quarterly updates for the 1st year. Optional yearly maintainance updates can be purchased at 30% of the annual fee.

The data are available on disc or tape in several formats, BNA (a version of ASCII), DXF, ArcInfo export or MapInfo (Windows or DOS).

Postcode points

The Royal Mail maintains Postcode Address Files (PAF), which contain all the postal addresses in the UK. Each address or group of addresses is assigned a postcode at unit level and a National Grid Reference (NGR). There are typically 15 houses in a unit postcode, but there can be as many as 99 houses. The NGRs are to the nearest 100m, so many postcodes can have the same grid reference. A postcode with a large area can appear more than once, depending on how addresses are grouped (e.g. 1-3, George Street, 4-11 George Street, etc) in which case there may be many grid references for a given postcode.

The Royal Mail holds a computer package called POSTZON. This contains addresses, postcodes and grid references for the whole of the UK, i.e 1.8 million postcodes and their addresses to the nearest 100m. It is available on magnetic tape and IBM 3480 cartridge tape. The initial cost for the UK data is £2500, with an annual licence fee of £50/user. The cost of a postcode area is £50, and the same licence fee applies. The minimum charge is £600, which equates to 12 postcode areas.

Geoplan also supply POSTZON for an initial cost of £950, with free updates every 3 months for the first year. Subsequent yearly updates cost 30% of the annual fee.

Another Royal Mail product is Address Manager, which contains interactive software to look at postcodes and retrieve NGRs. The data required can be extracted and exported for one's own use. The cost for the product is £1250.

Flood plain data

Background

Flood data is available from several sources, but the nature of the data available depends not only on the geographic area but the history of responsibility for flood defences.

The National Rivers Authority (NRA) covers the whole of England and Wales, and is split into eight regions (previously ten regions). One of its functions is to build and maintain flood defences. Work to identify flood plain boundaries and flooded areas has taken place over the years.

No similar authority exists in Scotland, as the organisational structure of water services in Scotland is different from that in the rest of the UK. Seven River Purification Boards (RPBs) are responsible for river pollution prevention; they also give out flood warnings, but have no powers with respect to flood defence. Regional Councils are responsible for water supply and sewerage. There are 3 islands regional councils which have the same responsibilities as the RPBs and Regional Councils combined.

The regional councils have powers given by various Local Authority Acts to promote flood defence schemes, but these are permissive, not mandatory, and only apply in urban areas. The councils are only responsible for sea defences where they have carried out sea

defence work in the past. In rural areas and elsewhere in coastal areas, responsibility is vested in the riparian owner. The councils may keep some data where they maintain any flood defences, but this is sparse.

Below is a list of available flood plain data; see Appendix 2 for further details and for more information on flood defence within the UK, and for a more detailed description of the data available from each source.

Historic flood boundaries (fluvial)

The boundaries of areas historically prone to flooding are available on Section 24/5 flood plain maps which are prepared and held by the NRA. These exist in paper form at a variety of scales but mainly 1:50000 and 1:25000. More recent flood plain maps also exist at a variety of scales. NRA Anglian, Severn Trent and Thames regions have some digital data. The appendices contain details of the data available and, where known, the cost of purchasing the maps. However, it is understood from Lindsay Pickles, responsible for flood defence at NRA Headquarters in Bristol, that it may be possible to gain access to them for digitising without the need to buy them.

A re-insurance broker, Alexander Howden, has been given permission to digitise the fluvial boundaries, and is expected to start work after April 1995.

Historic flood boundaries (coastal)

The situation is similar to that for fluvial flood boundaries, except that Howdens have been digitising the coastal boundaries from all eight regions and expect to finish this work in April 1995.

Return period boundaries

The NRA is currently considering how to meet the requirements of DoE Circular 30/92: Development and Flood Risk. This document provides guidance to planning and other authorities on measures to be taken to alleviate flood risk. It advises planning authorities to direct development away from flood risk areas and requires the NRA to liaise with planners to this end.

The NRA are required by Section 105(2) of the Water Resources Act 1991, to carry out surveys in order to carry out its flood defence duties. The NRA will carry out surveys of all main rivers and ordinary rivers; the output is likely to be flood risk maps, showing a measure of the risk associated with each area, probably in the form of a return period, typically 1:20, 1:50, 1:100 or 1:200 years. Some areas have been mapped already but considerable doubts have been expressed about the validity of the boundaries.

IH has been commissioned by MAFF to use its 50x50m digital terrain model together with flow and level records to obtain a 1:100 year flood boundary for the whole of England and Wales, at the 1:2 million scale. The work deliberately ignores flood defence

works. It is stressed that the current work aims to discover whether the methods applied can produce sufficiently accurate flood boundaries.

Flood prone coastal areas

The NRA carried out the Sea Defence Survey (SDS), which was based on a subjective assessment of the condition of sea defences. Data were collected on the condition of the defences, and maps were prepared showing the extent of the 1:200 year Graff level (i.e. area at risk of flooding) and flood defences at a scale of 1:25K. The survey was carried out in 1990 onwards, but updates to show new flood defences have not been done. Also, it should be recognised that the NRA has not been able to validate the data.

The SDS has now been superceded by the ABI/Halcrows study (1994), which identified areas at risk from coastal flooding in England and Wales. This does not use flooded area boundaries, but instead divides the coastal area into 1 km squares, giving each square a measure of risk and an indication of the depth of flooding to the nearest 0.5m.

The British Geological Survey (BGS) have recently developed the Geo-Hazard Susceptibility Package (GHASP), which was designed to help insurance underwriters assess risk from subsidence and thus reduce their losses. There are several areas of work either in hand or being considered which may be provide important data in future. These relate to different scale techniques for estimating accurate ground elevations over large areas. It is now being developed in relation to losses from coastal flooding.

Watercourses and water bodies

The Institute of Hydrology holds the digitised river network at the 1:50K scale for England, Wales and Scotland. The dataset includes rivers, canals and lakes. It is supplied in NTF on cartridge tape. The cost of supplying the rivers is £1/square kilometre; if the Digital Terrain Model (DTM) is also purchased, the combined cost is £3/square kilometre. There may be reductions for the bulk purchase of many regions.

Gauging stations and river flow data

These are held at the eight NRA regions for England and Wales and the seven RPBs for Scotland. They are also held in the National Water Archive at the Institute of Hydrology. Gauging station and flow data can be supplied by the Institute of Hydrology in National Transfer Format on cartridge tape. Data is charged at the rate of £10/gauging station/retrieval, with reductions for bulk purchases.

Urban areas

The Institute of Terrestrial Ecology (ITE) holds a 25m grid of land cover classifications. There are 26 land classes, two of which are urban and suburban. Each square on the grid has the value of the predominant land cover attached to it. In many respects the data are ideal for flood work and should enable priority areas to be identified. Disadvantages are the volume of data and the fact that some areas are incorrectly classified.

For the MAFF project, the data has been coarsened by ITE into a 50m grid to match the DTM. IH is investigating improved techniques for aggregating land cover data.

An alternative source of data is the OS 1:250K maps of urban areas, however this is slightly crude when computing flood susceptibility at the postcode level.

Digital terrain model

The Institute of Hydrology holds a digital terrain model. There is a 50m grid for each of height, inflow, outflow, cumulative area and surface type. These are supplied in NTF on cartridge tape. The cost of supplying the DTM and the watercourse network is £3/square kilometre. There may be reductions for bulk purchase of many regions.

Recommended data and sources

Postcode boundaries

Postcode sector boundaries should be acquired from Geoplan. At the time of writing, insurance data is usually only available down to the sector level. There are currently 9,500 postcode sectors for the UK, therefore an individual postcode sector will usually cover a wide geographical area, only a small proportion of which will be prone to flooding. If the area flooded needs to be identified either more generally or more precisely, then the postcode level used by the system will need to be broadened to the district level or narrowed to the unit level.

Postcode points

Grid references of postcode sectors should be acquired from Geoplan.

Flood plain data

Historic flood boundaries (fluvial)

Section 24/5 maps were prepared by the NRA in the mid-1970s across England and Wales and do not include flood defences. Since then, more floods have occurred and many more flood defences have been constructed. Therefore, the most recent flood plain maps (at the largest scale) should be acquired and digitised. Section 24/5 maps should be used where better data are not available. Most of the maps are available on paper only; the cheapest option would be to visit each NRA region and digitise their maps on site. Discussions with Ms Lindsey Pickles of the NRA (16th December, 1994) suggest that permission to do this would be given.

Very little data is available for Scotland; any data will come from the RPBs and/or Regional Councils. We suggest that IH Stirling be asked to investigate further the availability of records and whether or not we would be given permission to digitise them.

Historic flood boundaries (coastal)

It is recommended that Section 24/5 maps indicating coastal flooding are not taken from the NRA, as the maps are out of date, and further work has been carried out by Halcrows on flood risk in coastal areas. It is recommended that Jardines investigate how this data may be acquired through insurance industry channels.

Return period boundaries

Return period boundaries are not currently available from the NRA. However, the NRA are due to carry out development surveys and produce flood return period maps for several return periods, such as 1:20, 1:50 and 1:100 year floods. The NRA are currently planning and estimating the cost of this work which is due to take place over the next 5 years. The main rivers and development hotspots will be tackled first.

IH is also in the process of producing a 1:100 year flood boundary for England and Wales for MAFF. It has not yet been established whether the methods used will produce boundaries of sufficient accuracy, but if this should prove to be the case, it is recommended that this work be considered for Phase II.

Flood prone coastal areas

Historical flood boundaries (1:200 year Graff levels) are available on paper from the NRA, and could be digitised by IH with the NRA's agreement. Alternatively, the ABI hold flood risk classification data and estimated flood levels for 1 km squares along the English and Welsh coast. This is the recommended source, as the data is up to date. Contact should be maintained with BGS who are considering improving the current data.

It is recommended to keep up to date with any developments of BGS's package GHASP in relation to coastal flooding work; they are also considering improving the current Halcrows/ABI data.

Watercourses and water bodies

The digital river network for the UK including water bodies should be acquired from IH. There would be no charge if the masterfile were to be created at IH.

Gauging stations

The gauging stations and their daily mean flows should be acquired from IH. There would be no charge if the data were used at IH.

Urban areas

The urban land use classification grid should be acquired from ITE, Monkswood. There would be no charge if the data were used at IH.

Digital terrain model

The digital terrain model grids should be acquired from IH. There would be no charge if the data were used at IH.

Software

Figure 3.1 showed the proposed system as having two major components; the Master File Generator and the Portfolio Utility. Figure 3.2 expands on this to show the details of the Master File Generator. There are four steps in the production of a master file:

- convert flood and postcode data into a suitable format for loading into WIS
- load the converted data into WIS
- tidy the loaded data e.g. ensure that flood boundaries are made of polygons
- master file production

Figures 3.3 and 3.4 show the evolution of the system as new data types are added. The remainder of this section outlines the functionality of each component.

Figure 3.2 - Proposed Functional System Design - Phase I

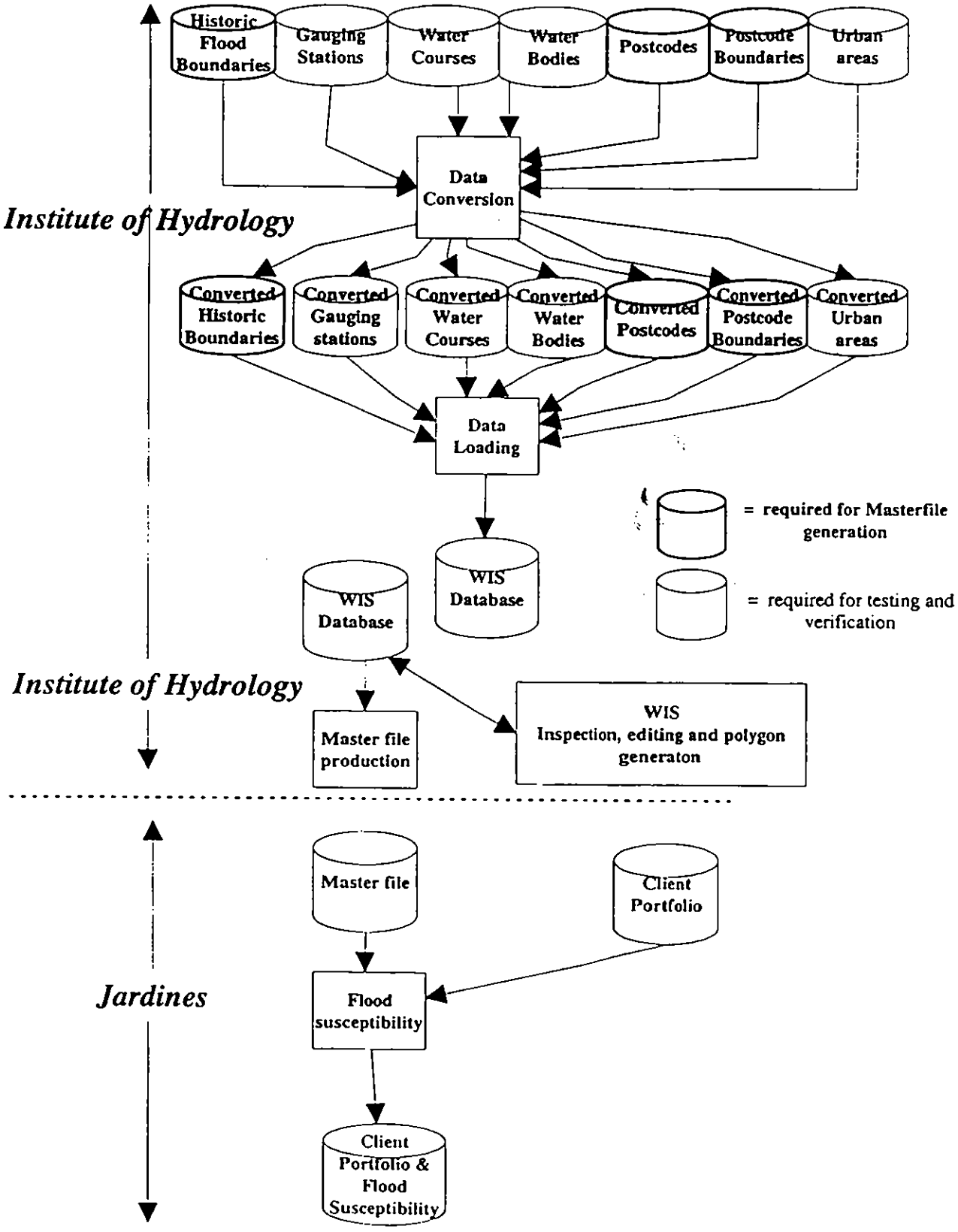


Figure 3.3 - Proposed Functional System Design - Phase 2 additions

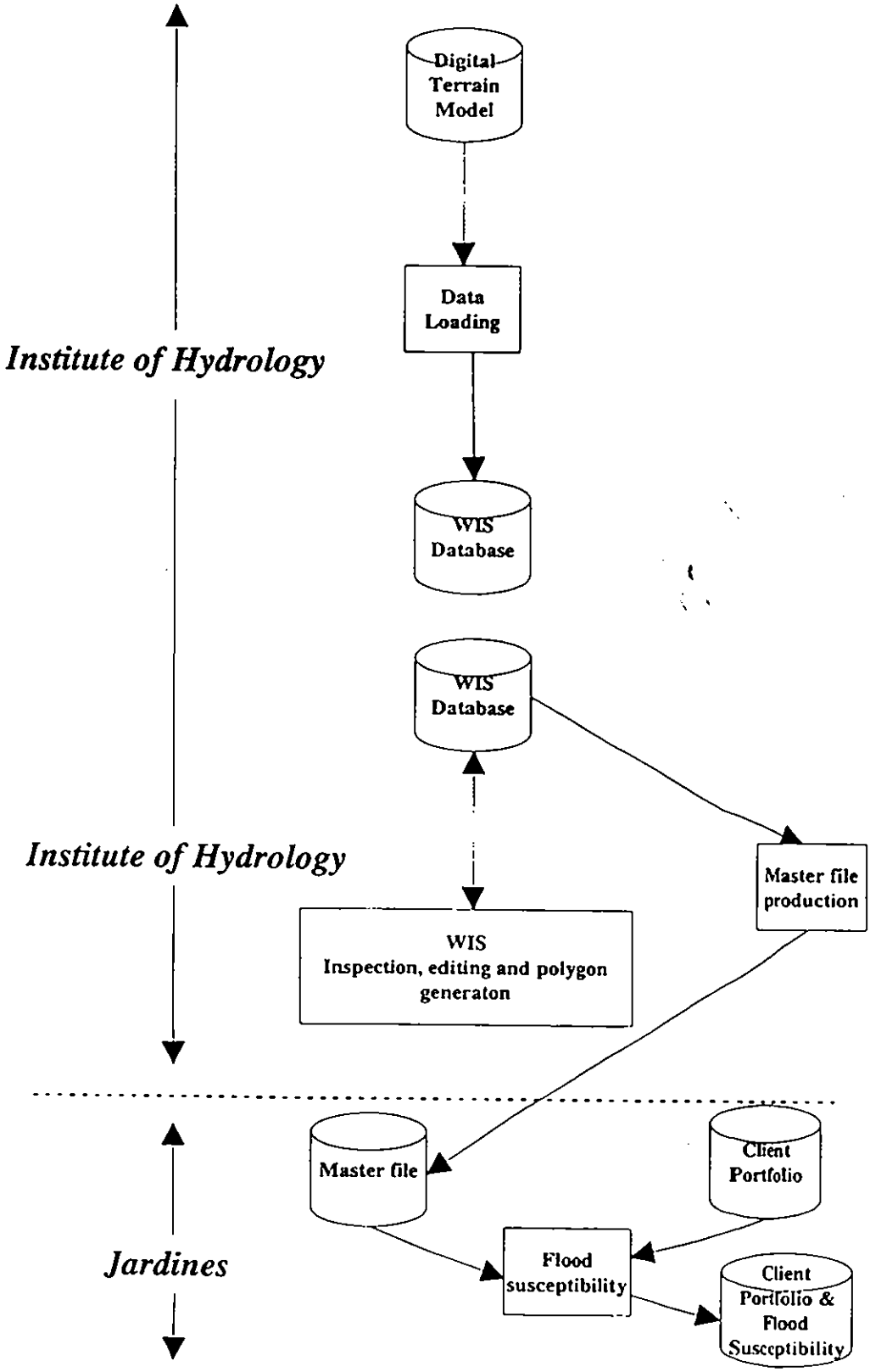
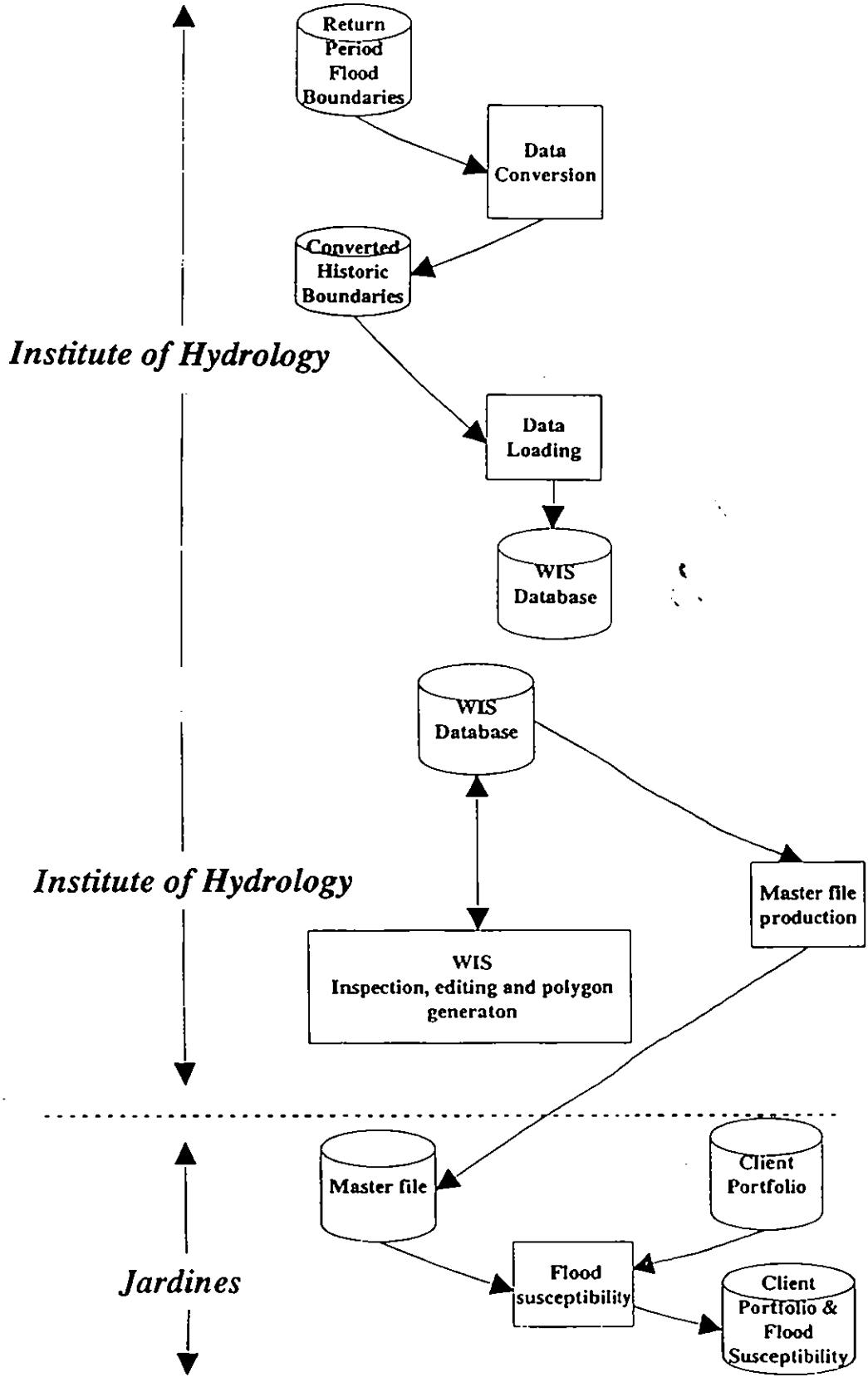


Figure 3.4 - Proposed Functional System Design - Phase 3 additions



Data conversion software

At the time of writing, WIS can only accept high volume data in National Transfer Format[1]. Therefore, loading data from external systems into WIS is usually a two stage process:

- convert the data from the supplier's format to National Transfer Format (NTF)
- load the data into WIS using the NTF-WIS load facility

The main inputs, processes and outputs of the conversion to the NTF standard are set out below.

Inputs:

- the supplier's data files
- look-up tables for any conversions that cannot be performed by NTF-WIS

Processing:

- map the data from the suppliers data model to the Flood Susceptibility System's data model.

- perform conversions to the data values outside the capability of NTF-WIS. The historic flood boundary data will arrive from various regions of the National Rivers Authority, Regional Councils and River Purification Boards. As yet none of the supplying organisations have any facilities for converting these files to NTF. It will therefore be necessary to design and write one general program or several (say four to six) format-specific programs to convert the data into an NTF format suitable for loading into WIS.

Outputs:

- a report of any data errors
- a summary of the data loaded
- the data in NTF

The program(s) will convert the historic flood boundary data by creating an output file containing the relevant NTF header records, followed by the NTF records necessary to describe each flood boundary as a polygon.

The postcode data provided by the Post Office will also be converted into NTF format by a similar process.

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[1] This is about to be extended to include facilities for loading time-series data in tabular form in 'comma separated variable' (CSV) files.

Data load software

The converted data will be loaded into WIS via the existing application NTF-WIS.

The input comprises:

- the data in NTF format
- a set of look up tables for translating feature type codes, dictionary codes and attribute codes

The processing has four main functions:

- to check the format of the NTF file data
- to perform conversions on feature type and attribute codes and values
- to make logical checks on the data and report unlikely values
- to update the database

The output comprises:

- an updated database
- an error report
- an update report on changes to the database

Validation software

It is likely there will be errors in the data beyond those which can be identified by the standard tests in the WIS data load program. Existing IH spatial validation software will be upgraded and used for this purpose.

The inputs comprise:

- the WIS database

The processing comprises tests for:

- 'knots'
- incomplete polygons
- imperfect nodes

The output comprises:

- a validation report

Editing software

The WIS Time-series and Spatial Editors will be used to correct and make minor updates to the data.

Polygon generation software

If the boundary data are not delivered as simple polygons, it is proposed to use Chiltern Digitising Services Polygon Builder to produce polygons from the supplied data.

Master file generation software

The inputs comprise:

- the WIS database

The processing for the Phase I requirement comprises:

- initialise
- sort the boundaries into order by size
- process the postcode points and find the boundaries that contain each point
- derive/compute characteristics for each point
- aggregate the output to the sector level

The outputs comprise:

- a file containing, for each postcode:
  - known historic river flooding:

    {YES | NO}

  - dates of historic river flooding:

    {No known river flooding | Unknown | date}[,{Unknown | date}]...

  - fraction of postcode area known to have flooded at sometime.

  - similar parameters for coastal flooding, to be defined when the available data are known. ABI data has been assumed for costing purposes.

Portfolio Utility software

The Portfolio Utility will be a PC based program run by the end user to add flood susceptibility data to a client's portfolio.

The input comprises:

- the filename of the file containing the client's portfolio
- the filename for the file to contain the updated client's portfolio

- the column containing the postcodes
- a list of the characteristics to be added to the client's portfolio data

The processing comprises:

- initialisation
- checking that the postcode column contains valid postcodes
- checking that the columns for results are empty
- adding the data from the Master File to the portfolio

The output comprises:

- an updated client portfolio
- a message to indicate that processing is complete

It is assumed that this output will be the input to one or more spreadsheets which perform the required 'insurance calculations' and which print a portfolio analysis.

Hardware required

To run the Portfolio Utility Jardines will require:

- a 66Mhz 486 PC, 4 - 8 Mbytes RAM and 100 - 200 Mbytes disc (accurate disc space estimates are difficult at this point).

For development IH will require:

- SUN SPARC 10 with 32 Mbyte RAM and 1 Gbyte of working disc space.
- access to the IH database server and 1 Gbyte of database disc space
- a 486 PC, 4 - 8 Mbytes RAM and 300 Mbytes disc or access to the IH file server (accurate disc space estimates are difficult at this point).

Software required

To run the Portfolio Utility Jardines will require:

- Windows
- DOS
- Microsoft Office (recommended)

For development IH will require:

- access to the IH database server and 1 Gbyte of database disc space
- Visual C++/Visual Basic Professional
- ODBC/Gupta
- all normal office and development software
- Oracle licences

- Oracle SQLnet
- Pro*C
- Pro*Fortran
- WIS licence
- IH spatial validation software
- Chiltern Digitising Services PC Map Editor
- Chiltern Digitising Services PC Polygon Builder

Supporting services

Optional services

Any service referred to as an 'optional service' is not included as part of the system but may be included if required by Jardines at an increase to the quoted system price.

Demonstration

A demonstration of the geographical information system used to create the user master file is available at the Institute of Hydrology. The demonstration will show in detail the data acquired on Jardines' behalf by overlaying postcodes, postcode boundaries, urban areas, watercourses, water bodies, historic flood boundaries and gauging stations on a UK outline.

Installation

The Portfolio Utility will be installed at Jardine's London offices. It is assumed that a 486 PC with DOS and Windows installed and sufficient spare disk space for the storage of the master file and applications will be available.

As an optional service the Institute of Hydrology will provide assistance in obtaining and installing or preparing current hardware at Jardines ready for the installation of the Portfolio Utility.

Training

Training in the operation of the Portfolio Utility will be provided for up to three Jardine employees. Training will take place on the same day as the installation and continue until the end of the working day. Any further training required by Jardines for their employees is available as an optional service.

Software support

Software support is available to Jardines during working hours for a three month period after the application has been installed. During this period, any bugs reported will be fixed free of charge. As an optional service, software support may be extended past the initial three month period to a level of cover required by Jardines.

Functional enhancements

As an optional service the Institute of Hydrology is available to produce a design and cost any functional enhancements to the system that may be required. Possible enhancements already discussed include links to external packages, e.g. MapInfo.

Data consultancy

As an optional service, the Institute of Hydrology will compile an annual report of available and anticipated data sets, and any other developments in the field that might be useful. Included in the report will be an indication of the benefits to Jardines, required enhancements to the system and the costs to complete the enhancements. It will also include a statement about any new releases of the operating system or database software which are significant.

Chapter 4

Project plan

A project plan (Appendix 4) has been assembled to indicate the tasks required to complete the Flood Susceptibility System. The major tasks have been described in terms of the steps, resources and duration needed to complete them. This section briefly describes each task.

Detailed specification

The outline plans presented in this report will be developed into full specifications and costed. These will cover both program specifications, data acquisition procedures and, if required, maintenance procedures. On completion of the work, there would be the opportunity to review the project, should the detailed analysis reveal problems as yet uncovered. This work would provide the basis for the final contract.

Should Jardines wish to see an example of the type of work to be undertaken here, they are welcome to see the documentation prepared for IH/ICL National Power Project. Although this was a much larger project, the nature of the work is similar.

Project startup

The first task of the project will be to assemble a project team and acquire the necessary development resources described in the Hardware and Software sections of Chapter 3. System development can then proceed.

Database

The data model describing the Flood Susceptibility System data will be finalised, loaded into WIS and documented.

The data sources, formats and acquisition processes will be checked and draft agreements prepared for the acquisition of the data.

Data acquisition

The data required by the system will be acquired from the sources identified in the data survey. Data acquisition will be a significant task.

Produce software

Four distinct groups of software items will be written, tested and documented as individual sub-systems before being joined to form the final solution. The main sub-systems are:

- the software necessary to convert the source data into NTF format; this will be developed for every format of data received. Potentially, different conversion software may be required for each of the eight NRA regions, seven RPBs, twelve Regional Councils and also for each of the postcode sector and postcode boundary data sets. However, the actual number is likely to be much less, probably around half a dozen (e.g. NTF, Arc, Intergraph, Laserscan, MapInfo, Spans and DXF), as there are a relatively small number of interchange formats for spatial data, mainly determined by the available GIS systems. For some of these, conversion software will already exist.

- specialist software to ensure that the loaded flood and postcode boundaries do not contain errors.

- software to produce the master file of postcodes and flood susceptibility by comparing postcodes with flood boundaries.

- the Portfolio Utility software to update client portfolios with flood susceptibility data.

Data conversion and load

The source data will be converted into NTF by the bespoke conversion programs and loaded into WIS. This will be repeated for every flood and postcode data file received.

The master file of postcodes and associated flood susceptibility data will be created via WIS and the results will be tested to ensure accuracy.

The Flood Susceptibility System composed of the different sub-systems will be tested as a whole to ensure that all parts of the solution work together to produce correct and consistent results within the limitations of the data.

Supply masterfile and utility

The Portfolio Utility and master file will be installed on a suitable PC at Jardines where the utility will be demonstrated and the rest of the working day given to training.

Chapter 5

Budgetary costs

The budgetary costs for Phase I are set out below under the same headings as the Project Plan. Brief descriptions of various elements are given in the subsequent paragraphs.

Detailed Specification (1)		£17,350	
Project			
Startup (2)	£ 975		
Management (-)	£23,200		
		£24,175	s
Database (3)		£ 3,275	s
Data Acquisition (4)			
Postcodes	£ 4,200		
Flood boundaries	£42,000		
IH data	£ nil		
		£46,200	d
Produce software		£19,100	s
Data conversion and load		£11,400	d
Supply masterfile and utility		£ 1,400	s
Support (3 months)		£ 3,000	s
Facilities at IH			
Database Licence	£ nil		
Other Software Licences	£ 2,000		
WIS licence	£ 4,500		
Development Hardware	£15,000		
		£21,500	s
Facilities at Jardines (Allowance if suitable PC not available)			
PC & s/w	£2,000		
Spreadsheet	£ 300		
		£ 2,300	s
Flood Susceptibility System		**£149,700**	

(Items marked 's' are system costs; those marked 'd' are data costs.)

Ongoing Charges		
WIS licence	£1,125	
Postcode updates	£ 975	
Support & Maintenance	£4,200	
Data Consultancy Service	£2,000	
Annual Charge		£8,300

Detailed specification of the data and programs must be completed before any programs are written. Agreements also need to be negotiated with data suppliers.

Project costs cover project setup and also its management to meet agreed cost and time parameters.

The database must be setup and documented ready for the development and implementation of the proposed system.

Data acquisition costs cover the price paid for all postcode and flood boundary information from the NRA and other sources, as set out elsewhere in this report, and include digitising the flood boundaries from those maps that are only in paper form. Note that it is not possible to finalise the data acquisition costs until all the maps have been obtained as the suppliers do not know how many exist. Therefore this figure is an estimate based on extrapolations of the information already available. It is assumed that the suppliers' original maps will be digitised on their premises to avoid having to pay the substantial costs of making paper copies. The NRA have indicated informally that there will be no charge for access to their maps, but they may demand a copy of the digitised data in return. Urban data and digital river data already held by the Institute of Hydrology will be provided at no cost.

The software to be developed is described in Chapter 5. After testing it will be used for data conversion. This comprises the final formatting and perhaps detailed adjustment of some maps, and the checking of all of them. Finally the system can be used to generate the masterfile.

Implementation comprises installing the masterfile and Portfolio Utility at Jardines and training in their use. It is assumed that a test client portfolio will be provided and that the spreadsheet to calculate the portfolio analysis has been built and tested by Jardines.

Support will be provided for three months after implementation to resolve any difficulties.

The facilities at the Institute of Hydrology comprise the software and hardware that will be used to develop the system and subsequently to maintain it. It is assumed that, apart from the WIS licence, these items will be purchased outright and will attract no maintenance charges. The items are Unix, utility and language software, and a workstation with appropriate disc capacity. The Institute has an Oracle database licence so this item has no cost.

The facilities at Jardines are given as an allowance, assuming a suitable PC is not already available and are for a conventional 486 PC with DOS, etc. and a spreadsheet.

The ongoing charges comprise the WIS licence, and a support & maintenance charge. This includes maintaining the availability of the data and related software, minor software upgrades and any hardware maintenance. It does not cover major software changes or enhancements to cater for new operating system or database releases or to process new or changed flood or other data. The implications of such changes will be discussed and any resulting actions agreed with Jardines.

The proposed Data Consultancy service is optional but has been included to give a complete price.

Chapter 6

Next steps

The report has described the feasibility of implementing a computer system to associate flood susceptibility to postcode sectors. A number of issues have been identified during the study which IH/ICL would like to discuss with Jardines before progressing to the next stage. These are:

- is the suggestion of a two part system acceptable to Jardines and do they feel it offers them a practical method of operation?
- the issues of ownership, copyright, intellectual property rights and the passing of data to third parties need to be discussed
- the acquisition of historical river flood boundaries
- the possibility of combining with others to share the costs might be considered
- the required relationship to GHASP
- what is the reason for developing the system : market edge or loss avoidance? The answer may influence the approach to the development of the system.

If the findings are acceptable and these issues can be agreed, then the next step is to specify each item in detail so that the budgetary prices may be translated into firm offers. This is likely to take three to four weeks.

Chapter 7

Suggestions for future work

During the course of the study, a number of areas where future work might be beneficial have emerged. These are:

- extending the system to operate at the unit postcode or individual property level
- extending the system to commercial property
- adding flood defence data
- closer collaboration with GHASP
- the detailed specification of Phases II and III.

Appendix 1

Draft data model

Listed below are the types of features and their attributes required for estimating flood susceptibility. The list will be refined at the next stage of the development process. Items marked with an asterisk are required for the first phase.

- Postcode boundaries *

  Postcode
  Coordinates of boundary

- Postcode points *

  Postcode
  Coordinate of point
  Other attributes could be included here from the PAF file

- Historic flood boundaries *

  Date of flooding if known
  Coordinates of boundary

- Return period flood boundaries

  Date of flooding if known
  Coordinates of boundary
  Return period of flooding

- Flood prone coastal areas *

  Date of flooding if known
  Coordinates of boundary
  Return period of flooding
  Depth of flooding for N-year period flood

- Watercourses

  Coordinates of river centre line

- Water bodies

  Coordinates of shoreline

- Gauging stations

  Name
  ID
  Coordinates of gauging station
  Daily mean flow

- Urban areas *

  Extent of urban area (rasterised)

- Digital terrain data

  The five IH grids:
  - Height
  - Inflow
  - Outflow
  - Cumulative area
  - Surface type

Appendix 2

Flood defence in the UK

Flood defence in England and Wales

The National Rivers Authority (NRA) covers the whole of England and Wales, and is split into eight regions (previously ten regions). One of its functions is to build and maintain flood defences.

Historical flood boundaries

Section 24/5 maps

In general, the only comprehensive survey of those areas which may be susceptible to flooding was compiled in the late 1970's under the (then) Water Act 1973 (Section 24(5)) and now superseded by Section 105(2) of the Water Resources Act 1991. The survey identified land in the flood plain, which is defined as those areas which have been known to have been subject to inundation by flooding from rivers or the sea or by overtopping or breaching of river flood banks and sea defences. The scale of the maps was typically 1:50K, but varied between regions.

However, the survey wasn't definitive of the land or area which might be flooded. Moreover, it was not always practicable to show flood plains within a 50 metre margin of either side of river or stream. It must be assumed therefore, in referring to the maps in the survey report, that a flood plain can exist within these limits even though it is not shown. Comprehensive updating of the survey has not generally been carried out.

Later maps

The Section 24/5 maps have not been systematically updated. Some regions hold 1:25K and/or 1:10K maps covering all or most of the region; others have carried out updates on an adhoc basis.

Alexander Howden have recently taken copies of Section 24/5 maps from all 8 regions of the NRA. These are understood to be a mixture of the original 1970s maps and later maps, the maps and scale varying between regions. The coastal boundaries are being digitised and are expected to be completed by April 1995, after which point work will be started to digitise the fluvial boundaries.

Our original understanding was that Howdens would digitise the boundaries, then give the digital data to the NRA to be placed in the public domain. However, no agreement has yet been reached between the two organisations.

Return period flood boundaries

NRA Flood Risk Surveys

The NRA are required by Section 105(2) of the Water Resources Act (1991) to carry out flood risk surveys; the NRA's Strategy for Flood Defence states that the requirement will be met by carrying out surveys of all main rivers and ordinary rivers to provide information on land at risk from flooding. They expect to produce flood risk maps showing return period boundaries.

The DoE's Circular 30/92 on Development and Flood Risk requires the NRA to liaise with planning authorities to ensure developments are directed away from flood risk areas, with the aid of those flood risk surveys for Section 105(2).

The NRA has produced a memorandum of understanding, which recognises the current shortfall in flood risk data, accepts the sound objectives of 30/92, but states that it has a resource problem in trying to meet these objectives. The NRA is currently assessing the cost of carrying out flood risk surveys, and this is expected to be completed by the end of 1994. The surveys have been set a 5 year timescale, and data collection is due to start in 1995. Each region is currently estimating the cost of producing flood risk maps over 5 years. Maps of main rivers and development hotspots will be produced first.

IH/MAFF Flood Risk Areas

The Institute of Hydrology has been commissioned by MAFF to produce flood risk areas of England and Wales. The aims of the project are :

- to produce a 1:2,000,000 scale map from the 1:50,000 scale digital terrain model which shows the extent of the 1:100 year floodplain and its relation to urban areas. This will initially show the original floodplain assuming no flood defences exist.
- to estimate the area at risk and the urban fraction within it.
- to determine whether this method is sufficiently accurate to estimate flooded areas.

Over 5% of the population of England and Wales live below the 5m contour; this represents 8000 square kilometres, much of which is protected by sea defences. The project will produce a flood risk map showing urban areas at risk of flooding.

The first version is expected to be ready in January; the model will then be tested against known flood plain boundaries from each NRA region and refined accordingly. The model will exaggerate areas at risk from flooding, as each square shows the predominant land cover.

The data required are :

- IH digital terrain model, 5 50m grids (inflow, outflow, elevation, cumulative catchment area, surface type).
- ITE land cover 25m grid. The raw data is a 25m grid, but this has been coarsened into a 50m grid to match the scale of the DTM.

Flood prone coastal areas

NRA Sea Defence Survey

Also available for public access is the Sea Defence Survey NRA's which was launched following the identification of the need highlighted by the flooding incident in Towyn in February 1990 and was built upon the previous National Survey of Sea Defences carried out by Herlihey in 1980.

The Sea Defence Survey was based on a subjective assessment of the condition of defences. Data were collected, documented and a database populated by Consultants on behalf of the NRA. The Sea Defence Survey is considered to be a useful snapshot in time but should be recognised as not being a living document. Also it should be recognised that the NRA has not been able to validate the data collected. Coastal defence maps, the result of the Sea Defence Survey, show the 1:200yr Graff levels and flood defences, at a scale of 1:25K.

Halcrows and the Association of British Insurers (ABI)

Halcrows has recently carried out the report 'Identification of Coastal Flood Areas in England and Wales' in association with the Association of British Insurers (ABI). This is an assessment of coastal flood risk for the insurance industry. Its aim was to identify flood prone areas and classify them according to three bands of risk, 1, 2 and 3, corresponding to return periods of 50, 100 and 200 years respectively. The study was restricted to sea defences and made use of the NRA's Sea Defence Survey (SDS) data for England and Wales.

The data can be provided on 10x10km paper maps showing, for each 1x1km square at risk, the risk bands, depth of flooding, postal sectors and an indication of changed flood risk in 50 years time due to estimated sea level rise. The maps are contained in 5 books, cost £2500 for the set and are available to the public. The ABI has a licence from the OS to reproduce these maps, provided they are for the ABI's members' business and internal use only.The maps are protected by Crown Copyright, and reproduction is by agreement with the Controller of Her Majesty's Stationery Office and the ABI.

The data can also be provided on disc in several formats: ASCII, CAD vector graphic file (DXF or DGN formats), Map Info data files, Modular GIS Environment data files. These are not subject to Crown Copyright and no OS permission is required for their use. The cost of supply of the data in a digital form is not yet known; this data is only available to ABI members.[2]

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[2] ABI members are defined as those companies which have been granted a licence by the Department of Trade and Industry to provide insurance cover. This includes insurance companies, re-insurance companies, but *not* re-insurance brokers, i.e. not Jardines or Alexander Howden. The ABI has provided the data in digital form free of charge to all its members; this however is *not* available to others.

BGS and GHASP

The Geo-Hazard Susceptibility Package has been developed by BGS in collaboration with Geographical Information Systems (GIS) Ltd, to help insurance underwriters make better assessments of the risks from subsidence. The objectives were :

- to aid the insurance industry in establishing more accurate and detailed buildings and insurance ratings
- to give underwriters a better understanding of their detailed exposure to the risks of subsidence
- to help insurers identify the type of subsidence in each claim

BGS are now developing GHASP as an aid to insurers when assessing flood risk.

The following table shows the available flood data across England and Wales.

TABLE 1: FLOOD DATA AVAILABILITY IN ENGLAND AND WALES

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
NRA Anglian	Historical flood boundaries (fluvial)	Section 24/5 maps, 1:50K	Whole region	22 paper maps		
	Historical flood boundaries (fluvial)	Section 24/5 maps, 1:50K	Whole region	34 digitised sheets - disc or xabyte tape, UNIX tar or CPIO format		Subject to OS copyright charges
	Historical flood boundaries (coastal)	Section 24/5 maps, 1:50K	Coastal part of region	Paper		
	Historical flood boundaries (fluvial and coastal)	Flood boundaries	Essex	Digital - disc or xabyte tape, UNIX tar or CPIO format		Subject to OS copyright charges
	Return periods : 30/92 survey	Areas at risk of flooding				

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	SDS	Flood plain maps, >1990, 1:50K		Paper maps, conditions in digital format (on datacase database)		
NRA Northumbria and Yorkshire	Historical flood boundaries	Section 24/5 maps, 1:25K (N) 1:50K (Y), 1980, with updates	Whole region, including main and other rivers	Paper (A2)		£150/sheet
	SDS	Flooded areas maps, 1:200 yr Graff level, 1:25K, >1990		Paper (A3,A4)		£150/sheet
	Return periods : 30/92 survey	Areas at risk of flooding, 1:20, 1:50, 1:100 yr boundaries	Work just started, to cover whole region, starting with main rivers	No means to provide the data		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
NRA North West	Historical flood boundaries	Section 24/5, 1:50K, worst flood or 1:100yr flood (fluvial), 1:200 yr Graff level (coastal)	Both fluvial and coastal, whole region, <= 1976	Paper maps	Plans to digitise, expected to be completed by June 1995	£150/sheet (1:25K)
	Historical flood boundaries	Flood plain maps, 1:25K, worst flood or 1:100yr flood (fluvial), 1:200 yr Graff level (coastal)	Both fluvial and coastal, whole region, 1991	~ 104 A1/A2 paper maps	Plans to digitise, expected to be completed by June 1995	£150/sheet (1:25K)
	Historical flood boundaries	Flood plain maps, 1:10K, worst flood or 1:100yr flood (fluvial), 1:200 yr Graff level (coastal)	Both fluvial and coastal, whole region	~ 680 A1/A2 paper maps	Plans to digitise, expected to be completed by June 1995	>= £150/sheet (1:10K)

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	SDS	Flood plain maps, 1:25K, 1:200 yr Graff level (coastal)	Whole region (1:25K)	~ 200-300 A4 paper maps (7 A4 volumes), sea defence information database		£150/sheet (1:25K)
	Return periods : 30/92 survey	Flood envelopes (return periods), 1:100yr, perhaps 1:50 yr flood, 1:10K (rural), 1:2500 / 1:1250 (urban)	Whole region, main rivers, then development hotspots, etc		Plans to start work and digitise over next 5 years	
	Historical flood boundaries	Representative flood risk areas, 1:100K, 1:250K	Whole region		NW plans to digitise maps in future	
NRA Severn Trent	Historical flood boundaries	Section 24/5 maps, 1:25K, fluvial only	Main rivers (22% accurate and valid) (~ 1979)	~ 250 paper maps		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Historical flood boundaries	Flood plain maps, 1:25K, 1:10K, 1:2500, 1:1250	Rural (1:10K), urban (1:2500, 1:1250)	Some paper, small proportion scanned raster (e.g. Severn Valley at 1:10K) (AutoCAD)		
	SDS	Little or no data, as ST region has very little coastline				
	Return periods : 30/92 survey	Flood plain boundaries, including 0.5m contours from aerial photos and land surveys		Mostly paper maps, some digital but not available for publication as yet		Cost estimation in 1994, data collection due to start in 1995, £2500 / sq km aerial survey
NRA Southern	Historical flood boundaries	Section 24/5 maps, 1:25K	pre-1973	Paper (47 A2 - A0 sheets)		£7050
	Historical flood boundaries	Flood plain maps, 1:10K	Patchy			
	SDS	Text descriptions only		Paper, 4 volumes		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Tidal level contours	IDE levels (similar to 1:200 yr Graf levels)	1989	Paper		
	Return periods : 30/92 survey					
NRA South Western	Historical flood boundaries	Section 24/5 maps, 1:100K (Southern), 1:50K (Wessex)	Patchy - not all main rivers - note only 10% of SW is urban	Paper		
	Historical flood boundaries	Flood plains (1:50K)		Paper		
	SDS	Flooded areas, 1:200 year, 1:25K	1990-93	Paper		
	Return periods : 30/92 survey					
NRA Thames	Historical flood boundaries	Section 24/5 flood plain maps (fluvial), 1:625K	Whole region, excluding London, mid 1970s	Paper		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Historical flood boundaries	Variety of scales: 1:10K, 1:25K, 1:1250, 1:2500	Most of region, all main rivers, including Thames coastal lowlands and London, not including sea defences built to withstand the 100 year flood event	Paper maps, some digital data on cartridge tape or disc (vectorised boundaries, some polygons) on SPANS ASCII or DXF format	Clean up data and polygonise if necessary	£250/day (staff time)
	Land drainage bylaw map	Worst actual floods, 1:25K	Whole region (excluding London), 1986	Paper maps, some digital data on cartridge tape or disc (vectorised boundaries, some polygons) on SPANS ASCII or DXF format	Clean up data and polygonise if necessary	Paper maps: £5/day
	Flooded areas	1:250K	not including London	Paper maps		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Return periods	several RPs, e.g. 1:5, 1:20, 1:50, 1:100 years, 1:10K scale	Oxford region, Maidenhead	Paper maps, some digital data on cartridge tape or disc (vectorised boundaries, some polygons) on SPANS ASCII or DXF format	Clean up data and polygonise if necessary	£250/day
	Return periods	several RPs, e.g. 1:50, 1:100, 1:1000 years, 1:10K scale	London region	Paper maps, some digital data on cartridge tape or disc (vectorised boundaries, some polygons) on SPANS ASCII or DXF format	Clean up data and polygonise if necessary	£250/day
	SDS	Flooded areas, 1:1250 scale, 1:1000 yr, 1:100 yr, maybe 1:200 year	Tidal Thames (to region limit, near R. Darent) and tidal rivers	Paper/ transparency		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Return periods : 30/92 survey	Return periods, 1:100 year, 1:10 year,	Urban : 1:10K, rural : 1:25K	Expected to be digital, not necessarily on same GIS		
NRA Welsh	Historical flood boundaries					
	Historical flood boundaries	Flood plain maps, 1:2500, 1:10K	Mostly urban areas, incomplete coverage of main rivers	Paper maps		
	SDS	Flood plain maps, 1:25K		90 A3 paper maps		
	Coastal flood plains	1:100K		40 A3 paper maps	Being prepared	
	Return periods : 30/92 survey					
IH	Historical flood boundaries			Paper		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Return periods	Flood return period boundaries (1:50K), generated with DTM	England and Wales	Digital	Project carried out under contract to MAFF, started Oct. '94, expected completion, Jan. '94	
	Land Drainage flood plain maps	Flood plain boundaries, 1:50K	England and Wales	Paper		
Halcrows	1 km square flood risk and depth of flooding	Flood risk and depth of flooding, current status and 50 years hence	Sea defences for English and Welsh coast	Paper maps		£2500 (paper maps)
	1 km square flood risk and depth of flooding	Flood risk and depth of flooding, current status and 50 years hence	Sea defences for English and Welsh coast	Digital (raster) data		Unknown

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
Alexander Howden	Historical flood boundaries	NRA Section 24/5 maps, 1:25K, 1:10K	Half regions have 1:10K data		Work due to start in April 1995	
	SDS	NRA Sea Defence Survey maps, 1:25K	Dependent on each region	Digital	Expected completion : April 1995	

Flood defence in Scotland

The organisational structure of water services in Scotland is different from that in the rest of the UK. River Purification Boards are responsible for river pollution and prevention; regional councils are responsible for water supply and sewerage. The 3 islands councils have the same responsibilities as the RPBs and Regional Councils combined. The Central Scotland Water Development Board is responsible for water supply to Central, Fife, Lothian, Strathclyde and Tayside regions.

River Purification Boards

Fluvial flooding

All RPBs hold river flows and levels at gauging stations. These are given to the Institute of Hydrology at Wallingford, which maintains the National Water Archive for England, Wales and Scotland.

RPBs have no powers of flood defence and consequently have no internal drainage boards (internal drainage boards work within flood defence sections in England). They are, however, responsible for giving out flood warnings.

Coastal flooding

The River Purification Boards are not responsible for coastal flooding, and keep no data.

Scottish Regional Councils

Fluvial flooding

Regional councils have powers given by various Local Authority Acts to promote flood defence schemes, but these are permissive, not mandatory, and only apply in urban areas. In rural and coastal areas, responsibility is vested in the riparian owner. Watercourses are not owned by any one body or person.

Coastal flooding

The regional councils are only responsible for sea defences where they have carried out sea defence work. Elsewhere in coastal areas, responsibility is vested in the riparian owner. The councils may keep some data, as they maintain any flood defences necessary, but this is also sparse.

IH Stirling

Fluvial flooding

Peaks over threshold values for Scotland are held at IH Stirling, from which return periods can be calculated.

TABLE 2: AREAS AT RISK FROM FLOODING IN SCOTLAND

RPB	SRC	River/coast	Type of flooding	Area
Clyde	Strathclyde	Firth of Clyde	Coastal	
Clyde	Strathclyde	Several rivers	Fluvial	Paisley, Glasgow
Clyde	Strathclyde	White Cart Water	Fluvial	Glasgow
Forth	Lothian	Braid Burn	Fluvial/ coastal	Edinburgh
Forth	Lothian	Water of Leith	Fluvial/ coastal	Leith
Highland	Grampian	Findhorn	Fluvial	
Highland	Highland	Ness	Fluvial	Inverness, Port Augustus
North East	Grampian	Dee	Fluvial	u/s of Aberdeen
North East	Grampian	Spay	Fluvial	
Solway	Dumfries and Galloway	Nith	Fluvial	Dumfries
Tay	Fife	Eden	Fluvial	Auchtermuchty
Tay	Fife	Isla	Fluvial	Cupear
Tay	Fife		Fluvial	Ceres (west of St Andrews)
Tay	Tayside		Fluvial	Arbroath
Tay	Tayside	River Tay	Fluvial	Perth and u/s
Tweed	Borders	Tyne	Fluvial	North of Berwick
		Muckle Spate	Fluvial	

TABLE 3: FLOOD DATA AVAILABILITY IN SCOTLAND

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
Clyde RPB						
Forth RPB	Historical flood boundaries		1950, small number of sites	Paper maps		Free
Highland RPB	No data in areal form					
North East	Historical flood boundaries	Flood plain maps, scale	R. Spey flood (1989/90), R. Don flood (1869)	6 A2 paper maps		£35
Solway RPB	No formal maps of flooded areas				Could draw up a paper map showing areas at risk from flooding	
Tay RPB	Historical flood boundaries	Flood plain maps	Tay and Earn catchments (1990)	Paper maps		
	Historical flood boundaries	Flood plain maps	Tay catchment (1993)	Paper maps		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Historical flood boundaries	Flood plain maps	South Esk catchment (1993)	Paper maps		
Tweed RPB	No historical flood boundaries					
Borders RC	No flood data					
Central RC	Historical flood boundaries		8 or 9 flood events in urban areas	Paper		
Dumfries & Galloway RC						
Fife RC	No historical flood data					
Grampian RC						
Highland RC	Flood risk areas	Sketches of flood plains in Local Plans	Specific catchments			
Lothian RC	Historical flood boundaries	Flood plain maps, 1:10K	Tyne catchment	Paper		

Source	Data type	Nature of data	Scope of data	Media, format	Work needed	Cost
	Historical flood boundaries (areas at risk from flooding)	Flood plain maps, 1:10K	Other rivers	Paper		
Strathclyde RC	No historical flood boundaries					
Tayside RC			Possibly Perth			
Central Scotland Water Development Board						

Appendix 3

Sources of data

The table below summarises the different sources of data and their costs in so far as they are known.

TABLE 4: SOURCES OF DATA IN THE UK

Data type	Supplier	Nature of data	Scope	Media and format	Cost
Postcode boundary	Geoplan	Postcode boundaries for postcode sector, district and areas	UK	Disc or mini data cartridge tape, one of BNA (ASCII), DXF, ArcInfo Export, MapInfo	1st year £3250, subsequent years 30% of annual fee
Postcode point	Postcode Products	PAF file	UK		
Postcode point	Postcode Products	POSTZON, containing addresses, postcodes, grid references	UK	Magnetic tape or IBM 3480 cartridge tape	1st year £2500, £50/user/yr for subsequent years
Postcode point	Geoplan	POSTZON, containing addresses, postcodes, grid references	UK	Disc or mini data cartridges	£950/yr, 30% of initial fee for subsequent yearly updates
Historic flood boundary (fluvial)	NRA	Most up to date maps (Section 24/5 maps or later)	England and Wales	Mostly paper	£150/map (1:25K), > £150/map for larger scales

Data type	Supplier	Nature of data	Scope	Media and format	Cost
Historic flood boundary (fluvial)	Alexander Howden	Maps digitised (Section 24/5 maps or later)	England and Wales	Digital, to be started in April 1995	
Historic flood boundary (coastal)	NRA	Most up to date maps (Section 24/5 maps)	England and Wales	Mostly paper	£150/map (1:25K), > £150/map for larger scales
Historic flood boundary (coastal)	Alexander Howden	Maps digitised (Section 24/5 maps or later)	England and Wales	Digital, completed by April 1995	
Historic flood boundary	RPB	Any flood plain maps available	Parts of Scotland	Paper	
Historic flood boundary	Scottish regional councils	Any flood plain maps available	Parts of Scotland	Paper	
Return period boundary	NRA	Flood return period maps	None at present, work to be started shortly	Will depend on regions' GIS systems	
Flood prone coastal area	NRA	SDS maps, extent of 1:200 year Graff level	England and Wales	Paper	£150/map (1:25K), > £150/map for larger scales
Flood prone coastal area	Halcrows	Flood risk classes and estimated depth of flooding	England and Wales	Paper	£2500 for report, including 5 volumes of paper maps

Data type	Supplier	Nature of data	Scope	Media and format	Cost
Flood prone coastal area	Halcrows	Flood risk classes and estimated depth of flooding	England and Wales	Digital	Unknown
Watercourse and waterbody	IH & OS	1:50K water-course network, including water-bodies	UK	Cartridge tape, NTF	£1/sq km
Gauging station	IH	Gauging stations and daily mean flows	UK	Cartridge tape, NTF	£10/station /retrieval
Urban area	ITE	25m landuse classification grid	UK	NTF	
Urban area	OS	1:250K urban areas	UK		
DTM *and* water-course, water-body	IH & OS	5 50m grids	DTM : England, Wales, part of Scotland, rivers : UK	Cartridge tape, NTF	£3/sq km + licence fee to OS

Appendix 4

Implementation Project Plan

The project plan for Phase I is set out on the following pages.

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ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	1 Detailed specification	28d	17/01/95	23/02/95		
2	1.1 Draft agreements for data acquisition	5d	17/01/95	23/01/95		
3	1.1.1 CDS	2d	17/01/95	18/01/95		CDW
4	1.1.2 NRA	3d	19/01/95	23/01/95	3	CDW
5	1.2 Program specification	23d	24/01/95	23/02/95	2	RVM,RJS
6	2 Project Start-up	4.5d	17/01/95	23/01/95		
7	2.1 Assign staff	0.5d	17/01/95	17/01/95		RVM
8	2.2 Assign Accommodation	0.5d	17/01/95	17/01/95	7	RJS
9	2.3 Acquire development hardware	0.5d	18/01/95	18/01/95	8	RJS
10	2.4 Instal development hardware	1d	18/01/95	19/01/95	9	NCS
11	2.5 Acquire development software	1d	19/01/95	20/01/95	10	RJS
12	2.6 Instal development software	1d	20/01/95	23/01/95	11	RJS
13	3 Database	4.7d	23/01/95	30/01/95		
14	3.1 Setup Oracle database	0.5d	23/01/95	23/01/95	12	RJS
15	3.2 Finalise data model	1d	24/01/95	24/01/95	14	RJS
16	3.3 Setup data model on WIS	2d	26/01/95	26/01/95	15	
17	3.3.1 Feature dictionary	0.5d	25/01/95	25/01/95		RVM,RJS
18	3.3.2 Dictionary of dictionary	0.3d	25/01/95	25/01/95	17	RVM,RJS
19	3.3.3 Attribute dictionary	0.3d	25/01/95	26/01/95	18	RVM,RJS
20	3.3.4 Attribute fields	0.3d	26/01/95	26/01/95	19	RVM,RJS
21	3.3.5 Units	0.3d	26/01/95	26/01/95	20	RVM,RJS
22	3.3.6 Permitted values	0.3d	26/01/95	26/01/95	21	RVM,RJS
23	3.4 Document data model	1d	26/01/95	26/01/95		RVM,RJS
24	3.5 Finalise details for:	3.2d	25/01/95	30/01/95		
25	3.5.1 data sources	0.4d	25/01/95	25/01/95	15	CDW
26	3.5.2 formats	0.4d	25/01/95	25/01/95	25	CDW
27	3.5.3 Acquisition process	2.4d	25/01/95	30/01/95	26	
28	3.5.3.1 Postcode points	0.4d	25/01/95	26/01/95		CDW
29	3.5.3.2 Postcode boundaries	0.4d	26/01/95	26/01/95	28	CDW
30	3.5.3.3 Historic flood boundaries	0.8d	26/01/95	27/01/95	29	
31	3.5.3.3.1 Thames	0.4d	26/01/95	26/01/95		CDW
32	3.5.3.3.2 CDS	0.4d	27/01/95	27/01/95	31	CDW
33	3.5.3.4 Return period boundaries	0.4d	27/01/95	27/01/95	30	CDW
34	3.5.3.5 Halcrow	0.4d	27/01/95	30/01/95	33	CDW
35	4 Data Acquisition	170.8d	26/01/95	21/09/95		
36	4.1 Postcode points	30.5d	26/01/95	09/03/95		
37	4.1.1 Order	0.5d	26/01/95	26/01/95	28	CDW
38	4.1.2 Receive	0d	09/03/95	09/03/95	37FS+30d	CDW
39	4.2 Postcode boundaries	30.26d	26/01/95	09/03/95		
40	4.2.1 Order	0.25d	26/01/95	26/01/95	29	CDW
41	4.2.2 Receive	0d	09/03/95	09/03/95	40FS+30d	CDW
42	4.3 Historic flood boundaries	170d	27/01/95	21/09/95		

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ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
43	**4.3.1 Thames**	32d	27/01/95	13/03/95		
44	4.3.1.1 Order	2d	27/01/95	30/01/95	31	CDW
45	4.3.1.2 Receive	0d	13/03/95	13/03/95	44FS+30d	CDW
46	**4.3.2 CDS**	169.6d	27/01/95	21/09/95	32	CDW
47	4.3.2.1 Commission to digitise NRA information	1d	27/01/95	30/01/95		
48	4.3.2.2 Contractual negotiations	7d	30/01/95	08/02/95	47	
49	4.3.2.3 Order	1d	08/02/95	09/02/95	48	
50	4.3.2.4 Receive data & digitise	130d	24/03/95	21/09/95	49FS+28d	CDS
51	**4.3.3 Urban data**	30.5d	30/01/95	13/03/95	47	
52	4.3.3.1 Order	0.5d	30/01/95	30/01/95		CDW
53	4.3.3.2 Receive	0d	13/03/95	13/03/95	52FS+30d	CDW
54	**4.3.4 Digital rivers**	30.5d	30/01/95	13/03/95		
55	4.3.4.1 Order	0.5d	30/01/95	30/01/95		CDW
56	4.3.4.2 Receive	0d	13/03/95	13/03/95	55FS+30d	CDW
57	**4.4 Halcrow data**	30.5d	30/01/95	13/03/95		
58	4.4.1 Order	0.5d	30/01/95	30/01/95	34	CDW
59	4.4.2 Receive	0d	13/03/95	13/03/95	58FS+30d	CDW
60	**6 Produce conversion software**	47.2d	24/02/95	02/05/95		
61	**5.1 Postcode points**	12.2d	24/02/95	14/03/95		
62	5.1.1 Design	1.25d	24/02/95	27/02/95	5	RJS
63	5.1.2 Write	1.25d	27/02/95	28/02/95	62	RJS
64	5.1.3 Test	1.25d	09/03/95	10/03/95	63,38	RJS
65	5.1.4 Document	1.25d	10/03/95	14/03/95	64	RJS
66	**5.2 Postcode boundaries**	5d	14/03/95	21/03/95	61	
67	5.2.1 Design	1d	14/03/95	15/03/95	65	RJS
68	5.2.2 Write	2.5d	15/03/95	17/03/95	67	RJS
69	5.2.3 Test	0.5d	17/03/95	20/03/95	68,41	RJS
70	5.2.4 Document	1d	20/03/95	21/03/95	69	RJS
71	**6.3 Historic flood boundaries - Thames**	5d	21/03/95	28/03/95	66	
72	5.3.1 Design	1d	21/03/95	22/03/95	70	RJS
73	5.3.2 Write	2.5d	22/03/95	24/03/95	72	RJS
74	5.3.3 Test	0.5d	24/03/95	27/03/95	73,45	RJS
75	5.3.4 Document	1d	27/03/95	28/03/95	74	RJS
76	**6.4 Historic flood boundaries - CDS**	6d	28/03/95	04/04/95	71	
77	5.4.1 Design	1d	28/03/95	29/03/95	75	RJS
78	5.4.2 Write	2.5d	29/03/95	31/03/95	77	RJS
79	5.4.3 Test	0.5d	31/03/95	03/04/95	78	RJS
80	5.4.4 Document	1d	03/04/95	04/04/95	79	RJS
81	**5.5 Extensions to validation software for return period boundaries**	27.2d	24/02/95	04/04/95		
82	5.5.1 Design	1d	24/02/95	24/02/95	5	RVM
83	5.5.2 Write	1d	27/02/95	27/02/95	82	RVM
84	5.5.3 Test	0.5d	03/04/95	03/04/95	83,79	RVM

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ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
85	5.5.4 Document	0.5d	03/04/95	04/04/95	84	RVM
86	5.6 Polygon generation software for flood plain boundaries	5d	04/04/95	11/04/95		
87	5.6.1 Design	1d	04/04/95	05/04/95	85	RVM
88	5.6.2 Write	2.5d	05/04/95	07/04/95	87	RVM
89	5.6.3 Test	0.5d	07/04/95	10/04/95	88,79	RVM
90	5.6.4 Document	1d	10/04/95	11/04/95	89	RVM
91	5.7 Polygon generation software for post code boundaries	5d	11/04/95	18/04/95		
92	5.7.1 Design	1d	11/04/95	12/04/95	90	RVM
93	5.7.2 Write	2.5d	12/04/95	14/04/95	92	RVM
94	5.7.3 Test	0.5d	14/04/95	17/04/95	93,69	RVM
95	5.7.4 Document	1d	17/04/95	18/04/95	94	RVM
96	5.8 Halcrow data	10d	04/04/95	18/04/95		
97	5.8.1 Design	3d	04/04/95	07/04/95	80	RJS
98	5.8.2 Write	5d	07/04/95	14/04/95	97	RJS
99	5.8.3 Test	1d	14/04/95	17/04/95	98,59	RJS
100	5.8.4 Document	1d	17/04/95	18/04/95	99	RJS
101	5.9 Master file generator	10d	18/04/95	02/05/95		
102	5.9.1 Design	3d	18/04/95	21/04/95	95	RVM
103	5.9.2 Write	5d	21/04/95	28/04/95	102	RVM
104	5.9.3 Test	1d	28/04/95	01/05/95	103	RVM
105	5.9.4 Document	1d	01/05/95	02/05/95	104	RVM
106	5.10 Portfolio utility	6d	18/04/95	25/04/95		
107	5.10.1 Design	1d	18/04/95	19/04/95	100	RJS
108	5.10.2 Write	2d	19/04/95	21/04/95	107	RJS
109	5.10.3 Test	0.5d	21/04/95	21/04/95	108	RJS
110	5.10.4 Help files	0.5d	21/04/95	24/04/95	109	RJS
111	5.10.5 Document	1d	24/04/95	25/04/95	110	RJS
112	6 Data Conversion and load	213.5d	13/03/95	04/01/96		
113	6.1 Postcode points	4d	14/03/95	20/03/95		
114	6.1.1 Run conversion software	1d	14/03/95	15/03/95	65	RJS
115	6.1.2 Load data into database	1d	15/03/95	16/03/95	114	RJS
116	6.1.3 Test	1d	16/03/95	17/03/95	115	RJS
117	6.1.4 Accept	1d	17/03/95	20/03/95	116	RJS
118	6.2 Postcode boundaries	6d	21/03/95	29/03/95		
119	6.2.1 Run conversion software	1d	21/03/95	22/03/95	70	RJS
120	6.2.2 Validate	1d	22/03/95	23/03/95	119	RJS
121	6.2.3 Form polygons	1d	23/03/95	24/03/95	120	RJS
122	6.2.4 Load data into database	1d	24/03/95	27/03/95	121	RJS
123	6.2.5 Test	1d	27/03/95	28/03/95	122	RJS
124	6.2.6 Accept	1d	28/03/95	29/03/95	123	RJS
125	6.3 Historic flood boundaries	128.8d	28/03/95	22/09/95		
126	6.3.1 Thames	11d	28/03/95	12/04/95		

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ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
127	6.3.1.1 Run conversion software	2d	28/03/95	30/03/95	75	RJS
128	6.3.1.2 Validate	3d	30/03/95	04/04/95	127	RJS
129	6.3.1.3 Form polygons	3d	04/04/95	07/04/95	128	RJS
130	6.3.1.4 Load data into database	1d	07/04/95	10/04/95	129	RJS
131	6.3.1.5 Test	1d	10/04/95	11/04/95	130	RJS
132	6.3.1.6 Accept	1d	11/04/95	12/04/95	131	RJS
133	6.3.2 CDS	123.8d	04/04/95	22/09/95		
134	6.3.2.1 Run conversion software	2d	04/04/95	06/04/95	80	RJS
135	6.3.2.2 Validate	3d	06/04/95	11/04/95	134	RJS
136	6.3.2.3 Form polygons	3d	11/04/95	14/04/95	135	RJS
137	6.3.2.4 Load data into database	1d	14/04/95	17/04/95	136	RJS
138	6.3.2.5 Test	1d	17/04/95	18/04/95	137	RJS
139	6.3.2.6 Accept	1d	22/09/95	22/09/95	138,50	RJS
140	6.4 Return period boundaries	6d	01/11/95	08/11/95		
141	6.4.1 Run conversion software	1d	01/11/95	01/11/95		
142	6.4.2 Validate	1d	02/11/95	02/11/95	141	
143	6.4.3 Form polygons	1d	03/11/95	03/11/95	142	
144	6.4.4 Load data into database	1d	06/11/95	06/11/95	143	
145	6.4.5 Test	1d	07/11/95	07/11/95	144	
146	6.4.6 Accept	1d	08/11/95	08/11/95	145	
147	6.5 Digital terrain model	4d	01/01/96	04/01/96		
148	6.5.1 Run conversion software	1d	01/01/96	01/01/96		
149	6.5.2 Load data into database	1d	02/01/96	02/01/96	148	
150	6.5.3 Test	1d	03/01/96	03/01/96	149	
151	6.5.4 Accept	1d	04/01/96	04/01/96	150	
152	6.6 Digital rivers	4d	13/03/95	17/03/95		
153	6.6.1 Run conversion software	1d	13/03/95	14/03/95	56	RJS
154	6.6.2 Load data into database	1d	14/03/95	15/03/95	153	RJS
155	6.6.3 Test	1d	15/03/95	16/03/95	154	RJS
156	6.6.4 Accept	1d	16/03/95	17/03/95	155	RJS
157	6.7 Halcrow	4d	27/04/95	03/05/95		
158	6.7.1 Run conversion software	1d	27/04/95	28/04/95	100FS+7d	RJS
159	6.7.2 Load data into database	1d	28/04/95	01/05/95	158	RJS
160	6.7.3 Test	1d	01/05/95	02/05/95	159	RJS
161	6.7.4 Accept	1d	02/05/95	03/05/95	160	RJS
162	6.8 Masterfile generation	2d	02/05/95	04/05/95		
163	6.8.1 Run	1d	02/05/95	03/05/95	105	RVM,RJS
164	6.8.2 Test	1d	03/05/95	04/05/95	163	RVM,RJS
165	6.9 Supply Masterfile and utility	2d	25/04/95	27/04/95		
166	6.9.1 Installation	1d	25/04/95	26/04/95	111	RVM,RJS
167	6.9.2 Training	1d	26/04/95	27/04/95	166	RVM,RJS
168	7 Acceptance of project	1d	12/10/95	12/10/95	50FS+14d,117,1	JARDINES

ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
169	8 Support	90d	13/10/95	15/02/96	168	RVM,RJS,CDW

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