

LEVELS *of* SERVICE
for
URBAN & RURAL
FLOOD DEFENCE



NRA
Thames Region

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NRA

Thames Region

Kings Meadow House
Kings Meadow Road
Reading
RG1 8DQ

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INTRODUCTION

A drainage authority has permissive powers to protect customer interests within the floodplain. This is achieved through the provision of capital works, maintenance programmes, the operation of river structures, a flood warning system and advice to local planning authorities on the drainage implications of new development. This document is concerned with levels of service for flood defence and land drainage. Levels of service for NRA Thames Region's other responsibilities in relation to customer interests are to

be covered elsewhere.

A flood or bankfull event is not a problem per se. It only becomes a problem where a customer interest is adversely affected and where damage occurs. But damage does not in itself justify action. The various customer interests at risk from flooding have to be balanced against NRA Thames Region's resources. This means that the Region constantly faces the task of deciding:

- *What are its customers' interests?*
- *What is an appropriate level of service?*
- *What are the best means of serving the various customer interests?*



Aerial view of flooding



Customers at risk



Waterlogging may also cause concern

INTRODUCTION



Control structures: an integral part of service provision

A study was commissioned by NRA Thames Region's predecessor, the Rivers Division of Thames Water in 1986 with the initial objective of reviewing existing standards. This review created an opportunity to re-appraise the approach and philosophy behind the assessment of appropriate levels of service. The study was therefore later extended to develop a new system of assessment. This new system, now the responsibility of NRA Thames Region:

- Provides a quick and simple method of assessing appropriate levels of service throughout the Thames Catchment;

- Consequently, provides the basis for a consistent and programmed approach towards service provision;
- Is based on an approach which has customer interests at its very heart.

The new system has been endorsed by the Water Authorities Association National Working Group.



Capital works: weir reconstruction



Maintenance practices: weed cutting

The most distinctive feature of the new system is that it relates levels of service first and foremost to current land use. As land use varies so therefore do customer interests and the requirement for flood defence and land drainage.

The disparate customer interests potentially found within any floodplain have been brought together into five **Land Use Bands**. These Land Use Bands range from “heavily urbanised” (Band A) to “unintensive agriculture” (Band E). A description of each band is given in Table 1. A target range of service levels has been identified for each Land Use Band. These targets are considered to be the level of service appropriate to the customer interests within the respective bands.

All Main River within the Thames Catchment is to be divided into reaches and associated floodplain classified by Land Use Band. Service targets will be compared with actual levels of service on a reach by

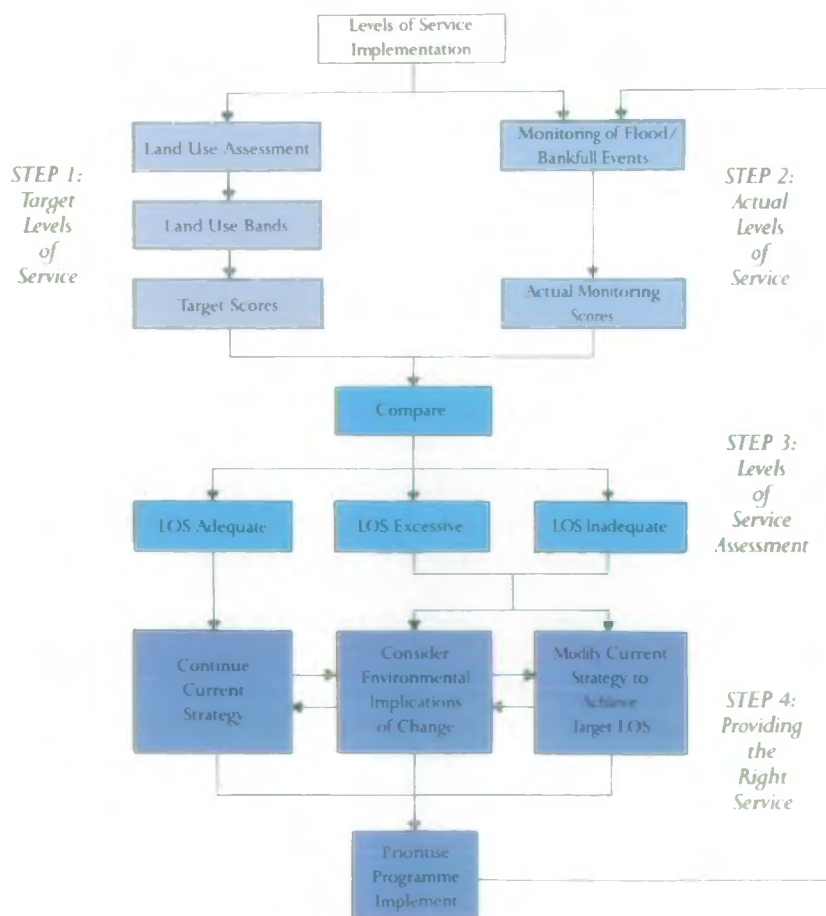
reach basis and levels of service classed as adequate, inadequate or excessive. This classification will form the basis for the review of existing river management regimes and future programming of works and operations.

Arriving at a satisfactory level of service provision can be seen as a four stage process:

- *Step 1 Identify Target Levels of Service*
- *Step 2 Identify Actual Levels of Service*
- *Step 3 Undertake Levels of Service Assessment*
- *Step 4 Provide the Right Service*

These steps are illustrated in the flow chart below and detailed in the pages that follow. Section 3 goes on to illustrate the system in practice using a section of the River Wey as an example. Finally, Section 4 outlines what the new system will mean to the customer.

Levels of Service Flow Chart



THE NEW SYSTEM

Step 1: Target Levels of Service

Land Use Assessment and Band Classification

Customer interests within the floodplain are many, but can be broadly categorised as domestic, commercial, industrial, agricultural, recreational or environmental. All these interests will be affected in different ways by a given flood event. For example, flooding of a house is generally perceived to be of more concern than

inundation of a playing field. Likewise, interests will vary from place to place. The extent of domestic interests will be much greater in a city or town than in a rural area; flooding will cause more damage to a high value arable crop than to low quality pasture.

Table 1: Land Use Band Descriptions

Land Use Band	Description of Typical Land Use
	<p>A</p> <p>A reach containing the urban elements of residential and non-residential property distributed over a significant proportion of its length, or densely populated areas over some of its length. Any agricultural influence is likely to be over-riden by urban interests. Amenity uses such as parks and sports fields may be prominent in view of the floodplain's proximity to areas of population density.</p> <p>Assessment Score: Over 100 HE/km</p>
	<p>B</p> <p>Reaches containing residential and/or non-residential property either distributed over the full length of the reach or concentrated in parts but characterised by lower densities than Band A.</p> <p>Assessment Score: 50-100 HE/km</p>
	<p>C</p> <p>Limited numbers of isolated rural communities or urban fringe at risk from flooding, including both residential and commercial interests. Intensive agricultural use could also be included.</p> <p>Assessment Score: 10-50 HE/km</p>
	<p>D</p> <p>Isolated, but limited numbers of residential and commercial properties at risk from flooding. Agricultural use will probably be the main customer interest with arable farming being a feature. In undeveloped pockets of largely urban use, amenity interests may be prominent.</p> <p>Assessment Score: 2.5-10 HE/km</p>
	<p>E</p> <p>There are likely to be very few properties and major roads at risk from flooding in these reaches. Agricultural use will be the main customer interest with either extensive grassland or, where the flood plain extent is small, arable cropping being the most common land uses. Amenity interests are likely to be limited to public footpaths along or across the river.</p> <p>Assessment Score: 0-2.5 HE/km</p>

THE NEW SYSTEM

To bring some sort of order to the multiplicity of customer interests, land use has been quantified. Twenty land use categories have been identified and allocated scores on the basis of potential flood damage. A unit known as the **House Equivalent (HE)** – the average cost of damage to the average house when flooded – has been developed as a means of quantifying these land use categories on a common basis. Whereas a house will therefore score 1 HE, the relative potential damage caused to other land uses gives a score of 64.6 for a factory, 57.3 for a railway and so on. A full list of land use categories and their scores is given in Section 3.

River reaches of similar land use can be expected to have similar HE scores. The five Land Use Bands given in Table 1 have therefore been given a range of HE scores per km reflecting the extent of customer

interests that can be expected to be found within each band. To arrive at a Land Use Band classification for an individual reach, each customer interest will be identified, categorised and scored. Individual scores will be totalled to give an **Assessment Score** thereby bringing the reach into one of the five Land Use Bands (see Section 3 and Diagram 1).

With the exception of recreation, quantification of environmental interests as part of the land use based assessment was considered inappropriate. It is recognised that environment is very much central to levels of service but in relation to **how** a level of service is achieved and not **what** level of service should be provided. Environmental implications of the new system and how these should be addressed are discussed separately in Step 4.

Target Scores

Each Land Use Band will differ in the way in which it is affected by flooding or the waterlogging that sometimes results from bankfull events. All other things being equal, a given flood or bankfull event will cause more damage in a reach classified as Band A than one classified as Band E. A higher level of service is therefore justified for Band A than for Bands B-E. The new system attaches target levels of service to the different Land Use Bands. Table 2 gives the kinds of flooding and bankfull events to which the target levels of service relate. These should be seen not in terms of a level of service per se but rather illustrations of types of events against which protection is justified.

Each Land Use Band is given its target level of service based on an event scoring system. Target scores for each Land Use Band have been arrived at by scoring potential flood and bankfull events in terms of their likely impact on the customer interests within each band.

The various scenarios described in Table 2 have therefore been scored in terms of:

- The number of HEs likely to be affected within the respective Land Use Bands
- In the case of agricultural land use categories, the effect of timing and duration.

Timing and duration have been built into the scoring system where agricultural land is affected since it is important to acknowledge that impact will vary as a result. For example flooding of agricultural land in January is less serious than in April.

Scenarios were scored first of all hypothetically and then, following testing against actual events, revised to better reflect the target levels of service. The figures given in Table 2 are the resulting Target Scores for each Land Use Band. The Maximum Target Score reflects the maximum annual degree of flooding and bankfull conditions considered acceptable for a particular Land Use Band. Scores higher than the target maximum for a particular band reflect an unacceptable degree of flooding ie. inadequate level of service. The Minimum Target Score reflects the minimum acceptable annual degree of flooding and bankfull conditions. Scores lower than the target minimum for a particular band may indicate an excessive level of service.

The objective of providing a range of values is two-fold: firstly to enable some variation in land use within a band to be taken into account and, secondly, to deal with annual variation in flood events. The system is therefore flexible and able to deal with unpredictability.

THE NEW SYSTEM

There is, of course, no correct or incorrect level of service, it is a judgement based on policy criteria, public and professional perceptions, and resources at a given point in time. Once the system is put into practice, and over time, target scores may need to be

reviewed and refined as both the information available becomes more sophisticated and as policies and perceptions change. The system has been designed in a way to accommodate such refinement and change.

Table 2: Description of Target Levels of Service by Land Use Band

Land Use Band	Description
A	<p><i>These heavily built-up areas should be protected to a standard such that the risk of flooding in any one year is no greater than 1 in 50. In some areas, higher standards may be applied.</i></p> <p>Levels of Service Target Range: Min 0 – Max 4</p>
B	<p><i>Buildings should be protected to a standard such that the risk of flooding in any one year is between 1 in 20 and 1 in 50. However, agricultural or amenity land found in these areas could remain susceptible to regular flooding.</i></p> <p>Levels of Service Target Range: Min 0 – Max 5</p>
C	<p><i>The chance of flooding of property in any one year would be between 1 in 10 and 1 in 50 years. Agricultural or amenity land, however, could be susceptible to more regular flooding.</i></p> <p>Levels of Service Target Range: Min 1 – Max 6</p>
D	<p><i>Agriculture and amenity land in this band should be protected to a standard such that the chance of flooding or prolonged bankfull events in any one year, at a time when crops are normally susceptible to damage (ie March to October inclusive), is between 1 in 2 and 1 in 5.</i></p> <p>Levels of Service Target Range: Min 2 – Max 7</p>
E	<p><i>Agricultural land in this category could be susceptible to yearly waterlogging and/or flooding, possibly occurring on several occasions throughout the year. Protection should be maintained to a standard which reduces the risk of either type of event to between one and three times per year at a time when crops are normally susceptible to damage.</i></p> <p>Levels of Service Target Range: Min 1 – Max 7</p>

Step 2: Actual Levels of Service

Following Land Use Band classification on a reach by reach basis, existing (actual) levels of service can be assessed on all rivers throughout the Thames Catchment. To do this, recorded flood events are being given scores calculated in the same way as described above and in the example given in Section 3. In certain cases, where they are likely to have a significant adverse impact on agricultural land, bankfull events are also being considered. Inclusion and calculation of these bankfull events will take into account – type of agricultural land use, area of floodplain and extent of field drainage. Event scores will be annualised to give **Actual Monitoring Scores**.

The initial Actual Monitoring Score is a product of the situation at a given point in time. For the future it is important that monitoring programmes are established to look at events over a longer period of time. This is essential to increase the system's accuracy and smooth out annual variations. Such monitoring is likely to affect the actual level of service assessment as will changes in maintenance practices, the construction of capital works and major changes in land use.

Step 3: Levels of Service Assessment

Actual levels of service will then be compared with target levels of service for individual reaches. In so doing, reaches will be found to be:

- adequate
- inadequate, or
- excessive

in terms of existing service provision.

The actual level of service is a product of the existing

maintenance regime and capital works. The implication of this service assessment is that where service is found to be inadequate, the existing regime should be enhanced, if adequate it should be continued, if excessive, there may be scope to reduce resource inputs whilst still providing customers with a sufficient level of service. To see how levels of service assessments are arrived at for individual reaches see Section 3.

Step 4. Providing the Right Service



Sensitive Improvement Works – during construction



– after sedge growth

Apart from providing a sound, consistent approach towards service provision, the new system can be used to:

- Highlight where modifications to existing maintenance regimes are required as well as possible new capital works;
- Help set objectives, prioritise needs and define programmes;
- Identify resource requirements and enable allocation according to need.

Local managers will, in future, be required to re-examine existing maintenance regimes in the light of the level of service assessment. By considering the problem in detail and, on the basis of local experience, he should be able to identify necessary modifications to the existing regime. In most instances where there is an imbalance, this is likely to involve changes to current maintenance practices but, occasionally, new capital schemes where problems cannot be met in this way.

Environmental interests will need to be examined where any change to an existing regime is proposed. Internal liaison and consultation with local groups at an early stage will identify environmental interests against which alternative options for change can be formulated and evaluated. This will help avoid adverse impact and identify potential environmental enhancement opportunities. In the light of Regulation 1217, an environmental impact statement may be required in the case of works which are judged to have significant environmental effects.

Finally, in providing a systematic, consistent method of assessing appropriate and actual levels of service across the board, NRA Thames Region now has a firm basis for developing prioritised work programmes and resource allocations.

THE RIVER WEY

Step 1: Target Levels of Service

(a) Land Use Assessment and Band Classification

Diagram 1 shows the Land Use Assessment results and Table 3 shows how a classification was arrived at for an individual reach—Wey 7.

Table 3: Wey 7 Land Use Assessment and Band Classification

Land Use Category	Unit	Number (determined by survey)	House Equivalents HE/Unit	Total HE
Houses	Total Number	52	1.0	52.0
Gardens/Allotments	Total Number	88	0.2	17.6
Non Res Prop				
– Distribution	Total Number	1	40.2	40.2
– Manufacturing	Total Number	1	64.6	64.6
– Other	Total Number	24	5.3	127.2
C Roads	Total Number	2	2.4	4.8
B Roads	Total Number	–	5.7	–
A Roads (Non Trunk)	Total Number	1	14.3	14.3
A Roads (Trunk)	Total Number	–	28.6	–
Motorways	Total Number	–	57.3	–
Railways	Total Number	–	57.3	–
Forestry and Scrub	100 Ha	–	0	–
Extensive Pasture	100 Ha	1.1	1.3	1.4
Intensive Pasture	100 Ha	–	3.0	–
Extensive Arable	100 Ha	–	6.9	–
Intensive Arable	100 Ha	–	40.2	–
Formal Parks	Total Number	–	0.6	–
Golf Courses	Total Number	–	0.6	–
Playing Fields	Total Number	–	0.1	–
Special Parks	Total Number	–	8.5	–
			Total HEs	322.1*
			Length of Reach	4.6 km
			HE/km	70.0

*of which 320.7 are urban and 1.4 are agricultural

Referring to Table 4 below, Wey 7 can therefore be placed in Band B.

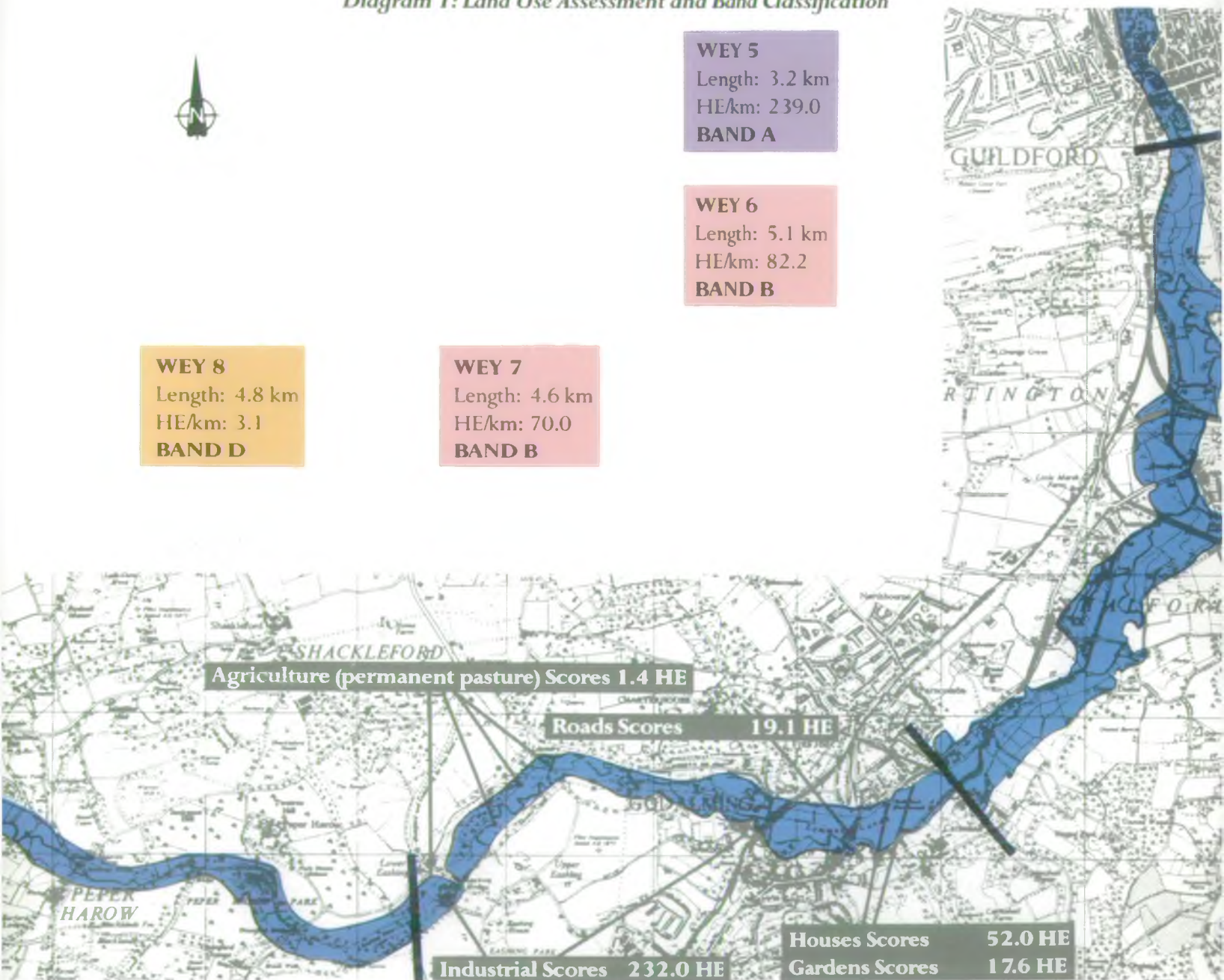
Similarly other reaches can be allocated to an appropriate band as shown in Diagram 1.

Table 4: Land Use Band Ranges

HE/km	Land Use Band (See Table 1 for descriptions)
Over 100	A
50 – 100	B
10 – 50	C
2.5 – 10	D
0 – 2.5	E

THE SYSTEM IN PRACTICE

Diagram 1: Land Use Assessment and Band Classification



(b) Target Score

Referring back to Table 2 showing Target Maximum and Minimum scores for each Land Use Band, the **Target Score** for Reach 7 of the River Wey is therefore 0–5.

Step 2: Actual Levels of Service

(a) Monitoring of Flood/Bankfull Events

Again, taking Reach 7 of the River Wey as an example, the events occurring during a two year trial period were as follows:

THE SYSTEM IN PRACTICE

Flood Event 1

Date	Mar 1986
Duration	6 days
Extent	30% floodplain
Urban HEs Affected	4.0

Flood Event 2

Date	Oct 1987
Duration	7 days
Extent	25% floodplain
Urban HEs Affected	2.4

Conditions are such along this reach that bankfull events are not significant and therefore do not require monitoring.

(b) Calculation of Actual Monitoring Scores

Actual Levels of Service are determined by scoring the monitored events. Each event will be scored using the following formula:

Urban HEs affected plus Agricultural HEs x % floodplain area affected x severity weighting

(i) The **Severity Weighting** for any event can be calculated using the severity weighting matrix – Table 5 below.

Table 5: Severity Weighting Matrix

Event	Weighting	Severity of Event			
		0	1	2	3
Flooding					
Timing	0.25	Nov-Feb	March or Oct	April or Sept	May-Aug
Duration	0.25	- 1 day	1-5 days	5-7 days	7+ days
Bankfull Events					
Timing	0.20	Nov-Feb	March or Oct	April or Sept	May-Aug
Duration	0.20	- 1 day	1-5 days	5-7 days	7+ days

So, for Wey 7, the severity weightings of each event are as follows:

Flood Event 1

Timing	March 1986 (1) x weighting (0.25)	= 0.25
Duration	6 days (2) x weighting (0.25)	= 0.50
Severity Weighting		= 0.75

Flood Event 2

Timing	October 1987 (1) x weighting (0.25)	= 0.25
Duration	7 days (2) x weighting (0.25)	= 0.50
Severity Weighting		= 0.75

(ii) The **Flood Event Scores** for Wey 7 can now be calculated.

Flood Event 1

Urban HEs Affected	= 4.00
Agriculture HE's (1.4) x Extent (30%) x Severity Weighting (0.75)	= 0.32
Event Score	= 4.32

Flood Event 2

Urban HEs Affected	= 2.40
Agriculture HE's (1.4) x Extent (25%) x Severity Weighting (0.75)	= 0.26
Event Score	= 2.66

(iii) To reduce annual variation, the sum of all events can be averaged over two years. This gives an annual average monitoring score, the **Actual Monitoring Score**.

$$\text{Actual Monitoring Score} = \frac{4.32 + 2.66}{2} = 3.49$$

THE SYSTEM IN PRACTICE

Step 3: Levels of Service Assessment

Land Use Band=B (Tables 1 and 4)

Appropriate Levels of Service Target Range=0 to 5 (Table 2)

Actual Monitoring Score=3.49

Therefore the level of service provided for Reach 7 of the River Wey is **ADEQUATE**

This exercise can be performed for the other reaches shown in the example in Diagram 1. The results are given in Table 6 below.

Table 6: Levels of Service Assessment

River	Reach No.	Land Use Assessment Score HE's/km	Band	Target Range		Actual Monitoring Score	Levels of Service Assessment
				MIN	MAX		
WEY	5	239.0	A	0	4	0	Adequate
	6	82.2	B	0	5	8.04	Inadequate
	7	70.0	B	0	5	3.49	Adequate
	8	3.1	D	2	7	0.95	Excessive



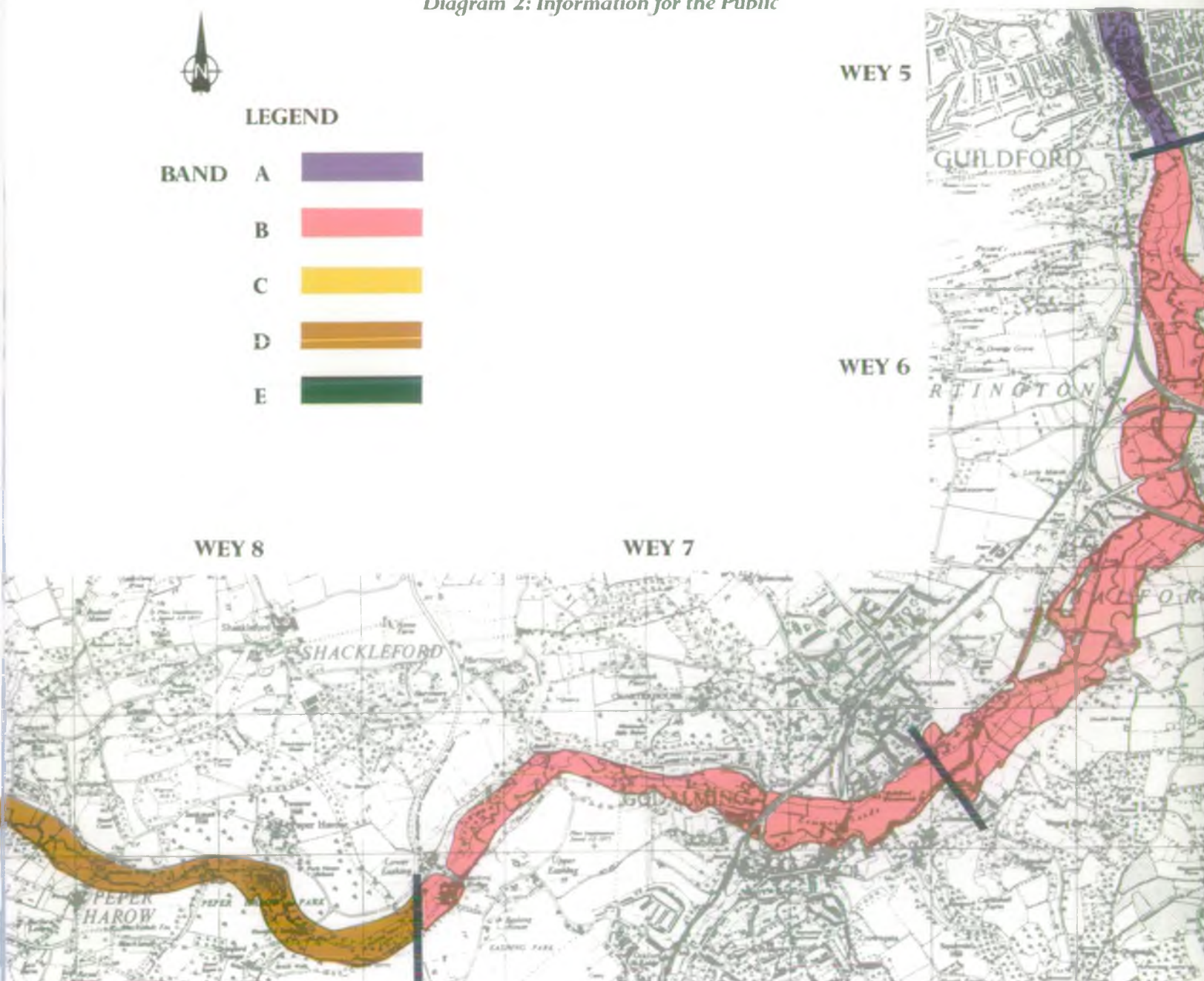
Capital works: landscaped 2 stage channel

CUSTOMER CONTACT

One of the most important features of the new system is that it will provide the customer with clear guidelines on how levels of service are determined and the level of service provision in a particular area. Customers will be able to identify the Land Use Band classification of any stretch of main river within the Thames Catchment. This information will be shown visually on O.S. maps. Customers will also be able to identify whether existing levels of service are adequate, inadequate or excessive. This will not only provide the

customer with clear information, based on a systematic assessment, but help NRA Thames Region in streamlining their response to ad hoc customer queries and pressure from individual members of the public to undertake works. This information will be publicly available at NRA Thames Region's offices. For further details of existing work programmes and proposals to rectify any service deficiencies, customers will be referred to the relevant local manager.

Diagram 2: Information for the Public



Any queries concerning the information contained in this document should be addressed to:
Colin Candish, Project Co-ordinator