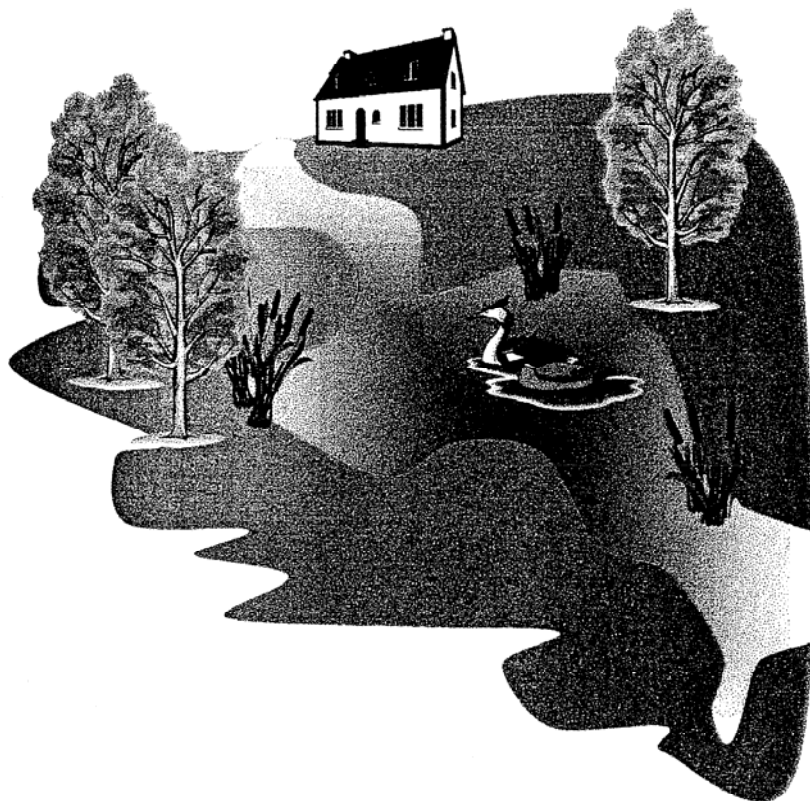


Benefit Analysis of River Restoration on the River Cole and River Skerne



Draft Report

RPA

November 1997

***Benefit Analysis of River Restoration
on the River Cole and River Skerne***


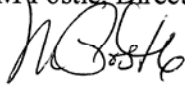
Draft Report - November 1997

prepared for

River Restoration Project (RRP)

by

Risk & Policy Analysts Limited,
Farthing Green House, 1 Beccles Road, Loddon, Norfolk, NR14 6LT

RPA REPORT - ASSURED QUALITY	
Project: Ref/Title	J206/River Restoration
Approach:	As laid out in the proposal and draft guidelines
Report Status:	Draft Report: J206.D1
Prepared by:	T Fenn, Researcher 
Report Approved for issue by:	M Postle, Director 
Date:	27 November 1997

CONTENTS

Page

PART ONE: SUMMARY

1. INTRODUCTION	
1.1 Objectives of Restoration	1-1
1.2 Economic Appraisal	1-1
2. AGRICULTURE AND WATER QUALITY	1-1
3. AMENITY	1-2
4. FISHERIES AND BENEFITS TO ANGLERS	1-2
5. FLOOD DEFENCES	1-3
6. RECREATION	1-3
7. CONSERVATION AND NON-USE	1-4
8. ANNUAL BENEFITS	1-5
9. DISCOUNTED BENEFITS	
9.1 Discounting Over 25 Years	1-6
9.2 Discounting Over 50 Years	1-8

PART TWO: RIVER COLE

1. INTRODUCTION	2-1
2. AGRICULTURE AND WATER QUALITY	
2.1 Agriculture	2-1
2.2 Water Quality	2-3
3. AMENITY	2-3
4. FISHERIES AND BENEFITS TO ANGLERS	
4.1 Overview	2-3
4.2 Benefit Estimates	2-4
5. FLOOD DEFENCES	2-5
6. RECREATION	
6.1 Activities Created by River Restoration	2-6
6.2 Estimation of Visitor Numbers	2-6
6.3 Benefit Estimates	2-7

7.	CONSERVATION AND NON-USE	
7.1	Overview	2-8
7.2	Number of Non-Use Households	2-9
7.3	Benefit Estimates	2-9
8.	CONCLUSIONS	
8.1	Overall Benefits from Restoration	2-11

PART THREE: RIVER SKERNE

1.	INTRODUCTION	3-1
2.	AGRICULTURE AND WATER QUALITY	
2.1	Agriculture	3-1
2.2	Water Quality	3-2
3.	AMENITY	
3.1	Overview	3-2
3.2	Number and Value of Properties	3-2
4.	FISHERIES AND BENEFITS TO ANGLERS	
4.1	Overview	3-4
4.2	Benefit Estimates	3-4
5.	FLOOD DEFENCES	3-5
6.	RECREATION	
6.1	Overview	3-5
6.2	Estimation of Visitor Numbers	3-5
6.3	Benefit Estimates	3-7
7.	CONSERVATION AND NON-USE	
7.1	Overview	3-8
7.2	Number of Non-Use Households	3-8
7.3	Benefit Estimates	3-9
8.	CONCLUSIONS	
8.1	Overall Benefits from Restoration	3-10
8.2	Comparison of Methodologies	3-12

PART ONE

SUMMARY

1. INTRODUCTION

1.1 Objectives of Restoration

Man's intervention has changed over 89% of Britain's rivers, regulated for flood defence or water supply purposes, leaving monotonous and poor quality river ecosystems. The value of river restoration lies in the re-establishment of a more natural river channel, and the benefits that are associated with such a change. The River Skerne and River Cole were chosen to provide an indication of the likely benefits in an urban and rural setting, respectively.

1.2 Economic Appraisal

Each restoration scheme will create new or different benefits, ranging from direct improvements in water quality to changes in flood damages. A more varied riverine environment is also likely to attract more visitors, thus increasing recreational opportunities, and may increase the diversity and numbers of plants, fish and other wildlife.

The assessments of both the Cole and Skerne schemes considered the benefits from restoration across the following categories:

- agriculture and water quality;
- amenity;
- fisheries;
- flood defences;
- recreation; and
- conservation and non-use.

2. AGRICULTURE & WATER QUALITY

Diversification, creation of new rural enterprises and extensification are benefits resulting from changes in agricultural practice. These include direct benefits to farmers from reduction of fertiliser and pesticide applications and of labour input. There are also payments, from MAFF, which result from changes in land use. Benefits to agriculture on the Cole were calculated using these payments, giving:

- upper bound: £25,000;
- mid bound: £19,000; and
- lower bound: £0.

The River Skerne scheme, being entirely urban, has no benefits to agriculture. For the River Cole benefits are estimated through land use changes especially from arable crops to water fringe habitats and set-aside land.

Monitoring at both sites has not shown any significant improvements in water quality. Hence benefits are taken as zero in both cases.

3. AMENITY

The characteristics and quality of the local environment can affect property values; furthermore, properties in close proximity to a pristine and attractive river can attract high price premiums (where flooding risks are not of concern). River restoration may result in increases in the price premiums attached to riverside properties through the creation of a more 'natural' and attractive channel.

It is assumed, using the FWR Manual, that only houses lying within 2,000 feet of the river will see any price premium. However, it is also likely that houses directly adjoining the river channel will be most likely to experience a price premium, or to receive a higher premium.

In the case of the Cole, there are no houses directly adjoining the river. Although a few houses in Coleshill do lie within 2,000 feet it is considered unlikely that restoration of the river would add any additional premium to house prices. This is because of the historic status of the village, which is also owned by the National Trust. For the river Cole, therefore, benefits to amenity are taken as zero.

Amenity benefits are predicted as resulting from restoration on the Skerne. A range of benefits are estimated by assuming premiums applied to all houses within 2,000 feet (the upper bound), all houses with direct access to the river (no roads, or other houses between it and the river; the mid bound) and all houses directly 'adjoining' the river (whose gardens lead directly to the river, or its floodplain; the lower bound).

Benefits are calculated using the Halifax House Price Index to give:

- upper bound estimate: £55,000;
- mid bound estimate: £13,000; and
- lower bound estimate: £6,300.

4. FISHERIES AND BENEFITS TO ANGLERS

Improvements to fisheries can arise from a change in habitat diversity, which may be more suited to the fish themselves or to their food source, removal of obstacles which prevented movement of migratory fish or changes in water quality that increase the amount and diversity of life a river can support.

Post-restoration on the Cole, electrofishing techniques found the biomass is significantly improved, especially just downstream of the restored reach where fish appear to be resting before swimming into the restored section. Monitoring data suggest the improvement from a moderate to good fishery (with categories taken from the FWR Manual). Willingness to pay figures and extra trips following improvements are also taken from the FWR Manual. Overall benefits are calculated as:

- upper bound estimate: £3,600;
- mid bound estimate: £1,500; and
- lower bound estimate: £180.

Similarly, improvements are also seen in the Skerne. Prior to restoration it was suggested that there was no known fishery, however, the public perception survey identified some fishing trips on the river. It is assumed, therefore that pre-restoration the fishery was, at best, poor. Following restoration, monitoring has indicated an increase in fish biomass, but the fishery is still poor. In order to calculate the benefits from restoration, it is assumed that the fishery to a poor coarse fishery from no fishery. The lower bound estimate uses the number of fishing trips, a willingness to pay for increased enjoyment and the number of residents expecting their enjoyment to increase as reported in the Public Perception Survey. The mid bound assumes all those who had previously fished in the river would experience greater enjoyment through the opportunity of catching more fish. The upper bound uses the standard method with figures for increased numbers of trips and willingness to pay taken from the FWR Manual. Benefits are calculated as:

- upper bound estimate: £5,600;
- mid bound estimate: £2,400; and
- lower bound estimate: £1,000.

Overall benefits to fisheries from restoration for both rivers are, therefore:

- upper bound estimate: £9,200;
- mid bound estimate: £3,900; and
- lower bound estimate: £1,200.

5. FLOOD DEFENCES

Potential benefits include reductions in flood damages, maintenance costs, both for flood defence works and river maintenance, and reduced land drainage costs.

Reduced river maintenance costs are the only benefit for the Cole, with these ranging from around £0 to £500. A slight increase in the amount of flooding is expected, but this will only occur over land for which this would be beneficial. Benefits are, therefore, small at:

- upper bound estimate: £500;
- mid bound estimate: £250; and
- lower bound estimate: £0.

In the case of the Skerne, the probability of flooding has increased slightly, but again will not result in an increase in flood damages. As for the Cole, some savings in river maintenance may be made, but which again would only be very small.

6. RECREATION

Benefits from restoration for informal recreation arise from increasing access to the river corridor, enhancement of the attraction of the area and creation of new recreational areas. Total benefits will also depend upon the size of the local population, those who would visit such sites, and their willingness to pay to do so. In order to estimate these benefits, standard visitor figures and willingness to pay per visit figures are used.

Restoration of the Cole improved access to the river by enhancing existing footpaths and allowing access to a mill of heritage value. The enhanced footpaths are assumed here to act as local park sites, and to attract visitors from within 1 km. The heritage mill is taken as a special attractive feature and treated as a honeypot site. Such sites attract visitors from within 3 km. Willingness to pay figures of £0.11, £0.50 and £1.50 are used for the local park sites. For the honeypot site, £1.50 is used for the lower bound with £3.50 per visit taken for the mid and upper bounds.

Benefits to recreation are thus calculated as:

- upper bound estimate: £110,000;
- mid bound estimate: £49,000; and
- lower bound estimate: £21,000.

The Skerne is treated similarly in the lower and mid bound estimates, by using standard figures and methodologies. For the upper bound, however, visit rates are taken from the Public Perception Survey, together with willingness to pay figures and indications of levels of increased enjoyment. It is interesting to note that the total number of visits in the upper bound case, at almost 69,000, lies just above the estimates of 65,000 and 40,000 per year derived using standard visitor figures of 27.6 and 17.1 visits per year, respectively. Benefits for recreation on the Skerne are calculated using a willingness to pay figure of £1.78, taken from responses of visitors in the public perception survey; with the standard figures of £0.50 and £0.11 for the mid and lower bounds:

- upper bound estimate: £120,000;
- mid bound estimate: £32,000; and
- lower bound estimate £4,400.

Benefits to recreation for both schemes, therefore, are estimated at:

- upper bound estimate: £230,000;
- mid bound estimate: £82,000; and
- lower bound estimate: £25,000.

7. CONSERVATION AND NON-USE

Any increase in plant, bird, fish or other animal diversity post-restoration will increase the conservation importance of the river channel. This will most likely arise from an improvement in habitat diversity, through the creation of pools and riffles, meanders or wetlands. Quantification of benefits relies on willingness to pay figures across local non-users, those living within 3 km who do not visit the river, general river users, those who visit rivers but not the river in question, or non-local non-users, those living more than 3 km from the river who do not visit.

Conservation benefits for the Cole are aggregated across the local population (those living within 3 km of the restored stretch) with willingness to pay of £6.70 per household per year. This reflects the higher value placed on a river by those living locally. The population of the District of Thamesdown are taken as general river users with standard willingness to pay figures of £0.02, £0.03 and £0.05 per kilometre. Non-local non-users are estimated from the

population of Wiltshire and Oxfordshire (in the lower and mid bounds) or the water company service area (Thames, for the upper bound, which also includes London and is, therefore, likely to be an over-estimate), using the same willingness to pay figures as for the general river users. Annual benefits for the Cole are calculated as:

- upper bound estimate: £210,000;
- mid bound estimate: £28,000; and
- lower bound estimate: £18,000.

On the Skerne, conservation benefits are estimated by the same method, with the Darlington population taken as general river users and the Northumbrian water company service area as non-local non-users. Benefits are estimated at:

- upper bound estimate: £53,000;
- mid bound estimate: £34,000; and
- lower bound estimate: £24,000.

The combined total for conservation and non-use are, therefore:

- upper bound estimate: £227,379;
- mid bound estimate: £89,533; and
- lower bound estimate: £59,849.

8. ANNUAL BENEFITS

Tables 8.1(a) and 8.1(b) present the annual benefits for the Cole and Skerne schemes, respectively.

Table 8.1(a): Annual Benefits for the River Cole Restoration Scheme (£1997)			
Benefit type	Upper	Mid	Lower
Agriculture	£24,553	£18,706	£0
Fisheries	£3,625	£1,505	£176
Flood Defences	£500	£250	£0
Informal Recreation	£109,968	£49,158	£20,746
Conservation and Non-Use	£208,683	£27,865	£17,810
TOTAL	£347,329	£97,484	£38,732

Table 8.1(b): Annual Benefits for the River Skerne Restoration Scheme (£1997)			
Benefit type	Upper	Mid	Lower
Fisheries	£5,620	£2,402	£1,033
Informal Recreation	£122,866	£32,472	£4,426
Conservation and Non-Use	£52,953	£33,803	£24,229
TOTAL	£181,439	£68,677	£29,688
Amenity*	£55,398	£13,313	£6,299

* Figures given are equivalent annual values

Table 8.1(c) represents the combined annual benefits for both schemes.

Table 8.1(c): Total Annual Benefits for the Restoration Schemes (£1997)			
Benefit type	Upper	Mid	Lower
Agriculture	£24,553	£18,706	£0
Fisheries	£9,245	£3,907	£1,209
Flood Defences	£500	£250	£0
Informal Recreation	£232,834	£81,630	£25,172
Conservation and Non-Use	£261,636	£61,668	£42,039
TOTAL	£528,768	£166,161	£68,420
Amenity*	£55,398	£13,313	£6,299

* Figures given are equivalent annual values

9. DISCOUNTED BENEFITS

9.1 Discounting Over 25 Years

Attributing these benefits over a twenty-five year period, applying an annual discount rate of 6% (in line with Treasury guidance) provides a prediction of the benefits across the lifetime of the restoration scheme.

Discounted benefits over 25 years for both the Cole and Skerne schemes are presented in Tables 9.1(a) and 9.1(b).

Table 9.1(a): Discounted Benefits for the River Cole (£1997 - at 6% over 25 years)			
Benefit type	Upper	Mid	Lower
Agriculture	£313,871	£239,126	£0
Fisheries	£46,340	£19,239	£2,250
Flood Defences	£6,392	£3,196	£0
Informal Recreation	£1,405,765	£628,406	£265,204
Conservation and Non-Use	£2,667,678	£356,209	£227,672
TOTAL	£4,440,046	£1,246,176	£495,126
TOTAL (check)	£4,440,046	£1,246,176	£495,126

Table 9.1(b): Discounted Benefits for the River Skerne (£1997 - at 6% for 25 years)			
Benefit type	Upper	Mid	Lower
Amenity	£1,384,950	£332,825	£157,475
Fisheries	£71,843	£30,706	£13,205
Informal Recreation	£1,570,645	£415,103	£56,579
Conservation and Non-Use	£676,919	£432,117	£309,729
TOTAL	£3,704,357	£1,210,751	£536,988
TOTAL (check)	£3,704,357	£1,210,751	£536,988

The overall benefits assuming a 25 year time horizon for both schemes are presented in Table 9.1(c).

Table 9.1(c): Overall Benefits for the Restoration Schemes (£1997 - at 6% over 25 years)			
Benefit type	Upper	Mid	Lower
Agriculture	£313,871	£239,126	£0
Amenity	£1,384,950	£332,825	£157,475
Fisheries	£118,183	£49,945	£15,455
Flood Defences	£6,392	£3,196	£0
Informal Recreation	£2,976,410	£1,043,509	£321,784
Conservation and Non-Use	£3,344,598	£788,327	£537,401
TOTAL	£8,144,404	£2,456,929	£1,032,115
TOTAL (Check)	£8,144,404	£2,456,929	£1,032,114

9.2 Discounting Over 50 Years

The benefits of the restoration schemes have also been discounted over 50 years, as presented in Tables 9.2(a) and 9.2(b). The combined benefits of both schemes are presented in Table 9.2(c).

Table 9.2(a): Discounted Benefits for the River Cole (£1997 - at 6% over 50 years)			
Benefit type	Upper	Mid	Lower
Agriculture	£387,002	£294,842	£0
Fisheries	£57,137	£23,722	£2,774
Flood Defences	£7,881	£3,940	£0
Informal Recreation	£1,733,305	£774,823	£326,992
Conservation and Non-Use	£3,289,237	£439,207	£280,724
TOTAL	£5,474,562	£1,536,534	£610,490

Table 9.2(b): Discounted Benefits for the River Skerne (£1997 - at 6% over 50 years)			
Benefit type	Upper	Mid	Lower
Amenity	£2,769,920	£665,629	£314,940
Fisheries	£88,584	£37,866	£16,283
Informal Recreation	£1,936,602	£511,813	£69,762
Conservation and Non-Use	£834,646	£532,807	£381,888
TOTAL	£5,629,752	£1,748,115	£782,873

Table 9.2(c): Overall Benefits for the Restoration Schemes (£1997 - at 6% over 50 years)			
Benefit type	Upper	Mid	Lower
Agriculture	£387,002	£294,842	£0
Amenity	£2,769,920	£665,629	£314,940
Fisheries	£145,721	£61,588	£19,057
Flood Defences	£7,881	£3,940	£0
Informal Recreation	£3,669,907	£1,286,636	£396,754
Conservation and Non-Use	£4,123,883	£972,014	£662,612
TOTAL	£11,104,314	£3,284,649	£1,393,363
TOTAL (Check)	£11,104,314	£3,284,649	£1,393,363

For the Cole the mid bound was predicted to give the most likely overall benefits. The Skerne benefits were expected to lie between the mid and lower bound. Overall, therefore, the annual benefit most likely to reflect the true benefit is between the lower and mid values, possibly erring towards the mid value. Thus, the overall benefits of the RRP restoration works are expected to be around £3.2 million with this being divided fairly evenly across the two schemes.

PART TWO
RIVER COLE

1. INTRODUCTION

The channel of the River Cole, as it flows through the National Trust Buscot and Coleshill Estate on its way to joining the River Thames, has been modified significantly over time. The mill at Coleshill is mentioned in the Domesday Book, possibly suggesting river impoundment more than 900 years ago. As a result of such interventions, a straightened, and artificially deepened and widened channel was created. For this river, the aim of the River Restoration Project (RRP) was to bring about naturalisation and rehabilitation along a 2 km stretch.

This assessment has been prepared approximately one year following the restoration works. It builds upon the various scientific and other data collected as part of the RRP and summarises the likely key benefits associated with the restoration works. The assessment tries to place a monetary value on predicted benefits through the use of environmental economics. It involves placing a monetary value on predicted agriculture, amenity, conservation, fisheries, flood defence, recreation and water quality improvement benefits.

The approach draws upon the use of existing data and valuation techniques to assess the environmental and other costs and benefits. The approach adopted for this benefit assessment is based on the types of desk-top procedures set out in the FWR Manual on *Assessing the Benefits of Surface Water Quality Improvements* (FWR, 1996), the Agency's *Low Flow Benefit Assessment Guidelines* (1997) and the *Draft River Restoration Benefit Assessment Guidelines* (undated). Where relevant, economic values have been taken from these various guidelines and the estimation procedures recommended in them have been followed.

For most of the benefit categories lower, mid and upper bound estimates have been calculated to give a range of estimates. This has been done to reflect uncertainty in willingness to pay values and other key variables such as the number of people visiting the river. These bounds provide a useful form of sensitivity analysis.

In the case of the Cole, it is unlikely that benefits will arise for all of the above categories. However, for completeness, they are all discussed in the assessment presented below.

2. AGRICULTURE AND WATER QUALITY

2.1 Agriculture

Oil-seed rape and winter cereal were the dominant crops before restoration, typical of intensive arable farmland. Upstream of Coleshill Bridge grazing still dominates, indicating that land drainage has not occurred. However, fertilisers and herbicides have been used to improve the grassland and to allow silage production.

Restoration has and will continue to involve diversification, reduction of farm outputs, and potentially the creation of new activities such as shooting and forestry. By 2035, for example, it is anticipated that woodland will cover 30% of the catchment, as part of the Great Western Community Forest.

Environmental benefits may be derived from such changes in land use, especially from increasing the amount of land under set-aside and/or the creation of water fringe habitats.

River Cole Benefit Assessment

Corresponding reductions in fertiliser use should also locally improve river water quality, especially in terms of nutrient concentrations.

It is difficult to place a value on such changes. Moves from intensive to extensive agricultural practices will result in losses to the particular farmer affected, either through a reduction in yield or moves to less valuable activities. For farmers on National Trust land, reductions in rent may be made to offset any loss of earnings. On a national level, however, the value of such losses will be small as consideration must only be given to the changes in net margins (representing economic rent) arising from changes in agricultural practice. Furthermore, in this case, such losses are partially compensated for by MAFF agri-environment schemes, for example for water-fringe and set-aside payments.

The payments made under these agri-environment schemes can be taken as providing a minimum valuation of the environmental benefits arising from the changes in practice. The per hectare payments represent a willingness to pay (by government) to secure the environmental benefits. This assumption is most valid for water fringe habitat payments, but may be a more questionable assumption for set-aside as the latter really reflects a desire to reduce total levels of agricultural production. However, these payments provide the 'best' means at the current time of valuing the associated environmental changes.

The benefit in terms of payments to the farmer for diversification and extensification are given in Table 2.1(a). For the lower bound scenario, it is assumed that the changes in agricultural practice result in no measurable benefits and thus that the net effect is zero. For the mid and upper bound scenarios, changes in land use are assumed within the riparian zone of the river. This has been calculated as 0.5 km either side of the 2 km stretch of river. Taking into account Coleshill Park, copses and the pastoral land, the number of hectares available for such a change is estimated at around 50 hectares. A change from intensive arable cropping is assumed for the mid bound, from 50% cereals and 50% oilseed rape, to more extensive practices under set-aside. For the upper bound, water fringe habitat payments are assumed to be made on the land within the riparian zone and, thus, to represent the value of the benefits from restoration.

Table 2.1(a): Agriculture Benefits				
		Upper	Mid	Lower
type of land use change	from	arable	arable	reduction in rent to account for loss of earnings
	to	water fringe habitat	set-aside	
number of hectares		50.6	50.6	50.6
MAFF payment per hectare		£485	£472 from oilseed rape £267 from cereals	£0
TOTAL PAYMENT		£24,553	£18,706	£0
source: CAP Reform: Arable Area Payments, MAFF Explanatory Guides (1997 Editions)				

2.2 Water Quality

The introduction of reed beds into the river, especially at the confluence of tributaries may buffer contamination brought down from urban areas. Similarly, reed beds may reduce levels of nutrients in the system. With changes in land use around the river, the input of nutrients, especially nitrogen, may also decrease with associated benefits being realised over time.

Changes in water quality can also affect fisheries and the conservation importance of the river. If significant changes in water quality were to be realised, these two categories would reflect the benefits from water quality improvements. Any change in the buffering capacity of the river, for example, may result in significant benefits to wildlife, especially fish, by reducing the impact of pollution events.

One year after restoration, however, there has been no clear change in water quality. It has been impossible to quantify any benefits from changes in land use to date, and it has thus no benefits are assumed here. This should not be taken as meaning that no water quality benefits are likely to arise, only that perhaps during the elapsed time between completion of the restoration works and preparation of this assessment none have been quantified. In addition, the lack of quantifiable benefits may be a reflection of the relatively small stretch of river which has been affected.

3. AMENITY

The characteristics and quality of the local environment can affect property values, with properties lying in close proximity to attractive sites attracting price premiums. In this regard, the creation of a more 'natural' river channel could be expected to result in increases in price premiums for riverside properties. However, no properties adjoin the River Cole with only a few properties in Coleshill (lying within 2,000 feet of the river) potentially benefiting from small increases in price premiums. Given that the village of Coleshill is a historic village owned by the National Trust, the influence of the river upon house prices is likely to be at best very small. As a result, benefits falling under this impact category are not considered further.

4. FISHERIES AND BENEFITS TO ANGLERS

4.1 Overview

Creating more and new habitats should result in improved angling opportunities, either through increased catch rates, improved access, or anglers experiencing greater enjoyment (note that the benefits associated with the creation of a higher quality natural fishery which are separate from gains to anglers fall under the general heading of non-use and conservation). River restoration on the Cole has increased the diversity and number of habitats, and it may be resulting in an improvement in the quality of the fishery (although such an improvement is also dependent on other factors such as water quality)¹.

¹ The terms 'poor' and 'moderate' and 'good' coarse fishery have been adopted here as they relate to the manner in which economic values have been developed for valuation of improvements in fisheries. See, for example, the FWR Manual (FWR, 1996).

Before restoration, there was some angling on the Cole, although monitoring indicated the quality of the fishery was variable, being between 'poor' and 'moderate' in the impounded section. Downstream of Coleshill Bridge, the fishery was of high quality (with biomass of 3,900 g/100m²).

Post-restoration, fish biomass has improved, although the species mix is very similar. Sections of gravelly eroding substrate, for example, now have a biomass of 3,560 g/100m². Just downstream of the restored section a biomass of 7,840 g/100m² was recorded, higher than any other site on the Cole. It was suggested that this reflected both the improved quality of the restored section, and that fish were resting before moving into the shallower water of the restored reach to spawn. The improvement therefore, is in the quality of the existing coarse fishery, rather than the creation of a higher value, such as a trout fishery.

4.2 Benefit Estimates

Again, three different sets of assumptions have been made concerning the level of benefits arising from these improvements to anglers. The mid bound estimates assume an improvement from a moderate to a good fishery. This probably reflects the actual state of the river, pre- and post-restoration, most closely. As a sensitivity analysis, the lower and upper bounds assume changes from a poor to a moderate, and a poor to a good fishery, respectively.

In order to calculate the benefits of river restoration to angling, it is also necessary to predict the number of angling trips made to the site. Varying assumptions have been made here on the number of trips. In general, it is assumed that there would be an increase in the number of angling trips from an improvement in the quality of the fishery, and that this would correspond to a rise in the level of enjoyment, also reflected by an increased willingness to pay.

The figures used in the benefit calculations presented in Table 4.2(a) are taken from the FWR Manual and relate to improvements in coarse fisheries:

- moving from a poor fishery to a moderate fishery (the lower bound assumption) is estimated to result in 9.29 extra trips per angler at a willingness to pay of £0.21 per trip;
- the move from a moderate fishery to a good fishery is estimated to result in 7.78 extra trips per angler at a value of £2.14 per trip; while
- moving from a poor coarse fishery to a good fishery increases the number of trips per angler by 17.07, with a willingness to pay for such an improvement of £2.35 per trip.

For coarse fishing, most anglers travel less than 20 miles, therefore, the relevant population is taken as the catchment population of 11,397 households. Office of Population and Census Surveys (OPCS) data suggest that 9% of households in Thames region contain at least one angler, giving a potential 1,026 anglers in total who may visit the site.

The fishery is owned by the Agency and, as such, there is free access along the whole of the 2 km restored stretch. As a result, anglers are assumed to use the whole stretch of the Cole. On a pro rata basis, the restored reach, making up 2 km of the total 22.7 km, would attract

about 10% of anglers. This does not take into account relative quality of the fishery, but ensures that the alternative 'sites' (e.g. the remainder of the 22.7 km) are considered.

Table 4.2(a) summarises the assumptions made in estimating the value of improvements in fishery quality to anglers and provides estimates of the benefits for each of the three scenarios. Note, that it is believed that the mid to upper bound values provide the most realistic estimates of benefits, particularly if there are knock-on benefits to river stretches downstream of the restored stretch.

Table 4.2(a): Angling Benefits			
	Upper	Mid	Lower
Number of households	11,397	11,397	11,397
Number of anglers (at 9% of households)	1,026	1,026	1,026
Number of extra trips	17,509	7,980	9,529
Extra trips to restored stretch (2 km in 22.7 km)	1,543	703	840
Willingness to pay per trip	£2.35	£2.14	£0.21
TOTAL BENEFIT TO ANGLERS	£3,625	£1,505	£176

As a sensitivity analysis, calculations have also been undertaken using data on typical charges per metre of accessible bank. The Agriculture Budgeting and Costing Book² gives a range of charges dependent upon the quality of the fishery, from £0.30 to £0.65 per metre of bank per annum. Over the 2 km stretch (or 4 km of bank) which was restored the potential charges, assuming the fishery was not owned by the Agency, would lie between £1,200 and £2,600. Since the quality of the fishery post-restoration is most likely to be good, the true value may lie closer to the upper limit. The correlation between the two methods (per trip willingness to pay and per metre of bank value) is seen to be very good in this case and indicates that the mid or upper values from Table 4.2(a) may most closely reflect the actual benefit to anglers on the River Cole.

5. FLOOD DEFENCES

Although it is predicted that there will be a slight increase in flooding, it is unlikely that any increases in flooding related damages to property will occur. In addition, changing land use from arable to grazing reduces any potential damages to crops. In contrast, benefits may arise from a reduction in flood defence expenditure or land drainage costs. Periodic flooding may also be advantageous for pasture and grazing land.

With reference to changes in maintenance costs, expenditure over the last 25 years has been estimated at between £500 and £1,000 per annum and included the occasional removal of silt

² Agro Business Consultants (1996): *The Agricultural Budgeting & Costing Book*, No 43, November 1996.

bars and obstructions, such as tree branches. The new maintenance plan, following restoration, will operate along similar lines with the removal of obstructions where necessary. Estimates for such work are in the order of £250 to £500 per annum. Therefore, the savings involved as a result of restoration will be minimal. The maximum potential saving is £500 per year, but even this figure is likely to over-estimate the potential benefits. The benefits from reduced maintenance are, therefore taken as £500 per year for the upper bound, £250 per year for the mid bound and £0 for the lower bound.

6. RECREATION

6.1 Activities Created by River Restoration

The restored river corridor will enhance the existing footpath along the river, create a new footpath through the Great Western Community Forest, and provide access to the ancient mill. Extra visitors and increased enjoyment may both result from these restoration works. These footpaths can effectively be assumed to act as local parks, receiving a similar number of visitors per year as such parks would, ranging between 10,000 and 30,000 visitors per annum (although in time with the development of the Community Forest it may attract a larger number of visitors). The mill, on the other hand, is more likely to act as a honeypot site due to its heritage value, attracting over 60,000 visitors per annum.

6.2 Estimation of Visitor Numbers

There are effectively three approaches which can be used to estimate the number of visitors who are likely to use a given site for informal recreation (including walking, picnicking, bird watching). These can be summarised as follows:

- adoption of standard figures on visit rates for local park and honeypot sites;
- use of general per household 'user' rates for rivers; and
- use of the distance decay approach together with standard visitor data to predict visitor numbers during specific months of a year.

For this assessment the first method has been adopted, using formulae that the University of Middlesex has established providing simple relationships on the number of visitors to local parks and honeypot sites. These formulae rely on data concerning the number of people living within 3 km of the site. Local park sites, such as the footpaths and cycleways, are assumed to attract visitors from 1 km, while honeypot sites which have more facilities, or special attractive features like the ancient mill, attract visitors from further afield with a radius of 3 km being taken as giving a conservative population. Middlesex have estimated that visits rates vary from 27.6 per adult to 17.1 per adult, with a mid estimate of 21.3 visits per adult. As noted above, it is suggested that roughly 10,000 to 30,000 visits per annum can be expected at local parks, with honeypot sites attracting between 60,000 and 250,000 visits.

For the River Cole, the population falling within 3 km is estimated from 1:10,000 maps and population density figures for rural, and urban areas. The total population of the catchment is thus calculated as roughly 22,800. The catchment lies within the district of Thamesdown, which includes Swindon, and has a total population of 173,100. The average population density across urban and rural areas is estimated at 7.5 and 0.75 respectively, over the total

area of 129 square kilometres. Hence, the population within 1 km of the river is about 180 and within 3 km is about 1,600.

Alternative sites close to the restored section of the river are taken as the Coleshill Parkland, a local park site, and the historic village of Coleshill, assumed to be a honeypot site. It is assumed, therefore, that two-thirds of all local park visits, and one-half of all honeypot visits are to sites along the restored length of river.

6.3 Benefit Estimates

The willingness to pay values for visits along rivers to local parks have been estimated to range between £0.11 and £1.50, with £0.50 providing a central value. The value of £0.11 represents the willingness to pay of visitors to rivers for improvements in river water quality. This value can be taken as reflecting, therefore, the fact that much of the footpaths (local parks as defined here) already existed and thus that restoration has only resulted in an improvement in the quality of the sites. In contrast, the values of £0.50 and £1.50 may be more appropriate as they reflect the fact that restoration is leading to the creation of a new footpath through the Great Western Community Forest, although tree planting to increase woodland cover in the catchment to 30% will not be completed until 2035. The forest itself will continue to expand into the catchment until this date.

For the honeypot site of the mill, a value of £1.50 was taken for the lower bound and £3.50 for the mid and upper bounds. Given that access to the mill was only possible post restoration, only the lower bound estimates takes the lower per visit value.

Table 6.3(a) presents the estimated benefits for the upper, mid and lower bound calculations. The total figures are in £ per annum (undiscounted).

The relatively low visitor numbers, when compared to the University of Middlesex estimates, suggests that the Middlesex figures may not be applicable to rural sites, especially where the local population is small. For example, the numbers of visitors (approximately 27,000) to the honeypot site of the heritage mill are on the low side when compared to the guide figures of 60,000 to 250,000. For this reason, the upper bound estimates assume visitor numbers of 60,000.

Table 6.3(a): Recreation Benefits				
Informal Recreation		Upper	Mid	Lower
Local park sites	population within 1 km	180	180	180
	visits per person per year	27.6	21.3	17.1
	total number of visits	4,968	3,834	3,078
	local park sites within restored stretch	2	2	2
	alternative sites	1	1	1
	total visits to restoration site	3,312	2,556	2,052
	wtp	£1.50	£0.50	£0.11
	benefit	£4,968	£1,278	£226
Honeypot sites	population within 3 km	1,600	1,600	1,600
	visits per person per year	na	17.1	17.1
	total number of visits	60,000	27,360	27,360
	alternative sites	1	1	1
	total visits to restoration site	30,000	13,680	13,680
	wtp	£3.50	£3.50	£1.50
	benefit	£105,000	£47,880	£20,520
TOTAL BENEFIT TO RECREATION		£109,968	£49,158	£20,746

7. CONSERVATION AND NON-USE

7.1 Overview

As well as values held by individuals towards the direct use of a site, individuals may also hold values which reflect their desire to conserve a site; these are generally termed 'non-use' or 'passive use' values and relate to the desire to conserve the environment for future use by either the individual herself or for future generations, or out of more preservationist wishes to ensure the existence of the environment for its own sake. As for the estimation of direct use values, non-use values are derived through contingent valuation surveys (providing willingness to pay values) and the results of some of the previous studies are generic in nature and thus can be used in benefit transfer with some confidence, as adopted here.

The studies which can be drawn upon to provide willingness to pay values all assume that there is a change in the conservation quality of the river following the introduction of scheme (where this may be either through low flow alleviation or water quality improvements). It is important, therefore, to consider the nature of potential improvements arising from restoration works. Restoration of the 2 km stretch of the Cole has increased the number of wetland plant species by a factor of four. An increase in both the numbers of marginal and channel vegetation species has also been also recorded. As the vegetation becomes established, the

number of habitats for birds, macro-invertebrates and fish should also increase. The value of the site, in terms of conservation importance, therefore, should improve.

7.2 Number of Non-Use Households

Previous studies have, in effect, identified two different groups of non-users. The first are individuals who do visit rivers but not the specific river in question, while the second group are those who do not visit any rivers at all. Studies have found that willingness to pay values vary over the two groups and there are indications that they vary depending upon how close the non-user lives to the river. Local non-users (e.g. those within 3 km) have been found to hold a higher willingness to pay value than non-local non-users, with this being explained by people having a greater desire to protect what is nearer to where they live.

As a result of these findings, estimates are generated below for:

- local residents who do not visit the river (local non-users);
- general river users (those who visit rivers but not the Cole); and
- the wider non-use population (i.e. with the relevant population being those households within the water company service area).

The local residents are taken as those living within the 3 km of the River Cole (795 households). It has been assumed that 45% of these households are non-users in line with figures from South West Region (ERM, 1997) for low flow alleviation (giving 358 non-use households). The general river user population is taken as that within the District of Thamesdown, which has a population of 173,098 and just over 86,000 households (85,205 when the local population is removed). Again, 45% are assumed to be general river users to be consistent with the 55% figure for direct river use (giving 38,342 general river user households).

Both the FWR Manual and the Low Flow Benefit Assessment recommend that the relevant water company service area is taken as the appropriate population for aggregation of non-use values. Use of this population suggests that there is a general desire for river restoration and that the site is viewed as being important in this regard. Being located near to an SSSI, a mill of heritage value and the historic village of Coleshill, this is seen as a valid assumption reflecting the conservation importance of the river. However, the Thames region includes London, and is likely to over-estimate benefits (4,584,000 households within the water company service area, of which 4,498,795 are general public households). The total number of water service area households have, therefore, only been included in the upper bound estimate, as a sensitivity analysis.

The combined households from Wiltshire and Oxfordshire, the two counties between which the original channel of the Cole marked the boundary, have been used for the mid and lower bounds (with 600,000 households overall, or 514,795 general public households). Taking 45% of the general public as non-local non-users gives 2,024,500 households in Thames region and 231,660 households in Wiltshire and Oxfordshire.

7.3 Benefit Estimates

The local population is likely to have the highest willingness to pay for conservation of the River Cole. The values which have been derived for those people who live locally to a river

but who never visit it relate to a willingness to pay per household per annum. Two values have been found in two separate studies, with these being as follows:

- lower bound: £6.70 per household/annum; and
- upper bound: £11.45 per household/annum.

The first value was derived in the River Darent study (ERM, 1994), while the second value was found for the River Misbourne (Middlesex University, 1995). Only the lower value is taken here, as it is assumed to better reflect the willingness to pay to improve the 'naturalness' of a river, rather than relieving low flow problems.

The most robust willingness to pay figures for the economic value of non-use benefits are those which have been developed on a per km of river improved basis. Such estimates exist for both water quality and low flow alleviation schemes. The water quality figures range from £0.02 to £0.05, while the low flow figure is £0.03 per km. Assuming that approximately 2 km of river will be affected, this yields a range for the non-use value per household of £0.04 to £0.10. They have been used for the lower, mid and upper bound estimates for the populations of general river users and households in Wiltshire and Oxfordshire respectively. The benefit estimates are presented in Table 7.3(a).

Table 7.3(a): Conservation Benefits				
		Upper	Mid	Lower
Local non-use households		358	358	358
Willingness to pay		£6.70	£6.70	£6.70
TOTAL		£2,399	£2,399	£2,399
General river user households		38,342	38,342	38,342
Willingness to pay (over 2 km)		£0.10	£0.06	£0.04
TOTAL		£3,834	£2,301	£1,534
General public:	Wiltshire and Oxfordshire		231,660	231,660
	Water Company Service Area	2,024,500		
Willingness to pay (per km)		£0.05	£0.05	£0.03
Willingness to pay		£0.10	£0.10	£0.06
TOTAL		£202,450	£23,166	£13,878
TOTAL BENEFIT TO CONSERVATION		£208,683	£27,865	£17,810

8. CONCLUSIONS

8.1 Overall Benefits from Restoration

The total benefits estimated as arising from restoration of the River Cole are shown in Table 8.1(a). They are made up of agriculture, informal recreation, conservation and non-use, and fisheries benefits.

Table 8.1(a): Annual Benefits for the Restoration Scheme (£1997)			
Benefit type	Upper	Mid	Lower
Agriculture	£24,553	£18,706	£0
Fisheries	£3,625	£1,505	£176
Flood Defences	£500	£250	£0
Informal Recreation	£109,968	£49,158	£20,746
Conservation and Non-Use	£208,683	£27,865	£17,810
TOTAL ANNUAL BENEFITS	£347,329	£97,484	£38,732

It can be seen that the total annual benefits from the restoration scheme on the Cole are estimated to range between:

- Lower bound: £39,000;
- Mid bound: £97,000; and
- Upper bound: £350,000.

Of this, use values account for around £21,000 for the lower bound, £70,000 for the mid bound and £139,000 for the upper bound benefit estimates. In terms of per annum benefits, therefore, the non-use values comprise about 59% of the lower bound, 46% of the mid bound and 60% of the upper bound figures.

It is usual practice to aggregate these benefits over 25 and 50 year periods (assuming that benefits start year one as opposed to year zero when the works were carried out), applying an annual discount rate of 6% (in line with Treasury guidance). This allows consideration of the stream of future benefits in present day terms (and thus allows comparison to the stream of costs associated with the RRP works). These present value estimates of benefits are given in Tables 8.1(b) and (c). As Table 8.1(b) shows, an estimate of the net present benefit provided by the restoration scheme over 50 years is around:

- Lower bound: £0.6 million;
- Mid bound: £1.5 million; and
- Upper bound: £5.5 million.

The true value of the benefits probably lies between the mid and upper bound estimates. Informal recreation makes up about 38% of the total mid bound benefits, which seems appropriate given the existing nature and location of the site.

As a calculation check it is interesting to compare these estimates with the results of the contingent valuation survey carried out to develop estimates of the benefits to local residents associated with river restoration works on the River Skerne. This study found a mean willingness to pay of £22.45 per household per annum in increased local taxes (with a median value of £10). This figure, which must be taken as representing both use and non-use values, when aggregated over the estimated 11,397 households in the catchment corresponds to annual benefits of about £256,000. This is much higher than the mid and lower bound estimates, but lower than the upper bound estimate. The Skerne figures were taken from a small study group living in an urban area, and transfer to a rural site, such as the Cole, may explain the difference between this figure and the mid bound estimate calculated here. Inclusion of the population of London in aggregation of non-use benefits, also an urban area, may account for the closer agreement with the upper bound estimate.

Table 8.1(b): Discounted Benefits for the Restoration Scheme (£1997 - at 6% over 25 years)			
Benefit type	Upper	Mid	Lower
Agriculture	£313,871	£239,126	£0
Fisheries	£46,340	£19,239	£2,250
Flood Defences	£6,392	£3,196	£0
Informal Recreation	£1,405,765	£628,406	£265,201
Conservation and Non-Use	£2,667,676	£356,211	£227,676
TOTAL	£4,440,044	£1,246,178	£495,127

Table 8.1(c): Discounted Benefits for the Restoration Scheme (£1997 - at 6% over 50 years)			
Benefit type	Upper	Mid	Lower
Agriculture	£387,002	£294,842	£0
Fisheries	£57,137	£23,722	£2,774
Flood Defences	£7,881	£3,940	£0
Informal Recreation	£1,733,305	£774,823	£326,992
Conservation and Non-Use	£3,289,237	£439,207	£280,724
TOTAL	£5,474,562	£1,536,534	£610,490

PART THREE
RIVER SKERNE

1. INTRODUCTION

Modifications have been made to the channel of the River Skerne, as it runs through Darlington, over the last century for flood defence purposes. A straightened and canalised channel resulted from these modifications, with uniform width and depth, and concrete flood banks. The aim of the River Restoration Project was to bring about a "riverside revival" focussing on amenity, recreation, and water quality improvements.

This assessment summarises the likely key benefits which have and will continue to arise from the restoration works. The assessment predicts the value of environmental benefits in monetary terms, based on the use of simplified desk-top appraisal techniques. These techniques involve taking economic estimates developed for other river situations (and environmental changes) and transferring them to the River Skerne context. This includes placing a monetary value on any predicted agriculture, amenity, conservation, fisheries, flood defences, recreation and water quality improvement benefits. As will be seen from the following sections, however, for the Skerne, it is unlikely that benefits will arise for all of the above categories; although all categories are discussed for completeness.

The approach which has been adopted here draws on the types of approaches set out in the FWR Manual (1996) for *Assessing the Benefits of Surface Water Quality Improvements* and the *Low Flow Alleviation Benefit Assessment Guidelines*. This includes the adoption of values set out in these reports and use of the same predictive techniques when it comes to estimating visitor numbers and participation rates.

Use has also been made of the public perception survey carried out by the University of Middlesex (Flood Hazard Research Centre - FHRC) and commissioned by the River Restoration Project. A total of 252 residents were interviewed in the survey with questions covering:

- use of the river and surrounding parkland;
- current perception of the river and surrounding parkland;
- perceptions of the proposed river restoration scheme;
- enjoyment value of visiting the river;
- willingness to pay for national and Skerne restoration schemes; and
- public expectation after changing the river.

The size of the survey was not sufficient to meet FHRC and National Oceanic and Atmospheric Administration (NOAA) guidelines for conducting contingent valuation (CV) surveys. FHRC also note that limitations on space in the questionnaire also produced willingness to pay results that should be viewed as exploratory.

2. AGRICULTURE AND WATER QUALITY

2.1 Agriculture

The restoration site lies entirely within urban fringe open space. Therefore, there is no land of agricultural importance which has been affected and, consequently, no benefits or costs to agriculture from restoration.

2.2 Water Quality

Monitoring of standard chemical water quality parameters, for example pH, suspended solids, biological oxygen demand (BOD), and dissolved oxygen (DO), was carried out on the Skerne before restoration. Results showed occasional acidic inputs, and low oxygen content, with a high mean for ammoniacal nitrogen. Suspended sediments and nutrient levels were also high. Levels of phenol often exceeded the EC guideline limit for abstraction of drinking water. Before restoration, the worst measurements for dissolved oxygen and biological oxygen demand put the river water in a RE5 classification. Mean measurements, however, suggest a RE2 class river. However, no obvious change in any of the determinands was found after restoration. Therefore, at present it appears that there are no measurable benefits to water quality as a result of restoration, although the potential for water quality improvements over time does appear to exist.

Water quality can affect fisheries and the conservation importance of the river. If significant changes had been found, these two categories would reflect benefits from water quality improvements. Any change in the buffering capacity of the river, for example, may realise significant benefits to wildlife, especially fish, by reducing the impact of pollution events. However, given the findings to date, the potential for such reductions cannot be predicted. Benefits from water quality improvements are, therefore, taken as zero.

3. AMENITY

3.1 Overview

The characteristics and quality of the local environment can affect property values; furthermore, properties in close proximity to a pristine and attractive river can attract high price premiums (where flooding risks are not of concern). As the increased property value partly reflects potential recreational benefits of the location (and perhaps some limited level of non-use values), incorporating these premiums into an economic analysis could result in some double-counting. This is more likely on rivers where activities such as boating and sailing are possible from the property itself, and thus is not thought to be a problem here. In any event, such premiums also comprise additional values to those included within 'recreation' and 'conservation and non-use' valuation, and so their inclusion is deemed appropriate.

River restoration may result in increases in the price premiums attached to riverside properties, through the creation of a more 'natural' and hence attractive channel. The FHRC public perception survey asked residents whether they thought the river affected house prices. Only 10% of those who could give an answer thought that the effect of restoration on house prices would be very good. The question was based on a sliding scale from -5 to +5, with +4 or +5 indicating a very good effect on house prices. The majority gave an opinion of 'no-effect'. These conclusions contrast with the views of estate agents who suggest that house prices may show small increases in price, with the greatest impact likely to be the saleability of houses.

3.2 Number and Value of Properties

Although no properties adjoin the river over the relevant stretch, all houses within 2,000 ft may benefit from amenity improvements (FWR, 1996). There are 630 properties lying within this distance, with the number of properties 'directly' adjacent to the river (i.e. no other properties

between it and the river) being 147. There are potentially 63 houses whose gardens lead down to or towards the river, or the floodplain of the river. The numbers of houses were counted from 1:2,500 maps of the restoration area and have provided the basis for developing upper, mid and lower bound estimates of benefits, respectively.

The *Low Flow Alleviation Benefit Assessment Guidelines* recommend that a range of potential price premiums for residential properties is considered (with these relating to the findings of research work), as follows:

- lower bound: 2%;
- mid bound: 10%; and
- upper bound: 15%.

For this assessment, a potential increase in price premium of 2% has been assumed to reflect that there are no houses directly adjoining the river, and the responses from the public perception survey.

In order to value the percentage increase in property prices associated with restoration, it is necessary to make some judgement as to the market value of affected properties. One of the most straightforward ways of approaching this is to use standard Council Tax Bands. For each band of prices A through G, the mid-price value can be taken for aggregating together with the number of properties falling into each band which front the affected river. Application of this approach, however, requires that data are available on the Tax Bands into which properties adjoining the river fall.

Alternatively, as in this case, the Halifax House Price Index can be used. This indicates that the average semi-detached house in Darlington was valued at approximately £54,000, for the third quarter of 1997. Detached houses in the north are valued at £93,000 and terraced houses at £40,000. Using these figures, table 3.2(a) presents the estimated amenity benefits arising from river restoration.

It is important to note that the values presented in Table 3.2(a) have been annualised. This has been done in order to convert the capital sum represented by the 2% change in price premium into a stream compatible with other benefit estimates for end aggregation purposes.

Table 3.2(a): Amenity Benefits			
	Upper	Mid	Lower
Number of detached @£93k	111	29	16
Semi-detached @£54k	309	78	47
Terraced @£40k	210	40	0
Total Capital Value	£35,409,000	£8,509,000	£4,026,000
Total Benefit (2% of capital value)	£708,180	£170,180	£80,520
Annualised at 6% over 25 years			
ANNUALISED BENEFIT	£55,398	£13,313	£6,299

4. FISHERIES AND BENEFITS TO ANGLERS

4.1 Overview

River restoration on the Skerne has increased the diversity and number of habitats for fish and aquatic life. This should result in improved angling opportunities, either through increased catch rates, improved access and thus numbers of anglers using the site, or anglers experiencing greater enjoyment.

Post-restoration the number of fish recorded in the restored stretch of the Skerne has increased both in terms of individuals and biomass. However, the total number of individuals was still small, with only 16 fish caught in total and a biomass less than 1 g/m². This is equal to 100 g/100 m², which is classed as a poor coarse fishery in the FWR Manual (1996) and includes all fisheries with a biomass less than 600 g/m².

4.2 Benefit Estimates

Before restoration, there was no real opportunity for angling on the Skerne. A fish survey by the NRA, for example, found only two individual fish that would have been of interest to anglers. A restocking programme began in 1992 as a result of the fish survey. However, the public perception survey indicated that fishing trips were made to the river. Post-restoration, the increased fish biomass which has been recorded during monitoring suggests the potential for the creation of a class three fishery, although this may not occur immediately.

In order to calculate the benefits of river restoration to angling, varying assumptions have been made on the number of trips. For the lower bound it has been assumed that there would be no increase in the number of trips, but that enjoyment would increase. Both the number of trips and enjoyment are taken from the public perception survey. Trips are calculated at 78 per 252 residents per year. This can be calculated on a pro rata basis from the responses and may over-estimate the actual number of trips. The increased level of enjoyment was also taken from the public perception survey, where 109 residents expected their enjoyment to increase after restoration. This gave an expected 43% increase in enjoyment after restoration (it is also interesting to note that 19 residents expected their enjoyment to decrease). Using willingness to pay figures from the public perception survey, it is possible to estimate an value of £1.65 for visits post-restoration.

The mid bound has used the same figures for the number of angling trips made to the river, at 1,456, and increased value of a visit, at £1.65, but assumed that the increased enjoyment would be experienced by 100% of anglers. This is justified by the increased chance of catching fish post-restoration and because there was no known fishery before restoration.

The upper bound calculation also assumes a 100% increase in enjoyment and 1,456 tips being made to the river. However, it takes the willingness to pay value to improve a fishery from a 'no fishery' status to a 'poor coarse fishery' status from the FWR Manual at £3.86 per trip.

The resulting benefit estimates are given in Table 4.2(a).

Table 4.2(a): Fisheries Benefits			
	Upper	Mid	Lower
Number of trips	1,456	1,456	1,456
Cost per trip	£3.86	£1.65	£1.65
Unadjusted Benefit Estimates	£5,620	£2,402	£2,402
Increased enjoyment	100%	100%	43%
TOTAL BENEFIT TO FISHERIES	£5,620	£2,402	£1,033

5. FLOOD DEFENCES

Restoration of the river changes the duration of flooding from a maximum of 1 to 2 days per year to less than 4.5 days per year. This is equivalent to a 0.8% rise in the chance of flooding. Such a small change is unlikely to result in any substantial increase in damages from flooding. The extra flooding is only expected to reduce access to part of the site for a short period of time.

No savings in flood defence expenditure associated with maintenance of the river stretch were identified for this stretch.

6. RECREATION

6.1 Overview

The restored river corridor will provide greater access both to the river and the new facilities created as part of the restoration project. For example, the existing riverside footpath and cycleway were extended as part of the restoration scheme. Such improvements may attract new visitors or increase the enjoyment of those visiting the site (as compared to pre-restoration). There are no known opportunities for in-stream recreation on the Skerne.

6.2 Estimation of Visitor Numbers

There are essentially three approaches which can be used to estimate the number of visitors who are likely to use a given site for informal recreation. These can be summarised as follows:

- adoption of standard figures on visit rates for local park and honeypot sites;
- use of general per household 'user' rates of rivers; and
- use of the distance decay approach together with standard visitor data to predict visitor numbers during specific months of a year.

For this assessment the first method has been adopted, together with the application of visit numbers taken from the FHRC public perception survey. With regard to the first approach, from other research the University of Middlesex has established some simple relationships for the number of visitors to local parks and honeypot sites based on data concerning the number of people living within 1 km and 3 km of a site. Local park sites, such as the footpaths and

cycleways, are assumed to attract visitors from 1 km. Honeypot sites are those that have more facilities, or special attractive features. They attract visitors from within a radius of 3 km. Middlesex have estimated that visits rates vary from 27.6 per adult to 17.1 per adult, with a mid estimate of 21.3 visits per adult. In general, it is suggested that roughly 10,000 to 30,000 visits per annum can be expected at local parks, while honeypot sites are likely to attract between 60,000 and 250,000 visits. It is important, however, to also consider alternative sites providing similar facilities. In this case, the Rockwell Conservation Area is taken as an alternative site, although it is not completely separate from the river.

Using figures available from the public perception survey on visits and activities which relate directly to the local population should provide a more accurate reflection of informal recreation at the Skerne than the use of standard formulae. Unfortunately, some of the public perception survey questions were answer by only a small sub-sample of the whole survey, due to the difficulty of putting a figure or value on enjoyment, willingness to pay, house prices etc., and thus the results may not be representative of the whole local population. The data will, however, provide good indicative figures.

On the basis of the public perception survey, the total number of visits were calculated using the percentage of respondents in each of the four zones around the river multiplied by their visit occurrence (daily, fortnightly, monthly etc.):

- riverside;
- within 250m;
- 250 to 500m; and
- further than 500m.

Specific activities undertaken per visit were determined from a table of percentages that showed walking to be the most popular activity, associated with 71.1% of trips (Table 6.2(a)). Often, more than one activity occurred per trip, which was corrected for by calculating the actual number of trips back to 100%.

For example, total trips for all activities was 205%, with walking making up 71.1% of the 205%. Dividing the estimated number of trips by 2.05 (correcting back to 100%) ensured that visits that involved two or more activities were only counted once. For walking, the total number of trips were 7,839, which corrected back to 3,824. Such a correction does not take into account which activities are more likely to occur together (walking and 'access to elsewhere', for example) but without further information it is not possible to correct the figures by any other method. Fishing and 'access to elsewhere' were also removed from the overall visit rate, as these are considered in the fisheries and conservation sections, respectively, to avoid double counting. This left pre-restoration annual visits per 252 residents of 8,221 (or 33 visits per resident per year). Of these residents, the user percentage was 65.4%. This is approximately 10% higher than the standard figure of 55% suggested elsewhere.

Table 6.2(a): Most Popular Activities			
Activity	%	Number of trips (uncorrected)	Number of trips (corrected)
Walking	71.1	7,839	3,824
Walking the dog	37.9	4,180	2,039
Sitting	3.0	334	163
Cycling	7.9	871	425
Playing	7.0	776	379
Football/games	7.2	790	385
Access to elsewhere	50.7	5,590	2,727
Wildlife	18.7	2,060	1,005
Fishing	1.5	161	79
TOTAL	205.0	22,600	11,024
Source: River Skerne Public perception Survey: Stage 2 (The River Restoration Project)			

Only additional visits, from those not previously visiting the river, and additional enjoyment for current visitors, have been used to calculate the recreational benefits from river restoration. The additional number of visits was 68,937, or 15 per resident per year. This approach ensures that visits which would have been undertaken without river restoration are not counted, hence reflecting only the additional benefit resulting from changes to the river.

The above provides the assumed number of visits for the upper bound scenario. For the mid and lower bounds, the standard formulae estimates of 27.6 and 17.1 have been applied here, as they offer a sensitivity check on visit figures calculated from the public perception survey.

6.3 Benefit Estimates

The value of the visits along the river have been estimated at between £0.11 and £1.50, with a mid value of £0.50. Because the restoration scheme will both improve access to the river and improve the river environment, it is assumed that the £0.11 and £0.50 values are most relevant here as representing the lower and mid bound values. The value for the upper bound was taken from the public perception survey, and varies depending on the proximity of the resident to the river:

- 'riverside' properties willingness to pay was £3.08;
- within 250m willingness to pay was £2.28;
- between 250 and 500m from the river willingness to pay was £1.07; and
- more than 500m from the river willingness to pay was £1.18.

The total recreation benefits have then been calculated by weighting the additional enjoyment by the number of additional visits from each zone. So, the average figure for increased

enjoyment is £1.78, rather than the mean of £1.90, reflecting the higher proportion of residents living more than 250m from the river.

Table 6.3(a) presents the estimated benefits for the upper, mid and lower bound calculations. These figures are in £ per annum and are undiscounted. It is interesting to note that using the figure of 27.6 visits per household gives an annual number of visits that would be typical of a honeypot site, rather than a local park. The use of willingness to pay figures related to the value of recreation at a local park may, therefore, underestimate the true benefit of the restoration scheme. In addition, from this comparison it would appear that the public perception survey results support standard figures taken from other studies.

Table 6.3(a): Recreation Benefits				
Informal Recreation		Upper	Mid	Lower
	wtp per visit	£1.78	£0.50	£0.11
Local park sites		68,937	64,943	40,236
TOTAL BENEFIT TO RECREATION		£122,866	£32,472	£4,426

7. CONSERVATION AND NON-USE

7.1 Overview

As well as values held by individuals towards the direct use of a site, individuals may also hold values which reflect their desire to conserve a site; these are generally termed 'non-use' or 'passive use' values and relate to desires to conserve the environment for future use by either the individual herself or for future generations, or out of more preservationist desires to ensure the existence of the environment for its own sake. As for the estimation of direct use values, non-use values are also derived through contingent valuation surveys and the results of previous studies can be used in benefit transfer.

Before restoration, the ecology of the Skerne river corridor was impoverished and only of moderate conservation value. No nationally rare or notable species were recorded along the surveyed reaches. Similarly, the macro-invertebrate species-richness was very low with a Species Rarity Index of one.

After restoration, the numbers of wetland species has increased in the river channel by 30%. Planted wetland vegetation has supplemented natural colonisation by a further 21%, or nine species. Benefits from conservation, therefore, will be positive, resulting from improvements in the natural environment.

7.2 Number of Non-Use Households

Previous studies have, in effect, identified two different groups of non-users. The first are individuals who do visit rivers but not the specific river in question, while the second group are those who do not visit rivers at all. Studies have found that willingness to pay values vary over the two groups and that they also vary depending upon how close the non-user lives to the

river. Local non-users (e.g. those within 3 km) have been found to hold a higher willingness to pay value than non-local non-users, with this being explained by people having a greater desire to protect what is nearer to where they live.

As a result of these findings, estimates are generated below for:

- local residents who do not visit the river (local non-users);
- general river users, which includes those who 'visit' the river to gain 'access to elsewhere'; and
- the wider non-use population (i.e. the general public which includes the water service area).

The local non-user population, for the lower bound, was estimated from the public perception survey. The local non-use population was calculated as 32.2% of the 2,353 local households. For an important scheme like the Skerne, it may also be appropriate to consider a wider population such as that within Darlington and the water service area. Note that it has been assumed that 45% of the households in Darlington and the water service area are non-users based on information gained during the low flow alleviation study undertaken for South West Region (ERM, 1997). This is also consistent with the 55% user figure taken for benefit estimates of informal recreation. To provide an upper bound, the number of households for the water service area has also been considered, but it has also been corrected to exclude the local non-users and the population of Darlington. The above assumptions have all been presented separately in Table 7.3(a) for clearer presentation.

7.3 Benefit Estimates

The local population is likely to have the highest willingness to pay for conservation of the River Skerne. The values which have been estimated for those people who live locally to a river but who never visit have been derived in terms of a willingness to pay per household per annum. Two values have been found in two separate studies, with these being as follows:

- lower bound: £6.70 per household/annum; and
- upper bound: £11.45 per household/annum.

The first value was derived in the River Darent study (ERM, 1994), while the second value was found for a sub-sample of those surveyed concerning low flow alleviation on the River Misbourne (University of Middlesex, 1995). The lower value is assumed here as it is more conservative.

For other non-users, the most robust willingness to pay figures are those that have been developed on a per km of river improved basis. Such estimates exist for both water quality and low flow alleviation schemes. The water quality figures range from £0.02 to £0.05, while the low flow figure is £0.03 per km. Assuming that approximately 2 km of river will be affected, this yields a range for the non-use value per household of £0.04 to £0.10. Thus for general river users and non-local non-users, the lower bound figure assumes willingness to pay of £0.02 per kilometre across the local non-use, general river users and water service area household. The mid bound figure assumes the same non-user population and takes a willingness to pay of £0.03 per kilometre. Similarly, the upper bound takes the value of £0.05 per kilometre. The benefit estimates are presented in Table 7.3(a).

Table 7.3(a): Conservation Benefits			
	Upper	Mid	Lower
Local non-use households	758	758	758
Willingness to pay	£6.70	£6.70	£6.70
TOTAL (@£6.70 per household)	£5,079	£5,079	£5,079
Darlington non-use households	21,261	21,261	21,261
Willingness to pay	£0.10	£0.06	£0.04
TOTAL	£2,126	£1,276	£850
Water Service Area	457,487	457,487	457,487
Willingness to pay	£0.10	£0.06	£0.04
TOTAL	£45,749	£27,449	£18,299
TOTAL BENEFIT TO CONSERVATION	£52,953	£33,803	£24,229

8. CONCLUSIONS

8.1 Overall Benefits from Restoration

The overall benefits estimated from restoration of the River Skerne are shown in Table 8.1(a). They are made up of recreation, conservation and non-use, amenity, and fisheries benefits. It can be seen that the total annual benefits (including amenity) from the restoration scheme on the Skerne are around:

- Lower bound: £35,000;
- Mid bound: £80,000; and
- Upper bound: £230,000.

Of this, use values account for only around £12,000 of the lower bound benefits, £58,000 of the mid bound benefits and £180,000 of the upper bound benefit estimates. On an annual basis, the non-use values comprise about 67% of the lower bound, 41% of the mid bound and 22% of the upper bound figures.

Table 8.1(a): Annual Benefits for the Restoration Scheme (£1997)			
Benefit type	Upper	Mid	Lower
Fisheries	£5,620	£2,402	£1,033
Informal Recreation	£122,866	£32,472	£4,426
Conservation and Non-Use	£52,953	£33,803	£24,229
TOTAL ANNUAL BENEFITS	£181,439	£68,677	£29,688
Amenity*	£55,398	£13,313	£6,299

* Figures given as annual equivalent values

It is usual practice to attribute these benefits over 25 and 50 year periods (assuming that benefits start in year 1), applying an annual discount rate of 6% (in line with Treasury guidance). This brings future benefits into the present and so provides an estimate of the scheme's net present benefits. These are illustrated in Tables 8.1(b) and 8.1(c). As this table shows, an estimate of the net present benefit provided by the restoration scheme over 50 years, is around:

- Lower bound: £0.8 million;
- Mid bound: £1.7 million; and
- Upper bound: £5.6 million.

The true value of the benefits probably lies between the mid and lower estimates, although figures taken from residents living near the river suggest these could be much higher. Informal recreation makes up about 30% of the mid bound total benefits.

As a calculation check, it is interesting to compare these estimates with the results of the willingness to pay for the national and Skerne schemes from the public perception survey. A mean willingness to pay of £22.45 per household per annum in increased taxes was found. The median value was £10. This figure which must be taken to represent both use and non-use, when aggregated over the 2,353 local households corresponds to annual benefits of around £53,000. This suggests the true value of the benefits from restoration lies between the lower and mid bounds possibly being closer to the mid bound.

Table 8.1(b): Discounted Benefits for the Restoration Scheme (£1997 - at 6% over 25 years)			
Benefit type	Upper	Mid	Lower
Amenity	£1,384,960	£332,814	£157,470
Fisheries	£71,845	£30,711	£13,206
Informal Recreation	£1,570,645	£415,096	£56,579
Conservation and Non-Use	£676,924	£432,123	£309,723
TOTAL	£3,704,374	£1,210,744	£536,978

Table 8.1(c): Discounted Benefits for the Restoration Scheme (£1997 - at 6% over 50 years)			
Benefit type	Upper	Mid	Lower
Amenity	£2,769,920	£665,629	£314,940
Fisheries	£88,584	£37,866	£16,283
Informal Recreation	£1,936,602	£511,813	£69,762
Conservation and Non-Use	£834,646	£532,807	£381,888
TOTAL	£5,629,752	£1,748,115	£782,873

8.2 Comparison of Methodologies

Only benefits for recreation and fisheries include figures from the public perception survey to estimate the overall benefit. Conservation also includes the non-user local population, which was calculated from the survey, but forms only a small percentage of the overall estimate. However, the total benefits calculated for fisheries and recreation can be compared to assess the similarities and differences between the two methods. It may also provide support to the standard methodologies, by giving results which compare favourably.

The total benefits for recreation and fisheries are presented in Table 8.2(a). It can be seen that the difference between the two totals is around £110,000, with the public perception survey over-estimating the benefits in comparison with the standard methodologies. For an urban scheme, with a local population regularly visiting the site, the standard willingness to pay figures may, therefore, underestimate the potential benefits. The visitor numbers did compare well suggesting the local park and honeypot site figures can be transferred to urban sites with a degree of confidence.

For fisheries the over-estimate is from standard methodologies, in particular the willingness to pay figure for an improvement to a poor coarse fishery. However, as noted in Section 4 above, the standard figure assumes no opportunities for angling before restoration. The public perception survey showed that there were some angling visits undertaken on the Skerne, therefore, the standard FWR willingness to pay figure used would be expected to overestimate the angling benefits as the change in the fishery is not directly from 'no fishery'.

Table 8.2(a): Comparison of Methodologies		
Benefit	Standard Methodologies	Public Perception Survey
Fisheries	£5,620	£2,402
Recreation	£68,677	£181,440
TOTAL	£74,298	£183,842