The Lower Colne Improvement Scheme: Environmental Costs and Benefits

A. Driver, BSc* and A. T. Pepper, BSc, CEng, MICE *(Fellow)***

Abstract

The Lower Colne improvement scheme, on a river system to the west of London, was the first in the Thames region to give equal importance to environmental and engineering aspects in a feasibility study which was carried out in the early 1980s. This resulted in a scheme proposal comprising sixty elements of discrete work, rather than a continuous new channel or embankments, which reduced the impact on the environment. Many of these separate elements comprise environmental mitigation and enhancement features. This paper focuses on (a) examples of different types of scheme, (b) the environmental advantages and disadvantages, and (c) the costs of incorporating such features into flood-defence works.

Key words: **Enhancement costs; environmental assessment; flood-defence works; mitigation costs.**

Introduction

The Lower Colne improvement scheme is a £15 million river-improvement project, at present under construction, in the River Colne catchment to the west of London (Fig. 1). It provides a 1-in-100 year standard of protection to about 2500 properties and has a cost-benefit ratio of 1.5:1. The scheme was the first major flood-alleviation scheme in the UK to break with river engineering tradition and include the appraisal of environmental components in parallel with engineering data gathering. Accordingly, the project team included specialists in agriculture, amenity, angling, aquatic biology, archaeology, fisheries, landscape, planning, recreation, water quality and wildlife working closely with the engineers who were producing potential solutions to the flooding problem. Another important innovation was the use of mathematical modelling[1] of the complex river, lake and floodplain systems, which allowed a rapid re-appraisal of new or revised flood-alleviation options. This combination resulted in a high level of environmental awareness throughout the appraisal, and the flexibility to review further options when undesirable impacts of proposed works were identified.

The study commenced with a data-gathering phase where appropriately skilled consultants and in-house staff identified the constraints and opportunities of an area from an engineering viewpoint and from the eleven environmental aspects. The team then met for an initial appraisal of a simplistic trial scheme where general issues were discussed (e.g. the impact on habitat of river-channel works, or the high engineering cost of diversion channels).

The second phase involved an iterative procedure whereby options for each section of the river system were considered by all specialists on the team, and was gradually refined to achieve a minimum adverse impact at an acceptable cost. This procedure can be summarized as:

(i) A combined familiarization and instant impact-assessment site visit by engineers and environmental specialists:
(ii) An initial set of engineering proposals for each problem area (often involving half a dozen specific pieces of work, such as weir modifications, flood banks, spillways, and diversion channels);
(iii) An impact assessment by each environmental discipline (separately);
(iv) An environmental coordination meeting with engineers answering questions on options and the production of impact matrices;
(v) A reconsideration of any unacceptable impact by the engineers with circulation of revised proposals; and
(vi) A meeting leading to the selection of a preferred option.

Occasional further iterative loops were required to deal with difficult issues.

An important part of the methodology was the careful recording of the impact appraisal at each stage of the process. A matrix format was used with the intention of carefully documenting all decisions for future reference if a proposal was challenged or an environmental impact report was needed (Table 1).

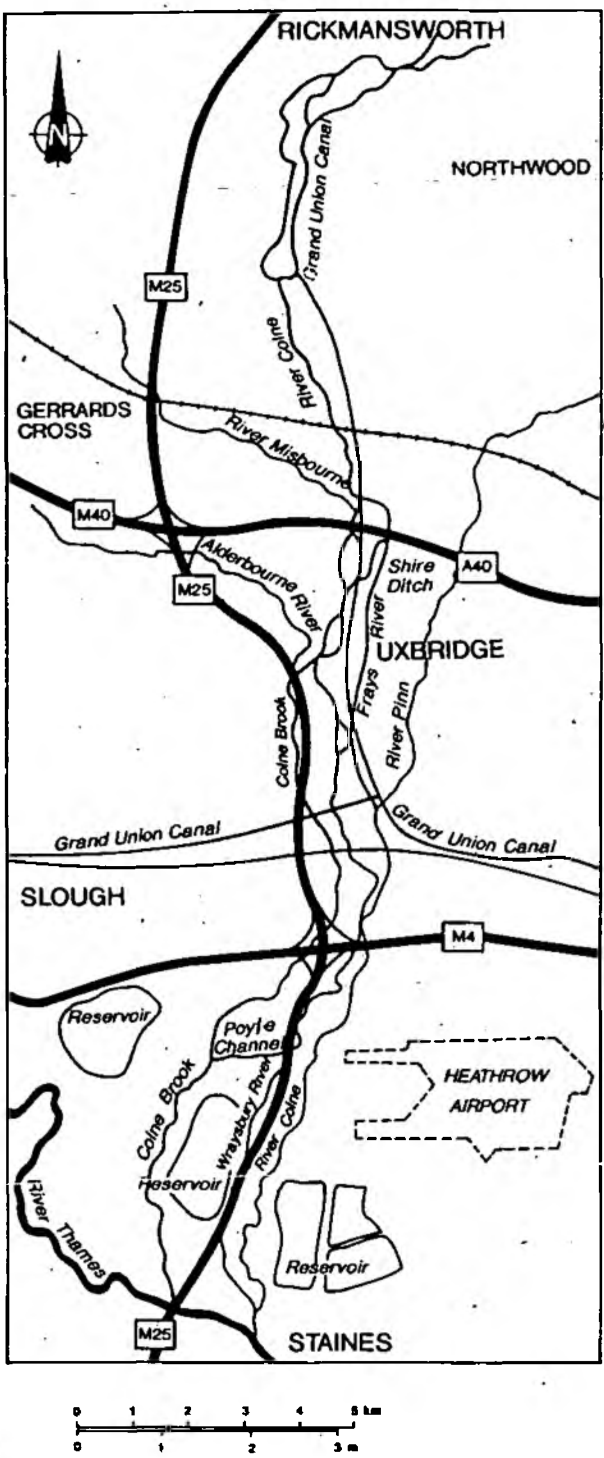
The final set of refined options formed the 'preferred scheme' and comprised a number of minor changes to weirs and sluices, different forms of flood protection (embankments, walls) together with some major changes involving regraded watercourses and new diversion or bypass channels. The preferred scheme was presented to advisory groups and followed the formal local-government procedure for public consultation.

During the external consultation process, preliminary scheme designs were drawn up by in-house engineers. These designs took account of modifications resulting from the public consultation as well as those originating from regular liaison with in-house environmental specialists. The latter used various appraisal

This paper was presented at a meeting of the River Engineering Section, held on 28 January 1994 in London.

* Regional Conservation Manager, National Rivers Authority (Thames Region), Reading, UK.

** Director, ATPEC Ltd, Camberley, Surrey, UK. (Lower Colne Project Manager.)



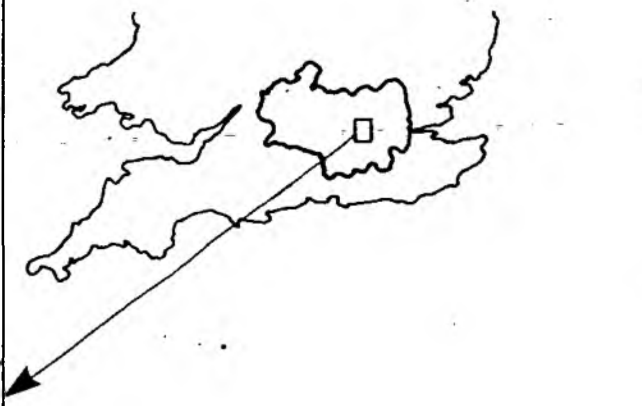


Fig. 1. River system of Lower Colne Valley

reports such as the Environmental Database, prepared during the study, to supplement their own on-site assessment of the impact of the detailed design proposals. External environmental organizations and societies were kept informed of progress by copying all relevant internal correspondence on option refinement, and were given the opportunity to further influence the design. In June 1989, this liaison was strengthened further by the establishment of a formalized environmental assessment procedure. This is a procedure which the National Rivers Authority (Thames Region) established for ensuring that environmental factors are taken into account in the design and implementation of their land-drainage improvement works. These environmental assessment guidelines were drawn up as a result of the requirements of Statutory Instrument (SI) 1217[3]. This legislation requires drainage bodies to prepare an environmental statement if they consider that their proposed river-improvement works are likely to have a significant effect on the environment. Furthermore, the drainage body must place a notice in at least two local newspapers, giving brief details of the proposed scheme along with a statement on the intention (or otherwise) of producing an environmental statement. Any person or body is then entitled to object to the proposal within 28 days, and if agreement cannot be reached the matter is passed to the Minister of Agriculture Fisheries and Food for adjudication. Therefore, it is important that thorough environmental assessment procedures are followed to avoid delays in scheme implementation. The assessment guidelines allow for this through (a) the requirement for full consultation between internal engineers and environmental staff, and (b) an agreed 'signing off' procedure before a scheme is advertized and a tender for construction is accepted.

Liaison with internal environmentalists is continuing through the detail design phase and the construction phase, with site visits being made whilst work is in progress and after completion. Some changes to the originally agreed proposals are inevitable as land usage changes, new legislation comes into force, or additional information becomes available, but the continued liaison ensures that, despite the changes, an acceptable scheme is still produced. Further visits are planned for subsequent years to assess both the engineering and environmental success of the scheme.

There are 60 separate sub-schemes within the Lower Colne improvement scheme, which are being implemented as separate contracts – many valued at less than £100 000. A check is always carried out to ensure that the construction of any one element will not locally worsen the overall or local flooding situation.

A selection of sub-scheme types has been chosen for the case studies, to illustrate the range of environmental mitigation and enhancement works and the costs of the environmental input. All these are taken from the downstream end of the scheme (south of the M4 motorway),

Table 1. Example of a Matrix Entry[2]

Environmental response to proposals for works in Area 3 (West Drayton to Staines)
Matrix for proposals 'in operation'[a]

	A/B[b]	S/L[b]	Lt/St[b]	Int/[b] Cont	D/Id[b]	I/R[b]	Comments
Frays Regrading[c]							
Agriculture[d]	—	—	—	—	—	—	No impact
Amenity	A	L	Lt	Cont	D	I	Grave concern over private amenity as hundreds of gardens back onto the river channel.
Angling	A	L	Lt	Cont	D	I	Loss of fast water fisheries, need angling access on high banks.
Aquatic biology	A	L	Lt	Cont	D	I	Difficult to recreate this stable fast-flowing reach.
Archaeology	—	—	—	—	—	—	No impact.
Fisheries	A	L	Lt	Cont	D	I	Difficult to recreate this stable fast-flowing reach. Important spawning area.
Landscape	A	L	Lt	Cont	D	I	Likely to be adverse even with sensitive working methods, materials and designs. Likely to result in substantial bankside tree loss and may necessitate bank stabilization works.
Planning	A	L	Lt	Cont	D	I	Loss of residents' amenity likely to generate considerable local reaction. L. B. Hillingdon concerned to ensure no impact on Frays island Nature Reserve.
Recreation	—	—	—	—	—	—	All works contained within private land with no public access.
Water quality	—	—	—	—	—	—	No impact.
Wildlife	A	L	Lt	Cont	D	I	Difficult to recreate this stable fast-flowing reach. Inevitable loss of many mature trees.
Maintenance considerations							

Note alternatives (1) Frays river embankments; (2) Divert flows to Colne upstream from railway line (to be evaluated) (see below)

Environmental response to proposals for works in Area 3 (West Drayton to Staines)
Matrix for proposals 'during construction'

	A/B	S/L	Lt/St	Int/ Cont	D/Id	I/R	Comments
Frays Regrading							
Agriculture	—	—	—	—	—	—	No impact
Amenity	A	S	St	Cont	D	I	Construction activity occurring in large number of private gardens.
Angling	A	L	St	Cont	D	R	Disruption to channel environment.
Aquatic biology	—	—	—	—	—	—	No impact.
Archaeology	A/B	—	—	—	—	—	Archaeological watching brief.
Fisheries	A	L	St	Cont	D	R	Disruption to channel environment.
Landscape	A	L	St	Cont	D	I	Potential major problems with disposal of spoil.
Planning	A	S	St	Cont	D	I	Access and works would cause much disruption for a large number of residents.
Recreation	—	—	—	—	—	—	All works contained within private land with no public access.
Water quality	—	—	—	—	—	—	No impact.
Wildlife	—	—	—	—	—	—	No impact.
Maintenance considerations							

Note alternatives (1) Frays river embankments; (2) Divert flows to Colne upstream from railway line (to be evaluated) (see below)

Key

(a) Impact of each proposal entered into two matrices, one for proposal 'In operation' and one 'During construction'.
(b) Categorization of impact: adverse/beneficial, strategic/local, long term/short term, intermittent/continuous, direct/indirect, irreversible/reversible.
(c) Name of proposal under consideration. (The Frays regrading proposal involved regrading of 1.5 km of stable, well shaded, fast flowing, gravel bedded river alongside a residential area. Regrading involved removal of 0–700 mm of bed material.)
(d) Environmental disciplines and their assessment of impact.

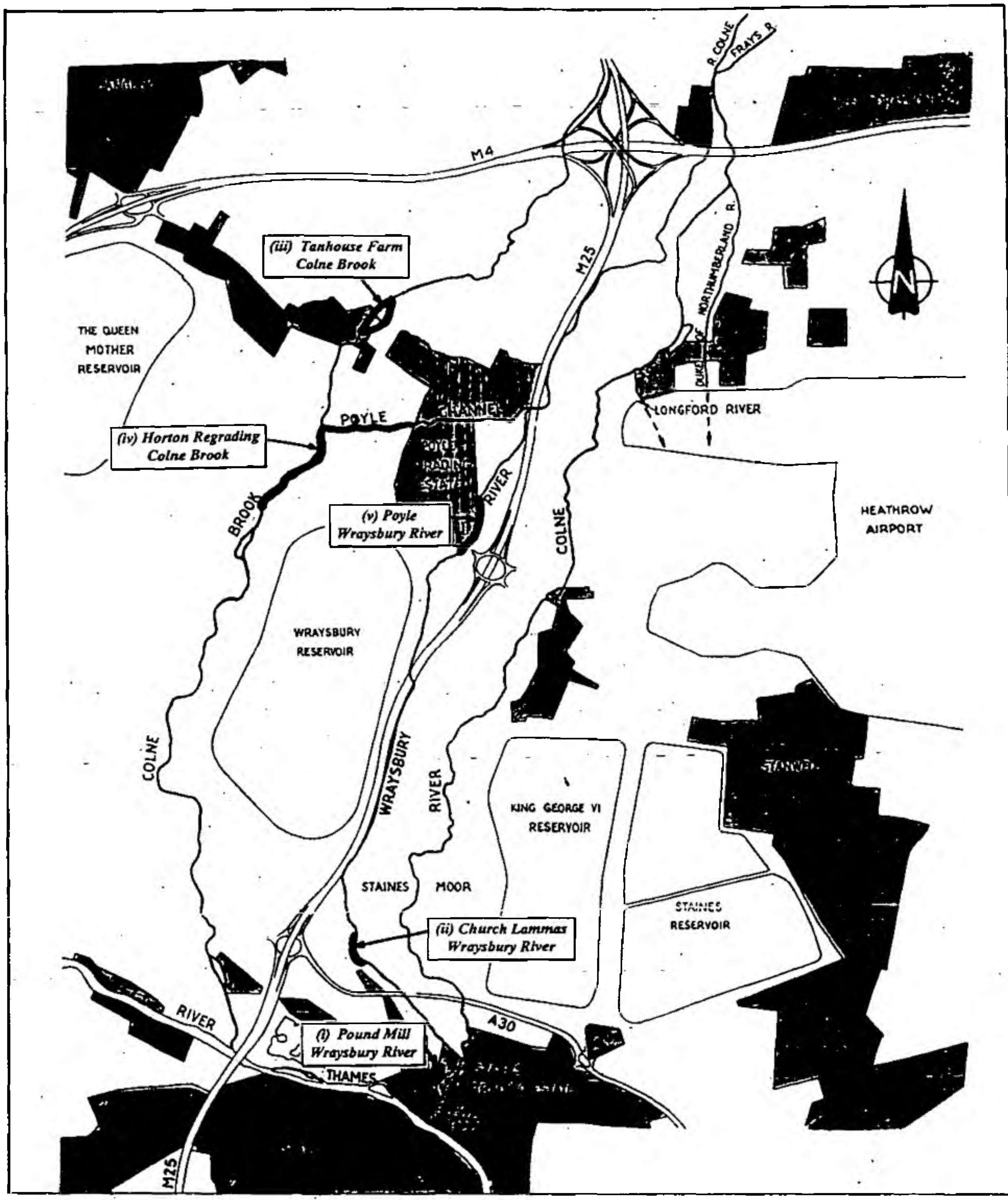


Fig. 2. Location of case-study examples

and their locations are shown in Fig. 2. A summary of the key costs and features is given in Table 2.

Case Studies

(i) Structure replacements and walls

Example: Wraysbury River at Pound Mill, Staines
At Pound Mill the existing old mill sluiceways were very restrictive and prone to blockage, and just downstream a twin brick-arch bridge further impeded flows. Low bank levels compounded the risk of flooding to the adjacent industrial estate. The solution included road bridge, footbridge and sluice replacement, flood-wall construction and channel de-silting. Overall, environmental impacts were not considered to be significant and therefore a written justification for not producing an environmental assessment was produced. The old sluice was replaced with a weir structure which allows the

Table 2. Summary of case studies

Sub scheme	Pound Mill	Church Lammas	Tanhouse Farm	Colne Brook Regrading	Wraysbury at Poyle
Date of construction	Early 1993	Early 1992	Early 1993	Early 1991	Late 1991
Total cost (£'000s)	69	65	277	78	499
Mitigation features	Flower beds Riverside path Native trees	Pools and riffles Native trees Wildflowers	Tree and shrub planting	Gravel bed Native tree and shrub planting	Habitat Recreation Blockstone
Mitigation costs (£'000s)	19	8	17	16	29
Mitigation as % of total cost	11	12	6	20	6
Enhancement features	Native tree and shrub planting	Native tree and shrub planting	Wetland and aquatic planting		Wetland and aquatic planting
Enhancement costs (£'000s)	2	2	9	Nil	3
Enhancement (as % of total cost)	1	3	3	0	<1

passage of migratory fish. The walls of the structure utilize as much of the old brick as possible, and clay nesting boxes were incorporated into the weir walls for wagtails. The de-silting was carefully localized with the most important wetland area being retained. The flood-wall installation involved excavating foundations very close to mature trees, but careful work using small specialized machinery significantly reduced damage to tree roots (Fig. 3). Hale Street Bridge, in a conservation area, was replaced by a higher, clear-span bridge with parapet and surface treatment to suit the area.

Ornamental planting has been carried out on the landward side of the newly constructed walls to complement the busy urban nature of the site. Tree and shrub planting of native species, especially climbers such as ivy, honeysuckle and bryony, has helped to break up the formality of the walls. Overall, the site is considered to be more attractive than it was prior to the scheme, and has won a civic award for environmental improvement.

(ii) Embankments

Example: Wraysbury River at Church Lammas (near Staines)

The scheme required the Wraysbury River at Church Lammas to carry an increased flow, which necessitated the construction of raised flood defences to protect property along Moor Lane, Staines. The scheme involved the construction of a 180-m length of embankment up to 1 m high along the right bank of the Wraysbury River, in a narrow strip between the river itself and Staines Moore 'site of special scientific interest' (SSSI). Planning permission was required for the work

Fig. 3. Flood wall at Pound Mill

and an environmental report was produced to accompany the planning application. This report concluded that impacts on the environment were not significant, even though access had to be gained across an SSSI wetland. The consent of English Nature was obtained to lay a temporary track across the edge of the wetland. The careful alignment of the embankment avoided the need to remove mature trees or infill any of the wetland (Fig. 4), and specialized small machinery and hand working avoided damage to these features. The embankment was sown with a low-maintenance wildflower and grass mix and planted with wildflower plugs, and tree and shrub planting was carried out on the landward side of the embankment. Minor mitigation was carried out in the channel nearby, through the excavation of a pool on the bend of the river, the installation of log-stub groynes using branches from a pollarded willow, and the introduction of gravel to create a riffle. Localized channel de-silting works were carried out alongside the embankment, to ensure that the hydraulic capacity of the watercourse was not reduced.

(iii) Bypass Channels

Example: Colne Brook at Tanhouse Farm, Colnbrook

The Colne Brook at Tanhouse Farm, just downstream from the A4 trunk road, had been identified as an important channel habitat, and it was agreed that excavation of this reach should be avoided if at all possible. Accordingly, a scheme evolved which required the excavation of a 300-m flood bypass channel alongside the Colne Brook and the construction of three new weirs to (a) regulate the flows between the two channels and (b) replace the inadequate mill structure. The bypass channel was sited on low-grade agricultural land of little ecological value, and the environmental impact of the scheme was not considered to be significant. Planning permission was required for the works and a brief environmental report was submitted with the planning application. The flood bypass channel was created with a meandering profile, marginal shelves and variable depth, to provide a variety of aquatic and wetland habitat types. The marginal shelves of the channel have been planted with aquatic and emergent vegetation including branched bur-reed, sweet flag and flowering rush. A wildflower mix has been sown on the banks of the flood channel, and a tree-planting scheme has been implemented both here and on the banks of the Colne Brook itself. This planting involves the establishment of native species including alder, ash, blackthorn, hazel and sallow. In order to ensure the retention of the conservation value of the Colne Brook, flows will not be diverted down the bypass channel in very low-flow periods. Nevertheless, the latter will act as an important wetland refuge with pockets of aquatic habitat at all times of year. A gravel substrate and fish passes at the structures encourage fish spawning and movement upstream.

Fig. 4. Flood embankment at Church Lammas

(iv) Channel Deepening

Example: Colne Brook upstream from Horton Mill

The study identified that this reach of the Colne Brook had inadequate hydraulic capacity, and therefore a scheme involving the partial regrading of the Poyle Channel and the Colne Brook, over a length of approximately 1.2 km, was prepared. The presence of contaminated landfill in the area precluded any bypass channel options, and the construction of floodbanks would have been too intrusive. On average, the channel bed was lowered by 300 mm, but significant areas of the channel bed were left undredged on either side of the channel according to the location of important emergent vegetation and water-lily stands. The impact of the dredging upon important fisheries and aquatic invertebrate habitats, combined with the requirement to remove several trees and trim many others, meant that the scheme was likely to have a significant impact on the environment. The primary environmental objective was therefore to minimize the degree of dredging and trimming as far as possible while ensuring that the objectives were met. In addition, measures were taken to re-create the gravel riffle and pool habitat at the new lower bed level by 'leap-frogging' the gravels upstream as the excavator moved downstream. An environmental statement was produced outlining these impacts and the measures to be taken to mitigate them. As compensation for the loss of several trees and shrubs along both banks, a localized native tree-planting scheme has been agreed with the local authority at the downstream end of the site, alongside their proposed Horton Lagoons local nature reserve. The National Rivers Authority is also intending to fund most of the landscaping work involved with creating this wetland nature reserve.

(v) Channel Widening

Example: Wraysbury River at Skyways Industrial Estate, Poyle

This scheme involved widening the Wraysbury River for 400 m alongside the industrial estate at Poyle, in conjunction with localized bank protection and bank raising, to increase the hydraulic capacity of the watercourse. A variety of alternative options was considered in some detail for the site because of concerns relating to potential impacts upon the river-corridor habitat of enlarging the channel (Fig. 5). However, the close proximity of other constraints, including the M25, a railway embankment, and a wet meadow SSSI, resulted

Fig. 5. Wraysbury River at Poyle (before widening)

in the channel widening being selected as the only practical solution. An environmental statement was prepared, explaining the significant impacts. Having accepted that the scheme would result in the loss of significant derelict willow, scrub and tall herb and grass habitats, the design team intended to create as much alternative wetland habitat as possible. As a result, the final scheme included riffle and pool habitats, a low-flow channel, seasonally isolated islands, shady backwater areas, aquatic and marginal planting, and tree planting (Fig. 6). Two years later, the site had recovered to the point where it provided valuable habitat for a wide range of flora and fauna, as well as being an aesthetic amenity feature. The habitat is certainly different from that which existed prior to the scheme, but is no less valuable in ecological terms and is visually more attractive. The maintenance regime of such a channel is important if it is to fulfil its flood-defence function without losing its environmental diversity, and an operation and maintenance manual has been produced which identifies the effects on channel capacity of various degrees of vegetation growth.

Fig. 6. Wraysbury River at Poyle (1 year after widening)

Conclusions

1. With 70% of the River Colne schemes now implemented (50% by cost), the overall impression is that almost all the sites have been left in an environmental condition which is as good or better than it was before the work commenced.
2. This satisfactory outcome is due to two major characteristics of the scheme:

   (i) *The strategic environmental-assessment process* which was carried out in conjunction with the examination of engineering options. This resulted in the targeting of sites which could provide the hydraulic improvements necessary while generally being of low ecological sensitivity, and the selection of preferred options for these sites in order to reduce the adverse impact while seeking positive enhancements to the area.

   (ii) *The on-going iterative process* which has taken place between engineers and environmentalists during the design process. This has resulted in the implementation of significant mitigation works at every opportunity, with all team members seeking to include enhancements wherever possible.

3. Taking the five case studies as typical examples of the various scheme options, it can be seen that the environmental costs (mitigation and enhancement) amount to about 11% of the overall cost of the schemes. If this is extrapolated to the whole £15 million scheme, approximately £1.5 million will be spent on mitigation and enhancement. This accords with the 10% level which is informally agreed for capital scheme environmental costs in the National River Authority's Thames Region. However, only £195 000 (1.3%) of this is likely to be genuine enhancement, if the case study proportions continue for the remaining projects. In reality, the enhancement figure is likely to be nearer £300 000 (2%), as several of the remaining schemes have appropriate significant ecological enhancements.
4. The multi-functional, iterative, and strategic approach applied to the Lower Colne improvement scheme has proven to be successful and sustainable for both people and wildlife and it is to be commended to all who are involved in promoting flood-alleviation works.

Acknowledgements

The authors wish to thank Kevin Patrick for providing the landscaping costs; Terrie Hunt for her endless patience with the typing; and Tony Dearsley for his valuable support with the introductory section. They are also indebted to the NRA (Thames Region) for allowing them to submit this paper.

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