WILTS & BERKS CANAL TRUST

Restoration of the Wilts & Berks Canal
Feasibility Study

Final Report January 1998

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SUMMARY OF PRINCIPAL FINDINGS

1. INTRODUCTION

This report has been prepared in fulfilment of a commission awarded to Scott Wilson by North Wiltshire District Council on behalf of the Wilts and Berks Canal Trust on 10 April 1997. The commission was for a Feasibility Study for the restoration of the Wilts & Berks Canal, over the full route between the Kennet & Avon Canal at Semington near Melksham in Wiltshire, and the River Thames at Abingdon in Oxfordshire. Also included were the North Wilts Canal from Swindon to Latton near Cricklade, and the Calne branch. The principal findings of the study are summarised below.

2. ROUTE SELECTION

The study has examined route options for restoration of the Wilts & Berks Canal with particular emphasis on reaches where the original route has been lost or obstructed by development. It concludes that in general there appear to be feasible engineering solutions to satisfy the major restoration objectives and which may be supported by the principal interested parties.

For the main urban centres (Melksham, Swindon, Cricklade and Abingdon) restoration on the original alignment, which would require significant property acquisition, and infrastructure modifications, has been found to be less favoured for a number of reasons. However, other than in Swindon, restoration on the original route may still be cost effective by comparison with the alternative options and if achievable would maximise the historic/heritage value of the whole restoration project.

At Melksham, the preferred alternative to the original route makes use of a short reach of the Avon through the centre of the town. This could have a significant impact on the river, and considerably more work will be needed in the next phase of studies to develop this option before the Environment Agency in particular could offer their support. However, another viable but less preferred alternative route to the east of Melksham has been identified and both options need to be retained for the present.

For the Calne branch, should the Conigre tunnel prove to be impracticable to restore, there is sufficient space to cut a new tunnel to the north.

At Wootton Bassett current plans for a new bypass allow for the A3102 to be closed off at this point to permit restoration on the line and level of the original Canal.

The major obstacle to restoration in Swindon arises from development, most particularly in respect of the North Wilts Canal. The principal issues identified in this study are the need for canalisation (i.e. making navigable) of natural watercourses, which the Environment Agency may oppose (but which the preferred route avoids); and the proximity of building development, especially Sainsbury's store at

Bridgemead. These constraints mean that only one possibly supportable alternative route for the North Wilts Canal has been determined.

For the main line of the Wilts & Berks Canal, a preferred new route to the south of Swindon has been identified which keeps the Canal as far from the M4 as possible. Crossings of the M4 and A419 would require thrust bored culverts, but there is adequate headroom. The route may create a new short summit pound at a level some 17m above the original summit although it may be possible (and is desirable) to lower this new summit pound at detailed design stage. Once east of the A419, the route is relatively constrained; the preferred alternative follows (but does not canalise) the Liden Stream, rejoining the original Canal route at Acorn Bridge.

At East Challow, an option to divert the Canal north of the village to avoid development on the original line has been examined, although restoration along the original route is preferred.

The proposed Thames Water Reservoir to the south west of Abingdon would be sited directly over the original Canal line, requiring a diversion around the north side. Such a diversion is likely to be included in Thames Water's plans for the reservoir.

At Abingdon, a new route along the Ock corridor appears feasible although giving rise to environmental objections. However, an alternative new route to the south of the town is likely to be less controversial, and is strongly favoured by local interests.

At Cricklade, there appear to be viable alternative new routes for the North Wilts Canal to both east and west of the town. Given the desire to allow for restoration of the Swindon-Cricklade railway through to Cirencester, which would need to share the same corridor as the Canal through Horsey Down, the western route option has been proposed as the preferred alternative.

3. ENGINEERING

The study has been based on the need to accommodate "standard" narrowboat dimensions of up to 22.0m length, 2.13m beam and 1.0m draft. Broader beam craft will not be accommodated.

The total volume of excavated material (mainly stiff clays from the new canal sections) is estimated to be about $1.4Mm^3$, of which only perhaps $0.1Mm^3$ will be required to form new embankments. There is potential to use up to $0.5Mm^3$ of surplus material in the forming of the surface water reservoirs required for water supply to the restored canal. The most significant new canal cut on the currently preferred routes would be through the Oxford Clay of Horsey Down at Cricklade, where a depth of up to 6m is anticipated. This cutting would be shared with a restored railway.

There will be numerous structures to be constructed or reconstructed for a restoration to navigable standards of the full 108km of Canal. For the vast majority of these crossings, the engineering solution is straightforward, and there is considerable scope for standardisation with resulting economy of construction.

In most cases at road crossings of the original Canal, the original structure has been removed and the channel infilled and culverted. There is now often insufficient headroom to permit the construction of a new bridge over the restored Canal without appropriate changes to the road alignment. The road approaches at each crossing have been examined to confirm that raising of the road level to achieve sufficient headroom (whilst maintaining acceptable standards of vertical and horizontal alignment and sight lines) would appear to be practicable.

For crossings under the M4 and the A419 at Swindon, the A34 at Abingdon, and at least one and possible up to three railway crossings, it is proposed to use the technique of structure jacking (commonly known as thrust boring) which enables the crossing to be undertaken without disturbance to the traffic. In every case there is adequate room to allow this technique to be employed, and, whilst the method is somewhat specialised and expensive (estimated cost ranging from £1.75M for railway crossings up to £2.25M for the M4), it is well tried and tested, and therefore these crossings are not considered likely to be critical in engineering terms to the feasibility of restoration.

The most critical obstruction on the whole length of the restoration is identified as the crossing under the car park of Sainsbury's store at Bridgemead, Swindon, on the North Wilts Canal. Two solutions have been developed; firstly the enlargement of the existing Elcombe Brook culvert for use by the Canal and the provision of a new dry weather flow culvert for the Brook, which would involve minimum disruption; secondly (and preferred), the construction of a new cut and cover culvert for the Canal through the car park.

A total of 82 locks may be required for the restored Canal, against 54 for the original. The additional locks are required primarily to cross the higher summit level on the new route south of Swindon, and for the diversions at Melksham, Cricklade and Abingdon. Each lock or lock flight is likely to require backpumping for water conservation. A total of 39 pumping stations is projected. Although locks may be seen as an interesting feature by non-boating visitors, this increase in the total number is seen as undesirable by boat users and attention will no doubt be required at later stages of the project design to reduce the number whenever possible, as an aid to navigation use.

4. WATER RESOURCES

Based on the clay-dominated geology underlying the original Canal route and a modelled historical water balance, a target total seepage/leakage loss of 10 mm d^{-1} has been assumed. Using this rate, further water balance modelling for the restored Canal has indicated a total water resource requirement of about 4200 Ml y^{-1}, in addition to direct rainfall on the Canal surface. This supply was calculated on the basis of a need to maintain a minimum water depth of about 1.4 m, assuming that, (a) backpumping is used to minimise lockage losses, and (b) ultimate losses of by-pass flows to waste weirs and downstream ends of the Canal are minimised.

An evaluation of water resources along the full length of Canal has identified the following resources as having the potential to supply a total of about 4800 Ml of water annually, and thus satisfy the calculated deficit in supply:

- surface water abstraction at high river flows, followed by storage in about 10 reservoirs;

- groundwater abstraction, using about 20 bored wells at 14 locations; winter abstracted groundwater may require storage in surface water reservoirs, for summer use.

The surface water reservoirs would supply about 2030 Ml y^{-1}, while the wells would supply about 2770 Ml y^{-1}. However, there is uncertainty concerning the availability and suitability of these water resources, e.g. there may be problems with groundwater quality which could reduce the total resource identified to date to about 4200 Ml y^{-1}. To ensure that use of these additional resources is optimised, strategic lining of the restored Canal is recommended:

- puddling of in-situ clay where localised fractures and fissures occur, and/or preparing the channel floor by rolling or producing a cleanly cut surface;

- lining of canal reaches which cross permeable formations where losses may reasonably be suspected; current estimates suggest a total length of just over 3 km will be required at a cost of about £1-1.5 million.

The current, approximate construction cost estimate of developing additional water resources to meet the supply deficit are £11.7 million (annual O&M costs of £82k) for surface water, and £2.5 million (annual O&M costs of £32k) for groundwater. This gives a total construction cost estimate of just over £14 million and an annual O&M cost of £114k. However, the construction costs for developing groundwater resources are cheaper than for surface water, the comparative costs for supplying 1 Ml d^{-1} being £2.1 million and £0.4 million respectively.

5. ENVIRONMENTAL ASSESSMENT

The environmental study has focused on a wide range of environmental issues including land use, ecology & nature conservation, landscape, water quality, archaeology & cultural heritage, noise, air quality and waste disposal. Overall, the proposed restoration of the Wilts & Berks Canal and the North Wilts Canal offers considerable opportunity for associated environmental enhancement both in terms of the natural environment and benefits to local communities. The extent to which this environmental enhancement can be realised will depend upon features built into the restored Canal and, the subsequent overall management and associated recreational activities.

The restoration proposals will raise a very large number of environmental issues, embracing a wide range of topics. The main disruption is likely to be during the construction phase but providing adequate mitigation and good construction practice is adopted the majority of negative impacts are likely to be reduced in magnitude and be temporary in nature. There is also scope for the majority of potentially negative impacts or conflicts which could arise during operation of the Canal to be overcome or minimised by good management and effective maintenance of the waterway. Key issues are outlined below.

In terms of ecology there is a wide range of habitat types along the routes corridor. Although none of the examined routes trangresses any formally designated nature conservation sites there are a large number of valuable sites close to the alignments including Sites of Special Scientific Interest and a large number of Alert Sites. Some changes in habitat type will occur but there is potentially considerable scope to enhance the existing ecological habitats along and adjacent to the Canal and the suggested water storage reservoirs. The scope of enhancement will depend upon careful planning and integration of design measures, the available water quality, and the level of boating and recreational activity. The most sensitive areas are likely to arise on the route options which make use of short sections of the River Avon through Melksham, the River Ray (sometimes referred to as the Elcombe Brook) through Swindon and the River Ock through Abingdon. However, if the preferred options were adopted only the River Avon would be affected.

The restored Canal will pass through or close to a number of towns and villages of varying size. It is considered that there are potentially more positive environmental impacts associated with a route running close to such settlements, particularly the larger urban areas of Melksham, Wootton Bassett, Swindon, Cricklade, Wantage and Grove, where the Canal could add a significant local recreational resource and provide deeper links into the countryside.

Although there are limited data currently available on the quality of water which may be supplied to the restored Canal, it is clear that all the catchments considered in this study suffer from excessive nutrient loading which is exacerbated at times of low flow. The main impacts which follow, therefore, are directly related to nutrient enrichment of the Canal waters, with localised deoxygenation and, in the longer term, eutrophication.

A number of archaeological records exist close to the original Canal route and within the corridor of new route options. Close consultation with the relevant authorities and interest groups will be required prior to the commencement of the restoration or development of any individual reach of the Canal in order that a full examination of the possible impact of the restoration can be assessed, and mitigated against where practicable.

The quantities of excavated material are expected to be large and they represent a significant component of the total scheme cost. A limited amount of excavated material could be re-used as fill but initial estimates suggest that off-site disposal costs could be in the order of £12 million. In order to minimise waste disposal costs it will be important to develop on-site disposal options further for each section of the Canal to be restored.

6. UTILITIES

The utilities companies have been contacted to provide current services information relating to the preferred alignments developed from the route options study. At the time of writing this report some responses remain outstanding.

Although from the information received to date there appears to be a number of important crossings of the proposed Canal route, and several sections where services are very close and may affect construction, we consider that in all cases an effective solution can be found to allow restoration of the Canal.

An allowance of £1.19m in total has been made for services diversions for the relatively minor works required for electricity, telecoms and gas and small piped services for water and sewage. In the case of major pipelines (primarily for petroleum products) across or alongside the route, it may be cheaper to adjust the route of the Canal to avoid interference. Clearly this is a matter that will need to be studied in more detail at later stages of the project, on a case by case basis.

7. COST ESTIMATE

The overall summary cost estimate for restoration is presented below

Section	Length (km)	Locks	COSTS (£ M) Canal Reach	Struct -ures	Serv- ices	Total Cost
ENGINEERING						
Semington to Hay Lane	37.60	29	5.95	9.01	0.26	15.22
Hay Lane to Acorn Bridge	17.05	16	5.87	10.57	0.18	16.62
Acorn Bridge to Abingdon	34.45	20	7.38	12.80	0.24	20.42
Calne Branch	4.85	2	0.59	2.14	0.03	2.76
North Wilts Canal	14.45	15	5.18	8.97	0.48	14.63
SUB TOTAL	108.4	82	24.97	43.49	1.19	69.65
WATER RESOURCES						
Surface Water Resources						9.50
Groundwater Resources						2.46
					SUB TOTAL	81.61
					Contingencies @ 10%	8.16
					Engineering services @ 11%	8.98
					TOTAL CONSTRUCTION COST	98.75
					Land, Legal and other costs	4.00
					TOTAL PROJECT COST	**102.75**
					ANNUAL OPERATING & MAINTENANCE COSTS	0.45

NOTES:
1. Costs exclude any canal related development, marinas etc.
2. Water resource costs are based on recommended lining option, costs of which are included in the engineering costs.
3. Annual costs for operation and maintenance cover all recurrent costs including staff, contract work, office overheads, maintenance and repair work, power supply and abstraction discharge licence charges, but depreciation of assets is excluded..
4. Engineering services includes topographic surveys, ground investigations, further engineering and environmental studies, planning approvals, detailed designs, construction contact documentation and site supervision costs.
5. Other costs includes for the establishment of a navigation authority
6. 95% confidence limits assessed at 67% to 150% of estimate

8. USE AND BENEFIT ASSESSMENT

It is estimated that the restored Wilts & Berks Canal and the North Wilts Canal will generate substantial economic benefits for both the immediate areas through which the Canals pass and for adjacent centres such as Chippenham. The leisure and tourism activities that will take place on and around the Canals will attract visitors to the area and provide recreation opportunities locally for people who live in the vicinity. The benefits are summarised as follows:

	Without Cotswold Canals restoration	With Cotswold Canals restoration
Gross visitor expenditure	£18 million	£20 million
Income retained	£ 7 million	£ 8 million
Permanent jobs created	730	790
Construction employment	1,519 man-years	1,519 man-years

In addition, the scheme will lead to an enhancement of residential property values for new housing alongside or close to the waterway. A 19% premium might be expected for waterside housing, while housing within the same development but without a waterside frontage might experience an 8% increase in value.

Indirectly, the re-opening of the Canals will raise the profile of the area and be a factor in attracting non-leisure and tourism related developments along the corridor but not directly related to the Canal markets such as office/retail development and leisure developments, e.g. pubs/restaurants.

The income retained in the local economy (£8 million per year) can be compared with the overall cost of the restoration project (£103 million). In simple terms, this suggests the pay-back can be achieved in around 12 - 13 years. In reality, however, the pay-back period is likely to be less than this since at least some of the capital involved will be raised outside the local area. For example, Heritage Lottery Funding[1] might meet up to 75% of the cost of a qualifying project. This means that 75% of the cost would be met from nationally derived sources, with local sources only requiring to raise 25% of the capital. In this case the scheme (assumed fully qualifying) would generate an inflow of capital to the area of £75 million (although this might be displaced from other projects in the area).

The restoration scheme will also generate social benefits for the locality, including opportunities for education initiatives; recreation and links to other recreation resources in the area; integration of recreation with the natural environment; health & fitness schemes; enhanced recreational facilities and infrastructure for disadvantaged groups; a focus for special events and festivals; community involvement in restoration

[1] Note that this study was not required to investigate sources of funding. At the time of writing this report a review of arrangements for all lottery fund organisations was being carried out by the Government and the future availability of money from the Heritage Fund for canal restoration projects was being reconsidered. This matter will need to be properly investigated in the next stage of studies

and subsequent management; involvement by third parties in special projects and initiatives; off-road commuting; and employment training.

9. RECOMMENDATIONS

This study has examined in some detail the difficulties to be overcome in order to achieve the goal of restoration of the Wilts & Berks and North Wilts Canals to a fully navigable standard. In engineering terms there appear to be practicable solutions to all the major obstructions; there are some significant (but localised) environmental issues, but the overall environmental enhancement arising from restoration is recognised as a major benefit. Water resources are seen as perhaps the most critical issue, and considerable uncertainty remains at the end of this study, but the initial assessment indicates that overall, sufficient water may be available from a combination of surface and ground water resources. An assessment of the costs and benefits of restoration suggests a reasonably sound economic basis for advancement of the scheme.

To progress the scheme, an overall Strategy Study is now strongly recommended as a first priority. This Strategy Study should draw upon the findings of this Feasibility Study and develop a detailed plan for implementation of the project encompassing all essential elements including: Planning and other consents; Business Plan and Funding Strategy; Land Ownership and Acquisition Strategy; Design and Construction Strategy and Programme; Management Strategy; and Marketing Strategy. We would suggest a budget of £50,000 be set aside for this Strategy Study which overall is likely to take about 5 - 6 months to complete.

Given the critical nature of water supply to the viability of the restoration, and the large uncertainty associated with both resource availablity and resource required (the latter primarily due to large uncertainty in likely seepage rates), further investigations to address these matters must be regarded as the next priority. An initial budget of £160,000 is recommended for these studies which could take about 9 - 12 months to complete depending on field measurement programmes.

In addition, but subsequent to the Strategy Study, and further investigations of water supplies, further work will be required in all the engineering topics covered in this Feasibility Study to confirm the viability of the proposed restoration options and to achieve the milestone of full and adequate incorporation of the final preferred routes into all Local Plans. The primary requirement for this will be good quality topographic survey. We would suggest an initial budget figure of £50,000 be set aside for topographic surveys primarily for the new Canal routes; £30,000 for preliminary geotechnical investigation work; and £300,000 for the ensuing engineering studies and preliminary acceptance design work to achieve the standards of information required for acceptance by the Local Authorities. A total time of 12 - 18 months may be required for this phase of work but much would depend on the programme for Local Plan review and the early agreement of a single preferred route.

Further environmental studies will then be required relating to ecology, archaeology, water quality, noise and waste disposal. Some initial work relating to these matters will also be required to assist with protection of the preferred routes in Local Plans, however, particularly those relating to ecology, archaeology and water quality. Further work is also required with regard to noise and waste disposal to help determine costs and methods for restoration work. To ensure that minimal environmental impact will occur and that relevant legislation is complied with, it is recommended that an Environmental Code of Construction Practice is drawn up and used in relation to construction works associated with the restoration. An initial budget of £90,000 is recommended for these further environmental studies, which will need to run concurrent with the further engineering studies.

On completion of the Stategy Study and the further water supplies, engineering and environmental studies, and assuming adoption of a preferred route in Local Plans, it should then be possible to consider the development of individual projects according to the availability of suitable funding. No details of these projects can be given at this stage.

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1. Introduction

1.1 Commission

This report has been prepared in fulfillment of a commission awarded to Scott Wilson by North Wiltshire District Council on behalf of the Wilts and Berks Canal Trust (the Trust), on 10 April 1997.

The commission was for a Feasibility Study for the restoration of the Wilts & Berks Canal, and covered the full route between the Kennet & Avon Canal at Semington near Melksham in Wiltshire, and the River Thames at Abingdon in Oxfordshire. Also included were the North Wilts Canal from Swindon to near Cricklade, and the Calne branch. The study was required in particular to address the following:

1. review the principal difficulties to be faced in restoring the Canal and consider how these may be overcome;

2. consider the best means and sequence of carrying out the restoration and determine the optimum route;

3. review the water requirements and the best means of providing the necessary resources;

4. assess the benefits of restoration to the local community, as well as regionally and nationally;

5. investigate the environmental impacts of restoration, assess the environmental enhancements achievable, and suggest suitable mitigation measures where necessary;

6. provide sectional cost estimates.

A copy of the full scope of study is included for reference in **Appendix A**.

This report presents all the findings on our field work and desk studies, and makes recommendations for the continuation of the restoration process. Estimated construction, maintenance and operating costs are given and a range of restoration options is proposed for further evaluation and selection.

1.2 Background

1.2.1 Wilts & Berks Canal Trust

The Wilts & Berks Canal Trust is a private company limited by guarantee and not having a share capital. It has been set up for the purpose of restoring the Wilts & Berks Canal and the North Wilts Canal for the use and benefit of the public. The current membership of the Trust is the District Councils of North Wiltshire, West Wiltshire and Vale of White Horse; Swindon Borough Council; the County Councils of Oxfordshire & Wiltshire; and the Wilts & Berks Canal Amenity Group.

1.2.2 Historical Context

The following is reproduced from the original Consultant's Brief for the Study:

The Wilts & Berks Canal extended from Semington Junction, on the Kennet & Avon Canal in Wiltshire, to the River Thames at Abingdon, which at the time of the Canal's construction was in Berkshire although it is now part of Oxfordshire. The route passes through or near Melksham, Chippenham, Calne, Lyneham, Wootton Bassett, Swindon and Wantage. The main line of the Canal was built between 1796 and 1810. A branch, the North Wilts Canal, was constructed in 1814-1819 between Swindon and Thames & Severn Canal at Cricklade. A number of smaller branches were built from the main line to Chippenham, Calne, Longcot and Wantage.

The Canal was built as a "narrow canal" to accommodate boats with maximum dimensions of 7ft 0in (2.13 m) beam and 72ft (22 m) length, and had a depth of 4ft 6in (1.37 m) except on the summit level which was probably 7ft (2.1 m) deep.[1] Use of the Canal declined in the second half of the nineteenth century and navigation effectively ceased early in this century. The Canal was abandoned by Act of Parliament in 1914 with the land reverting to the riparian owners. Most of the original bridges have been demolished

The total route of the main line from Semington to Abingdon is 83.9 km; the North Wilts branch is 14.5 km and the other branches total 9.5 km. There were 23 locks which climbed the 62.1m from the Kennet & Avon to the Canal's summit at Swindon, and 18 locks which descended from the 48.3 m from there to the Thames. 11 locks on the North Wilts descended the 18.0 m to the Thames & Severn. The average difference in level of the locks along the Canal varies: on the main line it is on average 2.7 m whilst on the North Wilts it is 1.6 m.

The Canal was originally supplied with water from Coate Water and Tockenham reservoirs and from a number of small streams; the reservoirs are now used for recreational purposes and may not be available to supply water to a restore Canal. The Wilts & Berks Canal Amenity Group was founded in 1976; its aim is to protect, conserve and improve the route of the Wilts & Berks Canal, and branches, for the benefit of the community and the environment, with the ultimate goal of restoring a

[1] Recent restoration work undertaken by the Amenity Group has cast doubt on this depth holding over the full length of the summit pound

continuous navigable waterway. The Group believes that the Canal is largely still in restorable condition in rural areas, albeit silted up, overgrown and in places obstructed by road crossings. Along the lengths passing through towns the original line has been subject to much redevelopment, particularly in Melksham, Swindon, Abingdon, Wantage and part of Cricklade. The Group has shown that alternative routes are available avoiding these developments. A total of 6.5 km of rural lengths of the Canal have been restored by the Group, largely using voluntary labour, for amenity purposes and to demonstrate the benefits of restoration to the community. The Group has received increasing support for this work from the district councils, the former National Rivers Authority (now the Environment Agency) and from a number of charities and other funding agencies.

1.2.3 The Current State of Restoration by the Amenity Group

The following has been contributed by Mr P A Smith, Restoration Director of the Wilts & Berks Canal Amenity Group:

Since the Amenity Group committed itself to full restoration of the Canal in 1988, considerable progress has been made, using mainly volunteer labour for labour-intensive tasks such as bricklaying, and generally employing specialist contractors for tasks such as large scale dredging.

As the Canal is in multiple ownership, with approximately 200 land owners, tasks have had to be tackled only when the land owner has been willing to allow access.

At Foxham, near Chippenham, a mile of Canal has been cleared and partly dredged. A lock has been rebuilt, and two lift bridges constructed, one of which is fully operational; the other will not be fitted with lifting beams until the Canal is more nearly restored. A major spillweir has been built, and one of the landowners has reinstated two accommodation bridges. This length requires one more accommodation bridge before it can be completed and put back into water; this is scheduled to be built in 1999.

At Dauntsey Lock, the Group has been working with the site owners, the Wilts & Berks Canal Company, a commercial organisation. One lock and a spillweir have been built, and nearly a mile of Canal has been dredged. One spillweir is needed to complete this section, and this is scheduled to be built during 1998. The Wilts & Berks Canal Company have restored a canal-side settlement comprising five cottages.

At Wootton Bassett, on the west side of Marlborough Road, the arch of Dunnington Aqueduct has been repaired and one portal restored. On the east side of the road, a length of nearly one mile has been dredged and put back into water, and is used to give boat trips to the public at weekends during the summer. A slipway, a footbridge and a spillweir have been rebuilt, and a temporary footbridge has been built on the foundation of an arch bridge. Two arch bridges remain to be built; the design is nearly complete, and has been passed by the Local Authority, and work will start in 1998.

Further to the east, the section of Studley Grange Farm, near Junction 16 of the M4, is adjacent to a landfill site owned by Barge Waste Management, who also own this length of the Canal. They are planning to dredge and reinstate it during 1998.

On the far side of the M4, a length of about half a mile at West Leaze Farm has been dredged and filled, and is currently used for fishing. Plans are in hand to dredge the next field going north east during 1998. This links with the section leading up to Kingshill Road, Swindon, which will be cleared and dredged in conjunction with Swindon Borough Council in the near future.

On the North Wilts Canal, at Moredon to the north east of Swindon, restoration of the three-arched Moredon Aqueduct has been progressing for two years and is very nearly complete. The Canal has been dredged for a quarter of a mile back towards Purton Road, and the remains of Mouldon Lock have been cleared. The Local Authority has plans to reinstate the bridge under Purton Road once finances become available. When plans for this are finalised, a decision can be made on whether to restore Mouldon Lock.

Near Shrivenham, about two miles of Canal have been cleared and dredged from near the junction of Shrivenham Road with the A420, to Stainswick Lane. On the eastern side of Stainswick Lane a field has been purchased by the Group, and in conjunction with Shrivenham Parish Council, it has been laid out as a park. Plans for 1998 include the installation of a slipway, dredging of the Canal as far as Tuckmill Brook, about half a mile further east, and a large-scale tree planting on the park.

In the Grove/Wantage area, more than two miles of canal have been cleared of vegetation and the towpath reinstated. Two lengths, one of 300 yards and one of about half a mile, have been dredged and put back into water. The tail bridge of a lock, which has virtually collapsed, has been re-built.

At Drayton, near Abingdon, half a mile of Canal has been cleared and clearance of an infilled lock is nearly complete. This site is in the area of the proposed new Thames Water Reservoir, and future work will depend on whether those proposals are implemented.

1.3 Project Team

The study was administered by a Management Group on behalf of the Trust. The Management Group comprised:

Mr A Harrison	Wilts and Berks Canal Trust (Chairman of the Management Group)
Mr J Dix	North Wiltshire District Council
Mr J Newton	Oxfordshire County Council
Mr P Hempstead	Environment Agency, Thames Region
Mr A Macdonald	Wilts and Berks Canal Amenity Group

The Management Group met for formal Progress Meetings with the Scott Wilson team on five occasions prior to the publication of the draft report. There were many other informal meetings and discussions throughout the progress of the study, including a series of route selection workshops (described in detail in Chapter 2 of this document).

The Scott Wilson team included in-house experts in civil engineering, hydrology and water resources, geotechnics, bridges, railways and roads, and the environment. To assist with the evaluation of economic benefits, the Market Research Unit at British Waterways was retained as a sub-consultant.

1.4 Approach to Study

Although essentially a desk study, a series of field visits were made to ensure that the whole of the original Canal route and the alternative route options were seen and reported on by Scott Wilson staff. Special attention was paid to known areas of difficulty with the historic or alternative routes, such as the North Wilts Canal route west of Swindon, and all major road and rail crossings were separately visited and evaluated by a specialist engineer.

The brief for the study included a list of consultees to be approached for discussions and information for each element of the study. All of these organisations were contacted and they provided valuable information. We also approached a considerable number of other organisations and individuals for information or advice during the investigations, and we list all the consultees in **Appendix B**.

1.5 Data for the Study

Notwithstanding the number of previous studies that have been undertaken and the extent of other information that already existed we found it necessary to obtain some further data in order to complete the study brief tasks. Generally these data were obtained from our own resources, from, published information or from specific investigations carried out as a part of the study work, and the references have been incorporated into this report.

In some instances however the data had to be purchased and/or will be of greater interest for later stages of the project. These data have been collected together for retention by the Trust.

A comprehensive list of all the data collected and the principal reference documents is given in **Appendix C**.

1.6 Abbreviations and Units

Abbreviations have been used for well known organisations throughout this report, although full titles have been given on the first mention.

Abbreviations used for units of measurements are given as follows:

mm	:	millimetre
m or lin.m	:	metre
m^2 or sq.m	:	square metre
m^3 or cu.m	:	cubic metre
Mm^3	:	million m^3
km	:	kilometre
kg	:	kilogram
t	:	tonne
ha	:	hectare
no.	:	number
dia or DN	:	nominal diameter (pipework)
%	:	percent
mm d^{-1}	:	millimetre per day
l	:	litre
l s^{-1}	:	litres per second
mg/l	:	milligrams per litre
ppt	:	parts per thousand
cumecs or m^3/s:	:	cubic metres per second
Ml d^{-1}	:	megalitres per day
Ml y^{-1}	:	megalitres per year

1.7 Acknowledgements

Many organisations and individuals have given willingly and generously of their time and other resources, to assist us with our investigations and the preparation of this report. To all these, too numerous to mention separately, we should like to record our appreciation.

However, particular thanks are due individually to all the members of the Management Group for their valuable advice and guidance throughout the various stages of the project.

2. ROUTE SELECTION

2.1 Introduction

Although a significant proportion of the original Canal and its branches can be traced on currently published maps, and on the ground, urban development in Melksham, Swindon, Abingdon and Cricklade since abandonment in 1914 has rendered restoration on or close to the original alignment in these areas very doubtful. Thus from the outset of this Study a need to develop alternative routes was appreciated, to overcome these and other more localised obstructions to restoration. In planning these alternative options, we considered it important to bear in mind that the main function of canals today is rather different from that for which they were originally constructed. Canals are no longer primarily used as a means of transport for goods and materials, but as a recreation and leisure facility for a multitude of activities such as boating, walking, fishing, canoeing, heritage interest and the like, and they can provide significant benefits in education, nature conservation, habitat creation and environmental enhancement.

Therefore in the planning and assessment of new route options, we have borne in mind the question of whether the route proposed will satisfy this latter day raison d'être, so that maximum benefit will ultimately be realised from the restoration project. This we have seen as particularly important when significant departures from the original alignment have had to be contemplated, but the principle has also been applied to relatively short diversions such as at major highway crossings: here the emphasis has been directed to mitigation, to minimise any disincentive to users, since it is rare for such crossings to prove an attraction in themselves.

Hence whilst the development of route options has required a professional engineer's view of what is practicable and achievable, the driving force has been the ultimate end user and the benefits to be gained. Engineering solutions can ultimately be found to almost any obstruction. We have taken the art of effective route planning to be the achievement of the best balance between practicality, benefits and costs.

It should be noted that, even where it was considered by inspection that restoration on the original alignment was probably impracticable, this was still the first route option we considered. As a base case this original alignment was permitted to deviate in only a very minor way from the historic route (where to do so would avoid what would otherwise be a major and costly obstruction) but major deviations were not permitted: so where the route has been built over or otherwise lost, the cost and consequences of restoration have been assessed, even if this would require demolition of properties and/or major disruption to existing infrastructure. We considered this approach to be essential even if such a route was likely to be unacceptable politically or on other grounds, in order to provide a control for comparison with other options which deviated significantly from the original alignment.

It should also be noted that in the selection of preferred (or optimum) routes, which have then been developed in more detail and are presented and costed on the Route Maps in Appendix D, it must be stressed that these routes should not be regarded as definitive. None of the route options is absolutely ruled out at this stage, since changing circumstances and opportunities or more detailed studies as the restoration project progresses could favour alternative routes or indeed routes which have not been considered by this study (although this is unlikely). Neither are the route options considered exhaustive of all possible variations. The aim has been to identify whether restoration is feasible and to present a scheme which is likely to be supportable by the majority of interested parties. The selection of 'preferred' routes thus necessarily involves compromise. Attendance of an appropriate cross section of interested parties at a series of route selection workshop meetings was intended to ensure that, as far as possible, all significant factors (engineering, environmental, economic, social, political etc) which could influence route selection were represented and taken into account.

2.2 Approach

2.2.1 Identification of Possible Routes

Following the guidelines noted in the previous section our approach to route selection started with the development by desk study and by limited walk-over survey of possible route options which we considered would overcome the identified obstructions to restoration. The resulting route options were essentially generic in principle - that is to say that whilst other options undoubtedly existed, they would only be 'variations on a theme' within a relatively narrow corridor, and would thus achieve the same objective. Where appropriate for comparison purposes, budget costings were prepared, and an initial assessment was made of the relative merits of the options developed.

The budget costs given in this Chapter of the report are first order estimates, and are indicative of construction works tender prices for comparison purposes only. Thus they are exclusive of all common costs (design, supervision, legal costs, land acquisition, contingencies etc.). It is stressed that these budget costs are therefore relative costs for route comparison only, and it should be noted that they have not subsequently been modified to match the more detailed estimates prepared for the preferred routes presented elsewhere in this report.

2.2.2 Workshop Meetings

This initial exercise was followed by a series of 'workshop' meetings, the intention of which was to ensure that full account was taken of the concerns of the key interested parties, and with the primary aims of identifying:

- Route options that were significantly less favoured because of fundamental problems or objections;

- The key issues, benefits and problems to be overcome, that needed to be further studied for the remaining options;

- Minor deviations from route options which might overcome or alleviate a key problem, or generate greater benefit; or major deviations which might constitute new options;

- Initial ranking of options to target and prioritise effort;

The workshop meetings were also intended to provide a general brainstorming session to generate solutions to problems or new ideas. Four such meetings were held, one for each of the District Council areas (Unitary Authority in the case of Swindon) through which the original route passed. The meetings were attended by officer representatives from planning and technical sections of the appropriate Local Authorities (District, County and Town), from the Canal Trust and the Canal Amenity Group, from the Environment Agency, and from the engineering and environmental divisions of Scott Wilson. Representatives were asked to consider not only their own particular interests but also the likely views and reactions of other interest groups within their organisations and elsewhere but not directly represented at the workshops.

2.2.3 Results of Workshop Meetings

The remainder of this Chapter of the report presents the results of this route selection process on a district by district basis, working west to east. For each district, following a description of the options (essentially as presented at the workshops), the issues raised at (and in some cases subsequent to) the meetings and the outcome of the exercise are described.

2.3 West Wiltshire

2.3.1 Introduction

The West Wiltshire DC common boundary with North Wiltshire DC follows the line of the Roman Road running east-west some 3km north of Melksham and about 1km south of Lacock. Thus the West Wiltshire DC area covers the original junction of the Wilts & Berks Canal with the Kennet of Avon Canal at Semington as well as the route through Melksham. Altogether eight new route options were developed for restoration of the Canal through, or in the vicinity of Melksham (see **Figure 2.1** overleaf), and these together with the original alignment were the topics for discussion at a workshop held on 8th August 1997.

The lengths given in the following discussions are for comparison purposes only from the junction with the Kennet & Avon Canal (K&A) to the District boundary just south of Lacock Lock. In addition to budget capital costs (as defined before) an assessment of annual operating and maintenance costs was made for each option.

2.3.2 Development of Route Options for Melksham

Route options utilising the River Avon were investigated in a study by Oxford Polytechnic (1987) and reference was made to this study in the Amenity Group's own study of 1988 (Griffiths and Williams, 1988). In reviewing these and developing other route options we realised that in terms of overall benefits to Melksham (and recognising as discussed later that restoration of the Canal on or near the original alignment through the Town should now be considered very doubtful), an alternative route option which would still allow navigation through the Town but along the Avon would probably be preferred to any new route option around the outside of the Town. Such an internal route would, however, be potentially more problematic and controversial than an external route.

Between the K&A and the River Avon south of the Town, all routes would need to pass through Terrace Gravels requiring lining, and Alluvium in the flood plain.

The eastern route options we developed were in fact the main focus of 'The Melksham Project' (Allen & Harris, 1994). The favoured option from that Report corresponds quite closely with Route E herein. Once clear of the urban constraints of Melksham, there is considerable freedom in route planning between the K&A and the original alignment which can be recovered south of Lacock. We have presented one of many possible variations on a basic theme, as route option G. These options pass mainly through Oxford Clay, hence lining requirements are minimised.

The option of an alternative route around the west side of Melksham was considered but was found to be unsatisfactory since it would suffer the same principal drawback as an eastern option, namely bypassing and sidelining the town, and additionally would be far more costly and complex as it would need two major crossings of the Avon and two railway crossings. This option was not therefore pursued further.

2.3.3 Route Description

2.3.3.1 Original Route Through Melksham

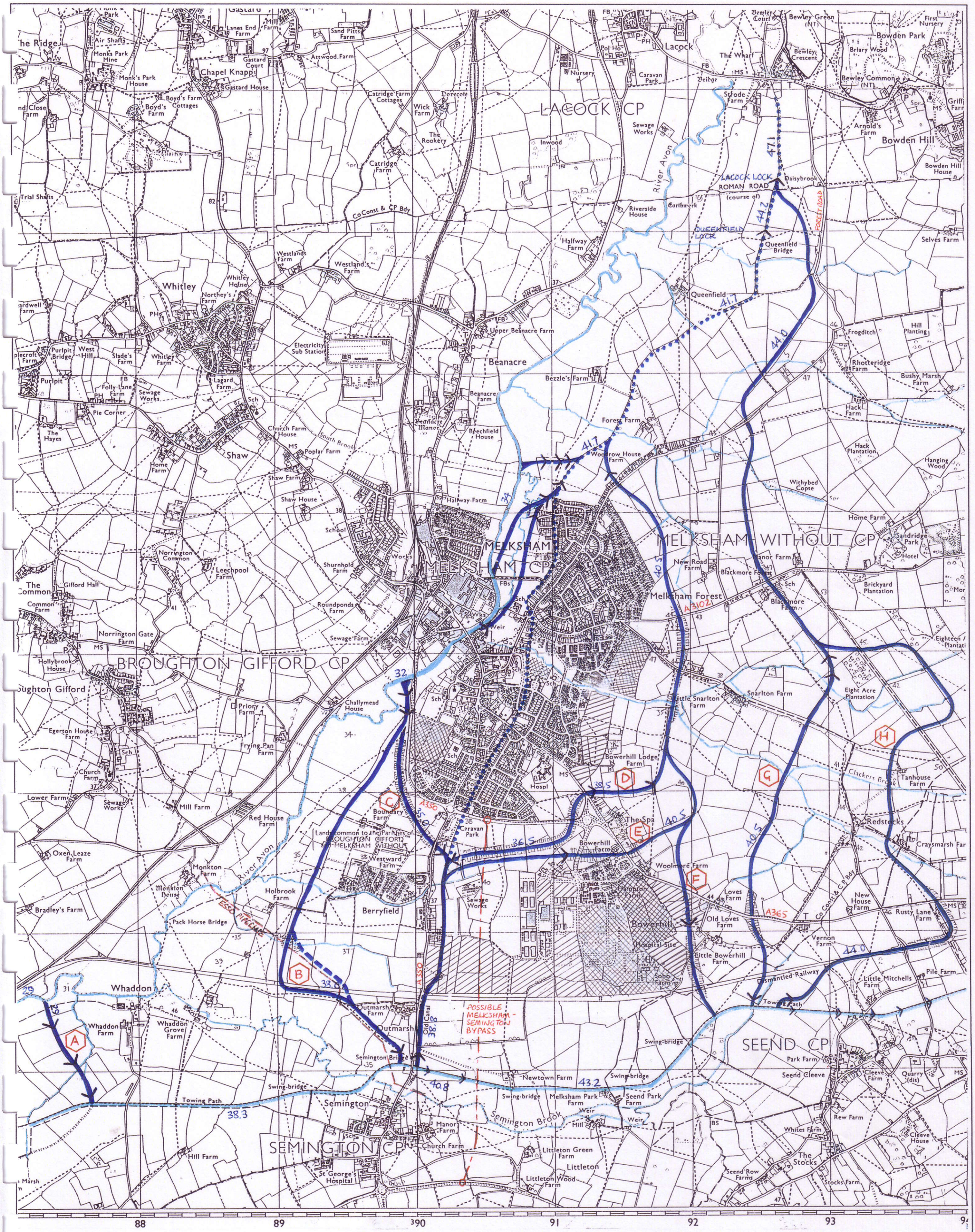
Length:	7.2 km
Locks:	3
Cost:	£8.3M + £33k pa

The problems of restoration from Junction Lock to the A350 south of the Town are common to other routes and are described elsewhere. From the A350 through to the northern limit of the Town, the original route is now heavily developed, mainly with gardens (perhaps 2km in total), but with some properties on the line, and in many cases the construction impact and land take in gardens would make further property acquisition necessary.

2.3.3.2 Alternative Route A

This route would require a new, short, link canal between the K&A and the River Avon at Whaddon. The River Avon would then be used for navigation through Melksham, and another new, short, link canal would be provided to the north of the Town to rejoin the original line.

There would be considerable engineering works required to make the River Avon navigable between Whaddon and Melksham Town Weir: the Polytechnic study concluded that dredging to maintain navigable depth would be impracticable, and that



Based upon the Ordnance Survey's 1:25000 scale map of 1990 with the permission of the Controller of Her Majesty's Stationery Office, Crown Copyright Reserved.

0 1km

RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options
Melksham

FIGURE 2.1

Scale at A3 : 1:25000		
Drn EMF	Appd	Revised
Chk	Date	Date 16/7/97

Scott Wilson

three or four long (70m or more) control weirs (or shorter weirs with flood gates as at Melksham) and locks would be required. Notwithstanding the considerable cost of the engineering works, the environmental impact would probably give rise to serious objections. This option is therefore not considered satisfactory but is included in the present study only for completeness.

The northern part of this route does appear practicable however and is further discussed as part of what is considered to be the first viable route, Route B.

2.3.3.3 Alternative Route B

Length:	8.8km comprising: 3.5km (K&A to R.Avon); 2.1km (R.Avon); 0.5km (R.Avon to W&B); 2.7km (restored W&B to Lacock Lock)
Locks:	8
Cost:	£5.9M + £48k pa

This route is designed to avoid the ongoing development on and around the original route to the south of Melksham. It would leave the K&A west of Semington Bridge (close to the original junction point) via a regulating lock and pass around the west of Berryfield until it reached the A350. From this point the route would descend via two locks into the River Avon just downstream of the A350 bridge. Some dredging work would be required to make the river navigable between here and the Town Weir some 0.7km upstream. A low weir might be required to ensure navigable depth, but a more detailed study would need to be carried out to confirm this. At Town Weir, a lock would be required, for which there is space on the east bank adjacent to the weir.

Upstream of Town Weir, almost certainly as far as the northernmost of the three new link canal options indicated on **Figure 2.1**, the River Avon should be navigable by canal boats without any dredging work, and is indeed presently being used for navigation. This northernmost link (which is the costed option) has the advantage of being the most straightforward in engineering terms, the least costly, and likely to require the minimum of construction within the flood plain. It would utilise about 1.2km of the river upstream of the weir. The southernmost link would minimise the use of the river, eliminating use of the river upstream of the weir, but at a cost premium of perhaps £0.4M. In between these points, the middle link canal would also have to cross the local parallel channel. Any of the three link canals would probably require 3 locks to overcome level differences.

The Avon bridges over the reach proposed for navigation all have ample clearance. The river over this reach is wide and generally sluggish (at least in summer), being very much in the nature of a canal in appearance. It would be necessary to design works in the flood plain in such a manner that neither discharge nor storage capacity were reduced, and in consequence such works would need to be designed to be submerged in a flood. This would render the route un-navigable in a flood, and river velocities in winter might also render the reach un-navigable during this period.

Pumping facilities would be required at each lock or flight for water conservation purposes (this is common to all options), and special measures might be required to limit mixing of Canal water and Avon water, depending on water source.

The original Canal route is recoverable from the immediate northern outskirts of Melksham, and for the purposes of route comparison this option is costed through to the District boundary south of Lacock Lock.

2.3.3.4 Alternative Route C

Length:	8.2km comprising 1.5km restored W&B and 1.4km new canal (K&A to R.Avon); 2.1km R.Avon; 0.5km new canal, R.Avon to W&B; 2.7km restored W&B to Lacock Lock.
Locks:	8
Cost:	£6.6M + £52k pa

This route differs from Route B only over its southern section, and is designed to maximise recovery of the original alignment south of Melksham. The original alignment would be followed to a point north of the sewage works. Here a lock would need to be provided to allow the Canal to pass under the existing A350, and to continue in cutting (up to about 3m deep to towpath level) to rejoin Route B at the locks descending into the Avon south of the A350 bridge.

At the K&A junction at Semington, there is currently a slaughterhouse on the original line. However, even if the original line could not be recovered at this point, a relatively minor diversion would be possible. A regulating lock would be required at the junction.

Of more concern are the proposed site developments in this area. The land to the north of the old railway is earmarked for business development in the Local Plan, and the plot including the Canal is currently up for sale. The Council would therefore need to move rapidly to protect this route if this option is preferred. The presence of a restored canal could make this a more attractive development site. At Shails Lane, which forms the northern boundary of the development site, there is a property built on the original line but a minor diversion to the east is feasible.

Another factor affecting this route option is the possible Melksham-Semington Bypass, for which a corridor is reserved through the earmarked Business Development Area, although no precise route has yet been finalised. Although the described canal route option should not affect any proposals for the bypass, the close proximity of such a new road may make this option less attractive to boaters and other users when compared to option B.

2.3.3.5 Route D

Length:	8.3km comprising 1.5km restored W&B (K&A to Melksham); 4.4km new canal; 2.4km restored W&B Melksham to Lacock Lock.
Locks:	6
Cost:	£7.2M + £37k pa

The southern and northern reaches of this route option are common with Route C, but instead of diverting west and using the River Avon, the route diverts to the eastern outskirts of the Town, keeping as close as practicable given the topography and current known development proposals. As the route turns east from the original alignment south of Melksham, a lock would need to be provided to allow for crossing under the proposed A350 bypass. This drop to a lower level should also enable roads to be crossed at the A365 Bowerhill roundabout: the Canal would need to be in cutting between these points up to about 3.5m deep to towpath level.

Once beyond the A365, another two locks would be needed to lift the Canal to a more suitable level to traverse the eastern outskirts, crossing under Snarlton Lane, the A3102 and Forest Road; then through one further lock to rejoin the original alignment north of the Town. This part of the route would feature cuttings up to about 4.5m deep and an embankment up to 6m high (across Clackers Brook). The presence of a sump pound is an undesirable feature, but overflows from the sump pound between the A350 and A365 could be taken to the Berryfield Brook

At both the Snarlton Lane and Forest Road crossings, land take from gardens would be required, but, other than these and the property already referred to for Route C, no other property would be affected

2.3.3.6 Alternative Route E

Length:	8.6km comprising 1.5km restored W&B (K&A to Melksham); 4.7km new canal; 2.4km restored W&B Melksham to Lacock Lock.
Locks:	4
Cost:	£6.4M + £31k pa

This route is essentially the same as Route D, but crosses roads south of Bowerhill roundabout, which would avoid the need for a sump pound and thereby eliminates two locks. The disadvantage would be the possible impact on the A350 bypass, which would need to be raised to cross the Canal (and thus might raise a strong or overriding objection), and the impact on Bowerhill Farm.

2.3.3.7 Alternative Route F

Length:	6.7km comprising 4.3km new canal (K&A to north of Melksham); 2.4km restored W&B Melksham to Lacock Lock.
Locks:	3
Cost:	£4.9M + £23k pa

This route is essentially the same as Route E east and north of Melksham, but would commence from the K&A immediately to the south east of Bowerhill. It would run north through the planned development area, with associated enhancement potential for the site and would descend via a lock to cross under the A365, to join Route E. The route would avoid all existing property disturbance south of Melksham, and any conflict with the proposed bypass, and should in consequence be significantly cheaper than Routes D or E. It would however result in the creation of a sump pound.

2.3.3.8 Alternative Route G

Length:	6.5km comprising 6.5km new canal to Lacock Lock
Locks:	3
Cost:	£4.9M + £21k pa

This route is one of several feasible routes well to the east of Melksham. It would drop from the K&A through a single lock to cross the A365 and the valley of the Clackers Brook, then rise through 2 locks (one might suffice) and follows close to the 44m contour to Lacock Lock. This route has the advantage over Route F of not encroaching on gardens, and would thus be less contentious, but would again require a sump pound.

2.3.3.9 Alternative Route H

Length:	8.5km comprising 8.5km new canal to Lacock Lock
Locks:	1
Cost:	£5.6M + £20k pa

This would essentially be a contour canal; the route being adjusted to suit field and land ownership boundaries as required. Only one lock should be required, at the K&A junction. The main advantage of this route over Route G (and all other routes) is its simplicity: a single lock should makes navigation easier. However, its remoteness from Melksham means there would be little direct or significant benefit to the Town.

2.3.4 Discussion on Melksham Routes

The original alignment and all of the developed route options were fully discussed at the workshop and as a result a number were considered as unlikely to be feasible. The historic interest of the original route through Melskham was recognised and it was noted that the Amenity Group had recently published a pamphlet entitled 'A walk along the lost waterway of Melksham'. It was also recognised, however, that restoration to navigable standards would probably not be practicable given the nature and extent of development on the original alignment in the years since the Canal had ceased to operate.

Route A, which would require use of a considerable length of the River Avon, could find little support due to its potential impact on the river environment: neither did it appear to offer any cost benefits, reference the earlier Oxford Polytechnic study.

In respect of the proposed routes from Semington to the southern edge of Melksham (Routes C, D and E), north of the old railway line, these would pass through land now allocated for business development, for which planning consent has been granted. To protect the route now would be very difficult. The old Canal bed here is also a habitat for the Great Crested Newt, a protected species.

The proposed A350 Semington-Melksham Bypass follows a line some 250m east of the original Canal route. This is Wiltshire County Council's highest priority scheme, but construction is likely to be in the medium term.

The just published (August 1997) local plan review document 'Housing Growth Options to 2011' indicates additional areas of land allocated for housing which would impinge directly on Routes C, D, E and F. There was no consensus at the workshop as to the possible benefit of integrating a canal with proposed business or housing development.

Route D would pass through a recent infill housing development north-west of the Bowerhill roundabout. All variants of this route would require some garden (or possibly property) acquisition, and this was seen as a potential major drawback.

Thus options C, D, E and F were considered to have significant problems in relation to existing planning allocations, and the consensus was to set these options aside in favour of the more viable alternatives.

2.3.5 Preferred Routes for Melksham

The remaining route options were considered in more detail by the workshop and this resulted in a choice between using the River Avon (Route B) through the centre of Melksham or bypassing Melksham entirely with a route well to the east (G or H).

The workshop attendees indicated a strong preference for the River Avon option, with the exception of the Environment Agency, because this route would bring significant benefit to the Town. The Agency expressed concerns on several issues, which would not apply to an eastern route. These included the impact of existing navigation, conservation and fisheries interests, the need for dredging, and the possible need for another weir to maintain water depth for navigation downstream of Town Bridge. The environmental issues are discussed further in Chapter 5 of this report. Town Bridge is a listed structure, but there would be ample clearance for navigation.

Flood defence would also be a concern. This would need to be studied in detail, but in practice the proposed canal works should not make the present situation worse. With careful design the situation could even be improved.

Melksham Gate (a float operated flood gate adjacent to the weir) has some problems and moorings upstream of this could be at risk from careless operation. Hence any day moorings would best be situated downstream. There could be mutual benefit, if navigation were to be permitted, by rebuilding this structure entirely as a combined long fixed weir and lock structure. Avon Rubber has a licensed abstraction point just upstream of the weir which would need to be maintained.

North of Town Weir, because of the impact of route options which cross the subsidiary channel (which is in fact the original river channel), the preferred option is the most northerly of the three routes considered and shown on **Figure 2.1**. Since this reach of the river should be navigable without any dredging work, this would also be the least cost option.

In view of the complex relationship between river flows and canalised sections of the River Avon options, close co-operation would be required between the Environment Agency and the Canal authority to ensure that all interests were effectively dealt with.

In respect of the eastern route options there appears to be some freedom for precise route selection but the key issue on these routes is likely to be highway crossings.

For the purposes of the present Study, the River Avon (Route B) has been selected as the preferred route, but, noting and addressing the Environment Agency's significant concerns, an eastern route option has been retained as a fall-back .

2.4 North Wiltshire

2.4.1 Introduction

North Wiltshire District Council area includes two separate sections of the original Canals. The longest section covers the route of the Wilts & Berks Canal from the boundary with West Wiltshire DC (Roman Road, near Lacock Lock) through to Hay Lane (the common boundary with Swindon BC).

The second section is the North Wilts Canal, from the District boundary north of Swindon (Mouldon Hill) through to the junction with the Thames & Severn Canal at Latton.

The workshop meeting was held on 19th August 1997.

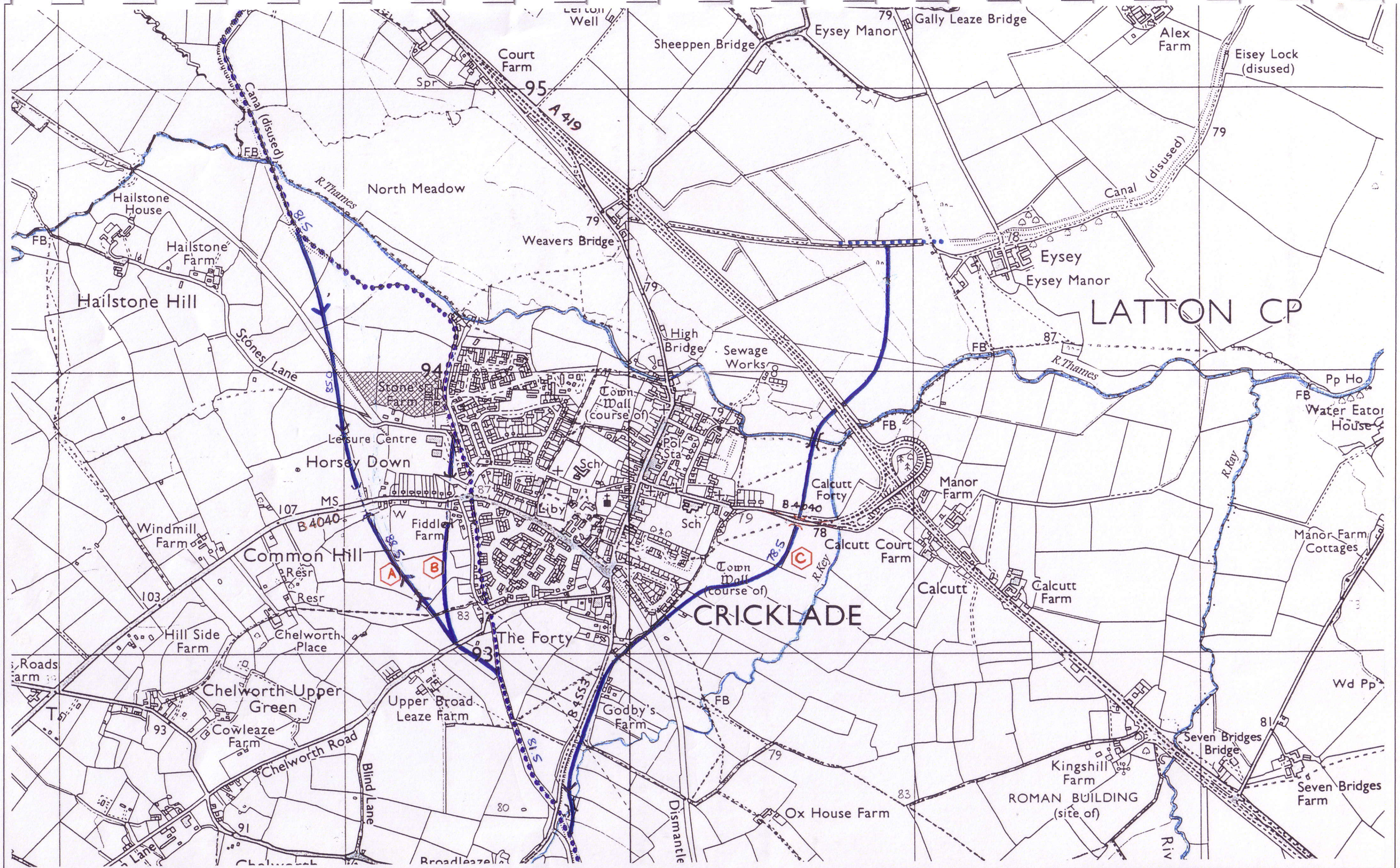
2.4.2 Development of Route Options for Wilts & Berks Canal

There are some difficult (or potentially difficult) highway crossings on this section, but only minor deviations from the original route would be required. A significant diversion might have been required at the A3102 at Vastern, Wootton Bassett. However, plans for the new bypass would allow (and indicate) closure of the existing road at this point thus allowing restoration of the Canal on the original alignment. Since it would appear likely that the new road will proceed, alternative options for dealing with the current blockage have not been developed. These issues are therefore covered in Chapter 3 and on Route Map Section 17 and schedules appended

2.4.3 Development of Route Options for North Wilts Canal at Cricklade

The options developed for consideration at the Workshop are shown on **Figure 2.2** overleaf. The lengths given below are for comparison purposes and have been taken from the common origin of all the options considered, just south of the River Key aqueduct.

Housing development along the original Canal alignment to the west of Cricklade will undoubtedly necessitate a local diversion of the channel or the provision of a completely new route to the east of the Town. Three alternative routes were therefore prepared and considered in the workshop.



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RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options Cricklade

FIGURE 2.2

Scale at A3 : 1:12,500		
Drn JAB	Appd	Revised
Chk	Date	Date 4/8/97

Scott Wilson

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2.4.3.1 Original Route through Cricklade

Length:	3.4km
Locks:	0
Cost:	£3.8M + £6k pa

The original route has been infilled and incorporated into gardens and domestic properties. The original Cricklade Tunnel is blocked at both ends and is inaccessible, hence its condition is unknown. If the property on the route could be acquired (£1.8M of the budget cost has been allowed for this), and assuming the tunnel is restorable, this route could be of similar cost to the alternatives. Access problems to Stone's Farm development in particular would remain, however.

2.4.3.2 Alternative Route A

Length:	3.4km (1.7km restored, 1.7km new)
Locks:	4
Cost:	£4.7M + £22k pa

This route would involve a diversion to the west of Cricklade, departing from the original route close to The Forty and locking up to an intermediate high pound to cross Common Hill and Horsey Down (Oxford Clay). The use of four locks would enable the depth of cuttings to be limited to a maximum of about 4.5m: this would be cheaper than the alternative of 2 locks with depths of cuttings then up to 8m but in either case a new short summit pound would be created. A short cut and cover tunnel would be required under the B4040. The original alignment would be rejoined to the east of Hailstone Farm. The route would follow the same corridor that would be required for an extension of the proposed restoration for the Swindon-Cricklade railway through to Cirencester (the former Midland and South Western Joint Railway, M&SWJR) which is also being considered. This would provide cost sharing potential between these restoration projects.

The option of a bored tunnel through Horsey Down (predominantly Oxford Clays) is feasible in engineering terms and would avoid the need for locks. However the cost is likely to be far greater, perhaps an additional £4.0M.

2.4.3.3 Alternative Route B

Length:	3.5km (2.5km restored, 1.0km new)
Locks:	0
Cost:	£4.2M + £11k pa

This route would leave the original alignment at the same point as Route A but would avoid the need to lock up the hillside. It would rejoin the original route near the leisure centre. A cut and cover tunnel is indicated under the B4040 and perhaps 3 residential properties would need to be acquired plus other miscellaneous outbuildings (£0.6M is included in the budget cost for this). More of the original route would be recovered under this option, and the capital cost of new locks and additional operating costs of a new summit section would be avoided. However, recovery of the original route by the leisure centre and the recent Stone's Farm development would be problematic.

2.4.3.4 Alternative Route C

Length:	2.6 km (all new)
Locks:	1
Cost:	£3.3M + £13k pa

This alternative route to the east of Cricklade would join the Thames & Severn Canal near Eysey. This route would leave the original alignment before the B4553 to the south of the Town, and cross the River Key before following the B4553. After Godby's Farm the route would turn to the north-east, passing under the old railway at the site of an original but badly damaged brick arch bridge. The route would then run across open farmland to the B4040. This road would need to be diverted onto an embankment south of its present alignment to cross the new Canal. The embankment would be about 4m high at the crossing point. Beyond this, the Thames would be crossed on a low aqueduct.

Within the scope of this Study it has not been possible to check the navigation rights on the Thames at this point to confirm that adequate headroom would be available. This would need to be done to check the viability of this proposal. The Canal would then pass under the A419, possibly by adapting an existing large accommodation bridge, or alternatively a new culvert, before crossing farmland to join the Thames & Severn Canal to the west of Eysey.

This route would recover less of the original route of the Canal but would offer an attractive route across fields close to the Town, and on budget costings also appears to be the most economic route. It would also provide a direct link to a restored railway terminating at Cricklade. The main issues are likely to be the impact on the River Thames flood plain (including navigation rights), aqueduct headroom, and archaeological impact on an ancient ridge and furrow site.

2.4.4 Discussion on Cricklade Routes

The discussions at the workshop indicated that it was unlikely that restoration on the original Canal route through Cricklade would be acceptable. Whilst Route B appeared cheaper than Route A, Route A had the advantage of a potential to share costs in a combined development with the railway. Even the limited number of property acquisitions associated with Route B would be problematic, and access problems (particularly to the Stones Farm development) would be created. On the other hand, both Route A and Route C appeared worthy of more detailed attention.

2.4.5 Preferred Routes for Cricklade

The workshop then examined Routes A & C in more detail.

In respect of Route C, it was noted that there was potential for a housing development with associated sports facilities and public open space to the east of the Town, north of Calcutt Street, and Canal Route C could be integrated into this. However, access to the housing would probably be adversely affected by the need to raise the road to allow the Canal to pass beneath.

The Canal corridor through Horsey Down (Route A) would also need to include a cycleway and possible bridleway. Both the rail and Canal restorations through Horsey Down would require significant cuttings. However, if the cost of the work were divided between the two restoration projects, this route option would be the most economic for the Canal. Otherwise, Route C would likely be the cheapest.

The relatively deep cutting would tend to isolate this section of the Canal from the Town visually, but closer linkage to the town centre would occur at The Forty, before the route went into cutting, and this was not therefore seen as a problem.

It was felt that there would be major archaeological issues associated with Route C which would pass through a site of ancient ridges and furrows. Although the Environment Agency had not raised any concerns about the potential impact of the Canal on the Thames flood plain or the headroom available at the new aqueduct, these would undoubtedly need to be resolved. There could be concern over the viability of a replacement aqueduct over the Churn on the original route near Latton (see Route Maps, Section 207), in terms of water freeboard requirements since the original clearance may not now be considered adequate. This would also be an issue with Route C crossing the Thames.

Since the Cotswold Canal culvert under the Latton bypass will now proceed, there is no preference between Routes A and C in terms of their linkage to the Thames and Severn Canal.

On balance the preferred route for the study has been taken as Route A which will accord with and support planning policy for the leisure/transport corridor. Route C should be retained as an alternative, however.

2.5 Swindon

2.5.1 Introduction

Within the boundary of Swindon Borough Council, the Wilts & Berks Canal originally ran from Hay Lane in the west to Acorn Bridge in the east, and the North Wilts Canal from its junction with the Wilts & Berks Canal in the south to just west of Mouldon Hill in the north. There is now very little left of the original route which would be potentially recoverable without significant effort. To restore the Canal links to Abingdon, Melksham and Cricklade would therefore require the provision of reaches of new channel in the Borough, with some difficult engineering and environmental problems to be overcome. The route options workshop was held on 26th June 1997.

2.5.2 Development of Route Options for Swindon

In developing route options for Swindon for consideration at the workshop, it became clear that relative cost was unlikely to be a significant factor in the selection of preferred routes, since the viability of options was constrained by other factors, in particular the engineering and environmental issues. Hence the budget costing exercise carried out for the other route option workshops was considered inappropriate for Swindon.

2.5.3 Original Routes Through Swindon

The Local Plan recognises the historic interest of the original route through Swindon, and future development will be restricted where appropriate to safeguard this. It is recognised however that restoration to navigable standards is unlikely to be practicable. The Town Centre has recently undergone substantial redevelopment, and there is thus little scope in the foreseeable future for any major building works which might incorporate a canal restoration.

There may be a possibility for the creation of a Town Arm along the original line of the Wilts & Berks Canal to Milton Road Bridge and the provision of a winding hole. This could be considered in the future subject to the route remaining available, but does not form part of the present study nor of the preferred route.

Linear ponds along the original canal route here or elsewhere would strengthen the historic link and awareness: such possibilities could be considered when an opportunity arises.

2.5.4 Northern Route Options

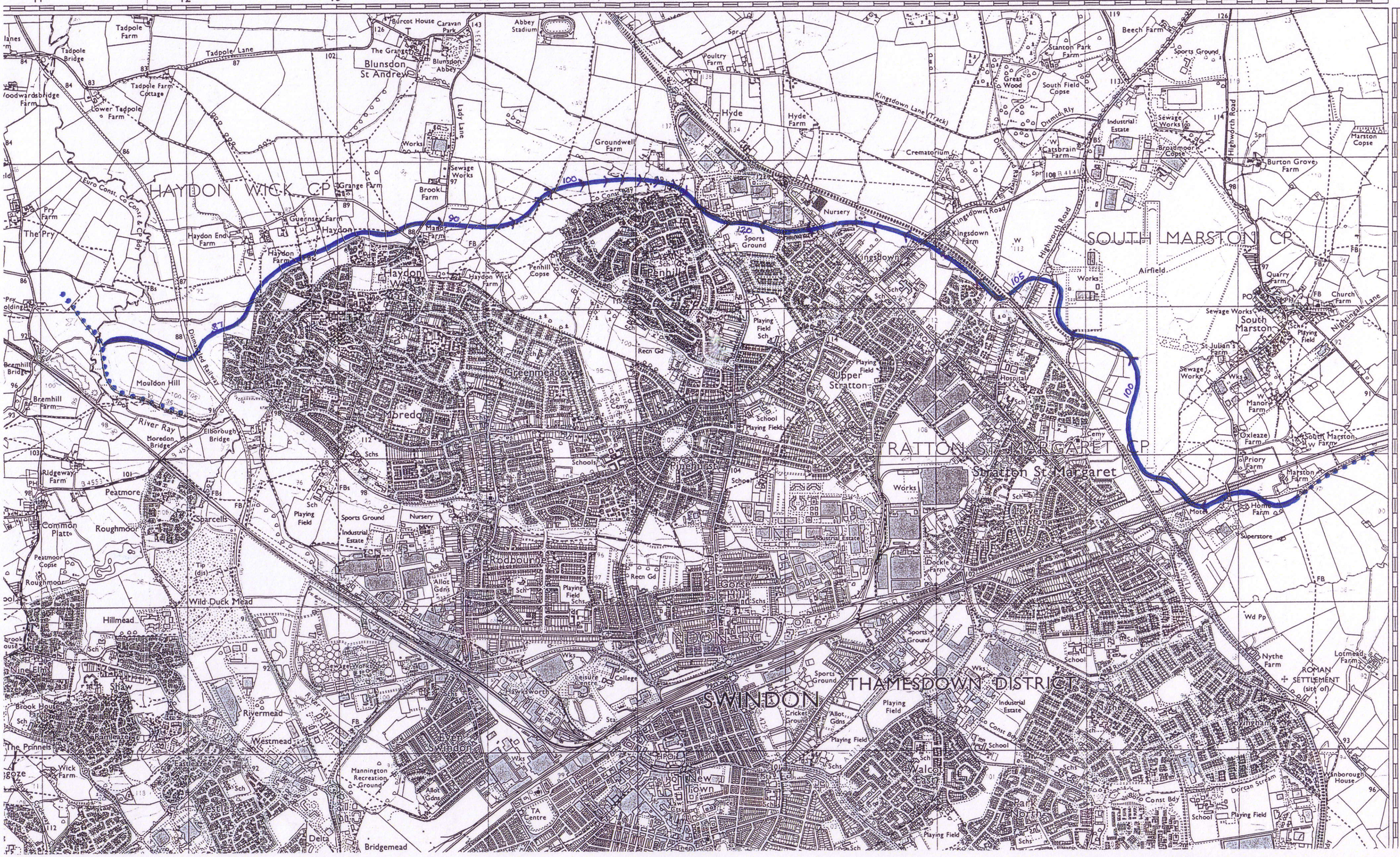
A northern route option, illustrated on **Figure 2.3** overleaf, which could serve as an alternative to either a southern route or a western route (North Wilts Canal), was postulated from a desk study at an early stage of investigations but has been rendered impracticable by virtue of the infill housing at Kingsdown and the pace of other development to the north of Swindon. It has not therefore been given further consideration in this report.

2.5.5 Western Route Options

Options considered for routes to the west of Swindon are shown on **Figure 2.4** following. This particular area was subject to a detailed study by Maunsell (1991). In our study we have reviewed and extended their proposals, taking account of site developments since that date, and of other comments and issues raised.

Swindon BC own the land between Hay Lane and Rushy Platt which encompasses the M4 crossing. Hence there may be opportunities to optimise the route subject to agreement on landowner, tenant farmer and general planning issues.

On the south side of the M4, routes which cross both Hay Lane and the B4005 (Wharf Road) in the vicinity of the junction would require careful consideration on highways safety issues by siting the crossing south of the junction. Routes which cross Wharf Road further east and thus clear of the junction would be less problematic in this respect.



Based upon the Ordnance Survey's 1:2500 scale map of 1990 with the permission of the Controller of Her Majesty's Stationery Office, Crown Copyright Reserved.	0 — 1km	RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY Possible Route Options North of Swindon	FIGURE 2.3

FIGURE 2.3

Scale at A3 : 1:25000

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Scott Wilson

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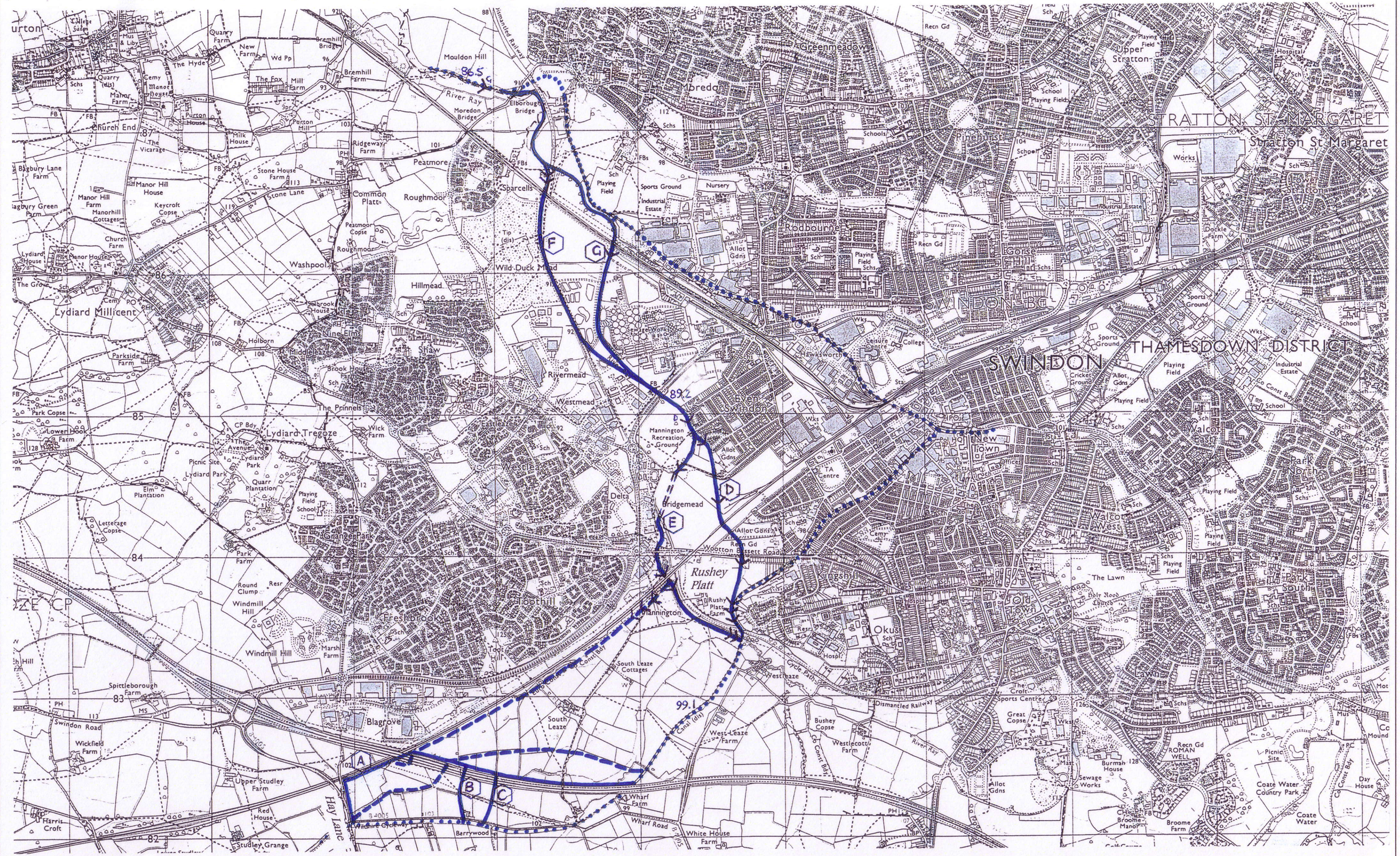

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RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options West of Swindon

FIGURE 2.4

Scale at A3 : 1:25000		
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Chk	Date	Date 27/5/97

Scott Wilson

DB3

There were no particularly strong preferences voiced at the workshop for any of the route options indicated south of the M4, (Maunsell Routes A, B or C, or the shorter alternative shown on **Figure 2.4**); option C which maximises restoration on the historic alignment has therefore been selected as the preferred option for the present study.

Once north of the M4, a route some distance from the motorway as indicated in the Figure 2.4 would be preferable in amenity terms to a route following along the toe of the M4 embankment. The option of following the railway could eliminate any conflict with the proposed Wharf Link Road, but this would only really work if the west-east alignment continued along the edge of the M4 (which is not the preferred option) thus avoiding the Mannington/Rushy Platt/West Leaze area entirely.

Assuming the route were to rejoin the original Canal line just north of the M4, (the preferred route), this would link into the existing in-water section of Canal at West Leaze. Swindon BC are currently making a Lottery Fund application to enable them to link this section through the Skew Bridge (under the former M&SWJR) to the in-water section to the north.

Route D from the earlier study (Maunsell & Partners, 1991) through Rushy Platt and following the River Ray through to Mannington Recreation Ground was carefully reviewed by the workshop but appeared even less practicable due to:

- Rushy Platt housing development, nearing completion, limiting space and introducing another bridge which would have to be rebuilt;

- Designation of the southern part of the site as the first nature reserve in Swindon for the Wiltshire Wildlife Trust;

- Lack of interest in the project from the developer for the business development north of Wootton Bassett Road, which is continuing apace;

- and impact of canalisation of the River Ray, a major issue of concern to the EA.

Maunsell's Route E was therefore considered likely to be the only practicable option but it was noted also to have significant problems. The most fundamental consideration was the availability of a passage under Sainsbury's car park. The existing culvert which carries Elcombe Brook under the car park may just be of navigable dimensions but is far less than the design standard. Enlarging the culvert would be difficult and the feasibility of its use is considered further in Chapter 3. The second major problem was the need for canalisation of the Elcombe Brook and the River Ray.

Of the two route options from Mannington Recreation Ground through to Mouldon Hill, Maunsell's route G would involve canalisation of significant lengths of the River Ray. This was reported to be of major and possibly fundamental concern to the Environment Agency. Route G might also conflict with the Spine Road proposal on the north side of the Swindon-Stroud Railway line. The treated effluent from Swindon sewage works is known to be vital to support flows in the River Ray, and comments from the EA indicate that such discharges would not be available for consideration as a water resource for the Canal (see Chapter 4 clause 4.7.8). Hence only the potential disbenefits of treated sewage effluent would be realised by route G, namely potential derogation of water quality, as well as aesthetic and public health issues to Canal users.

The main concern over the alternative Route F as presented in the Maunsell study was the potential impact on the M&SWJR cycleway as a result of having to traverse this route up to 2m below current level. This would severely limit space and could impact on drainage from the tips. Widening between the tips was considered impracticable. Leachate would also be a concern, although this problem is currently being addressed. In view of this it was proposed that these problems be alleviated by provision of a pair of locks to create a local summit pound along the M&SWJR. This would require backpumping to maintain level in the pound, but since backpumping at locks would be a standard feature of restoration for water conservation, this was not seen as a particular burden. The routing of the Canal through the proposed Shaw Tip Forest Park would likely enhance both these facilities.

The preferred route thus comprises options E and F. In order to address the Environment Agency's concerns over canalisation of the Ray and the Elcombe Brook, the preferred route has been further modified from the Maunsell study proposals to eliminate use of these watercourses for navigation (see **Figure 2.5** and **Figure 2.6** following). We now propose that new culverts should be installed under Wootton Bassett Road, Sainsbury's car park and Great Western Way to take dry weather flow only from these watercourses. Storm flows would overflow to the Canal. The route would then pass around the other two sides of Mannington Recreation Ground: alternative sites for existing sports pitches thus affected would need to be found. Separation between watercourse and Canal would be preserved throughout.

2.5.6 Southern Route Options

The options considered for routing of the Canal to the south of Swindon are shown on **Figure 2.7** following. Of the two route options between the original Canal route north of the M4 through to Nightingale Farm (a-c and b-c), there was strong support at the Workshop for the northernmost route (b-c) via Westleaze. This would be far more attractive to users than the southern alternative which would run alongside the M4.

For the northern route option (b-c), between Skew Bridge and Croft Road, there is a potential engineering difficulty with fine sands and water issues from the slope of Swindon Hill, although the route should be just on the edge or just clear of this problematic geology. The crossing of the River Ray would need to ensure that free surface flow could be maintained at least at normal flows, and a future east-west road crossing might also need to be considered.

A park and ride scheme is planned for the land immediately east of Croft Road (both options would need to take this into account). Beyond here the routes would pass between Pipers Way and the cricket pitch (see Route Plans Route Section 25). We have considered it inappropriate to route the Canal across the Broome Manor golf course and hence the only practicable alignment here would need to run for a short length adjacent to the M4 up to Nightingale Farm (c-d).

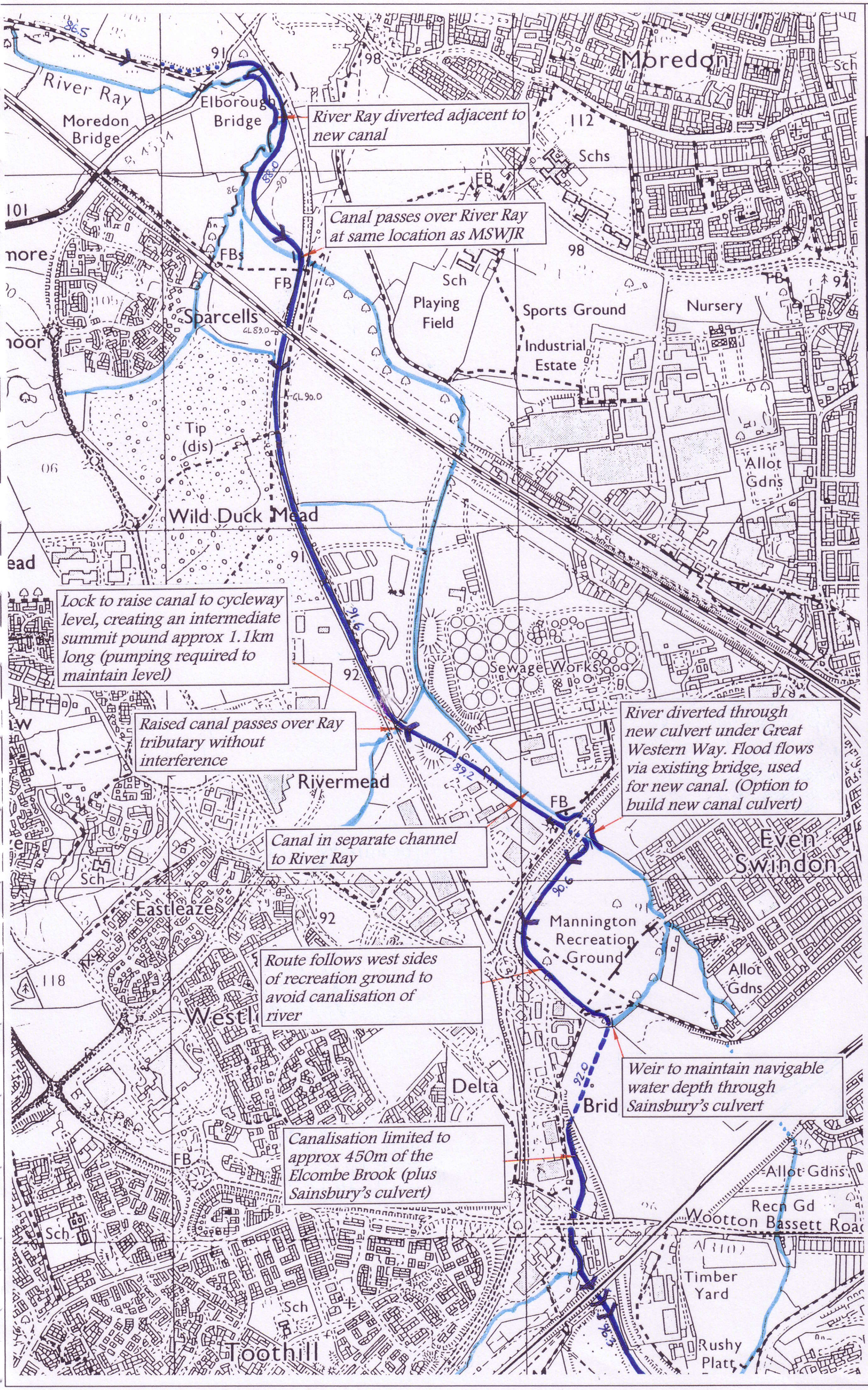

FIGURE 2.5

Scale at A3 : 1:10,000

Date 15/7/97

RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
West Swindon Route Option
Minimizing Canalisation

DB3

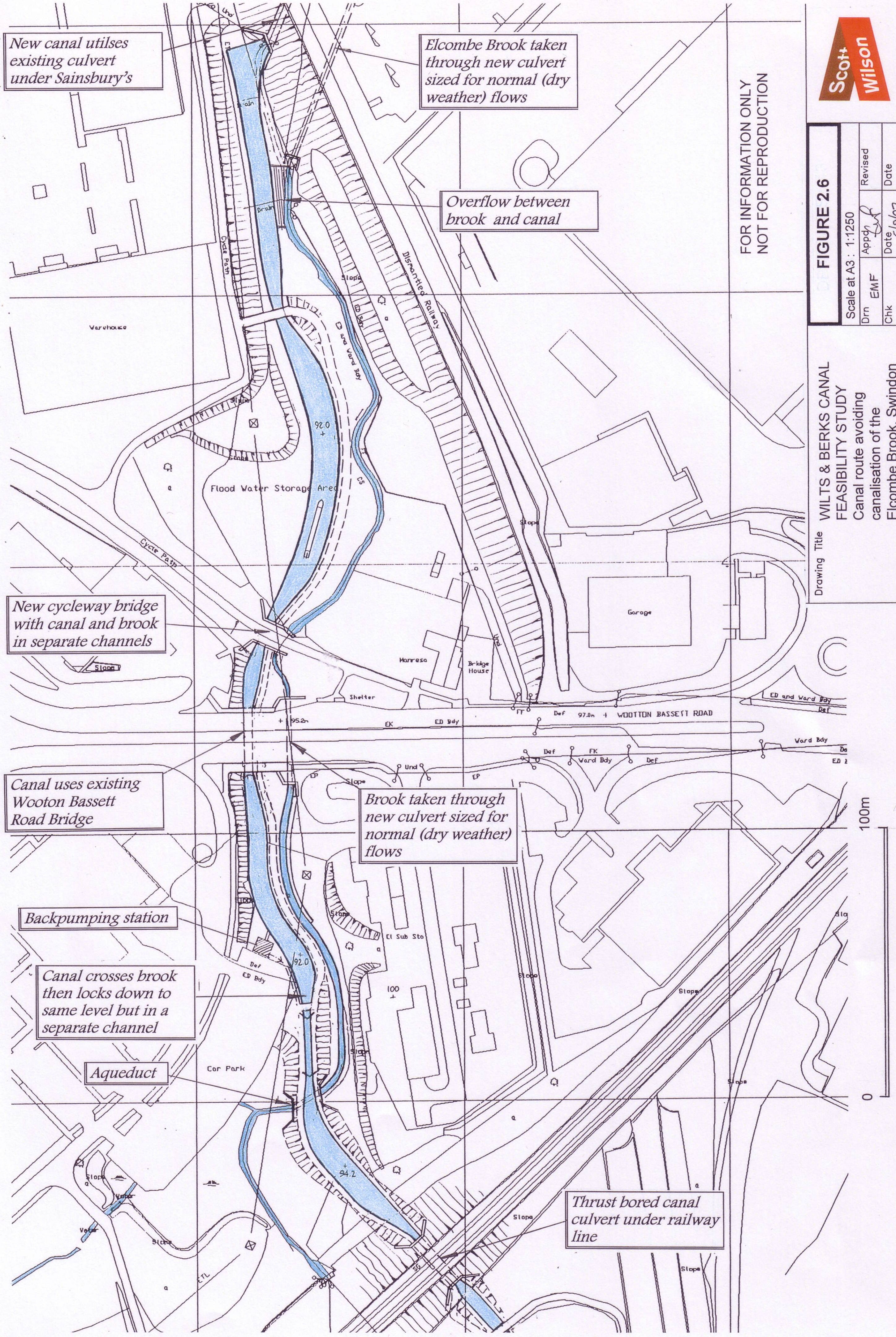
New canal utilses existing culvert under Sainsbury's
Elcombe Brook taken through new culvert sized for normal (dry weather) flows
Overflow between brook and canal
New cycleway bridge with canal and brook in separate channels
Canal uses existing Wooton Bassett Road Bridge
Brook taken through new culvert sized for normal (dry weather) flows
Backpumping station
Canal crosses brook then locks down to same level but in a separate channel
Aqueduct
Thrust bored canal culvert under railway line
Flood Water Storage Area
Warehouse
Dismantled Railway
Cycle Path
Garage
Manresa
Bridge House
Shelter
WOOTTON BASSETT ROAD
El Sub Sta
Car Park
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FIGURE 2.6
Scale at A3 : 1:1250
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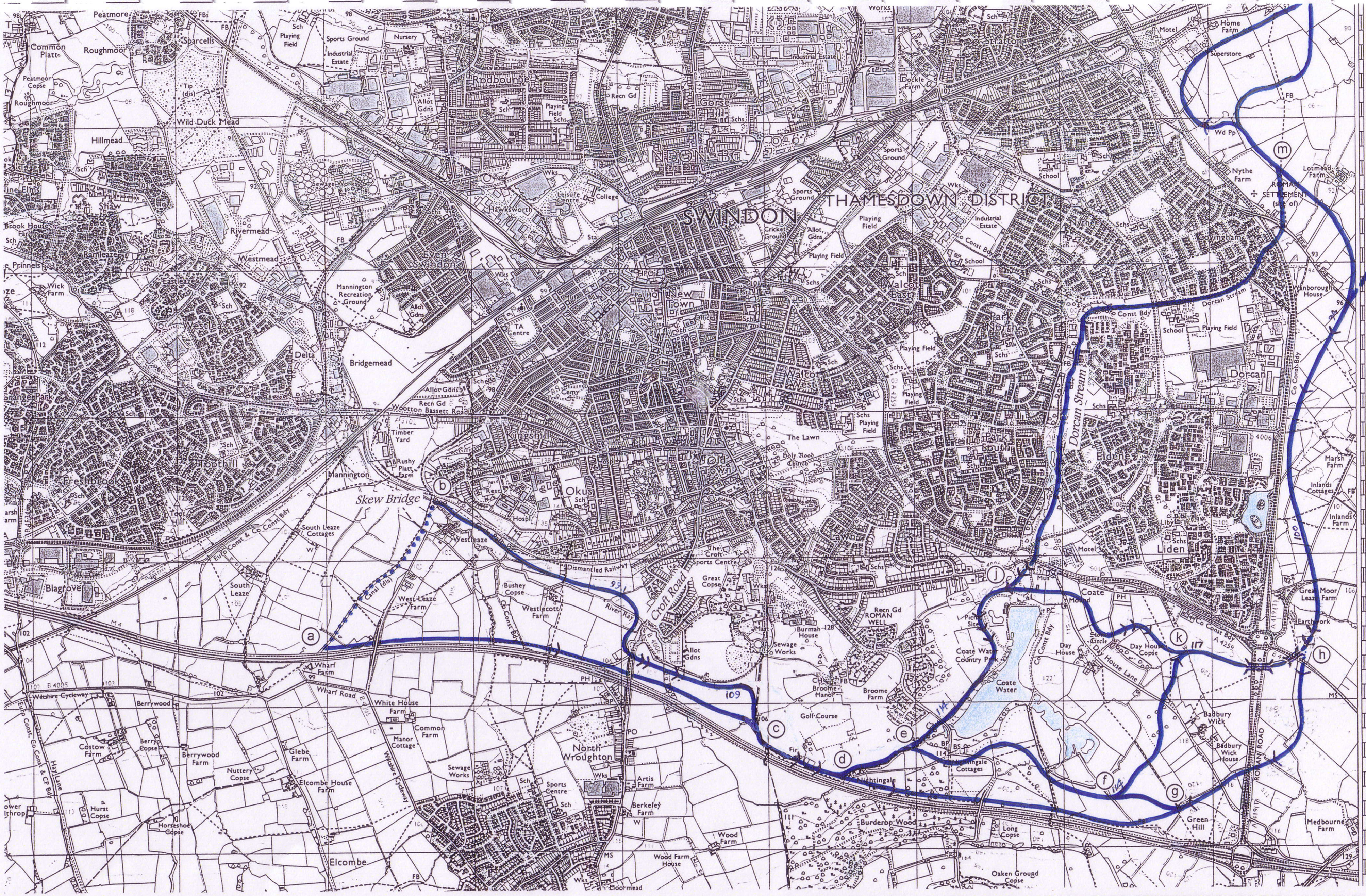
Chk
Date 5/9/97
Revised
Date
Drawing Title
WILTS & BERKS CANAL FEASIBILITY STUDY
Canal route avoiding canalisation of the Elcombe Brook, Swindon



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RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options South of Swindon

FIGURE 2.7

Scale at A3 : 1:25000		
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Scott Wilson

DB3

From Nightingale Farm, the option of a route utilising the Dorcan Stream (d-e-j-m) was carefully considered. Although probably feasible in engineering terms, there appeared to be many problems with acceptability including proximity to housing near the A419; loss of trees; general construction impact; potential vandalism; canalisation issues; and, possibly overriding, the fact that a canal would seem to provide little additional benefit above the significant recreational facility that the Dorcan Stream already provides. This route was therefore not preferred.

The option of a route around the north side of Coate Water (d-e-j-k), whilst it would bring the Canal very much to the forefront of an existing well-used leisure facility, would involve the provision of an additional six locks, engineering problems with foundations in the Greensand, and there would be adverse temporary and permanent impact on the existing facilities. It was considered that a route close to the southern boundary of Coate Water (d-e-f-g) would be close enough to be well integrated with the Country Park, and hence this is the preferred route over this section.

The option of following the northern edge of the M4 (d-g) was not preferred because of noise, remoteness and general unattractiveness and it would in any case impinge on part of Burderop Wood (which would be likely to raise a fundamental objection from English Nature).

The main engineering problems with the preferred route would be the potential foundation problems in the Greensand, and the presence of an old brickwork's spoil heap (although a slight diversion towards the M4 may avoid this at additional cost).

Of the two options east of Coate Water for crossing the A419, the northern option of crossing on an aqueduct (k-h), whilst this could be a key 'gateway' feature, was rejected primarily because of likely objection from the Highways Agency. The aqueduct structure would have to be founded on HA land and would prevent future grade separation of the adjacent road junction. In addition the land at the south west corner of the junction is earmarked for a park and ride facility. Therefore the preferred option is the southern route (g-h) with a culvert to be thrust bored under the existing road.

2.5.7 Eastern Route Options

Once across the A419, there is considerable freedom for route selection. The options we have prepared for consideration at the Workshop are shown on **Figure 2.8** following.

Between the A419 crossing and Great Moor Leaze Farm, the proposed route passes through an Area of Outstanding Natural Beauty. Care would be required to ensure a sympathetic design over this reach.

From Great Moor Leaze Farm through to the Wanborough Road, the adopted alignment is further east than indicated on the Figure, both to minimise problems of Greensands and to avoid services, in particular a DN500 water main. The greater separation from the A419 would also limit traffic noise impact.

Of the three options shown between Wanborough Road and Acorn Bridge, the most direct route (C) following the valley of the Liden Stream (but not canalising the waterway) was preferred. To rejoin the original Canal route sooner would require passing through a fairly extensive site of a Roman settlement; 2 locks up would be required to rejoin the original line next to Sainsburys (Route A); whilst restoration between here and Acorn Bridge on the original alignment would also be problematic due to proximity of houses and gardens (Routes A and B).

2.6 Vale of White Horse District

2.6.1 Introduction

Although much of the original Wilts & Berks Canal route remains traceable within the Vale of White Horse District, between Acorn Bridge and the River Thames at Abingdon, there are three areas where significant obstructions are encountered and for which diversions may or will be required to allow restoration, namely at East Challow, at the site of the proposed Thames Water Reservoir to the south west of Abingdon and in Abingdon itself. These obstructions are considered in detail below. Elsewhere there are some difficult highway crossings to be undertaken (in particular at Grove) but no major deviations from the original alignment are likely to be required, hence these issues are dealt with in Chapter 3 of this report and on the Route Plan Sections and schedules appended.

The options workshop for Oxfordshire was held on 5th August 1997.

2.6.2 East Challow Route Options

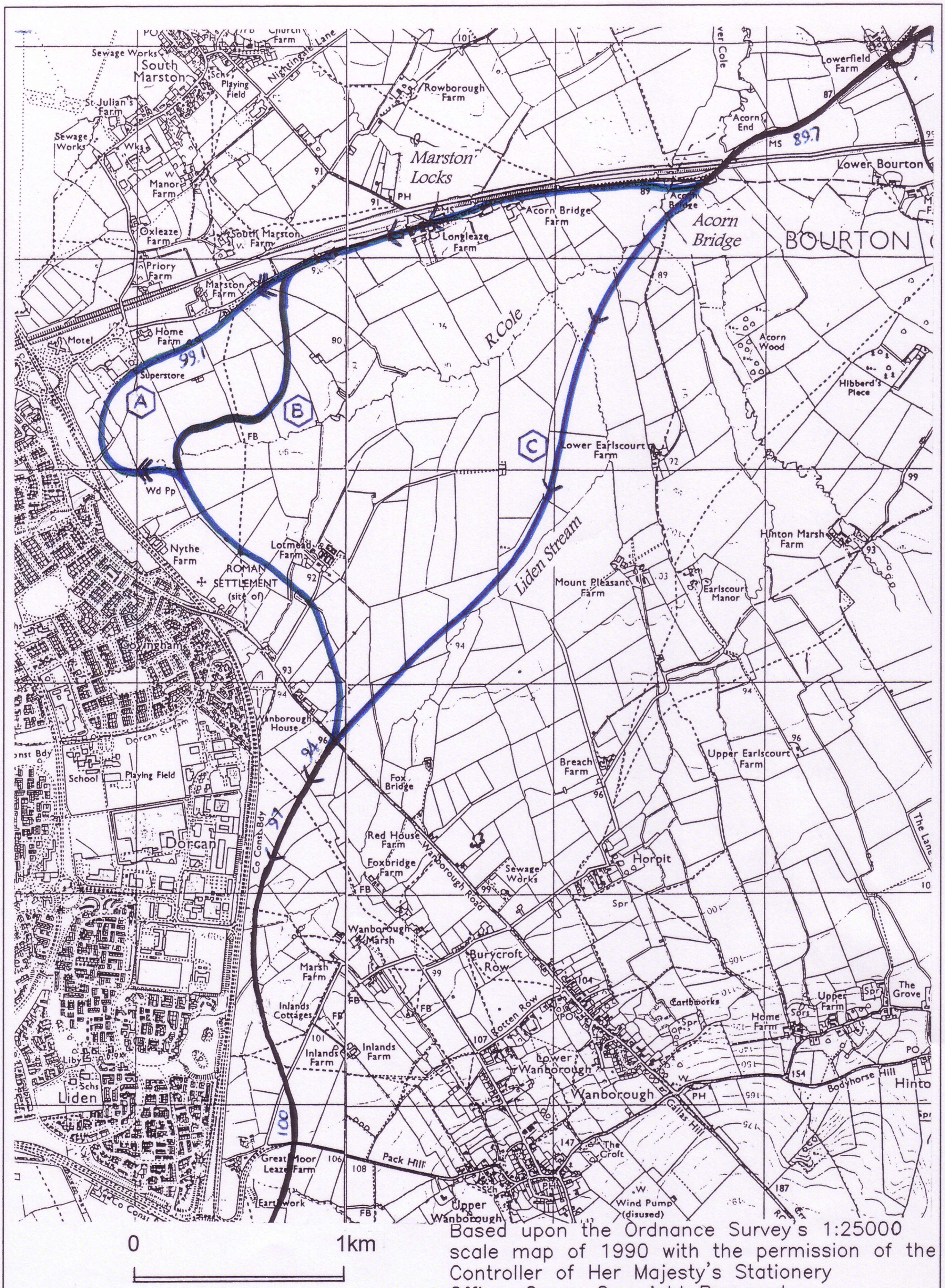
At East Challow residential properties have encroached upon the historical route of the Canal. We have therefore considered options for restoration on (or very close to) the original alignment, or a diversion to the north of the settlement (see **Figure 2.9** following).

2.6.2.1 Alternative Route A

Length:	1.55 km
Locks:	0
Cost:	£1.9 million

This route involves restoration as far as possible along the historical alignment. Land take would be required from the gardens of up to 19 properties. A narrow channel through this section (4-5 m) would avoid the need to divert an access road to properties on the northern side of the route. On the western side of the A417 the total width of the restored Canal would have to be reclaimed from residential gardens and the acquisition of one property would probably be necessary.

The major impediment to restoration on this route would be the crossing of the A417 over the Canal. The road at this point would need to be raised to the original level (about 1m) to allow sufficient headroom or the Canal would need to be deepened along perhaps a 2 km section, or some combination of these options would be



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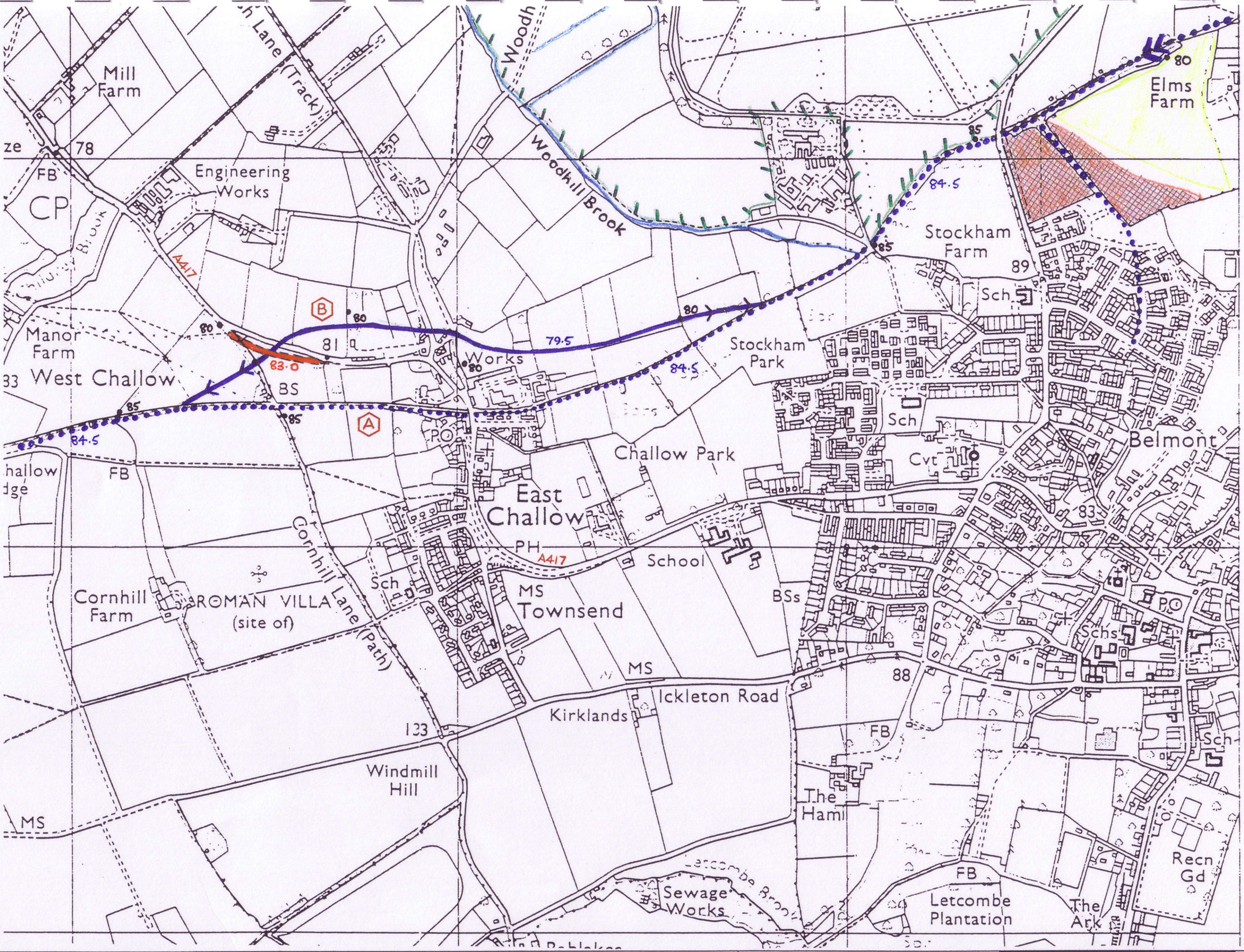
RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options East of Swindon

FIGURE 2.8

Scale at A4 : 1:25000		
Drn EMF	Appd	Revised
Chk	Date	Date 7/2/97

Scott Wilson

DB4V



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0 1km

RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options
East Challow

FIGURE 2.9

Scale at A3 : 1:10,000		
Drn JAB	Appd	Revised
Chk	Date	Date 24/7/97

Scott Wilson

DB3

required for vertical alignment. Any raising of the bridge would need to incorporate appropriate sight lines. It may be possible to move a lock to the west of East Challow to minimise deepening of a long pound.

A lift bridge could be constructed to give access to Canal Farm and Canal Way, or alternatively a narrow straight section of channel could maintain access.

The major issues are thus related to property acquisition, land take from gardens and the road crossing.

2.6.2.2 Alternative Route B

Length:	1.65 km
Locks:	0
Cost:	£2.3 million

An alternative route at East Challow would have to be to the north to avoid the main village housing. Due to unfavourable ground levels and the likely cost and unacceptable environmental impact of a high embankment, it would be necessary to lock down into a low pound from the level of the original Canal through two new locks at either end.

The route proposed would avoid land take from residential properties. Two new minor bridges would be required to maintain access. A new section of the A417 incorporating a navigation culvert would need to be built on embankment.

The use of an intermediate sump pound would be an undesirable feature of this option and it would introduce additional operating costs owing to the necessity to pump water from the new pound to reduce water losses from the Canal and to prevent flooding.

2.6.2.3 Preferred Route for East Challow

The actual preferred route would depend very much on negotiation for the necessary land. This could equally apply to the historical Route A and the northern Route Option B, and therefore for the present study the consensus view at the workshop meeting was to work on the basis of restoration on the original alignment Route A but with the retention of the northern route as a fall back option.

2.6.3 Thames Water Reservoir Route Options

Thames Water have proposed to construct a large raw water storage reservoir south west of Abingdon. A revised planning application is likely to be submitted within the next 2 years. The reservoir would be roughly circular in shape and formed with an earth bund constructed directly over the original Canal route. The likely site and impact is shown on **Figure 2.10** following.

2.6.3.1 Alternative Route A

Length:	1.75 km
Locks:	2
Cost:	£1.3 million

This route, along the historical alignment, would be viable should the reservoir proposals be abandoned.

2.6.3.2 Alternative Route B

Length:	2.15 km
Locks:	2
Cost:	£1.9 million

This route would follow around the toe of the new embankment to the north and west side of the proposed reservoir. Although longer than the original route, the levels would be similar and two locks would be required as for Route A.

We understand that even if there are no further delays to programme, the reservoir is unlikely to be in operation before 2015 and would involve perhaps a 7-10yr construction programme. It should be possible to reach an agreement with Thames Water to divert the Canal around the north side of the reservoir, either at the same time as the reservoir is built or before then. This route could have a better amenity value than the existing alignment.

2.6.3.3 Thames Water Reservoir Preferred Route

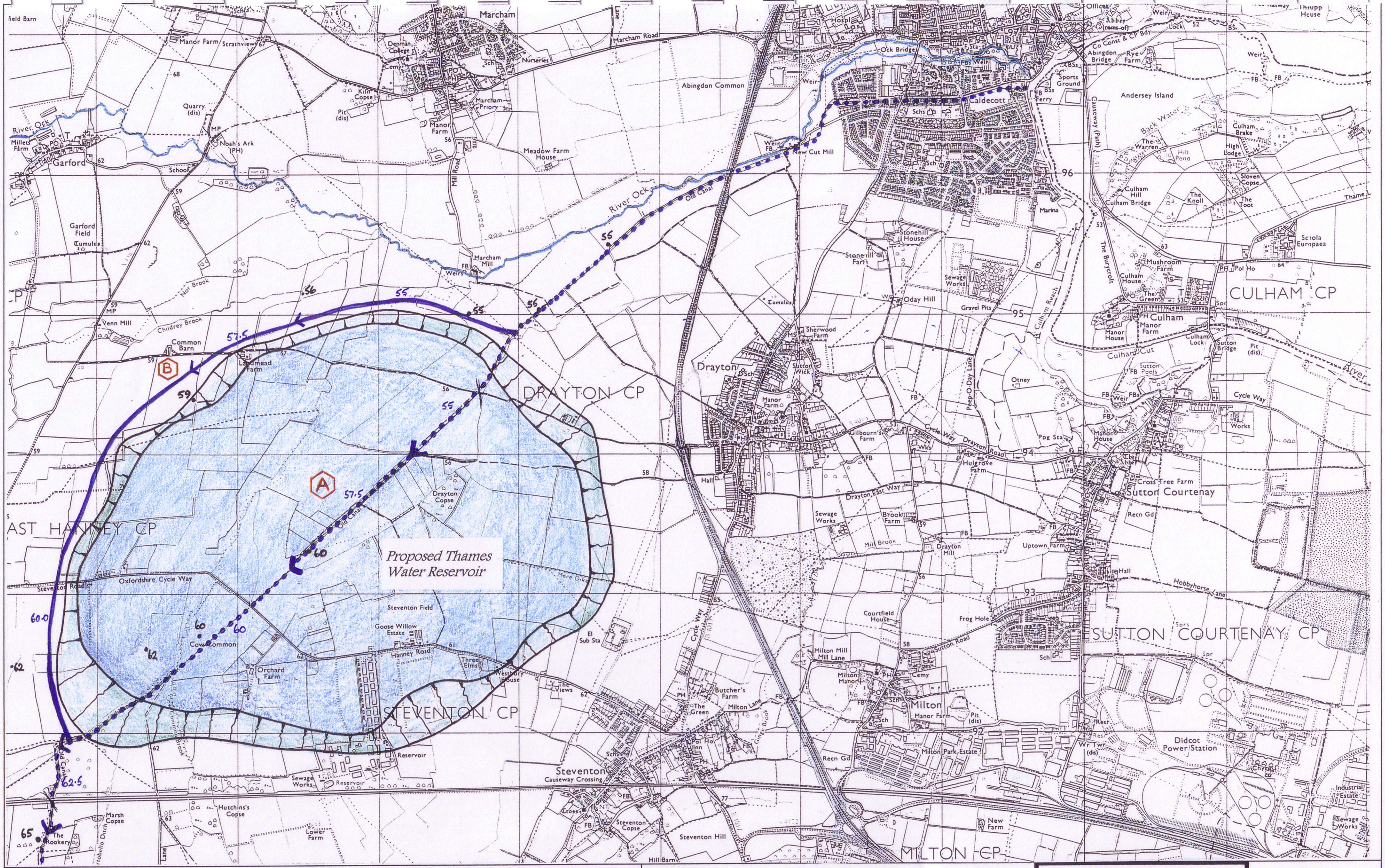
Due to the uncertainty over the reservoir's future, no decision on canal routing can be given at this time; if the reservoir is not to be built, the original alignment would be preferred for economy and historical reasons. If the reservoir is built, the diversion would be required.

2.6.4 Abingdon Route Options

In Abingdon, the original route of the Canal through Caldecott to the River Thames near the confluence with the River Ock is now significantly affected by housing development. Three alternative route options were therefore developed for examination alongside the original route at the workshop as shown on **Figure 2.11**. following. Lengths given for comparison in the following discussion are taken from the common origin of options on the original Canal line west of the A34 through to the River Thames.

2.6.4.1 Original Route Through Abingdon

Length:	3.1 km
Locks:	2
Cost:	£6.0 million



0 1km

RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options in vicinity of potential reservoir site SW of Abingdon

FIGURE 2.10

Scale at A3 : 1:10,000		
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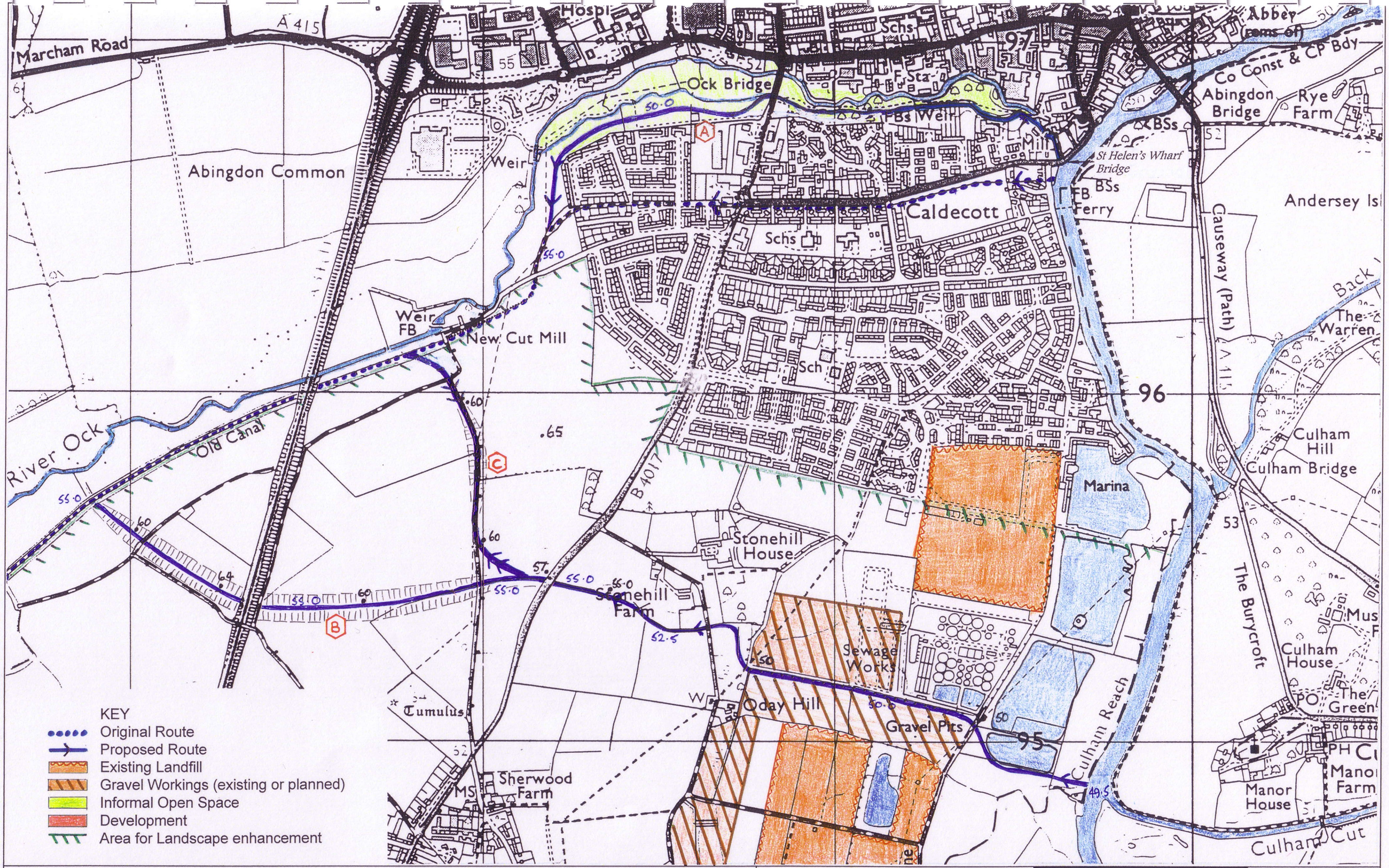

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0 — 1km

RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Possible Route Options
Abingdon

FIGURE 2.11

Scale at A3 : 1:10,000

Drn JAB	Appd	Revised
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1.4km of the original Canal is now within the urban limits of Abingdon, and is incorporated into properties, gardens and under roads. We estimate that at least 25 property acquisitions would be required to make restoration viable on the original route. Political, social and construction impacts would be major, and bridging works would also be a significant engineering problem. Nevertheless, the estimated comparision cost is comparable with alternative southern route options, partly because the original route is the shortest.

2.6.4.2 Alternative Route A

Length:	3.4 km (1.6km restored; 1.4km new; 0.4km canalised watercourse)
Locks:	3
Cost:	£2.5 million

The canalisation of any significant length of the River Ock (as for the Avon and the Ray) is likely to raise objections because of an unacceptable environmental impact. We have therefore developed this alternative route along the floodplain which avoids canalisation of the main river and minimises impact on Sandford Brook which shares the Ock floodplain.

Use would be made of the original Canal route to the west of the A34 but a new culvert would be required under the trunk road. The route would continue along the original alignment to the west of the A34 to New Cut Mill where it would turn to the north. Shortly after passing under a minor road the route would depart from the original line and continue north and then east parallel to the River Ock to pass under the southern arch of the B4017 Ock Bridge. Two locks would be required on this section. The route would then continue eastwards on the line of the Sandford Brook, passing through an existing informal open space and urban woodland area before passing through a regulating lock to enter the lower 100m length of the River Ock where the Canal and river would share an existing canalised section. The Sandford Brook would thus have to be made navigable over a length of about 0.8km.

Major issues associated with this route include the potential impact on the Ock Bridge; the navigation arrangements at the Canal junction with the River Thames; clearance at the St. Helen's Wharf Bridge; routing of the Canal through an existing attractive amenity and woodland area; and canalisation of part of Sandford Brook.

The Ock Bridge is a Listed Building and a Scheduled Ancient Monument. Any alteration or interference is unlikely to be acceptable. Since a new bridge for a new canal cut south of the Ock Bridge would require road raising at the Ock Bridge itself, this is also unlikely to be acceptable. However, the southern arch of the Bridge, which carries the Sandford Brook, is 3.65m wide and would be of navigable dimensions if the brook were deepened.

St. Helen's Wharf Bridge (erected as accommodation works by the Wilts & Berks Canal Company in 1824) at the confluence with the Thames, has clearance inadequate for navigation. Hence either the bridge must be raised, the Canal moved to allow construction of a new bridge with adequate headroom, or a pair of locks must be provided allowing local water level to be lowered. This issue is discussed in more detail in Chapter 3 of this Report.

High River Thames flow velocities below Abingdon Weir occur at high water levels during the winter. This would compound the difficulties of navigating the junction on a corner of a busy section of the River Thames.

The route would impact on what is considered to be an environmentally sensitive corridor and thus may not be acceptable. Moorings would be a problem on this route (and moorings would be essential to take full advantage of the town centre location). The works would result in the loss of some mature trees and a change in character of the informal recreation area. Canalisation of the stream (as elsewhere) would be a significant concern in principle to the Environment Agency, primarily on nature conservation grounds - the flood defence function of this particular watercourse would probably be enhanced by being made navigable.

2.6.4.3 Alternative Route B

Length:	3.95 km
Locks:	3
Cost:	£6.2 million

Some investigation of the possible alignment of a new Canal route to the south of Abingdon had been carried out in previous studies by Oxford Polytechnic (1987) and WBCAG members (Griffiths and Williams, 1988). The route we have developed from these previous studies would run south of Abingdon from the original alignment west of the A34, but would then turn south east to pass under the trunk road to the north west of Drayton, before turning east to join the River Thames at Culham Cut. This route would require a regulatory lock at the River Thames and two further locks in the vicinity of Stonehill Farm. The route would require a major cutting up to 9 metres depth but averaging about 5 metres, between the B4017 near Stonehill Farm and the junction with the original alignment, enabling it to pass under the A34 some 600m south of the original line. The level of the A34 and the ground in this vicinity would make an alternative tunnel solution prohibitively expensive.

The major issues with this route include the location of a landfill site close to the proposed route. The Canal channel would have to be constructed with a fully impervious lining along this reach to avoid contamination of the Canal, and potentially the River Thames, as well from polluted groundwater.

The route would need to be developed having regard to any future proposals for a by-pass (possibly from Marcham Interchange, passing close to New Cut Mill and around the southern edge of the Town) and a new river crossing. An Integrated Transport Study for Abingdon is due to be published in July 1998 and may feature such a proposal.

The inlet/outlet for the proposed Thames Water reservoir may be located mid-way along Culham Reach. Should the reservoir be constructed up to 1000 Ml/d of waterare likely to be abstracted from the River Thames during times of high flows and up to 500 Ml/d could be returned to the River at other times. This could have some effect upon local navigation on the Thames.

There may be scope to use a flooded gravel pit to the south of this route, by the sewage works, as a canal basin for additional moorings. This may not be a prime site for moorings, however, and the EA has raised the issue of connecting a water body to the Thames.

The deep cutting required to the west of the B4017 would help muffle traffic noise but would have no other benefit, and would result in significant quantities of material to be disposed of.

Delay costs associated with traffic disruption at the A34 crossing could be considerable but there is sufficient headroom for a thrust bore which would avoid these costs and this is the method of construction assumed acceptable for the purpose of this Report.

2.6.4.4 Alternative Route C

Length:	4.35 km
Locks:	7
Cost:	£4.6 million

This route is a combination of the historic route and part of alternative Route B with a short interconnecting reach in new cut. The original Canal route would be used to the west of the A34, and to the east as far as New Cut Mill. Just before the Mill the route would turn south east then south to join up with Route B at the B4017 crossing. It would then follow the Route B course to the River Thames.

This route would make slightly greater use of the original alignment than Route B. From the topographic information available at the moment there may be a need for an intermediate summit pound on the new cut south of New Cut Mill, or a deep (10m) cutting shorter than on Route B. Clearly an intermediate summit pound would require additional locks and backpumping facilities, and give rise to several navigation and water supply issues and should be avoided if at all possible. For this present Report however the summit pound option has been used for route evaluation purposes. On this basis, the route appears to be cheaper than Route B and to have no other issues accept those common to Routes A & B.

2.6.4.5 Discussion on Abingdon Routes

There was majority support at the workshop meeting for Route A (the Ock Valley route), mainly on amenity grounds, provided that the potential problems with the Ock Bridge could be dealt with and subject to nature conservation and other issues being satisfactorily resolved. However, it was appreciated that restoration on the original line could be economically viable in spite of the housing development. Subsequent to the workshop we were advised of a strong local preference for a southern route to avoid the problems with the other routes and to take advantage of the existing marina facilities or provide an opportunity to develop a new canal basin in one of the lakes left by the former gravel workings.

2.6.4.6 Preferred Routes for Abingdon

Therefore at the Workshop there was no consensus as to a preferred route. For present purposes, in view of the more extensive difficulties and concerns anticipated with Route A and restoration on the original alignment, and potential cost advantage over Route B, we have elected for this study to present the southern option Route C as being the most likely to gain acceptance.

2.7 Conclusions

This Chapter of the Report has examined route options for restoration of the Wilts & Berks Canal and the North Wils Canal where the original routes have been lost or obstructed by development. It concludes that there appears to be a feasible engineering solution in every case which achieves the major restoration objectives whilst being supportable by the principal interested parties.

For the main urban centres (Melksham, Swindon, Cricklade and Abingdon) in no case has restoration on the original alignment, which would require significant property acquisition, been felt to be supportable. However, other than in Swindon, this option could be cost effective and would maximise the historic/heritage value of the restoration.

At Melksham, the preferred alternative route is to make use of a short reach of the Avon through the centre of the town. This route option does create a significant impact on the river, and considerably more work will be needed in the next phase of studies to develop this option before the Environment Agency could offer their support. However, there is a viable alternative route should the Environment Agency's concerns prove to be fundamental, namely a route to the east of Melksham. Both options need to be retained for the present.

At Wootton Bassett, the main obstacle to restoration is the A3102 crossing; however, current plans for a new bypass provide for the A3102 to be closed off at this point which will allow restoration on the original line and level; hence although there are practicable alternative routes should the A3102 remain in its present form, these have not been developed in any detail in the present study.

On the Calne branch, the major obstacle to restoration is the Conigre tunnel. Should the tunnel prove to be impracticable to restore, then there is sufficient space to cut a new tunnel to the north. This will be costly; structural survey and investigation work will be necessary on the existing tunnel to establish which option will be adopted.

At the outset it was anticipated that the major obstacle to restoration would arise from development in Swindon, and this has proved to be the case, most particularly in respect of the restoration of the North Wilts Canal through west Swindon. The principal issues for this branch are the possible canalisation (i.e. making navigable) of watercourses, which the Environment Agency will strongly oppose; and the proximity of development, especially Sainsbury's store at Bridgemead which straddles the only practicable route. The constraints mean that only one possible viable and supportable route for the North Wilts branch has been identified (see later for description of detailed issues). Further work will be necessary to confirm the viability of this route.

A route option to the north of Swindon (which could have served as an alternative to the problematic southern reaches of the North Wilts Canal through Swindon) has been found to be not viable, largely due to the rapid pace of development in this area. To the south of the Town, a preferred route has been identified which keeps the Canal as far from the M4 as possible: a route which follows the M4 would be quite straightforward in engineering terms but would be highly unattractive to users. A crossing of the M4 at the west end of Swindon would require a thrust bored culvert, but there is ample headroom and thus in routing terms the M4 has not proved to be a significant constraint. At the east end of Swindon, the option of a route utilising the Dorcan Stream was considered but rejected, mainly because of the negative impact of the works which would bring little (if any) enhancement to the current amenity value of this corridor, in favour of crossing the A419 closer to the M4 again using a thrust bored culvert. The southern route option results in creation of a new short summit pound at a level some 17m above the original summit. More detailed studies will be required to confirm the precise alignment and viability of this route.

Once east of the A419, the route is relatively unconstrained; the problems involved in getting back to the original alignment at the earliest opportunity result in the preferred alternative which essentially follows (but does not canalise) the Liden Stream, rejoining the original Canal route at Acorn Bridge.

At East Challow, an option to divert the Canal north of the village to avoid the development on the original line was rejected in favour of restoration on the original route, but needs to be retained as a fall back solution.

The proposed Thames Water Reservoir to the south west of Abingdon would be sited directly over the original Canal line, requiring a diversion. Such a diversion is likely to be included in Thames Water's plans, and hence the base case for this study has been restoration on the original line, which is readily recoverable should the reservoir not proceed.

At Abingdon, a route down the Ock corridor is feasible, and would appear to offer cost savings over an alternative route to the south of the Town. However, there was no clear consensus in favour of either option, and since the latter is likely to be less controversial, this is the preferred route for the present study.

At Cricklade, there appear to be viable alternative routes both east and west of the Town. The former could be significantly cheaper since it avoids deep excavations and locks necessary to cross Horsey Down; however, given the desire to allow for restoration of the Swindon-Cricklade railway through to Cirencester, which would need to share the same corridor as the Canal through Horsey Down, the western route option is adopted as the preferred alternative.

3. ENGINEERING CONSIDERATIONS

3.1 Introduction

This section of the Report discusses the general engineering considerations and issues associated with the preferred new route(s) identified from the route options study and the restoration of the original Canal. The detailed results of the engineering assessments on a feature by feature basis, including costs, are presented on the comprehensive 1:10,000 scale Route Plans and Schedules in **Appendix D**. Engineering issues specifically relating to water resources are described in Chapter 4; these include (in particular) canal linings, surface and groundwater abstraction and storage.

3.2 Restoration Standards

3.2.1 Specified Criteria

The Terms of Reference for the study defined a set of basic design standards to be adopted. These have been developed and are summarized below in **Table 3. 1** and on **Figure 3.1** following.

Table 3. 1 Canal Design Criteria

Craft maximum size:	
Length	22.0m
Beam	2.13m
Draught	1.0m
Channel size:	
Bed width	4.27m minimum; 5.33m desirable (or as original)
Depth of water	1.37m minimum; 1.5m desirable (or as original)
Freeboard	0.3m
Waterway area	$10m^2$ minimum; $13m^2$ desirable
Width at locks	2.2m minimum (or as original)
Lock length	22.6m minimum (or as original)
Bridgeholes width	2.4m minimum; 2.7m desirable (or as original)
Air draught	2.3m minimum, 2.7m desirable, over 2m width
Water velocity	0.37m/s (0.83mph) maximum
Other Criteria	
Towpath width	2.0m minimum
Towpath headroom	2.0m minimum, 2.3m desirable (for pedestrians)
Water Supply:	1 in 10 year drought
Boat Usage:	As determined by the use and benefits and environmental study

3.2.2 Design Dimensions

The original dimensions of locks on the Wilts & Berks, are reported in the Royal Commission on Canals and Waterways 1907. All locks were reported as having a length of 74'0" (22.555m); the majority were of width 7'2" (2.184m) with the widest at 7'6" (2.286m). Depth of water over the cill was reported as 4'0" (1.219m) between Swindon and Abingdon and generally 4'2" (1.270m) elsewhere, with a maximum of 4'8" (1.422m) at Chaddington Top (Summit) Lock.

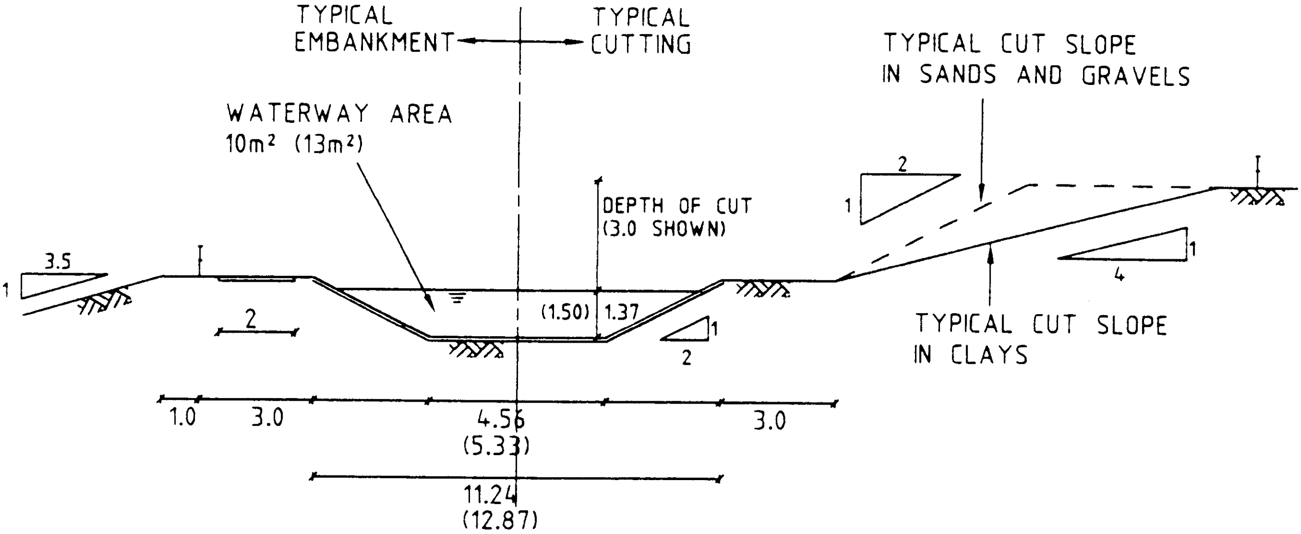
It is useful to set both absolute and desirable minima to ensure that rigid adherence to desirable standards does not preclude cost effective solutions to overcoming major obstructions which might be achieved through a relaxation of standards. This is a particular issue with the potential use of the existing Elcombe Brook culvert under Sainsbury's at Bridgemead, Swindon (discussed in detail later in this section), as well as generally where there is potential to use existing structures rather than build new. In this respect an absolute minimum water depth of 1.2m and air draught of 2.0m might be considered.

A typical channel trapezoidal cross section with 1 in 2 side slopes and minimum water depth 1.37m, would require a bed width of 4.56m to provide a minimum waterway area of $10m^2$. This cross section yields a surface width of 10.04m. A cross-section with vertical banks would require a bed width of 7.30m for the same waterway area and depth. Hence the minimum bed width criterion is not a primary parameter. Applying the same calculation to the $13m^2$ desirable waterway area and 1.5m desirable depth yields surface width of 11.67m and bed width 5.67m at 1 in 2 side slopes, and width of 8.67m with vertical banks. Again this exceeds the desirable bed width criterion. It is recommended that these desirable dimensions are adopted where space allows.

Water velocity will be an issue where navigation on existing watercourses is required. The desirable maximum velocity may be exceeded regularly during times of flood.

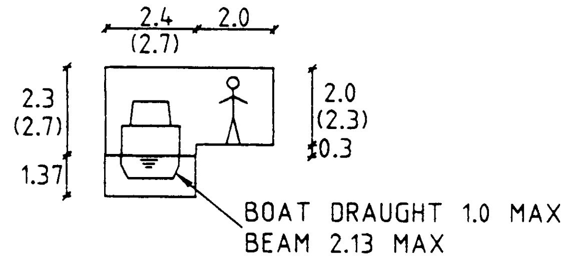
The freeboard requirement will need to be expanded in due course to indicate maximum and absolute minimum acceptable. These could vary with location (amenity value in urban areas may dictate less tolerance of variation of levels than in the rural sections) and with season. These constraints will become important in assessing water resource issues and hydraulics, paticularly backpumping and lockage.

Towpath width and headroom requirements will be influenced by the need to accommodate cyclists and horse riders in some locations. Criteria will need to be defined in due course, and sections of the route which should accommodate other than pedestrians will need to be identified. It will be preferable, where practicable, to provide separate paths for cycleways or bridleways to avoid conflicts between users.
The IWA paper "Waterway Restoration" (Harrison, 1996) suggests that for new and rebuilt lengths of channel the bed width should be at least 2.5 times the beam of typical craft. This has been used to set the desirable minimum bed width of 5.33m.
Desirable and minimum criteria for winding holes - dimensions and frequency - will need to be set in due course, but are not of major concern to this present study.

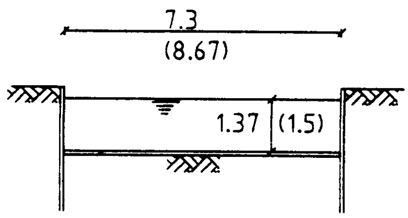


TYPICAL CROSS SECTIONS 1:200

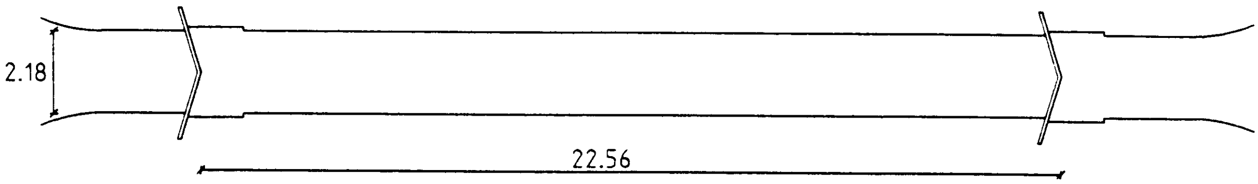
DRAWN TO MINIMUM DIMENSIONS
(DESIRABLE DIMENSIONS IN PARENTHESES)



BRIDGEHOLE



RECTANGULAR SECTION



TYPICAL LOCK PLAN 1:200

Drawing Title
RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY
Typical Canal Sections and Dimensions

FIGURE 3.1

Scale at A4 : NTS

Drn SMB	Appd	Revised
Chk NAW	Date	Date 16/10/97

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Criteria for capacity and clearances for aqueducts over or culverts under significant watercourses will need to be set in due course in consultation with the Environment Agency. In general there will be a need to ensure free surface flow in the watercourses under normal conditions although a degree of surcharge may be acceptable for extreme floods.

The minimum clearance required for an aqueduct over a highway is 5.3m. For the main railway line, allowing for possible future electrification of the line, would mean a minimum clearance above track level of 4.78m, and 2.78m clearance between track and abutments on each side. However, none of the preferred route options require aqueducts over highways or railways.

In the case of a crossing under main railway lines (of which there are several), the minimum requirement would be for 300mm of ballast beneath the track. A rectangular culvert section is likely to be preferred to circular. Runoff slabs are commonly required. A temporary speed restriction would be required to install the structure and for a short period of time thereafter, for which a payment would be required.

3.3 Earthworks and Geology

The earthworks required the Canal restoration involve in the main only small embankments up to 3.5m above existing ground level, and cuttings generally of a similar depth, but up to a maximum of 6m at Cricklade. Some of the non-preferred routes have higher embankments. There will be a net surplus of material arising from the restoration, ie there will be significantly more material arising from cuttings (perhaps $1.4Mm^3$) than required to form embankments (perhaps $0.1Mm^3$).

Potential problems with disposal of surplus material from the canal restoration, including contaminated land through illicit dumping, are discussed under environmental issues. It would be intended however that as far as possible all suitable material arising from the works is put to beneficial re-use, and in particular it would be appropriate wherever possible to utilise surplus material in the forming of the surface water reservoirs necessary to meet the water demands of the restored canal. The forming of these reservoirs could potentially utilise up to $0.5Mm^3$ of surplus.

The use of materials arising from the works and their use in embankments, together with the stability of cut slopes, is discussed below. However, it should be noted that geotechnical design, particularly of cut slopes, will depend upon the precise nature of the soils as determined by site investigation.

In all cases the initial operation will be the stripping of topsoil from all areas where new earthworks are required; this should be stockpiled for re-use as far as possible on the completed earthworks.

The outcrop geology along the route of the Canal is indicated in **Table 4.1** of later Chapter 4.

3.3.1 Embankment and Materials

It is likely that the only materials that will prove unsuitable for use in earthworks will be soft clays of the alluvium deposits. Otherwise, all materials should be useable although different techniques may have to be employed in their placement.

Sands and gravels can be easy to place and compact; relatively light plant can be used depending upon the layer thickness adopted during placement. Some problems have been encountered during earthworks in the Lower Greensand, as the upper weathered layers of this material can be clayey and difficult to handle. However, the use of lighter plant eases these problems, so it is not anticipated that major difficulties will be encountered on this type of project. In view of their permeability, a lining will be required for new embankments formed of sands and gravels.

The Corallian deposits can, depending on their degree of weathering, be excavated as large individual blocks. This does not necessarily produce a difficulty providing such material is used on higher embankments. Nevertheless, some breaking down of such material, if encountered, would probably be worthwhile.

The main difficulty envisaged lies with the stiff clays of the Gault, Kimmeridge and Oxford Clays. These tend to be excavated, and therefore deposited, as large individual "lumps" unless heavy compaction plant is used (including use of sheepsfoot type rollers). The use of lighter plant leads to a more open textured compacted material, which not only is more permeable, and hence requires a liner, but can soften with time resulting in settlement. The latter can be accommodated by an increase in freeboard.

3.3.2 Cuttings

It is unlikely that cuttings will be required in the flat topography where alluvial deposits are to be encountered.

Cuttings into Lower Greensand deposits and sands and gravels may require some stability analysis, but slopes of 1(v) : 2(h) can be used for preliminary design. The main concern with these materials is the early placement of topsoil to prevent erosion. Cuttings into the Gault, Kimmeridge and Oxford Clays will require more consideration. This particularly applies to the deepest section of cut (up to 6m) proposed to cross Horsey Down at Cricklade. There has been considerable recent study of cuttings formed in these materials, following a series of slope failures some time (up to 20 years) after construction. This has been attributed to equalisation of the negative pore water pressures developed within the clays as a result of the removal of material. The solution that has been adopted for motorway cuttings is to form relatively flat slopes, between 1(v) to 4 or 5(h); this would be impracticable for this project. Possible solutions may be provision of retaining walls at the toe of cuttings to reduce soil slopes, or the use of bio-engineering to minimise restoration of pore water pressures. This aspect requires further study.

3.4 Structures

3.4.1 Bridge Type Selection

There are three principal factors which influence bridge type selection; *function, form* and *cost.*

In consideration of the function of a bridge, the end use of the bridge should be examined in detail. For the purpose of this study, there are three principal crossing types; primary and secondary public roads, private access roads and tracks, and railway lines.

The public roads vary from motorways with high volumes of traffic, particularly at peak hours, to quiet country lanes with little or no traffic during a single day. Similarly the private access roads or tracks may have little or no traffic. Both public and private roads carry vehicles of varying size and weights and, from 1999, public road bridges will be required to carry vehicles with 40T gross vehicles, or 11T axles for short spans.

Private roads may generally carry lighter vehicles; this does not mean however that access for larger vehicles is not required. A private access road to a farm, for example, may on occasions carry heavy vehicles (farm machinery or deliveries of bulk animal feed). A further example may be a private access track used very little (once or twice a week) by a farmer driving an off-road vehicle to visit a fallow field. It is therefore necessary to carry out a detailed study of the types of vehicles which could possibly use a bridge before the type of bridge can be selected.

The London to Bristol railway line crosses the route of the Canal at four locations and the Swindon to Stroud railway line crosses the Canal at one location, both of which are in continual use. The loading from rail vehicles is greater than that arising from road vehicles and this has an impact on bridge type selection. Over many years British Rail developed 'standard' bridge designs, with both steelwork and reinforced concrete decks. These standard designs are relatively cost effective and easy to construct and a major benefit of adopting such a design is that the gaining of approval from theinfrastructure owner (Railtrack) should be straightforward. It should be noted however that structure jacking (thrust boring) of reinforced concrete boxes under railway lines has been successfully completed at a number of locations on the rail network.

The second major consideration is the form of the bridge. Form is related to function, indeed many designers believe that 'form follows function' and that simple functional structures are the most aesthetically pleasing to the eye. Visual impact and aesthetics are major considerations, together with the appropriateness for a particular location. For example, a footbridge constructed in timber would be more in keeping within a rural setting than a similar structure formed in concrete. Aesthetics is an emotive subject and individual tastes vary considerably. Therefore in determining bridge aesthetics there should be a high degree of involvement from all the interested parties and local residents (where appropriate). The structural form of the bridges could be chosen in such a way so as to project an image for the Canal and where appropriate traditional canal architecture could be replicated to produce a "family" of bridges. It is expected that brick facades will be utilised to dress basic concrete structures.

The bridge type should also be selected to suit the expected ground conditions and its impact on the environment and any existing infrastructure. Consideration should also be given to the method of demolition when the structure has reached the end of its economic life.

Structural form has an impact on buildability. Placing horizontal and vertical concrete surfaces is easier to form than inclined surfaces or arches. Forming concrete within a factory (pre-casting) is easier than undertaking the work on site.

Cost may be considered to be the most important factor in bridge type selection. It is essential to consider the whole life cost for a particular bridge type and not merely the construction cost. The cost of construction does however play a major part in the selection process. Material selection (steel, concrete, timber, etc.) and the cost of protection and maintenance of the materials should be considered.

Concrete is relatively maintenance free, whereas steelwork requires regular protective maintenance. Timber hardwoods, provided they are fully treated before erecting on site, generally remain maintenance free for 50 years or more.

The location of the crossing point has an effect on the total cost of the construction work. A crossing at or adjacent to the original crossing point of a road for example, will create little difficulty for the contractor to gain access. In contrast a footbridge or a culvert which is a considerable distance from a public road will result in the contractor needing to negotiate rights of access and construct a temporary road for the movement of construction plant, materials, etc. to the site of the work.

The number of bridges within a contract and the degree of standardisation between the bridge types will affect the costs such that to increase either will give rise to a reduction in unit cost.

The manner in which the construction work is procured has an impact on the whole life cost. Modern methods of procurement (Design & Construct, Management and Partnering) can lead to significant savings in construction costs. With long term projections of turnover, the Principal Contractor will be able to reduce profit margins. It should be noted that the majority of contracting organisations with sufficient resources to undertake a project such as the Wilts & Berks Canal are moving away from traditional competitive tendering and toward negotiated contracts. One aspect of this approach is that the contractor will wish to standardise the bridge types, for 'production line' construction and this will have an impact on structural form. The level of acceptability for standardisation will need to be determined in consultation with the interested parties and local residents.

3.4.2 Standard Methods of Bridge Construction

The most appropriate and cheapest method of construction for most road crossings will usually be to temporarily divert the road around the site. At some of the wider road crossings, it may be possible to halve the width of the road and divert all traffic onto one half whilst the bridge is constructed over the other half. Once the road has been removed, the form of bridge constructed is likely to be one of the following types:

- Precast concrete bridge beams on conventional concrete abutments;
- In situ concrete box structure;
- Precast concrete arch.

A conventional bridge (a deck supported on abutments) will commence with the provision of the abutment foundation, and depending on the ground conditions will range from a simple spread footing to an arrangement of piles which are driven or placed into position. The abutments are generally of cast in situ concrete, which is either plain or reinforced depending on the design. The bridge deck, either prefabricated steelwork of precast concrete beams, is then placed on bearings supported by the abutments. The final tasks are to place waterproofing to the deck and the road surfacing / railway track.

The foundation for an in situ reinforced concrete box structure also depends on the ground conditions, although in the vast majority of situations a spread footing is all that is required. A horizontal base slab is placed at the foundation level and is followed by the vertical walls of the box. Temporary formwork is then fixed into position to provide support for the top slab while it is being cast. On completion of the box structure filling material is placed onto the top slab and the road surface / railway track is completed.

A precast concrete arch bridge is constructed using segmental units supported on strip foundations which may be supported on an arrangement of piles. Two rows of piles (one vertical and one raked) would be required at each foundation to carry the vertical and horizontal loads arising from the arch units. A key is cast into each foundation to locate the arch units and transmit the horizontal forces to the piles. The precast concrete arch units are usually one complete semi-circular section, although two halves can be used for larger spans. On completion a precast concrete spandrel wall is fixed into position and granular backfill material is placed on top of the arch units followed by completion of the road surfacing.

The above structural forms of are illustrated in **Figure 3.2**, **Figure 3.3** and **Figure 3.4**. The most appropriate and economic form of structure will need to be established at a later stage. It is anticipated that there would be considerable scope for standardisation for bridges along the length of the Canal, which should lend itself more readily to the use of pre-cast concrete elements or prefabricated steelwork.

The use of alternative materials for the majority of the crossings may lead to considerable cost savings. The use of reinforced soils for example has recently emerged in the UK and the technique has primarily been used for stabilising and repairing soil slopes and acting for retaining walls. Use of the technique for forming bridge abutments, particularly for bridges on private roads or access tracks with little traffic loading, may be advantageous. Its use for bridges on public highways with high traffic loading is questionable at present due to uncertainty over long term durability. More evidence in respect of its suitability may become available in the future.

A number of masonry/brick arches have been built in recent years and, assuming some standardisation of arch profiles, this could be a low maintenance and very traditional form of construction, but cost is likely to be a constraint.

Where locks occur immediately adjacent to crossings (and in planning the location of proposed new locks this has often been a consideration), there is an opportunity to combine the bridge and lock structures, the bridge becoming a 'tailbridge' below the bottom gate.

3.4.3 Additional Factors for Railway Crossings

For each railway line, Railtrack produces an annual private publication known as 'The Rules of the Route' which details the no-train periods in which normal weekday and weekend possessions of the line may be available. Also included in the publication are abnormal possessions which have been allocated to major items of work, such as bridge reconstruction or permanent way renewal. With the agreement of Railtrack, it may be possible to utilise suitable abnormal possessions for installing a structure across the railway.

Under the terms of the agreement required for crossing the railway, the ownership of the structure will be vested in Railtrack. Railtrack would wish to recover maintenance costs on an "as and when" basis and undertake to give a minimum of two years notice of the requirement for major maintenance or repair. Railtrack would also require an authority for the expenditure of £5000 per annum for day-to-day maintenance.

3.4.4 Alternative Crossing Methods

There are a number of crossings of major roads and railway lines along the line of the Canal for which the standard methods mentioned above would not be appropriate. The following three techniques would be available to create openings at these crossings without diverting the road/railway and with little disruption to existing users.

3.4.4.1 Structure Jacking

Structure jacking is a technique of installing a circular or rectangular concrete tunnel-like structure underground by thrusting horizontally a single or several pre-fabricated elements (usually boxes), from a prepared pit. A shield is provided at the front to cut the ground and support the exposed face whilst spoil is removed from the face by mining and passed back through the box. The structure is thrust forward by means of hydraulic jacks bearing against a temporary thrust wall or jacking base. To reduce the effect of the moving structure on the overlying road / railway an anti-drag system can be introduced at the top and bottom of the box to reduce friction.

Structure jacking is essentially a soft ground tunnelling technique and its success is dependant on an adequate foreknowledge of the ground conditions to be expected along the proposed drive. The ideal ground conditions for structure jacking is stiff

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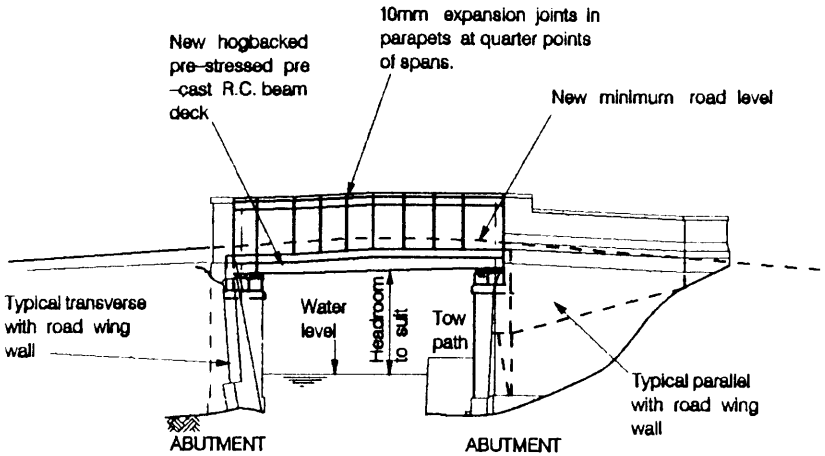
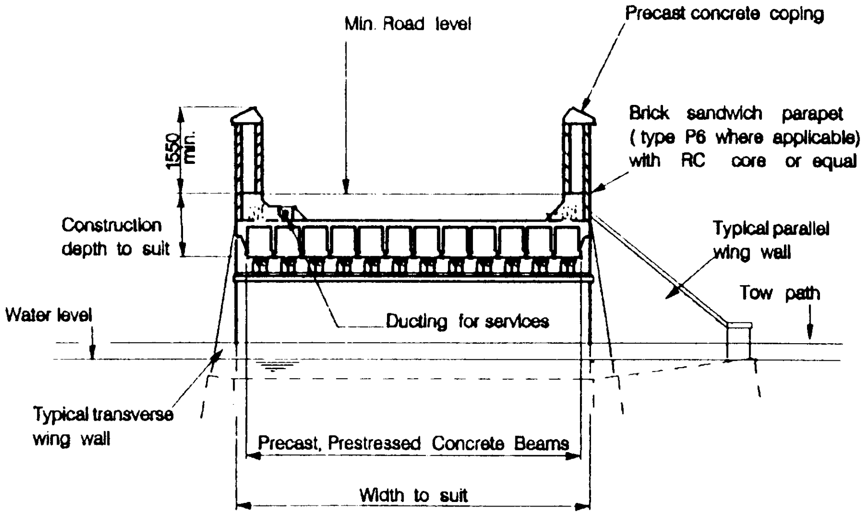
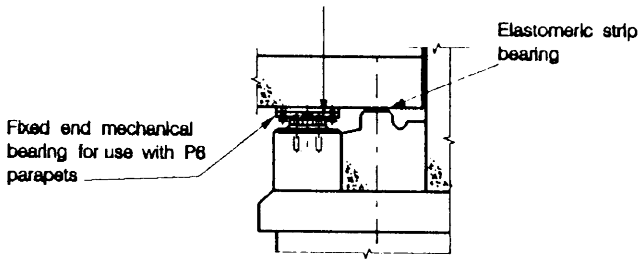


ELEVATION



TYPICAL CROSS-SECTION



TYPICAL DETAIL OF BEARING SUPPORT

Drawing Title:
WILTS & BERKS CANAL FEASIBILITY STUDY

Precast concrete beams on conventional abutments

FIGURE 3.2

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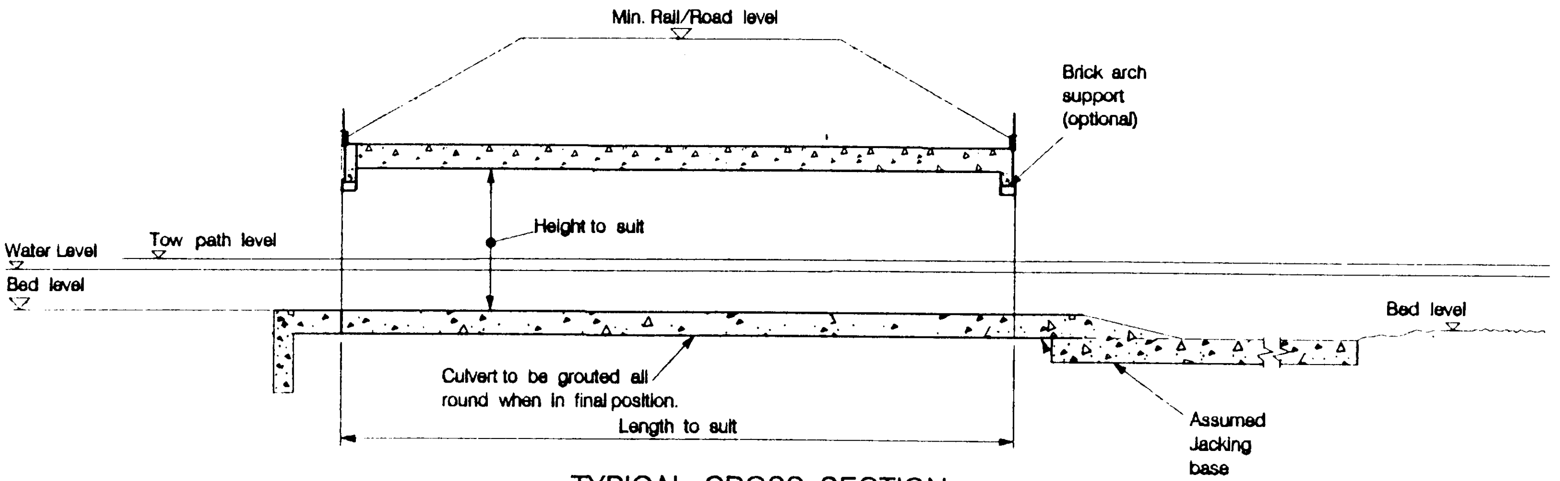

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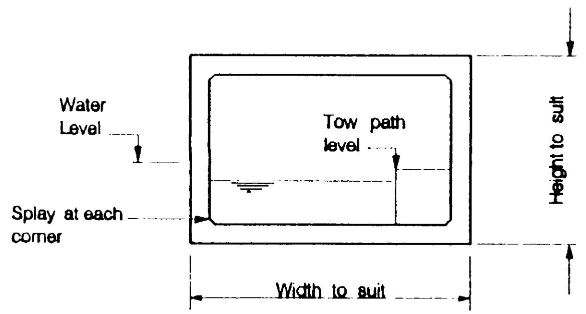
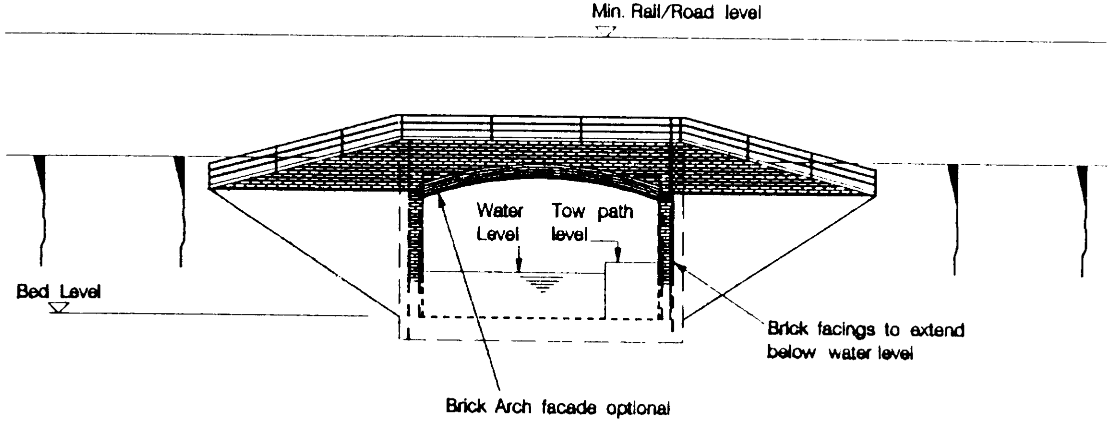


R. C. BOX CROSS-SECTION



ELEVATION

Drawing Title: WILTS & BERKS CANAL FEASIBILITY STUDY Concrete box structure	FIGURE 3.3		
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	Chk: MCL	Date: SEPT'97	Date:

Scott Wilson

All changes to this CAD generated drawing MUST be made via the master CAD file 7029212.dgn.

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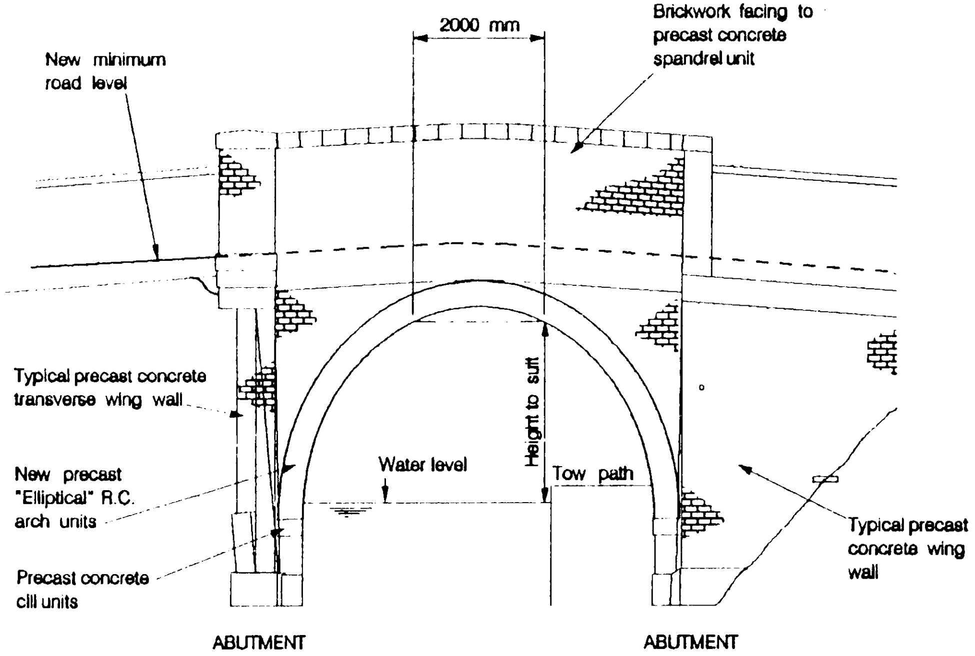

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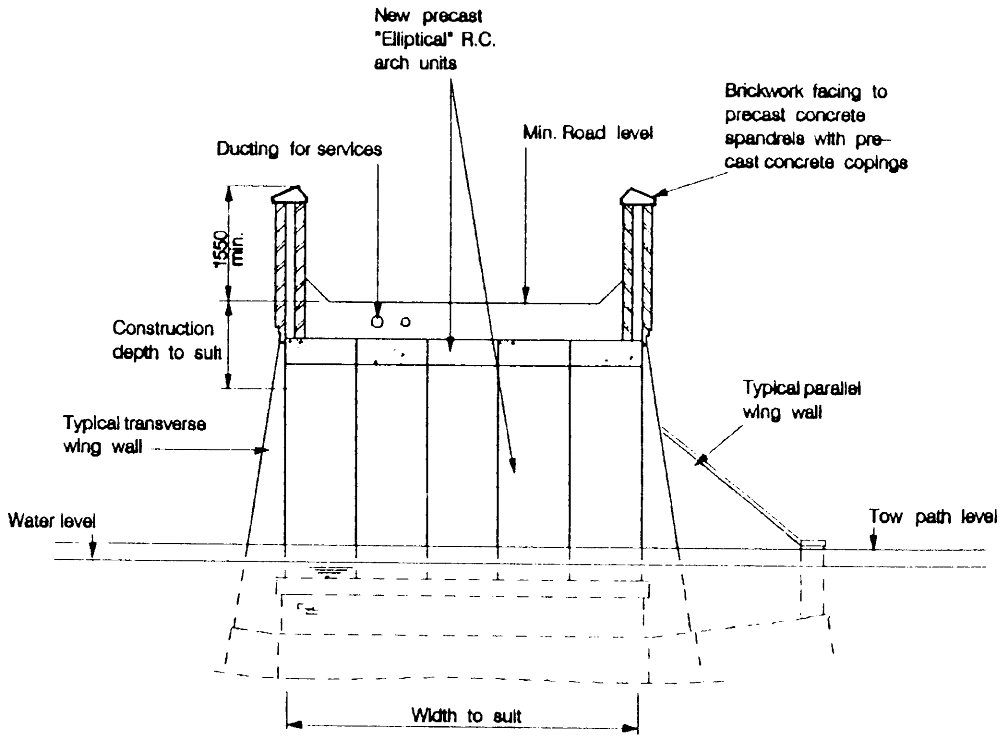

TYPICAL CROSS-SECTION

Drawing Title:

WILTS & BERKS CANAL FEASIBILITY STUDY

Precast concrete arch

FIGURE 3.4		
Scale at A4: NTS		
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Chk: MCL	Date: SEPT'97	Date:

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clay or dense fine sands with apparent cohesion as these require the minimum of support and can readily be mined.

A small amount of settlement of the road/railway above will inevitably arise from this method, but can be controlled by careful design of tunnelling shield and interaction between excavation and progress of shield. If a structure has very little cover, then a grillage of steel beams may be required to maintain the vertical alignment of the road/railway.

It should be noted that the jacking of box structures, particularly under railway lines where the limitations on the variation of vertical alignment are more stringent than roads, has been completed successfully on a number of occasions and that there are a number of contractors with the expertise to carry out such work.

The pre-fabricated units are most economically made of reinforced concrete as this material provides a rigid unit capable of withstanding the jacking forces in addition to earth pressure and live loads without undue distortion.

Steerage of the unit is achieved primarily by adjusting the inclination of the shield or lead unit. The jacking work is normally carried out on a continuous round-the-clock basis both to minimise the installation period and to avoid a high restart jacking force which may result from an appreciable delay in jacking due to settlement of the ground and a consequent build up of ground pressure against the units.

Structure jacking may be considered when a bridge is required under an existing road, railway or other service, where disruption of the service during construction would be either inconvenient or costly. The direct civil engineering cost of structure jacking will generally be higher than that of a more conventional alternative method.

An alternative to structure jacking under a live railway as described above would be to jack a similar structure into an open cut should it be possible to utilise an abnormal railway possession. The structure would be constructed adjacent to the railway line, together with a jacking pit and, on taking possession of the railway line, the tracks and embankment would be removed. The structure would then be jacked into its final position and the embankment and railway line reinstated. The major advantages of this technique are speed of installation and a considerable reduction in costs.

3.4.4.2 Work Within a Cofferdam

The canal bridge structure will be approximately 6m overall span and temporary bridging units can be obtained or fabricated to cope with this span. To construct a bridge, two lines of steel sheet piles are driven across the road/railway during a weekend closure. During a further closure, the gap between the lines of sheet piles is spanned by temporary bridge units. The area under the temporary bridge units can then be excavated without further disruption to the road/rail traffic and a reinforced concrete box structure cast in-situ.

On completion of the permanent structure the temporary bridge units are removed during a final closure of the road/railway and the carriageway/track reinstated directly on the new box structure.

3.4.4.3 Tunnelling

Standard tunnelling methods using a circular tunnelling shield and off-the-shelf precast concrete linings could provide a suitable opening. Standard linings are available for tunnels of internal diameter 4.5 m, 5.0 m, 5.5 m, 6.0 m or larger.

As with structure jacking the tunnel would require both a start and reception pit at either end and settlement similar to the structure jacking technique can be expected. A possible difficulty could be finding a tunnelling shield available to suit the chosen diameter.

Tunnelling could be cheaper than structure jacking since there is less temporary works and the lining is available as a standard precast item. Its suitability would, however, be dependent on the type of ground to be encountered.

3.4.5 Bridges for Footpaths and Bridleways

Both footbridges and bridleways can be constructed of steel, concrete or timber. In the rural setting of the Canal, timber bridges would merge in with the countryside better. However, in more urban areas where vandalism is likely, steel or concrete would be more appropriate. Durable hardwood timber bridges would be more expensive than steel or concrete, but would need less maintenance than a steel bridge and have lighter foundations than a concrete bridge.

3.4.6 Particular crossings

3.4.6.1 A4, near Chippenham (Route Plans, Section 7, ST946717)

A rise in the ground profile at the original crossing point is evident. The original bridge is off-line from the current road alignment. Each of the approaches is reasonably straight with the crossing point on a slight curve. It is anticipated that the road could be raised in the order of 2.0m at the crossing point for the installation of a new bridge. The need to reduce the canal pound level (as currently proposed) is reduced and there is a possibility that the Chippenham Branch could be re-opened. There is a car show room in close proximity to the crossing point and the access to it will require re-grading and re-modelling. There is also a nearby house and its access may also need re-grading and re-modelling. There is scope for improvements to the alignment of the A4 which may allow the road to be raised further at the crossing point, together with the added benefit that the bridge could be built off-line, thereby reducing traffic disruption and construction costs.

3.4.6.2 A3102 Public Road, Vastern (Route Plans, Section 17, SU053815)

Current proposals for a by-pass to Wootton Bassett indicate closure of the A3102 to allow restoration of the canal at original line and level. Therefore, assuming plans for the by-pass are implemented, there will be no need for a canal crossing of the road.

Should the plans not be implemented it would be possible to align the canal to the west of the original course to cross the A3102 in a cutting. In this situation a bridge would be required with re-modelling work to the junction of the public road leading to

Vastern itself. This canal alignment would remove the need to provide a bridge at the original road crossing in the village.

3.4.6.3 M4 Motorway (Route Plans, Section 22, SU117825)

This crossing occurs between junctions 15 and 16 of the M4. As all motorways can be extremely busy, particularly at peak hours, and given the likely high cost of lane closures (for which the Highways Agency impose lane rental charges) it has been determined that the most practicable method of providing a canal crossing of the motorway is to jack a structure through the motorway embankment. From inspection there is sufficient vertical clearance between the carriageway surface and the adjacent ground level (at the foot of the motorway embankment) to undertake such an operation without disruption to the motorway traffic.

3.4.6.4 A419(T) Dual Carriageway, Swindon (Route Plans, Section 27, SU192813)

From inspection it is possible to provide a crossing of the A419 given the height of the embankment at the proposed crossing point. As the road is very busy, particularly at peak hours, a cut & cover method for the provision of a bridge is not practicable. Adopting a similar technique as proposed for the M4 Motorway, a precast concrete culvert could be jacked through the road embankment. A slip road from the A419 runs parallel with the dual carriageway and is graded down to a junction with a minor public road passing under the A419. The crossing point has been chosen as it is close to the exit of the off-slip and there is scope (if necessary) to raise the slip road to pass over the canal culvert and then grade down to the existing junction.

3.4.6.5 A420 Acorn Bridge (Route Plans, Section 30, SU218874)

The A420 currently uses both arches of the Acorn Bridge (Great Western Railway), one of which it is understood was originally provided by the railway company for the canal. It is also understood that a new link road, to the North of the railway line, avoiding the Acorn Bridge is proposed. It is therefore possible that the original arch opening will become available once again for the canal. If this is the case remedial works will be required to provide a channel for the canal through the opening.

It is also possible that the link road will not be implemented, in which case a new crossing of the railway line will be required. From inspection there is sufficient clearance from the track level to the adjacent ground level (at the foot of the railway embankment) to jack a concrete structure through the railway embankment. A jacked structure will cause little or no disruption to rail traffic. While this option would appear costly, the provision of a 'standard' structure requiring long weekend track possessions (which requires a road connection for rail customers) is likely to be of greater cost.

3.4.6.6 Belmont Roundabout, Wantage (Route Plans, Section 42, SU394891)

Original canal crossing point (known as Hunters Bridge) is too close to the roundabout to raise the road without raising the roundabout, which is impractical given there are a further three approach roads. There is also an electricity sub-station in close proximity.

Align the canal to the North of the roundabout and provide bridges for access to the Technology Park and the public road heading North from the roundabout. The road at each bridge location will have to be raised and both approaches re-graded to give sufficient vertical clearance for the canal.

3.4.6.7 A338 Public Road, Grove (Route Plans, Section 43, SU401894)

During the site visit it was determined that the level difference between the invert of the existing culvert to Letcombe Brook and the carriageway is approximately 3.0m. Given the design requirements, the road would need to be raised in the order of 1.0m to provide sufficient clearance. This would be possible with the re-grading of the approaches to the crossing point, access to private residences along the A338 and Grove Bridge Farm. The nearby junction with a minor road, which is controlled by traffic lights, would also need re-modelling and the approach re-graded.

3.4.6.8 St Helens Wharf Bridge, Abingdon (Route Plans, Section 49, SU496966)

The headroom at this bridge is critical to the viability of the River Ock corridor option. It is considered that there is no viable alternative to the raising of the original bridge. The difference between the bridge soffit and water levels is approximately 1.30m and the structure will therefore need to be raised in the order of 1.0m to provide sufficient clearance for the canal. Jacking of the main girders and deck is possible, however special care will have to be taken during such an operation. During the jacking operation the bearings to the abutments could be raised using sympathetic materials. Both of the approaches, together with a private access road and public road will require re-grading and retaining walls will be required adjacent to the River Thames and the canalised section of the River Ock.

An alternative canal alignment immediately to the South of the St Helens Wharf Bridge would still result in the need to jack the existing bridge. The road level at an alternative crossing point will require raising in the order of 1.0m and the re-graded approach will affect the existing bridge.

3.4.6.9 Elcombe Brook Culvert, Swindon (Route Plans, Section 201, SU132844)

Following an earlier study by Maunsell & Partners (1991), it was proposed that the canal utilises the existing Elcombe Brook culvert which passes under Sainsbury's car park, Bridgemead. A survey of the culvert revealed that the fall over its length is approximately 400mm and that the cross section changes within its length. A drawing for the development of the site for Sainsbury's indicates that the change in cross section is at the site boundary.

The upstream portal invert to soffit level is approx. 2.00m and a width of 2.46m at the springing level to a brickwork arched roof. The existing cross section is insufficient for the canal clearance requirements. Given that the original railway embankment, which this section of the culvert passes under is no longer in use (or likely to be used in the future), this section of the culvert could be removed.

The downstream portal invert to soffit level is approx. 3.20m and a width of 3.70m at the springing level to a cast in-situ concrete arched roof. This cross section is also insufficient for the canal and remedial work to lower the invert level (the preferred option), while removing the fall appears practicable, will be costly. Thames Water have an outfall into the existing culvert approx. 100 yards from up stream portal. An outfall into a natural water course will have to be maintained and this is likely to be in the form of a replacement culvert for Elcombe Brook.

The dry weather flow of Elcombe Brook is low and it is anticipated that a culvert of the order of 0.75m diameter would be sufficient. Storm weather flow would spill into the canal and the existing culvert to pass under the car park. Existing plans indicate an easement of 5.0m to the South of the existing culvert and the foundations for Sainsbury's building. Assuming that the building is not supported on piled foundations it would be possible to install the new culvert using a micro-tunnelling technique within the width of the easement. Some settlement due to tunnelling is anticipated but this could be prevented by compensation grouting.

Alternatively it might be possible to construct a new walkway in the reconstructed culvert in such a manner as to provide a conduit for the Elcombe Brook within it.

A viable alternative (with the co-operation of Sainsbury's) would be to provide a new covered channel for the canal using a cut & cover technique for approximately half the cost of the above. This option would require the closure and reinstatement of sections of the car park (say 50.0m at a time), installing temporary works, placing a reinforced concrete base slab and side walls with a precast concrete roof slab. The principal advantages of this option is the reduced cost. A further benefit is that the canal would not be required to act as a storm water channel and the slight bend which occurs as it exits the culvert would be eliminated.

3.5 Pound Levels, Locks and Backpumping

3.5.1 Pound Level and Lock Lifts

The pound level between locks fixes the vertical alignment/clearance requirements at all the crossings on that reach, and is therefore of fundamental importance. In assessing pound levels for restored sections, the Study has identified significant discrepancies between published sources, in particular the lock lift data in the 1907 Royal Commission returns (Royal Commission, 1907), in the appendices to Dalby (1986) and the pound levels indicated in the study by Allen & Harris (1994). We have reviewed these data, taking into account known levels at the summit (99.1mAOD), the K&A at Semington (43.2mAOD above Semington Top), and a mean for the Thames at Abingdon (49.5mAOD ranging from 49.3 at low flow to 50.1 at a low flood). The results are presented on **Table 3.2**

Table 3.2 Historic Lock Lifts and Pound Levels

Lock	Royal Comm 1907		LJ Dalby		Difference		A&H Levels	Comments
	Lift (m)	Level (m)	Lift (m)	Level (m)	Lift (m)	Level (m)		
K&A at Semington Junction		**38.3**		**38.3**			39.6	Semington Top = 43.2, less 2.39, less 2.51 = 38.3mAOD
Semington Junction	0.69	39.0	0.50	38.8	-0.19	-0.2	40.4	
Melksham Forest	3.08	42.1	2.86	41.7	-0.22	-0.4	42.9	
Queenfield	2.75	44.8	2.39	44.0	-0.36	-0.8	45.4	
Lacock	3.06	47.9	2.84	46.9	-0.22	-1.0	47.0	OS map suggests 46-47m
Pewsham Bottom	3.08	51.0	3.01	49.9	-0.07	-1.1	49.7	
Pewsham Middle	2.90	53.9	3.01	52.9	0.11	-1.0	52.3	
Pewsham Top	2.68	56.5	2.61	55.5	-0.06	-1.0	55.0	GL at A4 crossing = 55m
Stanley Bottom	2.90	59.4	2.74	58.3	-0.17	-1.2	57.7	
Stanley Top	2.68	62.1	2.36	60.6	-0.31	-1.5	60.4	Hugs OS 60m contour
Foxham Bottom	2.80	64.9	2.74	63.4	-0.06	-1.6	63.0	
Foxham Top	2.83	67.7	2.71	66.1	-0.11	-1.7	65.7	Hugs OS 65m contour
Wood Common	2.88	70.6	2.69	68.8	-0.19	-1.9	68.4	
Dauntsey	2.68	73.3	2.59	71.4	-0.09	-1.9	71.0	
Lyneham Flight (Seven Locks)	15.95	89.3	17.97	89.3	2.02	0.1	89.7	Big discrepancy between figures for total lift.
Wootton Bassett Bot.	2.45	91.7	2.46	91.8	0.02	0.1	92.4	
Wootton Bassett Top	2.52	94.2	2.61	94.4	0.09	0.2	95.1	
Chaddington Bottom	2.45	96.7	2.34	96.7	-0.11	0.1	97.7	
Chaddington Top	2.45	99.1	2.39	99.1	-0.06	0.0	100.3	
Summit Pound		**99.1**		**99.1**		0.0		99.1m AOD actual
Error Factor:		**1.003**		**0.980**				
Marston Locks (4No)	9.78	89.3	9.61	89.5	-0.17	0.2		
Longcot Top	2.79	86.5	2.79	86.7	0.00	0.2		
Longcot Bottom	2.97	83.6	2.92	83.8	-0.05	0.2		Towpath 84.1 East Challow
Grove locks (6 No)	16.84	66.7	16.66	67.1	-0.18	0.4		1875 OS map gives towpath level 67.4m
Ardington Top	2.90	63.8	2.92	64.2	0.02	0.4		Ditto, towpath level 64.3m
Ardington Bottom	2.74	61.1	2.92	61.3	0.18	0.2		Ditto, towpath level 61.9m
Steventon	2.84	58.2	2.89	58.4				Ditto, towpath level 58.8m
Drayton	3.02	55.2	3.07	55.3				Ditto, towpath level 55.8m
Tithe Barn	2.79	52.4	2.84	52.5				Ditto, towpath level 53.0m
Abingdon	2.90	**49.5**	2.94	**49.5**				Thames mean = 49.5; 1907 figures match exactly
Error Factor		**1.000**		**1.017**				

NOTES:
1.Dalby quotes 21' (6.40m) rise from Stanley Junction (Stanley Top) to Calne Wharf. OS map shows GL 68m at Calne Wharf; 1907 figs would give WL = 68.4, too high
2. Lock lifts are metric conversions from the imperial measurements as reported in the Royal Commission survey and LJ Dalby. Levels in both cases have been adjusted (using the error factor) to match the reference levels at the summit, Semington and the Thames at Abingdon.

USE 1907 FIGURES FOR SUMMIT TO ABINGDON; ADJUSTED DALBY FIGURES FOR SUMMIT TO MELKSHAM

The error factor represents the correction applied to the total lift as calulated from the sum of the stated individual lock lifts, in order to match the actual lift. It will be seen that the overall error is around 2% for the Dalby figures; and under 0.3% for the Royal Commission figures suggesting that the latter would be most reliable. However, there are significant discrepancies (up to 2m), in particular the reported lift through the Lyncham flight (Seven Locks) and the evidence from the OS mapping would suggest that the adjusted Dalby figures are more representative for Semington to the Summit pound. There are no major discrepancies in the Summit to Abingdon section (still up to 0.4m however), and since the adjusted Dalby figures indicate inadequate freeboard in some reaches against levels for historic (1875 OS) mapping, the 1907 figures (which provide an exact match in total lift) are taken as representative for this section.

These pound levels, and the lock lifts arising as a consequence, are reported on the detailed route plans and schedules appended. It should be noted that the levels for each pound will need to be refined in due course as designs are developed in detail, and the levels finally selected need to optimise the cost and practicalities of bridge raising against canal lowering/deepening.

3.5.2 Locks and Backpumping

Water resources are likely to be critical to the prospects for full restoration, and losses will need to be minimised. It is becoming more and more common to provide backpumping facilities to recover water used in lock operations, the K&A being a prime local example. It is therefore proposed that, from the outset, backpumping of all lockage water will be an integral feature of the Wilts & Berks restoration. In view of the disparate nature of the likely water sources, such pumping facilities may also be required for water transfer up the system and will need to be designed accordingly. In some locations there may be a net transfer requirement down the system, after taking lockage into account; in these circumstances backpumping would not be necessary. However, for present purposes it is assumed that a backpumping station will be required for every lock or flight of locks.

There will be an economic optimum solution in respect of the diameters and lengths of pipeline ('rising main') and numbers of pumping stations for each flight. We have indicated likely requirements on the route plans and schedules. The pumping stations can utilize either submersible (wet well) pumps (probably most common) or pumps located in a dry well, and because of the importance of this system, should include standby provision (typically 1 duty and 1 standby pump, on rotating duty to equalise hours run). Power supply to these stations could be a significant cost item, and where possible loctions should be selected close to road access and power availability. This will not always be possible however.

Pump sizing/capacity will depend on maximum number of lock operations to be catered for, and the storage capacity between minimum and maximum acceptable operating water levels in the pounds connected by the station. The larger the storage capacity, the lower the rate at which water needs to be returned, and hence the cheaper the installation and running costs. Detailed design will need to consider whether off peak (Economy 7) tariffs are viable.

In respect of pump control, the operation really needs to be fully automatic. Use of a simple float switch or electrode in a stilling well adjacent to the lock chamber can be used to give a count of lock usage; this count can then be used for pump control to run the pump for 'x' hours per lock operation to ensure that all lockage is backpumped. This will need to be delayed or overridden according to levels in the upstream and downstream pounds: i.e. don't pump if the upstream pound is overflowing or the lower pound is below minimum level; and pump if lower pound is overflowing and upper pound is not.

It is recommended that the aim should be to provide a telemetry system for the whole of the Canal, with a centralised control/monitoring facility. This will enable pound levels, lock usage, pumping operations and fault conditions to be monitored remotely in real time. Remote control may also be considered, enabling pump control parameters to be adjusted in response to changing circumstances. Whilst this may all seem rather 'high tech', the basic technology is very well established, and, since effective water management will be absolutely crucial to the success of full restoration, it is considered vital that effective tools are provided for monitoring and control of the system.

3.6 Conclusions

It is proposed that the Canal be restored to accommodate standard narrowboat dimensions up to 22.0m length, 2.13m beam and 1.0m draft. Broader beam craft will not be accommodated. A range of minimum and desirable standards have been proposed for the dimensions of channel, bridgeholes and locks, and these will be generally achievable. However, marginal relaxation of standards may be, or may need to be, considered at certain critical obstructions. This applies in particular to the option for use of the existing Elcombe Brook culvert under Sainsbury's at Bridgemead, Swindon.

The total volume of excavated material arising from the restoration is estimated at around 1.4Mm^3, of which only perhaps 0.1Mm^3 will be required to form embankments. The materials arising, mainly stiff clays, whilst generally suitable for embankment construction, will need careful and appropriate design and construction techniques. The maximum height of embankment anticipated is about 3.5m. If contracts can be so arranged, there is potential to use up to 0.5Mm^3 of surplus material in the forming of the surface water reservoirs required for water supply to the restored canal.

The most significant new canal cut would be through the Oxford Clay of Horsey Down at Cricklade, where a depth of up to 6m is anticipated. This cutting would be shared with a restored railway. Problems are anticipated with this, and other lesser cuts through clays, since long term slope stability ideally requires slopes as flat as 1 in 5, but the land take will generally make this impracticable. Further study will be required in these areas to identify appropriate solutions which may involve retaining walls or bio-engineering techniques.

Potential problems with disposal of surplus material from the canal restoration, including contaminated land through illicit dumping, are discussed under environmental issues.

There will be numerous structures to be constructed or reconstructed for a restoration to full navigable standards of 108km of canal. In respect of bridges, there are three principal vehicular types: public highways (from the M4 to secondary and tertiary roads); private access roads and tracks; and railway crossings. For the vast majority of these crossings, the engineering solution is straightforward, and there is considerable scope for standardisation and resulting economy of construction. Some generic typical arrangements for these conventional structures are presented on **Figures 3.1** to **3.3**.

In the majority of cases at original Canal crossing points, the original structure is lost, the Canal infilled and culverted, and there is often insufficient headroom for a new bridge over a restored Canal with the road alignment unchanged. In these cases, we have examined the road approaches to determine whether raising of the road level to achieve sufficient headroom (whilst maintaining acceptable standards of vertical and horizontal alignment and sight lines) is practicable. Where this appears so, and where there is already sufficient clearance, the crossing is relatively straightforward, and not been subject to more detailed study. In some cases, where very light traffic usage is anticipated, traditional lift bridges will be appropriate; and similarly, traditional arch bridges could be used where the traffic type permits (neither of these types is likely to be acceptable on public roads). Costs for these 'standard' types of crossing (excluding services diversions) are estimated typically in the range £60,000- £100,000.

For crossings under the M4 and the A419 at Swindon, and the A34 at Abingdon, it is proposed to use the technique of structure jacking (commonly known as thrust boring) which enables the crossing to be undertaken without disturbance to the traffic. The same technique would be employed for the railway crossings - the GWR main line crossing of the North Wilts Branch in Swindon; at Acorn Bridge east of Swindon (which may not be necessary if a proposed new link road goes ahead, allowing the canal to use the original crossing currently used for the highway); and a little further east at Uffington (which also may not be needed if use of a nearby farm crossing can be negotiated). In every case there is adequate room to allow this technique to be employed, and, whilst the method is somewhat specialised and expensive (estimated cost ranging from £1.75M for railway crossings up to £2.25M for the M4), it is well tried and tested, and therefore these crossings are not considered likely to be critical in engineering terms to the feasibilty of restoration.

In addition to these vehicular crossings are footbridges and bridges accommodating bridleways and cycleways. A variety of forms can be used (concrete, steel, timber), and unit costs have been estimated typically in the range £25,000 to £50,000.

The most critical obstruction on the whole length of the restoration is identified as the crossing under the car park of Sainsbury's store at Bridgemead, Swindon, for the North Wilts Canal. We have investigated the use of the existing culvert which carries the Elcombe Brook under this site, and find that it appears practicable to lower the invert to achieve navigable depth (budget £350,000). However, because the Environment Agency indicate that it will be necessary to provide, as a minimum, a new dry weather flow culvert for the Brook, (which should be small enough to be feasible using microtunnelling techniques, budget £600,000), the overall cost and difficulty exceeds that of what appears to be a better alternative, namely a new canal culvert installed using a cut-and-cover method. This could be installed through the car park in short sections (say 50m possessions), and would require the agreement of Sainsbury's, but would be less costly overall (budget £450,000) and, more importantly, would ensure that full restoration standard could be achieved.

A total of 82 locks is projected for the restored Canal, against 54 for the original. The additional locks are required primarily to cross the higher summit level on the new route south of Swindon, and for the diversions at Melksham, Cricklade and Abingdon. Locks would be constructed (or reconstructed) to the same length and breadth as for the original Canal. Each lock or lock flight is likely to require backpumping for water conservation. A total of 39 pumping stations is projected. It is recommended that these stations be automatically controlled and that the system be remotely monitored via a telemetry system at a central location.

In all cases as designs develop, each proposed canal pound (between existing or proposed locks) must be examined in the light of more detailed topographic surveys to determine the optimum water level which achieves the best balance between earthworks and bridging costs (i.e between road raising and canal lowering).

4. Water Resources

4.1 Introduction

Along much of its length, the main line of the Wilts & Berks Canal runs across Kimmeridge, Gault and Oxford clay deposits within 8 km of the base of the chalk escarpment of the Lambourn, and Marlborough Downs. A large number of springs occur along the footslope of the Downs, where water from the extensive chalk aquifer is forced to the surface by the underlying clay deposits. These springs feed a large number of brooks and streams, some of which are seasonal in the headwater areas, running roughly south-north and which eventually discharge into either the Thames or Avon river systems. Owing to the relatively short distance between the chalk escarpment and the Canal, most of the surface water catchment areas of watercourses which traverse the route of the Canal are relatively small.

4.2 Background and Previous Studies

4.2.1 Original Water Supply

A rich source of historical information on the Canal is provided in the account of Dalby (1986). Initially after completion of the mainline in 1810, the spring-fed surface water courses directly supplied the Canal's water requirements. With a few exceptions, the Canal Act empowered the Company to take water from all rivers, springs, brooks, streams and watercourses within 2000 yards of the Canal (Dalby, p107). Abstractions were not permitted from the Avon or its tributaries between Trowbridge and Stanley Abbey, or from Tockenham Water, Trow Lane Water or Wootton Bassett Brook between 10 June and 10 September. Dalby reports that at this time the Wanborough feeder supplied the Canal with 3.7 Ml d^{-1}; this water course is inferred to be a tributary of the River Cole (see **Drawing No. DBKEP/004/02**). The Company were also required to construct and maintain drains to convey water from adjoining lands; this is inferred to mean taking water under the Canal but it is unclear (Dalby, p107).

To provide additional in-line water storage, the summit section of the Canal near Swindon was constructed wider and deeper than the rest of the Canal (Dalby, p10).[2] However, water shortages were apparently a major constraint on the operation of the Canal. Presumably, shortages would have been most serious during the summer months owing to reduced stream flows and the lack of storage. In 1816, shortages led to the digging of a well to tap the Corallian aquifer to the north of Swindon, where water was struck at 80m depth. However, the supplies were limited and the well was quickly abandoned.

To provide off-line storage of surface runoff during the winter, the Coate Water reservoir with a capacity of 555 Ml was completed in 1822 (Dalby, p65). However,

[2] but recent restoration works have cast doubt on Dalby's assertions.

water supplies were still apparently inadequate. Historically, this was a period of peak usage of the Canal. For example, in 1838 the Wilts & Berks Canal Co. paid compensation to divert water from Dray Mill into the Canal to augment supplies (Dalby, p73). To further increase storage, the Tockenham reservoir was completed in 1840 (Dalby, p74) with a capacity of 273 Ml (Allen & Harris/Royal Insurance, 1994).

During the latter part of the 19th Century, traffic along the Canal declined and evidence suggests that the water supply problems also lessened. In 1843, the Wilts & Berks Canal Co. entered into an agreement to sell water to the Great Western Railway (Dalby, p86). In 1871, in a dispute over the abstraction of water from Wroughton Brook, a court remarked that 'except during the exceptionally dry year of 1870, there had not been, nor was there now any deficiency of water' for the Canal (Dalby, p87).

Dalby also makes useful references to efforts to minimise losses of water from the Canal. Firstly, the channel was required to be puddled during construction to reduce seepage losses (p107). There was clearly recognition that seepage would be a major cause of water loss and that this could be minimised by puddling the excavated channel, presumably with *in-situ* clay. Second, a reference is made to pumping to the summit which ceased in 1898 (p92). During the period of historical operation it therefore appears that pumping was required to minimise the effect of lockage losses, although the rate of any pumping is not known.

In summary, water resources for the historical operation of the Canal were supplied from:

- a large number of surface water courses which were largely spring-fed;
- storage in Coate Water, Tockenham Reservoir and to a lesser extent, the summit reach of the Canal; and
- presumed, but unconfirmed drainage of adjoining agricultural land.

Measures to minimise losses in the historical operation of the Canal included:

- construction across clay soils along much of the Canal length, and puddling the sides and bed of the channel to minimise seepage[3]
- pumping water that accumulated in lower pounds back to the summit.

4.2.2 Previous studies

Previous studies which have addressed aspects of the water supply needs for restoration were:

- A report by Griffiths (1986) which considered some aspects of the amount and likely cost of water requirements. Based on local experience, and converted to an

[3] If lining was restricted to puddling in situ clay, the full extent of lining will not have covered the whole length of the canal.

equivalent depth of water using an assumed average bed width of 10m, a seepage rate of 4.7mm d^{-1} was suggested for water balance studies.

- An outline feasibility study by Allen & Harris/Royal Insurance (1994) which included an approximate water balance for the western section of the mainline and the North Wilts Canal. Assuming a seepage rate of 20mm d^{-1} and an evaporation rate of 4.5mm d^{-1}, a summer water requirement of 1.9Ml d^{-1} was estimated before allowing for any loss due to lockage.

4.3 Methodology

A monthly water balance model of the original Canal system was developed for the four main reaches (Eastern mainline, Summit, Western mainline, North Wilts), and including branches at Chippenham, Calne, Longcot and Wantage. This model was used to:

- Analyse the historical water supply management of the Canal;
- Make an assessment of the water requirements for a restored Canal;
- Analyse various water supply, construction and operation scenarios for a restored Canal.

The model was calculated on a monthly basis for improved representation of storage within the Canal water supply system, and the likely importance of seasonal fluctuations in resource availability and operation of the Canal.

4.3.1 Data collection and analysis

All data were derived from published or official sources. Meteorological data were provided by the Environment Agency for the Upper Thames region. Evaporation data for a grass surface were corrected to open water evaporation using coefficients determined by Penman (in Shaw, 1994). Rainfall and open water evaporation during an average 1:10 year return period drought were determined for subsequent computation of the water balance. Drought was defined for this purpose as the deficit between rainfall and open water evaporation. On average the annual deficit was 82 mm, and for a 1:10 year return period drought the deficit was 262mm. The monthly input data for a 1:10 drought year for the water balance model were computed by reducing the monthly mean rainfall, and increasing the monthly mean open water evaporation in proportion to the monthly mean totals to obtain an overall deficit reflecting a 1:10 year drought.

No quantitative site investigations (such as flow measurement) were carried out during this Study. In a phased programme of restoration, such monitoring would be desirable to test the results of the water balance model and options for new water resources.

4.3.2 Water requirements

4.3.2.1 Seepage and Leakage

Seepage can be defined as the diffuse outflow from the Canal bed which may be reduced by lining, whereas leakage is usually a localised loss of water which may be reduced or eliminated by repair. In this study, seepage and leakage losses were considered together.

Initial consideration of the water balance for a restored Canal showed seepage and leakage to be the most important parameter, not least, owing to the long length of the proposed restoration. The outcrop geology along the route of the Canal was determined from the published geological map, at 1:100000 scale[4] (Institute of Geological Sciences/Thames Water Authority, 1978) (**Table 4.1**).

Table 4.1 Outcrop Geology Along Original Canal Route

Reach	Total	Length by outcrop geology (km)						
	length (km)	Allu-vium	Fluvial sands & gravels	Gault Clay	Lower Green-sand	Kimme-ridge Clay	Coral-lian	Oxford Clay
Western mainline (inc. branches)	42.7	0.6	1.4	0.0	0.0	2.6	1.3	36.9
Summit	13.5	0.0	0.0	0.0	0.0	13.5	0.0	0.0
Eastern Mainline (inc. branches)	37.2	3.6	11.3	8.4	1.2	11.3	1.4	0.0
North Wilts branch	14.5	0.7	0.7	0.0	0.0	2.9	2.2	8.0
W & B total	107.9	4.9	13.4	8.4	1.2	30.3	4.8	44.9
% total length by outcrop geology	100.0	4.6	12.4	7.8	1.1	28.1	4.5	41.6

Over most of its length the original Canal was constructed on clays of the Gault, Kimmeridge and Oxford formations. The total length on these clay deposits amounted to 83.8km (77.4%). These materials have the lowest permeability rates and, depending on local construction methods, a relatively low seepage rate would be expected from the Canal in these areas. Other geological units along the original route are alluvium, fluvial sands and gravels, Lower Greensand and Corallian deposits. The alluvial deposits, fluvial sands and gravels tend to have higher permeabilities, and greater seepage rates from the Canal would be expected unless it was lined with clay. According to the published maps, a total length of 18.3km was constructed across these materials, primarily at the eastern end towards Abingdon. However, investigations by Thames Water in relation to the siting of a proposed reservoir in this area have shown that clays rather than fluvial sands and gravels dominate the surface geology. Short lengths of Canal were constructed in areas where the mapped outcrop geology is Lower Greensand sands (1.1km) and Corallian limestones and sands (4.5

[4] This map is based on geological maps published at 1:50,000 by Institute of Geological Sciences (now British Geological Survey). Soils have developed on these formations, comprising the solid and drift geology, often reflecting closely the geology.

km). Permeability and consequently seepage rates would also be expected to be relatively high on these materials unless the Canal was lined during construction (see later **Table 4.2**).

4.3.2.2 Evaporation

Open water evaporation from a restored Canal was calculated on a monthly basis for 1:10 year return period drought conditions. Evaporation is strongly seasonal with maximum rates observed during the summer.

4.3.2.3 Lockage

The water balance model enabled the calculation of lockage as a function of lock dimensions, and the amount and pattern of traffic movement. For scenarios involving backpumping at locks this parameter was effectively set to zero, although it is probable that some loss via lockage will continue even with the implementation of backpumping.

4.3.2.4 Abstractions

In case of future need, abstractions from the Canal were incorporated in the model. However, non-Canal water demands are currently met from other sources and given the potential water resource shortfall, it is unlikely that future abstractions will be authorised. This parameter was therefore set as zero in all simulations.

4.4 Assessment of Existing Water Resources

4.4.1 Historical Water Services

Following the abandonment of the Canal in the 1914 Act, the historical water sources have been put to other uses:

- Coate Water is owned by Swindon Borough Council and is now a Country Park and an important local nature reserve designated as an SSSI in part. The reservoir also apparently has a flood storage function. The Council have indicated that use of Coate Water as a source of water supply of the Canal would not be acceptable. The main reasons against re-use as a water resource for the Canal are firstly the need to maintain relatively stable water levels for both recreational purposes and for the SSSI; and secondly that the original capacity of the reservoir is no longer available due to safety considerations for the dam (under the Reservoirs Act 1975) which make it unsafe to impound to the original level.

- Tockenham Reservoir is reported to be in the ownership of Bristol, Bath and Wiltshire Amalgamated Anglers. No enquires have been made with this society regarding any potential for Canal water supply from the reservoir.

- Surface water courses which cross the Canal alignment may be considered as existing water resources. Any abstraction would require licensing from EA and it is likely that all watercourses would need to be culverted under the Canal to ensure that downstream flows were not reduced.

4.4.2 Other Sources

The only remaining existing water supplies for the Canal were identified as:

4.4.2.1 Natural Inflows

The short sections of the Canal remaining in water are presumably supplied by drainage systems and runoff from localised areas around the Canal. These were considered negligible in comparison with the overall requirements of a restored Canal.

4.4.2.2 Direct rainfall

Direct rainfall is the quantity of water falling directly on the surface area of the Canal. Rainfall inputs were determined from monthly rainfall records provided by the Environment Agency for the Upper Thames region.

Average annual rainfall varies between approximately 600mm at the eastern end to 800mm at the western end of the Canal. Average annual rainfall for the Upper Thames area over the period 1961-1996 was used in this Study, i.e. a rainfall of 687mm, which was applied to the whole Canal length. There is very little seasonality in rainfall amount in the region, but monthly variations were taken into account. However, there are large variations in open water evaporation during the year with peak rates recorded in the Summer, result in a mean water surplus (rainfall minus open water evaporation) during the months October to March and a mean deficit during the months April to September.

Rainfall was multiplied by the average channel width and route length to determine the volume of direct rainfall input during each month. As the model simulates conditions averaged over each month throughout the year, specific account is not taken of, for example, individual summer storms and the potential loss of water over waste weirs.

4.4.2.3 Groundwater inflow/outflow

Groundwater inflow to the Canal is expected to be low as over 75% of the original Canal route passes over outcrops of low permeability clays of the Gault, Kimmeridge and Oxford Clay formations. However, there are several locations where the main route of the Canal passes across permeable formations as summarised in **Table 4.2**. Along the whole length of the Canal, calculations in this study suggest that there is a net loss of the order of 2 Ml d^{-1} which is dominated by losses in the River Sands and Gravels between Chippenham and Melksham.

Table 4.2 Estimated Water Fluxes (between the Canal and groundwater in aquifers)

Location	Geology	Groundwater Levels (mAOD)[1]	Canal Water Level (mAOD)	Canal Length (km)	Loss or Gain by Canal	Rate (Ml d^{-1})	Comments
Lower Ock, nr Abingdon	River Sands & Gravels	50-80	49.5-67	15	Gain	0.05-50	Thames Water data indicate low permeability ∴ gain closer to lower estimate
North of Uffington	Lower Greensand	80[2]	83	1.2	Loss	0.16	
South west of Wootton Bassett	Corallian	95	87	1.3	Gain	0.008	Upper estimate. Possible confinement clays & limited aquifer thickness suggests low potential for inflow[3]
Chippenham to Melksham	River Sands & Gravels	32-57	38-50	2	Loss	1.9	Some gain is also likely.
Longcot Branch	Corallian	95	93	1.4	Gain	0.009	Possible confinement clays & limited suggests low potential for inflow
North Wilts Branch	River Sands & Gravels	80	80	1.4	Loss/Gain	-	Net gain estimated as zero
North Wilts Branch	Corallian	130 (max)	86.6	2.2	Gain	0.014	Upper estimate. Aquifer confined by Corallian Clays
Upper Calne Branch	Corallian	?	80-90	1.5	?	?	Groundwater levels are unknown; further data required

Notes:
1. Groundwater levels estimated from published hydrogeological map , or as river levels for the Sands & Gravels
2. Lower Greensand believed to be in hydraulic continuity with Corallian; groundwater levels for Corallian assumed
3. "Mud springs" occur at Templars Firs, south of Wootton Basset. These unique features bring up clay-rich waters from the underlying Kimmeridge and Oxford Clays, implying the Corallian is thin. The driving head may originate from the Cornbrash or Great Oolite Aquifers.

4.5 Historical Water Balance

A water balance was calculated to evaluate the historical water resources of the Canal and draw lessons from the available historical data. This was nominally calculated for the year 1841. By this time the reservoirs at Coate Water and Tockenham were completed, traffic rates were high, and the balance between water resource supply and demand was apparently still rather tight. The number of boats which passed along the western mainline in 1841 was 2902, along the eastern mainline it was 2477 and along the North Wilts Canal it was 681. It was assumed that boat movement was uniform over the year, which is likely for a commercial waterway.

4.5.1 Model Assumptions

Bearing in the mind the reference to facilities to pump water back from the lower pounds to the summit it is difficult to assess the actual lockage losses. However, for the purpose of estimating the maximum historical demand, backpumping was set to zero. Meteorological data were taken as the same as at present, i.e. average rainfall and evaporation. Historical seepage rates for the Canal are unknown, but the water balance evaluation allows inferences to be made about minimum likely seepage rates.

It was assumed that the off-line storages totalling 828 Ml were fully refilled by excess runoff during each winter, and the annual reliable yield was estimated as twice the reported reservoir capacity. The reliable yield is greater than the storage capacity, as the reservoirs would be recharged throughout the year, but the actual reliable yield is a further uncertainty. The total amount of water taken from surface water courses and supplied by drainage systems is not known. However, as a minimum, it is reported by Dalby (1986) that 3.7 Ml d^{-1} were provided by the Wanborough feeder.

The short Calne branch was excluded from this analysis as it was probably supplied by abstraction from the River Marden. It was assumed for the purpose of this simulation that when any pound is at capacity, overflows occur as bypass flows down the Canal, rather than being lost over waste weirs, but ultimately the excess capacity is lost as outflow from the West and East Mainline as well as the North Wilts Canal. Bypass flows from the summit section were routed in proportion to the length of each of the three lower reaches of the Canal. In model simulations a minimum water depth of 1.37 m was permitted in any reach, during any month of the year, the ultimate aim of the model being to produce a water at or above this depth with the addition of a minimum amount of water from other sources.

4.5.2 Model Results

Table 4.3 shows a historical water balance for the Canal at seepage rates of 10, 20 and 30 mm d^{-1}. A net deficit is indicated for all scenarios, owing to neglect of additional surface water supplies other than the Wanborough feeder (which was taken to supply 1351Ml per year), the possible underestimation of reservoir yield, and the neglect of the contribution made by groundwater inflows. From **Table 4.2**, an upper figure of 50 Ml d^{-1} is suggested for annual groundwater inflow. However, owing to the probable low ground permeability in the Lower Ock area and possible existence of puddled clay lining in these sections of the original Canal, this contribution would presumably have been reduced dramatically; a net loss of about 2Ml d^{-1} along channel sections crossing aquifers is perhaps a more realistic estimate. Assuming that the total supply from other sources was equivalent to that provided by the Wanborough feeder, the water balance could almost be closed for a seepage rate of 10mm d^{-1}, with a deficit of about 550Ml being reduced by a degree of backpumping. However, it is possible that the water balance could be closed at a seepage rate of 20mm d^{-1}, with a remaining deficit of about 4500Ml reduced by backpumping. These estimates suggest historical seepage rates of <20mm d^{-1}, and it was probably closer to 10mm d^{-1}.

Table 4.3 Historical Annual Water Balance

Seepage rate (mm d^{-1})			**10**	**20**	**30**
Demand	Seepage/leakage	Ml	3985	7969	11954
	Direct evaporation from Canal	Ml	589	589	589
	Lockage	Ml	1041	1041	1041
	Lock leakage	Ml	51	51	51
	By pass losses	Ml	144	138	137
Supply	Direct rainfall on Canal	Ml	786	786	786
	Required abstractions & storage (total demand less rainfall)	Ml	4911	8895	12880
Minimum known resource		Ml	3007	3007	3007
Other sources		Ml	1351	1351	1351
Net Balance	Calculated balance	Ml	-553	-4537	-8522
	Order of magnitude estimate*	Ml	-550	-4500	-8500

Note: * = order of magnitude estimate quoted to reflect uncertainty in parameters

The above water balance estimate supports the range of seepage rate values used in previous calculations, which were 4.7mm d^{-1} in the calculations by Griffiths (1986; calculated from an estimated discharge in gallons per day) and 20mm d^{-1} in the study by Allen & Harris (1994) although considerable uncertainty remains. Average daily losses from various British Canals as summarised by Hyde (1977) are shown in **Table 4.4**. These losses incorporate lockage, leakage, seepage and evaporation and would be affected by a whole range of factors including geology, construction, traffic rates, maintenance and management of the Canal. However, seepage and leakage are the most important losses from most Canals, and after making a deduction of say 5mm to account for evaporation and other losses, the values may be used to infer the range of actual seepage and leakage rates for British Canals.

Given the largely clay surface geology along the route of the Wilts & Berks Canal, it is considered that an actual seepage and leakage rate close to the minimum 10mm d^{-1} for the Union Canal is achievable, if puddling during restoration was comparable with the original construction of the Canal. To support the use of a seepage rate from the lower part of the estimated range, the following is of note:

- For a minimum Canal water depth of 1.4m and a basal clay layer thickness of 1m, Darcy's law gives a permeability for the clay layer of $1.4x10^{-2}$ to $7x10^{-3}$m d^{-1}

assuming seepage rates of 20 and 10mm d^{-1} respectively. Although fractures as well as burrows and roots produced by Canal fauna and flora may locally increase the clay layer permeability, these calculated permeability values are significantly greater than reported permeabilities for the Gault, Kimmeridge and Oxford Clays ($5x10^{-4}$ to $2x10^{-7}$m d^{-1}). It is expected that permeabilities lower than those calculated above can be achieved on puddling, thus minimising seepage.

Table 4.4 Losses from British Canals

Canal	Canal Length (km)	Daily loss (mm)
Union Canal	48	15
Birmingham Canal Navigations	67	20
Chesterfield Canal	10	20
Lancaster Canal	66	25
Llangollen Canal	74	25
Macclesfield Canal	36	32
Shropshire Union Canal	106	35
Leeds & Liverpool Canal	203	38
Trent & Mersey Canal	89	44
Caldon Canal	27	54
Oxford Canal	18	65

The British Waterways target water loss for restored Canals is 1.75 Ml/km/week, which is equivalent to 25mm d^{-1}, and is the same as proposed by Dunwoody to the 1906 Royal Commission on Canals and Waterways (Hyde, 1977). For the Wilts and Berks Canal, this equates to a total annual water loss of about 10,000Ml.

4.6 Water Balance For A Restored Canal

A water balance was calculated to identify the water requirements for a restored Canal (**Table 4.5**). The goal of the simulation was to achieve a water depth at or above the design minimum of 1.37m, but minimise the additional water supplied to the Canal. The simulation included:

- calculation of requirements with and without backpumping at locks, assuming boat traffic similar to other local Canals;

- calculation of requirements with and without the elimination of net losses from the system of bypass flows.

The identified water requirements were due to seepage/leakage, evaporation, lockage, lock leakage and bypass flow, while the only identified water resources were from direct rainfall. It should be noted that the direct rainfall is lower than that used in estimating the historical water balance, while the evaporation is higher; these differences reflect drought conditions used in assessing the water balance for a restored Canal. The required water supply at the summit level was calculated by assuming that a constant abstraction source was made available throughout the year.

The net deficits in the water balance, even allowing for elimination of net by-pass and lockage losses, clearly show that new water sources will be required to maintain navigation on a restored Canal. As indicated in **Table 4.5**, a demand reduction could be made via:

- reducing by-pass losses which are ultimately lost from the Canal over waste weirs and at the terminations, mainly during the winter. These losses are produced by the model owing to the limited in-line storage of the channel, and the crude simulation of water level management operating procedures simulated by the model. Storage could be increased during restoration to reduce these losses. For the conditions simulated this would be an additional storage of about 500Ml, although by careful management of water flows from the summit to lower pounds the increase in storage could be reduced.

- backpumping at locks to reduce lockage losses to a level as low as reasonably achievable.

Even assuming implementation of both these measures, an annual water supply of the order of 4200Ml made available throughout the year would be required to meet the resource deficit if a seepage rate of 10mm d^{-1} were achieved. If the seepage rate were 20mm d^{-1} the demand would increase to about 8400Ml (**Table 4.5** and **Figure 4.1**).

Table 4.5 Water Balance for a Restored Canal

Seepage rate (mm d^{-1})			**1**	**5**	**10**	**20**	**30**
Demand	Seepage/ leakage	Ml	417	2087	4173	8347	12520
	Evaporation	Ml	981	981	981	981	981
	Lockage	Ml	112	112	112	112	112
	Lock leakage	Ml	31	31	31	31	31
	By pass losses	Ml	495	495	495	495	495
Supply	Direct rainfall	Ml	683	683	683	683	683
	Net loss from in-line storage	Ml	324	324	324	324	324
	Required abstractions & storage	Ml	1029	2698	4785	8959	13132
Current resource		Ml	0	0	0	0	0
Net Balance		Ml	-1029	-2698	-4785	-8959	-13132
Net Balance (less by-pass losses)		Ml	-534	-2203	-4290	-8463	-12637
Net Balance (less lockage and by-pass losses)	Calculated balance	Ml	-422	-2091	-4178	-8351	-12525
	Order of magnitude estimate	Ml	-420	-2100	-4200	-8400	-12530
Equivalent Net Daily Balance		Ml d^{-1}	-1.2	-6	-11.5	-23	-34

4.7 Proposals To Meet The Resource Deficit

4.7.1 Development of Historical Resources

Restoration of water supply from Tockenham Reservoir may be possible if improvements were made to reduce the impact of low water levels on fish populations, and if alternative angling facilities could be provided during these periods on the Canal or other reservoirs. Currently, the reservoir discharges a small amount of water into the Canal, but if restoration was possible to restore the original capacity of 273Ml, requiring dredging, the reliable yield may crudely be estimated as twice the capacity, 546Ml. Potentially this would meet 13% of the total water demand for the Canal at a seepage rate of 10mm d^{-1}.

4.7.2 Demand Reduction Options

To further reduce the demand placed on the identified water resources, a number of options were considered to conserve the water supplied to the Canal:

4.7.2.1 Water Level Management

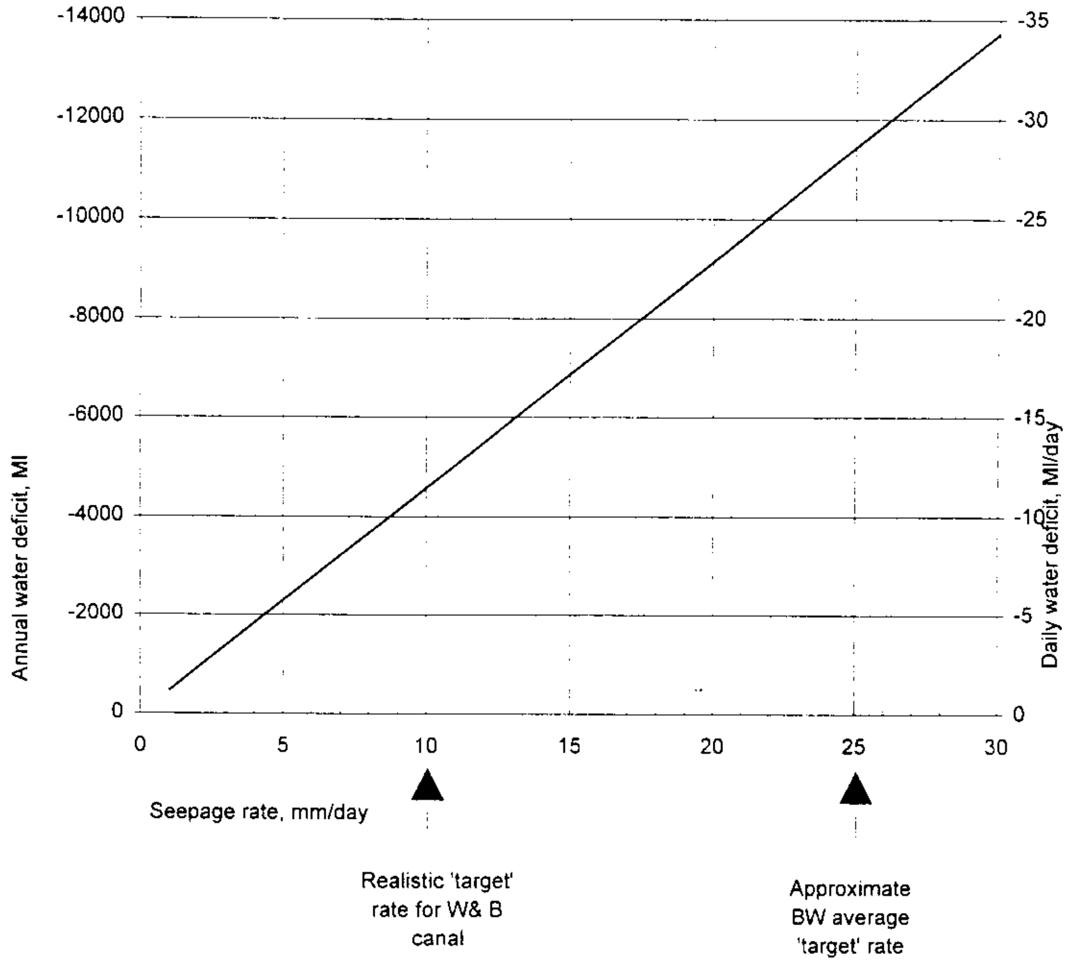
By maintaining a minimum practical depth of water in the channel, seepage and leakage through the bed may be reduced by the reduction in the head of water. This might be most effective in winter months when traffic is limited and optimum navigation conditions would not be essential. As an illustration of the potential impact, a reduction of 0.3m from 1.7m to the 1.4m minimum water depth results in a decrease in seepage of 5mm/day; this is a 25% decrease on the upper estimate of 20 mm/day. The aim of this strategy is to maintain a minimum water depth for as long a period as possible, but care is essential to ensure that, if high water levels are drawn down to this minimum depth, drying of the formally submerged bank does not induce cracking, and thus greater seepage/leakage, if water levels return to the former high level.

On the other hand, control of the maximum water level is important to achieve minimisation of losses over waste weirs and bypass losses at locks.

4.7.2.2 Basal Drainage Layer

To capture seepage and leakage through the Canal bed a drainage blanket could be engineered beneath a reduced thickness of puddled clay. Water collected could then be pumped and returned from sumps spaced along the Canal. The drainage layer could comprise the following elements, from top to bottom,

- puddled clay
- geotextile to limit mixing of the clay with the underlying aggregate drainage blanket
- aggregate blanket including porous drainage pipes
- impermeable geomembrane.



Drawing Title

RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY

Projected canal water demand as a function of seepage rate

FIGURE 4.1

Scale at A4 : NTS		
Drn SMB	Appd	Revised
Chk NAW	Date	Date 16/10/97

Scott Wilson

Using a range of estimates for seepage (10 to 25mm d^{-1}), and considering a fine gravel aggregate (permeability of 2000m d^{-1}), the drainage blanket needs to be only about 1 cm thick. However, from a practical point of view a minimum thickness of about 0.15 to 0.3m would be required. With a fall in the drainage blanket of 0.5m per 100 m flow rates would be small, but could still cope with the best estimates for seepage.

The use of a drainage blanket could be combined with a puddled clay layer of 0.5m, thus reducing the depth of excavation and amount of excavated material requiring disposal. Such an approach could be adopted for reaches of the Canal crossing non-aquifers (i.e. clay formations) and aquifers.

It should be noted that the inclusion of an impermeable basal geomembrane could be used to prevent any seepage and leakage (see below), thus making the overlying drainage layer redundant. However, the large permeability contrast between the drainage blanket (2000m d^{-1}) and underlying clays (reported permeabilities for the Gault, Kimmeridge and Oxford Clays range from $5x10^{-4}$ to $2x10^{-7}$m d^{-1}) suggests that the drainage blanket could be placed directly on natural clays, resulting in the capture of the majority of the water seeping through the bed. Although potentially feasible for about 77% of the Canal where it crosses non-aquifers, its construction, operation and maintenance are likely to be problematic and expensive, as a result this option is not considered further.

4.7.2.3 Wellpointing

A series of wellpoints, driven by a vacuum abstraction system, located along the route could be installed to capture water that has seeped and leaked through the channel. Low ground permeability constrains the effectiveness of wellpointing, thus limiting its practicality to reaches crossing permeable aquifers, i.e. about 23% of the route.

If the aquifer water table in the vicinity of the Canal is low, and thus the ground is unsaturated under natural conditions, then water lost through the bed will move downwards vertically, making it impractical to capture the water using wellpoints. Along the 23% of the route which crosses permeable units, available information suggests that groundwater levels are close to or below the Canal level, potentially producing an unsaturated zone beneath the channel, e.g. the 1km stretch of the Canal north of Uffington where the Lower Greensand is inferred to have an unsaturated zone about 3m thick. In addition to constraints imposed by an unsaturated zone, the applicability of wellpointing may be further reduced by, (a) restrictions on groundwater abstraction from sands and gravels along the River Avon to avoid exacerbating low flow problems, and (b) limited stretches where groundwater levels are above the Canal level e.g. the 2km stretch of the North Wilts Canal which crosses the Corallian aquifer. Under these conditions, inflow of groundwater into the Canal would be expected, making wellpointing redundant.

From the above analysis, available information suggests that the general applicability of wellpointing has very low potential.

4.7.2.4 Impermeable Basal Liner

In place of a puddled clay liner, an impermeable geomembrane would prevent any seepage and leakage if its integrity could be maintained during construction and operation of the Canal. Protection of the geomembrane could be afforded by an unpuddled clay layer. Further details are given below.

Lining of existing short sections of channel often takes place as a maintenance measure on other Canals to repair leaks and breaches, or to cure specific sections of high seepage, e.g. where the underlying geology is particularly permeable. Lining is not usually employed in the construction of new Canals for any great length due to its prohibitive expense, but it is an option that must be considered for the Wilts & Berks Canal owing to the significant water resource shortfall that exists.

A range of lining materials is available. British Waterways have carried out trials using:

- puddled clay, the most common liner,
- concrete, and
- a variety of flexible membrane liners such as PVC (e.g. Schlegel lining), Butyl Rubber lining, and bentonite matting.

4.7.3 Channel Lining

Puddled Clay, concrete with a PVC liner and Bentonite Matting, have all been used in BW trials on the Kennet and Avon Canal, and there is no doubt that any of these types of liner, correctly placed, can reduce seepage/leakage dramatically, usually to near zero. Although zero seepage/leakage is attainable, piercing of a liner, for example by dredging, root penetration, drying and cracking etc., can lead to an increase in seepage/leakage with time.

Information on the costs of the various liners and on their relative performances has been obtained from experienced Canal engineers in four BW offices and from a company who supply and place Puddled Clay. However, the type and thickness of liner, and thus the costs and seepage value that can be attained, depend on site-specific conditions. British Waterways generally conduct detailed ground surveys before selecting a liner for Canal repairs. Consequently, there are no definitive costs per metre length of channel that can be applied to the Wilts & Berks Canal with guaranteed accuracy, but the following comments and prices reflect, as far as possible, "typical" conditions. They have been provided here to facilitate not only a comparison between liner types, but also a broad comparison between Canal lining and other potential solutions to the identified water resource problems.

4.7.3.1 Puddled Clay

This is the most common liner in use to date. The costs and seepage value that can be obtained are highly dependent on the skill of those who lay it and on the quality of the clay itself. It is reported that few people are able to place puddled clay well and hence BW do not tend to use this liner. Puddled clay of about 1m thickness for the bed and 700mm for the sides is generally used, although thickness may go as low as 600mm all round. The greater thickness helps to limit the occurrence of localised leakage arising from burrowing animals and later dredging, and is therefore generally preferred.

The cost of supplying and placing puddled clay, including excavation and disposal of material, is reported to range up to £66/m^3 although a typical cost is closer to £22/m^3. Assuming £28/m^3, for the 1m and 700mm thicknesses given, and with the Canal's design dimensions, the cost of puddled clay works out at around £340/m length, providing that,

- the clay is available locally, and
- excavated material can be disposed of locally.

Castle Clay Aggregates, a company used previously by BW, have informed us that they could supply puddled clay from a source near Oxford for a price of £13/m^3. To this figure would need to be added the cost of excavation, disposal of excavated material and emplacement of the clay. A total figure of £28/m^3 is therefore not unrealistic.

The seepage value that can be obtained from well placed puddled clay is reported to be almost zero, but localised leakage and the fact that very few people can apparently place clay well enough to achieve zero seepage makes it sensible to adopt a small seepage value above zero. The permeabilities of the Gault, Kimmeridge and Oxford Clays which would probably be used for lining the Canal are estimated as $5x10^{-4}$ to $2x10^{-7}$ m d^{-1}. The EA specified permeability for clay used for landfill sites is 10^{-4} m/d, which is also reported to be that adopted by British Waterways for use on their Canals. Assuming a hydraulic gradient of 1.4m (i.e. the minimum Canal water depth), the maximum estimated permeability equates to a seepage of about 0.7mm/d. This is therefore a realistic seepage value to use but in view of the potential for future localised leakage, we have adopted a more conservative figure of 1mm/d.

4.7.3.2 Concrete

This is generally used in conjunction with PVC liners as a protection. In areas of instability and slippage, reinforced concrete of around 250mm thick is used. This ensures zero seepage is obtained in most cases but would cost about £1100/m length, and even more if contaminated material was excavated and had to be disposed of. In areas of stability, the thickness of concrete used is more usually 100mm or 150mm placed over the top of a PVC liner. The seepage value that can be achieved is again near zero, because of the PVC lining, but localised leakage through the concrete joints or at the lined/unlined boundary can occur. A reasonable seepage value to be used in the water balance is therefore considered to be 1mm/d. At this thickness of concrete, the cost of a combined concrete/PVC liner is reported by BW to be in the order of £330-550/m length (average £440/m).

4.7.3.3 Bentonite Matting

This is a flexible membrane liner generally comprising clay powder, granules or partially hydrated layer sandwiched between geotextile mats, producing a permeability of the order of 10^{-14} m/s[5]. It is often protected with excavated material (usually to a depth of greater than 200mm) rather than with concrete, and is usually used to plug holes rather than reduce seepage over a significant length of Canal. Unlike puddled clay, highly specialised labour is not required to place it. Its effectiveness in reducing seepage depends on how it is laid, but it is reported that if a leak develops it can sometimes reseal itself. The consensus of opinion is that seepage could be reduced by over 80% and therefore a 25mm d^{-1} seepage could be reduced to 5mm d^{-1}.

The cost of Bentonite Matting is reported to be similar to that for a combined concrete/PVC liner; a current estimate of about £500/m length has been adopted in this study for cost comparison purposes.

4.7.3.4 Lining Costs

Table 4.6 provides an indication of the costs for lining the Canal with puddled clay and concrete/PVC along those reaches where it crosses permeable (aquiferous) ground where seepage is likely to occur. It is important to note that BW would generally recommend the adoption of two or more lining methods for a long stretch of Canal to ensure that lining did not result in a "uniform Canal"[6]. Scheme costs could therefore be expected to fall between the maximum and minimum values given in **Table 4.6.** These costs for lining of key Canal sections, including those noted below are included in the Schedules in **Appendix D**.

Table 4.6 Costs for Lining Leaking Canal Reaches

Reach	**Geology**	**Length**	**Loss**	**Approx. Cost (£)**	
		(m)	**(Ml d^{-1})**	Puddled Clay	Concrete/PVC
North of Uffington	Lower Greensand	1200	0.16	408,000	528,000
South of Melksham	River Sands & Gravels	2000	1.9	680,000	880,000
TOTAL		**3200**	**2.06**	**1,088,000**	**1,408,000**

Other reaches of the Canal could also lose water, but there are uncertainties in the available, existing data which prevent their identification. Considering the worst case, if all reaches of the Canal crossing permeable ground were subject to seepage/leakage, costs for lining would increase significantly as indicated in **Table 4.7**.

[5] These costs are based on figures obtained in early 1995, but inflated by 10%
[6] Use of two or more lining types has the potential to produce more diverse Canal bed and bank substrates, thus influencing ecological conditions.

Table 4.7 Costs for Lining All Canal Reaches

Reach	Geology	Length (m)	Approx. Cost (£)	
			Puddled Clay	Concrete/PVC
Western Mainline (inc. branches)	River Sands & Gravels	2000	680,000	880,000
	Corallian	1300	442,000	572,000
Eastern Mainline (inc. branches)	River Sands & Gravels	14900	5,066,000	6,556,000
	Lower Greensand	1200	408,000	528,000
	Corallian	1400	476,000	616,000
North Wilts Canal	River Sands & Gravels	1400	476,000	616,000
	Corallian	2200	748,000	968,000
TOTAL		**24,400**	**8,296,000**	**10,736,000**

The difference in estimated costs in **Table 4.6** and **Table 4.7** illustrate the importance of investigating water fluxes between groundwater and the Canal. Based on current knowledge, the lining requirements are likely to be closer to those outlined in **Table 4.6**

There is uncertainty over construction/restoration measures needed for sections of the Canal crossing low permeability clays such as the Oxford and Kimmeridge Clays. Leakage will probably be very low unless localised fractures and fissures are present. It is likely that puddling of in situ clay would be sufficient to seal these fractures, rather than puddling imported clay. The cost for in situ puddling is uncertain, but is estimated to be of the order of £10-15/m^3, giving a cost of about £120-180/m length of Canal. Alternatively, the clay surface forming the floor could be rolled, or prepared as a cleanly cut surface. The costs of lining are included in the Schedules for each 2 km length of Canal included as **Appendix D**.

4.7.4 New Surface Water Abstractions

4.7.4.1 Historic Abstractions

Surface water abstractions from the many watercourses which cross the Canal alignment once provided the bulk of the water supply. In addition to direct abstractions, surface water was stored in impounding reservoirs at Coate Water and Tockenham. The Coate Water reservoir had a capacity of 555 Ml with an approximate catchment area of 8.0 km^2. Tockenham Reservoir had a capacity of 273 Ml and an approximate catchment area of 4.0 km^2.

4.7.4.2 Abstraction Licences

After restoration, any authority responsible for the Canal would no longer have any abstraction rights from watercourses or aquifers. Abstraction applications would need to be made to the Environment Agency, who license both ground and surface water abstractions to protect and maintain the water environment. The evaluation of abstractions for this Study was therefore carried out in close liaison with the EA, who commented on the initial water resource development proposals; those comments are included in the proposals presented here.

4.7.4.3 Existing Low Flow Problems

Almost all of the watercourses which could potentially provide water to the Canal suffer from low flows during the summer. The Environment Agency actively manage flows in the region to minimise the environmental impact of low flows, for example, flows in the Letcombe Brook (which flows through Wantage) are supplemented with water from outside the catchment during the summer. Owing to low flow issues, any successful application for surface water abstraction would almost certainly be limited to abstraction during periods of high flow, with water being stored for later use. Restoration of the Canal, with a water supply from storage, would consequently have beneficial environmental impacts by reducing low flow problems in watercourses with catchment areas incorporating the Canal alignment. Flows in these streams and rivers would in general be enhanced by the continuous seepage losses from the Canal.

4.7.4.4 New Storage Reservoirs

It is proposed that the most appropriate surface water schemes to replace the dispersed historical water supplies would be the construction of a large number of small storage reservoirs along the restored Canal route, rather than a small number of large reservoirs. Smaller schemes will be easier to construct as part of a phased programme of restoration, with reduced environmental impact and easier acquisition of suitable sites. Development of dispersed water supplies would also minimise the water transfer effect of the restored Canal which will lose water along its entire length by seepage. There would be opportunities for multi-purpose schemes to be developed with land owners, for example to provide wildlife habitats and fishing and other recreational facilities, although the reservoirs would have to be designed to enable a sufficient water level fluctuation for adequate storage. There would still clearly be a preference, owing to reduced operating costs, for sites close to the summit near Swindon. However, this need is reduced by the proposed installation of backpumping facilities at all locks. This gives considerable flexibility in the siting of storage reservoirs which need not be located immediately adjacent to the proposed abstraction point but could be placed along the Canal with water being transferred to storage via the Canal.

4.7.4.5 Catchments

The Canal route has been subdivided into six sub-catchments which broadly follow surface water catchment divides. There are three sub-catchments within the EA Thames Region and three in the EA South West Region (see **Drawing No. DBKEP/004/01** at end of report). Catchments with the best potential for abstraction and storage were initially identified on the basis of catchment area and the likelihood of finding a suitable site near the Canal. Catchments with an area less than 6.0 km^2 were excluded. The flows from each catchment were estimated using procedures for low flow estimation in the United Kingdom (Gustard et al., 1992;). The area of different soil associations within each catchment were determined from Soil Survey of England and Wales maps in order to calculate the 1-day flows which are exceeded 95% of the time (referred to as Q95(1)); this flow determines the type curve for the catchment. Type curves range from 0 (impermeable catchment) to 19 (permeable catchment). The type curve is used together with an estimated mean flow to calculate a flow duration curve for each catchment, from which the available water resources may be estimated. The mean flow was determined from published data for gauging stations at the nearest location, weighted according to the catchment area. Gauging stations in the vicinity are located on Letcombe Brook at Letcombe Bassett, on the River Cole at Inglesham, the River Ray at Water Eaton, the River Marden at Stanley and the River Avon at Melksham (Institute of Hydrology, 1993).

The estimates of possible resources which could be abstracted have been based on average flow conditions and not 1:10 drought conditions, as insufficient data are available for drought conditions. However, to account for potential drought conditions a set of very conservative assumptions were made, essentially limiting the water resource available for abstraction; the assumptions are as follows:

1. abstraction only when flows exceed Q_{20} (i.e. that flow which is exceeded 20% of the time), but ceasing abstraction when river flow falls to the Q_{25} level;

2. abstraction for only 20% of the time available based on assumption no. 1 above;

3. abstraction of only 20% of the volume available during the time defined by assumption no. 2 above.

Possible abstraction from the lower River Avon is not based on catchment characteristic data for this large catchment (666 km^2) but would more likely be limited by land availability and environmental problems associated with a larger storage reservoir. In discussion, the EA noted that although the upper Avon is subject to low flow problems, the lower Avon is a very important strategic resource and central to possible solutions for resolution of these problems. It will be important in more detailed studies to ensure that this resource is not jeopardised by increased abstraction by others, particularly as there are existing abstractions for industrial[7] and agricultural use.

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[7] Licensed abstraction from the Avon at Melksham is for industrial cooling. There is potential for water re-use here which should be investigated,but it is disadvantaged by its location at the lower end of the Canal.

Resources would be available to enable greater abstractions. However, it was considered that large storage schemes would be likely to present considerable environmental and land acquisition difficulties. For small schemes the estimated reservoir area was calculated by assuming a circular shape with a 2.0 m water level fluctuation. It was assumed that reservoirs were filled once during the winter and the daily summer yield was estimated assuming that the stored water was used over a period of six months. Results for each sub-catchment are shown in Table 4.8, together with indicative construction costs.

Most of the catchments identified are quite permeable with type curve numbers of 12 or above. These catchments have significant areas of chalk geology where the hydrology is baseflow dominated. Two of the catchments have a more impermeable nature, the Brinkworth Brook and Cade Burna catchments, with type curve numbers of 7 and 10 respectively, where clays (particularly the Denchworth series) dominate and result in a more flashy hydrological response. Type curve numbers refer to those described by Gustard et al. (1992; see above).

Mean flow of the watercourses varies between 0.07 m^3s^{-1} for the small and less permeable catchment of the Cade Burna, to 6.67 m^3s^{-1} for the much larger catchment of the River Avon near Chippenham. The estimated storage capacity, based on the assumptions listed above, varies between 19 Ml and 252 Ml. Abstraction rates could vary between 15 and 200 ls^{-1} with average daily abstractions of between 1.3 and 17.3 Ml. The surface area of reservoirs is crudely estimated to be between 1 and 13 ha for this Study, although clearly the shape and size of any reservoir would also be determined by site specific conditions.

Information on licensed surface water abstractions made available by EA South West Region indicates that there are few likely to be impacted by proposals made here. Small abstractions from the River Marden (0.02 Ml d^{-1}) are downstream of the proposed reservoir in the Fisher's and Cowage Brook catchment (AM1)[8]; moderate abstractions (14.7 ls^{-1}) proposed from this large catchment (46 km^2) are unlikely to affect abstractions downstream. Other small licensed abstractions within the Clackers Brook catchment (AL3) (e.g. agricultural abstractions of up to 0.9 Ml d^{-1} around Bromham) are in the headwaters of the catchment and are unlikely to be affected by larger abstractions (3.8 Ml d^{-1}) downstream (see **Drawing No. DBKEP/004/02** at end of report).

4.7.4.6 Total Estimated Yield

Based on implementation of surface water storage schemes at all of the sites listed in **Table 4.8**, with capacities and yield as estimated, the total yield would be about 1020 Ml, equivalent to a daily summer yield of 5.6 Ml d^{-1}. Additional abstractions during the winter, over the amount of water abstracted for storage, would be required to meet winter losses from the Canal. Given the conservative assumptions made in calculating the surface water yield, it is estimated that an abstraction for winter use of a roughly equivalent volume to that stored for summer use is feasible. Potentially therefore, the total water abstracted from surface watercourses would be doubled to 2034 Ml.

[8] Coding system refers in turn to, the main catchment (A=Avon; T=Thames); the sub-catchment (e.g. M=Marden; see Dwg. No. DBKEP/004/01); the proposed scheme number.

Table 4.8 Catchments With Potential for Surface Water Abstraction and Storage

Watercourse	Approximate location	Code	Catchment area	Type curve	Mean flow	Storage capacity	Avg. abs rate	Avg. daily abs.	Surface area	Cost
			(km^2)		(m^3s^{-1})	(Ml)	(ls^{-1})	(Ml)	(ha)	£000
Tributary of Stutfield Brook	SE of Broadleaze Farm	TO6	7.0	15	0.21	50	40	3.4	2.5	800
Tributary of River Ock	Downstream of Uffington	TO9	6.0	12	0.18	54	43	3.7	2.7	840
Tributary of River Ock	Downstream of Cowleaze Farm	TO1 0	6.5	12	0.19	63	50	4.3	3.2	920
River Cole	S of Acorn Bridge	TC4	54.0	13	0.46	140	111	9.6	7.0	1500
Brinkworth Brook	E of Greenhill Common Farm	AU1	23.0	7	0.27	126	100	8.6	6.3	1410
Cade Burna	SW of Stockham Marsh Farm	AU4	6.0	10	0.07	19	15	1.3	0.9	470
Fisher's and Cowage Brook	Swerves Farm	AM1	46.0	12	0.55	215	171	14.7	10.8	2000
Tributary of River Avon	S of Forest Farm	AL2	8.5	14	0.10	41	32	2.8	2.0	710
Clackers Brook	N of Bowerhill Lodge Farm	AL3	15.5	13	0.19	56	44	3.8	2.8	850
Avon	S of Chippenham	-	-	-	6.67	252	200	17.3	12.6	2230
Total storage of combined schemes (Ml)						1017				11730
Daily summer yield (Ml d^{-1})						5.6				

The above schemes alone are unlikely to meet the estimated water demand for the restored Canal, unless an average seepage rate of 4.9 mm d^{-1} were achieved. It is therefore likely that in addition to surface water storage schemes, other water supply options would be necessary. However, at a target seepage rate of 10 mm d^{-1} the schemes could provide an estimated 2034 Ml, i.e. about 49% of the required resources. There may also be the potential, within the resource constraints identified, to increase the capacity of reservoirs where suitable sites could be acquired.

4.7.5 Groundwater Abstractions

4.7.5.1 Introduction

For the majority of its length, the Wilts & Berks Canal overlies low permeability non-aquiferous clays. However several aquiferous horizons either crop out nearby, or are expected at depth adjacent to the Canal. These aquifers contain and transmit groundwater which potentially could be used to supply the Canal. Individual aquifers hold different potential for development. This variety is due to many factors including:

- the natural lithology of the formation;
- the rate of recharge, and
- the rate of discharge, both naturally and through abstraction.

4.7.5.2 Hydrogeological Study

A desk study has been conducted to evaluate the development potential of all aquifers present. This has included a review of the geological and hydrogeological systems, and a review of licensed and unlicensed boreholes present in the vicinity of the Canal route using EA records. The desk study was carried out in close liaison with the EA, who were asked to comment on initial groundwater resource development proposals; the proposals presented here take account of those comments received.

Set against the baseline hydrogeological conditions, consideration of individual aquifers as groundwater sources to supply the Canal must take account of the following:

- is the resource, both in terms of quantity and quality, available in the right locations?
- will groundwater abstraction impact detrimentally upon surface water resources such as spring flow, stream baseflow or known wetland conservation areas?
- will abstraction derogate other private and public groundwater users?
- what measures are available to mitigate any identified problems?

4.7.5.3 Aquifers

The main aquifers considered during the desk study are illustrated in **Drawing No. DBKEP/004/01**, with areas proposed for potential development in **Drawing No. DBKEP/004/02** appended to this document, and their potential evaluated in each of the six sub-catchments in **Table 4.9**. This table notes several proposed borehole locations which have an estimated potential yield of zero. These locations were proposed originally as having limited resources, but abstraction at these locations was not supported by the EA; they are included in the tables and figures for completeness. To obtain additional information with regard to potential yields, a groundwater yield assessment was commissioned from the British Geological Survey (BGS) as part of this study (see **Appendix G**).

Table 4.9 Potential for Developing Groundwater Resources

Catchment	Sub-catchment	Aquifer	Potential Locations and Map Ref. Number	Issues	EA Response	Estimated Potential Yield
Thames	Ock	1) Chalk (contributions from Upper Greensand)	TOgw 1 - White Horse Hill, south of Uffington.	Abstraction impacts on chalk springs used for supply. No reports of low flows although Public Water Supply boreholes have caused the Letcombe Brook, to the east, to suffer low flows. Any abstraction would require detailed test pumping and monitoring.	Awaited	1 Ml/day (winter only)
		2) Lower Greensand (Corallian)	TOgw 2 - 2.5km north of Uffington	Groundwater occasionally iron rich. Unknown thickness and continuity, but high permeability. Possibly in continuity with Corallian Aquifer. Many boreholes and wells have been drilled into the aquifer, but current abstraction. is uncertain. Proximity of Canal increases potential for development	Awaited	Several shallow boreholes totalling 1 Ml/day.
	Cole	1) Chalk (contributions from Upper Greensand)	TCgw 1 - Odstone Hill, north east of Ashbury	Several springs present at base of escarpment. Nearest PWS is distant enough for development to have little impact, however due to vulnerable nature of Chalk, detailed test pumping and monitoring will be required	Awaited	1 Ml/day (winter only)
		2) Lower Greensand	TCgw 2 - south east of Bourton	Little knowledge, no known boreholes. Possibly high iron, excessive salinity and expected limited thickness restricts development potential to small scale abstraction.	Awaited	0.25 Ml/day per borehole.
		3) Corallian	TCgw 3 - Stratton St. Margaret	Borehole located on aquifer outcrop as an increase in salinity is postulated within the confined area. Many disused boreholes but little information on current abstractions. Reasonable potential for small scale development.	Awaited	0.25 Ml/day per borehole.
	Ray	1) Chalk (contribution from Upper Greensand)	TRgw 1 - 3km south west of Wroughton	Little local abstraction, some springs used for supply. Any development to be sufficiently test pumped and adjacent resources to be monitored. Expected to be winter only abstraction.	Awaited	0.5 Ml/day (winter only).
		2) Lower Greensand-Portland/Purbeck Beds	TRgw2 - North of Wroughton	No abstractions from aquifer. Possible high iron content and excessive salinity. Unknown interconnection of Lower Greensand and Portland/Purbeck beds, although limited thickness would prohibit substantial development	Awaited	0.25 Ml/day per borehole.
		3) Corallian	TRgw3 - west of Swindon	Good potential of small supply. Current use is low. Water quality deteriorates in the confined aquifer.	Awaited	0.25 Ml/day per borehole.
		4) Great Oolite	TRgw4 - Purton	Within catchment aquifer is found at depth and is confined. Unknown quality. Expected to deteriorate away from outcrop.	Awaited	Unknown-requires investigation

Table 4.9 Potential for Developing Groundwater Resources (cont'd)

Catchment	Sub-catchment	Aquifer	Potential Locations and Map Ref. Number	Issues	EA Response	Estimated Potential Yield
Avon	Upper Avon	1) River Gravels	AUgw1 - Great Somerfield to Sutton Benger	Existing abstractions. Quality unknown, and susceptible to contamination. Concerns over low flows observed in the River Avon would limit development.	Not supported	Zero
		2) Chalk (contributions from Upper Greensand)	AUgw2 - Broad Hinton	Some chalk springs, impact would be assessed. Possible adverse effects on upper Kennet flows would necessitate detailed test pumping. Feeds springs and provides baseflow for local streams	Not supported	Zero
		3) Corallian	AUgw3 - Tockenham	No known abstractions. Aquifer resources unknown.	No data	0.25 Ml/day per borehole
		4) Great Oolite	AUgw4 - Bradenstoke	Public supply boreholes around Malmesbury and Chippenham indicate good quality water. Water quality deteriorates to the east.	Some potential	Uncertain but up to 1 Ml/day
		5) Great Oolite	AUgw5 - North of Callow Hill	Location at distance from Canal in order to abstract groundwater of reasonable water quality within the confined aquifer. Water quality is postulated to deteriorate rapidly towards the Canal.	Some potential	Uncertain but up to 1 Ml/day
	Marden	1) River Gravels	AMgw1 - West Tytherton	Current small abstractions, quality susceptible to contamination. Concerns over low flows observed in the River Avon would limit development.	Winter only	0.25 Ml/day per borehole (winter only)
		2) Lower Greensand	AMgw2 - Compton Basset or Heddington	Some current abstractions, quality unknown but can occasionally be high in iron concentrations and elevated salinity. Aquifer thickness is highly variable and may not allow significant development.	Not supported	Zero
		3) Corallian	AMgw3 - surrounding Calne	Little known abstraction. Low flow problems associated with surface abstractions may prohibit further development.	Not supported	Zero
		4) Great Oolite	AMgw4 - Christian Melford	Public water supply boreholes to the west indicate good quality water. However development to the east may encounter a deterioration in the water quality in the confined aquifer. Consideration of the impact on the existing boreholes would also be undertaken. The estimated yield is dependent on test pumping and monitoring results.	Potential for winter only	0.5 Ml/day (winter only)

Table 4.9 Potential for Developing Groundwater Resources (cont'd)

Catchment	Sub-catchment	Aquifer	Potential Locations and Map Ref. Number	Issues	EA Response	Estimated Potential Yield
	Lower Avon	1) River gravels	ALgw1 - West of Bowden Hill	Several wells abstract from shallow aquifer. Unknown quantities and qualities, and would be at risk from surface contamination. Concerns over low flows observed in the River Avon would limit development.	Potential for winter only	0.25 Ml/day per borehole (winter only)
		2) Lower Greensand	ALgw2 - Sandy Lane to Bowden Hill	Only one licensed borehole currently abstracting. Resource unknown however variable thickness and possible excessive iron and salinity would limit the development of the aquifer. Interconnection with Corallian aquifer below is uncertain.	Potential for winter only	0.25 Ml/day per borehole (winter only)
		3) Great Oolite	ALgw3 - 1.5km west of Derry Hill	Several public water supply boreholes around Chippenham indicate good quality water. Development would be possible with a careful monitoring scheme to assess the impact on current abstractions. Present location may yield poor water quality in the confined aquifer necessitating relocation to the west. Estimated Yield dependent on test pumping and monitoring results.	Potential for winter only	0.5 - 1 Ml/day (winter only)

Note: The estimated yields have been derived from adjacent licensed boreholes of similar characteristics (where available), and taking account of the occurrence of any particular concerns such as low flows and the general hydraulic properties of the aquifer.

Sand and Gravel Aquifer - The main areas where river sands and gravels occur are as follows:

1. The main outcrop is found between Grove and Abingdon. However, previous studies by Thames Water revealed the formation to be clay-rich, therefore its low permeability, and poor aquifer properties, would limit the resources available.
2. The sand and gravel aquifer is present in the extreme east of the River Ock sub-catchment at the greatest distance from the Canal's high point around Swindon. A significant pumping scheme would be required to pump the groundwater to the most efficient length of the Canal. However, inferred groundwater levels are often above the probable Canal water level indicating a groundwater influx.
3. In the extreme western reach of the Canal, sands and gravels associated with the River Avon out crop within half a kilometre of the Canal. There are a number of small licensed abstractions for agricultural use (0.02Ml d^{-1}) around Lacock (e.g. Lacock Abbey; licence no. 175301G139 at ST914675). It is not anticipated that individual boreholes could sustain a large abstraction but a carefully designed scheme could produce a reasonable yield. However, the EA have commented that they would not support development of the groundwater resource (AMgw1[9]) due to low flow concerns associated with the River Avon although the main concerns are believed to be significantly upstream of the suggested abstraction schemes.

Chalk-Upper Greensand Aquifer - The Cretaceous Chalk is the most important aquifer in England. The flow is fracture controlled with a low matrix porosity. The upper 60m of the Chalk is the most productive as this is the principal fissured zone with occasional fissured horizons at depth.

The feather edge of the western extremity of the Chalk outcrop forms the Berkshire Downs escarpment, running east-west from the east before turning at Compton Bassett to a more north-south lineation. The Canal route mirrors this arc to the north and west. Although the main flow directions within the Chalk aquifer are to the south east, the groundwater highs found in the highest Downs do generate a small proportion of flow to the north and north-west discharging in a prominent spring line at the foot of the Downs.

Borehole yields are greater for the Middle and Upper Chalk horizons although abstractions of up to 4Ml/d are recorded from the Lower Chalk. The Chalk is a very sensitive aquifer and further development of the resource would need a strict licensing procedure involving detailed test pumping of an exploratory borehole and, if granted, the licence would almost certainly carry a winter only abstraction condition. The South West Region of the EA have responded that, due to the Chalk's contribution to a number of springs and the baseflow of a few brooks, they would not support development of Chalk groundwater. Although no official response has been received from the Thames Region, the same hydrogeological conditions exist and therefore it is expected that no abstraction would be possible from the Chalk unless a detailed impact assessment was conducted including test pumping.

[9] Coding system refers in turn to, the main catchment (A=Avon; T=Thames); the sub-catchment (e.g. M=Marden; see Dwg. No. DBKEP/004/01); "gw" refers to groundwater source, and the proposed scheme number. See Appendix F.

The Upper Greensand aquifer is separated from the Chalk aquifer in the east by the relatively impermeable Chalk Marl, however for the majority of the study area the Upper Greensand is believed to be in hydraulic continuity with the Chalk and therefore holds a similar development potential and limitations.

Lower Greensand Aquifer - This is an impersistant minor aquifer of high permeability. It was eroded to a varying extent prior to the deposition of the overlying Gault Clay, causing uncertainty in estimating aquifer thickness. Where significant thicknesses of sand exist boreholes may yield small quantities of iron-rich groundwater which would probably require treatment prior to usage.

The largest Lower Greensand outcrops are located north of Uffington, to the west of Compton Basset and between Rowde and Bowden Hill **(Drawing No. DBKEP/004/01)**. North of Uffington, the significant outcrop appears to offer development potential, but given the number of boreholes currently believed to be abstracting and its limited thickness it is unlikely that there would be significant potential for any major supply.

Within the South West Region of the EA two outcrops of Lower Greensand are observed (**Drawing No. DBKEP/004/01**). The EA have stated that they would not support development of the Lower Greensand in the Marden sub-catchment owing to low flow concerns in the River Avon. In addition there are small existing licensed abstractions (e.g. Compton Basset; licence no. at SU035729 for 0.011Ml d^{-1}) in the vicinity of the proposed abstraction area (AMgw2). In the Lower Avon sub-catchment, the EA comment that there may be potential for winter/high flow abstraction from the Lower Greensand, therefore more detailed study is needed to assess the resource development potential.

Corallian Aquifer - The Corallian aquifer varies both laterally and vertically, with clays acting as aquitards and occasionally confining the underlying limestone and sandstone aquifers. The yields produced by boreholes tapping the aquifer are limited to small quantities, usually below 1Ml/d. The lateral variations observed within the aquifer create a greater risk in borehole location exemplified by the previous Corallian borehole drilled as a top-up supply for the Canal which failed to supply the required quantities. Proposals made here include a bored well in the River Cole catchment (TCgw3) yielding about 0.25Ml d^{-1}, but the groundwater yield assessment by BGS suggests a yield of the order of 0.04Ml d^{-1} (less than 0.5 l s^{-1}). Information made available from the EA database indicates yields ranging from the order of 0.05 to 0.5 Ml d^{-1} which demonstrates the significant uncertainty in making yield assessments.

The Canal crosses portions of the aquifer which are confined and are potentially artesian. Artesian groundwater is believed to show increased salinity and total dissolved solids which could prohibit development. Today, this aquifer is considered to yield only small supplies in most areas, although better yields are possible on the eastern margins of the aquifer near Abingdon (IGS, 1978).

Within the EA South West region there are two main outcrops (**Drawing Nos. DBKEP/004/01** and **DBKEP/004/02**):

- Tockenham - no other boreholes are currently abstracting from this outcrop and the EA have no data to be able to express a detailed view on the resource potential. It would be prudent to conduct further desk and walk-over studies to assess the development potential.

- Calne - this part of the aquifer is tapped by a significant number of licensed boreholes and the EA would not support further development of the aquifer in this area.

Within the Thames region the Corallian crops out extensively. Many boreholes are currently licensed to abstract from the aquifer although, without detailed assessment, it is unclear how many are abstracting at present.

- River Ock sub-catchment - the Corallian is potentially in hydraulic continuity with the Lower Greensand as the Kimmeridge Clay is of limited thickness. The potential for developing small supplies here is good although yields are not anticipated to be high and the deteriorating water quality down gradient could prevent a significant supply.

- River Cole sub-catchment - here there are many disused Corallian boreholes located on the exposed aquifer. The reasons for the current lack of abstraction is unclear, and there may be merit in approaching the licensees' of disused boreholes regarding possible transfer or renewal of licences.

- River Ray sub-catchment - this has a small number of boreholes abstracting from the Corallian and potential for further development of small supplies is good, although water quality may prohibit significant development as a supply for the Canal.

Great Oolite Aquifer - Beneath the Canal route the limestone aquifer of the Great Oolite is confined by the Oxford Clay. Recharge occurs in the Cotswolds where limestone hills allow precipitation to permeate into the aquifer. The confined aquifer has dominantly fracture characteristics with bedding planes and solution fissures creating a high permeability. Some boreholes yield high quantities of good quality groundwater such as the public supply boreholes at Latton and Ashton Keynes, which yield 25 and 10Ml/d respectively.

Several boreholes constructed into the deeply confined areas of the aquifer have produced poor quality water that would prove expensive to treat prior to supplying the Canal. Generally with increasing distance from the outcrop area the water quality deteriorates, however drastic deterioration generally occurs approximately 6-10km from the outcrop. The two large public water supplies, mentioned above, both abstract good quality water at greater distances from the outcrop. However this could be related to the very high abstraction rates that encourage rapid groundwater flow from the recharge area.

The area of greatest potential for developing the Great Oolite aquifer is within the EA South West Region as boreholes could be positioned closer to outcrop and could produce fresher water (i.e. borehole locations AUgw3, AUgw5, ALgw3, AMgw4; shown on **Drawings DBKEP/004/01** and **DBKEP/004/02**). The EA have responded by stating that there is development potential within the Great Oolite although there are concerns over:

- low flows in the Avon in the Marden and Lower Avon sub-catchments, causing the EA to comment that only winter abstractions may be feasible (Table 4.9), despite the Great Oolite being confined by the Oxford Clay;

- impact on the two major public water supply boreholes noted above.

It is unclear whether or not the proposed location for a borehole into the Great Oolite in the far west of the EA Thames Region (i.e. TRgw4 near Purton) would yield good quality or whether the distance from outcrop would cause a rapid deterioration in the water quality. A response is awaited at present from the Thames Region water resources department, which may give a better understanding of the potential.

4.7.6 Reactivation & Purchase of Abstraction Licences

There is a growing awareness that former groundwater abstraction licences may be suitable for reactivation. Many licences have been revoked, typically when the resources became redundant after the industries they supplied closed down. In addition, there may be cases where licence holders retain their abstraction licence, but do not actively abstract water, as it is potentially a very beneficial item when trying to sell land or industry. There has been much attention over recent months to such inactive and revoked licences which could be reactivated.

It could prove beneficial to search out both revoked and lapsed licences within close proximity of the Canal route to assess the potential for additional resources.

4.7.7 Urban Runoff

Given the large urban area close to the summit section of the Canal, there is potential to make use of urban runoff particularly in the Swindon area as a water supply. There is similar potential for utilising treated runoff from RAF Lynham and roads within the Canal corridor. The principle of using these potential resources is considered here, but the detailed estimates of volumes available from such sources cannot be made until the later stages of the project.

A possible process sequence for treatment of urban runoff, including runoff from roads and other impermeable areas, as discussed with the EA, is as follows:

1. urban runoff passed through silt trap and oil interceptor
2. storm balancing pond, with overspill to watercourse
3. discharge to specially constructed wetlands
4. feed to Canal from storage lagoon, probably by pumping
5. return of excess water (i.e. overspill) to watercourse.

Thames Water have responsibility for surface water drainage in the Swindon area. Currently, all storm runoff is routed into surface water courses. Thames Water look for the most flexibility when planning discharge of storm water and it is reported that discharge via non-traditional routes, such as a Canal, can cause legal complications in future operation, for example over liabilities regarding poor water quality. Although possible, the contractual arrangements would therefore need to be carefully drawn up. The EA would also be required to consent to storm water discharge to the Canal. Benefits and disbenefits of re-using urban runoff are summarised in **Table 4.10**; these were identified with the assistance of the EA.

Table 4.10 Benefits and Disbenefits of Re-using Urban Runoff

Benefits	Disbenefits
1. Treatment of previously untreated runoff	1. Net loss of water to watercourse, particular concerns over diversion during low river flow periods.
2. Habitat & amenity improvements	2. Construction, operation & maintenance costs.
3. Improved flow attenuation & storm balancing	

There may be suitable opportunities for storm drainage from new building developments to supply the Canal. The EA have suggested Melksham, north and north-west of Calne and south of Wootton Bassett as locations of potential development. With a phased programme of restoration, it would be important that the Canal could provide a reliable discharge route for such storm water. It is anticipated that such schemes would also make a small contribution to the water balance. Importantly, the supply is unreliable but runoff during summer storms would be particularly beneficial.

4.7.8 Sewage Effluent

Sewage treatment works (STW) could potentially provide a limited water resource for the restored Canal. The advantage of using sewage effluent is the potential for a continuous supply during the year, with summer supplies being of considerable value. Sewage effluent would require treatment and storage which could be provided by the following sequence:

1. discharge to specially constructed wetlands
2. storage and flow, through a series of maturation/storage lagoons
3. feed to Canal
4. return overspill to watercourse.

There are about 14 sewage works serving towns and villages along, and adjacent to, the Wilts & Berks Canal (**Table 4.11** later). As might be expected they range in size, and thus discharge rates, from the largest in west Swindon to small works serving small towns such as Letcombe Regis. Based on a production rate of 200 l/person/day, a sewage treatment works serving a town of 55,000 people would need a base treatment capacity of 11Ml d^{-1}, which is the calculated water deficit for the Wilts &

Berks Canal assuming a seepage rate of 10mm d^{-1}. The total population served by the treatment works included in **Table 4.11** is at least of the order of 500,000 and possibly more, which potentially equates to 100Ml d^{-1}. Those sewage treatment works considered here together with the issues associated with re-use of treated effluent are summarised in **Table 4.11**[10].

The benefits and disbenefits of re-using effluent from STWs are summarised in **Table 4.12**; these were identified with the assistance of the EA. The main concern is the loss of contribution to streams and rivers which suffer from low flow problems. This latter issue lead the EA to indicate that they would not look favourably on the use of discharges from the west Swindon treatment works to supply the North Wilts Canal as the EA judged that flows in the River Ray would suffer. Despite this potential difficulty, there is a general potential for diverting treated effluent discharges from water courses during winter/high flow periods, followed by treatment and storage for use in periods of lower flow. In addition, increased volumes of treated sewage effluent are likely to derive from new building developments, along similar lines noted for increased opportunities for using stormwater drainage (Clause 4.7.7)

From this preliminary assessment, the potential for year-round use of treated sewage effluent appears limited, but the following treatment works ranked in order of decreasing potential need to be considered further:

1. Wroughton;
2. Swindon (south);
3. South Marston;
4. Steventon;
5. Abingdon;
6. Childrey.

With regard to using treated sewage effluent during winter/high flow periods, all of the treatment works listed have potential to provide water resources for storage and subsequent use. If such proposals were implemented they would replace, at least partially, winter/high flow abstractions taken directly from the receiving watercourse. In this case, it is likely that costs would be higher for re-use of sewage effluent due to treatment costs. Thus this source of water is of reduced interest on purely economic grounds.

[10] The locations of the sewage treatment works considered were taken from 1:25,000 OS maps. The current operation, nature and volumes of treated effluent discharge of these works was not confirmed.

Table 4.11 Sewage Works Considered for Supplying Treated Effluent

Location	Watercourse Receiving Discharge	Issues
Melksham	River Avon	Contribution potentially included in resources of Lower Avon sub-catchment, & located at lower (western) end of Canal
Chippenham	River Avon	Contribution potentially included in resources of Lower Avon sub-catchment
Calne	River Marden	Discharge supporting river during low flow stages
Wootton Bassett	Brinkworth Brook	Contribution effectively included in resources of sub-catchment AU1
Swindon (east)	River Ray	Discharge supporting river during low flow stages
Swindon (south)	Upper River Ray	Discharge possibly supporting river during low flow stages; some potential for Canal use
Wroughton	River Ray (?)	Discharge possibly supporting river flows; some potential for Canal use
South Marston (x2)	Tributary of River Cole	Small treatment works; some potential for Canal use
Sparsholt	Unnamed chalk stream	Contribution effectively included in resources of sub-catchment TO6
Childrey	Childrey Brook	Discharge possibly supporting river flows; some potential for Canal use
Letcombe Regis	Letcombe Brook	Discharge supporting river during low flow stages
Steventon	Cow Common Brook	Small treatment works; some potential for Canal use
Abingdon	River Thames	Located at lower (eastern) end of Canal; some potential for Canal use

Table 4.12 Benefits and Disbenefits of Re-using Effluent

Benefits	Disbenefits
1. Higher dilution for remaining effluent; supported by overflow of effluent treated in wetlands.	1. Net loss of water to watercourse; particular concerns over diversion during low river flow periods
2. Habitat & amenity improvements	2. Construction, operation & maintenance costs

4.7.9 Land Drainage

Land drains on agricultural land could potentially be modified to supply the Canal. Such works would not be subject to Environment Agency consent. Furthermore, restoration of the Canal would probably require ameliorative measures to improve drainage of lands detrimentally affected by seepage from the Canal. The contribution to the water supply would be mainly during the winter, when water would be of lesser value to the Canal. However, sumps for water collection, and pumps for feeding water to the Canal would probably be required unless the Canal was in a cutting.

4.8 Water Quality Issues

Information summarised in **Table 4.9** before indicates that water quality is likely to constrain development of groundwater resources for supplying the Wilts & Berks Canal. These constraints include natural variations in groundwater chemistry as follows:

- Lower Greensand - potentially iron-rich groundwater leading to precipitation of iron oxides/hydroxides on abstraction and discharge;

- Corallian - increase in salinity (total dissolved solids; TDS) in the confined aquifer distant from recharge areas;

- Great Oolite - increase in TDS in the confined aquifer distant from recharge areas; there is evidence from large public water abstractions (Ashton Keynes and Latton, north west of Swindon) that the act of abstracting can improve water quality by drawing in groundwater from the recharge areas.

In addition to these natural variations, unconfined aquifers are susceptible to contamination by various point and diffuse sources; shallow parts of confined aquifers are also potentially susceptible. The types of contamination include, but are not restricted to, (a) nitrate and pesticides, mainly from agricultural use, and (b) a range of organic compounds, particularly petroleum hydrocarbons and solvents, due to unplanned releases from manufacturing and commercial uses.

Due to unknown distributions of artificially introduced contaminants, the potential impact was not included in guiding the consideration of suitable groundwater sources. However, natural water quality variations were used to dismiss the following groundwater sources:

- Lower Greensand source north of Wroughton (TRgw2), potentially with high iron and TDS

- Great Oolite sources near Christian Melford (AMgw4) and Bradenstoke (AUgw4) with total dissolved solids concentrations of the order of 10,000 mg/l (Bromley, 1975).

No data are currently available on the historical water quality of the Wilts & Berks Canal, and any changes in quality gradients along its length. It is probable that the historical water quality was dominated by contributions from chalk-fed streams and reservoirs. Nevertheless, restoration of the Canal is not constrained to matching the historical water quality, but the introduction of water quality gradients could be of significant benefit in ecological terms (see Chapter 5). Using the water balance for a restored Canal (**Table 4.5**), and proposed groundwater sources accounting for about 50% of the water deficit.

Table 4. 13 shows an estimated average water quality composition for the Canal. The source of water is as follows:

1. Rain water 14.1%
2. River Sand & Gravel Aquifer 2.3%
3. Chalk Aquifer & Streams 51.2%
4. Lower Greensand Aquifer 10.3%
5. Corallian Aquifer 3.9%
6. Great Oolite Aquifer 18.2%

These results give an indication of the water quality, but owing to limited data it is not possible to confirm whether the supplied water would result in the Canal meeting the design standards proposed in **Table 3. 1** before. As the groundwater sources are distributed along the length of the Canal it is probable that water quality gradients will result, particularly if backpumping limits overall circulation within the Canal. An approximate estimate of water quality in the Canal in the East and West lengths is also given in **Table 4. 13** to illustrate potential water quality gradients.

Table 4. 13 Average Water Quality for Restored Canal*

Quality parameter	Estimated Concentration (mg/l)		
	Whole Canal	E**	W**
pH	?	?	?
TDS	530	394	617
Na+K	88	34	123
Ca	65	66	65
Mg	6.8	6.7	6.9
HCO_3	265	229	289
Cl	73	26	103
SO_4	24	25	23
NO_3	7.5	7.4	7.6

* - see **Appendix H** for water quality data used in calculations
** - E and W refer to the Canal east and west of Swindon

4.9 Strategy to Meet Canal Water Demand

With a target seepage/leakage of the order of 10mm d^{-1}, the annual water resource requirement of the Wilts & Berks Canal is estimated as 4200Ml, assuming no net by-pass or lockage losses. This is not a fixed daily amount throughout the year, but it averages about 12Ml (**Table 4.5** before). From water resource estimates in this Study, this requirement can be met by a combination of:

- surface water abstraction at high river flows, followed by storage in reservoirs;
- groundwater abstraction, either year round or only during winter months in catchments subject to low flow problems; winter abstracted groundwater may require storage in surface water reservoirs;
- intercepting and treating urban runoff, which would be of particular benefit during periods of low flow;
- further treatment of treated sewage effluent before storage and use, potentially only during periods of high river flow.

As there is much current uncertainty about the volumes, reliability and availability of treated urban runoff and sewage effluent, the basic strategy to meet the Canal's water demand relies solely on surface water and groundwater resources. **Table 4.14** suggests that surface water and groundwater resources would be able to supply the estimated 4200Ml y^{-1} required by the restored Canal, even if those Great Oolite and Lower Greensand sources with presumed poor water quality are excluded from consideration.

Table 4.14 Surface Water and Groundwater Resources Available

Source	**Estimated Resource Available (Ml y^{-1})**
Surface water abstraction	2030
Groundwater abstraction	
- winter only (all sources)	860*
- winter only (excl.poor quality water)	*770**
- year round (all sources)	1910
- year round (excl.poor quality water)	*1400*
TOTAL	
All sources	4800
Excluding sources of poor quality	*4200*

* - assumes winter only use groundwater abstracted for 6 months

Excluding those locations where groundwater quality may be poor, groundwater would need to be developed at a total of 14 locations, with a total of about 20 bored wells to produce the resources included in **Table 4.14**. This estimate is based on current information, and it is possible that the number of locations and wells might need to be increased or decreased to meet the water requirements. With regard to spatial distribution of these resources, the following points are of note:

- 4.2 Ml d^{-1} is available to the east of Swindon
- 7.5Ml d^{-1} to the west of Swindon
- about 3.5Ml d^{-1} of this total is available in the vicinity of Swindon and the North Wilts Canal, i.e. at the summit of the Canal.

Estimated costs for developing both surface water and groundwater resources are summarised in **Table 4.15**; these are presented for comparative purposes only. Most of the proposed groundwater sources are located some distance from the Canal, varying between about 300m to 4.5km. As a result, the costs of developing groundwater include for construction, operation and maintenance of a pipeline to deliver abstracted groundwater to the Canal, but it is assumed that the water will be delivered under gravity, and the majority of the water from winter groundwater abstractions would be stored in surface water reservoirs. **Table 4.15** indicates an approximately 50:50 percentage spilt between surface water and groundwater, and shows that comparative costs (based on construction alone) for supplying 1Ml d^{-1} are about:

- surface water = £2,100,000
- groundwater = £404,000.

Assuming that additional surface storage is required for the whole of the 860Ml abstracted from winter-only groundwater sources, the total construction cost for developing groundwater sources would increase significantly to about £7 million, thus increasing the cost of supplying 1Ml d^{-1} from groundwater to about £1.1 million.

Table 4.15 Costs of Developing Resources

Surface Water Resources			
No. of reservoirs	**Average Annual Yield (Ml d^{-1})**	**Construction Costs (£)**	**Annual Operation & Maintenance Costs (£)***
10	5.6	11,730,000	82,125
Groundwater Resources			
No. of wells	**Average Annual Yield (Ml d^{-1})**	**Construction Costs (£)**	**Annual Operation & Maintenance Costs (£)***
14-20	6.1	2,463,000	32,000
	Totals	**14,193,000**	**114,125**

* = O&M costs include annual abstraction charges

Although groundwater resources appear to be the most favourable target on economic grounds, there remains uncertainty over the resources available from both groundwater and surface water sources, thus further investigations are required. Further investigation of surface water resources requires additional desk study, field data collection and perhaps mathematical modelling, whereas to reduce uncertainty associated with groundwater resources desk study followed by drilling and testing of exploratory wells is required. Consequently, the cost of further groundwater investigations is much more expensive (see Chapter 9), and the choice of pursuing surface water or groundwater resources might be dependent on the capital available for the next stage of the study.

Where the Canal crosses more permeable ground, leakage is likely to be increased. Two particular cases are considered below.

Case 1 - North of Uffington, where the Canal crosses the Lower Greensand, a loss of 0.16Ml d^{-1} over a 1.2km length has been estimated. The economics of lining this stretch are as follows:

- lining could reduce this loss to about 0.032Ml d^{-1}
- cost of lining is about £468,000
- as the water deficit is reduced, the proposed reservoir (TO6) south of Uffington could be reduced slightly in size
- cost saving for smaller reservoir is negligible.

As the cost saving for a smaller reservoir does not cover the costs of lining, the lining of this stretch of the Canal does not appear economic. However, in practice the lining of this stretch may be driven by environmental requirements, therefore lining is recommended.

Case 2 - Between Chippenham and Melksham losses from the Canal to the underlying river sands and gravels were calculated as 1.9Ml d^{-1} over a 2km stretch. Groundwater and surface water abstractions are proposed in this area, but the EA has concerns over Lower Avon as it may well play a role in long term solutions for addressing low flow problems in the Upper Avon. By lining this stretch of the Canal, losses would be reduced significantly and the proposed surface water abstraction from the Lower Avon sub-catchment could be reduced effectively to zero. The economics of lining this stretch are as follows:

- lining could reduce this loss to about 0.4Ml d^{-1}
- cost of lining is about £780,000
- as the water deficit is reduced, the Lower Avon surface water abstractions could perhaps be omitted
- the cost of surface water abstraction from the Lower Avon and reservoir storage is £2,230,000
- cost saving by lining is approximately £1,450,000.

4.10 Conclusions

Water balance modelling of the Wilts & Berks Canal has revealed that seepage/leakage dominate water losses from the Canal at all but the lowest seepage/leakage rates considered. However, as the geology underlying the majority of the Wilts & Berks Canal route is dominated by clay, it is estimated that seepage/leakage losses will be close to the lower end of the range inferred for British Canals (10-60mm d^{-1}), and lower than the British Waterway target of 25mm d^{-1}.

A target seepage/leakage of the order of 10mm d^{-1} was set. This target is supported by:

- estimation of the historical water balance for the Canal, which showed that water demands and inferred supplies approach a balance with a seepage/leakage rate of 10mm d^{-1};

- calculations using permeability values for in situ clays also indicating seepage/leakage rates <10mm d^{-1}.

Assuming a seepage/leakage of 10mm d^{-1}, water balance modelling has estimated the annual water resource requirement to be about 4200Ml, in addition to direct rainfall on the Canal. This supply has been calculated to maintain a minimum Canal water depth of about 1.4m, assuming that, (a) backpumping minimises lockage losses, and (b) ultimate losses of by-pass flows to waste weirs and downstream ends of the Canal are minimised. To ensure that the use of the additional water resources supplied to the Canal is optimised, the following channel lining requirements have been recommended:

- puddling of in situ clay where localised fractures and fissures occur and/or preparing the channel floor by rolling or producing a cleanly cut surface;

- lining of reaches which cross permeable formations where losses are inferred, using puddled clay, bentonite matting or concrete; current estimates suggest a total length of just over 3 km at a cost of about £1-1.5 million.

An evaluation of water resources along the full length of the Canal has identified the following resources as having the potential to supply about 4800Ml of water annually, and thus satisfy the calculated deficit in supply:

- surface water abstraction at high river flows, generally during winter months, followed by storage in about 10 reservoirs;

- groundwater abstraction from the Great Oolite, Corallian, Lower Greensand, Chalk, River Sands & Gravels aquifers, using about 20 bored wells at 14 locations; winter abstracted groundwater may require storage in surface water reservoirs.

The surface water reservoirs would supply about 2030Ml y^{-1}, while the wells would supply about 860Ml y^{-1} from "winter only" abstractions and 1910Ml y^{-1} from "year round" abstractions. However, there is significant uncertainty concerning the availability of these water resources. One of the issues concerns groundwater quality, e.g. the potential for high salinity in the Great Oolite and high iron and manganese concentrations in the Lower Greensand aquifers, which could potentially reduce the total resource identified to date to about 4200Ml y^{-1}.

The basic water supply strategy noted above relies on surface water and groundwater resources, but additional resources may potentially be available from, (a) intercepting and treating urban runoff, and (b) treated sewage effluent. Both resources would be of particular benefit during periods of low flow, but the latter may only be available during periods of high river flow because during low flow stages, the treated effluent supports natural flows. Use of treated sewage effluent rather than surface water resources appears environmentally friendly, but it is likely that the costs would be higher for re-use of sewage effluent due to the additional treatment costs, thus on economic grounds this resource is of reduced interest.

The current, approximate cost estimate of developing additional water resources to meet the supply deficit are as follows:

- surface water: construction costs - £11.7 million; annual operation and maintenance costs - £82k;

- groundwater resources: construction costs - £2.5 million; annual operation and maintenance costs - £32k.

This gives a total construction cost estimate of just over £14 million and an annual operation and maintenance cost of £114k. However, it is clear that the costs for developing groundwater resources are cheaper; the comparative costs (based only on construction) for supplying 1Ml d^{-1} are, (a) surface water £2.1 million, and (b) groundwater £0.4 million (this increases to £1.1 million if more reservoirs are required for the winter-only groundwater abstraction). Despite this, investigations to reduce the remaining uncertainty in both resources are much more expensive for groundwater. Thus, if funding for the next stage of the study is limited, surface waters might become the target for development, although as the prognosis is good for at least some groundwater development, efforts should not neglect the potential of this resource.

Significant uncertainty remains in the assessment of both, (a) the deficit in water supply to restore the whole Canal, and (b) the surface water and groundwater resources available to overcome this deficit. Consequently, a number of key tasks are recommended for action in the next stage of the study (see Chapter 9); in order of priority these are:

1. Measurement of seepage/leakage using existing "in-water" sections of the Wilts & Berks Canal.

2. Programme of hydrological data collection to improve estimates; river flows & water levels, especially in winter, at carefully selected sites.

3. Further desk studies of groundwater resource potential, followed by a programme of exploratory drilling and test pumping.

4. Desk study and site investigation of key sections of the Eastern Mainline and North Wilts Branch overlying permeable ground to determine whether lining is necessary.

5. Discussions regarding the potential use of urban and road run-off with local authorities, the MOD (re. RAF Lyneham), and further discussions with the EA.

6. Programme of water quality data collection to establish trends over a period of about 2 years, in water courses with potential to supply the restored Canal.

5. ENVIRONMENTAL ASSESSMENT

5.1 Introduction

5.1.1 Aims

This Environmental Appraisal has been prepared as part of the feasibility study for the restoration of the Wilts and Berks Canal. This Chapter of the Report aims to identify the:

- key environmental issues, including opportunities and constraints along the route options for restoration;
- any key issues which extend beyond the Canal corridor;
- impacts associated with both construction and operation of the Canal;
- environmental legislative obligations associated with construction, operation & maintenance;
- realistic mitigation measures;
- opportunities for enhancement;
- further environmental studies that would be required to be carried out prior to the actual restoration of the Canal.

5.1.2 Methodology

The environmental analysis has been based upon:

- a desk study evaluating published and unpublished information. A comprehensive list of this information is given in **Appendix C**;
- a two day site visit, which concentrated upon strategic sections along the length of the Canal and areas to which access could be gained via public rights of way. The site visit allowed a greater appreciation of the environmental character of areas through which the Canal passes as well as the identification of features which could not readily be determined from the published/unpublished information;
- a series of meetings with key consultees including four workshops to consider preferred options around Abingdon, the proposed Abingdon Reservoir Site, Grove/Wantage, East Challow, Swindon, Wootton Bassett, Cricklade and Melksham as well as options around other isolated obstructions such as major road, rail and river crossings;

- additional meetings and consultation with the Environment Agency regarding use of the River Avon at Melksham and River Ray (Swinbourne) at Swindon;

- consultation with other key consultees by means of a telephone call or in writing;

- close liaison with Scott Wilson's engineering and water resources teams.

The main topic areas which the environmental study focused upon were land use, ecology and nature conservation, archaeology & cultural heritage, landscape, amenity and leisure, waste management including geology & soils, noise, water quality and air quality. Planning policies relating to these topic areas are discussed under the individual topic headings.

Environmental issues were taken into account at the workshop meetings in relations to all the options put forward (refer to Chapter 2). However, the environmental assessment concentrates upon the preferred route options agreed during these meetings.

5.2 Existing Land Uses

The main land use types along and dominating the areas which the Canal passes through are:

5.2.1 Agricultural Land

5.2.1.1 Existing Situation

The majority of agricultural land is Grade 3 with smaller areas of Grade 4 interspersed between. These grades are defined as follows:

- Grade 3 - good to moderate quality agricultural land

Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in grades 1 or 2.

- Grade 4 - poor quality agricultural land

Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereal and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties with utilisation. The grade also includes drought prone arable land.

5.2.1.2 Agricultural Impacts & Mitigation

The key impacts upon agricultural land uses are

- Loss of agricultural land where the Canal has been in-filled and the route restored to agricultural use or the loss of agricultural land where a new route is required.

- Severance

- Interception of field drains

The land is not high quality agricultural land and in a regional context its loss would probably not be significant. However in addition to land purchase costs, additional payment may be required as compensation to individual farmers, including the disruption caused by any severance effects. It may be necessary to build lift bridges or a similar structures across the Canal at strategic points to mitigate severance effects. The main areas where this may be a consideration is between Wantage and Abingdon, along the Calne branch where much of the original alignment has been filled in and between Swindon and Bourton where a new alignment is required.

In the remaining reaches the Canal channel has not been filled in and often forms a field boundary.

Interception of field drains is a consideration that would need to be taken account of in the detailed design. It should not present a significant problem in terms of agricultural interests, but there may be some implications for water quality where high levels of fertilisers or pesticides are being used.

5.2.2 Settlements

The main settlements which the Canal route passes through or close to include:

- Melksham (R. Avon route option);
- Lacock;
- Chippenham (approximately 1km to the eastern side of the town);
- Calne (Calne branch);
- Foxham;
- Dauntsey;
- Wootton Bassett;
- Swindon;
- Cricklade (North Wilts Branch);
- West Challow;
- East Challow;
- Wantage;
- Grove;
- Abingdon.

The following key impacts are likely to arise in the vicinity of these settlements:

- Some disruption & disturbance during the construction phase (refer to Sections, 5.7 & 5.9) later;
- Amenity, recreational, socio economic and aesthetic benefits.

There are potentially more positive impacts associated with the route running close to settlements rather than negative impacts. Particularly in the larger settlements, i.e. Melksham, Wootton Bassett, Swindon, Cricklade, Wantage and Grove, the Canal would potentially add a significant local recreational resource and provide deeper links into the countryside.

In Melksham it is felt by the local authorities that the creation of a navigation through central Melksham would offer both aesthetic, recreational and economic opportunities along a river frontage that has become quite degraded over the years. The reach of the River Avon above the Melksham weir up to Beanacre is currently used for canoeing, pleasure boating and sailing. A slipway is located in King George Playing Field.

Some Canal restoration has already taken place at Calne and Wootton Bassett which has been integrated into the amenity facilities of the Towns, particularly use of the tow paths for walking & cycling. Other areas where restoration has taken place include Dauntsey and Foxham Locks although the extent of public access along these areas does not yet appear to be as extensive as at other restored sections.

Around Swindon, the southern route flanks the southern edge of a golf course. For the most part the Canal runs through existing landscaping and rights of way and does not impinge directly on the golf course. This route also provides good access into/from Coate Water County Park and links into the countryside both to the east and west of Swindon.

The North Wilts Canal link through Swindon integrates well into the recreation and amenity area running up from Mannington Recreation ground to Mordon via the valley of the River Ray and extends these opportunities to the north. Cycle ways and extensive landscaping works have been taking place through this area and the Canal would need to be designed to fit and complement these works with minimal disruption to the new landscaping.

In Abingdon there is some conflict over the recreational benefit of the Canal through the Ock Valley. The Ock Valley already provides good passive recreational facilities with a network of paths and cycleways, some of which are next to the River Ock. It also likely that a children's playground would need to be relocated. The introduction of a Canal along this route would supplement the existing recreation features and would probably be more interesting to the Canal users and allow direct access to the sites and facilities of Abingdon. However there are potential constraints associated with the Ock Bridge (Section 5.6) and local concerns that building a Canal along this route would change the character of the existing landscape and ecological features. The only place where property would be directly affected by preferred restoration route options is at East Challow, where one property is built over the preferred alignment. Access into Canal Farm and Canal Way would need to be modified unless the Canal could be engineered to be narrow enough to maintain the existing access. The Canal would also affect the car park of the public house at Lacock and alternative parking facilities would need to be provided.

5.2.3 Recreation & Leisure

Recreation and leisure benefits based upon existing attractions are discussed in Chapter 6 of this Report and some discussion on local amenity benefits to settlements along the route has been highlighted above. However, opportunities are presented along the length of the restored route for such activities as walking, cycling, fishing, informal boating & canoeing. Equestrian use of towpaths is prohibited under British Waterways Byelaws and although such byelaws may not apply to the restored Wilts & Berks Canal horses will probably be prohibited from towpaths except those which are statutory bridleways.

It is recognised in Local, District and Catchment Management Plans that there is a general need within the area covered by the Canal to promote and improve recreational and amenity features. The Great Western Community Forest plan which covers a wide area from the west to east of Swindon highlights that water for recreation is in short supply in the forest area.

5.2.4 Angling

Fishing is a particularly popular pastime on Canals. Stocking of the Canal with fish will require a Section 30 licence from the Environment Agency, under the Salmon and Freshwater Fisheries Act 1975. In addition the release of any exotic species, for example Grass Carp, requires a licence from MAFF, under Section 14 of the Wildlife & Countryside Act 1981. This is to ensure that such introductions are controlled and releases are made in suitable locations with appropriate precaution to prevent the fish escaping in to the wild.

The most commonly stocked species are

- Carp *Cyprinus carpio* - a bottom feeder which uproots plants and can create turbid conditions through its feeding behaviour and is generally not favoured.

- Bream *Abramis brama* - behaves in a similar fashion to carp but is not quite so destructive

- Roach *Rutilus rutilus* - little known effect on vegetation

- Gudgeon *Gobio gobio* - little known effect on vegetation

- Tench *Tinca tinca* - little known effect on vegetation

The general stocking density which is recommended by English Nature and the Environment Agency is 200 to 300 kg/ha. But as discussed later in this Chapter there are various environmental influences which can affect the quality of the fishery.

In order to provide ease of access and to protect bankside vegetation and minimise erosion, fishing platforms can be built (such as those installed at Wootton Bassett). Consideration could also be given to platforms which can be accessed by wheelchair users.

5.2.5 Walking

Walking is a particularly popular past-time associated with Canal users. As well as the scope presented by the creation of new lengths of towpath there is also scope to link the towpath routes into the existing local network of public rights of way in order to create circular routes, and into long distance footpaths.

Key lengths of the Canal which are not currently rights of way and which would particularly open up greater access into the countryside for walkers include:

- Along the riverside through Melksham
- Sections of the Canal between Chippenham, Dauntsey and East Challow
- East of Wootton Bassett (Padbrook Farm to Swindon)
- Up to Cricklade from Moredon

In order to maximise the benefits from towpaths the following should be taken into consideration in the detailed design:

- Routing the towpath along only one side of the Canal and diverting it to the least sensitive side where nature conservation issues prevail.

- Deciding on the class of towpath that is suitable for particular sections of Canal. For example, British Waterways divide their towpaths up into three grades. A suggestion as to where such grades of towpath would fit into the Wilts & Berks Canal is given in **Table 5.1**.

Table 5.1 Potential Grades of Towpath

Tow path class	**Surface Conditions**	**Potential use along the Wilts & Berks Canal**
Class A	Even hard surface that drains immediately after rainfall with no ponding. Suitable for people wearing town shoes	Area of high usage e.g. Melksham, Swindon, Abingdon
Class B	Generally even surface with only nominal ponding after rainfall and with minimal formal drainage. Suitable for people wearing country shoes	Areas of moderate usage e.g. Grove/Wantage, Wootton Bassett and other villages along the route
Class C	Some lengths of uneven surface with no formal drainage to remove rainfall. Suitable for people wearing walking boots or wellingtons	Area of low usage e.g. rural sections

5.2.6 Cycling

Cycling is also a popular pastime along towpaths but there are often conflicts with other towpath users and safety issues to consider. There are a number of measures that can be adopted in order to reduce potential conflicts:

- Use of a permit system - this has not always been successful on other Canals because cyclists were unaware of the need for a permit and an efficient administration system is required with effective policing.

- Construction of a wider towpath which could be segregated in strategic places, for example in the larger settlements where the Canal could be integrated with cycleways. In addition there are sections of the Canal network which link into major cycleways, for example the Wiltshire Cycleway to the east of Wootton Bassett.

- Restricting cycling to certain parts of the Canal route, although this could be difficult to enforce.

5.3 Existing Ecology

Information relating to the present ecological status of the Canal has been drawn from the Oxford Biological Records Centre, Wiltshire Biological Records Centre, English Nature, Alert Maps produced for Oxfordshire, the Environment Agency (Catchment Management Plans, River Corridor Survey data and consultation), Local Plans and District Plans. In addition three ecological surveys have been commissioned by the Wilts & Berks Canal Trust for the areas at Calne, Wootton Bassett and Moredon. Parts of the former two sections of the Canal have subsequently been restored.

At this phase of the project no additional survey work has been commissioned although it is recognised that this will need to be done as the project proceeds. However it is important that the timescale of the project is borne in mind as restoration could take more than 20 years, by which time the nature and status of habitats along the route, as well as nature conservation legislation, could have changed significantly.

5.3.1 Habitats Along the Existing Route

The existing Canal can broadly be divided up into the following habitat types:

Open standing water typified by the restored sections of the Canal at Calne, Wootton Bassett (**Plate 1**) (Dauntsey and Foxham Locks. These sections support a range of submerged and emergent species with a well developed and bankside community. Duckweed (*Lemna* spp.) was noted as being particularly abundant in certain areas, particularly at Calne where there is potential for it to become troublesome. It would appear that the Canal is supporting a range of invertebrates including damselflies and dragonflies with several species of dragonfly noted at Foxham Locks.

Swamp which generally comprises many sections of the Canal which have not been filled in over the years and are still shown as standing water on the Ordnance Survey maps. Over the years the Canal bed has silted up and during the time of the field visit (11th & 12th June, 1997) either the bed was damp and marshy or contained a few centimetres of standing water in isolated sections (**Plate 2**). A variety of damp loving species currently colonise such areas including Reed canary-grass *Phalaris arundinacea*, Reed sweet grass *Glyceria maxima*, Common reed *Phragmites australis*, Meadowsweet *Filipendula ulmaria*, Yellow iris *Iris pseudacorus*, Horsetails *Equisetum* spp. and rushes *Juncus* spp.

Woodland and **Scrub** which has colonised the Canal bed particularly where it has been filled in or become dry over the years (**Plate 3**). Typical species include Ash, Hawthorn and Elder and in many areas the former bankside trees are still noticeable (e.g. salix and alder spp). In these areas the ground flora tends to be fairly rank dominated by such species as Nettle *Urtica dioica*, Ground Ivy *Glechoma hederacea* and Common Cleavers *Galium aparine*.

Tall herb and fern type communities have developed in open areas where the Canal bed has silted up to an extent that the channel bed is dry.

Arable habitats dominate particularly across the Oxfordshire sections of the Canal between Abingdon and Wantage where the former route has been filled in and the land use reverted to agriculture (**Plate 4**).

Neutral grassland which dominates more across the Wiltshire sections of the Canal where the Canal has been filled in and the land used for grazing (**Plate 5**). A range of pasture types can be found including improved, semi-improved and some localised fields of unimproved pasture (identified from existing habitat surveys).

5.3.2 Habitats along Alternative Routes

As identified in Chapter 2 of this Report there are stretches where it is not possible for the Canal to follow the original alignment. In addition to those mentioned above the following habitat types predominate:

Running water where the Canal route proposes to use or run parallel to the River Ray (Elmcombe Brook) through Swindon, the River Avon through Melksham and the River Ock through Abingdon. These areas are discussed in more detail in Clauses 2.3.4, 2.5.5 & 2.6.4.

Amenity grassland for example where the Canal runs across the golf course at Swindon and recreational areas in the Ock Valley

5.3.3 Statutory and Non Statutory Nature Conservation Sites

The Canal routes (original and alternative) have been checked for designated sites of nature conservation interest, notably:

- Sites of Special Scientific Interest (SSSI);
- Special Areas of Conservation (SAC);

Plate 1: Restored canal at Wootton Bassett.

Plate 2: Original canal, marsh/wetland habitat.

Plate 3: Typical woodland and scrub habitat.

Plate 4: Arable habitat.

Plate 5: Neutral grassland habitat.

- RAMSAR/Special Protected Areas (SPA);
- National Nature Reserves;
- County Wildlife Sites;
- Local Wildlife Sites.

A check has also been carried out of sites which are known to be sensitive but which are not currently designated (Alert Sites).

Although very few sites actually lie on the Canal route itself, several lie within 1km of the Canal, as shown in the Route Maps (**Appendix D**) and **Table 5.2**.

Countryside Act 1981 (& amendments). Fauna is protected under Schedule 5 while flora is protected under Schedule 8. Badgers are afforded special protection under the Badger Act 1992. It is an offence to purposely kill, injure or destroy any protected species or its habitat. Where protected species occur along the Canal route it will be necessary to avoid them either through detailed alignment or by devising appropriate mitigation measures in close consultation with English Nature. (English Nature is currently conferring with their species officer regarding the possible presence of protected sites along the Canal route but this has not been notified at the time of writing.

The following protected species are known to be present along the route.

- Badgers

Certainly one badger set is known of close to the route in the vicinity of Cow Common and a number of badger sets are located within the Wiltshire sections of the route.

- Great Crested Newts

Great Crested Newts are reported to be colonising the former Canal route north of Semington. Although there are a number of constraints to restoration on their part of the original alignment, as discussed in Chapter 2, and it is not the preferred option, there is still keen interest to recover the historic route if possible. Clearly the presence of Great Crested Newts will have to be taken into full account, but it should also be noted that Great Crested Newts may be present in other small areas of standing water and thus are likely to affect other reaches of the historic route.

Table 5.2 Sites of Nature Conservation Interest

Site	OS Grid Ref	Comments/Selection Criteria
WILTSHIRE		
Bristol Avon River (ST96.43)	ST905643	Freshwater habitat
Tacklemore Wood, Wheelers Wood, Hazel Copse (ST96.3)	ST936695	Woodland
Stanley Abbey Farm Meadows (ST97.2)	ST965719	Grassland
Bencroft Hill Meadows (ST97.5)	ST959727	Grassland
Bremhill Grove (ST97.38)	ST973746	Woodland
Melsome Wood (ST985787)	ST985787	Woodland
Lackham Wood (ST97.55)	ST927720	Woodland
Hazeland Wood (ST97.44)	ST977720	Woodland
Middle Lodge Wood (ST97.68)	ST931705	Woodland
Great Bodnage Copse (ST97.45)	ST968722	Woodland
Bencroft Hill Meadows SSSI (ST962732)	ST962732	SSSI
Bremhill Field Farm Meadows (ST97.16)	ST979743	Grassland
Elm Farm Meadows (ST97.16)	ST983780	Grassland
Charwood Copse (ST97.57)	ST982782	Woodland
Bittlesea Farm Meadow (ST97.14)	ST991794	Grassland
Round Wood, Christian Malford	ST993796	Woodland
Horse Leys Wood (ST97.25)	ST996797	Woodland
Swallet Farm Meadow (ST98.15)	ST987801	Grassland
Canal Side, Tockenham Manor (SU08.52)	SU033813	Grassland
Morningside Farm Meadow (SU08.52)	SU092817	Grassland
Tockenham Reservoir (SU08.54)	SU026806	Freshwater

Table 5.2 Sites of Nature Conservation Interest (continued)

Site	OS Grid Ref	Comments/Selection Criteria
West Close Copse (SU08.56)	SU032811	Woodland
Vastern Wood (SU08.50)	SU043815	Grassland
Tockenham Manor Slope (SU08.16)	SU042812	Grassland
Oaklands (SU08.65)	SU041863	Woodland
Wootton Bassett Mud Spring SSSI (SU08.66)	SU078815	SSSI
Chaddington Lane Verge (SU08.53)	SU092820	unknown
Kingshill Canal and Old Railway (SU18.50)	SU133837	Freshwater, artificial habitat
Burderop Wood North (SU18.24)	SU171814	Woodland
Coate Water SSSI (SU18.16)	SU178820	SSSI
Rushy Platt Swamp (SU18.60)	SU136836	Mires, Swamp, Fen
River Cole (SU28.19)	SU217880	Freshwater
OXFORDSHIRE		
Uffington Gorse (38 E03/1)	SU 314899	A Woodland Trust Nature Reserve
Long Spinney Copse (38 J02)	SU 330895	A semi-natural ancient woodland
The Cutting (49F01)	SU 437916	Wetland, woodland & scrub. Proposed Canal route intersects this site
A badger sett (49SS5)	Not given for security reasons	Exact location and foraging routes would need to be checked in the field

5.4 Ecological Impacts

The only established aquatic communities are those associated with the reaches of the Canal that which have recently been restored. Many of these communities are still evolving. As the great majority of the Canal is not currently in water, there is not an established aquatic community. The scope for a diverse aquatic community to develop in the restored reaches will mainly depend upon:

- The level of boating activity
- The cross sectional profile and bank design
- Water quality and chemistry

Positive Impacts

- Potential to create extensive linear open water habitat with range of habitat niches. Scope will ultimately depend upon the level of boating activity.
- Opportunity to improve habitat diversity in areas where habitats are currently poor and under developed e.g. arable areas, areas of improved pasture, through settlements
- Scope to develop adjacent wetlands associated with both the Canal and adjacent storage reservoirs
- Scope to incorporate such features as bat boxes in new or restored brick structures

Negative impacts (prior to mitigation)

- Some loss, disturbance and changes to existing habitat types e.g. loss of trees, scrub, hedges, and marshy areas established along former Canal bed
- Changes in the habitat types associated with off line storage reservoirs
- Change in character of limited sections of river courses should these be selected as the preferred route options e.g. River Ock, River Ray and River Avon due to "Canalisation" leading to changes in the flow regime and effects of boating activity on water quality and turbidity with potential associated knock on effects on macro invertebrate communities, plant communities and fisheries.
- Disturbance at river crossings, primarily during the construction phase.
- Effects of boating activity.

5.4.1 Vegetation Clearance

Clearance of vegetation will required from the existing Canal corridor which has become choked and overgrown, either with marsh loving species where the Canal bed is damp or trees and scrub where the channel bed is drier.

The vegetation will also require to be stripped along the new Canal channel. This may particularly affect short sections of hedgerows which intercept the Canal corridor. Clearance of hedges will need to take account of the requirements of SI 1160 The Hedgerows Regulations 1997, which came into force on 1 June, 97. These regulations apply to any hedgerow growing in, or adjacent to, any common land, protected land, or land used for agriculture, forestry or the keeping of horses, ponies or donkeys if it has a continuous length of, or exceeding, 20m or has a continuous length of less than 20m where it intersects another hedgerow at either end.

Under Section 6 of the Regulations - Permitted Work, hedgerows are allowed to be removed if planning permission has been obtained or work is being carried out under the Land Drainage Act 1991, Water Resources Act 1991 or the Environment Act 1995. Otherwise, written permission needs to be given from the local authority that removal of the hedgerow is authorised.

Under the Wildlife & Countryside Act 1981, it is an offence to knowingly disturb or destroy the nest, eggs or fledglings of any wild bird. Therefore in order to comply with the Act and to minimise general ecological disturbance, it is recommended that any vegetation clearance takes place outside the nesting season (ie between September to March).

5.4.2 Effect on River Sections

5.4.2.1 River Avon

2,100 m of the River Avon through Melksham from the Melksham Weir to the off take lock for the Canal would need to be altered to allow navigation should this be selected as the preferred route option. The main works that would be required would be dredging a channel deep enough to allow navigation.

The river is currently slow flowing and shallow in places with a silty substrate. Yellow water-lily (*Nuphar lutea*) and stands of bur reed, which are species typical of slow flow conditions dominate (**Plates 6&7**). The Environment Agency advise that the Avon is important for the rare white legged damsel fly, loddon pond weed and flowering rush. However, it is not possible to determine due to the lack of data whether these species are present in the reach which would require "Canalisation".

The channel has become degraded over the years, principally due to changes in its character from former widening and straightening as part of land drainage/flood defence schemes. The Environment Agency is planning a river restoration scheme involving natural regeneration of meanders and channel deepening through channel narrowing by means of coir fronted gabions and planted tops to create a flood berm and two stage channel. This is expected to take place within the next 18 months.

The aim for this section of the River Avon is to attain River Ecosystem class 3, which is water of quality suitable for high class coarse fish populations, by 1998.

As well as the potential conflict with the river restoration scheme, the Environment Agency have a number of concerns regarding the effect of boating on the condition of channel, particularly on the likelihood of increased turbidity and siltation, effects on water quality and erosion which can all have knock-on effects on the aquatic communities (see Section 5.5).

5.4.2.2 River Ray

An important strategic area in terms of restoration is the link to Cricklade which follows the valley of the River Ray. As described in Chapter 2, the Canal cannot be restored along its original alignment for much of its length, therefore an alternative alignment has been developed. For most of the route every effort has been made to ensure that the Canal avoids the River Ray and its associated tributaries. However, there is one significant pinch point between the Swindon - Paddington railway line and the culvert below the former railway works/Sainsbury's car park where the route is heavily constrained by new retail and commercial development to the west and the embankment of a disused railway track to the east. This section is critical in the overall strategy to restore the remainder of the alignment up to Cricklade and it will be impossible to avoid disturbance to the 450m of the river in some way.

From analysis of river corridor surveys of this reach it would appear that the river is 1 to 2m wide, less than 20cm deep with shallow slopes. The stream winds gently through a low marshy area with the water margin being a transition from a perennially water covered course to damp marshy land (Comet Marsh). The habitat quality in this area is considered to range from reasonable to good to critical. It is recommended in the River Corridor Survey that *"every effort should be made to conserve the wet habitats for what must be a first class location for wildlife"*. Relevant extracts from the river corridor survey are included in **Appendix I.**

Two restoration options have been considered:

- Canalisation of 450 m of the River Ray

Moving the River Ray into a new channel and building a new Canal section alongside which would use the Sainsbury's culvert. The River would then be diverted into a new thrust bored culvert beneath the A420 and Sainsbury's car park. Both options would have significant impact on the existing character of this reach. With the Canalisation option the character of the river channel itself would be entirely changed and some bankside habitat required to accommodate the extra width of the Canal and the towpath. However it should be possible to maintain a good part of the marshy habitat. Soft banks and an appropriate profile could be developed to maximise the nature conservation benefit of the Canal through this reach, although the ultimate nature conservation potential would depend on the level of boating activity (as discussed further in Sub-clause 5.3.2.4).

The option of relocating the River Ray into a new channel could offer some potential to enhance the new river channel itself and at least recreate the general character of

Plate 6: River Avon below Melksham.

Plate 7: River Avon downstream from Town Bridge, Melksham.

the former channel. The existing substrate could also be translocated into the new channel to preserve much of the substrate character and existing invertebrate community. However this option would do little to conserve the existing marshy habitat due to the amount of land take in an already restricted area that would be required to accommodate the Canal and river channel.

It is anticipated that neither option will be readily acceptable to all parties within the Environment Agency.

From an environmental point of view it is important that the significant impacts that would occur in this reach are weighed against the overall benefits that would accrue in opening up the remaining Canal route to Cricklade. In particular appropriate mitigation could be incorporated into key areas in the remaining sections to ensure that marshy habitat develops elsewhere. Certainly it would be expected that similar vegetation species would develop along sections of the restored Canal as seen along existing restored sections (i.e. *Glyceria maxima*, *Filipendula ulmaria* and *Epilobium hirsutum*, *Phragmites Australis* and *Glyceria maxima*).

5.4.2.3 River Ock

Efforts have been made over the last few years to improve the habitat and quality of the Ock through Abingdon and this has largely been achieved. The River Ecosystem (RE) use class is RE2 which means that the water is of good quality suitable for all fish species. It is recognised that in places the Ock supports a good fish population but this is variable depending upon the habitat quality of various sections. Efforts are still continuing to improve and enhance the River Ock further. There are currently no statutory designated nature conservation sites on the river.

The Canal would avoid the River Ock for the majority of its length if this were the selected route option, with the exception of the last 100m. This section of the river is already Canalised for much of the length that would be incorporated into the Canal and supports some limited navigation for small boats. Some dredging and tree clearance would probably be necessary to allow larger boats to pass.

The Thames (Eynsham to Benson) and Ock Local Environment Agency Plan Draft Consultation Report, under Issue No 14: Wilts and Berks Canal Restoration, raised the following:

" *One proposal put forward involves Canalising the lower reaches of the Ock to link it with the River Thames. This proposal however, would be detrimental to the existing habitat and is therefore unacceptable from a conservation and fisheries point of view*".

From feedback on consultations held with the Environment Agency it would appear that there is no fundamental objection to Canalisation of the extreme lower reach as this is already affected by Canalisation and influenced by navigation from the Thames.

However, the Ock Valley is identified in the Vale of White Horse Local Plan (Policy L6) as an environmentally sensitive corridor which deserves special recognition and protection. Local opinion is that the establishment of a Canal through the Ock Valley will not preserve the valley's special character nor protect its open nature.

5.4.3 Disturbance at River Crossings

Where the Canal crosses existing river and drains (highlighted in Chapter 2 and Section 5.5) it is important that construction works minimise the risk of pollution and increased turbidity through adopting good construction practice. The design of the river crossings is important to ensure that through-flow continues with minimal effect upon the aquatic environment and passage of fish. This is also true of the drains and ditches feeding Coate Water SSSI. Inverted siphons are not recommended because they can impede the passage of fish and other aquatic animals. Clear span bridges or culverts are preferred. Where there is any chance that otter may be using the river courses then the culverts should be an adequate size with a ledge inside to encourage otters to pass through. Further comments on river crossings are made in Section 5.5.

5.4.4 Effects of Boating

Initial estimates suggest that the annual number of through boat movements is likely to be in the order of 3000 to 5000, although it could be some years before this level of boat traffic is achieved. However, in order to maximise any ecological benefit which this level of boating could sustain the Canal will need to be designed with this level of boating in mind.

A unique property of the Wilts and Berks Canal is that about 55km of the original route has not been infilled over the years. Of this only 8km is currently in water (due to the efforts of recent small restoration projects). The remainder tends to be either marshy or dry as outlined in Sub-clause 5.3.1.1. From the biological records and surveys carried out to date it would appear that relatively few, if any Canal sections, have developed a unique or particularly diverse ecological character (although there are valuable undesignated nature conservation sites close to the Canal corridor). This situation should help to avoid some of the controversy associated with other Canal restoration projects in the UK. The river sections (2km) are potentially likely to be more sensitive to boat traffic.

In order to determine the issues which need to be taken into account in the design, it is necessary to understand some of the impacts which boating can cause. Canals are multi functional, supporting recreational boating, angling, active and passive recreation such as walking and cycling as well as providing nature conservation, landscape and heritage value. Although the primary aim of the restoration project is for navigation, maintaining the environmental quality of the Canal is still essential to derive the maximum benefit to other multi functional users. For example, it is important to maintain a reasonable water quality to support the plant and macro invertebrate life which is in turn essential to support the fish populations necessary to satisfy the angling interests.

Boat management will be important because uncontrolled boating (i.e. high number of boats, travelling at high speed, careless mooring and steering, or unrestricted discharges) could lead to the following undesirable effects, particularly in the narrower, more sensitive rural Canals such as the Wilts & Berks:

- physical damage to vegetation by propellers & hulls
- increased turbidity causing reduction in light penetration, degradation of plants from increased siltation and smothering of invertebrates
- decrease in the quality and diversity of the fish populations
- reduction in variety and density of submerged and floating macrophytes
- bank erosion and degradation of emergent bankside vegetation
- pollution from engines and waste water
- general disturbance to waterfowl and nesting birds

At the level of boating envisaged, there is still a good range of plant species which could potentially colonise the Canal. **Appendix J** lists a range of typical species which, from research on other Canals, might be expected to be tolerant of the density of boat traffic predicted for the Wilts & Berks Canal. Many of these species already occur in the wetter, marshy sections of the old Canal bed. During clearance of the channel, there is scope for non invasive plants to be laid to one side and replanted at the Canal edge or berm when the excavation work is complete.

In order to maintain a healthy fishery, an ecological balance needs to be struck. A reasonable amount of marginal vegetation is required to provide shelter and refuge for small fish and fry. In terms of food supply for fish, submerged and floating plants provide a more taxon rich fauna than non-macrophyte substrata, while emergent and tall emergent macrophyte communities are even richer. Submerged plants also provide a substrate for fish to lay their eggs on. Thus a balance needs to be struck between density of plant cover and fishing interests. The creation of areas of deeper, cooler water may benefit fish, particularly during periods of hot summer temperatures and promote the growth of submergent plant species which would be deep enough in the water column to avoid tangling lines.

There are a number of ecological design options which can be considered through consideration of the cross sectional profile and bank design as outlined below.

The design of cross section offers opportunity to maximise the ecological diversity of the Canal and to integrate natural erosion protection measures. Depth and cross profile are important considerations. If designed properly, the cross section together with bank design can minimise the potential impacts of boating and improve the conditions for supporting a diverse ecosystem and good quality fishery.

The ideal situation is to have a range of channel depths over the cross profile, ranging from shallow, gently sloping berms to a deeper central channel. A cross profile which is too shallow can encourage excessive weed growth, the effectiveness of the Canal to convey drainage & flood water is reduced, facilities for fishing deteriorate and leisure activities such as boating are curtailed. In order to be effective, the main channel needs to be at least 1m deep and this will be achieved through the design depth of 1.37m set for the Study. In order to restrict the disturbance of the silt, the navigation channel should be at least 300mm deeper than the draft of the typical boat using the Canal. Again a depth of 1.37m will satisfy this requirement.

The wider the berm that can be accomodated, the greater the potential to achieve natural erosion protection measures through use of reeds and natural vegetation. A variety of techniques can also give some berm protection in areas where levels of boating activity will potentially result in an erosion risk, particularly where the berm is narrow. Such techniques include use of geotextiles, spiling and toe boards. There may also be scope in winding holes to create shallower berms towards the edges. . However it may not always be possible to achieve the width of berm required to combat erosion within the minimum design specification and a wider cross profile would be required resulting in a greater land take. However the cost of adopting softer, more environmentally friendly techniques would need to be considered against the generally higher costs of harder bank protection measures.

In certain areas, for example close to moorings and where land take is constrained by surrounding land uses it is likely that harder protection measures will be required such as sheet steel or wooden piling.

There is also the potential to site marinas strategically in order to provide more control over boat movements through different parts of the Canal therefore indirectly controlling the pressure on certain parts of the Canal corridor.

Imposition of strict speed limits can do much to limit boat wash and the resulting damage which this causes.

Consideration could be given to restricting boating activity in certain sections of the Canal. For example it is likely that the highest number of boat movements will occur at the Kennet & Avon end and at the Abingdon end. Therefore there may be scope to limit boat movement in the central section, for example between Wootton Bassett and the Calne branch.

Table 5. 3 highlights the bank protection options which could be applied along the Canal where boat movements are likely to result in potential erosion. The need for bank protection and suitability of the options would need more consideration at the detailed design phase. This is because each reach of the Canal is different in character and this would need to be considered along with the level of boating activity, tow path recreational uses and ecological/landscape character.

Table 5. 3 Bank Protection Options

Bank Profile	Water depth	Bank Protection Options
Sloping	<0.5m	reed bed thorn faggots interlocking concrete blocks asphalt filled geotextile mat & geomembrane
	0.5 to 1m	2-D geotextiles Toe structures and low upstands including: staked willow and willow poles gabion box toe piling trench sheeting
	> 1m	rip-rap gabion mattresses cable tied/geotextile bonded concrete blocks grout-filled container dense stone asphalt prefabricated asphalt mattress
Vertical	<0.5m	Walling comprising: gabions & pre-cast units crib work trees piling timber retaining geotextile
	>0.5m	Piling/sheeting comprising: steel, concrete & timber

Source: RW Hemphill & ME Bramley, Protection of River and Canal Banks

Effects on river sections were discussed in Sub-clause 5.3.2.2. In addition it is highly likely that some dredging will be required in these river section. From discussion held with the EA to date it is likely that any river dredging will be a sensitive matter and careful consideration of suitable dredging profiles will be required.

5.4.5 Off- line Storage Reservoirs

At this stage it is difficult to predict the impacts created by off line storage reservoirs because their precise locations are not yet defined. However it can be assumed that there will be some habitat loss. The significance of any impact would depend upon the quality and status of this habitat but there may well be scope to improve upon the existing habitat through the creation of well designed lakes and wetlands. Issues relating to water quality are highlighted in Section 5.5. One important factor to consider in any design is that water level is likely to fluctuate considerably, particularly during the summer months when there will be increased demand upon water resources for the Canal. Potential enhancement measures which could be considered include:

- Use of a diverse cross profile to maximise habitat niches

- Creation of adjacent marshy areas

- Planting of trees, hedges & scrub for example:
  Osier & Sallow species as part of landscaping and screening measures although coppicing would be necessary every 2 to 3 years to promote dense scrubby growth.
  Blackthorn, Hawthorn and Dog Rose

- Construction of central islands and scrapes as nesting sites for birds. At least 1m depth of water needs to be maintained around the islands to prevent predation by foxes. Islands are best placed 100m from overhanging trees. Several islands are better than one.

- Fluctuating water levels can be useful for creating gravel, mud shorelines and shallow pools which provide valuable feed in areas for waders. In order to retain their value such areas should be kept free of vegetation

- Planting of marginal reed beds (depending upon the likely fluctuation of water levels)

5.5 Landscape

5.5.1 Existing Landscape Character & Features

For most of its length the Canal corridor runs through the Clay Vale Landscape Zone, formed by the broad lowland of Kimmeridge and Gault clays. The key landscape character of the Canal is described below:

5.5.1.1 West Wiltshire District

From Semington northwards the Canal runs through the flat gently undulating topography of the valley of the River Avon. Near views are dominated by pastureland and hedgerows. The existing river landscape through Melksham up to the Melksham Weir is somewhat degraded with the river flowing between high walled embankments. Between Melksham and Chippenham the eastern Canal route options run close to the edge of a Special Landscape Area, which is recognised a having county-wide landscape importance. Specific planning policies apply to Special Landscape Areas, in terms of developments which could be detrimental to the landscape character. However, due to its location, none of these are directly relevant to the Wilts & Berks Canal.

5.5.1.2 North Wiltshire District

From Spye Park to Wootton Bassett the views from the Canal are dominated by a ridge of Corallian limestone to the south and the Canal generally has a more enclosed feel. Views to/from the corridor are generally enclosed or restricted by hedges, trees and the gentle undulations of the topography.

5.5.1.3 Swindon Borough

From the point where the Canal crosses the Swindon Borough boundary and along the majority of its route to the A419 (T) the route runs through an Area of Local Landscape Importance. This area makes an important contribution to the quality and character of the Borough's landscape and has particular value or potential for countryside recreation.

To the east of Swindon from the A419 (T) to Pack Hill the Canal passes through the North Wessex Downs Areas of Outstanding Natural Beauty. The purpose of the AONB designation is to conserve and enhance the natural beauty of this area which is formally recognised as having a landscape of national importance. Policies for protecting this area are given in Policy TEV55 which is set out in clause 5.5.3.

5.5.1.4 Vale of White Horse District

Within the Vale of White Horse the route runs through the Western, Central and Eastern Clay Vale. The Western Clay vale has been celebrated in literature for its atmospheric landscape and is characterised by the pastures and hedgerows established on the clay soil and gently undulating topography. Although the loss of Elm Trees has left the landscape more open than it used to be there are still plenty of hedgerows, copses, green damp channels and brick & tiled hamlets and villages usually on outcrops of gravel above the damp land. The remaining trees still retain the feeling of the traditional landscape.

The land to the north of the Canal between Stockham Bridge and the western side of Grove of Wantage is designated as an Areas for Landscape Enhancement (Policy C12). Much of this landscape was cleared of woodland and trees during the Second World War to make way for airstrips and other installations. The area has never fully recovered and the Council consider that opportunities should be taken to enhance this area.

Beyond Grove & Wantage to the A34 the topography is flatter and there are more hedgeless larger, arable fields, particularly on the thin gravel terraces which overlie the clay sub soil. The area is generally characterised by a feeling of wide spaces, expansiveness and rurality. The flat open landscape provides views of the Berkshire Downs to the south and Corrallian Ridge to the North.

At the edges of some of the settlements along the route e.g. Grove, Wantage and Abingdon, a more rural fringe type landscape prevails.

East of the A34 the Canal route becomes more urban fringe in nature. The route following the Ock valley runs through a mixture of meadows, open more formal recreational areas and urban woodland/parkland. Houses dominate the more distant views towards the edge of the flood plain.

5.5.2 Impacts of the Canal

Where the Canal route will follow its original alignment there is likely to be little visual intrusion. This is because many of the original tree lines still persist and these will largely be preserved. Some tree and vegetation clearance, pollarding and coppicing will be necessary, either where trees and scrub have encroached into the original channel or to improve the nature conservation benefit of the area. The surrounding vegetation, particularly hedges and trees, screens the Canal from medium and distant range views.

The Canal will potentially have the greatest visual impact where it passes along entirely new routes introducing a new, large linear feature into the landscape. But even in these areas the near, medium and distant view tend to be restricted by trees and hedgerows.

Areas where the Canal could have the greatest impact, by changing the landscape character is through settlements such as Melksham, Lacock, parts of Swindon, Grove and Abingdon.

5.5.3 Landscape Mitigation

The aesthetic appearance of the Canal is important because it promotes greater enjoyment by users. Features which generally enhance the landscape often have other positive attributes e.g. nature conservation, or heritage benefits.

Generally, the softer the techniques that can be used and the more natural the materials e.g. wood versus sheet piling, the better the aesthetic appearance. A number of suggestions in relation to bank treatments have been made in Error! Reference source not found.. However, the choice of material is often constrained by the anticipated level of use and thus the strength and endurance of materials.

The Local Authorities along the length of the route have set out various landscape policies which the design of the Canal will need to take account of as set out below:

"*.... The District Council will seek to enhance damaged or compromised landscapes. It will particularly look for landscape improvement schemes in the areas identified on the proposals map.*" Policy C12, Vale of White Horse Local Plan

"*The District Council will normally expect the landscape features which contribute to the ecology, character and appearance of the landscape (such as trees and hedgerows) should be protected and integrated into the landscaping scheme for any proposed development*" Policy C9, Vale of White Horse Local Plan

"*Proposals for new development which would result in the loss of trees of amenity value will not normally be acceptable*" Policy C10, Vale of White Horse Local Plan

"In connection with the restoration of the Wilts and Berks ... Canal, development will not be permitted where proposals are likely to result in:

1. A significant adverse effect on the amenities and open landscape of the Canal corridor..." Policy RTM5, North Wiltshire Local Plan

"Development will not normally be permitted except where it is essential to the local rural economy, or desirable for the enjoyment of its amenities, or is otherwise acceptable having regard to other policies in the plan. Where in these areas development in these categories, is permitted, particular care should be taken to integrate it into the rural landscape. Special landscape or other conditions may also be imposed" Policy TEV55, Swindon Local Plan

Aims of the Local Authorities along the route which would be compatible with Canal restoration include:

- replanting of hedgerows;
- tree planting within hedgerows, belts or copses;
- clearance & restoration of ponds;
- replacement of hedges;
- retention and maintenance of willows along streams.

In some areas grants are available for small planting schemes and willow pollarding.

Restoration of industrial heritage features such as locks and wharves can also do much to enhance the appearance and interest of the Canal environment and can act as a focal point to view the Canal from.

Attention should also be given to the visual appearance of bridges and lock structures. From analysis of historic pictures, it would appear that many of the original bridge structures were brick built arches with either brick or iron gridwork parapets. Although it may not be possible to restore traditional hump back bridges due to the constraints imposed by modern sight lines and road safety, the use of brick where possible is recommended. There is also scope with brick to install such features as bat bricks.

5.6 Water Quality

This section addresses potential water quality impacts arising from the restoration and construction, as well as the future maintenance and operation of the Canal. Specifically, this includes:

- impacts on the Canal and adjoining watercourses during restoration & construction;

- impacts on the water quality of watercourses and groundwater used to supply the Canal;
- impacts on Canal water quality during operation.

5.6.1 Legislation and Regulation

There are a number of pieces of legislation dealing with water pollution. The potential for deterioration in the water quality of both the Canal and adjoining watercourses has to be considered within the framework of the statutory requirements which aim to prevent pollution or deal with the consequences once pollution has occurred. In addition to liability under Common Law, there are two main statutory environmental laws to be considered in this case:

5.6.1.1 Water Resources Act 1991

The Water Resources Act 1991 sets out a number of offences which are committed by allowing pollution of "controlled waters". Controlled waters are described in Section 104 of the Act and include inland freshwaters, lakes and ponds (natural or artificial and above or below ground) which discharge into rivers and watercourses together with rivers and watercourses which are not public sewers nor drains or sewers into a public sewer, and groundwaters; those in underground strata.

Under Section 85 of the Water Resources Act 1991, it is an offence to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste matter (which includes silt, cement, concrete, oil, petroleum spirit, sewage or other polluting matter) to enter any "controlled waters".

As for the control of water quality, Sections 82 - 84 of the Act provide for a system of statutory Water Quality Objectives (WQOs) in order to maintain and improve the quality of controlled waters. The WQO scheme is designed to provide a range of standards for water quality which reflect the uses of the particular watercourse, e.g. fishery, ecosystem, abstraction, amenity etc., however so far only one standard has been introduced. The Surface Waters (River Ecosystem) (Classification) Regulations 1994, define five use classes of water quality for fish communities which range from RE1 - water of very good quality suitable for all fish species, to RE5 - water of poor quality which is likely to limit coarse fish populations. Maintenance and improvement of the WQOs is a duty of the Secretary of State and the Environment Agency, and is facilitated through the use of their pollution control powers.

5.6.1.2 Environment Act 1995

The Environment Act 1995 further strengthens the provisions available to the Environment Agency by providing it with the ability to forestall potentially polluting events, undertake anti-pollution works or serve a "works notice" on any person in situations where polluting matter has entered, or is likely to enter any controlled water. The "works notice" can require the person to undertake:

- the removal or disposal of the polluting matter;
- the remedying or mitigation of any of the effects of pollution;
- the restoration of the affected water(s) and any flora and fauna dependent on the aquatic environment.

Under the 1995 Act, for the first time there is also a statutory definition of contaminated land, namely:

> "any land which appears to the local authority in whose area it is situated to be in such a condition, by reasons of substances in, or under the land, that -
>
> (a) significant harm is being caused or there is a significant possibility of such harm being caused; or
>
> (b) <u>pollution of controlled water is being, or is likely to be, caused</u>".

'Harm' is defined by the Act to mean harm to the health of living organisms or other interference with the ecological systems of which they form part, and, in the case of man, includes harm to his property.

5.6.1.3 Common Law

The owners of a site may be held liable under common law if contaminants escape and interfere with an adjacent landowners use of the land (riparian rights) or interfere with a right such as abstraction of groundwater.

5.6.2 Baseline Conditions

As part of the baseline survey, it is essential to assess the quality of those rivers and streams which the Canal affects, either through direct abstraction during peak winter flows to fill supply reservoirs, or through joining the rivers or canals at some stage along the route of the Canal, e.g. rivers Avon and Ock. In doing so it will be possible to determine the main issues which are currently affecting each watercourse, and determine how restoration of the Wilts & Berks Canal, will affect the water quality of both the restored Canal and the river systems which it will interact with **(Table 5.4)**

Table 5.4 Watercourses Affected by Canal Infrastructure

Watercourse	Location	Approx. NGR	Reason for Study
Clackers Brook	E. of Melksham	ST 914637	Surface water reservoir supply
Avon Tributary	S. of Forest Farm	ST 917646	Surface water reservoir supply
Avon Flood Plain	S. of Chippenham	ST 920705	Surface water reservoir supply
Fishers/ Cowage Brook	N.W. of Calne	ST 980720	Surface water reservoir supply
Cade Burna	S.W. of Stockholm Marsh Farm	ST 990768	Surface water reservoir supply
RAF Lyneham		SU 005785	Storm water supply
Brinkworth Brook	S. of Wootton Bassett	SU 062815	Surface water reservoir supply
R. Cole	S. of Acorn Bridge	SU 216873	Surface water reservoir supply
Ock Tributary	ds Cowleaze Farm	SU 285894	Surface water reservoir supply
Ock Tributary	ds Uffington	SU 302898	Surface water reservoir supply
Stutfield Brook	S.E. of Broadleaze Farm	SU 344888	Surface water reservoir supply
Thames	at Abingdon	SU 500957	Confluence with W&B Canal
Ock	at Abingdon	SU 475960	Confluence with W&B Canal
Ray/ Elcombe Brook	at Swindon	SU 137834	Confluence with W&B Canal
Oxford Canal	N. of Cricklade	SU 087947/109944	Confluence with W&B Canal
Avon	at Melksham	ST 900638	Confluence with W&B Canal
Kennet and Avon Canal	S. of Melksham	ST 900610/932614	Confluence with W&B Canal

Until the concepts and plans developed within the feasibility study are more fully defined, it would be both time consuming and potentially wasteful to undertake a detailed study of the water quality of each of the watercourses outlined above, as it would require a large volume of detailed monitoring data from the Environment Agency (EA), as well as some additional survey work, in order to comprehensively assess the effects of the restoration as it is currently envisaged. In addition, it has not been possible to obtain publicly available water quality data on ground water supplies which have been outlined for potential use in this report. All the information contained within NRA Catchment Management Plans or EA Local Environment Agency Plans has been assessed for both surface water abstraction and ground water abstraction, and the main issues are presented below.

5.6.3 General Quality Assessment & Water Quality Objectives

The Environment Agency undertake routine sampling of controlled waters in England and Wales using both biological and chemical parameters in order to monitor water quality. Since 1994, the Environment Agency have used the General Quality Assessment (GQA) scheme for rivers and Canals which has the benefit of providing water quality assessment results which are nationally consistent.

In addition to assessing water quality through the GQA scheme, the EA also use a system of Water Quality Objectives (WQOs) which establish clear quality targets for individual reaches of watercourses. At present only the River Ecosystem use category has been developed, and is in widespread use following its introduction through the Surface Waters (River Ecosystem) (Classification) Regulations 1994.

The biological and chemical parameters for the GQA scheme, as well as a description of the use classes and standards required to meet the use classes is given in **Appendix K** and **Appendix** L.

For each of the reaches of rivers and streams which are affected by the Canal infrastructure, the biological and chemical GQA grades, and the WQO grades are presented in **Table 5.5** following. (N.B. some of the streams highlighted in are so small that sampling has either not occurred or been reported by the EA). Also, where it has been published, compliance with the River Ecosystem use class targets are presented.

5.6.4 Specific Catchment Water Quality Issues

In addition to the assessment of biological and chemical water quality, and the setting of water quality targets, a number of issues specific to certain catchments and watercourses are discussed within the published Catchment Management Plans and Local Environment Agency Plans. Some of the main issues surrounding water quality in reaches of rivers and streams identified in **Table 5.5** are as follows:

5.6.4.1 Upper Bristol Avon Catchment

This catchment is covered under two NRA reports: The Upper Bristol Avon Catchment Management Plan Consultation Report, dated June 1994; and The Upper Bristol Avon Catchment Management Plan Action Plan, dated March 1995.

General: there is ongoing survey work to establish the nutrient status of the catchment, especially downstream of the Sewage Treatment Works (STW) at Chippenham, in order to assess whether this part of the catchment should be designated as sensitive under the Urban Waste Water Treatment Directive (91/271/EEC). This would allow nutrient removal at qualifying STWs (NRA, 1994, pp10 & 50).

Table 5.5 Water Quality for Watercourses

Location	NGR	GQA Biol	Year of Data	GQA Chem	Year of Data	WQO Ecology Use Class	Pass / Fail	Year of Data
Unnamed tributary of Stutfield Brook to SE of Broardleaze Farm (West of Wantage)	SU34488 8							
Unnamed tributary of River Ock downstream of Uffington (North of Uffington)	SU30289 8							
Unnamed tributary of River Ock downstream of Cowleaze Farm (West of Uffington)	SU28589 4							
River Cole to South of Acorn Bridge (Southwest of Shrivenham)	SU21687 3	B	1991-1993			RE3 (1994)	?	
Brinkworth Brook East of Greenhill Common Farm (South of Wootton Bassett)	SU06281 5							
RAF Lyneham	SU00578 5	-	-	-	-	-	-	-
Point where Canal joins **River Ock** in Abingdon	SU47596 0	A	1995	B (1993-1995)		RE2	Pass	1993-1997
Point where Canal joins **River Ray** in Swindon	SU13783 4	Fair D	1993-1995					
End point North of Cricklade (E)	SU08794 7							
End point North of Cricklade (W)	SU10994 4							
Point where Canal joins **River Thames** at Abingdon	SU50095 7	B	1993	C (1993-1995)		RE2 (1998)	Fail	
Cade Burna SW of Stockham Marsh Farm (Southwest of RAF Lyneham)	ST990768							

Table 5.5 Water Quality for Watercourses (continued)

Location	NGR	GQA Biol	Year of Data	GQA Chem	Year of Data	WQO Ecology Use Class	Pass / Fail	Year of Data
Fisher's and **Cowage Brook** at Swerves Farm (Northwest of Calne)	ST980720					RE3	Pass	March 1995
Unnamed tributary of River Avon South of Forest Farm (Northeast of Melksham)	ST917646							
Clackers Brook North of Bowerhill Lodge Farm (East of Melsham)	ST914635							
Avon Floodplain near Chippenham	ST920705					RE3	Pass	March 1995
Point where Canal joins **River Avon** in Melksham	ST900638					RE3 (1998)	Fail (significant)	March 1995
End point South of Melksham (E) (**K & A Canal**)	ST900610					RE5	Pass	March 1995
End point South of Melksham (W) (**K & A Canal**)	ST932614					Canal compliant with proposed WQO	Pass	March 1995

Note: Awaiting further information from the Environment Agency. Comments will be made at a later stage.

In addition to the above, studies are also being undertaken to establish if the catchment, or part of it, should be designated as a Nitrate Vulnerable Zone (NVZ), as potable water supplies downstream of the catchment boundary have high concentrations of nitrate. Designation as a NVZ is governed by the EC Directive 'concerning the protection of waters against pollution caused by nitrates from agricultural sources' (91/676/EEC), and would require action plans to be drawn up to reduce nitrate pollution from agricultural sources (NRA, 1994, p51).

The combination of these two sources of nutrients has led to eutrophication problems occurring in long sections of the Avon, and the reach between Chippenham STW and Avoncliffe Weir at Bradford-on-Avon is specifically targeted for further study (NRA, 1995, p8).

- Avon at Melksham:

Owing to the above, the Avon at Melksham appears to have significant problems associated with a high nutrient load from both point (STWs) and diffuse sources (agricultural runoff). In Melksham, concentrations of nitrate have exceeded 50 mg NO_3/l (NRA, 1994, 62). Melksham STW is degrading downstream water quality (NRA, 1994, p63) possibly as a result of increased organic input from an expanding population, and the current consented effluent discharge is due for review (NRA, 1994, p64). If the Upper Bristol Avon catchment is designated as 'Sensitive' under the Urban Waste Water Treatment Directive (UWWTD), then the population equivalent figure (which is indicative of the volume of treated effluent being returned to the Avon) under which the STW operates will be reviewed (NRA, 1994, p65).

In addition to the above, there is mention of the possibility of an urban river restoration project in Melksham which would reduce the amount of siltation in the river within the town (NRA, 1994, p15).

- Cowage Brook / RAF Lyneham:

Examination of the water quality of these two potential sources goes hand-in-hand as both sewage effluent and storm water discharges which are liable to contain oils, rubber compounds and, in winter, de-icing fluids (NRA, 1994, p65) from RAF Lyneham are fed in to the Strings watercourse situated at the headwaters of the Cowerage Brook (NRA, 1995, p12). In addition, to the effluents which are discharged to the Strings watercourse, there are intermittent pollution events which are usually large scale fuel spillages which have a highly damaging effect on the small watercourse (NRA, 1994, p65). The EA are currently in negotiation with RAF Lyneham to improve the performance of the STW, employ improved pollution emergency response measures, and prevent fuel oil and de-icing fluid from entering the watercourse (NRA, 1994, p66).

- Brinkworth Brook:

Brinkworth Brook, upstream of the likely location for the proposed surface water supply reservoir, has a number of significant effluents discharged into it. There is a fish farm; Ivy House Lakes, to the north west of Wootton Bassett which both extracts water from the Brook, and discharges farm derived effluent into it (NRA, 1994, p39). Upstream of Wootton Bassett the St. Ivel factory has a consent to discharge factory waste (1500m^3/d) to the watercourse, although there is no detail of consent conditions (NRA, 1994, p37), and finally there is a STW below Wootton Bassett, which discharges into Hancocks Water (a tributary of Brinkworth Brook), upstream of the proposed surface water supply reservoir (NRA, 1994, p37). Problems with water quality downstream of the STW is being dealt with by the EA through renegotiation of Wessex Water's consented discharge conditions to bring about improvements in final effluents leaving the works (NRA, 1994, p64; NRA, 1995, p10).

5.6.4.2 Upper Thames

This catchment covers a relatively small part of the Wilts & Berks Canal geographical area, however it includes the area around Swindon, and the rivers Ray and Cole, as well as the Cole tributaries to the east of Swindon. The only proposed surface water supply reservoir in this catchment is located on the River Cole south of Acorn Bridge, however there will be a small stretch of the Canal which adjoins the River Ray to the south of Swindon for a short length before separating once more.

The NRA Report which covers this catchment is the Upper Thames Catchment Management Plan Consultation Report which was published in January 1995.

The River Ray, through Swindon, and especially downstream of Swindon STW, has poor water quality and has been designated a 'Sensitive Area' under the UWWTD (NRA, 1995, p58). Improvements have been made to Swindon STW to improve final effluents, however phosphate stripping has not been included in the improvements, and may be incorporated at a later stage (NRA, 1995, p58). Owing to the poor water quality in the River Ray, EC Fisheries Directive water quality standards have not been met (NRA, 1995, p64), nor have fisheries biomass targets for the river (NRA, 1995, p71). It is hoped that as a result of upgrading at the Swindon STW, both of these failures will be corrected in the future.

5.6.4.3 Thames (Eynsham to Benson) and Ock Catchment

This catchment is covered by the Thames (Eynsham to Benson) and Ock Local Environment Agency Plan Draft Consultation Report (Second and Final Draft) published in June 1997, and covers the geographical area to the east of Swindon up to Abingdon.

There is no data contained within the Report which specifically identifies the Ock tributaries which are listed as potential feeds for surface water supply reservoirs, however the Ock catchment is defined as having poor water quality as a result of agricultural runoff (EA, 1997, p42) and the EA is currently visiting farms to assess the risks associated with each holding and advise farmers on surface water pollution prevention.

The Wilts & Berks Canal restoration is specifically highlighted as an issue with regard to Canalisation of the lower reaches of the Ock, and water supplies to feed the Canal (EA, 1997, p48), however some of these misgivings may have been assuaged in recent discussions between the EA and members of the Wilts & Berks Amenity Group.

5.6.4.4 Groundwater Quality

The issue of groundwater quality is very poorly covered in any of the NRA/EA reports, save that there are no Groundwater Protection Zones around the aquifers which may be used to feed the Canal.

Information which has been made available by the EA in the calculation of potential groundwater supplies for the Canal has indicated that in many cases there may be problems with using groundwater resources; in the majority of cases, this includes increased salinity and excessive iron concentrations.

5.6.5 Impact Prediction

Determining the exact nature of the impacts which may take place can not be precise at this time because the final locations and requirements for Canal infrastructure have not been decided, and a much greater level of detail on existing surface and groundwater quality would be required. As a result, generic impacts associated with this type of development are highlighted here, and where possible, predictions are augmented by the information presented in the baseline data section.

As outlined in the introduction, the water quality impacts that are likely to arise from the Canal restoration/construction can be broken down into three distinct sections as follows:

5.6.5.1 Construction Related Impacts

There will be a variety of structural works which will affect the quality of both existing river quality where the Canal joins other rivers and Canals, and the water quality of those lengths of the Canal in water. The main impacts from construction related activities are :

- *Increased turbidity/siltation*

This is likely to be one of the most common impacts associated with restoration, as whenever dredging, excavation work, thrust boring or box jacking, bypassing channels (especially associated with coffer dams) and piling take place, to a greater or lesser extent muds and silts will be mobilised either from channel banks and substrates or from external sources. Mobilising these sediments and arisings will have a number of effects on channel morphology, habitat and water quality. Dealing specifically with the water quality issues, releasing sediments or other organic arisings into a waterbody has three main effects: it increases the organic load on the watercourse leading to an increased biochemical oxygen demand (BOD) on the surrounding waters as the organic particles are colonised by bacteria; it releases nutrients into the watercourse which may have hitherto been locked up in the channel substrate; and it reduces ability of submerged and benthic plant species to photosynthesise efficiently.

Increasing the organic load on a watercourse may be acceptable where there is sufficiently high concentrations of dissolved oxygen, however as with many watercourses in the catchments studied, there are already problems with the BOD of existing discharges, and where this type of problem is severe, increased sediment load may lead to a pulse of deoxygenated water travelling downstream, killing fauna which are not able to evade it. This problem may be further exacerbated as phosphorous in sediments is released in anaerobic conditions, providing further nutrient enrichment of the waterbody.

Where nutrients are released into the watercourse, especially phosphorous which is often the limiting nutrient in many waterbodies, it can cause excessive algal and macrophyte growth, followed by a high BOD in the waterbody once the flora have died-back. Once phosphorous is freely available in a waterbody, it is notoriously difficult to remove. Increasing the organic/nutrient load on an impounded waterbody often leads to eutrophication, and this is a particular problem for many standing waters in the UK. When a waterbody suffers from eutrophication, water quality and ecosystem are degraded such that the only organisms able to thrive are algae/phytoplankton. Algal blooms effectively shade-out higher plants (macrophytes) which support and offer refuge to macroinvertebrates, fry and zooplankton, the latter of which is the phytoplankton's only predator. When zooplankton no longer have a refuge they are predated more easily by fish, and thereafter there is little to stop the algal population from expanding unchallenged.

Eutrophic waters, characterised by algal blooms, have low amenity value as they offer little in the way of species and habitat diversity, they have limited angling potential (fisheries are initially dominated by cyprinids which eventually die out if the situation worsens), and watersports are often curtailed as a result of the potentially toxic effects from ingesting cyanobacteria (blue-green algae).

Increased turbidity/siltation can affect a plant's ability to photosynthesise efficiently, however in most cases, where there is movement in the water body, the sediment load will travel in the direction of the current, and the water will clear once more. There is a problem where silt gets deposited on the leaves of plants and effectively smothers them, or where there is no movement in the waterbody, and fine sediments take longer to settle out. In these situations, some of the flora affected may die, and once more the BOD of the surrounding water will be increased.

- *Pollution from construction related materials*

Whether the restoration works involve the use of an engineering contractor, or a volunteer workforce, there will be certain materials in use which have the ability to create a significant pollution problem. Fuels, oils and ancillary fluids required for items of plant offer the greatest potential for pollution either through accidental spillage, unauthorised use or vandalism. In addition there are likely to be materials stored on site such as construction related chemicals or concrete. Where construction compounds are formed adjacent to the area of working, there is the additional potential for pollution to occur from domestic waste, litter and accumulated debris from the runoff from the compound.

Where oils or oil derivatives enter a waterbody a number of changes occur: plants which become coated in oil are unable to respirate or photosynthesise and hence die; in addition the water soluble components of oil are highly toxic to most organisms living within the waterbody, regardless of their lifestage (although the younger they are the more vulnerable they are likely to be). The secondary effects of an oil spill are similar to those mentioned in the preceding paragraph, that of increased BOD and nutrient release as a result of bacterial colonisation of the dead flora and fauna. In addition to the above, oil pollution has a derogatory effect on the amenity and aesthetic value of a waterbody, limiting its potential for the duration of the pollution event for such activities as fishing and canoeing.

Cement is particularly toxic to fish in its uncured form, having lethal effects within the locality of a spillage.

As for pollution associated with compound establishment, much of the potential for detriment to a watercourse is as a result of nutrient enrichment, and the effects of this have been adequately described hitherto.

5.6.5.2 Water Supply

Possible impacts on water quality issues for each of the potential resources are:

- *Surface water*

In almost all cases, where baseline water quality data has been available on the rivers and streams identified in this report, there are water quality problems associated with elevated nutrient levels derived from either STWs or agricultural runoff. To some extent, these problems are ameliorated through the movement of water in the river channel, where any turbulence in the water helps aerate it, and hence increase the supply of dissolved oxygen. In addition, the movement of water ensures that organic pollution is continually moved downstream, hence no one area is permanently under severe organic pollution unless it is downstream of a STW, although this will be ameliorated in times of peak winter flows.

Canal systems and the reservoirs that feed them are, on the whole, quite different. The reservoirs and the Canal system will act to impound the water, and a high organic/nutrient load can have long lasting detrimental effects on individual locations where movement is restricted.

As with river systems, this effect will be ameliorated to a certain extent especially where there are weirs or lock systems which allow the water to fall through the air and act turbulently with the receiving water, thereby aerating it. In addition, there is the added bonus that water from the streams and rivers identified will be taken only in times of peak flow which will mean that any organic/nutrient load on the river from point sources such as STWs will be diluted to its greatest extent, and the river or stream will also be at its most turbulent, hence potentially with an elevated level of dissolved oxygen.

Unfortunately, there are also disadvantages to taking water from a stream or river at times of peak flow, as it is likely that there will be a greater sediment load on the river, much of which will either be attributable to road runoff (in urban areas) or agricultural runoff (in rural areas). Once the water reaches the storage reservoir, its velocity will be abruptly diminished, and its sediment load will be deposited at the bottom of the reservoir, or for finer organic sediments in suspension, degraded by bacteria, thereby reducing available dissolved oxygen. In addition to the above, whilst the benefits to the Canal system around locks and weirs have been identified, there will remain large sections of the Canal located some distance from the nearest source of turbulence, and the increased oxygen supply that goes with it.

In a worst case, where no mitigation is used to prevent excessive nutrient input to the Canal, one would expect to observe water quality typical of a hyper-eutrophic conditions, dominated by algal blooms and potentially anaerobic conditions which do not support higher forms of floral or faunal species. This situation would be ameliorated slightly around locks and weirs however, where the Canal adjoined other rivers and Canals there would potentially be reduced water quality around the locality of the confluence.

The issue of reduced water quality in times of low flows has not been addressed because none of the supplies to the storage reservoirs will be taken at these times.

- *Stormwater runoff from RAF Lyneham*

The option of using storm water runoff from RAF Lyneham has been raised as a potential additional water supply. Earlier, the problems which are currently experienced with the quality of the effluent and its effects on the Strings watercourse were explored.

If the Canal was supplied with storm water runoff from RAF Lyneham, a number of impacts would occur around the discharge point. The pollutants and their effects are as follows:

- Oil and fuel - The effects of these pollutants were described earlier and include suffocation of plant life, and poisoning of fish and lower faunal lifeforms.

- Increased suspended sediment load, especially mud, grit, metal particles and tyre organics. This increased sediment load would lead to siltation, increased turbidity, toxic substance contamination and nutrient enrichment.

- De-icing fluids/compounds - These will be seasonally dependent but will consist mainly of sodium and chloride. Increasing the salinity of a waterbody will cause the reduction of species diversity either through evasion (such as fish), or death as a result of the toxic effects on species which are less mobile.

- Metals, such as lead, zinc and cadmium - Although it is unlikely that there would be large volumes of these materials entering the Canal, most elevated levels of metals have a toxic effect on fauna, depending on the individual species' resistance levels. The sublethal effects of these toxic pollutants may reduce an organism's ability to perform necessary functions, lowering its efficiency and hence survival chances. In addition, there can be cumulative effects on fauna when there is a combination of toxic pollutants entering the waterbody which may have a synergistic or additive effect so that sublethal concentrations of individual metals become lethal.

Apart from the primary effects of the pollutants on the waterbody, it is worth considering how the silts and muds around these offtakes will be disposed off when management dredging takes place. If samples indicate that the silts contain elevated levels of pollutants such as heavy metals, it will not be possible to dispose of them to agricultural land, and they will be treated as contaminated waste (see Sub-clause 5.9.4.3).

- *Groundwater*

Little water quality data on the potential groundwater supplies is currently available, however it is accepted that most of the possible supplies are contaminated with iron, and have elevated salinity.

Iron contamination of groundwater is a common phenomenon. Iron is soluble in its ferrous state (Fe^{2+}) where water is totally deoxygenated, however when the water becomes oxygenated it will oxidise into its ferric form (Fe^{3+}) and become insoluble. If the groundwater was pumped directly into the Canal system this would lead to ochreous deposits around the area of the discharge unless the water could be aerated beforehand.

As salinity describes the concentration of ions in solution, without determining which elements are to be found in the water it is not possible to make any meaningful comment regarding the likely effects of using these supplies.

- *Runoff from new development*

The water resources element of the report identifies the potential for additional water supplies by taking stormwater runoff from new development (housing). Runoff from residential areas will typically consist of dust, litter and grit, organics such as leaves, grass cuttings and pet faeces, and fuel and lubricants from drives and roads.

The problems associated with these types of pollutants have been adequately described above and include increased turbidity, siltation, nutrient load and oil pollution. The problem can be exacerbated, particularly in summer months after a long dry period when DO levels in the Canal are particularly low, by storm events which place a shock load of the above pollutants on the Canal. Such an event can create localised anaerobic conditions and, where species are unable to evade the area, can have lethal effects.

5.6.5.3 Operations and Maintenance

The water quality aspects associated with the operation of the Canal are difficult to predict as it is not yet known what mitigation measures will be incorporated into the restoration, however there are certain impacts which will occur if mitigation is not carried out. These are split into impacts resulting from amenity use, and impacts associated with maintenance.

- *Amenity use*

It is predicted that there will be up to 5,000 boat movements per year on the restored Canal, in addition there are likely to be permanent moorings, boat maintenance and refuelling facilities and service facilities (restaurants, pubs, shops etc.).

The various impacts that can occur through fuel spills, litter etc. have been adequately described above, however the types of impacts associated with boat traffic have not been explored. The leakage of lubricants to the Canal as a result of the cycle of engine cooling water is a relatively minor impact, and even with boat traffic approaching 5,000 movements it is not expected to be a particular problem. Boats do discharge 'grey water' effluents (such as washing-up water which contain phosphates) which are allowed to be pumped straight into the waterbody. However it is likely that run off of fertilizers from surrounding agricultural areas would potentially have a greater potential effect (risk of eutrophication) than discharge from boats.

The movement of the boats through the waterbody also has a number of effects, if the channel is shallow enough, base sediments will be constantly moved, thereby increasing turbidity locally and making nutrients available once more. In addition, the boat's movements may have the effect of eroding banks and release soils into the waterbody (Clause 5.4.4.) The props will, however, have a beneficial impact as they will create turbulence in the water around the blades, aiding the aeration of the water.

Angling can also have some impacts on the waterbody, for example water fowl can become entangled in discarded fishing line and hooks and unless adequate access is provided to the waterside bankside vegetation can be degraded. However, good management of the fishery can do much to avoid problems developing, as outlined in Clause 5.2.4.

- *Maintenance*

There are two areas of routine maintenance on the Canal which can have an effect on water quality, they are dredging and bankside vegetation control.

Dredging has a major beneficial impact on Canals which have poor water quality as a result of elevated nutrient levels. Dredging is an effective method of removing nutrients and organic matter from the system completely. This is especially true of phosphorous which can be locked up in sediments, but released when conditions become anaerobic. Purely organic dredgings have a value to agricultural land, and dredgings should always be removed from the bankside otherwise nutrients may be leached back into the waterbody.

The only negative impact of dredging on water quality is a localised increase in turbidity and, if there is any flow in the channel, downstream siltation.

It will be essential as part of the day-to-day management of the Canal to maintain access to boat traffic in the channel and pedestrian traffic on the towpath. Banks and verges will be cut on a regular basis, however there will be an effect on water quality if cuttings are allowed enter the waterbody, this will provide an elevated organic load leading to many of the problems discussed earlier. Cuttings should be removed from the bankside, however there may be a conservation interest in keeping cuttings and dieback within the Canal corridor. Although some shade from overhanging trees helps to maintain a balanced ecosystem, too many overhanging trees can be a hazard to boating and leaf fall can be detrimental to water quality due to the build up of organic detritus. Therefore regular tree maintenance may be required.

5.6.6 Mitigation

The single most important form of pollution identified in this study is the addition of organic materials/nutrients. The control of the nutrient levels within the Canal will be of particular importance not just to water quality, but also to amenity and conservation interest. During each phase of construction, supply and operation, the potential for nutrient inputs has been identified. In each case this section will present the types of mitigation which could be used to stem both the short term impacts (deoxygenation of the water) and the long term impacts (eutrophication) of elevated nutrient levels, as well as the other types of pollution that may occur.

5.6.6.1 Construction

The effects of siltation and turbidity during construction will be particularly difficult to mitigate against, however contractors should be able take steps to ensure minimal uptake of sediments, especially when constructing cofferdams/bypass channels or at confluences with major rivers such as the Avon. During excavation and dredging work, plant operatives should ensure that arisings are removed from the bankside so that they can not fall or be leached back into the waterbody.

Wherever compounds are constructed, fuel and oil storage should be such that it is secure and bunded in the event of an accident or vandalism. Plant should be refuelled from the compound wherever this is possible, rather than bringing the fuel to the plant. Construction materials should be used such that only the immediate needs of the operative are satisfied in the area of working, and materials are stored away from the waterbody. All compounds should be fenced and secured, and positively drained away from the waterbody to a soakaway or to the mains sewer (consents will be required from the licensing authority in either case). In addition foul and grey effluents should either be discharged to mains sewer or, where this is not practicable, stored and taken offsite for disposal at a licensed premises.

Undertaking these measures should ensure that risk of pollution to the waterbody is reduced significantly, even though some of the effects sediment release will go unmitigated.

5.6.6.2 Supply

The main consideration with supply is to ensure that the wherever the water is derived from, it is as clean as is economically possible before it is discharged into the Canal. As mentioned in the baseline survey, a number of the catchments in the area of supply have particular problems with nutrient loading on river systems due to a combination of point and diffuse pollution, and low flows. Some catchments (e.g. River Ray) have already been designated with a status which recognises the problems of nutrient enrichment, and others may follow shortly (e.g. Upper Bristol Avon).

Allowing for the fact that the restoration of the Canal is likely to be a long term process, it may be possible that a number of the problems highlighted will be ameliorated to a certain extent through the actions of the Environment Agency. They have been proactive in recognising and attempting to resolve the problems associated with both STW final effluent limits/volumes and the standards of housekeeping on farms. It is hoped that the actions that have been taken to date (such as tightened discharge limits on certain STWs), and those which may happen in the future (such as phosphate stripping at certain STWs) will provide a better river water quality from which to take supplies at times of peak flows.

Even if the Environment Agency is successful in its mission to reduce nutrient loadings on local watercourses, it will still be necessary to provide some form of treatment to water abstracted from them. As discussed earlier, peak flow rates are usually attributable to winter storm events, and as it is likely that storm sewers also discharge into the watercourses identified for supply, there will be increased loads of organics, litter, dusts and sediments in the supply to the reservoirs. There are two main recommendations for treatment of water that is taken from local rivers (this also applies to storm runoff from RAF Lyneham): settlement ponds and constructed wetlands for supply polishing.

- *Settlement Ponds*

As discussed in the impacts section, peak flows will have heightened velocities, and hence will be able to carry an increased suspended sediment load. Without utilising a settlement pond much of the suspended load will be deposited in the reservoir leading to lower capacity and a requirement for regular maintenance dredging. If a series of settlement ponds were introduced, then these could be allowed to fill up with sediment and be planted, or dredged routinely without affecting the reservoir capacity. In addition, much of the insoluble polluting matter such as litter, debris and some metals can be settled out at this stage. Once the water is free of its sediment load it could pass to a constructed wetland.

- *Constructed wetlands*

Constructed wetlands or reed bed systems are a low technology and maintenance, economic and efficient method of cleaning water. They can be used in a variety of situations and have a seemingly universal application. They are efficient at reducing nitrate, removing phosphorous and organics, oxidising ammonia and have variable success in removing metals. Their application would not only benefit water quality, but also improve habitat as they are readily colonised by bird and insect species. A view would need to be taken on the siting of each system (depending on the quality of the water after it is discharged from the settlement pond), however perhaps the most applicable supply to benefit from constructed wetland treatment would be storm run off, whether it be from RAF Lyneham or from new development.

- *Eutrophication and Deoxygenation*

Where nutrient loads in the Canal are not stripped out at source, and eutrophic conditions do arise, this can be particularly difficult to manage, however there are some measures which can be taken to reduce the effects.

Where there are long lengths of Canal where there is relatively little cover, and no added turbulence from lock functioning, it would be prudent to consider placing a supply discharge in the centre of the length, and supply water so that it is well aerated as it enters the Canal, this will combat deoxygenation in the localised area which may occur after algal blooms have subsided, and can be undertaken using an elevated water supply point so that the supply reacts turbulently with the receiving waters. In addition, landscaping can be planned into the restoration so that lengths which may become eutrophic are shaded to a greater extent. This will affect the ability for algae to photosynthesise efficiently and therefore the success of algal species.

Once the Canal in restored, the treatment options for eutrophication become more expensive, but include regular dredging to remove nutrient rich sediments in the localised area and placing barley straw in the channel which has an unexplained toxic effect on algae. As a last resort, where deoxygenation has taken place, aeration systems can be brought in which pump air through the waterbody. This is often undertaken as a last resort and in conjunction with a fish rescue.

- *Iron contamination*

In consideration of the treatment which would be required for groundwater, it is only possible to comment on the iron content of the water. As mentioned previously, as the iron is in its ferrous state it will oxidise readily once oxygen is added to the water. Before making any decisions about the treatment possibilities, it is necessary first to assess how much iron is in the water. If iron levels are only slightly above normal levels, then it would be practical to supply it directly into the Canal, all other things being equal, however there may be a need to remove other contaminants, and this process could include exposure to oxygenated water. Where simple aeration is not a practical proposal, or will not work effectively, there are processes which involve the addition of other compounds to precipitate out the iron. Whichever method is used, it will be necessary to remove the ochreous deposits from the base of any tank or clean filters, both of which have management obligations.

- *Siltation and turbidity*

Canal channels naturally become silted-up and choked through the accumulation of organic detritus and fine sediments. A dredging regime will ensure clearance of the channel and Canal structures, as well as the removal of nutrient rich sediments. Dredging will be particularly important around the confluences with other systems such as the River Avon and the Kennet and Avon Canal. It will not be acceptable for silt to be washed into these 'partner' systems, especially where they are already under pressure because of high nutrient load and siltation, e.g. the Avon at Melksham. A dredging regime should therefore incorporate regular work at junctions and confluences. In addition, siltation is likely to occur around supply points where fine sediments which have not been settled out previously are deposited. The dredging regime should also take account of this.

5.6.6.3 Operation

It would be prudent when licensing the retailing of fuel, to obtain a contractual commitment from the prospective licence holder to retain onsite pollution abatement equipment such as oil booms, and for the licence holder and their staff to be trained in the use of the equipment and possess a valid emergency response plan. If there was a significant oil/fuel spill into the Canal, without this equipment to hand, much of the flora and fauna within the vicinity of the spill would be harmed or killed. In addition there would be a costly and lengthy clean-up operation which would have been avoided if the equipment was onsite to stop the spread of the spillage.

Where other bankside facilities are envisaged, it is essential that their effluent is directed to the sewerage system wherever possible. However where this can not be achieved as a result of locational difficulties, the effluent should be discharged into properly sited septic tank.

Finally, when fishing rights for the Canal are licensed, it would be useful if notices were put up on notice boards alerting anglers to the consequences posed by irresponsible actions auch as hazards to wild fowl posed by discarded fishing line and hooks. There may also be potential to develop a leaflet highlighting a code of practice for anglers which could be issued with fishing permits.

5.7 Archaeology

Obtaining detail on the whereabouts of archaeological finds in close proximity to the route of the Wilts & Berks Canal will be of particular significance during its restoration. New route options, access points from road and alongside the Canal, construction compounds and the route itself may all be subject to constraints if they are located within the confines of sites of archaeological importance or interest. It is therefore imperative that this early stage of the restoration planning process, archaeological considerations are assessed and interruption with known sites of archaeological importance is planned out of the restoration wherever possible.

Legislation covering archaeological and cultural heritage is embodied in a number of different Acts and government guidance. The Ancient Monuments and Archaeological Areas Act 1979 and The Town and Country Planning Act 1990 are the main elements of primary legislation which afford protection to archaeological and cultural assets. Under the former, certain sites identified as being of national importance are given protection, and are referred to as Scheduled Ancient Monuments (SAMs). Any works to or within a SAM, or even works which affect the setting of an SAM are governed by a consenting system operated by English Heritage. Under the latter Act, local authorities have the ability to protect areas which are of archaeological interest through the invocation of planning conditions on development. This will usually entail a commitment on the behalf of the developer to undertake field investigations and report on the findings prior to any development taking place. The powers under both these Acts have the potential to affect the planning and development of the restoration of the old Canal alignment, but perhaps more significantly, the new development associated with it such as new route options and feeder lakes.

The objective of this part of the study has been to collect and present existing data relating to the historical route alignment of the Canal as well as the most promising new route options.

5.7.1 Methods

A desk based study of the entire Canal route, including the most favoured route options, has been undertaken. The main reference for this has been the Sites and Monuments Record (SMR) held by Wiltshire and Oxfordshire County Councils.

For each reach of the Canal, a corridor width of around 100m was viewed, and a number of separate items were noted, these are included in **Appendix M**.

There are a number of limitations with the Sites and Monuments Record. Whilst the Oxfordshire SMR includes listed buildings and industrial archaeology (evidenced by the references to Canal structures), it does not include crop markings interpreted from aerial photography although we understand that this information is separately available. Similarly, with the Wiltshire SMR, crop markings were included, but no industrial archaeology or listed buildings were noted. It was decided for the purposes of the Feasibility Study to include only the industrial archaeology noted on the SMR, bearing in mind that the vast majority of the Canal route passes through rural areas. It should also be noted that whilst a 'Find' may be noted at a specific location, it does not necessarily follow that all archaeological interest in the area ceases where the Find's boundaries are marked. This will require consultation with the County Archaeologist over each reach of the Canal.

Until the restoration proposals for each reach of the Canal are more fully developed, it will not be possible to obtain comprehensive coverage showing areas of archaeological interest as, in order to do this, detail relating to the location of haul roads, compounds, feeder lakes etc. will be required. There should, therefore, be a separate and more detailed study undertaken for each reach, in consultation with the relevant County Archaeologist.

5.7.2 Results

Results from the SMR survey are presented in **Appendix M**, and individual Finds/ Scheduled Ancient Monuments have been added to the mapped sections within the main body of the report. In each case, where possible, information has been obtained on the exact location of each find, although care must be taken in interpreting this as many of the finds are linear features or enclosures, therefore where information relating to the geometry of the find is available it has been added to the mapped section.

The Find number referred to in the table is the same number as would appear in the particular SMR, and can therefore be used to refer back to the SMR if necessary.

It was considered beneficial to add 'proximity' information to the table. This should act as a guide only as all measurements are rough, but will provide a good approximation of the likelihood of the Canal works affecting the particular find.

5.7.3 Impacts

It is of primary importance that none of the proposed options affect existing Scheduled Ancient Monuments, and this has been successfully achieved along the historical alignment, and the new route options. However, there are four SAMs listed in the table which are passed closely by various route options, and these sections of Canal may require consenting by English Heritage if they are taken forward. They are as follows:

- Cricklade Town Wall (Saxon) to the east of the town
- West Leaze, a shrunken medieval village to the south of Swindon
- A complex of enclosures and field markings to the south west of Caldecott
- The Ock bridge and site of a 14th.century hospital.

In addition to the SAMs, there are a number of Finds, and groups of Finds which may be affected by certain route options, as well as the restoration of the existing alignment. Where the route passes through or in close proximity to the Find area, close consultation must be established with the relevant County Archaeologist in order to both assess the importance of the area, and to devise appropriate mitigation measures where it is deemed necessary. It may be the case that certain Finds are not necessarily indicators of greater archaeological interest in the specific area, and hence mitigation may not be required. There are two main groups of Finds which are likely to be affected by certain options, they are as follows:

Route option A to the west of Cricklade: there are at least 7 finds which are either on, or in close proximity to this new route option, all of which relate to late medieval pottery fragments.

Route Option B to the south west of Melksham: there are a cluster of undated and unexplored ringditches and earthworks, which as a group may have significant value.

5.7.4 Mitigation and Enhancement

In order to avoid undue disturbance of archaeological remains, it will be necessary to ensure that those route options which lie on or in close proximity to archaeological finds are given careful consideration against other factors used to establish route option acceptability. In essence, wherever possible, these routes should be avoided. Where the existing alignment lies in close proximity to areas of archaeological interest, restoration proposals must take this into account, hence ensuring that access points, haul routes etc. are positioned well away from the area. Where destruction of the area is unavoidable, consultation with the County Archaeologist must take place in order to assess the requirement for survey work prior to the Canal restoration taking place.

As the restoration of each reach of the Canal is planned and programmed, negotiation with County Archaeologist, English Heritage (where a SAM is involved) must take place well in advance of works starting. Under the Planning legislation mentioned above, it is likely that the County Archaeologist will require a certain amount of survey work to take place, especially with the new route options. Procedures must also be set up which account for the discovery of 'unexpected finds'. This is where archaeological remains are uncovered during the construction process, and a set of predetermined procedures will ensure that finds are not unwittingly destroyed.

Finally, it should be appreciated that the restoration of the Canal to its original line will entail the refurbishment of many of the existing structures already listed as of archaeological importance to the region. Restoration will seek to enhance both the heritage and amenity value of these structures, as well as bring them back into productive use once more.

5.8 Noise

Noise associated with demolition and construction activities can cause significant disturbance to nearby residences, domestic livestock, and to local animal habitat, especially bird habitats which are used as secure, feeding or overwintering sites. In the longer term, although it is difficult to make firm predictions, the operation of the Canal is not expected to cause significant noise nuisance at any of the sites along the Canal route.

The types of operations which will give rise to noise generation are demolition, structural operations and general construction, however all operations have the potential to cause nuisance if they are located in close proximity to sensitive receptors such as homes, schools and offices. It is, therefore, of importance to identify where the main areas of sensitivity along the Canal alignment are located, and establish the types of operation which are likely to impact on those receptors at this early stage so that significant impacts can be mitigated against before the operations commence.

5.8.1 Regulation

Construction work on the Wilts & Berks Canal may be located in a variety of situations from predominantly rural and urban localities to city centres. The nature of the work can vary significantly, as with all construction activities, hence regulation to control the noise from construction activities requires some flexibility. The standard BS 5228 "Noise control on construction and open sites" attempts to do this. It comprises four parts; part 1 gives basic information and procedures; part 2 deals with demolition and road maintenance; part 3 applies to coal extraction by open cast methods; and part 4 deals with piling operations.

Part 1 contains a large data bank of noise levels created by various items of equipment and operations. The noise levels are given as sound power levels and the equivalent continuous sound pressure level, L_{Aeq}, at 10m from the noise source. The test results on which the data bank is based were obtained in the 1970's, since then manufacturers have produced significant reductions in equipment noise. It is preferable, therefore, to use manufacturers data when carrying out noise predictions.

The definition of acceptable noise levels is outside the scope of BS 5228 because the local authority has the power to fix limits under the Control of Pollution Act, 1974 (see below) and the Environmental Protection Act, 1990. In the absence of local authority guidance, the values given in advisory leaflet number 72, issued by the defunct Ministry of Public Buildings and Works, may be used. The recommendation is that for daytime working the noise level outside the nearest window of the receiver's dwelling should not exceed :

- 70dB(A) in rural, suburban and urban areas away from main roads and industrial noise

- 75dB(A) in urban areas near main roads and heavy industrial areas.

Prosecutions for creating noise are normally brought under the Environmental Protection Act 1990. No objective definition of a statutory nuisance is given in the Act and acceptable limits are not specified. In practice it is the duty of the Environmental Health Officer to decide whether or not a particular noise is a statutory nuisance.

Under the Control of Pollution Act 1974 Sections 60 & 61, certain types of construction activity are regulated through a consenting arrangement. Contractors are obliged to apply to the local authority for a 'Section 61 Consent'. In doing so the contractor makes available a range of details on the types of operations, plant utilised, manufacturer's technical information on noise and vibration emissions and mitigation proposals. If the Consent is forthcoming, the contractor and the local authority have a legally binding agreement on the noise and vibration emission levels from the site.

5.8.2 Impact Identification

This section briefly outlines construction activities which are likely to cause significant nuisance from noise emissions. It is not possible predict with any degree of certainty the noise levels which will be generated as these are dependent on many factors, such as the type and condition of the plant used, the levels of maintenance, and the methods of operation proposed, which can not be ascertained at this time. In addition, it is also not possible to determine the duration of each stage of construction, as this will depend upon a number of factors such as whether the contract is being undertaken by volunteers or engineering contractors.

In general, construction noise will be confined to specific sites along the proposed route alignment. Anticipated construction noise impacts are discussed under the following operations:

5.8.2.1 Demolition

It is difficult to determine the absolute noise levels for demolition, and so make generalisations, because methods used tend to vary from site to site. Nevertheless, noise levels from demolition are generally only marginally louder than those from construction activities, but shorter in duration. However, as demolition is only likely to take place in centres of population, there is a high potential for the activities to cause nuisance, even though the duration of demolition is expected to be short in any one area. So far, only a few locations where the demolition of structures is required have been established (e.g. at East Challow) however there may be further sites as the project progresses.

5.8.2.2 Structures

Piling operations are potentially the main source of noise during construction. The most prominent impacts are anticipated to arise from the construction of retaining walls, wharf fronts and mooring facilities. Such facilities are most likely to be placed in or near to centres of population. As yet the locations for these types of facility have not been determined, however locations with the most potential are likely to be some or all of the following: Abingdon, Grove/Wantage, Swindon, Cricklade, Wootton Bassett, Calne, Melksham and either Semington or Seend Cleeve.

In the "worst case", that of sheet piling, daytime noise levels may fall outside guidance levels outlined earlier, but the noise impact can be lowered by using alternative piling methods, i.e. bored piling for the construction of retaining walls. In general, however, noise impacts at the receptors within a close proximity to the source of the emissions are likely to be significant.

Thrust boring and box jacking operations will only be used where it is necessary to provide new Canal access through structures which have either been built over the Canal, or where the original crossing structure no longer exists. Both techniques are generally utilised where the structure to be crossed lies on an embankment. The noise from these activities can be significant, although, once again, generally short term in duration and dependent on the proximity of sensitive receptors . Predictions for noise attributable to these operations can be prepared in advance once the exact location of the activity is known, and the type of mitigation measures which are to be employed.

Areas where this type on construction can be used are outlined in **Table 5.6**.

Table 5.6 Box Jacking Locations

Location	NGR	Structure	Name
S.W. of Abingdon	475958	Trunk Road	A34 (T)
N.E. of Uffington	298903	Railway Line	Intercity
N.E. of Uffington	292900	Railway Line	Intercity
W. of Uffington	282893	Railway Line	Intercity
S.W. of Shrivenham	220875	Railway Line	Intercity
S.E. of Swindon	192814	Trunk Road	A419 (T)
S.W. of Swindon	121823	Motorway	M4

There may be other crossings where this technique could be used, such as culverting streams and rivers under the Canal, and these will become apparent as the project progresses. One important aspect regarding each of the crossings above is that they are all relatively remote (> 100m) from any centre of population, hence significance of the noise from these particular crossings may be slight.

5.8.2.3 General Construction and Excavation

General construction activities will include establishment of compounds, construction of haul roads, bulk excavation, dredging, haulage of materials and construction/ restoration of Canal structures such as locks.

In general, construction sites will only have significant noise impacts on residential or commercial areas where noise levels reach or exceed $75dB(A)L_{Aeq,10hr}$, at the receptor. Where this is the case, impacts are generally of a temporary nature. However, there are exceptions where the duration of the construction activities and/or the close proximity to sensitive buildings and residential premises are unavoidable. Areas which will be particularly sensitive to general construction activities, based upon their proximity to the construction activity, are listed in **Appendix O**.

5.8.3 Mitigation of Construction Noise

There are a number of established procedures and techniques that can effectively reduce the level of noise to which residents of surrounding neighbourhoods will be exposed. Noise impacts may be largely avoided by prior planning, following a detailed study of noise impacts that includes the establishment of baseline levels.

Additional consideration should be given to the different statutory requirements of local authorities, concerning noise levels and working methods.

For each stage of the restoration programme the contractor should seek a consent from the relevant local authority under the Control of Pollution Act 1974 Section 61 on noise limits for the proposed construction works.

Details of construction activities, prediction methods and noise levels should be discussed with the local authority both prior to construction work and throughout the construction period. Since detailed construction programmes are only likely to be available a short time in advance of work starting on site, prediction, evaluation and assessment of noise as well as discussion between the contractor and the relevant local authority should, by necessity, be a continuous activity throughout the construction period.

Where construction noise is assessed as having a potential impact on residents or the environment, the Contractor should aim to achieve compliance set out within the relevant legislation and standards. Measures to be considered should be consistent with the recommendations of BS5228 and include the following:

- Hours of work should be agreed with the local authority (e.g. 0800 to 1730) with limitations on weekend working.

- Careful selection of plant and construction methods. Only plant conforming with relevant national or international standards, directives and recommendations on noise and vibration emissions should be used.

- Design and use of site hoarding and screens, where practicable and necessary, to provide acoustic screening at the earliest opportunity. For example, noise from a hammer-driven piling operation can be limited by enclosing the hammer head in an acoustic screen, which will reduce noise levels by 10dB(A), i.e. sheet piling noise impacts are expected to drop from 75dB(A) at 110m to 75dB(A) at 26m. Where practicable, doors and gates should not be located opposite occupied noise-sensitive buildings.

- Use of alternative kinds of screening, such as storage piles (spoil or construction materials)

- Strategic location of temporary site compounds, buildings (such as offices and stores) and haul roads to avoid sensitive locations. Choice of routes and programming for the transport of construction materials, spoil and personnel. Construction vehicle routing should take account of the need to reduce noise

- All plant items should be properly maintained, provided with effective silencers and operated in such a manner as to avoid causing any excessive noise or exhaust emission. All items of plant operating on the site in intermittent use should be shut down in the intervening periods between use. All stationary plant should be sited within the defined construction site so as not to be a nuisance to residents and, where necessary, screening should be provided.

- Monitoring of noise and vibration levels at selected sensitive sites should be undertaken on a regular basis.

- Where excavation takes place adjacent to residential or other types of units, consideration should be paid to the possibility of financial claims for compensation from cracking, settlement or other structural defects arising as a direct result of the works. Where these locations are identified it is recommended that a photographic survey be carried out on a "before and after" basis.

- Where noise could significantly affect residential properties the possible need to offer financial compensation or short term alternative accommodation should be borne in mind.

5.9 Waste Disposal

5.9.1 Introduction

This section of the environmental appraisal explores the type, quantity and disposal options for wastes generated during the restoration/construction and operation of the Canal. The following issues will be identified and developed in light of current knowledge of the Canal restoration scheme:

- the type of waste generated and at what stage
- the regulatory framework
- material excavated from the Canal route
- material dredged from the channel
- vegetation clearance
- construction waste
- disposal costs, and
- the requirement for further studies.

Table 5. 7 below identifies the broad types of wastes that are likely to arise during the construction and operation of the Canal. Each of these types of waste differ in composition and therefore have different options for disposal. The composition and disposal options for each waste type are considered further below:

Table 5. 7 Materials Generation

Source	Waste type	Phase of Waste Generation	
		Construction	Operation
Material excavated from Canal route	excavation spoil	✓	X
Material dredged to form / maintain channel	dredgings	✓	✓
Vegetation clearance	green waste	✓	✓
Construction activities	general wastes	✓	X

5.9.2 Definitions and Regulations

The regulations governing waste management are specific to the type of waste concerned. Definitions for some key types of wastes are given below.

5.9.2.1 Inactive Waste

This covers materials which do not undergo significant physical, chemical or biological reactions or cause environmental pollution when deposited at a landfill under normal conditions e.g., masonry and brick rubble, or uncontaminated soils in their natural state. Inactive waste currently attracts Landfill Tax at £2 per tonne. Inactive waste includes soils and rocks, ceramics, concrete, minerals, furnace slags, and ash.

5.9.2.2 Active Waste

Active waste includes acids, pesticides, fly ash, wood preservatives, oily sludges, batteries, waste oils, asbestos, timber, and plastics. Active waste attracts Landfill Tax at £7 per tonne.

5.9.2.3 Difficult Waste

Generally this term is applied to describe wastes which could in certain circumstances be harmful to human health or the environment in the short of long term due to their chemical or biological properties, for example, dry cell batteries and mineral oils. This term is also applied to wastes whose physical properties present handling problems at the point of disposal, for example, dredgings that have not been dewatered.

5.9.2.4 Special Waste

The definition of special waste is waste that is deemed to be *dangerous to life*. They may be classified as special waste as they are for example: corrosive, reactive, explosive, oxidising, carcinogenic or flammable. Some of the more common special wastes include: acids, alkaline solutions, industrial solvents, oily sludges, and waste oils. The criteria to be used to determine whether a waste is special waste is laid down in the Special Waste Regulations 1996 and the technical guidance given in DoE Circular 6/96.

5.9.2.5 Summary of Key Legislation

The following legislation is particularly relevant with regard to the management of wastes on site:

- Environmental Protection Act 1990
- Environmental Protection (Duty of Care) Regulations 1991
- Special Waste Regulations 1996
- Landfill Tax (Qualifying Material) Order 1996
- Waste Management Licensing Regulations 1994.

5.9.3 Material Excavated from the Canal Route

5.9.3.1 Introduction - quantity and composition

The material excavated to form the route of the Canal will be excavated either from natural undisturbed ground (where the Canal runs along a new route) or from made ground infill (where the Canal runs along the existing route). A preliminary assessment of the likely quantities of these two types of material is presented below in **Table 5. 8**; the assumptions on which these figures are based are presented in **Appendix N**.

Table 5. 8 Quantities of Excavated Materials

Type of material	**Quantity arising (m^3)**
Material excavated from natural ground	330,000
Material excavated from made ground / infill	648,000

At this feasibility stage, baseline surveys have not been carried out to provide detailed information on the likely composition of the material that will be excavated to form the channel. For this reason, the following assumptions have been made:

95% of the excavated material from natural ground is uncontaminated and therefore inactive

75% of the excavated material from made ground / infill is uncontaminated and therefore inactive.

- *Excavation from natural ground*

Uncontaminated natural ground will consist predominantly of clays (see **Drawing No. DBKEP/004/01**).

Although there are currently no data available on any material that falls under the category of contaminated natural ground at this feasibility stage, it is possible that such a material type may arise in excavating the channel. Investigative surveys along the route should be carried out in order to identify areas of contaminated natural ground.

- *Excavation from made ground / infill*

This material will be found where the old Canal channel has been infilled, either purposely or naturally. The composition of this material is likely to be highly variable along the route, varying from inactive wastes (such as soils) through to contaminated material that has been tipped in the channel over the years.

The Environment Agency have been consulted to find out whether they have any records of closed landfills along the old route. Responses will be incorporated into the final draft of this report.

There is some anecdotal evidence regarding the composition of material used to infill the Canal. This information is given below:

- The tunnel at Calne may have been infilled with waste from the nearby meat processing factory.

- The channel may have been 'used as a rubbish tip' near Broadleaze Farm (098923) according to Dalby (1986).

- The channel from Cricklade to Moreton may now be infilled with ash produced from the now demolished Moredon Power Station, according to Dalby (1986).

- Option E around Swindon, through Bridgemead, consists of old railway sidings.

- Option F to the north of Swindon takes the Canal route through Shaw Tip, which is currently undergoing restoration to a forest park. This landfill was licensed to receive household wastes. However, as the channel will be raised through this area using excess spoil generated elsewhere along the route, it is unlikely that the landfill will have to be disturbed.

- It is understood that there is a brickwork spoil heap located at Green Hill, situated to the east of Coate Water.

In addition, as suggested in the available literature (Dalby, 1986), it is likely that adjoining land users have used the old Canal channel as a void in which to dump waste. As the length of the route passes through both agricultural land and urban land, it is difficult to make further comments regarding the likely composition of the infill.

5.9.3.2 Disposal options

Assumptions have been made as to the percentages of material that may be suitable for reuse, recycling or disposal. These assumptions are presented in **Appendix N**. In order to assess the disposal options for excavation spoil in more detail, investigative surveys will be required to provide information on its composition.

- *Inactive material*

Where suitable in engineering terms, this class of material may be reused in the scheme for landscaping, fill or to form banks. It is anticipated that 10% of the arisings which are inactive can be reused within the restoration, for example as fill material to form bridge abutments for roads that currently cross the Canal route at ground level. Opportunities to reuse this material outside of the scheme for construction offsite also exist, although it is not possible to explore these further at this stage.

The excess material (forming an estimated 733,500m^3) will be accepted at landfill for disposal as inactive waste and therefore will be subject to the lower rate of landfill tax (currently £2 per tonne) and a disposal charge of around £5 per tonne. However, this figure should be taken as indicative and highly subject to variation, as it will depend significantly on the availability and proximity of appropriate landfill sites.

- *Contaminated material*

The options for reuse of this material will depend on the level of contamination present. 'Interim guidance on the disposal of contaminated soils' prepared by the Environment Agency (1997) and identifies that a hazard assessment and risk assessment should be carried out prior to examining the disposal options for this type of material.

The material will not be accepted for disposal at a landfill site as inactive waste, and will therefore be liable to the higher rate of landfill tax (currently £7 per tonne) and a higher cost of disposal than that of inactive wastes.

5.9.4 Material Dredged from the Canal

5.9.4.1 Introduction

This material will be generated both during the construction of the Canal channel and during routine maintenance to keep the channel navigable.

5.9.4.2 Construction - quantity and composition

At this feasibility stage, baseline surveys of the composition of dredgings have not been carried out. Therefore, the options for management and disposal of this material are identified in outline so that they may be taken forward in conjunction with sampling and testing at a later stage for each reach of the Canal that is restored.

5.9.4.3 Operation - quantity and composition

The dredging strategy for maintenance of the Canal (in terms of its frequency and depth) will be a function of the rate of accumulation of silts in the channel (amongst other things), and will determine the quantity of dredgings arising during the operation phase. The water source for the Canal (considered in detail in Chapter 4, and particularly in Section 4.8), and number of boat movements may have implications both for the rate of accumulation of silts building up in the channel and their composition. For example, the use of stormwater to supply a section of the Canal may result in the silts being slightly contaminated to such an extent that this limits the disposal options of any dredged material arising from that section.

5.9.4.4 Options for disposal of dredgings arising from construction and operation of Canal

The quality of the silt is a key factor in determining what the dredged material can be used for and what the impact upon water quality might be during the actual dredging operation. In order to evaluate the real feasibility of alternative uses, a comprehensive testing programme is required. The testing programme would conform to the British Waterways Classification System for Sediments which takes into account the Department of the Environment Transport and the Regions' Code of Practice for Agricultural Use of Sewage Sludge; the ICRCL's threshold levels for land reclamation for use as open space and playing fields and areas not used for growth of food stuffs; and Kelly/Greater London Council Waste Disposal Authority guidelines. Thus the material to be dredged would need to be tested for the contaminants listed in **Table 5.9** below:

Table 5.9 Potential Contaminants

pH	Cyclohexane extract	Silver
Antimony	Ferricyanide	Sulphate
Arsenic	Lead	Sulphide
Barium	Manganese	Thiocyanate
Beryllium	Magnesium	Tin
Boron	Mercury	Thallium
Cadmium	Moybdenum	Toluene extract
Chromium	Nickel	Vandadium
Coal Tar	Organic Matter	Zinc
Cobalt	PAH	
Copper	Phenol	
Cyanide	Selenium	

In addition a particle size analysis would need to be carried out in order to determine the structural character of the material.

Following baseline surveys, consultation would need to be carried out to establish what would be acceptable to the statutory authorities. Consultation would also be carried out with interested parties, including District Councils, Oxfordshire County Council, and Wiltshire County Council and local landowners to establish the "potential local markets" for the dredged material and the level of demand for material.

- *Beneficial reuse of dredgings in accordance with the Waste Management Licensing Regulations (1994 and subsequent amendments)*

An exemption can be obtained from waste management licensing regulations for the following activities concerning waste arising from dredging inland waters, and from clearing plant matter from inland waters. (For more information on the latter waste, see Clause 5.9.5).

Paragraph 7 Spread to land for agricultural / ecological improvement
No more than 5,000 tonnes of waste per hectare can be spread on the land in any period of 12 months. Results in benefit to agriculture or ecological improvement. Inform waste regulation authority in advance of the spreading.

Paragraph 9 Spread to land that requires reclamation or improvement to bring it back to beneficial use
The land should be incapable of beneficial use without treatment. The spreading should be carried out in accordance with a planning permission for the reclamation or improvement of the land, and should result in benefit to agriculture or ecological improvement. No more than 20,000m^3 of waste should be spread per hectare.

Paragraph 25 Deposition along the bank or towpath of the waters where the dredging or clearing takes place
The waste may be deposited along the bank or towpath of any inland waters so as to result in benefit to agriculture or ecological improvement. The total amount deposited each day must not exceed 50 tonnes for each metre of the bank or towpath.

- *Disposal to landfill as solid waste*

For disposal as a solid waste it will be necessary to dewater the silt before disposal. Where silt has to be transported to its point of disposal, transport costs decrease in proportion to the degree of dewatering achieved and a balance must be struck between the treatment (dewatering) cost and the transport cost. Dewatering is most cost effectively carried out as close as possible to the dredging area. Dewatering can be carried out using a variety of methods, including settlement lagoons, and mechanical methods like belt presses. The establishment of dewatering plant usually requires a waste management licence unless an exemption can be obtained by virtue of disposal for agricultural or ecological benefit.

- *Disposal to landfill as liquid waste (or difficult waste)*

A few landfill sites are licensed to receive Canal dredgings that are classed as liquid wastes (i.e. not dewatered). Although it may prove worthwhile to investigate this option further, it is usually an expensive disposal option as specialised equipment is needed to pump the dredgings ashore, and the costs of road haulage are significantly more than that of dewatered dredgings.

5.9.5 Green Waste

5.9.5.1 Introduction - quantities and composition

Green waste will arise during construction in large quantities and during ongoing maintenance in smaller quantities. It may comprise a mixture of the following types of material:

- material with a high lining content (e.g. trees and shrubs) arising from vegetation clearance

- material which will degrade more readily (e.g. aquatic plants) arising from clearance of plant matter from the Canal.

As aquatic plant matter generally degrades more rapidly than waste arising from vegetation clearance on land, it may be appropriate to segregate the two types of waste. It will be important to control the length of time such wastes should be kept on site before they will start decomposing to form odours and leachate. The Environment Agency is likely to be concerned about the potential impact on the Canal's water quality of storing such materials alongside the banks for extended periods of time.

5.9.5.2 Disposal options

Cleared vegetation should be stored separately from other wastes so that its options for reuse are not inhibited by cross contamination of wastes.

- *Beneficial reuse*

The Waste Management Licensing Regulations (1994 & amendments) cover the beneficial reuse of dredged plant matter. The relevant paragraphs were discussed in Sub clause 5.9.4.4 above, and so will not be discussed further here.

- *Composting*

As the material is organic, composting may be a suitable disposal option, depending on the distance the material will have to be transported. Once it is known what quantity of green waste will be generated, the local district council recycling officers should be consulted to explore potential composting operations in the locality.

- *Disposal to landfill*

If there are no suitable composting operations nearby that are able to receive this waste, it may have to be sent for disposal to a landfill licensed to receive putrescible waste. It will be subject to the higher (£7 per tonne) landfill tax.

In addition, the strategy for the disposal of green waste may be affected by the proposed EC Landfill Directive. At this stage it is thought that the adoption of this directive as it stands could result in a significant reduction of the landfilling of green waste. Therefore, this may have the effect of increasing facilities for recycling such waste through processes like composting or anaerobic digestion. This example merely serves to emphasise the importance of taking into account changing legislation throughout the course of this extended restoration project.

5.9.6 Material Arising from Construction

A variety of other wastes will be generated during the Canal restoration works including, for example, metals, packaging, oils and timber. Their quantities, relative to that generated of excavation spoil and dredgings, are insignificant. However, such wastes should not be ignored. They should be segregated at source and reused or recycled wherever possible to minimise the amount requiring final disposal to landfill and therefore to minimise costs of disposal and costs of landfill tax. Reference should be made to the work carried out by the Construction Industry Research and Information Association in dealing with this waste stream (e.g. CIRIA, 1997).

5.9.7 Costs of Disposal

A preliminary assessment of the likely costs of disposal of excavation spoil and dredgings arising from the works has been carried out and has been estimated to be £12,047,895 based on the assumptions and calculations presented in **Appendix N**. Currently, the rate of landfill tax is set at £2 and £7 (for inactive and active waste respectively). It is widely believed that these levels will rise in the future, most likely before work begins on the Canal restoration. This analysis is carried out only for the disposal of excavation spoil and dredgings arising from the works, as these will form the greatest component of the costs of waste disposal, and are easier to make assumptions about at this stage. A figure of £10 per tonne is taken as an average to represent the costs of disposal. The relative costs of different waste management options should be studied further.

5.10 Air Quality

This section describes the effects of the Canal restoration on local air quality. The two main sources of emissions to air are likely to be from construction vehicles and plant, and from the generation of dust. It is therefore, during the construction stages that impacts on local air quality are considered most significant. Operational activities once the Canal is complete are unlikely to have a significant deleterious effect.

Reduced local air quality, brought about by construction activity, can be a cause of significant nuisance to nearby residences, however with careful planning, the generation of emissions can be severely limited by using relatively simple mitigation measures. In the following section, the regulatory framework for controlling air quality, the types of generic impacts which can be predicted, and suitable mitigation measures are presented, culminating in a summary which highlights the work necessary to ensure that these issues are taken full account of in the restoration planning process.

5.10.1 Regulation

The main pieces of legislation dealing with the types of air pollution anticipated during the restoration of the Wilts & Berks Canal include:

5.10.1.1 The Statutory Nuisance provisions in Part III of the Environmental Protection Act 1990

In the event that atmospheric emissions from premises which are neither subject to Integrated Pollution Control nor Local Authority Air Pollution Control regulations give rise to a statutory nuisance, then the provisions of Part III of the EPA 1990 are relevant. Section 79 of the EPA 1990 lists matters which constitute a statutory nuisance, including:

- any accumulation or deposit
- any dust, steam, smell or other effluvia arising on industrial, trade or business premises (which includes land).

For any of the above matters to constitute a statutory nuisance, it must be proved that they are "prejudicial to health or a nuisance". This definition is further defined by case law.

5.10.1.2 The Environment Act 1995

Part VI of the Environment Act 1995 addresses air quality and requires the Secretary of State for the Environment to publish a national air quality strategy. The Act also requires local authorities to conduct a review of their air quality and likely future air quality. Where such a review indicates that air quality objectives are not being met, the local authority must designate the area an Air Quality Management Area (AQMA). This requires the preparation of an Air Quality Action Plan as well as a strategic review of development, transport and pollution control policies.

5.10.2 Assessment of Construction Impacts

During the construction phase of the works there is potential to impact upon air quality by dust generated from construction activities and from vehicle emission from construction traffic. Potential sources are as follows:

5.10.2.1 Dust generation

In general, most construction related dust is generated by three mechanisms: pulverisation and abrasion of surface materials by mechanical force such as vehicle movements over loose surface materials, e.g. unpaved roadways; the action of turbulent currents on stockpiles or mounds; and the demolition of structures.

The potential for dust generation during construction depends upon the type of activity being carried out, the soil and sub-strata types, wind speed and the number of preceding activities.

The excavation of surface materials and their subsequent mounding for disposal or reuse has a large potential for dust generation. The dumping and placing of materials is a discontinuous batch process which will give rise to considerable but localised dust emission. In addition, excavation at contaminated sites during construction activities could cause the release of potentially hazardous contaminated dusts and/or gases, and the removal of some materials may liberate odours. The location of such sites would need to be determined by site survey.

The subsequent behaviour of dust particles in the atmosphere will largely be determined by the size of the particle and the prevailing meteorological conditions. Dust from demolition and construction is usually of a large particle size emitted from a relatively low elevation and is thus rapidly deposited. Under most weather conditions a large proportion of the dust will be deposited in close proximity to the source, however where sensitive receptors are located in close proximity (< 200m), there is considerable potential for nuisance to occur. The location of receptors in close proximity to the Canal restoration is presented in **Appendix O**. Even though dust impacts may be minimal, there are many instances where residents have made compensation claims to meet the cost of cleaning curtains and upholstery.

Smaller dust particles are of particular concern, particularly those of under 0.01mm in diameter, which are inhalable. Health problems associated with such particles, which have been termed "PM_{10s}", are matters of growing public concern, the adequacy of conventional dust suppression methods in controlling the release of such particles therefore deserves careful review.

5.10.2.2 Vehicle emissions

The primary pollutants produced by construction plant and vehicles which give rise to concern with regard to public health are carbon monoxide (CO), nitrogen dioxide (NO_2), and hydrocarbons (emissions of unburnt fuel).

The significance of these emissions from construction machinery and vehicles will depend upon several factors: the number of vehicles, background concentrations of airborne pollutants and proximity to particularly sensitive areas. As the greater part of the Canal route is located in rural areas, it is anticipated that the emissions from plant and machinery used on site will be dispersed into the surrounding atmosphere, hence any potential nuisance is widely scattered.

Where activity is taking place in close proximity to sensitive receptors (i.e. local residents, local employees, hospitals, schools, parks and gardens, play areas and old peoples homes), impacts from construction plant and vehicles may be discernible and cause a nuisance.

5.10.2.3 Proximity of sensitive receptors

As with the location of receptors sensitive to noise impacts, centres of population will be most sensitive to emissions. Providing a secondary tier of detail which actually pinpoints the location of all sensitive areas is not possible at this time for a number of reasons. Issues such as location of haul roads, compounds, storage mounds etc. need to be resolved before the significance of impacts on air quality can be assessed. It is also envisaged that in the planning process for each phase of the restoration, due regard will be taken of the issues highlighted here, and the mitigation measures outlined in the paragraph below. However, receptors sensitive to both noise and dust emissions who are within close proximity to known areas of working in the Canal corridor have been identified and are presented in **Appendix O**.

5.10.3 Mitigation

5.10.3.1 Dust emissions

Some of the best available techniques for controlling dust utilise water. Regular watering using mobile bowsers on exposed surfaces can reduce wind-blown dust emissions by up to 40% during dry, windy periods. Similarly, watering of unpaved haul roads on a regular basis can reduce emissions from multiple wheel action by up to 60%. The difficult operations to control are wholesale earth moving, involving excavation of material, transfer to dump trucks and subsequent deposition from the trucks. Here superficial watering would not be particularly effective, and comprehensive watering will be impractical owing to the large volume of water that would be required. In addition to the above, there will be certain reaches of the Canal where there is no access to any water resources, for instance where the Canal is infilled. In these locations it would be better to concentrate on the other mitigation measures. The range of mitigation measures which could be used to prevent dust emissions during the restoration of the Canal are highlighted below:

- The siting of stockpile areas and haulage roads should be planned so that wherever possible they avoid sensitive receptors. In addition, stockpiles should be carefully sited in order that use is made of manmade and natural shields such as fences, shrubs or other barriers.

- Where there is a significant requirement the disposal of large quantities of arisings offsite, haul routes should be designed to avoid sensitive areas wherever this is possible.

- Stockpiled material such as top soil should be kept watered frequently to reduce the rate of dust liberation in dry weather and/or windy weather. Where stockpiles are liable to remain in situ for a month or more, they should be sown with a fast growing grass variety in order to stabilise surface materials.

- Provision should be made at site exits for either wheel washing facilities or rumble grids which allow soil and dirt to drop from the lorry into a sunken pit. Vehicles leaving the site with a dusty cargo such as excavation arisings should be covered with a tarpaulin.

- Activities generating dust should be curtailed during periods of high wind speed particularly if the winds are in the direction of sensitive receptors.

- Regular cleaning patrols of the immediate site access roads should also be undertaken to reduce build-up of dusty material

- Drop heights for construction material during loading and unloading can be minimised, particularly in dry or windy conditions

- Engine exhausts, if directed at the ground, can liberate dust from the surface, and hence exhaust gases should be directed away from the ground.

5.10.3.2 Vehicle emissions

There are relatively few mitigation measures available to reduce the emissions from construction plant and machinery, and hence careful planning needs to be used to reduce both the amount of trips, as well as the distance travelled wherever this is possible. Other practical measures include:

- Regular checking and servicing of petrol and diesel engines used to power equipment and vehicles in order that construction-related plant and traffic emissions can be reduced.

- Use of alternative means of transport, such as rail and barge, for carrying spoil and construction material to reduce lorry traffic should be considered wherever this is practicable

- Ensuring that vehicle engines are never left running when they are not in use, and excessive revving is kept to a minimum.

- Speed limits on site roads should be kept to speeds which allow most efficient fuel consumption of the plant operated.

- Provide haul routes which are kept away from sensitive receptors wherever practicable.

5.11 Conclusions

The environmental study has focused on a wide range of environmental issues including land use, ecology & nature conservation, landscape, water quality, archaeology & cultural heritage, noise, air quality and waste disposal.

Overall, the proposed restoration of the Wilts and Berks offers considerable opportunity for environmental enhancement both in terms of the natural environment and benefits to local communities. The extent to which this environmental enhancement can be realised will depend upon features built into the detailed design and overall management of the Canal and associated recreational activities.

The restoration proposals raise a very large number of environmental issues, embracing a wide range of topics. The main disruption is likely to be during the construction phase but providing adequate mitigation and good construction practice is adopted the majority of negative impacts are likely to be reduced in magnitude and be temporary in nature. There is also scope for the majority of potentially negative impacts or conflicts which could arise during operation of the Canal to be overcome or minimised by good management and maintenance of the Canal. However, the issues which could arise need to be recognised and understood in order to minimise any undesirable effect.

The key features associated with each topic area are as follows:

The main land uses along the Canal corridor include agriculture, settlements, recreation & amenity and infrastructure. The majority of agricultural land is not of high quality and in a regional context its loss would probably not be significant. However, in addition to land purchase costs other costs may be incurred for compensation payments and undertaking mitigation measures.

The Canal passes through or close to a number of settlements of varying size and it is considered that there are potentially more positive impacts than negative impacts associated with the route running close to settlements particularly in the larger settlements such as Melksham, Wootton Bassett, Swindon, Cricklade, Wantage and Grove where the Canal could add a significant local recreational resource and provide deeper links into the countryside. Opportunities are presented along the length of the restored route for activities such as walking, cycling, fishing, boating and canoeing. There is also potential for aesthetic benefits particularly in Melksham and parts of Swindon. Evidence from other small restored sections (e.g. Calne and Wootton Bassett) has shown how restoration of the Canal can be successfully integrated into the amenity facilities of towns and villages. However, in Abingdon there is some conflict over the recreational benefit of the Canal through the Ock valley which already supports good passive recreational facilities. Disturbance from construction activities, particularly noise and dust, are likely to be more disturbing close to settlements and isolated properties. The only location where property would be directly affected is in East Challow where one property is built over the alignment.

In terms of ecology there are a wide range of habitat types along the proposed route including open standing water, swamp, woodland & scrub, tall herb and fern, arable, neutral grassland, running water and amenity grassland. Although the Canal does not intercept any formally designated nature conservation sites there are a large number of valuable sites close to the Canal alignment including Coate Water SSSI, Wootton Bassett Mud Springs SSSI and a large number of Alert Sites. Badgers, Great Crested Newts and bats which are all protected species are known to be present along the route. Care will need to be taken during the construction phase to ensure that the requirements of the Wildlife and Countryside Act 1981 (& amendments) and the Hedgerows Regulations 1997 are understood and adhered to. Although some changes in habitat type will occur there is potentially considerable scope to enhance the ecological habitats along and adjacent to the Canal and storage water reservoirs. The scope of enhancement will depend upon careful planning and integration of design measures, water quality, level of boating and recreational activity. The most sensitive points are potentially where it is proposed to route the Canal along short sections of the River Avon through Melksham, River Ray (sometimes referred to as the Elcombe Brook) through Swindon and River Ock through Abingdon. However, the most favoured options only affect the River Avon. The Environment Agency is opposed to Canalisation and there is concern about impacts on the river environment. More detailed work will be required to resolve conflicts in these areas.

For most of its length the Canal corridor runs through the Clay Vale Landscape Zone formed by the broad lowland of Kimmeridge and Gault clays. The route passes through a number of landscape designations including Areas of Local Landscape Importance (County/Borough importance), North Wessex Downs Area of Outstanding Natural Beauty (National Importance) and Landscape Enhancement areas (local/district importance). Where the Canal route will follow its original alignment there is likely to be little change in the overall impression of the landscape due to the preservation of original tree lines. The surrounding vegetation screens the Canal from medium and distant views. The greatest change is potentially where the Canal follows an entirely new alignment but again medium and distant views will be screened by surrounding hedges and trees. The aesthetic appearance of the restored Canal and associated structures, for example bridges, will be important to promote the enjoyment of Canal users. Where appropriate, it is recommended that softer more natural materials are used and that brick or brick facing could be used for bridge restoration. The local authorities along the route have a number of landscape policies which the aesthetic appearance of the Canal would need to comply with.

Although there is limited data currently available on the quality of water which may be supplied to the Canal, it is clear that all of the catchments considered suffer from excessive nutrient loading which is exacerbated at times of low flow. The main impacts which follow, therefore are directly related to nutrient enrichment of the Canal waters, with localised deoxygenation and, in the longer term, eutrophication. There are a number of mitigation measures which can be taken to substantially reduce the problems associated with nutrient enrichment, and they are best achieved prior to supply water entering the Canal system. Once the nutrient enriched water is in the Canal, it is less effectively removed and more costly to do so and combat the effects.

Once the potential water supplies to the Canal have been agreed, it will be important to establish background information on the nutrient input to the rivers and streams identified, as well as the actions that are being taken to reduce them. Thereafter it will be necessary to obtain or test water quality data for each supply (whether it is surface water, ground water or storm runoff), and establish the treatment options within the economic framework that has been established. Some of the mitigation measures highlighted in the report should be incorporated into restoration proposals within the planning stage so that they are accounted for in future development work.

The survey of the Oxfordshire and Wiltshire Sites and Monuments Records along the historical alignment of the Canal, as well as the most promising new route options, uncovered a number of archaeological records within close proximity to the Canal. Although there were four Scheduled Ancient Monuments identified within the survey, none of them are physically touched by the current planned alignments, although permission may need to be sought from English Heritage for the work to take place if it is deemed that the restoration will affect the setting of the SAM. Unavoidably, some of the Finds recorded on each SMR will be lost, however the importance of each Find needs to be established with the relevant county Archaeologist. It may be that survey work is required before restoration or development of new alignments is permitted to commence. There must be close consultation with the relevant authorities and interest groups prior to the commencement of the restoration or development of any individual reach of the Canal in order that a full examination of the possible impact of the restoration can be assessed, and mitigated against where practicable. Finally, it should be noted that this survey only accounts for the historical alignment and the most promising new route options. No research relating to access points, haul roads, construction compounds and associated Canal infrastructure has been undertaken and as the restoration of each reach is progressed, these areas must also be surveyed for possible archaeological interest.

Having identified the most sensitive receptors to noise generated by construction activities, and the types of activities which will give rise to significant noise emissions unless mitigated against, the next step in the planning process will be to undertake an empirical study in order to assess the scale of the impacts, for each phase of the restoration process. The first stage would be to carry out a baseline survey of background noise readings at each of the sensitive positions identified in section 5.7.2 or where this has not been possible (for instance locations of wharfs and moorings), when this information is made available. In addition, as the techniques of construction for each phase of the restoration are developed, it will be possible to predict the impact from construction activity on the receptor positions surveyed. Predictions will allow precision in identifying the significance of the noise and vibration impact on each of the sensitive areas, and mitigation measures can be designed to reduce these impacts wherever practicable.

The discussion concerning the disposal options for the waste materials arising from restoration of the Canal provides an initial indication of the opportunities for reusing the wastes. As the quantities of arisings of these waste materials are expected to be large, they represent a significant component of the total scheme cost. Initial estimated suggest disposal costs could be in the order of £12 million. In order to minimise waste disposal costs it will be important to develop disposal options further for each section of the Canal to be restored. This will require a thorough baseline survey of contamination to be undertaken along the route. Having obtained this data, the emphasis should be placed on identifying waste reuse and recycling options rather than identifying landfill disposal as the primary option. The relative costs of different waste management options should be studied further.

In the course of this study, some preliminary information has been obtained on the location of landfills in the vicinity of the proposed route of the Canal. However, further work will need to be carried out with regard to:

- the precise location of landfills in the area,
- the terms of their waste management licence (i.e. which wastes they are permitted to receive),
- their charges.

Prior to restoration works commencing, the following actions should be taken:

- establish dialogue with regulatory agencies to explore opportunities for reuse,
- conduct sampling/testing to establish baseline information,
- consult with local landowners and parties who may require materials.

The main impacts on air quality associated with the Canal restoration will be dust and vehicle emissions during the construction/restoration process. In this instance, until highly specific facts about the construction phase are known, it is particularly difficult to make any sort of accurate prediction regarding the location and scale of the impact on local air quality. It is, however, possible to assume that sensitive receptors will be in all centres of population that the Canal passes through or by. As it probably will not be possible to gain any further detailed information on construction activity in the near future, the safest course of action would be to devise an air quality plan which can be incorporated into subsequent tenders (for external contracts) and construction method statements for volunteer works. The air quality plan would provide generic mitigation measures which could be incorporated into any further construction work.

6. Use & Benefit Study

6.1 Market Setting & Prospects

6.1.1 Introduction

This chapter sets out the key trends in leisure and tourism that will affect the market within which the Wilts & Berks Canal will have to compete. The review includes the regional performance of the West Country in tourism and trends within day visitor markets.

6.1.2 Tourism

The tourist market can be segmented in a variety of ways, including by the type of visit (day/overnight), the purpose of trip, length of stay and mode of transport.

The day visitor market can involve those who are on a day trip from home but also those who have visitors (staying away from home) in their party. Whilst the overnight visitor market consists of those staying in commercial accommodation such as hotels, Bed & Breakfast, self-catering, caravan/camping, as well as those staying with a friend or relative (VFR).

6.1.2.1 Day Visitors

The 1996 Day Visits Survey revealed that 425 million leisure day trips (urban, rural and seaside) were made within or to the West Country Tourist Board region. These were estimated to be valued at £3,884 million (£9.14 per person).

From an analysis of the 1994 Day Visits Survey, it is estimated there are 158m informal leisure visits to canals and navigable rivers each year, many by residents who see the canal as an attractive, safe, traffic free environment. The day trip (from home) sector can make up anything from 40-80% of the market for visitor attractions/events. The importance of this market is based primarily upon the size of the resident population catchment.

There are no consistent national forecasts for the day trip market as a whole, but the general trends in car ownership/access, disposable income and leisure time all point to an increase.

6.1.2.2 Overnight Visits

The data on overnight visitor markets are derived from national surveys. At the regional level, the survey data are relatively reliable, however at county level the data are only used as a rough indicator of market size, trends and characteristics.

In 1995, the West Country Region received 17.42 million overnight visitors, of which 15.8 million (91%) were from the UK and 1.62 million (9%) were from overseas. Wiltshire received 1.34 million overnight visitors, representing about 8% of the total.

Domestic visitors to Wiltshire accounted for 82% (1.1 million) of all visitors and overseas visitors accounted for 18% (0.24 million).

In Wiltshire, the 1.34 million trips were valued at £127 million, with a tourism spend of £95 per trip, compared with an average spend in the region of £154 per trip. In terms of spend per night, the average figure for Wiltshire was £25.40.

For the West Country as a whole, accommodation used was as follows (Note: percentages add up to more than 100%, because more than one accommodation type can be used):

Serviced accommodation (hotel, guest house etc.)	24%
Unserviced accommodation (rented house, caravan, camping etc.)	22%
Home of friend/relative	37%
Other	23%

Holiday trips were the most popular reason for visits by both UK and overseas residents. However they were more important for UK residents (70% of trips compared with 52% for overseas visitors). Overseas residents were more likely to be on business trips or visiting friends and relatives than UK residents.

The domestic overnight market can be divided into those on a short-break of 1-3 nights and those on a longer trip of 4+ nights. The long holiday sector is the largest single domestic market (40 million trips) but has remained static since the 1980's and is not expected to increase. Key trends within this sector include the use of self catering rather than serviced accommodation, inland destinations as opposed to traditional coastal resorts, reduction in length of stay from two weeks to one week, increasing consumer expectations, and the taking of second and third holidays.

The short break sector has shown the most growth over the medium term and now accounts for one in four trips. The hire boat market has experienced a similar trend. Key features are that 66% of trips are taken in the periods January-May and October-December. The South East is the leading generator of short break takers, with commercial establishments being the main form of accommodation. There is a high proportion of AB socio-economic households and adults in the 45-65 age groups.

Those on holiday in the surrounding area (or passing through) are also an important market. The touring sector is comprised of people with the inclination to go to events and visit attractions, receptive to information and who are actively looking for things to do/places to go and have a higher level of spend than day visitors. They are generally better informed about attractions in the area and tend to be from the higher spending socio-economic groups. For Wiltshire, this sector will be drawn mainly from within the 60 minute drive-time zone ie. Avon, Somerset, Dorset, Berkshire, Oxfordshire and West London.

6.1.2.3 VFR Visitor Market

The VFR market is an important sector as it can generate a substantial number of trips. Of the 17 million trips made to the West Country in 1995, 19% were made to visit friends or relatives. The importance of this market is also illustrated by the fact that 37% of the visitors to the region stayed with friends and relatives, as opposed to only 35% using commercial forms of accommodation. The size of a facility's catchment population determines the likely importance of the VFR visitor market. Consequently, a site with a small catchment population, will not have as many VFR visitors as an area with a large catchment population base.

It is estimated that every head of population generates around one VFR visit to an area. However, it is also important to note that many VFR trips are for non-recreational purposes and will not involve a visit to an attraction. Overall the VFR sector is expected to increase at around the same rate as the day trip market, reflecting levels of economic activity and increasing levels of car ownership.

6.1.2.4 Group Excursions Market

This includes educational groups and club/society outings etc. The day trip excursion sector is of more importance than the overnight touring market, which is not generally regarded as a prime market and is not considered to be a growth sector, accounting for 3% of trips to the West Country in 1995.

6.1.3 Population Catchments

The population structure of the catchment has been analysed for 20 and 40-mile catchment zones around the Canal. The results are shown in **Table 6. 1** below.

Table 6. 1 Population Catchments

Age Group	20 - mile	40 - mile
Under 15	186,270	588,213
16 - 24	123,625	384,681
25 - 24	285,244	891,235
45 - 64	203,253	637,257
65+	144,633	442,293
Total	**943,025**	**2,943,679**

In relation to the 20-mile catchment, it is estimated that 88% of informal towpath visitors and 81% of angling visits are from within this zone. The 40-mile zone is more relevant to boat ownership; we estimate that 80% of boat owners live within 40 miles of where their boat is normally based.

6.2 Methodology

6.2.1 General Approach

The broad methodology used for assessing benefits arising from the scheme has been developed over the years by British Waterways. In 1996, the methodology was reviewed by Ecotec Research & Consulting Ltd (1996), who suggested a few amendments. It is this revised methodology that is followed in this assessment.

The methodology concentrates on estimating the leisure and tourism benefits arising from schemes. To this are added any further economic benefits that can be identified from other elements, such as (non-tourism) businesses locating in the area because of the presence of the restored Canal.

Broadly the method for estimating leisure and tourism benefits uses a multiplier approach. Outputs are initially expressed as Gross Visitor Spend per year arising from visits to the waterways, using annual visit data and information on spend per visit. Standard industry multipliers are then used to convert this gross spend to take account of:

- indirect and induced expenditure (whereby the gross spend is re-spent on other goods and services within the local economy and income levels rise within the economy due to the scheme). This increases the overall expenditure effect; and

- leakages of expenditure from the local economy. This reduces the overall expenditure effect.

In this case, three scenarios have been considered:

1. Baseline - the current situation with minimal recreation use.

2. Scenario 1, whereby the Canal is fully restored, but is not linked to the Cotswold Canal. In other words, it is assumed that the Cotswold Canals scheme has not been completed.

3. Scenario 2, with linkage through the North Wilts Canal to the restored Cotswold Canal.

The final outputs are expressed in terms of:

- gross spend by visitors to the area attracted by the restored canal;

- income retained in local economy (whereby leakages are excluded and account is taken of indirect and induced effects);

- full-time employment equivalents; and

- temporary construction employment arising from the restoration works.

6.2.2 Multipliers

The multipliers used in this study are based on a study of tourism multipliers in Scotland (Scottish Tourist Board, 1993). This is one of the most comprehensive studies of its type carried out in the UK. It is specifically concerned with tourism and considered the impacts in a range of different types of areas, ranging from urban centres to remote rural areas.

6.2.3 Analysis Assumptions

A number of overall points need to be considered in this analysis:

1. Assumptions. The basic data regarding visitor numbers and spend were not available for all activities. In particular there was a lack of local data on cyclists, anglers and informal visitors. Surrogate data were used if no local data were available. Key assumptions are discussed in the following sections, while more detailed explanation of the sources of surrogate data can be found in the tables contained in **Appendix P**, which set out how the benefits have been calculated for the base situation and the two restoration scenarios. Where possible assumptions have been cross-checked with other information sources. In general we have used data for equivalent BW waterways or from other tourist/day visit survey sources.

2. Displacement. In carrying out an analysis of this type, it is necessary to discount expenditure that would be made in the local area, whether or not the trip to the waterway had taken place. In this analysis, no displacement has been assumed for boating activities, since people would have to go outside the area to participate in equivalent boating activities. For angling, again zero displacement has been assumed. Without the navigable waterways, canal and river angling opportunities would be limited. Still waters in the area, such as lakes and gravel pits, would provide alternative fishing, but, in many cases, this would constitute a different type of market. High levels of displacement have been built in for cyclists and informal visitors, since alternative locations exist locally for these activities. Assumed displacement levels are based on information from British Waterways visitor surveys for canals and navigable rivers.

3. Temporary construction employment has been considered separately, using standard industry indicators.

6.2.4 Baseline

Tourism and recreation activity is limited along the line of the canal, therefore the baseline is virtually zero:

- Boating activity - No boating activity assumed, although there is a trip boat which operates from Wootton Bassett on Sundays between May & October.

- Canoeing/other unpowered boating- Assumed zero.

- Angling - Assumed zero.

- Cycling - Limited activity on bridleways, the current length estimated at about 4 km.

- Informal visitors - Limited activity on footpaths & bridleways; the current length is estimated at about 12 km.

6.2.5 Assumptions for Preferred Route

As mentioned earlier, two scenarios have been assumed:

1. the waterway is fully re-opened, including the North Wilts Canal, but without connection to the Cotswold Canal at Cricklade.

2. a link to the Cotswold Canal is developed.

In both cases it is assumed that the waterway is opened in a single stage, rather than through a phased re-opening. Also the usage projections are those for the mature waterway ie. they are assumed to be achieved about 5 years after re-opening, after a phased build-up. It might be expected that further growth in activity would take place after this period, provided current trends in the leisure and tourism industry continue.

Scenario 2, with the opening up of a new series of network routes, will obviously stimulate greater boating activity than Scenario 1. It might also be expected to give rise to a modest increase in other recreation activities, partly through increased publicity, but also through the creation of more extensive routes for activities such as long distance walking and cycling. These impacts have been taken into account in the analysis (see **Appendix P**).

6.3 Economic Evaluation

6.3.1 Boats on Passage

It is assumed that private & hire boats from adjacent waterways will immediately use the new link once it is completed. Current boat traffic on adjacent waterways is estimated at:

Thames -	Lechlade	6,000 movements/yr
	Abingdon	14,000 movements/yr
K&A -	Semington	3,500 movements/yr (up from 1,500 in 1989)
	Fobney	2,500 movements/yr

Normally we would estimate boat traffic levels on a re-opened waterway through running the Boat Traffic Model[11]. However this has not been done in this case, because of the:

[11] A mathematical model developed for British Waterways by Liverpool University.

1. Complexity of the network and route choice options;
2. Lack of sufficiently detailed data on EA boat mooring locations;
3. Lack of specific mooring locations identified for waterway-based boats.
4. Uncertainty of preferred overall route at this stage.

Instead the estimate has been based on parallels with traffic levels on other waterways/waterway systems, taking account of the volumes of traffic on the adjacent waterways, to give an indication of the level of transfer. In Scenario 1, it is assumed that traffic levels will reach 2,500 movements per year on the main line, with 1,000 movements per year on the North Wilts Canal. In Scenario 2, it is assumed that traffic levels will rise to 3,500 movements on the main line and 2,500 on the North Wilts Canal. (Note: These traffic levels relate to boats travelling to or crossing the waterway boundaries. Some movements will result from boats based on the Canal, while others are from visiting boats.)

The hire/private boat mix has been assumed at 40:60.

6.3.2 Private Boats: Waterway-based

Immediately after re-opening, it is assumed that no boats are based on the Canal. A gradual build up then occurs to the optimum level, reached after 5 years.

It is assumed that the growth in private boating will come from:

- a transfer of boats from other waterways (in the short-term);

- a long-term growth in national boating demand - which can only be accommodated by increasing supply.

National growth in inland boat ownership is forecast at 3% - 5% pa. General trends are favourable for growth in boating activity nationally, due to:

- a growing economy, with low bank base rates, which should benefit boating. Growth in the short-term has been hampered by the lack of the elusive "feel-good" factor, but recent windfalls from Building Societies has stimulated interest in further investment in boating;

- demographic changes, with a significant increase in the population aged 45 - 64, the main boat-owning group. In particular a growth in affluent active retired people (especially the early-retired) should boost boat ownership and participation, although concerns about long-term health care/pensions may reduce funds for leisure activities;

- spending on leisure is forecast to grow at a higher rate than consumer spending in general;

- an increasing demand for active leisure pursuits, associated with concerns about health and fitness

The forecast growth on adjacent BW waterways (Southern Region) is high, 5% pa in the medium term, due to the proximity to areas with high boat ownership potential, i.e. ABC1s concentrated in a few 'lifestyle' areas.

Demand potential will be high on the Wilts & Berks Canal since:

- it is a scenically attractive waterway, close to places of interest;
- it will give a range of route options, particularly if the Cotswold Canals scheme is implemented;
- a parallel high growth rate has been achieved on the adjacent Kennet & Avon Canal,
  - 1987 = 613 boats;
  - 1996 = 1,071 boats;
  - increase c8% pa.
- From an analysis of density of boat ownership by area (relating to BW/EA boats only), there is already high boat ownership per head of population in the east of the area (Berks/Oxon), but it is moderately low in the west (Swindon area). The population catchments for the 20 and 40-mile zones are 0.9 million and 2.9 million respectively.

The estimate of demand for privately-owned boats on the restored Canal is based on experience from the Kennet & Avon Canal. These boats will give rise to both long-distance and short-distance trips. The long-distance trips have been taken account of in the estimates of traffic arising from boats in passage. However it is assumed that all short-duration trips (4 days or less) will be entirely within the confines of the Canal. The volume of such trips has been estimated separately using data from a survey of BW boat owners.

6.3.3 Hire Boats

The market for boating holidays has been at best static since the early 1980s. On BW waterways numbers of boats licensed have been about 1,500 - 1,600 since the mid-1980s. On the Broads and Thames, boat numbers have actually declined:

- on the Broads, from 1,976 in 1984 to 1,616 in 1994; and
- on the Thames from 698 to 361 boats.

It has been suggested that the market still suffers from over-supply of boats, which is buoyed by the 'lifestyle' nature of many boat operators. However the 'Discover a Whole New World' and 'Drifters' campaigns on BW waterways have increased awareness and interest in canal boat holidays, as reflected in increased bookings and boat utilisation, over the past year or two. Improved marketing may lead to an increase in supply. However other factors still act against growth in the hire boat market, including:

- high perceived costs compared with competitors;

- the British weather, which increases the perceived risk of boating holidays; although this may change with long-term weather trends.

Overall therefore there would appear to be little growth potential in the industry at least in the short-term. However the opening-up of a new network linking the Thames and the Kennet & Avon, and possibly the Cotswold Canals, will be an undoubted attraction to operators, both new operators and existing operators locating from elsewhere. For example, on the Kennet & Avon Canal, where the number of boats based grew from 38 in 1988 to 57 boats in 1995 following full restoration.

There are two reasons why additional growth might be anticipated on the Wilts & Berks Canal:

- The proximity to markets concentrated in London and the South-east; 42% of the BW market is from this region.

- Scenery, places of interest & route choice.

The number of boats based on the Canal is derived from the density of boats on the K&A.

6.3.4 Trip Boats

There is potential, over and above the existing services noted before in 6.2.4, for trip boats in the vicinity of visitor attractions/honeypot sites, giving possible links with other attractions in the area. Possible locations include:

- Lacock
- near Bowood House
- Swindon
- Cricklade
- Wantage/Uffington.
- Chippenham
- Melksham
- Calne
- Wootton Bassett
- Abingdon

In the analysis, 5 such operations are assumed. This may well be a conservative estimate, since there are around 15 such craft on the Kennet & Avon. However many of these are low-key/low turnover operations.

6.3.5 Day Boats

This is a growing market, which could possibly be linked to canoe hire/cycle hire/hire boat operations. A potential of 1 to 2 operators in the area has been assumed.

6.3.6 Hotel Boats

The market for existing hotel boat operations in Britain is heavily orientated towards overseas visitors in the older age groups. Because of the proximity to Oxford and potential US interest associated with air bases etc., there may well be potential for such an operation.

6.3.7 Restaurant Boats

The urban market of Swindon is currently unserved by such an operation, so there is scope here for development. The Abingdon area is also a possibility. It is close to Oxford, but it would be in competition with Thames operations. Overall it is assumed that 2 such boats will be in operation. Assumed levels of occupancy and expenditure are incorporated in the projections.

6.3.8 Canoeing/Unpowered Boating

The total regular participation in canoeing is estimated at around 100,000 people per year in Britain. Canoeing is relatively inexpensive and easy to learn, but the demand is forecast to grow by around 3% p.a. to the end of the century (Leisure Consultants, 1989).

With regard to canoe hire, there is potential to establish facilities in association with day boat/cycle hire operations. Assumptions made in the projections are:

- boat utilisation levels are assumed split between 1-day and multi-day hires;
- day hire expenditure is estimated at an assumed day hire rate plus daily visitor spend for leisure day visits from the UK Day Visit Survey 1996;
- multi-day hire expenditure is based on 2-day hire charges plus 2-day tourist spend from the West Country Tourist Board sources.

For casual canoeing, the following were considered:

- canoe club activities;
- special events, e.g. the Devizes to Westminster race on the Kennet and Avon Canal;
- canoe touring.

The level of activity was assumed to be the same as the Kennet & Avon Canal, i.e. 700 visit/ km/ yr. concentrated at Clubs, with visitor expenditure derived from BW survey data.

6.3.9 Angling

It is difficult to determine trends in coarse angling over time, because of inconsistencies in survey methodologies and rod licence sales. Data from membership of the National Federation of Anglers show a reduction in the number of affiliated clubs and the number of individual members within clubs since 1975. This suggests there may have been a decline in angling participation over the same period, at least in terms of organised activity. Probably at best, the market is static. Trend data show that, since the 1970s, carp have increased in popularity, at the expense of perch and pike, especially amongst young anglers. This is reflected in the development of intensively-managed stillwater fisheries, often specialising in carp. This type of fishery has been a major growth area in recent years, with growth in this sector probably corresponding with a decline in canal fisheries. Canal fisheries are technically more difficult, particularly for novices.

Overall however the re-opened Wilts & Berks Canal will provide a new market for fishing. Assumption for predictions are:

- Kennet & Avon visit rate is 800 visits/km/yr, which is slightly less than the BW Southern Region average of 900 visits/km/yr.

BW expenditure data are used to estimate impacts.

6.3.10 Cycling

In recent years there has been a marked increase in cycling for recreational purposes. It is estimated that the percentage of people participating in recreational cycling rose from 0.8% in 1977 to 8.4% in 1987 (Countryside Commission, 1995). This trend is reflected in the growth of:

- cycle hire operations, with around 450 suppliers throughout the country, often linked to specific cycle trails. For example, the Camel Trail in Cornwall attracts 250,000 hires per annum;
- the number of (mainly) off-road cycle trails, such as the Sustrans network;
- organisations catering for cycle touring holidays (estimated at around 600).

The signs are that growth in cycling, and particularly recreational cycling in the countryside, is likely to continue, due to:

- concerns about health and fitness;
- "green" environmental values;

- increased off-road / quiet road cycling opportunities;
- increased interest by the Department of Transport in encouraging cycling as a "green" transport option;
- technical improvements in cycle design;
- the growth of activity holidays.

The Canal has potential to take advantage from these trends, due to the off-road nature of the waterway towpath, and its proximity to existing cycle routes, both on- and off-road. However, there are serious concerns over the use of a towpath by both pedestrians and cyclists, particularly where width is constrained.

With regard to cycle hire, there are opportunities for the establishment of such facilities in association with boat/canoe hire. However, bikes hired will not necessarily use the towpath. There is potential at crossing points for cycleways, where perhaps short stretches of towpath could be developed orientated towards the family market. Careful design and effective segregation will reduce conflict with other waterway users.

The extent of cycle touring and casual cycle use depends on lengths to be available for cycling. In making the estimates, we have assumed that cycleways will be provided to allow access to / from towns along the route. In other areas cycling will not be encouraged, but quiet parallel roads will be promoted instead. The development of cycling commuter routes in towns, such as Abingdon & Swindon will help further "green transport" policies.

Casual cycling has been assumed at the same level as on the Kennet & Avon. Density of cycling on the Kennet & Avon is 3,400 visits/km/yr, compared with 3,000 for the BW Southern Region as a whole.

6.3.11 Informal Visitors

6.3.11.1 Day trips

Data on trends in recreation use are difficult to interpret from the various national waterway usage surveys, due to the fact that visits vary from year to year, depending upon the prevailing Summer weather conditions. Overall though, there is felt to have been a growth in outdoor recreation activity in general since at least the 1960s. It has been estimated that day trips increased by 15% between 1981 and 1991 (English Tourist Board, 1991).

Nationally, visits to attractions (historic buildings, gardens, museums, art galleries, wildlife attractions etc.) increased by 10% (to 383 million visits) between 1990 and 1995 (Leisure Consultants, 1996). It is forecast that visits will continue to increase by 19% between 1995 and 2000 (an average of 3.5% growth per year) (ibid.). A number of factors support continued growth in visits to attractions, including:

- more flexibility in time use, from new working patterns, plus more thoughtful use of time;
- increasing car ownership;
- increasing concerns about quality of life, health etc.;
- an increase in 45 - 64 age groups.

On the other hand, growth will be tempered by factors such as:

- increasing congestion, particularly on roads
- further development of large shopping malls, open 7 days a week, together with family entertainment centres (to get around planning restrictions on purely retail developments)

The same factors will affect all informal outdoor recreation, so a similar level of growth might be anticipated. However informal recreation is very susceptible to weather conditions. Recreation activity is reduced during poor Summers and it can also be reduced during very hot Summers. Therefore a more variable pattern of growth can be anticipated.

There are opportunities in the area for visits in association with other local attractions. These include:

	Visits 1996
Bowood House and Gardens, Calne	155,000
Lacock Abbey, Chippenham	64,600
Corsham Court, Corsham, Wiltshire	10,000
Kelmscott Manor, Kelmscott, Lechlade	14,400
Avebury Manor gardens, Wilts.	16,000
Great Western Railway Museum, Swindon	27,700
Railway Village Museum, Swindon	24,000

Density of informal visits to the Kennet & Avon is 48,300 visits/km/yr, which is the same as the BW Southern Region average. This includes all informal visits, both day and holiday visits. The level of activity on the Wilts & Berks Canal has been forecast at a slightly lower level than this, because of the high level of visitors to the major tourist centre of Bath on the Kennet & Avon.

6.3.11.2 Holiday trips

For holiday trips (ie. trips involving a stay away from home), the volume of holidays in GB by GB residents fell slightly during the early 1990s, during the economic recession, but grew again between 1993 and 1995, with most gain being in the short-break sector (1 - 3 nights). This growth was fuelled by the weakness of Sterling plus the long, hot summer of 1995. It has been forecast that overall both long and short holidays will remain static at about the 1995 level to the year 2000. This is because consumers will return to overseas holidays as the economy continues to grow and consumer confidence increases.

There is also a specific growth area in domestic tourism is activity holidays. This is where the Canal has real potential, e.g. for long distance walking where the Canal towpath can be linked directly to established long distance towpaths or where short diversions can be encouraged.

6.3.12 Temporary Construction Employment

The total capital cost of the proposed Canal restoration works is £98.75 million. Assuming a multiplier of 1 man-year employment per £65,000 capital spend, total temporary construction employment would be 1,519 man-years. This multiplier is derived from a study by Ecotec (1996), and takes account of indirect and induced effects.

6.3.13 Impacts on Existing Users

Impacts on existing users will be limited as public access is currently restricted to a few areas.

6.3.14 Implications for Boat Traffic

Estimates for the re-opened Canal, with the link to the Cotswold Canals, are based on a background traffic level of 3,500 movements per year on the main line and 3,000 movements per year on the North Wilts Canal. Locally these traffic levels will be exceeded by short-duration traffic generated by boats based on the Canal, plus activity by trip boats, maintenance boats etc. The extent of this traffic is difficult to estimate, as it depends upon the location of mooring bases. However it indicates that boat traffic levels forecast from these estimates are likely to lie within the range of 3,000 to 7,000 movements per year. On BW waterways, traffic levels on intensively used waterways can reach levels of over 15,000 movements per year. 7,000 - 8,000 movements per year is an average traffic level. These forecasts suggest that traffic levels on the restored Wilts & Berks Canal will be slightly below the average for BW waterways as a whole.

6.3.15 Property Development

There will be opportunities for the development of property in direct association with the Canal in urban areas, especially at Swindon, Wootton Bassett and Melksham. A study carried out by Newcastle University (Willis and Garrod, 1993) suggests that canal-side properties can command a premium of around 19%, when developed in a pristine waterway environment. The effect is not just confined to those properties that are actually waterside. The study also showed that properties that are not actually beside the water, but are in a waterside development, generate premiums of around 8%.

6.3.16 Indirect Economic Impacts

The impacts so far considered, relate to leisure activities and the residential use of waterside land. Canals can also provide positive economic benefits through:

- Leisure, tourism and retail activities that do not directly relate to usage of the canal. Developments (eg. supermarkets; night clubs) may locate alongside the restored waterway that are not directly aimed at the leisure market that the canal provides. In most cases, such developments would occur in the area in any case, with the waterway providing a convenient and attractive location for the activity;

- other developments that may take advantage of the attractive location that the waterway offers - offices, business parks etc.;

- a general increase in economic activity in the area, stimulated by the publicity and ambience of the re-opened canal.

Because of the time horizons involved, it is difficult to make an assessment of the extent of these types of activity in the case of the Wilts & Berks Canal. The impacts are more likely to take place in urban areas, particularly on the North Wilts Canal at Swindon. However comparatively few areas alongside the Canal are zoned for retail/ office/industrial development. The Ecotec study, already mentioned, suggests that, for these activities, the benefits for developers in locating waterside mainly relate to the potential for leasing out or selling properties. There is evidence to show that the marketability of such developments is improved through a waterside location, enabling developers to obtain a quicker return on investment than would otherwise be the case.

In estimating the benefits arising from such activities, displacement is a major consideration, since the availability of waterside sites is only one factor amongst many that will influence the location of these types of business activity. Drawing upon the Ecotec study, it is possible to give indicative levels of investment and employment arising from these indirect effects. For example, if the restored canal resulted in the development of 100,000 sq. ft of office / retail, impacts would be:

- Capital investment — £18.0 million
- Temporary construction employment — 276 man-years
- Permanent employment — 450

Similarly, if leisure developments (such as pub / restaurants), not directly related to the canal market and totalling 18,000 sq. ft were to take place, impacts would be:

- Capital investment — £0.9 million
- Temporary construction employment — 12 man-years
- Permanent employment — 33

6.3.17 Other Economic Impacts

The restoration scheme may provide opportunities for land drainage enhancement in some areas, with the potential for raising land values.

There may also be potential for using the towpath as a communications channel, by laying ducts for fibre-optic cables. Such a scheme (Fibreway) is under way on the BW network.

6.4 Community & Social Benefits of Restoration

As well as providing economic benefits to the area through which it passes, the restored Wilts & Berks Canal will provide real benefits for the people who live and work in the area. Work carried out on behalf of British Waterways by Newcastle University (Willis and Garrod, 1990), using environmental economics techniques, found that informal visitors to canal towpaths experienced a real increase in welfare of £0.51 per visit (at 1989 prices). People visit canals for many activities, e.g. boating, fishing, walking, sightseeing, cycling, jogging, photography, even just feeding the ducks. Most of these are available free of charge, yet people get real value from their visits. Canals allow people to experience the past at first hand. Although the activities undertaken have changed, the way in which inland waterways operate remains much the same as it was during the Industrial Revolution, around 200 years ago. Canals form a unique living heritage, comprising a mix of historical, cultural, environmental and landscape elements, in and around which a wide range of recreational activities take place.

More than that, people place a value on the retention of canals whether or not they actually visit them. Canals are valued as part of our national heritage, and for their environmental and landscape attributes. People wish to ensure that they can be passed on intact to future generations. In 1994, further research by Newcastle University, also using environmental economics methods, placed a monetary value of around £150 million per year on peoples willingness to pay for the continued maintenance of Britain's canal network (British Waterways, 1994).

A range of specific benefits will arise from the restored Wilts & Berks Canal, which will have a positive impact upon local communities and inhabitants of the Canal corridor:

6.4.1 The ability to see boats moving on the water

A recent study by Bradford University (Nolan and Hopkinson, 1997) used environmental economics techniques to place a monetary value on the extent of visitors' enjoyment from watching boats passing along canals. The study found that a significant part of peoples' enjoyment arises from the presence of boats. From the perspective of the waterway user on the towpath, the presence of boats transforms them from being mere drainage channels into waterways with movement, interest and colour.

6.4.2 Education

The restored Canal will form a significant educational resource. It will provide active learning opportunities for many subjects within the National Curriculum, e.g. history, geography, biology, environmental studies etc. The production of support material, such as teachers' packs geared to the National Curriculum, can help teachers take advantage of the opportunities available and in the future there may be possibilities to access lottery funds for education-related schemes, through the proposed New Opportunities Fund.

6.4.3 Recreation opportunities close to home

Around 3 million people live within 40 miles of the Wilts & Berks Canal. Within 20 miles we estimate that there are almost 1 million people. The adverse environmental effects of road transport are becoming increasingly recognised, as reflected in the recent Royal Commission report on transport and the environment (Royal Commission, 1994). Recreational transport is a major contributing factor to atmospheric pollution, with leisure journeys, most of which are made by car (74%) now accounting for 40% of all distance travelled by people in the UK. The development of recreational facilities close to where people live, such as the Wilts & Berks Canal, will help reduce these adverse effects, and also help alleviate visitor pressures on sensitive recreational sites further afield.

6.4.4 Links

The linear nature of canals means that they can easily provide links between recreational sites and other tourist attractions, such as country parks, historic buildings etc. Development of the Wilts & Berks Canal corridor will enhance the potential of these other tourist sites as well.

6.4.5 Integration of recreation and environment

The restored Canal will bring together the community's needs for recreation with an opportunity to experience and understand the historic waterway environment, in a package that meets the aspirations of sustainability. Agenda 21, signed by most of the world's governments at the Earth Summit in Rio de Janeiro in 1992, provides a guide for national governments in the pursuit of sustainable development. The challenge of Agenda 21 is to "*balance the need for food and other raw materials, the demand for jobs and homes, the opportunities for recreation and the need to safeguard wildlife and landscape*" (HMSO, 1990). Canals projects, such as the restoration of the Wilts & Berks Canal, are wholly in tune with this objective. The project seeks to secure the future of the waterway heritage and environment, while making them accessible to people - both visitors and local communities. This linkage of heritage and environment with accessibility provides a basis to attract the resources to manage and sustain the Canal and to provide a viable future.

6.4.6 Health and fitness

The re-opened Canal will give opportunities for the promotion of health and fitness activities for local residents. Again lottery funds may become available for health & fitness-related schemes, through the proposed New Opportunities Fund.

6.4.7 Development of enhanced recreational facilities and infrastructure for local communities

The provision of visitor facilities will be of direct benefit to local communities as well. The development of car parks, towpath improvements, information provision, stages for disabled anglers etc. will improve accessibility and enjoyment of the Canal for local residents and visitors alike. In particular, the close-to-home recreational opportunities opened up by the canal will benefit people with impaired mobility - the elderly and disabled. Canal towpaths provide flat, easy walking surfaces, while boats specially designed to accommodate the disabled and elderly permit even greater interest to be generated. On the nearby Kennet & Avon, the Bruce Trust operates a boat specially adapted to meet the needs of the disabled, while some of the existing public trip boats have lifts to accommodate disabled passengers.

6.4.8 Events and festivals

The restored Canal will provide opportunities for the development of events and activities involving local people, targeting schools, young people, the elderly and other minority groups.

6.4.9 Community involvement

In practical terms, opportunities will become available for local people to become involved in voluntary activities associated with the Canal, through the Wilts & Berks Canal Trust. More than that, the Canal can provide a focus for the development of local strategies under Agenda 21. A recent study of urban parks (Greenhalgh and Worpole, 1995) suggested three areas where parks can contribute to the Local Agenda 21 process. Canals can provide a similar focus in:

1. the demonstration and practical development of practical applications in sustainability, particularly in urban areas;
2. providing a practical way of approaching the social issues Agenda 21 seeks to embrace, such as children's freedom and mobility, fitness and health and access to public places; and
3. allowing the development of more genuine and more sophisticated methods of consulting, involving and listening to people's ideas through new kinds of public participation in the management of the resource.

6.4.10 Third party involvement

The restored Canal will become a focus upon which other organisations can develop schemes of benefit to local communities, e.g. projects, such as angling competitions, for the rehabilitation of young offenders, in association with the police and probation service; environment and access projects, in association with local conservation groups; low cost activities for youth groups, such as canoeing and cycling.

6.4.11 Commuting

The towpath of the restored Canal will provide a traffic and pollution-free natural 'green corridor' link to and from towns along the route, particularly in the Swindon area, but also around Abingdon. This gives opportunities for traffic-free commuting by cycle or on foot.

6.4.12 Enhanced property values

The restored Canal will provide an environment that people will actually want to live close to. This is reflected in higher residential property values as shown by the Newcastle University research already mentioned. Canals provide peaceful, quiet havens, close to population centres, where people can escape from the hustle and bustle of the modern world and enjoy the natural environment and canal heritage.

6.4.13 A safe environment

Visitor safety is a prime concern in managing recreation resources. Education plays a vital role in safety by promoting familiarity and respect for canals and awareness of risks and how to minimise them. This new understanding, linked to an increase in usage of the waterways will help ensure that canals are a safer place for all age groups. A busy, well-used canal in the heart of the community is a much safer place than a neglected derelict waterway, shunned by local people. Specifically safety is enhanced through:

1. opportunities to cycle or walk away from public roads;
2. promotion of water safety through the information and interpretation elements of the project;
3. minimising risk through the design of scheme components, for example through the provision of gently shelving canal cross-sections;

    increased use of the canal resource. *"The key to reducing fear of crime is the presence of other people, lots of other people, doing many different things"* (Burgess, 1994).

6.4.14 Employment Training

The Canal restoration project will provide opportunities for employment training and skills development programmes, based on canal maintenance and improvement. This potential is on-going, after implementation of the scheme. For example, at any one time, there are over 600 people on Government training schemes on British Waterways canals and rivers throughout the U.K. There may also be a possibility of integrating elements of the Government's Welfare to Work initiative within the restoration project.

6.5 Conclusions

It is estimated that the restored Wilts & Berks Canal will generate substantial economic benefits for the area through which the Canal passes. The leisure and tourism activities that will take place on and around the Canal will attract visitors to the area and provide recreation opportunities locally for people who live in the vicinity. These benefits will be even greater if the Cotswold Canals are also restored. The benefits have been estimated using a multiplier approach and are expressed in the following terms:

- Gross expenditure in the locality by visitors on goods and services;
- Income retained within the local economy, taking account of indirect and induced effects, together with leakages from the economy;
- Permanent employment generated by this expenditure, expressed as full-time job equivalents (FTEs), taking account of indirect and induced employment;
- Temporary construction employment, expressed in man-years.

The benefits are summarised in **Table 6. 2** following

Table 6. 2 Summary of Economic Benefits

	Without Cotswold Canals restoration	**With Cotswold Canals restoration**
Gross visitor expenditure	£18 million	£20 million
Income retained	£ 7 million	£ 8 million
Permanent jobs created	730	790
Con struction employment	1,519 man-years	1,519 man-years

These estimates are of a similar order of magnitude to those forecast for the Cotswold Canals restoration scheme, where full restoration is estimated to give rise to 868 permanent jobs. The slightly higher figure for the Cotswold Canals might be expected, given the higher profile of recreation and tourism in the Cotswold area. In addition, the scheme will lead to an enhancement of residential property values for new housing alongside or close to the waterway. A 19% premium might be expected for waterside housing, while housing within the same development, but without a waterside frontage might experience an 8% increase in value.

Indirectly, the re-opening of the Canal will raise the profile of the area and be a factor in attracting non-leisure and tourism related developments along the Canal corridor. Because of the time horizons involved, together with the factor of additionality, it is difficult to assess the actual impacts that will arise in this way. However examples of the types of impact that might result are:

For 100,000 sq. ft of office/retail development:

- Capital investment £18.0 million
- Temporary construction employment 276 man-years
- Permanent employment 450

For 18,000 sq. ft of leisure developments, e.g. pub/restaurants, not directly related to the canal market:

- Capital investment £0.9 million
- Temporary construction employment 12 man-years
- Permanent employment 33

The income retained in the local economy (£8 million per year) can be compared with the capital cost of the restoration project (£100 million). In simple terms, this suggests the pay-back can be achieved in around 12 - 13 years. In reality however the pay-back period is likely to be less than this, since at least some of the capital involved will be raised outside the local area. For example, Heritage Lottery funding might meet up to 75% of the cost of a project. This means that 75% of the cost would be met nationally, with local sources only requiring to raise 25% of the capital. In this case the scheme would generate an inflow of capital to the area of £75 million (although this might be displaced from other projects in the area).

The restoration scheme will also generate the following social benefits for the locality:

- Opportunities for education initiatives;
- Recreation opportunities close to home for local residents;
- Links to other recreation resources in the area;
- The integration of recreation with the natural environment, providing a focus for activities under Agenda 21;
- Opportunities for health & fitness schemes, in association with local community health interests;
- The development of enhanced recreational facilities and infrastructure for disadvantaged groups, such as the disabled;
- A focus for special events and festivals;
- Opportunities for community involvement both in the restoration scheme and in the subsequent management of the restored waterway;

- Opportunities for involvement by third parties in special projects and initiatives;
- Off-road commuting opportunities by foot or cycle in the vicinity of towns along the route of the canal;
- Opportunities for employment training.

7. Utilities

7.1 Introduction

Requests for information about apparatus which would affect or be affected by the restoration proposals were made to the utilities undertakers for electricity, gas, water, telecoms and pipelines. Details of the undertakers contacted will be found in **Appendix B** at the back of this Report.

Information for the historic route and for the proposed route options was supplied by the undertakers.

The requests for information were not made under Section 79 of the New Roads and Street Works Act 1991 although the undertaker's reponses would have complied with this Act. In all cases where undertakers had apparatus that would be affected paper record plans were provided free of charge, as listed in **Appendix Q** at the back of this report. These records are of variable quality and extent but they have enabled us to identify the most likely areas of concern for the restoration project.

In all cases the undertaker's issued caveats with their reponses, to cover potential inadequacies in their records, to advise the need for further consultation and to carry out specific on-site detection for buried apparatus before commencing any excavations. Useful information was also provided about working adjacent to apparatus and minimum clearances to be observed for permanent construction works and services diversions. All this information is included in the data handed over to the Trust on completion of this study, for use in later stages of the project.

7.2 Pipelines

7.2.1 Pipeline Management (Esso Pipelines)

Two of this company's pipelines are affected by the proposed restoration routes. At the Semington end of the Canal the proposed route runs adjacent to the Fawley-Avonmouth Pipeline for a short distance close to Outmarsh Farm. The approximate position of the Pipeline is shown on Route Map Section 1 in **Appendix D** and, subject to a detailed location survey and observances of the requirements for safe working during the detailed design and construction stages of the project, the Pipeline should not interfere unduly with Canal restoration.

To the west of Cricklade, the company's Midline Pipeline approaches the proposed route of the Canal over the section between Upper Broad Leaze Farm on the Chelworth Road, and The Basin at Latton. The approximate route of the Pipeline is shown on Route Map Sections 206 and 207 in **Appendix D**. Further information about the precise location has been requested from Pipeline Management to assist with confirmation of the Canal route but their response is not yet to hand.

To the south west of Swindon the company's Midline Pipeline is again encountered, this time by an almost square crossing just to the east of Hay Lane Bridge (Route Map Section 22). Insufficient information was supplied by Esso Pipelines with the initial reponse to our request to determine if there is a clash at this point and we have therefore asked for more details. These are not yet to hand.

7.2.2 Serco Gulf Engineering Ltd (Government Oil Pipelines, GPSS)

There are three crossings of the Canal route by GPSS pipelines:

1. Just to the west of the A4 at Forest Gate Farm/Green Lane Farm (Derryhill Wharf) east of Chippenham. Approx. OS ST 9471

2. At Chaddington Locks, south west of Wootton Bassett. Approx. OS SU 0881.

3. Near the Ray Aqueduct at Mouldon Hill on the North Wilts Canal. Approx. OS SU 1187.

Unfortunately insufficient information was supplied by the undertaker to determine the impact of these crossings. We have requested more details but these are not yet to hand.

7.2.3 ICI Chemical & Polymers Ltd

We have been advised that ICI Chemicals & Polymers Ltd has no pipelines in the vicinity of the Canal.

7.2.4 Fina plc

We have been advised that Fina plc has no pipelines in the vicinity of the Canal.

7.3 Telecoms

7.3.1 BT plc

The information provided by BT indicates several Canal crossings with overhead lines, and a few crossings with cables (usually in bridges). In general these crossings are what might reasonably be expected and most will not have an impact on the viability of the restoration proposals. However, there are a few instances of note where the records indicate services lines running closely parallel to or perhaps along the Canal alignment; where a greater impact may arise:

- OH line on Canal bed, at Foxham Locks (30m, Route Map Section 11)
- OH line close to alignment at Grovehill Bridge (50m, Route Map Section 17)
- UG line between Nightingale Farm Footbridge and Broome Manor Lane Bridge (15m, Route Map Section 26)

- Several UG lines at Belmont Roundabout (30m, Route Map Section 42)
- OH line on Canal route between Hanney Road Bridge and Bridleway Bridge (60m, Route Map Section 46)
- UG line close to Canal (North Wilts Canal) between The Pry and Hayes Knoll Farm (200m, Route Map Section 204 & 205)

We believe that these obstructions or interferences should be capable of resolution, either by adjustment of the Canal alignment or by re-routing the services. However, precise requirement can only be established at the detailed design stage following the acquisition of large scale topographic plans and the carrying out of a services detection survey.

7.3.2 Mercury Communications Ltd

Mercury has advised us of only one crossing of the Canal, at Wootton Bassett Road in Mannington, Swindon (Route Map Section 201). Unfortunately only a small scale sketch was provided with their response, with no detailed drawings or descriptions, so we have raised a further query but do not yet have a reply.

7.4 Electricity

7.4.1 National Grid

We have been advised of only one crossing of the Canal by a National Grid pylon line, to the north of Bezzle's Farm Bridge, Melksham (Route Map Section 3). The crossing is in open country and would appear not to coincide with a pylon. We therefore believe that the Canal would have no impact on this utility.

7.4.2 Southern Electric plc

The information provided by Southern Electric indicates many crossings of the Canal with overhead HV lines (33 kv and 11 kv) and a few LV buried cables. In general, as for the telecoms, these crossing are what might reasonably be expected and most are unlikely to seriously affect the restoration proposals.

However, there are a few instances of note where the utility's records indicate a density of services on or alongside the Canal where further attention will be needed at the detailed design stage. These include:

- 33 kv pylon line between Park Farm Lift Bridge and just north of City Bridge (Route Map Sections 12 & 13). The Canal is here on its original route and should be capable of adjustment to thread through the pylons.
- LV buried cable along original Canal bed at Station Road Bridge (25m, Route Map Section 19)

- 33 kv pylon line alongside Canal route at Westleaze (40m, Route Map Sections 23 & 24)

- 11 kv pole line alongside route between Acorn Railway Bridge and Lowerfield Farm Bridge (60m, Route Map Section 30)

- 11 kv pole lines either side of Canal and Shrivenham Sub-station (150m, Route Map Section 31)

- 11 kv pole line and LV street lighting cables in centre of East Challow (35m, Route Map Section 41)

- 11 kv buried (?) cables and LV street lighting cables at Belmont Roundabout (Route Map Section 42)

- 11 kv pole line alongside or on Canal route between Hanney Road Bridge and Steventon Lock (50m, Route Map Sections 45 & 46). See also Telecoms para 7.3.1, item 5.

- 11 kv pole line alongside and on Canal route between Drayton Lock and A34 crossing (300m, Route Map Section 47 & 48)

- Complexity of HV & LV cables and pylon lines at Toothill Substation, Wootton Bassett Road, Swindon, North Wilts Canal (Route Map Section 201).

- 132 kv pylon line alongside North Wilts Canal route between Rivermead lock and Purton Road Bridge (210m, Route Map Section 202)

- Complexity of HV & LV cables & pylon lines at Swindon Sub-station, North Wilts Canal (Route Map Section 203)

- 33 kv pylon line alongside proposed route of North Wilts Canal at Horsey Down (80m, Route Map Section 207)

We believe that these obstructions or interferences should be capable of resolution, either by adjustment of the Canal alignment or by re-routing the services. However, precise requirement can only be established at the detailed design stage following the acquisition of large scale topographic plans and the carrying out of a services detection survey.

7.5 Gas

7.5.1 Transco Ltd

Information on gas pipelines (all buried) was obtained from Transco Ltd. Their principal low pressure mains are found in the towns as local distribution networks of relatively small pipe diameters. In the rural areas the Canal route is crossed by a number of medium and intermediate pressure transmission pipelines in diameters up to 16", and one high pressure main of 350mm diameter. Insufficient information is available from the records to establish the full potential impact at crossings or close approaches but in most instances the presence of the service should not seriously affect the restoration proposals. The main areas of concern have been identified as:-

- 12" Steel IP close approach near Melksham Forest Locks (20m, Route Map Section 3)
- 300 DI MP along canal bed(?) at Studley Grange/Hay Lane Bridge (55m, Route Map Section 21)
- 250 PE MP crossing at West Leaze Farm (Route Map Section 23)
- 8" CI & 250 PE close approach and crossing in bridge, Croft Road Crossing (30m, Route Map Section 24)
- 8" CI crossing at Nightingale Cottages (Route Map Section 26)
- 2x8" SI IP crossing adjacent to Wanborough Road Bridge (Route Map Section 28)
- 4" Steel crossing at Station Road Bridge (Route Map Section 31)
- 90 PE along canal bed, East Challow (15m, Route Map Section 41)
- 4" in Stockham's Bridge (Route Map Section 42)
- 200/250 MP at Belmont Roundabout (Route Map Section 42)
- 250 MP crossing at Grove Bridge (Route Map Section 43)
- 16" IP crossing alongside Ardington Railway Bridge (Route Map Section 44)
- 12" IP alongside/crossing route east of A34 Crossing (30m, Route Map Section 48)
- 12" MP crossing in B4107 Bridge (Route Map Section 48)
- 250 PE MP crossing at Rushy Platt Farm (Route Map Section 201)

- 180 PE/8" steel alongside under Wootton Bassett Road crossing (20m, Route Map Section 201)

- Several MP up to 125, alongside North Wilts Canal near Sainsbury's Culvert (Route Map Section 201)

- 12" Steel IP crossing alongside Great Western Way Bridge (Route Map Section 202)

- 350 Steel HP crossing on skew near The Pry (Route Map Section 204)

- 6" DI MP crossing at Broadleaze Bridge (Route Map Section 206)

- 180 PE LP crossing alongside B4040 Bridge (Route Map Section 207)

We believe that these obstructions or interferences should be capable of resolution, either by adjustment of the Canal alignment or by re-routing the services. However, precise requirement can only be established at the detailed design stage following the acquisition of large scale topographic plans and the carrying out of a services detection survey.

7.6 Water

A response to our enquiry is still awaited

7.7 Sewerage

A response to our enquiry is still awaited

7.8 Conclusions

The responses obtained from most of the utility undertakers were adequate for the present purposes although every effort will be made to obtain the missing information as soon as possible.

Although there are a number of important crossings of the proposed Canal route, and several sections where services are very close and may affect construction, we consider that in all cases an effective solution can be found to allow restoration of the Canal.

For budget estimation purposes we have made an allowance of £1.19m in total for services diversions and at the moment we consider this to be adequate for the minor works required for electricity, telecoms and gas. In the case of pipelines, it would probably be necessary to adjust the route of the Canal in view of the likely high cost of diverting these particular services. In this case the additional costs are deemed to be covered by the general contingency of £8.16m.

8. Cost Estimate

The engineering cost estimate for restoration is detailed on a feature by feature and section by section basis on the schedules accompanying the 1:10,000 scale Route Maps. The prices represent estimated tender prices in late 1997, on the basis of normal competitive tendering and typical contract rates, for work packages of reasonable size (say £0.5 million and up), and do not take account of possible labour-free elements of work carried out by volunteers. Disposal costs for surplus spoil (**Appendix N**) are included. No contingency allowance is included in these schedules.

The estimates have been prepared commensurate with the objectives of the present study and the level of detail available at this stage. It is important to recognise that the level of detail is not great; no detailed topographic surveys or ground investigations have been carried out; fundamental decisions on routing remain; land acquisition, compensation and environmental mitigation costs are not included in the schedules and add to the overall cost and uncertainty thereof.

In respect of water resources, the schedules include for the recommended lining option in Chapter 4 of this Report (**Table 4.6**), which would form an integral part of any work packages for the Canal itself; however, costs for water supply provision (boreholes, reservoirs, pipelines, treatment etc) are excluded from the schedules, but are included in the overall summary table below.

Data used in the preparation of cost estimates has included recent tenders available to the firm and published data in price books, in particular Spon's Civil Engineering and Highway Works Price Book (published annually and updated quarterly). We have also made use of a Water Research Centre (WRc) Technical Report TR61 'Cost Information for Water Supply and Sewage Disposal', particularly for the water resources estimates. This report involved statistical analyses of a large number of contract prices, and the production of 'Cost Functions' for items such as reservoirs, pipelines, pumping stations etc, based on key parameters (capacity, length, diameter etc). A benefit of such analyses is that confidence limits can be derived for estimates; it is revealing to consider how wide these limits are even with sizeable data sets. Rarely are the 95% confidence limits (ie the range of prices within which 95% of actual prices would be expected to fall) better than 67% to 150% of the estimate; and more often prices would be in the range 50% to 200% (i.e between half and double the estimate).

It is not possible to assign a statistically based confidence limit to the overall estimate for this project, but given the uncertainties inevitable at this early stage, the 67% to 150% range is likely to be of the right order. This uncertainty will be reduced as the project develops, as further studies are undertaken and designs become more firm. Uncertainty of course continues until construction is complete, when the cost becomes a matter of record of actual expenditure.

The overall summary cost estimate for restoration is presented in.Error! Reference source not found.

Table 8. 1 Overall Project Cost Estimate

Section	Length (km)	Locks	COSTS (£ M) Canal Reach	Struct -ures	Serv- ices	Total Cost
ENGINEERING						
Semington to Hay Lane	37.60	29	5.95	9.01	0.26	15.22
Hay Lane to Acorn Bridge	17.05	16	5.87	10.57	0.18	16.62
Acorn Bridge to Abingdon	34.45	20	7.38	12.80	0.24	20.42
Calne Branch	4.85	2	0.59	2.14	0.03	2.76
North Wilts Branch	14.45	15	5.18	8.97	0.48	14.63
SUB TOTAL	108.4	82	24.97	43.49	1.19	69.65
WATER RESOURCES						
Surface Water Resources						9.50
Groundwater Resources						2.46
SUB TOTAL						81.61
Contingencies @ 10%						8.16
Engineering services @ 11%						8.98
TOTAL CONSTRUCTION COST						98.75
Land, Legal and other costs						4.00
TOTAL PROJECT COST						**102.75**
ANNUAL OPERATING & MAINTENANCE COSTS						0.45

NOTES:
1. Costs exclude any canal related development, marinas etc.
2. Water resource costs based on recommended lining option, costs of which are included in the engineering costs.
3. Annual costs operating and maintenance cover all recurrent costs including staff, contract work, office overheads, maintenance and repair work, power and abstraction charges, but depreciation of assets is excluded..
4. Engineering services includes topographic surveys, ground investigations, further engineering and environmental studies, planning, detailed design and construction supervision costs.
5. Other costs include establishment of a navigation authority
6. 95% confidence limits assessed at 67% to 150% of estimate

9. Recommendations

9.1 Introduction

This study has examined in some detail the difficulties to be overcome in order to achieve the goal of restoration of the Wilts & Berks Canal to a fully navigable standard. In engineering terms there appear to be practicable solutions to all the major obstructions; there are some significant (but localised) environmental issues, but the overall environmental enhancement arising from restoration is recognised as a major benefit. Water resources are seen as perhaps the most critical issue, and considerable uncertainty remains at the end of this study, but our initial assessment is that sufficient water could be made available. An assessment of the costs and benefits of restoration suggests a reasonably sound economic basis for restoration.

In order to progress towards this goal, we now make recommendations for the next phase of work. Primary amongst these recommendations is the preparation of an overall Strategy Study; in addition, further work will be required in the areas covered in this study to confirm the viability of the restoration and achieve the milestone of full and adequate incorporation into all Local Plans. These further studies are also described. Such work could be progressed in parallel with the Strategy Study but these tasks will in any case be addressed in some degree as part of the Strategy Study.

9.2 Strategy Study

An overall Strategy Study is strongly recommended, drawing upon the findings of this study and developing a detailed strategy for implementation of the project encompassing all essential elements including:

- Planning and other consents - including requirements for incorporation of a preferred route into Local Plans, consultation with statutory bodies, major landowners and businesses, and general public consultation;

- Business Plan and Funding Strategy - including the obvious sources such as Lottery funding and Landfill Tax, but to include contingency planning in particular to cover failure to secure Lottery funds. Including also justification studies such as Leisure & Tourism;

- Land Ownership and Aquisition Strategy - including assessment of need for compulsors purchase linked to requirement s for planning approval and funding;

- Design and Construction Strategy and Programme - including identification of works practicable for volunteers; design development including environmental assessments and mitigation where required; contract packages; opportunistic works coinciding with other projects; programming of works to take advantage of planned closures on major road and rail crossings;

- Management Strategy - both during and following restoration, in particular the form and establishment of a Navigation Authority and ongoing role of the Canal Trust and supporting Local Authorities and the Amenity Group;

- Marketing Strategy - in particular for leisure and tourism, but also for residential, commercial and industrial development opportunities arising from restoration.

There will be overlap and interaction between these separate elements: for instance, an opportunistic land acquistion strategy may be practicable if a long term programme (say 20 years) is adopted for restoration; funding availability may dictate restoration programme; a successful marketing strategy should help to attract funding.

This overall Strategy Study will require a multi-disciplinary team including legal, financial, commercial, marketing, planning and management expertise as well as the central engineering and environmental disciplines. Once the Strategy Study has been developed and approved, this will set the scope and direction for all further work from each discipline to achieve the goal of full restoration.

We would suggest a budget of £40,000 be set aside for this Study, to cover also the cost of high quality report and publicity materials.

9.3 Engineering Studies

In order to confirm routes for, and viability of the new sections of proposed Canal , further engineering study is essential. The primary requirement is for good quality large scale topographic survey followed by geotechnical investigation work. There are two options suggested for topographic survey according to circumstance, namely ground based survey work and photogrammetry (i.e. survey from aerial photography). Accurate ground based survey will eventually be required in all cases, and is recommended where the route is heavily constrained e.g. west and south of Swindon, south of Abingdon and on the River Avon through Melksham. This type of survey we would budget at £3,500 per kilometre run based on a 100m wide corridor and production of 1:500 scale plans with full surface features and 0.5m contouring.

In all areas where there is more flexibility on the precise routing and a 100m wide corridor may not cover the route possibilities survey from aerial photography could be a sensible first step, since it would be considerably cheaper although less accurate. For instance the Ordnance Survey can produce 1m contouring using existing aerial photography as an overlay to existing OS digital mapping backgrounds (1:2500 or 1:1250). For the same 100m corridor we would budget £500 per km by this method (and £900 per km if the routes were flown specially). The digital background mapping is an additional cost. Ground survey should still follow once routes are defined more precisely. One advantage of the aerial survey technique over the ground based technique is that it avoids the need to enter private land and disturbance from clearing sight lines. It can however miss data due to tree cover.

In addition to the new routes, we would also recommend 1:500 ground survey at the more difficult of the localised obstructions on the existing alignment, such as at East Challow and Grove, and at the most costly (but not necessarily difficult) crossings.

It is recommended that, irrespective of any more detailed survey work, the Canal Trust should retain the right of access to the OS digital mapping held by the Local Authorities.

Detailed ground investigation work can probably be deferred until a later stage. We would budget typically between £5,000 and £10,000 per km for a full geotechnical investigation, but some preliminary and relatively inexpensive work targeted at key locations would be appropriate in the next phase to supplement any existing SI data obtainable, in particular through BGS.

Engineering studies will be required to develop the new routes and produce engineering drawings sufficient for the purposes of route definition in the Local Plans. With the topographic survey work proposed above, 1:2500 / 1:1250 will be an appropriate scale to develop the routes over the whole alignment with the 1:500 scale survey to support this level of presentation. Further investigation will be needed in particular on the west and south Swindon routes, and the River Avon route, and will include hydrological/hydraulic studies looking at flood plain impacts in these and other areas.

It is likely that most if not all of the public highway crossings will need to be developed to outline design stage in order to secure acceptance from the Planning Authorities. It may be opportune to consider architectural input particularly with a view to early establishment of a distinctive and easily recognisable style for the majority of new structures required for the restoration.

We would suggest an initial budget figure of £50,000 be set aside for topographic surveys primarily for the new canal routes; £30,000 for preliminary geotechnical investigation work; and £300,000 for the ensuing engineering studies and design work. These estimates and programme for expenditure will of course have to be reviewed and refined as part of the Strategy Study, and will undoubtedly need to be+ prioritised against other demands on expenditure.

9.4 Water Resources Studies

A series of key recommendations for further work to assist resolving water resources issues are given in **Table 9. 1**. Given the critical nature of water supply to the viability of the restoration, and the large uncertainty associated with both resources available and resources required (the latter primarily due to large uncertainty in seepage rates), investigation to address these matters must be regarded as high priority.

Table 9. 1 Recommendations for Further Water Rersources Investigations

Subject	Issues	Action	Responsibility	Indicative Costs
Surface water resource availability	River flow data limited; resource estimates uncertain.	Programme of hydrological data collection to improve estimates; river flows & water levels, especially in winter, at carefully selected sites	WBCAG with advice from Consultant to ensure data quality & assess results	£5,000
Water quality of surface water resources	Limited data are available to assess resultant canal water quality and any treatment requirements	Programme of water quality data collection to establish temporal trends over a period of about 2 years, in water courses with potential to supply a restored canal	Consultant & contract laboratory	£20,000
Canal seepage/leakage rates	Actual values for achievable seepage/leakage rate are uncertain	Measurement of actual seepage & leakage using existing "in-water" sections of the Wilts & Berks Canal	WBCAG with advice from consultant to ensure data quality & assess results	£5,000
Groundwater resource availability	Potential yield quantity & quality uncertain.	(1) Comments on initial proposals from EA Thames (2) Further desk studies using BGS & EA data (3) Exploratory drilling & test pumping; initially of 2 no. wells	(1) EA Thames comment & Scott Wilson to assess impact (2) Consultant (3) Consultant & contractor; EA consent required	(1) Within current contract (2) £5,000 (3) £100,000
Canal lining	Some canal sections overlying permeable ground could be unlined. Other sections have net groundwater contribution	Desk study & site investigation of key sections on the Eastern Mainline crossing River Sands & Gravels, and N. Wilts Branch crossing Corallian	Consultant & contractor	£20,000
Use of urban runoff	Principle of use needs extending to address practical issues & volumes available	Discussions with local authorities & MOD (re. RAF Lyneham) & further discussions with EA	Consultant & WBCAG	£5,000

9.5 Environmental Studies

Throughout the course of the environmental study, the need for further research has been emphasised in a number of sections. The need for further study stems from the requirement to obtain qualitative data in order to make detailed predictions on the nature and significance of the impacts of the restoration. Some of this work can be undertaken almost immediately and will be required in order to obtain protection of the route in Local Plans. However, other areas will require a greater level of detail relating to the restoration and how it is to be progressed. The requirements for further study are presented in **Table 9. 2** alongside an approximation of the prerequisite knowledge needed before the studies can be meaningfully achieved.

In addition to the factors covered in the table, in each of the areas covered there will be a requirement to consult with statutory consultees, interest groups and local communities during the development of the restoration proposals.

Most of additional survey work required can either be carried out for the canal as a whole or, if the restoration is likely to be split into individual lengths or reaches, as each one of them is developed.

Table 9. 2 Further Environmental Studies Required

Area	Study	Prerequisite information	Approx. cost (£)
Ecology*	Phase 1 Habitat survey of entire canal route, including storage reservoirs, compounds, river sections and access areas.	Land ownership: information for access. Detail on: final option choice, location of reservoirs and compounds and access routes.	10,000
	Phase 2 Habitat survey where Phase 1 surveys reveal the need	Phase 1 Habitat survey	Unknown
	Specialist surveys may also be required for protected species	Phase 1 Habitat survey	Unknown
Water Quality*	Collection and interpretation of long-term chemical and biological monitoring data (existing) against hydrological data + pinpoint gaps in knowledge. For each supply prepare treatment recommendations.	Detail on choice of final water resource options, specific locations of storage reservoirs etc.	2,500-5,000 per supply

Table 9. 2 Further Environmental Studies Required (continued)

Area	Study	Prerequisite information	Approx. cost (£)
Archaeology*	SMR survey of reservoir locations, compounds and access routes. Location of other areas of historical and archaeological areas (e.g. listed structures)	Detailed of boundaries for each location	2000
	Negotiation with County Archaeologist, plus archaeological survey work prior to work starting	Ditto	Unknown
Noise	Baseline studies of background noise at sensitive receptor positions	Reservoir, compound and access locations	7500
	Impact prediction	Detail of operations, plant used at each location.	2500
Waste Disposal	Baseline ground testing of canal route and ancillary structures	Location of reservoirs	30000
	Landfill survey	none	2500
	Arisings disposal strategy	The two surveys above	10000
General	Environmental Code of Construction Practice	Detail from baseline studies	5000
Landscape	Detailed landscape assessment of the canal route and evaluation of detailed design criteria for canal structures and furniture	Engineering designs need progressing sufficiently for exact locations and dimensions of structures to be determined. Landscape architect and design engineers should liaise closely to ensure that the correct material specifications are adopted.	3500
Access Study	Review of existing rights of way to determine exact requirements for existing footpath diversions (permanent or temporary), need for additional access and scope to improve both footpath/bridleway network and integration with other countryside initiatives.	Final preferred route choice	2500

* this information is likely to be required to assist with safeguarding of the route in Local Plans

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The Ancient Monuments and Archaeological Areas Act 1979, HMSO

The Hedgerows Regulations 1997, HMSO

The Town and Country Planning Act 1990, HMSO

Vale of White Horse 1995. Local Plan Written Statement Deposit Draft. Vale of White Horse District Council. October 1995

Waste Management Licensing Regulations 1994, HMSO

Water Resources Act 1991, HMSO

West Wiltshire District Council, 1996. West Wiltshire District Plan - Adopted Plan, March 1996

Wildlife & Countryside Act 1981 (& amendments), HMSO

Willis, K. and Garrod, G., 1990. Valuing Open Access Recreation on Inland Waterways. Report by the Dept of Agricultural Economics & Food Marketing, University of Newcastle-upon-Tyne.

Willis, K., and Garrod, G., 1993. The Value of Waterside Properties. Report by the Countryside Change Unit, University of Newcastle-upon-Tyne.

Wiltshire County Council, Sites and Monuments Record, unpublished

11. APPENDICES

Appendix A Study Brief

Appendix B Organisations Contacted

Appendix C Project Document Register

Appendix D Route Maps and Schedules of Features

Appendix E Surface Water Catchment Flows

Appendix F Coding System for Potential New Water Supplies

Appendix G Groundwater Yield Assessment Report

Appendix H Water Quality Data

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Appendix J Sensitivity of Aquatic Plants to Boat Movements

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Appendix L Standards for River Ecosystem Use Classes

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Appendix O Receptors Sensitive to Noise and Dust Emissions

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Appendix Q Responses To Utilities Enquiries

Appendix A Study Brief

(now the Environment Agency) and from a number of charities and other funding agencies. With the imminent formation of the Trust it has now been agreed that the time has come to commission a study of the feasibility of restoration of the whole Canal.

2.6 A list of relevant studies and publications, which will be available to the consultant, is given in Appendix A.

Objectives of the study

3.1 The objectives of the study are to:

(a) review the principal difficulties to be faced in restoring the Canal and to consider how these difficulties might best be overcome,

(b) consider the best means and sequence of carrying out the restoration works and,where there is a choice, determine the optimum route,

(c) review the water requirements of the restored Canal and the best means of providing the necessary water resources,

(d) assess the benefits of restoration to the local community, as well as regionally and nationally,

(e) investigate the environmental impacts of restoration, assessing the environmental enhancements achievable and suggesting mitigation measures where an adverse impact is likely,

(f) provide an estimate of of the cost of restoration for separate sections of the Canal.

Scope of study

4.1 The study is to cover the main line of the Wilts & Berks Canal and the Calne and North Wilts branches.

4.2 Where the Canal is obstructed by development the Consultant shall review various options for dealing with the situation; these shall include restoration along the original route, restoration along alternative route(s) suggested by the Trust and restoration along other routes which appear to the Consultant to be practicable.

4.3 The Consultant is not required to investigate land ownership. Where it is necessary to enter private land for the purposes of the study, the Consultant shall make his own arrangements with the landowner. Details of land ownership, where known to the Client, will be made available to the Consultant.

4.4 Water resources shall be reviewed in consultation with the Environment Agency, Southwest and Thames regions. This aspect of the study shall consider surface and ground water supplies, including runoff from major paved surfaces (eg the M4), reuse of treated effluents and possibilities for storage within or outside the Canal and of back pumping. The impact of restoration on water quality, land drainage and flood management are to be included.

4.5 The Study shall include sufficient engineering detail, including all critical dimensions and levels, to permit realistic estimates of the costs of the works proposed. All cost estimates shall be based on the assumption that the works will be carried out by commercial contract awarded through competitive tendering. The Consultant may indicate those works which could be undertaken by voluntary groups and the cost savings that would be achieved.

4.6 The assessment of the environmental impacts of restoration shall be based upon an initial outline baseline survey of the Canal route and its environs. The magnitude and significance of the impacts of the proposed works, including any major alternatives, shall be ascertained and the results presented in the form of an environmental statement.

4.7 Benefits shall be assessed in terms of user visits and enjoyment value, additional income attracted to the area, increased employment, enhancement of property values etc, so that the benefits of restoration can be compared with those of other public investments in the area.

4.8 The standards to be adopted in the study are as follows:

(a) Craft - maximum size:

length 22 m beam 2.13 m draught 1 m

(b) Channel

bed width	14 ft 0 in (4.27 m), or as original construction
minimum width at locks	7 ft 2 in (2.18 m)
minimum width at bridges	2.4 m or as original construction
towpath width	2 m
depth	1.37 m or as original construction
freeboard	0.3 m
minimum air draught	2.3 m over 2 m width

(c) Level of use. This should be estimated from levels of use of similar British Waterways canals, taking account of any restrictions revealed by the engineering study, and of the levels of demand indicated by the benefits study.

(d) Water supplies should be adequate to cope with the effects of a 1 in 10 year drought.

4.9 The Consultant shall obtain information on all utilities crossing, or passing near to, the Canal and should estimate the costs of rerouting them where necessary.

4.10 During the course of the study the Consultant shall consult the following bodies:

The Planning, Engineering and Recreation departments of North Wilts District Council, West Wilts District Council, Thamesdown Borough Council and Vale of the White Horse District Council.

The Planning and Highways departments of Wiltshire and Oxfordshire County councils.

The Water Resources, Land Drainage and FRCN departments of the Environment Agency, Southwest and Thames regions.

The Department of Transport/Highways Agency

Railtrack

The Wiltshire Wildlife Trust

The Berks, Bucks and Oxon Naturalists Trust (BBONT)

The Wilts & Berks Canal Amenity Group.

Appendix B Organisations Contacted

North Wiltshire District Council Monkton Park Chippenham Wiltshire SN15 1ER	Tel: Fax: Contact:	01249 443322 01249 443152 Bruce Matthews - Head of Admin Peter Jeremiah - Solicitor Jerry Dix - Head of Leisure Strategy Allan Chaplin - Forward Planning
Oxfordshire County Council County Hall New Road Oxford OX1 1ND	Tel: Fax: Contact:	01865 792422 01865 726155 Joe Newton - Development Control Peter Brown Craig Blackwell - Ecology
Swindon Borough Council Premier House Station Road Swindon SN1 1TZ	Tel: Fax: Contact:	01793 466316 01793 466459 Martin Cobden - Parks Countryside Development Officer (liaison officer [LO] for this study)
Swindon Borough Council Civic Offices Euclid Street Wiltshire SN1 2JH	Tel: Fax: Contact:	01793 463000 01793 490420 Colin James x 6271 (OS Maps)
West Wiltshire District Council Bradley Road Trowbridge Wiltshire BA14 ORD	Tel: Contact: Fax: Contact Fax:	01225 776655 Pat Tidy x 297 (OS Maps) 01225 770316 Mr Karol Jakubczyck x226 (Planning)(LO) 01225 770314
Wiltshire County Council County Hall Bythesea Road Trowbridge Wiltshire BA14 8JG	Tel: Contact: Fax: Contact: Fax:	01225 713000 Richard Lander, Director of Highways and Environment (LO) 01225 713999 John Rogers, Countryside LO 01225 713400
Wilts & Berks Canal Amenity Group c/o 13 Lycroft Close Goring-on-Thames Reading RG8 0AT	Tel: Fax: Contact:	01491 872380 01491 872380 Tony Harrison (and see W&BCAG contact list)

Vale of White Horse District Council Abbey House Abbey Close Abingdon OX14 3JE	Tel: Fax: Contact:	01235 520202 01235 554960 Mrs Heather Lee (OS Maps) Alison Blythe (LO)
Thames Water Utilities Ltd Gainsborough House Reading Berkshire	Tel: Fax: Contact:	01734 591159 01734 539203 Dave Cook
Wessex Water plc Wessex House Passage Street Bristol BS2 OJQ	Tel: Fax: Contact:	01179 290611 01179 293137
Environment Agency Thames Region Kings Meadow House Kings Meadow Road Reading Berkshire RG1 8DQ	Tel: Fax: Contact:	01734 535000 01734 500388 Richard Green - Conservation
EA Thames Region West Area Office Isis House Howbery Park Crowmarsh Gifford Wallingford Oxfordshire OX10 8BD	Tel: Fax: Contact:	01734 535000 01734 535900 Peter Hempstead (LO for the study) Cathy Glenny (Water Resources)

EA South Western Region Rivers House East Quay Bridgewater Somerset TA6 4YS	Tel: Fax: Contact:	01278 457333 01278 452985 Barry Smith (Planning Liaison Officer) Robin Callender (Water Resources) Ann Skinner (Conservation) John Southwell (Flood Defence) Barry Gray (Water Quality)
Scott Wilson Mainline Western House 1 Holbrook Way Swindon SN1 1BY	Tel: Fax: Contact:	01793 5159** 01793 515487 David Hubie x33 Jeff Gibson x21 (main contact)
J.Sainsbury Ltd Wakefield House Rennie Street LONDON SE1 9LL	Tel: Fax: Contact:	0171 921 6000 Robin Anderson, Director of Estates
English Nature Prince Mains Court Hambledon Avenue Devizes Wiltshire SN10 2RT	Tel: Fax: Contact:	01380 726344 01380 721411 Patrick Cashman
Biological Records Centre 41 Long Street Devizes Museum SN10 1NS	Tel: Contact:	01380 727369 Sally Scott White
Wiltshire Wildlife Trust	Tel: Contact:	01793 526233 Paul Derby Jo Taylor
BBONT	Tel: Contact:	01865 775 476 Ian Corbin

Abingdon Town Council Stratton Lodge 52 Bath Street Abingdon OX14 3QH	Tel: Fax: Contact:	01235 522642 01235 533112 Brian Toomkin (Town Clerk)
Alastair MacDonald 25 Coxwell Street Cirencester GL7 2BQ	Tel: Fax:	01285 652006 01285 651274
British Waterways Willow Grange Church Road Watford WD1 3QA	Tel: Fax: Contact:	01923 226422 01923 201300 Glenn Millar (Research Manager)
MAFF Farming & Rural Conservation Div. Block A Government Buildings Coley Park Reading RG1 6DT	Tel Contact:	01734 581222 x 3373 Paul Fellows
Thames Water Technical Information Rose Kiln Court Rose Kiln Lane Reading RG2 0PH		
Transco Network Records Department Abingdon Road Didcot Oxford Oxfordshire		
Developers Group Holdenhurst STW Riverside Avenue Castle Lane East Bournemouth Dorset BH7 7EF		

Transco
Network Records Department
PO BOX 502 Bedminster Road
Bristol
BS99 5RS

BT SWAMP
Post Point TKS/G40/1
Trunk Exchange
Long Road
Cambridge
CB2 2HG

Southern Electric
Mapping Services
PO BOX 6206
Basingstoke
RG24 8BW

BT SWAC
Post Point 318c
24 Pendwyallt Road
Coryton
Cardiff
CF4 7YR

Mercury Communications Utilities
Department
Waterside House
Waterside Park
Bracknell
Berkshire
RG21 1XL

Pipeline Management
Heley House
Dean Road
Andover
Hampshire
SP10 2AA

Serco Gulf Engineering Ltd
Islip Depot
Letchingdon Road
Oxfordshire
OX5 2TQ

Fina Plc
Fina House
Ashley Avenue
Epsom
Surrey
KT18 5AD

ICI Chemicals & Polymers Ltd
Estates Department
PO BOX 14
The Heath
Runcorn
Cheshire
WA7 4QG

BP International Ltd
Research and Engineering Centre
Chertsey Road
Sunbury on Thames
Middlesex
BW16 7LN

Tel: 01932 762000
Contact: Mr J Dowsett

Appendix C Project Document Register

Item	Title	Source
	Wilts & Berks Canal Amenity Group Publications:	
1.	The Wilts and Berks Canal, L.J.Dalby, Oakwood Press 1971.	NAWyld
2.	The Wilts and Berks Canal, Feasibility Study, Allen & Harris/Royal Insurance, 1994.	Paul Pennycook
	Local Authority Publications:	
3.	Thamesdown Local Plan, Deposit Draft 1994.	Paul Pennycook
4.	North Wiltshire Local Plan Review, Proposed alterations 1994-2001.	Paul Pennycook
5.	West Wiltshire District Council Canals Policy Statement (Draft) 1994.	Paul Pennycook
6.	Oxfordshire Structure Plan, Consultation Draft.	Paul Pennycook
7.	Vale White Horse District Plan, Consultation Draft.	Paul Pennycook
	Environment Agency Publications:	
8.	River Thames Recreation Strategy, Draft for consultation and appendices, NRA and Sports Council.	Paul Pennycook
9.	Upper Bristol Avon Catchment Management Plan Action Plan, NRA.	Paul Pennycook
10.	Upper Thames Catchment Management Plan Consultation Report, NRA.	Paul Pennycook
11.	Upper Bristol Avon Catchment Management Plan Consultation Report, NRA.	Paul Pennycook
	Other Relevant Publications:	
12.	Cricklade Swindon Recreational Corridor Study, Sustrans 1995.	Paul Pennycook
13.	Great Western Community Forest Plan Consultation Draft 1994.	Paul Pennycook
13a.	Great Western Community Forest Plan - October 1994	Martin Cobden
	Proposed New Routes of Canal:	
14.	Study on Alternative Routes for the North Wilts Canal around Swindon, by D Mack of Maunsell's, 1991.	Paul Pennycook
14a.	Officer Reaction to Initial Proposals for New Canal Route West of Swindon (D Mack) from Thamesdown Borough Council, 1991.	Paul Pennycook
15.	Proposal for New Route of Main Line Canal Utilising the Dorcan Stream Near Swindon.	Paul Pennycook
16.	Designs for Alternative Routes for Main Line of Canal Around Swindon by B.Brown, 1993.	Paul Pennycook
17.	Maps of Proposed New Routes of North Wilts Canal around Cricklade. B.Brown, 1993.	Paul Pennycook
18.	Information Note on Possible Routes Utilising the River Ray Valley around Swindon, by K & M Walker, 1987.	Paul Pennycook
19.	Map Proposing NE Route for Canal Utilising Gravel Working South of Abingdon, G.Austin, W&BCAG, 1996.	Paul Pennycook
20.	Map Proposing New Routes around Proposed Thames Water Reservoir South of Abingdon, G.Austin, W&BCAG, 1994.	Paul Pennycook
	Maps and Correspondence:	

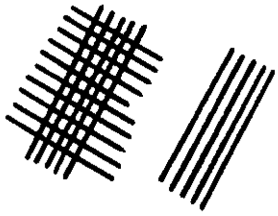
Item	Title	Source
21.	Correspondence and Map Relating to Canal Near Swindon from Berners-Allsopp (Agents), 1992.	Paul Pennycook
22.	Correspondence from NRA Regarding Canal Restoration at Challow near Wantage, 1992.	Paul Pennycook
23.	Correspondence from NRA Regarding Canal Restoration Near Abingdon, 1992.	Paul Pennycook
24.	Correspondence from British Waterways Board on Canal Usage Calculations, 1993.	Paul Pennycook
25.	Maps Relating to Canal in Vicinity of Chippenham believed dating from, 1860.	Paul Pennycook
26.	Comments by Wilts & Berks Canal Amenity Group on the Report Entitled "Urban Fringe and Countryside Strategy Parts 1&2" Prepared by Borough of Thamesdown, 1988.	Paul Pennycook
27.	Discussion Document by W&BCAG Entitled "The Canal from Seven Locks to Hay Lane, a Discussion Document Issue 2" 1992.	Paul Pennycook
28.	Maps Relating to the Canal in Oxfordshire believed dating back to 1860.	Paul Pennycook
29.	1:2500 OS Map of Tockenham Reservoir.	Paul Pennycook
30.	Wilts and Berks Canal Schemes Showing Restored Areas.	Paul Pennycook
31.	Contour Maps of North Wilts Canal and Environs.	Paul Pennycook
32.		Paul Pennycook
	Other Studies:	
33.	Ecological Study of Canal Corridor from Vastern to Hay Lane (Nr Wootton Bassett) Chalkhill Environmental Consultants, 1994.	Paul Pennycook
34.	Ecological Study on Canal at Calne, Chalkhill Environmental Consultants, 1994.	Paul Pennycook
	Other Initial Data Received	
35.	The Wilts and Berks Canal within the Boundary of the Great Western Community Forest, 1992 by W&BCAG.	Paul Pennycook
36.		Paul Pennycook
37.	The Wey and Arun Canal Restoration.	Paul Pennycook
38.	The Melksham Project W&BCAG, Jan: 1988.	Paul Pennycook
39.	Wilts and Berks Amenity Group. K&A to Abingdon Junction; Database of Lectures, Route Descriptions and Restoration Needs, 1991.	Paul Pennycook
41.	IWA Restoration Committee - Notes of Meetings and Visits 4-6 October 1991.	Paul Pennycook
42.	Technical Appraisal Report for a Cycle Track between Swindon and Wootton Bassett (mostly along line of the W&B Canal) Wilts C.C, 1994 (?).	Paul Pennycook
43.	W&BCAG: Comments on Wiltshire Structure Plan - Deposit Draft (with extracts from Draft): Sept 1996.	Paul Pennycook
44.	"Cricklade Leisure Corridor" A5 Leaflet by Cricklade Town Council, 1996.	Paul Pennycook
45.	Wiltshire Structure Plan 2011 - Consultation Draft - January 1996	Ray Denyer
46.	Wiltshire Structure Plan 2011 - Deposit Draft - Explanatory Memorandum & Written Statement - August 1996	Ray Denyer
47.	Comments on Item 46 by W&BCAG - 12 Sep 96, 27 Jan 97 and 28 Jan 97	Ray Denyer
48.	Oxfordshire Structure Plan 2011 - Deposit Draft - November 1996	Ray Denyer
49.	North Witshire Local Plan Review - Deposit Document - April 1995	Ray Denyer
50.	Correspondence and other info relating to Item 49	Ray Denyer
51.	Vale of White Horse Local Plan - Deposit Draft -Written statement - October 1995	Ray Denyer
52.	Vale of White Horse Local Plan - Deposit Draft - Proposed Changes - August 1996	Ray Denyer
53.	Vale of White Horse Local Plan - Deposit Draft - Proposed Changes to Maps - August 1996	Ray Denyer

Item	Title	Source
54.	IWA paper "Waterway Restoration" by Tony Harrison, June 1996	Tony Harrison
55.	Upper Thames catchment: monthly rainfall and potential evaporation data 1961-1997	Cathy Glenny EA
56.	Ecological Survey of the North Wilts Branch of the Wilts & Berks Canal at Moredon, Chalkhill Environmental Consultants,October 94	Paul Pennycook
57.	Shaw Tip Forest Park (Swindon), Master Plan, August 1994.	Martin Cobden
58.	Swindon Old Town - Geological Plan [A2] and section [A4]	Martin Cobden
59.	Rushy Platt Housing Development	Martin Cobden
60.	Thames Water Reservoir News: No 3, Feb 93	Thames Water
61.	West Wiltshire District Plan	
62.	Thames (Eynsham to Benson) and Ock Local Environment Agency Plan Draft Consultation Report	Peter Hemstead
63.	Alert Sites Map - Oxfordshire	Craig Blackwell
64.	Vale of White Horse Local Plan, Deposit Draft, October 1995	Tony Harrison
65.	W&B lock Dimensions - extract from Royal Commission on Canals and Waterways 1907	Peter Smith
66.	Croft Woodlands (Nationwide Sports Facility, Swindon) Site Layout and Survey	Martin Cobden
67.	Draft notes on feasible lines for canal near Abingdon, by G. Austin & R. Murrell	G. Austin
68.	Metereological data at Wantage	G. Austin
69.	Contour plan of Broome Manor Golf Course, Swindon	Martin Cobden
70.	West Wilts District Plan 1st Alteration - Housing Growth Options to 2011, August 1997	WWDC
71.	A350 Semington/Melksham Diversion - public consultation leaflet	WCC
72.	A350 Improvement Options - Melksham (A3 drawing - Brian Colquhoun & Partners)	WCC
73.	Plan of Esso Pipeline in vicinity of Melksham	WWDC
74.	Wootton Bassett Bypass/ Local Plan Revisions (Provisional)	NWDC
75.	Cricklade: Possible Local Plan Proposals to East of Town	NWDC
76.	Cricklade: Possible transport/leisure corridor west of town plus housing	NWDC
77.	1993 Adopted North Wiltshire Local Plan - Extracts and plan relating to Wootton Bassett Bypass	NWDC (Julie Evans)
78.	The New Heart of Calne - A5 Leaflet for public consultation	Calne TC
79.	River Ray Catchment Survey	EA
80.	River Corridor Surveys - River Ray	EA
81.	Local Landfill Sites in Oxfordshire	Geoff Austin
82.	Wiltshire Landfill Sites	Geoff Austin

Appendix D Route Plans and Schedules of Features

KEY TO PLANS

Canal Route and locks



Development and Proposed Development Sites

• 653 **Sites and Monument Record**

Nature Conservation Site

RESTORATION OF THE WILTS & BERKS CANAL
Feasibility Study
ROUTE PLANS AND SCHEDULES OF FEATURES

NOTES:

1. The canal route has been divided into sections typically 1.5 to 2.5km in length. For each section a plan at 1:10,000 scale and an accompanying schedule of features and restoration costs and route description has been prepared. Key plans are appended at the end of this appendix. Sections are numbered 1 to 49 for the main line of the canal starting at Semington Juction at the west end and ending at the Thames at Abingdon, and descriptions are presented as if travelling in this direction (hence locks are described as rising to the summit at Swindon and falling towards Abingdon). In a similar fashion, the Calne Branch is numbered 101 to 103 and the North Wilts Branch 201 to 207, in both cases commencing at their junctions with the Wilts & Berks Canal.

2. Background mapping is enlarged from the Ordnance Survey 1:25,000 Pathfinder series. Linework and contouring are the same as on larger 1:10,000 mapping, but with the benefits of showing rights of way and easy to read text (by virtue of enlargement). Additional survey information has been added from other sources where appropriate.

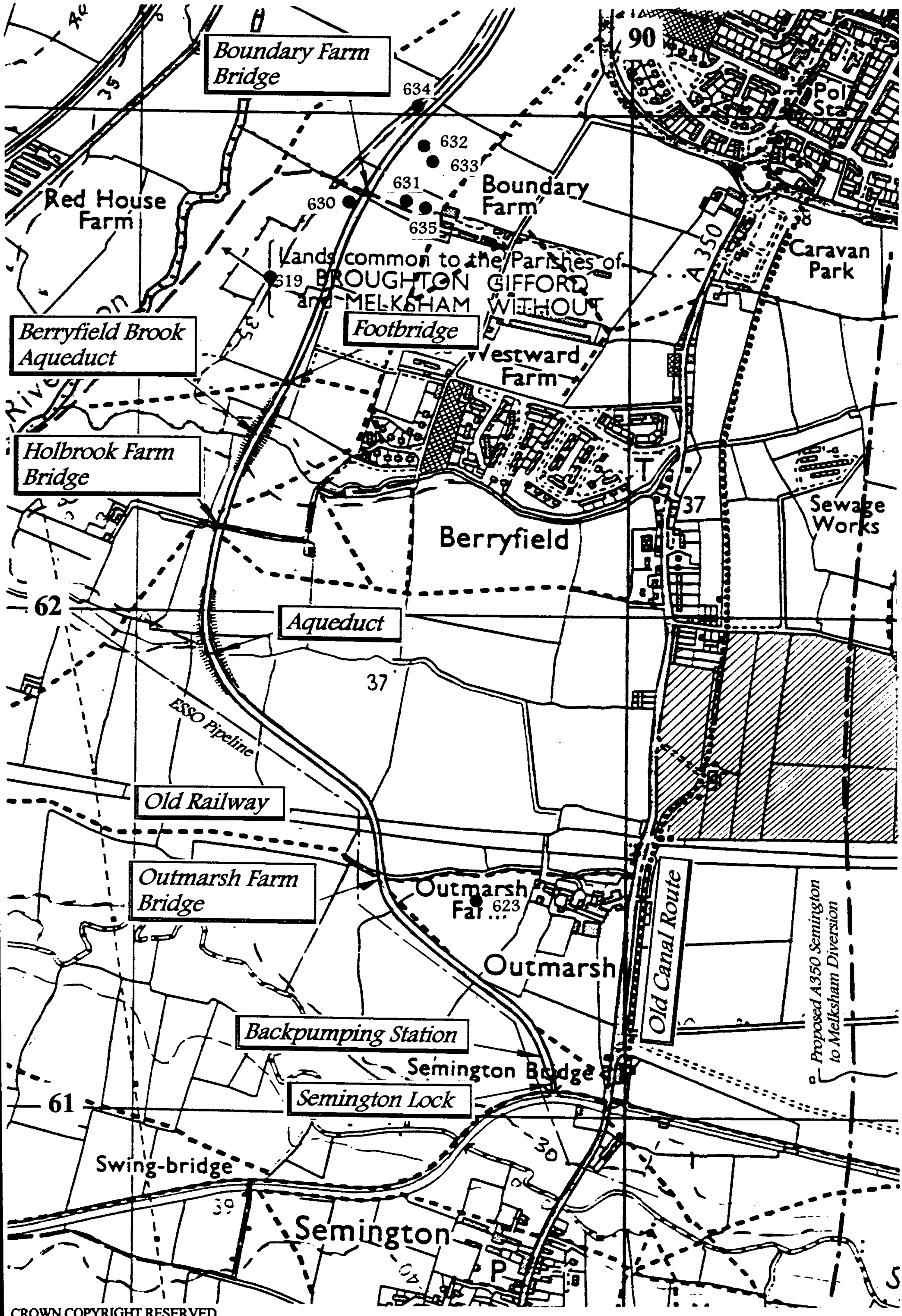
3. For new sections of canal, or new structures on restored sections, in many instances working names have been assigned to assist in identification.

4. Chainages have not been given, because of the problems this would create when considering alternative route options. Section lengths (rounded to the nearest 0.05km) and OS grid references of the features at each end of the section are given.

5. Levels for each pound are given to the nearest 0.1m, referenced to Ordnance Datum. These are based on analysis of historic lock lifts where appropriate. These levels should be used only as a general guide however.

6. The cost estimates for each section are estimated current tender prices based on conventional procurement through competitive tendering, and make no allowance for voluntary (labour free) costs. Land acquisition, design and supervision and contingencies are excluded. Costs of water procurement works (reservoirs, pipelines, boreholes, treatment etc), costs for related development and facilities (marinas etc), and operation and maintenance costs are also excluded. Costs shown for 'Canal Reach' include all earthworks, lining where recommended, towpath, finishing, fencing and all other costs not directly associated with individual structures or features, or services diversions. Refer to Chapter 3 for discussion on confidence levels for cost estimates.

SECTION 1



Boundary Farm Bridge
90
634
632
633
631
630
635
Red House Farm
Boundary Farm
Pol Sta
Caravan Park
A 350
Lands common to the Parishes of BROUGHTON GIFFORD and MELKSHAM WITHOUT
619
Berryfield Brook Aqueduct
Footbridge
Westward Farm
Holbrook Farm Bridge
37
Sewage Works
Berryfield
62
Aqueduct
37
ESSO Pipeline
Old Railway
Outmarsh Farm Bridge
Outmarsh Far
623
Outmarsh
Old Canal Route
Proposed A350 Semington to Melksham Diversion
Backpumping Station
Semington Bridge
61
Semington Lock
30
Swing-bridge
39
Semington
P

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 1: Semington Junction to Boundary Farm Bridge (New Canal)

Length: 2.20km **OS Ref: ST 898610 to 895628** **Level: 38.3 to 37.8mAOD; 1 lock**

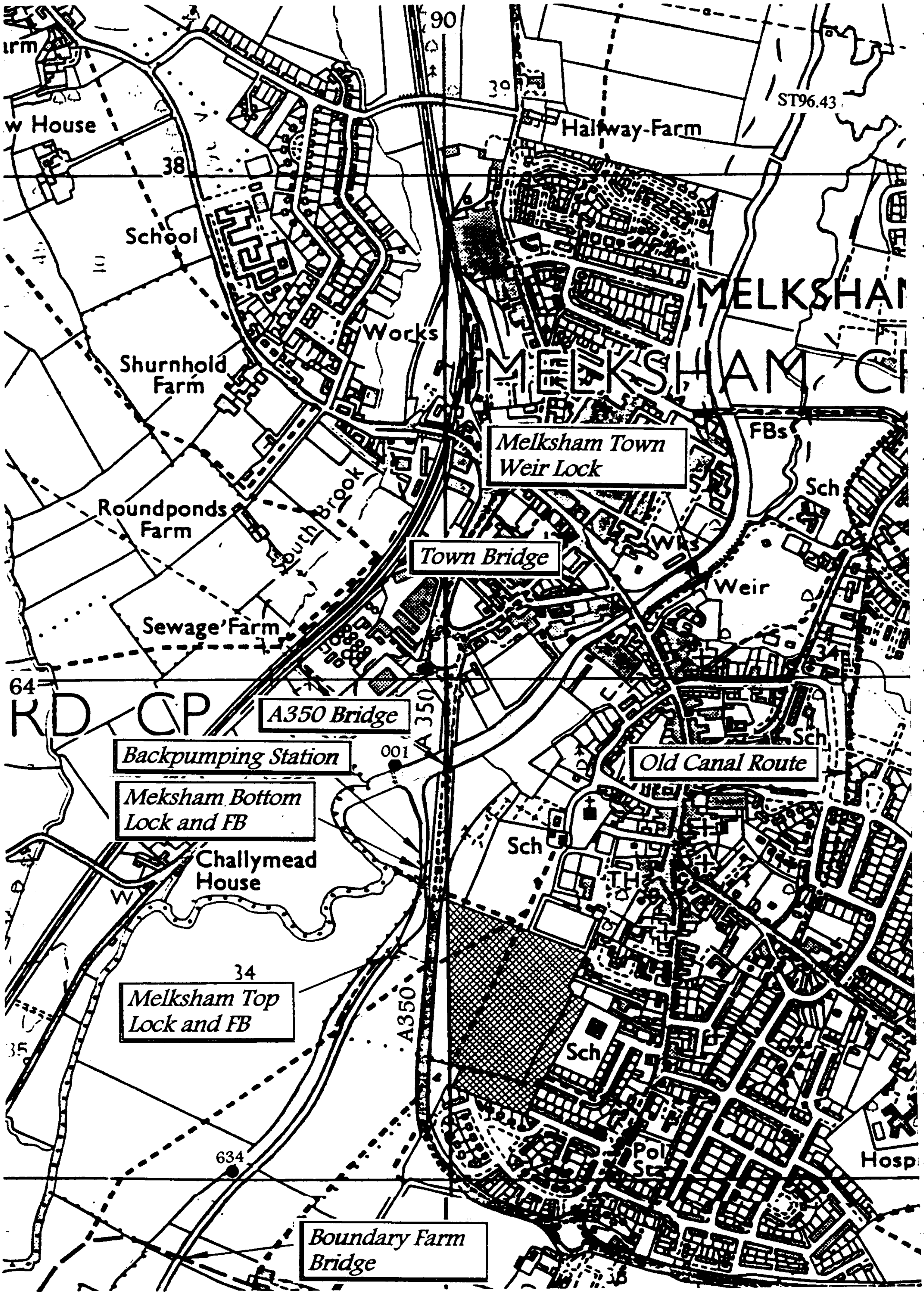
Description: New canal reach (together with Sections 2 and 3) to replace original route through Melksham which is not recoverable. This route utilises the River Avon for navigation through the centre of Melksham. This section is over relatively level agricultural land, and crosses two Avon tributaries including the Berryfield Brook, which takes discharge from the Berryfield Sewage Treatment works. The alignment is flexible.
Geology: River Terrace deposits and head deposits overlying Oxford Clay
Water Resources: Currently no proposals for water resource development in this section. Melksham sewage works within 1 km of the new alignment.
Navigation, Recreation and Leisure:
Environmental Features:
Services: Esso pipeline (route planned to avoid this but follows same corridor)
Land Use: Agriculture, Grade 1.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Simple engineering work mainly through open fields at-grade; embankments required over the two watercourse crossings. Lining of approx 1km required to minimise excessive leakage (Cost £390,000)	1,025,000
Services		15,000
Semington Regulating Lock	New regulating lock at the junction with the Kennet & Avon Canal. Fall of 0.5m assumed to 37.8mAOD	135,000
Backpumping Station	Required for lockage conservation. Rising main length 60m to discharge above lock.	45,000
Outmarsh Farm Bridge	Allow for a fixed farm accommodation bridge	50,000
Old Railway Crossing	No special measures allowed for	0
Aqueduct	Allow for a large diameter culvert	20,000
Holbrook Farm Bridge	Allow for a fixed farm access bridge, also for right of way	50,000
Berryfield Brook Aqueduct	Allow for a large diameter culvert	20,000
Footbridge	Allow for footbridge for existing right of way	25,000
Boundary Farm Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,385,000

Notes:
This route is strongly prefered on amenity grounds to maximize benefits to Melksham; however, the impact of introducing navigation on the Avon is significant. Use of the river will mean navigation is impracticable at times of high flow. An alternative route for the canal to the east of Melksham is feasible and should be considered as a fall-back option.

SECTION 2



Melksham Town Weir Lock
Town Bridge
A350 Bridge
Backpumping Station
Meksham Bottom Lock and FB
Old Canal Route
Melksham Top Lock and FB
Boundary Farm Bridge
Halfway Farm
ST96.43
MELKSHAM
Works
School
Shurnhold Farm
Roundponds Farm
South Brook
Sewage Farm
Challymead House
FBs
Sch
Weir
Hosp
A350

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 2:Boundary Farm Bridge to Melksham Town Weir (New Canal)

Length: 1.1 + 0.7km (river) **OS Ref: ST 895628 to 905642** **Level: 38.0 to 31.0mAOD; 2 locks**

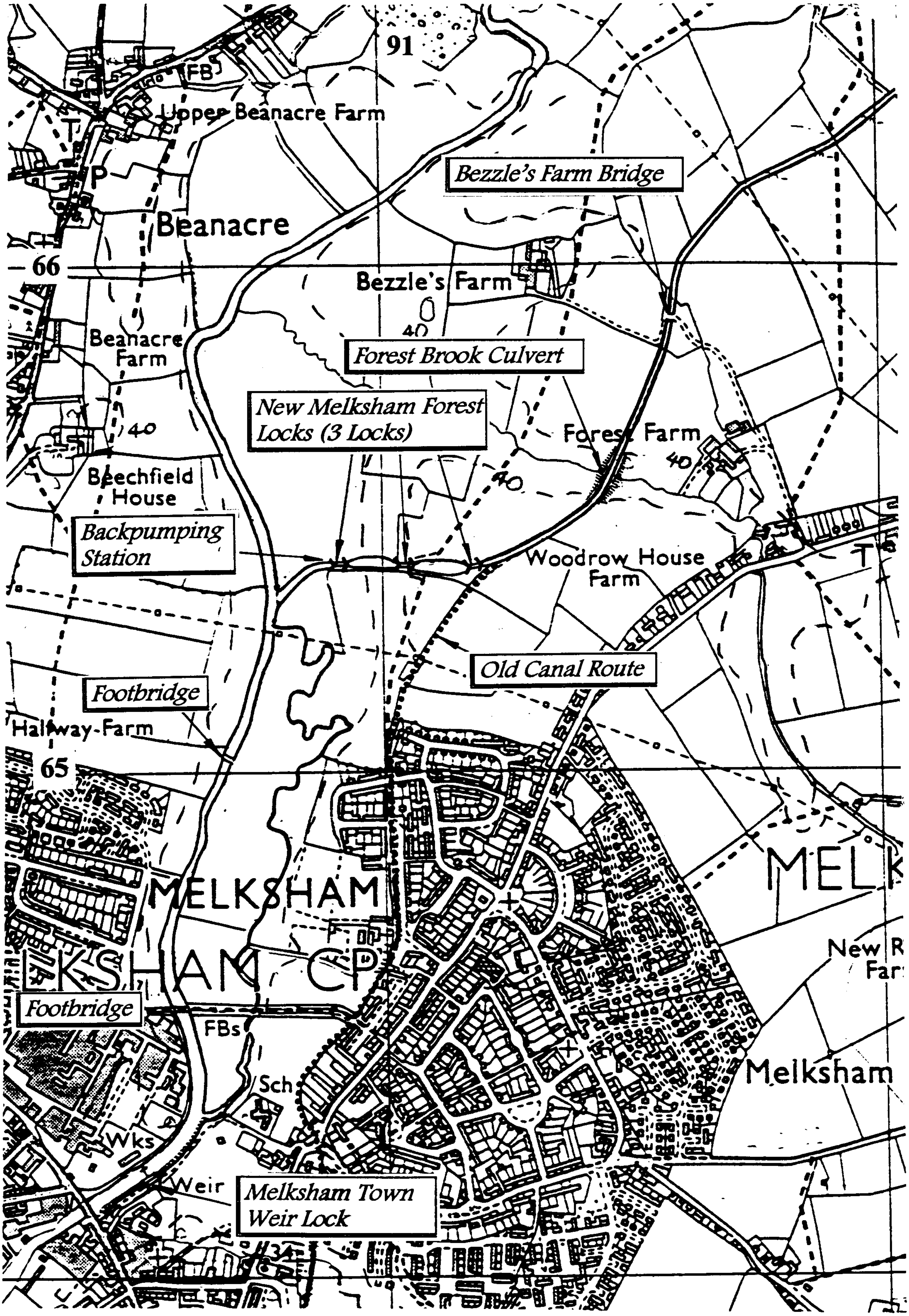
Description: New canal reach (together with Sections 1and 3) to replace original route through Melksham which is not recoverable. This route utilises the River Avon for navigation through the centre of Melksham. This section includes locks to drop down into the Avon beside the A350.
Geology: River Terrace deposits and Alluvium overlying Oxford Clay
Water Resources: Potential winter abstraction from Clackers Brook, with reservoir storage. Potential for re-use of treated urban runoff from Melksham.
Navigation, Recreation and Leisure: Melksham Gate (Town Weir): Environment Agency automatic flood control/level regulating structure. Melksham town facilities.
Environmental Features:
Services: Avon Rubber river intake upstream of Melksham Gate
Land Use: Agriculture, Grade 4; River Avon and flood plain.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Simple engineering work mainly through open fields at-grade; special measures to tolerate flooding where route crosses flood plain. Lining of approx 1km required to minimise excessive leakage (Cost £390,000)	735,000
Services		10,000
Boundary Farm Bridge	Allow for a fixed farm accommodation bridge, also for right of way (bridleway)	80,000
Melksham Top Lock and footbridge	New lock, fall assumed 3.5m, with footbridge over lock chamber	225,000
Melksham Bottom Lock and footbridge	New lock, fall assumed 3.5m, with footbridge over lock chamber	225,000
Backpumping Station	Required for lockage conservation. Rising main length 250m to discharge above Top lock. Special measures to tolerate flooding (submersible pumps with remote pump controls above flood level)	68,000
River Avon junction	Allow bank protection works at confluence	10,000
River Reach	Allow for low (bed) check weir just downstream of confluence, dredging of a central navigable channel and bank protection works (environmentally sensitive and sympathetic treatment will be essential).	250,000
A350 bridge	No works required, bridge has ample clearance	0
Day Moorings	Allow for provision of a number of day moorings on this reach.	80,000
Town Bridge	No works required, bridge has ample clearance	0
Melksham Town Weir Lock	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,683,000

Notes:
Two locks are assumed dropping into the Avon; dependent on detailed survey three might be required.
See also notes for Section 1.
It may prove desirable or necessary to reconstruct the town weir to accommodate the lock and a more reliable level control (eg a long weir); this will be very costly however, perhaps £2M.

SECTION 3



91
FB
Upper Beanacre Farm
Bezzle's Farm Bridge
Beanacre
66
Bezzle's Farm
40
Beanacre Farm
Forest Brook Culvert
New Melksham Forest Locks (3 Locks)
40
Forest Farm
40
Beechfield House
40
Backpumping Station
Woodrow House Farm
Old Canal Route
Footbridge
Halfway Farm
65
MELK
MELKSHAM
KSHAM CP
New R Far
Footbridge
FBs
Sch
Melksham
Wks
Weir
Melksham Town Weir Lock

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 3: Melksham Town Weir to Bezzle's Farm Bridge (New Canal)

Length: 1.25 (river) **+ 1.1 km OS Ref: ST 905642 to 916659 Level: 31.0 to 41.7mAOD; 4 locks**

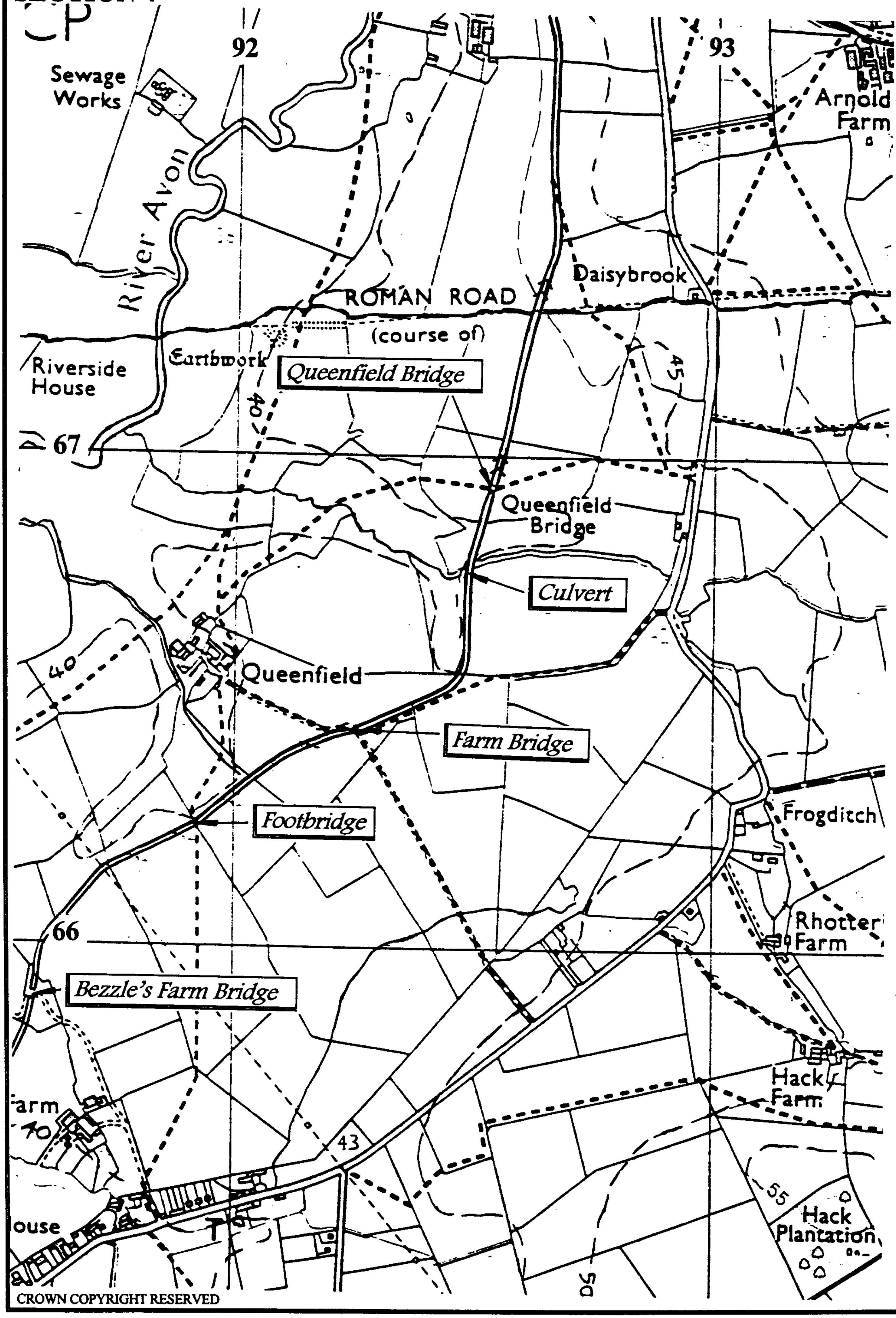
Description: New canal reach (together with Sections 1and 2) to replace original route through Melksham which is not recoverable. This route utilises the River Avon for navigation through the centre of Melksham. This section includes locks to climb from the Avon to rejoin the original route north of the town.
Geology: Thin River Alluvium and Terrace deposits overlying Oxford Clay; Oxford Clay on original alignment
Water Resources: Potential winter abstraction from tributary of River Avon south of Forest Farm, with reservoir storage
Navigation, Recreation and Leisure:
Environmental Features: Possible conflict of fishing interests and navigation on the Avon reach
Services:
Land Use: River Avon; Agriculture, Grade 4

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
River Reach	No works should be necessary to the river reach above Town Weir.	0
Melksham Town Weir Lock	Lock rise to 32.8mAOD (target level automatically maintained by Melksham Gate), estimate 1.7m.	750,000
Footbridge	Existing footbridge over the River Avon	0
Footbridge	Existing footbridge over the River Avon	0
River Avon junction	Allow bank protection works at confluence	7,000
Canal Reach	A short length (450m) of new cut across the Avon flood plain to rejoin the original alignment, requiring special measures to tolerate flooding; the old canal has been infilled over the remainder of this reach, but is readily recoverable.	295,000
Services		10,000
Backpumping Station	Required for lockage conservation. Rising main length 350m to discharge above Top lock. Special measures to tolerate flooding (submersible pumps with remote pump controls above flood level)	90,000
New Melksham Forest Bottom Lock	New lock, rise assumed 3.0m	210,000
New Melksham Forest Middle Lock and Bridge	New lock, rise assumed 3.0m, with bridge over lock chamber for right of way (allow for vehicle crossing)	220,000
New Melksham Forest Top Lock	New lock, rise assumed 2.9m to 41.7mAOD to rejoin original canal line and level near the remains of an arch bridge (assumed no longer required)	210,000
Forest Brook Culvert	Existing culvert in good condition	2,000
Bezzle's Farm Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,794,000

Notes:
See also notes for Section 1.

SECTION 4



92
93
Sewage Works
Arnold Farm
River Avon
Daisybrook
ROMAN ROAD
(course of)
Earthwork
Riverside House
Queenfield Bridge
45
40
67
Queenfield Bridge
Culvert
40
Queenfield
Farm Bridge
Footbridge
Frogditch
Rhotter Farm
66
Bezzle's Farm Bridge
Hack Farm
43
55
Hack Plantation
50

SECTION 4:Bezzle's Farm Bridge to Queensfield Bridge

Length: 1.50km **OS Ref: ST 916659 to 925669** **Level: 41.7mAOD**

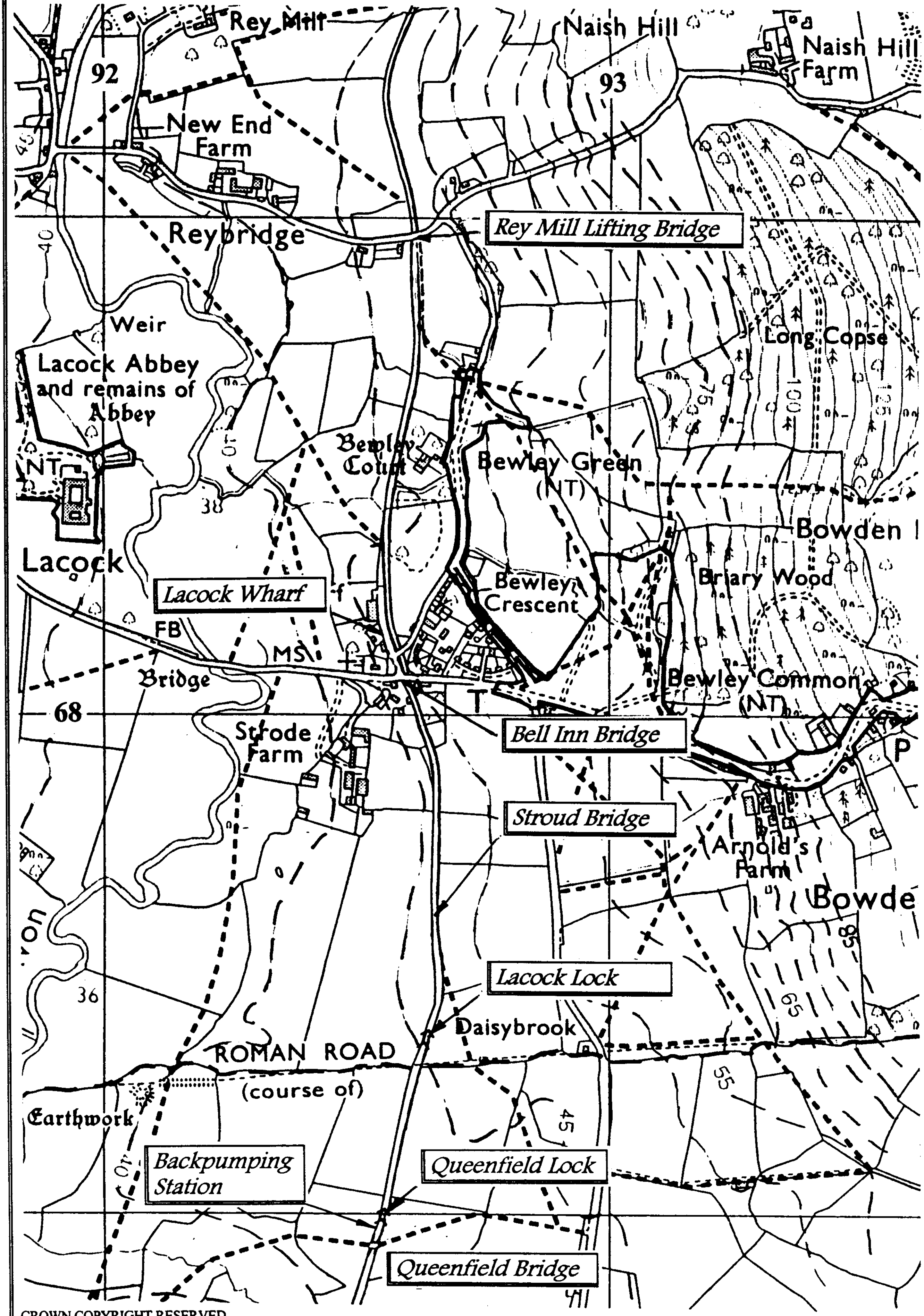
Description: Rural reach through farmland, readily recoverable
Geology: Oxford Clay with a short section on thin River Terrace/Head deposits
Water Resources: Potential winter abstraction from River Sands & Gravels aquifer around Queenfield
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal infilled for some 0.5km around Queenfield, otherwise canal bed generally clear	215,000
Services		10,000
Bezzle's Farm Bridge	No remains visible; allow for new fixed farm access bridge with regrading of approaches	50,000
Bridge	Original bridge removed. Allow for new footbridge for right of way	25,000
Farm Access Bridge	Provide new fixed farm access bridge with regrading of approaches	50,000
Culvert	Existing culvert in good condition.	0
Queenfield Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	350,000

Notes:

SECTION 5



Rey Mill
Naish Hill
Naish Hill Farm
92
93
New End Farm
Reybridge
Rey Mill Lifting Bridge
Weir
Lacock Abbey and remains of Abbey
Long Copse
Bewley Court
Bewley Green (NT)
NT
Bowden
Lacock
Briary Wood
Bewley Crescent
Lacock Wharf
FB
MS
Bridge
Bewley Common (NT)
68
Bell Inn Bridge
Strode Farm
Stroud Bridge
Arnold's Farm
Bowde
Lacock Lock
Daisybrook
ROMAN ROAD (course of)
Earthwork
Backpumping Station
Queenfield Lock
Queenfield Bridge

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 5: Queenfield Bridge to Rey Mill Bridge

Length: 2.10km **OS Ref: ST 925669 to 926689** **Level: 41.7 to 46.9mAOD; 2 locks**

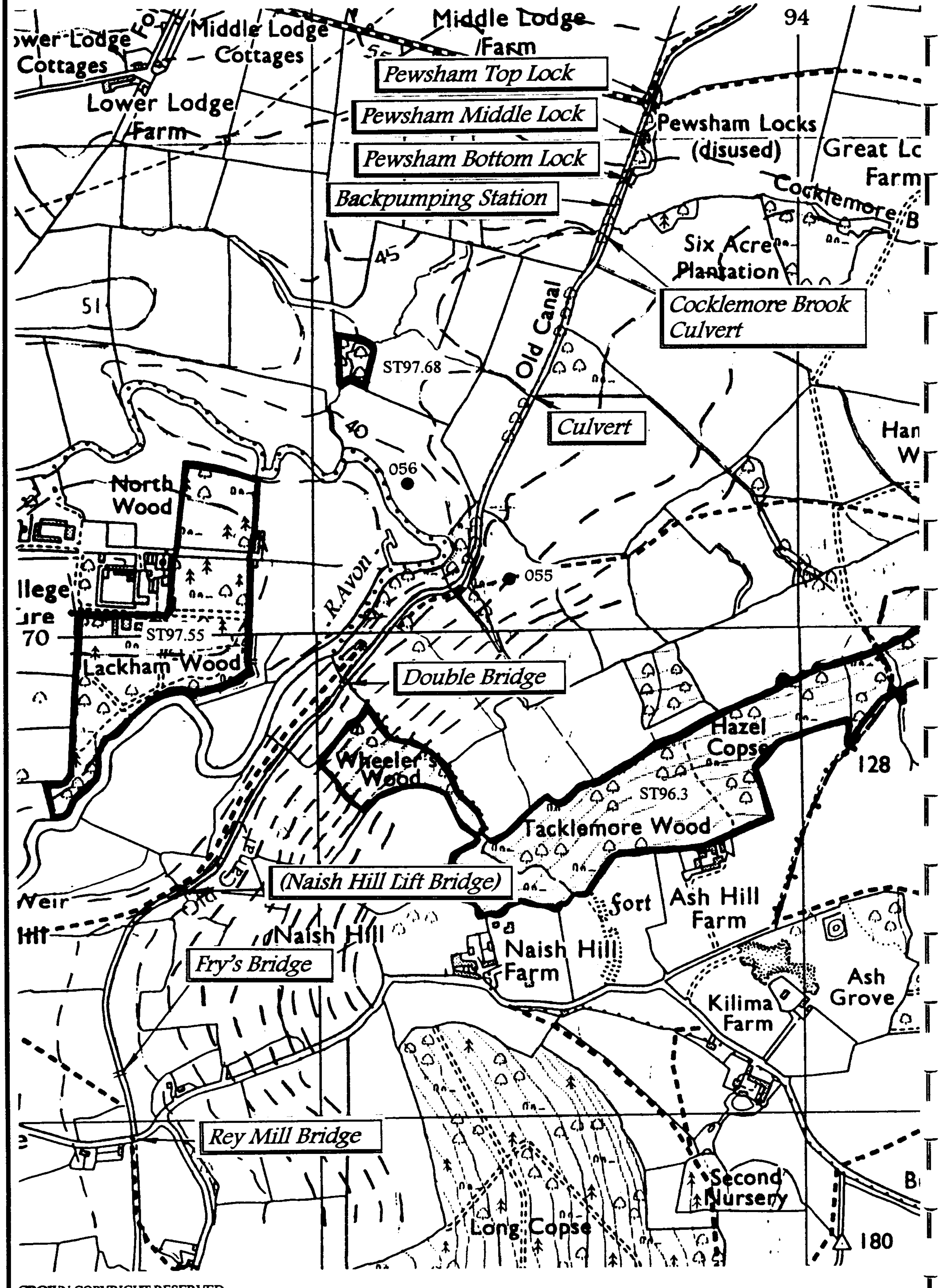
Description: Rural reach including historic Lacock and Lacock Abbey
Geology: Oxford Clay; route skirts River Terrace deposits
Water Resources: Potential winter abstraction from Lower Greensand aquifer east of Bowden Hill
Navigation, Recreation and Leisure: Lacock Abbey, Bewley Green and Bewley Common (all National Trust) within 1km of canal
Environmental Features:
Services: O/H elec pole to be moved opposite Bell Inn
Land Use: Agriculture, Grade 3. Residential (Bewley Crescent)

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	From the Bell Inn northwards the canal is infilled and forms a garden for Bewley Court. There is a slurry pit between Queenfield and Lacock Lock. Otherwise the canal bed is relatively clear.	460,000
Services		20,000
Queenfield Bridge	Original bridge removed. Provide new farm accommodation bridge, also for right of way.	50,000
Backpumping Station	Required for lockage conservation. Rising main length 400m to discharge above Lacock Lock	75,000
Queenfield Lock	Fair condition but filled with rubbish. Original lift 2.39m to 44.0mAOD	75,000
Lacock Lock	Fair condition but overgrown. Restore lock or build new lock at Reybridge to lower canal under road crossings. Original lift 2.84m to 46.9mAOD	75,000
(Stroud Bridge)	One abutment remains. Partly clear, bridge probably not now required.	0
Bell Inn Bridge	Canal infilled forming gardens (and swimming pool) on south side of bridge. Divert canal through Bell Inn car park and construct new canal bridge, with regrading of approaches. Additional parking required for Bell Inn.	125,000
Access Bridge	North of Bell Inn Bridge, move junction of twin tracks northwards clear of road to provide space for canal and provide new access bridge.	60,000
Lacock Wharf	Only house remains, canal infilled to form access track.	0
Rey Mill Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	940,000

Notes:

SECTION 6


Middle Lodge Cottages
Lower Lodge Cottages
Lower Lodge Farm
Middle Lodge Farm
94
Pewsham Top Lock
Pewsham Middle Lock
Pewsham Bottom Lock
Backpumping Station
Pewsham Locks (disused)
Great Lo
Farm
Cocklemore B
Six Acre Plantation
Cocklemore Brook Culvert
45
51
Old Canal
ST97.68
Culvert
40
056
North Wood
R.Avon
055
llege
ire
70
ST97.55
Lackham Wood
Double Bridge
Hazel Copse
128
Wheeler's Wood
ST96.3
Tacklemore Wood
(Naish Hill Lift Bridge)
Weir
Hill
Naish Hill
Fort
Ash Hill Farm
Naish Hill Farm
Fry's Bridge
Ash Grove
Kilima Farm
Rey Mill Bridge
Second Nursery
Long Copse
180

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 6: Rey Mill Bridge to Pewsham Top Lock

Length: 2.70km **OS Ref: ST 926689 to 937712** **Level: 46.9 to 52.9mAOD; 2 locks**

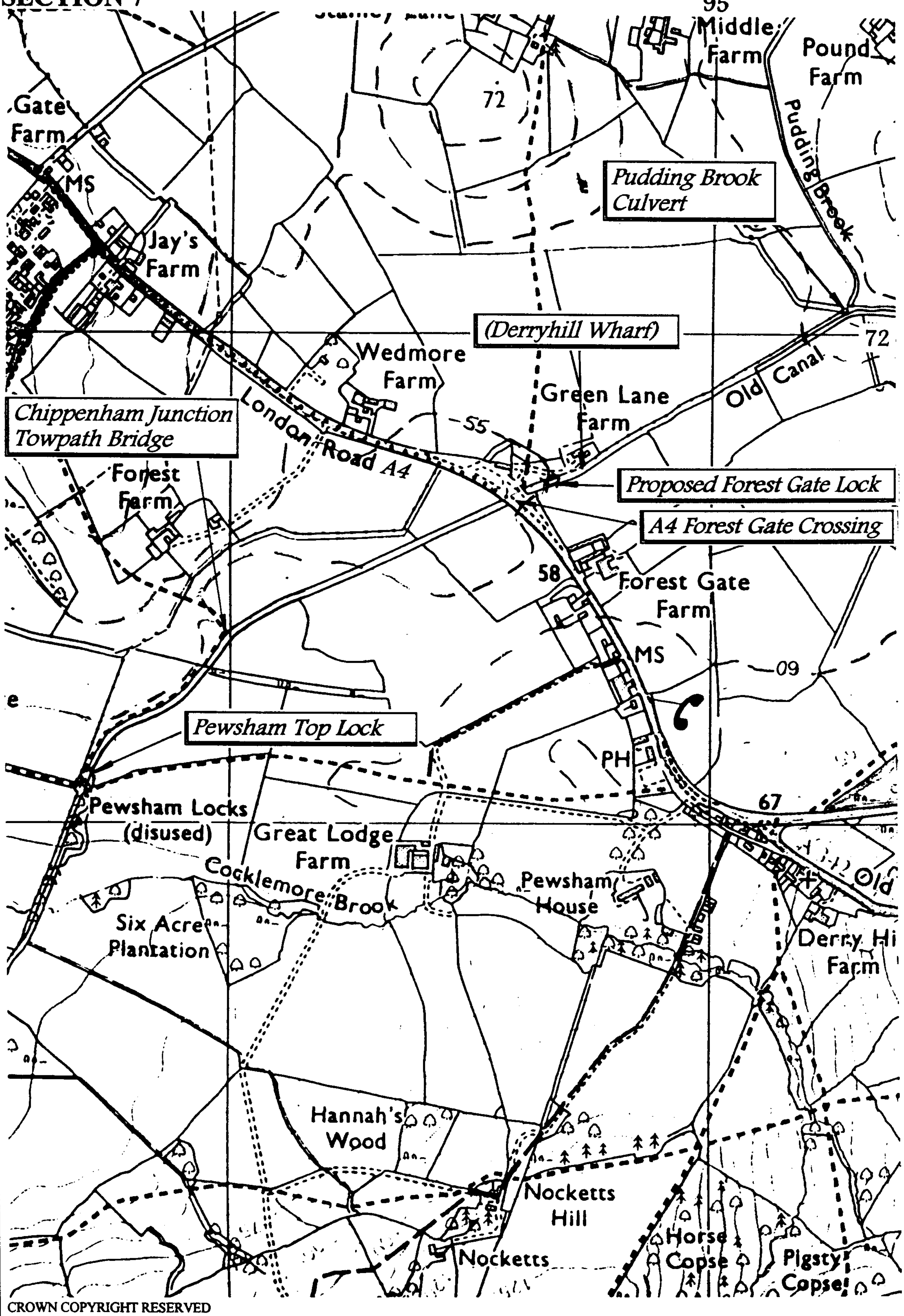
Description: Rural reach, relatively inaccessible except on foot.
Geology: River Alluvium of the Avon from Rey Mill to just south of Cocklemore Brook; then Oxford Clay
Water Resources: Potential winter abstraction from the deep Great Oolite aquifer in the vicinity of Great Lodge Farm
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 3; some woodland

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal infilled for approx 0.5km between Rey Mill Bridge and Naish Hill Bridge, and 0.5km north of Pewsham Top Lock. Canal is dry, grassed over and well silted up along the hillside above the River Avon, although there is a wet and reedy section north of Naish Hill Bridge which may require additional drainage works to stabilise.	440,000
Services		10,000
Rey Mill (Lift) Bridge	Original lift bridge removed and infilled. Replace with new fixed road bridge. Alternative farm access required.	60,000
Fry's Bridge	No trace visible. Small ditch. Allow for a farm accommodation bridge at this location.	50,000
(Naish Hill Lifting Bridge)	No trace visible. Bridge not now required.	0
Double Bridge	Parapet missing. Brick Arch in place. Restore bridge to safe condition.	5,000
Culvert	Restore culvert.	2,000
Cocklemore Brook Culvert	Partly destroyed. Well defined bedsides overgrown. Replace culvert. Also location of original brickwork overflow channel.	50,000
Backpumping Station	Required for lockage conservation. Rising main length 350m to discharge above Pewsham Top Lock	110,000
Pewsham Bottom Lock	One wall left overgrown. Rebuild lock. Original lift 3.01m to 49.9mAOD	120,000
Spillway and wide pound	Wide spillway (east bank) and 100m semicircular pound	5,000
Pewsham Middle Lock	Both chambers mostly intact but overgrown. Rebuild lock. Original lift 3.01m to 52.9mAOD	90,000
Pewsham Top Lock	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	942,000

Notes:

SECTION 7



95
Middle Farm
Pound Farm
72
Gate Farm
MS
Pudding Brook
Pudding Brook Culvert
Jay's Farm
(Derryhill Wharf)
72
Wedmore Farm
Old Canal
Chippenham Junction Towpath Bridge
London Road A4
55
Green Lane Farm
Forest Farm
Proposed Forest Gate Lock
A4 Forest Gate Crossing
58
Forest Gate Farm
MS
09
Pewsham Top Lock
PH
67
Pewsham Locks (disused)
Great Lodge Farm
Cocklemore Brook
Pewsham House
Old
Six Acre Plantation
Derry Hill Farm
Hannah's Wood
Nocketts Hill
Nocketts
Horse Copse
Pigsty Copse

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 7: Pewsham Top Lock to Pudding Brook Culvert

Length: 1.90km **OS Ref: ST 937712 to 953720** **Level: 52.9 to 55.5mAOD; 1 lock**

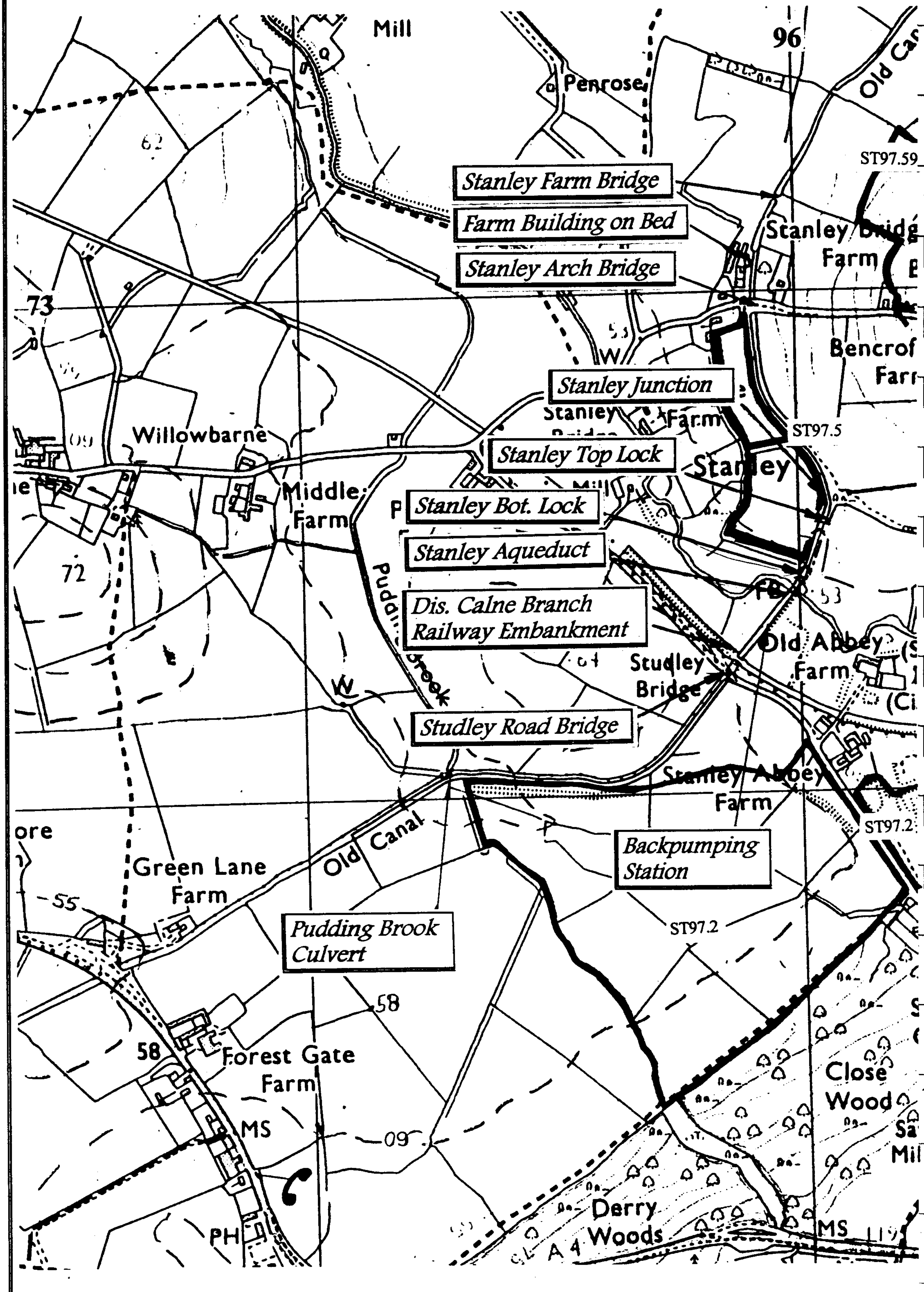
Description: The main feature is the A4 crossing at Forest Gate
Geology: Oxford Clay
Water Resources: Potential winter abstraction from Lower Avon south of Chippenham, with reservoir storage. Chippenham sewage treatment works about 2 km from canal, but within Lower Avon catchment proposed for abstraction.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 3; SAAB garage at A4 Forest Gate

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	South of the A4, canal bed generally clear; north side good condition but overgrown. Infilled between Pewsham Top and Chippenham Junction.	265,000
Services		30,000
Pewsham Top Lock	Both chambers mostly intact but overgrown. Original lift 2.61m to 55.5mAOD. Make safe remains but otherwise abandon to allow canal to continue (at 52.9mAOD) to cross under the A4. Provide pedestrian tailbridge for right of way.	20,000
Chippenham Junction Towpath Bridge	No trace of original bridge. Junction infilled. Allow for a footbridge / farm accommodation bridge.	25,000
A4 Forest Gate Crossing	Infilled, original bridge removed. Bed culverted. Realign A4 west of existing to raise level approx 1.2m. Provide wide carriageway to allow for right hand turning lane to garage.	250,000
Backpumping station	For lockage conservation. Rising main length 60m discharging above New Forest Gate Lock.	45,000
(New) Forest Gate Lock	Replacement for Pewsham Top Lock. (Original lift 2.61m to 55.5m). Combine with farm access crossing.	195,000
Derryhill Wharf	No remains; development potential.	0
Pudding Brook Culvert	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	830,000

Notes:
Work on clearance of Pewsham Top lock started in 1991, but politics prevented extensive work being done. Lowering the canal above Pewsham Top should improve land drainage locally.

SECTION 8



Stanley Farm Bridge
Farm Building on Bed
Stanley Arch Bridge
Stanley Junction
Stanley Top Lock
Stanley Bot. Lock
Stanley Aqueduct
Dis. Calne Branch
Railway Embankment
Studley Road Bridge
Backpumping
Station
Pudding Brook
Culvert
ST97.59
ST97.5
ST97.2
ST97.2
Mill
Penrose
96
73
72
Willowbarne
Middle
Farm
Stanley Bridge
Farm
Bencrof
Old Abbey
Farm
Studley
Bridge
Stanley Abbey
Farm
Old Canal
Green Lane
Farm
Forest Gate
Farm
58
MS
PH
Derry
Woods
Close
Wood
A 4

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 8: Pudding Brook to Stanley Farm Bridge

Length: 1.70km **OS Ref: ST 953720 to 960732** **Level: 55.5 to 60.6mAOD; 2 locks**

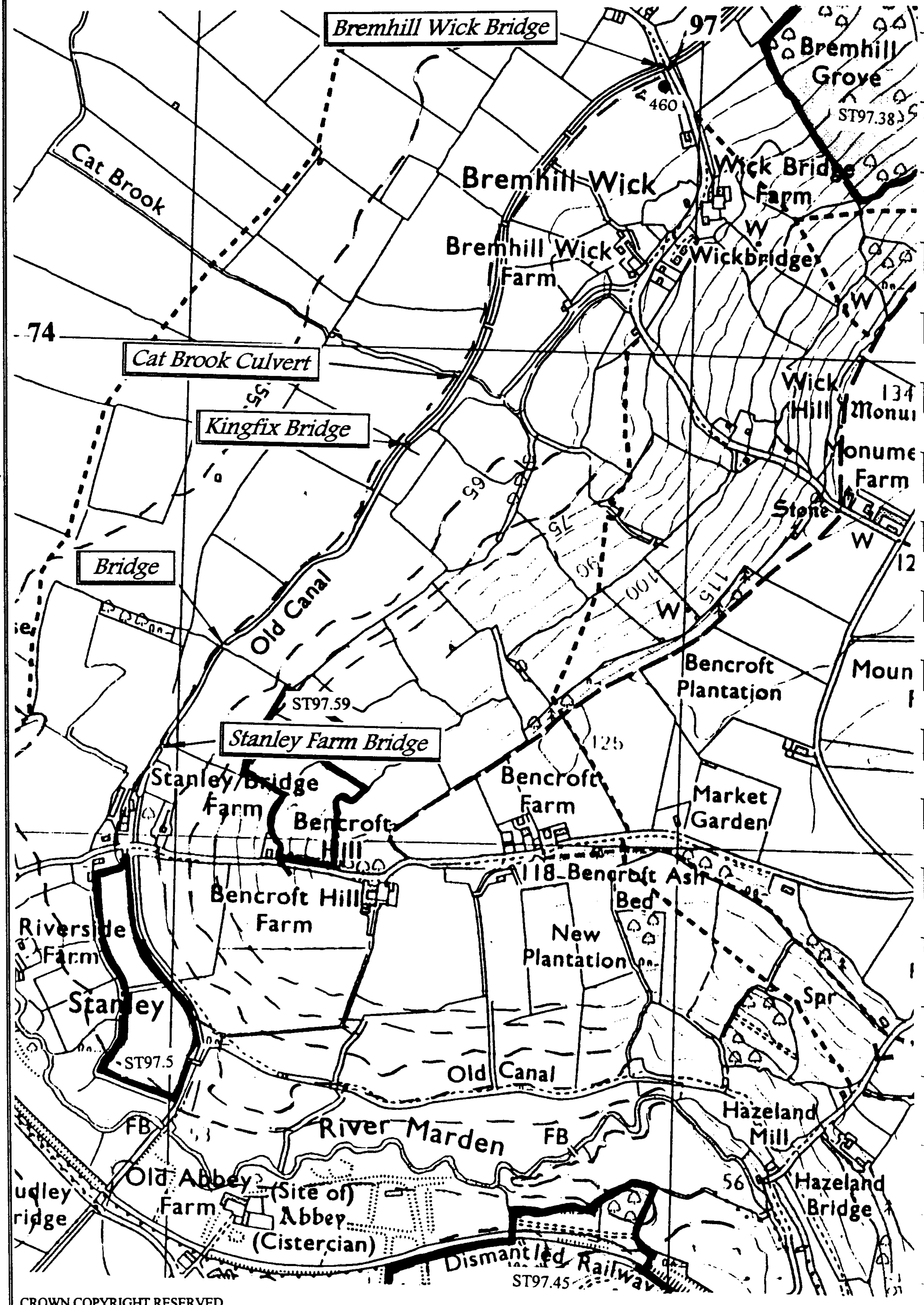
Description: A busy rural reach including Stanley Aqueduct across the River Marden, the crossing of the old Calne Branch railway and the junction with the Calne Branch of the canal.
Geology: Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture Grade 3.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal is infilled for some 100m north of Stanley Bridge (with a farm building on the line) and some tipping has taken place nearby. Elsewhere the original route is generally recoverable with clearance and dredging.	170,000
Services		15,000
Pudding Brook Culvert	Provide new culvert	25,000
Studley Road Bridge	Road crosses at high level on infill. Provide new bridge.	50,000
Disused Calne Branch Railway Embankment	Clear bridgehole and make safe.	5,000
Backpumping Station	Required for lockage conservation. Rising main length 200m to discharge above Stanley Top Lock	65,000
Stanley Aqueduct	Partly collapsed altough abutments reasonable. Reconstruct aqueduct.	100,000
Stanley Bottom Lock	Poor condition. Rebuild lock. Original lift 2.74m to 58.3mAOD	120,000
Stanley Top Lock	Brickwork in very good condition. Restore lock. Original lift 2.36m to 60.6mAOD	60,000
Stanley Junction	Very overgrown. Restoration cost included in canal reach.	0
Stanley (Arch) Bridge	Original bridge removed. High road level with steep approaches. Provide new bridge.	50,000
Farm Building on bed	Relocate building.	100,000
(Bridge)	Original bridge removed. Assume no longer required.	0
Stanley Farm Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	760,000

Notes:

SECTION 9



Bremhill Wick Bridge
Cat Brook Culvert
Kingfix Bridge
Bridge
Stanley Farm Bridge
Cat Brook
Bremhill Wick
Bremhill Wick Farm
Wick Bridge Farm
Wickbridge
Bremhill Grove
ST97.38
Wick Hill
Monument Farm
Stone
Old Canal
ST97.59
Bencroft Plantation
Stanley Bridge Farm
Bencroft Hill
Bencroft Farm
Market Garden
Bencroft Hill Farm
Bencroft Ash Bed
Riverside Farm
Stanley
New Plantation
ST97.5
Old Canal
River Marden
FB
Hazeland Mill
Hazeland Bridge
Old Abbey Farm
(Site of) Abbey (Cistercian)
Dismantled Railway
ST97.45

SECTION 9: Stanley Farm Bridge to Bremhill Wick Bridge

Length: 1.75km **OS Ref: ST 960732 to 969746** **Level: 60.6mAOD**

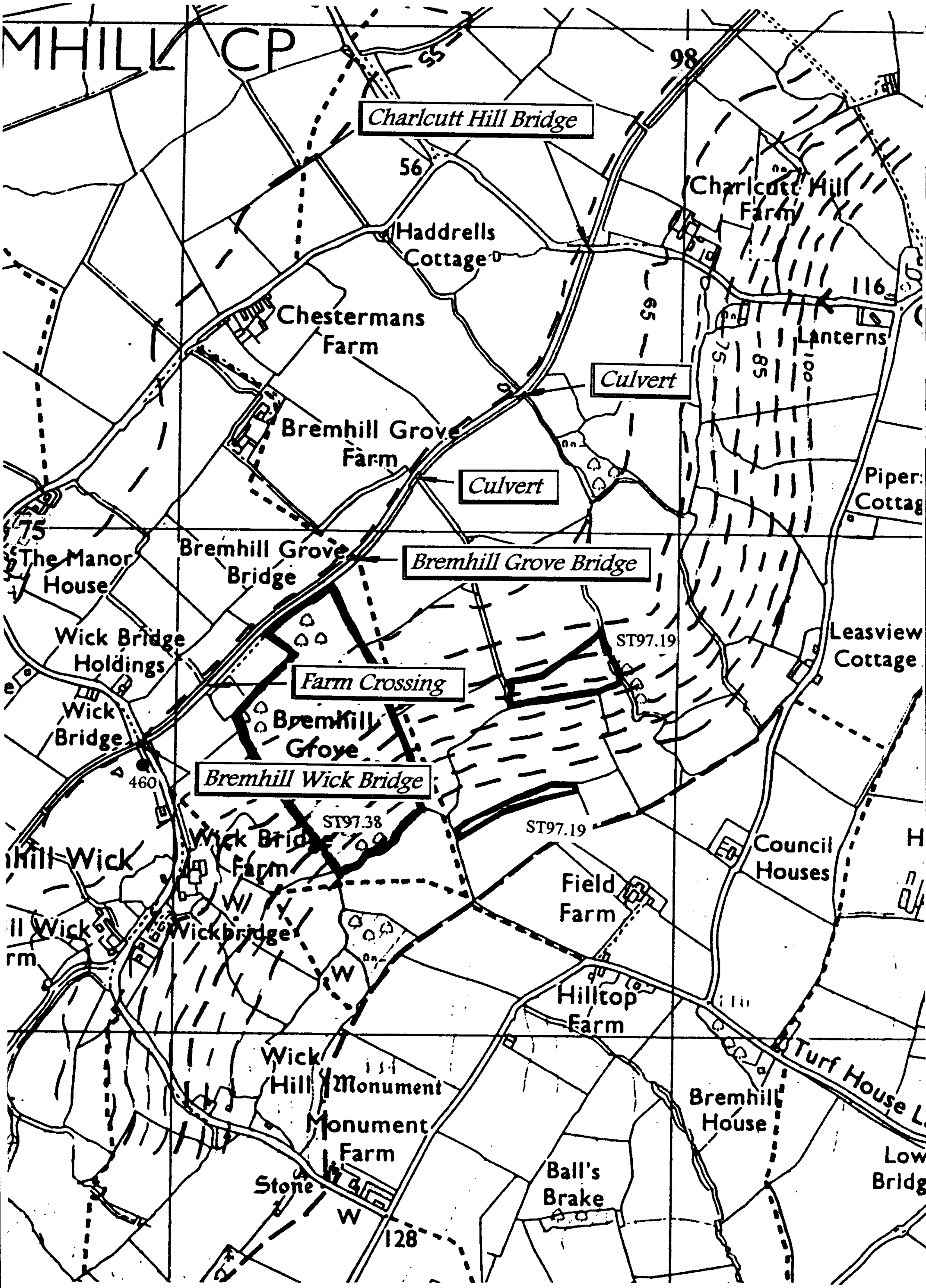
Description: Rural reach with limited access (no public rights of way)
Geology: Oxford Clay
Water Resources: Potential winter abstraction from River Sands & Gravels in the vicinity of West Tytherton
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 3.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal bed well-defined but sides over grown.	157,000
Services		5,000
Stanley Farm Bridge	Removed. Assume new farm accommodation bridge required.	50,000
Bridge (?)	Not visible. Assume new farm accommodation bridge required.	50,000
King Fix Bridge	Not visible. Assume new farm accommodation bridge required.	50,000
Cat Brook Culvert	Not visible. New culvert required.	30,000
Other crossings	Allow two further farm accommodation bridges on this reach	100,000
Bremhill Wick (Arch) Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	442,000

Notes:
Lift bridges or traditional arch bridges may be appropriate on this reach.

SECTION 10



MHILL CP
Charlcutt Hill Bridge
Culvert
Culvert
Bremhill Grove Bridge
Farm Crossing
Bremhill Wick Bridge
ST97.19
ST97.38
ST97.19
Haddrells Cottage
Chestermans Farm
Bremhill Grove Farm
Bremhill Grove Bridge
The Manor House
Wick Bridge Holdings
Wick Bridge
Bremhill Grove
Wick Bridge Farm
Wickbridge
Wick Hill
Monument
Monument Farm
Stone
Charlcutt Hill Farm
Lanterns
Pipers Cottag
Leasview Cottage
Council Houses
Field Farm
Hilltop Farm
Bremhill House
Ball's Brake
Turf House L
Low Bridg
98
56
55
65
75
85
100
116
75
460
128

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 10: Bremhill Wick Bridge to Charlcutt Hill Bridge

Length: 1.35km **OS Ref: ST 969746 to 978755** **Level: 60.6mAOD**

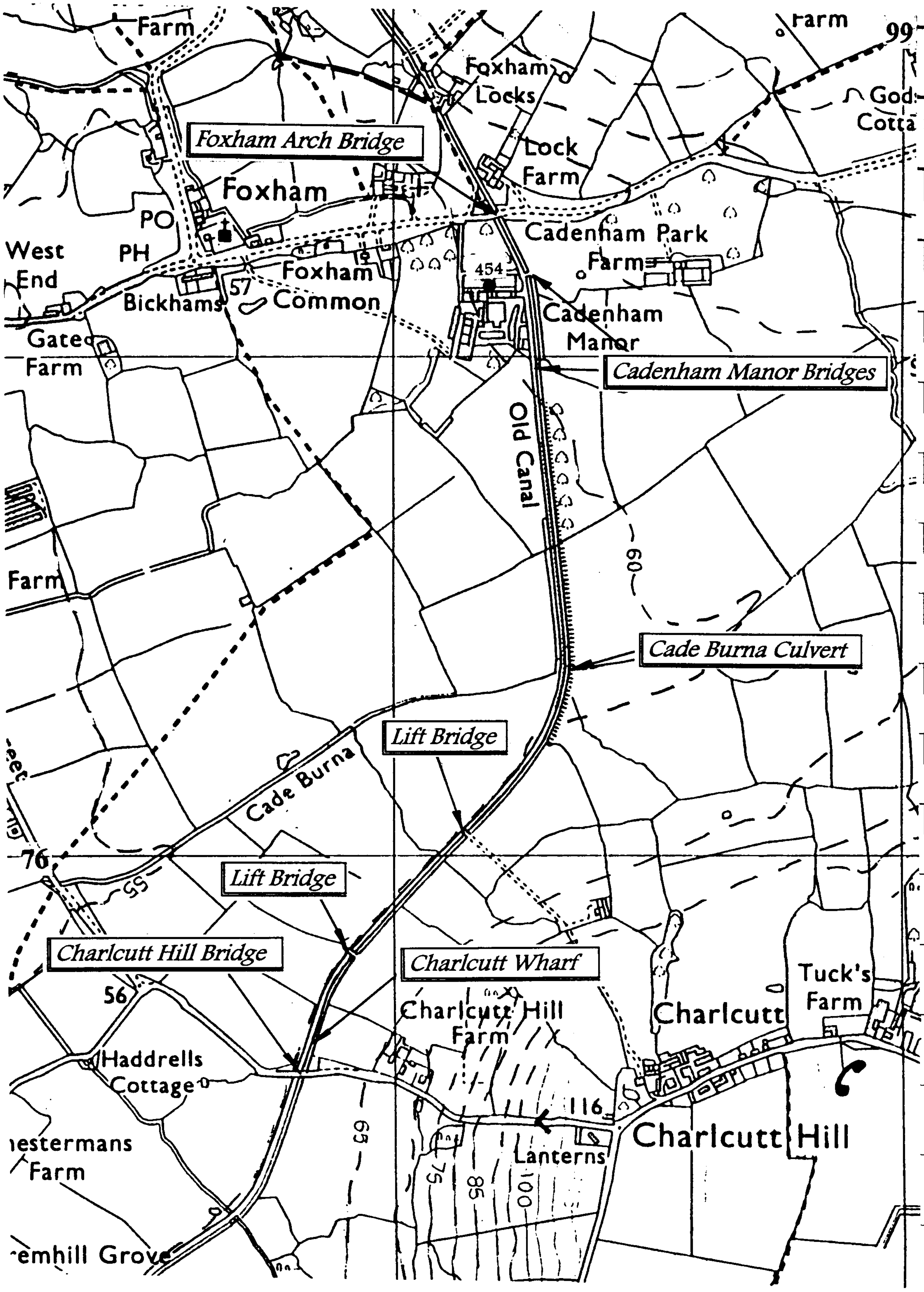
Description: Rural reach through farmland
Geology: Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 3; woodland (Bremhill Grove)

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	For the first 150m of this reach, the canal bed has been narrowed and carries a watercourse, which enters at Wick Bridge from the SE, running parallel to the road and leaves turning NW. The next 270m is infilled. The balance is in-water though not restored, and otherwise generally clear, but the towpath is overgrown.	180,000
Services		5,000
Bremhill Wick (Arch) Bridge	The original Wick Arch Bridge is infilled and the canal bed piped. New fixed bridge required. It will need a slight rise in the road to achieve this, but this should not be a problem.	75,000
Farm Crossing	Accomodation bridge to replace existing farm crossing	50,000
Bremhill Grove (Lift) Bridge	Bridge abutments and wooden decking remain, serving as a public footpath. Restore, or replace with fixed footbridge for right of way.	25,000
Culvert	Culvert required for drainage off the escarpment.	25,000
Culvert	Culvert required for drainage off the escarpment.	25,000
Charlcutt Hill Road Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	385,000

Notes:

SECTION 11



Farm
Farm
99
Foxham Locks
God
Cotta
Foxham Arch Bridge
Lock Farm
Foxham
PO
West End
PH
Foxham
Cadenham Park Farm
454
57
Bickhams
Common
Cadenham Manor
Gate Farm
Cadenham Manor Bridges
Old Canal
Farm
60
Cade Burna Culvert
Lift Bridge
Cade Burna
76
Lift Bridge
55
Charlcutt Hill Bridge
Charlcutt Wharf
Tuck's Farm
56
Charlcutt Hill Farm
Charlcutt
Haddrells Cottage
116
Charlcutt Hill
65
Lanterns
75
85
100
Farm
Grove

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 11: Charlcutt Hill Bridge to Foxham Bridge

Length: 1.90km **OS Ref: ST 978755 to 981775** **Level: 60.6mAOD**

Description: Rural reach through farmland ending at Foxham. No public right of way or vehicle access south of Foxham.

Geology: Oxford Clay

Water Resources: Potential winter abstraction from Cada Burna, with reservoir storage. Possible use of treated runoff from RAF Lyneham.

Navigation, Recreation and Leisure:

Environmental Features:

Services:

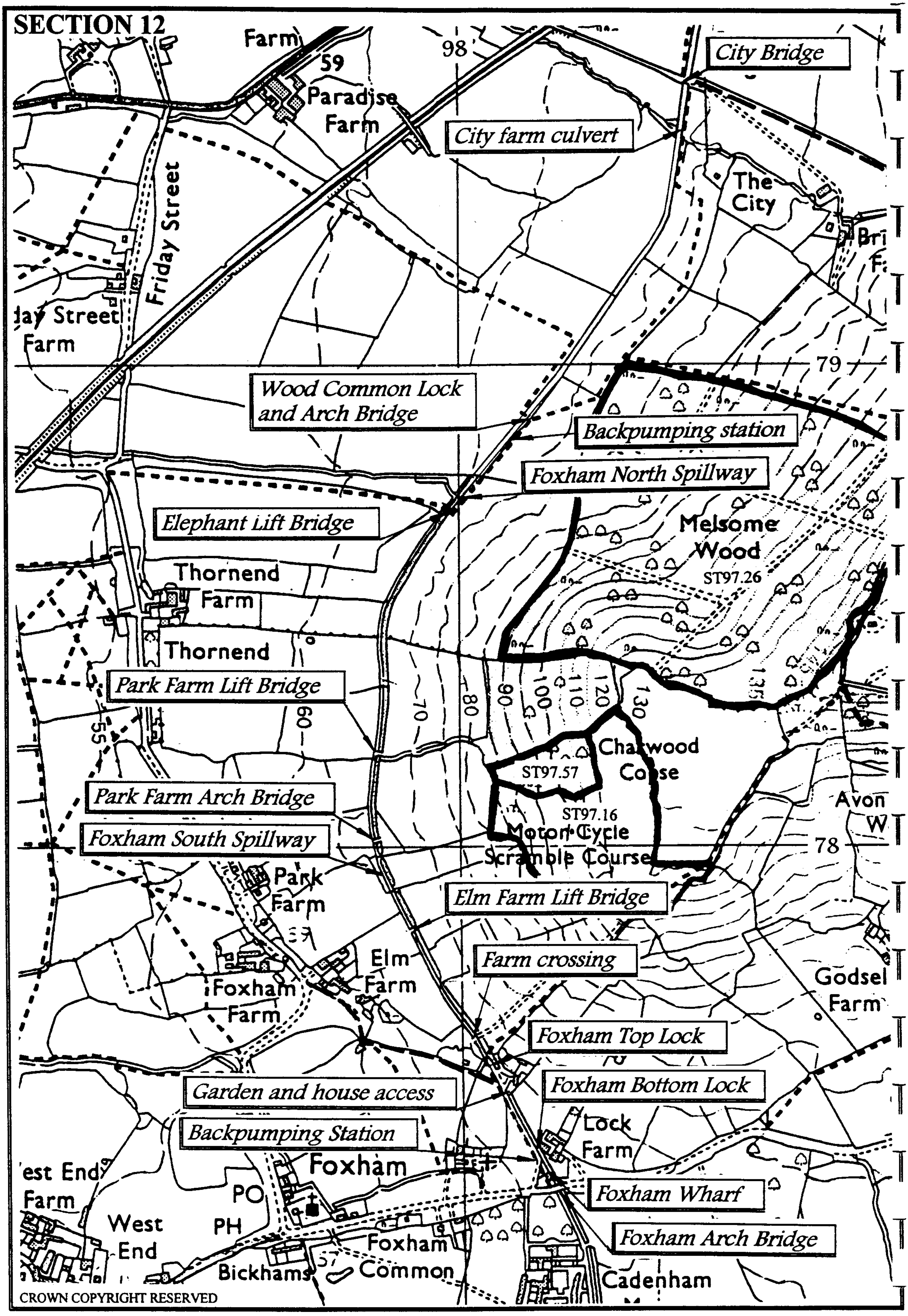
Land Use: Agriculture, Grade 3; rural residential at Foxham

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal bed generally clear, with water present for perhaps half the length.	170,000
Services		5,000
Charlcutt Hill Road Bridge	Bridge removed and canal culverted via 3x30" pipes. Fixed bridge required, road to be raised slightly.	70,000
Charlcutt Wharf	Basin visible. No buildings. Re-development potential.	0
Lift Bridge	Original bridge removed. Assume no longer required	0
Lift Bridge	Original bridge removed, new (lift) bridge required.	60,000
Cade Burna Culvert	Poor condition. Provide new culvert.	30,000
Cadenham Manor Bridges	Assume one vehicle and one foot bridge required.	75,000
Foxham Arch Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	410,000

Notes:

SECTION 12



City Bridge
City farm culvert
Paradise Farm
Farm
59
98
Friday Street
Friday Street Farm
The City
Wood Common Lock and Arch Bridge
Backpumping station
Foxham North Spillway
Elephant Lift Bridge
Melsome Wood
ST97.26
Thornend Farm
Thornend
79
Park Farm Lift Bridge
90
100
110
120
130
135
70
80
60
55
Charwood Copse
ST97.57
ST97.16
Motor Cycle Scramble Course
Park Farm Arch Bridge
Foxham South Spillway
Avon W
78
Park Farm
Elm Farm Lift Bridge
Farm crossing
Elm Farm
Foxham Farm
Godsel Farm
Foxham Top Lock
Foxham Bottom Lock
Garden and house access
Backpumping Station
Lock Farm
West End Farm
Foxham
PO
PH
West End
Foxham Wharf
Foxham Arch Bridge
Foxham Common
Bickhams
Cadenham

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 12: Foxham Bridge to City Bridge

Length: 2.60km **OS Ref: ST981775 to 985796** **Level: 60.6 to 68.8mAOD; 3locks**

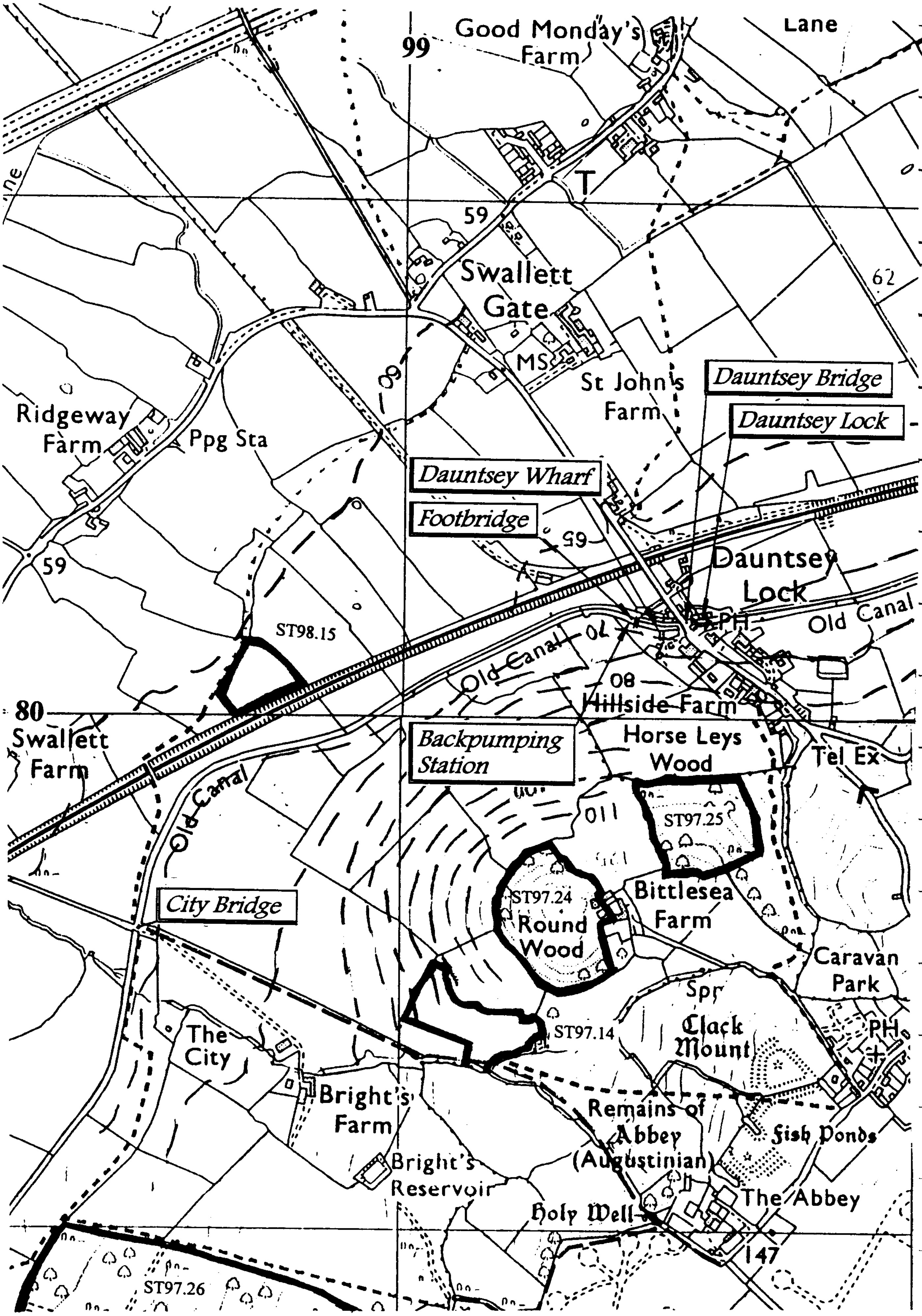
Description: Partially restored section. Lyneham Airfield 1km to the east.
Geology: Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure: Foxham Inn 0.8km west of Foxham Locks.
Environmental Features:
Services:
Land Use: Agriculture Grade 3; residential at Foxham (garden on line)

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	The first 1.65km from Foxham is generally in good order with water present in places, but overgrown. The remaining 0.95km up to City Bridge has been infilled. Garden on line at Foxham.	330,000
Services		15,000
Foxham (Arch) Bridge	Original bridge removed and culverted. New bridge required with regrading of approaches. Also regrading of access to Cadenham Manor, private residences and Foxham Lock.	150,000
Foxham Wharf	Wharf buildings lost; Wharf Cottage in original condition.	0
Access Bridge	Allow for new access, and land swap or compensation	80,000
Backpumping Station	Required for lockage conservation. Rising main length 300m to discharge above Foxham Top Lock.	73,000
Foxham Bottom Lock	Fair condition; cleared and brickwork made safe 1992. Restore. Original lift 2.74m to 63.4mAOD	75,000
Foxham Top Lock	Lock chamber restored. Gates required. Lift 2.71m to 66.1mAOD	30,000
Farm crossing	New fixed bridge required 4.6m wide.	50,000
Elm Farm Lift Bridge	Restoration completed 1993	0
Foxham S.Spillway	Rebuilt in concrete with DN300 exit pipe, completed 1994	0
Park Farm Arch Bridge	Being restored by landowner, but arch likely to be replaced by concrete slab. Navigation clearance to be confirmed.	0
Park Farm (Lift) Bridge	Partially rebuilt with fixed deck. Deck to be raised or new bridge required to permit navigation.	30,000
Elephant Lift Bridge	Restoration work complete except for balance beams, counterweights and supporting columns. Will carry right of way across canal.	0
Foxham North Spillway	Spillway now rebuilt; the adjacent watercourse discharges to the R.Avon approx 2.2km distant.	5,000
Backpumping Station	Required for lockage conservation. Rising main length 60m to discharge above lock.	60,000
Wood Common Lock and Arch Bridge	Buried, possibly destroyed, appears as a rise in the field. Allow for new structure including farm bridge over lock. Right of way crosses at this location. Original lift 2.69m to 68.8mAOD	230,000
City Farm Culvert	Existing culverted watercourse, culvert in good condition	0
City Bridge	*see next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,128,000

Notes:

SECTION 13



Good Monday's Farm
Lane
99
T
59
Swallett Gate
62
MS
St John's Farm
Dauntsey Bridge
Dauntsey Lock
Ridgeway Farm
Ppg Sta
Dauntsey Wharf
Footbridge
59
Dauntsey Lock
PH
Old Canal
59
ST98.15
Old Canal
Hillside Farm
80
Swallett Farm
Backpumping Station
Horse Leys Wood
Tel Ex
Old Canal
ST97.25
ST97.24
Round Wood
Bittlesea Farm
City Bridge
Caravan Park
Spr
Clack Mount
PH
ST97.14
The City
Bright's Farm
Remains of Abbey (Augustinian)
Fish Ponds
Bright's Reservoir
The Abbey
Holy Well
147
ST97.26

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 13: City Bridge to Dauntsey Lock

Length: 1.35km **OS Ref: ST 985796 to 996802** **Level: 68.8 to 71.4mAOD; 1 lock**

Description: Rural reach, restoration work in hand. Development plans for Daunstsey Lock and immediate environs are included in the Local Plan

Geology: Oxford Clay

Water Resources: Currently no proposals for water resource development in this section

Navigation, Recreation and Leisure: Peterborough Arms (listed building) at Dauntsey, with possible extension, canal basin, winding hole, slipway and Canal Visitor Centre allowed for in the Local Plan.

Environmental Features:

Services: Pylon 0.6km from City Bridge with bracing wire anchors in bed of canal

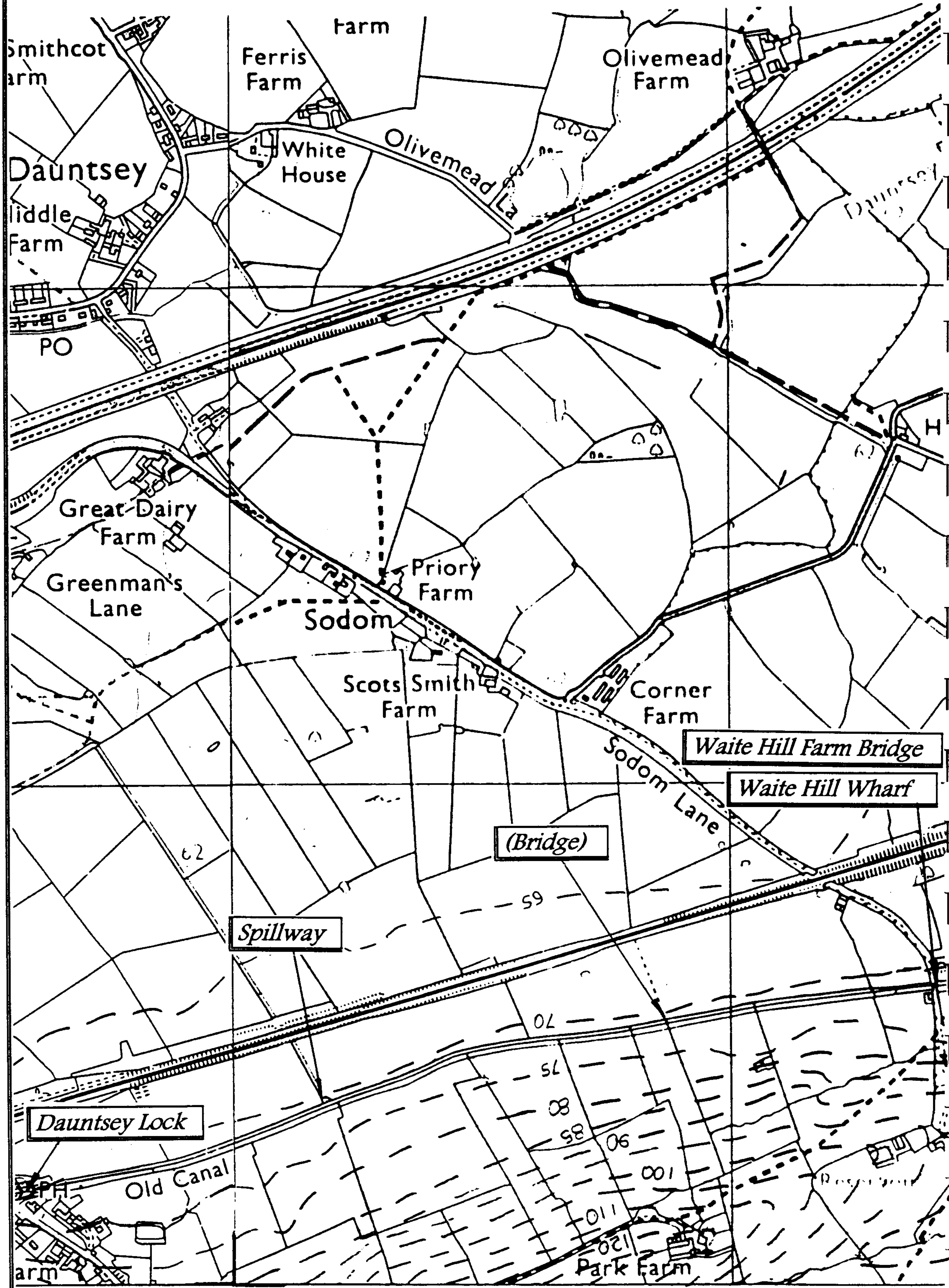
Land Use: Agriculture, Grade 3; residential at Dauntsey. Canal reach from electricity pylon to Dauntsey Lock (and beyond) is in ownership of local W&BCAG chairmain and is being restored.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Generally clear but silted up. From the electricity pylon, the towpath is heavily wooded with overgrown towpath hedge, but is being cleared. Canal has been dredged locally in the vicinity of Dauntsey Wharf and in water (but 0.6m below navigable depth)	148,000
Services		15,000
City Farm Road Bridge	Original bridge removed, canal infilled and culverted. Road rises at original crossing point. Farm bridge required.	55,000
Footbridge	New bridge proposed to divert towpath to opposite side of canal at Dauntsey Wharf to avoid canalside cottages.	25,000
Dauntsey Wharf	Canal frontage recently sheet piled and paved as an amenity to the restored canal cottages (now in individual private occupation).	0
Dauntsey Bridge (B4069)	Original bridge demolished and culverted. Provide new bridge with regrading of approaches. Also regrading of access to private residences.	80,000
Backpumping Station	Required for lockage conservation. Rising main length 60m to discharge above lock. A back pump system is proposed as part of the current local restoration, but this would need upgrading for the full canal restoration	45,000
Dauntsey Lock	Restoration of brickwork almost complete, paddles and gates to be made and fitted. Original lift 2.59m to 71.4mAOD	0
	ESTIMATED TENDER PRICE FOR RESTORATION	368,000

Notes:

SECTION 14



Farm
Smithcot
arm
Ferris
Farm
Olivemead
Farm
Dauntsey
White
House
Olivemead La
iddle
Farm
PO
H
Great Dairy
Farm
Greenman's
Lane
Priory
Farm
Sodom
Scots Smith
Farm
Corner
Farm
Waite Hill Farm Bridge
Sodom Lane
Waite Hill Wharf
(Bridge)
62
65
Spillway
70
75
80
85
90
100
110
120
Dauntsey Lock
PH
Old Canal
arm
Park Farm

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 14: Dauntsey Lock to Waite Hill Wharf

Length:1.90km **OS Ref: ST 995802 to SU 014806** **Level: 71.4mAOD**

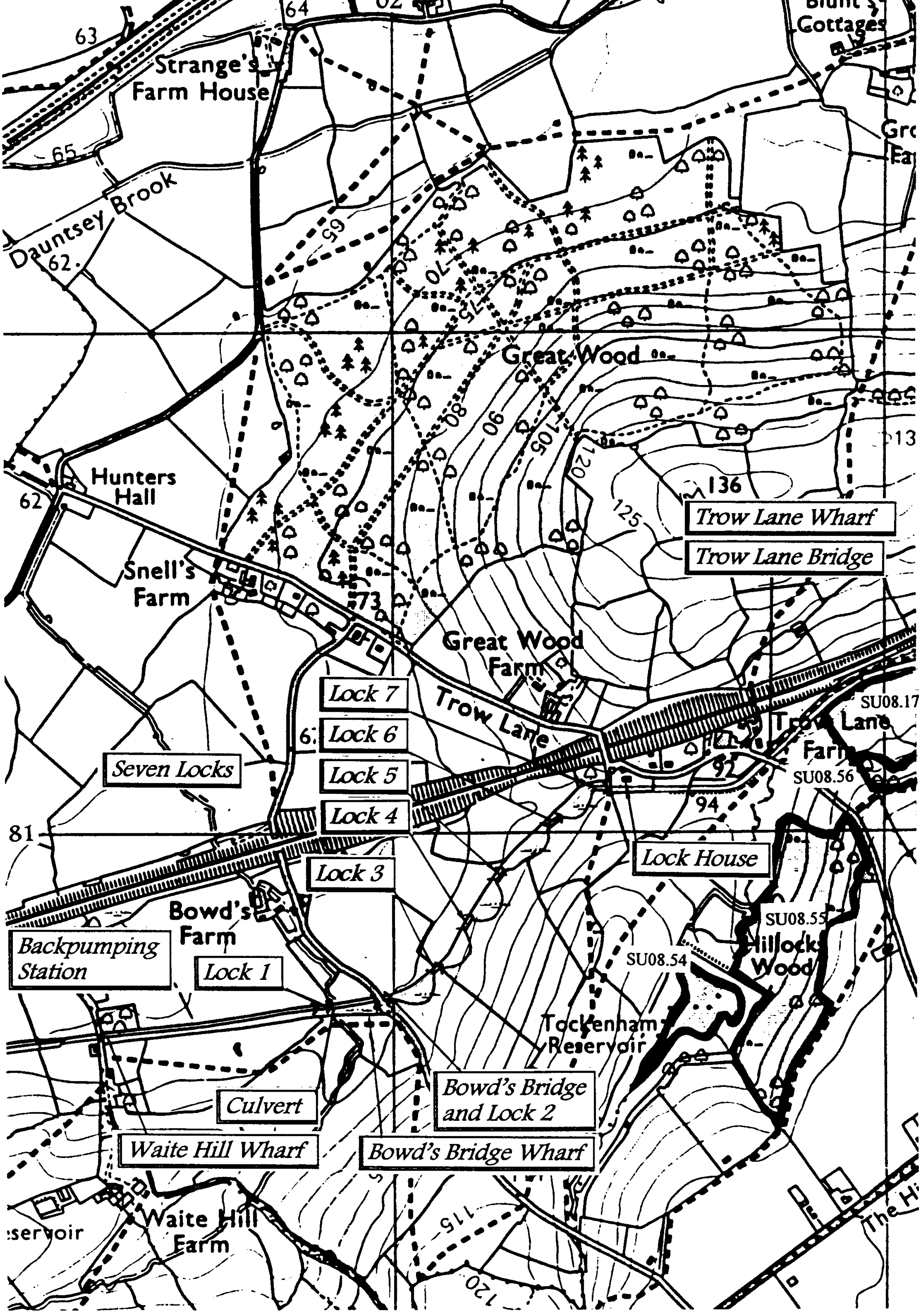
Description: Rural reach, restoration work in hand.
Geology: Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 3; Canal reach from Dauntsey Lock to approx 100m short of Waite Hill Bridge is in ownership of local W&BCAG member and is being restored.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Section currently being restored, except the last approx 100m to Sodom Lane which is clear but infilled and used as farmland.	30,000
Services		5,000
Dauntsey Lock	*See previous section*	0
Spillway	Completely restored	0
(Bridge)	No trace. Crossing assumed no longer required	0
Waite Hill Farm Bridge	Bridge removed and canal bed culverted. New farm accommodation bridge required with regrading of approaches.	70,000
Waite Hill Wharf	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	105,000

Notes:

SECTION 15



Strange's Farm House
Blunt's Cottages
Dauntsey Brook
Great Wood
Hunters Hall
Snell's Farm
Great Wood Farm
Trow Lane
Trow Lane Wharf
Trow Lane Bridge
Trow Lane Farm
SU08.17
SU08.56
SU08.55
SU08.54
Lock 7
Lock 6
Lock 5
Lock 4
Lock 3
Lock 1
Seven Locks
Lock House
Bowd's Farm
Backpumping Station
Hillocks Wood
Tockenham Reservoir
Culvert
Bowd's Bridge and Lock 2
Waite Hill Wharf
Bowd's Bridge Wharf
Waite Hill Farm

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 15: Waite Hill Wharf to Trow Lane Bridge

Length: 1.60km **OS Ref:SU014806 TO 027811** **Level: 71.4 to 89.3mAOD; 7 locks**

Description: Restoration area.The Seven Locks are very overgrown and although many bricks have been removed, the sites of all chambers, intermediate pounds etc, can be found. The towpath from Sodom Lane (Waite Hill Wharf) to Lock 5 is publically accessible but not a right of way. At the top of the flight the route passes through a pony training paddock and gardens belonging to the old lock house. A minor diversion could avoid this land.

Geology: Oxford Clay

Water Resources: Currently no proposals for water resource development in this section

Navigation, Recreation and Leisure: Fishing club at Tockenham Resrvoir

Environmental Features:

Services:

Land Use: Agriculture, Grade 4

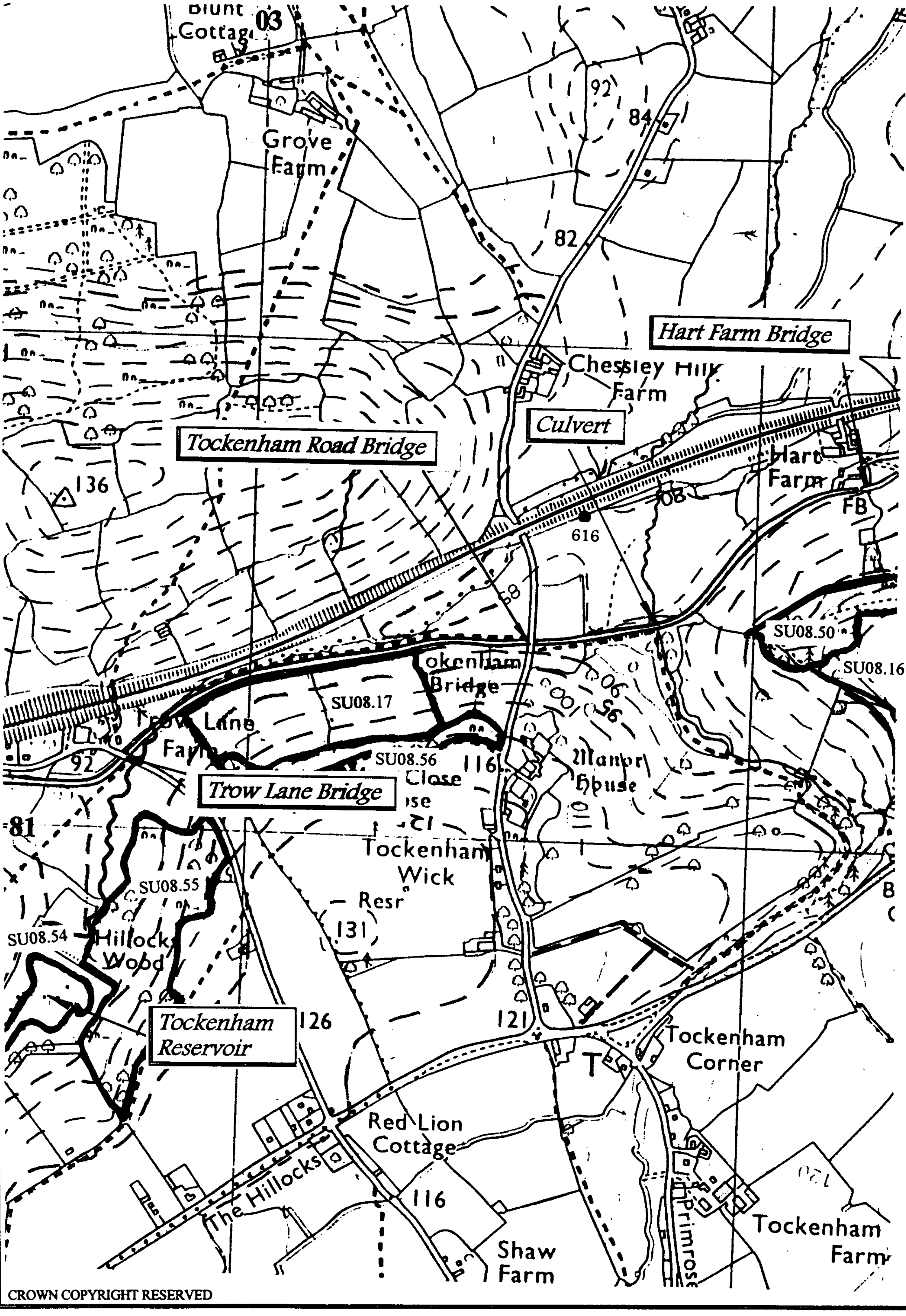
Schedule of Features and Restoration Costs:

Feature / Name	**Description**	**Cost(£)**
Canal Reach	Generally heavily silted (0.6m typical) and overgrown, but not deliberately infilled. The proximity of the locks means that intermediate pounds are wide. Heavily wooded between Locks 5 and 7.	250,000
Services		5,000
(Waite Hill Wharf)	Remains not visible.	0
Backpumping Station	Required for lockage conservation. Rising main length 900m to discharge above Lock 7 (Top).	140,000
Seven Locks Lock 1 (Bottom)	Remains barely visible. Structure demolished/robbed down to water level including top cill, but remains probably sound and thus lock restorable.	75,000
Culvert	Believed to be in fair condition, restore.	2,000
Bowd's Bridge and Lock 2	Originally a lift bridge spanning the lock chamber, Bowd's Lane now crosses Lock 2 on infill. Provide new fixed bridge integral with Lock 2 restoration.	110,000
Bowd's Bridge Wharf	Remains not visible.	0
Lock 3	Chamber walls lowered to water level and many bricks at head removed. Cleared and under restoration.	60,000
Lock 4	Full height walls but poor condition, severely damaged by wartime demolition practice. Cleared and under restoration.	30,000
Lock 5	Full height walls but poor condition, also severely damaged by wartime demolition practice. Restore.	90,000
Lock 6	Damaged, has a wall with drainage pipe built across the head. Restore.	90,000
Lock 7 (Top)	Good condition, gates still present. Head of lock infilled and crossed by a farm track. Restore.	40,000
Trow Lane Wharf	Remains not visible.	0
Trow Lane Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	892,000

Notes:

Overall lift through the Seven Locks taken as 17.9m, average 2.56m per lock

SECTION 16



Hart Farm Bridge
Culvert
Tockenham Road Bridge
Trow Lane Bridge
Tockenham Reservoir
Blunt Cottage
03
Grove Farm
92
84
82
136
Chessley Hill Farm
Hart Farm
FB
616
08
SU08.50
SU08.16
SU08.17
Tokenham Bridge
SU08.56
Trow Lane Farm
92
116
Manor House
81
Tockenham Wick
Resr
131
SU08.55
SU08.54
Hillocks Wood
126
121
Tockenham Corner
Red Lion Cottage
The Hillocks
116
Shaw Farm
Primrose
Tockenham Farm

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 16: Trow Lane Bridge to Hart Farm Bridge

Length: 1.60km **OS Ref: SU 027811 to 042817** **Level: 89.3mAOD**

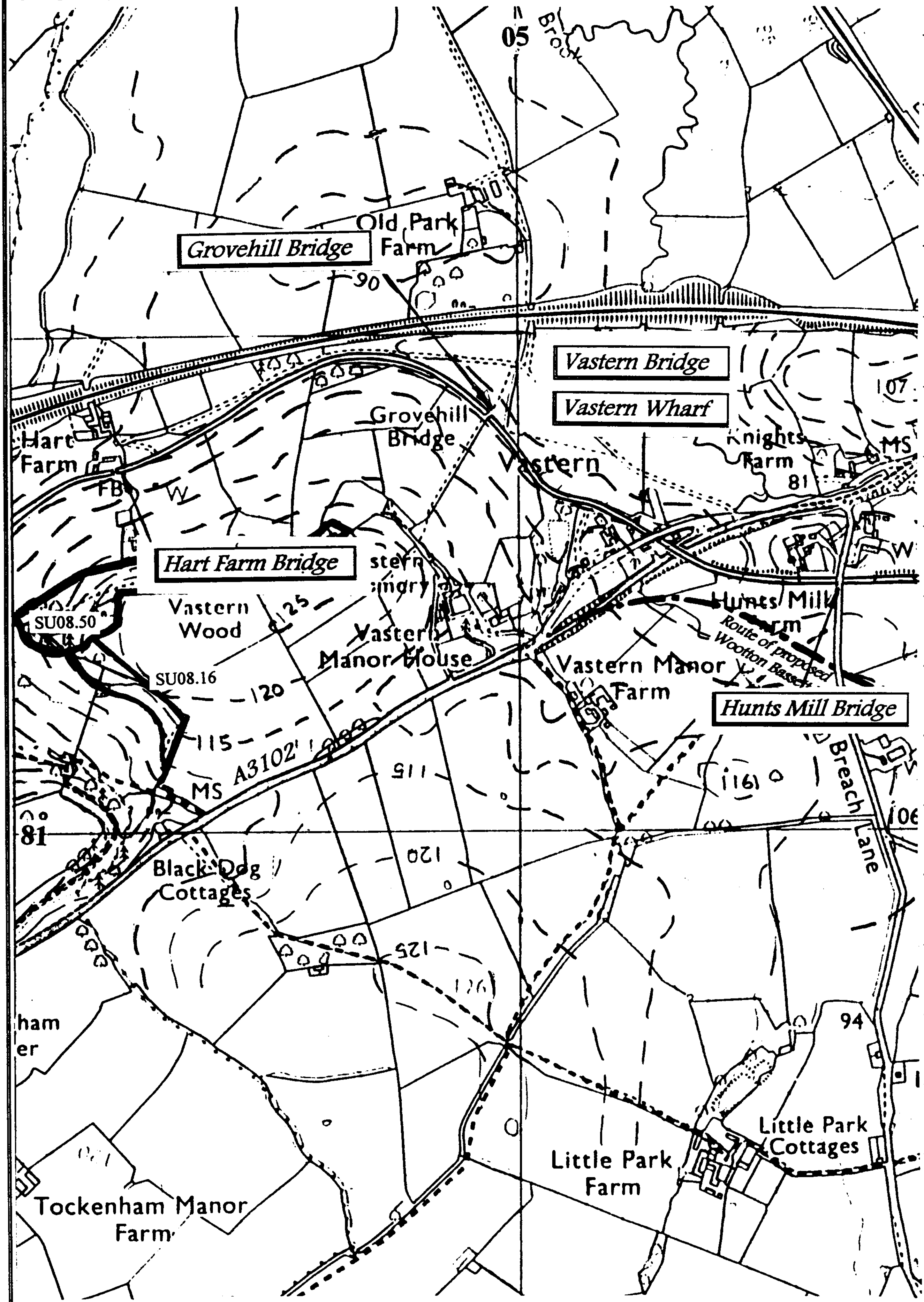
Description: Water from the original canal supply of Tockenham Resevoir enters the canal in this reach just north of Trow Lane. Towpath is a right of way between Trow Lane and Tockenham Bridge
Geology: Oxford Clay; Alluvium at watercouse
Water Resources: Potential abstractions from the deep Great Oolite aquifer north of the canal & fromthe Corallian aquifer south of the canal near Tockenham. Possible re-introduction of Tockenham Reservoir into the canal water supply system.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Wet, silted and overgrown, but easily restored. Infilled locally around Tockenham Bridge and Hart Farm Bridge.	240,000
Services		10,000
Trow Lane Bridge	Bridge removed and canal culverted. New fixed road bridge required.	65,000
Trow Lane Wharf	Wharf remains not visible.	0
Spillway	Heavily overgrown and silted. Restore.	3,000
Watercourse	Cuts across canal bed and culverted through towpath. Allow for culverting (unless permitted as a resource)	8,000
Tockenham Road Bridge	Infilled and canal bed culverted. Road at high level over bed. Provide new canal culvert under road.	75,000
Culvert	Brinkworth Brook tributary. No evidence of existing culvert; allow for new culvert.	25,000
Hart Farm Bridge	*See next section.*	
	ESTIMATED TENDER PRICE FOR RESTORATION	426,000

Notes:

SECTION 17



05
Brook
Old Park Farm
Grovehill Bridge
90
Vastern Bridge
Vastern Wharf
107
Hart Farm
FB
W
Grovehill Bridge
Vastern
Knights Farm
81
MS
W
Hart Farm Bridge
SU08.50
Vastern Wood
125
Vastern Manor House
Hunts Mill Farm
Route of proposed Wootton Bassett
SU08.16
120
Vastern Manor Farm
Hunts Mill Bridge
115
MS
A3102
115
116
Breach Lane
106
81
Black Dog Cottages
120
125
126
94
Little Park Cottages
Little Park Farm
Tockenham Manor Farm

SECTION 17: Hart Farm Bridge to Hunts Mill Bridge

Length: 1.67km **OS Ref: SU 042817 to 057815** **Level: 89.3mAOD**

Description: Readily recoverable rural section as far as Vastern Woodyard. Between the A3102 and Breach Lane, restoration much depends on the implementation and alignment of the proposed Wooton Bassett Bypass. No existing rights of way.

Geology: Oxford Clay; Corallian limestone between A3102 and Hunts Mill Bridge

Water Resources: Currently no proposals for water resource development in this section

Navigation, Recreation and Leisure:

Environmental Features:

Services:

Land Use: Agriculture, Grade 4; Commercial (Vastern Woodyard); residential at Vastern Wharf (garden)

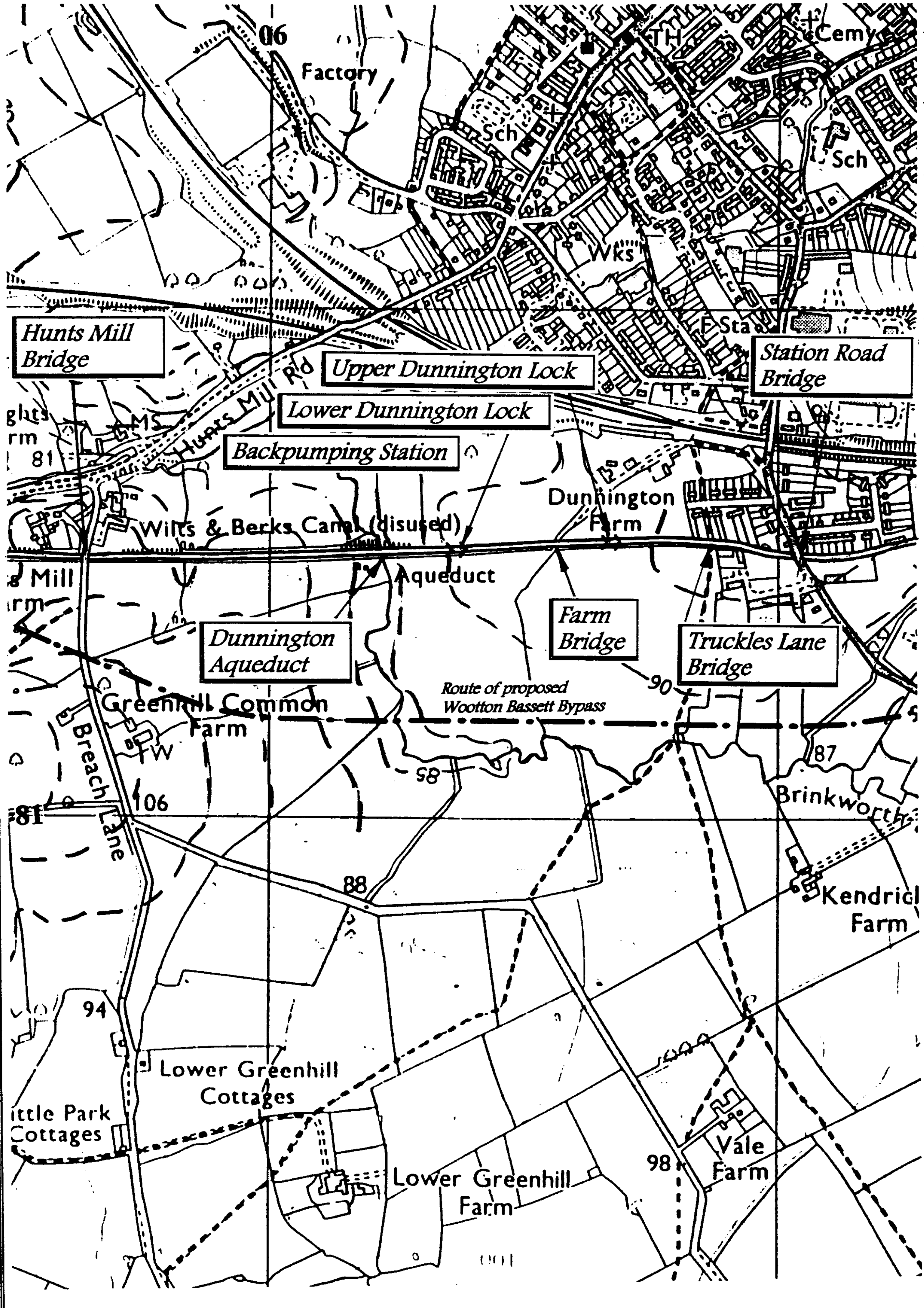
Schedule of Features and Restoration Costs:

Feature / Name	**Description**	**Cost(£)**
Canal Reach	Canal is generally clear and holding water between Hart Farm bridge and Vastern Woodyard, but heavily overgrown . Relocation of wood storage will be required. Infilled between Vastern Bridge and Hunts Mill Bridge. The canal bed immediately east of Vastern Bridge now forms an area of lawn for a recently built property 'Vastern House'.	350,000
Services		30,000
Hart Farm Bridge	West parapet collapsed. Poor condition. Restore to safe condition.	25,000
Grovehill Bridge	Access track, no traceof bridge. Within Woodyard. Allow for a new fixed crossing.	50,000
Vastern Wharf	No trace of Wharf. Redevelopment potential.	0
Vastern Bridge	Bridge removed. Road at high level. Provide,new canal culvert.	65,000
Vastern House Garden	Allow for cut and cover culvert extension from Vastern Bridge (30m)	45,000
A3102 Crossing	Current plans for the Wootton Basset Bypass indicate that the A3102 can be closed off and infilled at this point allowing the canal to be restored at its original line and level. Canal restoration cost therefore included in Canal Reach. Redevelopment potential eg canalside public house and roadside facilities.	0
Hunts Mill Bridge	*See next section.*	
	ESTIMATED TENDER PRICE FOR RESTORATION	565,000

Notes:

Alternative routes have been considered for restoration should the current situation with the A3102 remain unchanged. See eg W&BAG "The Canal from Seven Locks to Hay Lane - A Discussion Document"

SECTION 18



Hunts Mill Bridge
Upper Dunnington Lock
Lower Dunnington Lock
Backpumping Station
Station Road Bridge
Dunnington Aqueduct
Farm Bridge
Truckles Lane Bridge
Route of proposed Wootton Bassett Bypass
Factory
Sch
TH
Cemy
Wks
F Sta
Hunts Mill Rd
Wilts & Berks Canal (disused)
Aqueduct
Dunnington Farm
Greenhill Common Farm
Breach Lane
Brinkworth
Lower Greenhill Cottages
Lower Greenhill Farm
Vale Farm

SECTION 18: Hunts Hill Bridge to Station Road Bridge

Length: 1.40km **OS Ref: SU 057815 to 070815** **Level: 89.3 to 94.4mAOD; 2 locks**

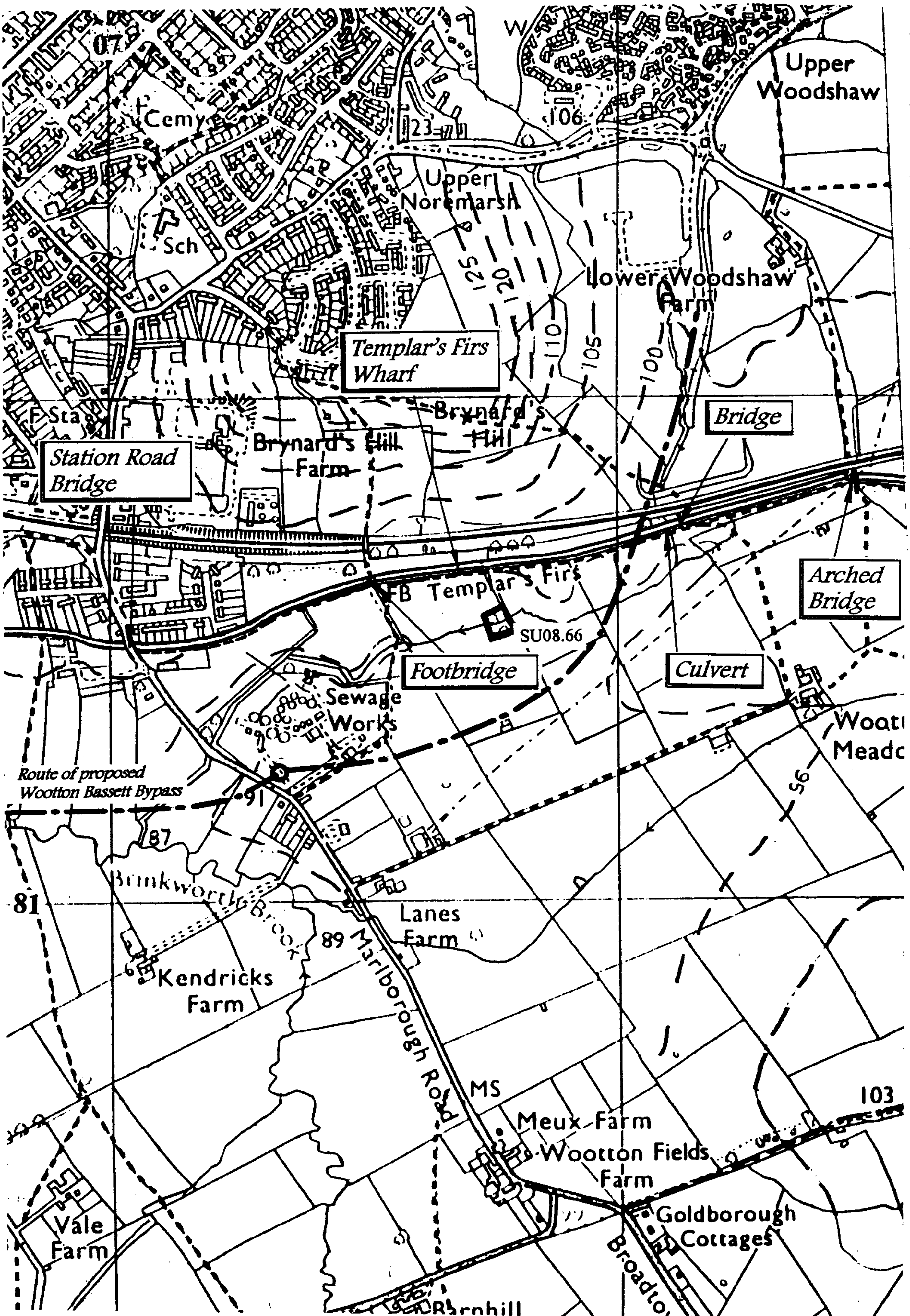
Description: Straight reach through farmland approaching Wootton Bassett
Geology: Kimmeridge Clay
Water Resources: Potential winter abstraction from Brinkworth Brook to the east of Greenhill Common Farm
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agricultural, Grade 3 to 4; residential at Station Road. Possible housing development at Dunnington Farm.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Generally intact and holding some water as far as the site of Lower Dunnington Lock; infilled thereafter. The original canal line is incorporated into gardens of properties along Dunnington Road for a length of about 200m	290,000
Services		10,000
Hunts Mill Bridge	No trace visible. Road bridge required, clearance adequate.	60,000
Dunnington Aqueduct	Exisiting aqueduct over the Brinkworth Brook, in excellent condition. Restore aqueduct.	15,000
Backpumping Station	Required for lockage conservation. Rising main length 400m to discharge above Upper Dunnington Lock	85,000
Lower Dunnington Lock	No trace, buried. Rebuild lock. Original lock lift 2.46 to 91.8mAOD	150,000
Bridge	Buried. Assume new farm bridge required.	50,000
Upper Dunnington Lock	No trace, buried. Rebuild lock. Original lock lift 2.61 to 94.4mAOD	150,000
Truckles Lane Bridge	Allow for new footbridge for right of way	25,000
Station Road Bridge	*See next section.*	
	ESTIMATED TENDER PRICE FOR RESTORATION	835,000

Notes:

SECTION 19



07
Ceme
Sch
Upper Noremarsh
106
Upper Woodshaw
Lower Woodshaw Farm
125
120
110
105
100
Templar's Firs Wharf
Brynard's Hill
Brynard's Hill Farm
F Sta
Station Road Bridge
Bridge
FB
Templar's Firs
SU08.66
Arched Bridge
Footbridge
Culvert
Sewage Works
Woott Meado
Route of proposed Wootton Bassett Bypass
91
87
Brinkworth Brook
81
Lanes Farm
89
Kendricks Farm
Marlborough Road
MS
Meux Farm
Wootton Fields Farm
103
Goldborough Cottages
Vale Farm
Broadtown
Barnhill

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 19: Station Road Bridge to Arched Bridge (Templar's Firs)

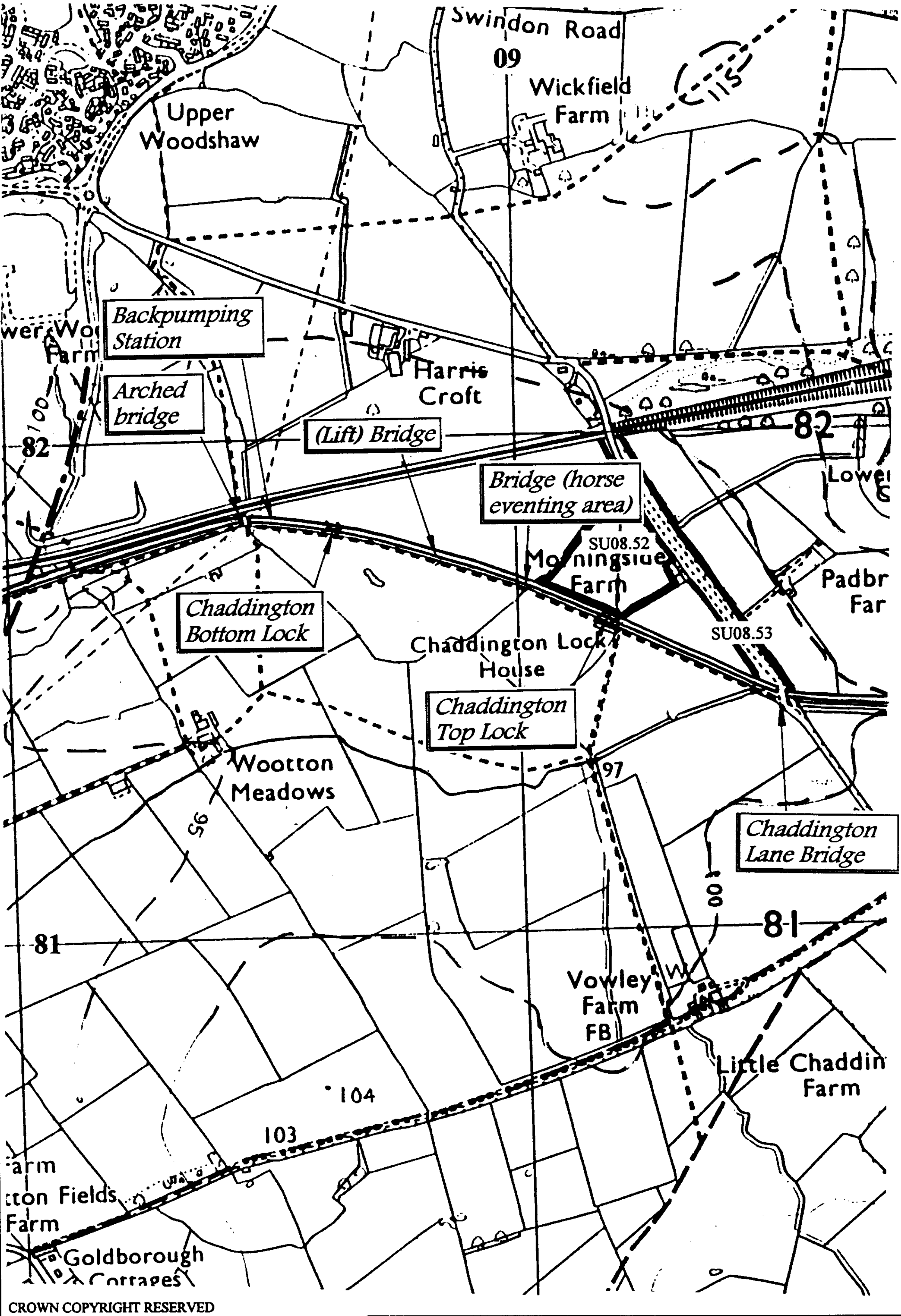
Length: 1.50km **OS Ref: SU 070815 to 085818** **Level: 94.4mAOD**

Description: Templars Firs restoration area; canal restored and in water east of Templars Firs estate.
Geology: Kimmeridge Clay
Water Resources: No proposals for water resource development in this section, but it is currently proposed to construct a storage pond on this reach. Wootton Bassett Sewage Treatment works within 200m of canal; effluent discharge included in Brinkworth Brook water resources (see Section 18). Potential for re-use of treated urban runoff from Wotton Bassett.
Navigation, Recreation and Leisure: Wootton Bassett town facilities
Environmental Features: Wootten Bassett Mud Spring SSSI within 50m of canal
Services: 2 No. sewers crossing canal line.
Land Use: Urban to Agricultural, Grade 4; Residential at Templar's Firs estate

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	The original alignment is incorporated into the end of gardens and garages of the Templars Firs estate, a length of some 250m. A new alignment is proposed just south of the original, through the Council Depot. The rest of this reach is already restored.	80,000
Services	Including sewer diversions	20,000
Station Road Bridge	Original bridge removed, no trace. Build new fixed bridge on diverted canal route, minor regrading of approaches.	95,000
Arch Bridge (Noremarsh Bridge)	Original arch bridge destroyed, some brickwork visible. Foot bridge required for right of way.	25,000
Templars Firs Wharf	Wharf not visible. Redevelopment potential	0
Culvert	Watercourse to be culverted	20,000
Bridge	Mostly good condition. Bridge hole restored. Restore as a footbridge.	8,000
Arched Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	248,000

Notes:


Swindon Road
09
Wickfield Farm
115
Upper Woodshaw
Backpumping Station
Farm
Harris Croft
Arched bridge
(Lift) Bridge
100
82
Bridge (horse eventing area)
SU08.52
Morningside Farm
Padbr
Far
Chaddington Bottom Lock
Chaddington Lock House
SU08.53
Chaddington Top Lock
97
Wootton Meadows
95
Chaddington Lane Bridge
81
Vowley Farm
FB
Little Chaddin
Farm
104
103
arm
ton Fields
Farm
Goldborough
Cottages

SECTION 20: (Templars Firs) Arched Bridge to Chaddington Lane Bridge

Length: 1.10km **OS Ref: SU 085818 to 095815** **Level: 94.4 to 99.1mAOD; 2 locks**

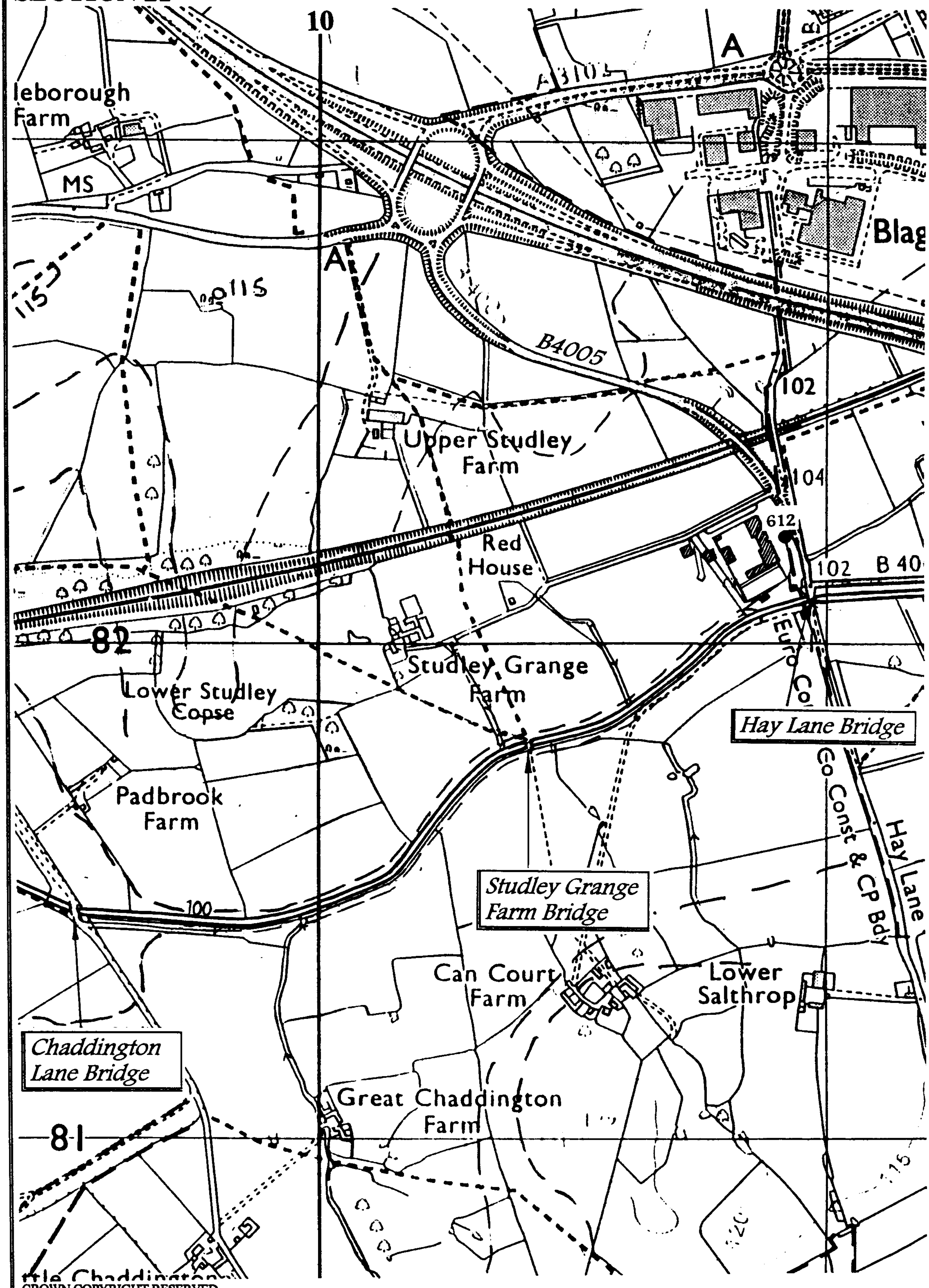
Description: Rural reach including the summit lock. Targeted for early restoration.
Geology: Kimmeridge Clay
Water Resources: Currently no proposals for water resource development in this section.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agricultural, Grade 4 to 3

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Bed well defined with towpath	90,000
Services		5,000
Arched Bridge	Abutments remain. Mostly good condition. Holding water. Foot bridge required.	25,000
Backpumping station	Required for lockage conservation. Rising main length 700m discharging above Chaddington Top Lock.	120,000
Chaddington Bottom Lock	Infilled. Rebuild lock. Original lock lift 2.34m to 96.7mAOD	90,000
(Lift) Bridge	Original bridge removed. Farm bridge required.	65,000
Bridge	Allow for new bridge for horse eventing area	50,000
Lock House	Demolished.	0
Chaddington Top (Summit) Lock	Chamber visible. Rebuild lock. Original lock lift 2.39m to 99.1mAOD. Include tailbridge for right of way.	100,000
Chaddington Lane (Arch) Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	545,000

Notes:

SECTION 21


10
A
A3102
A
leborough
Farm
MS
Blag
115
B4005
102
Upper Studley
Farm
104
612
Red
House
102
B 40
82
Studley Grange
Farm
Euro
Co
Lower Studley
Copse
Hay Lane Bridge
Padbrook
Farm
Co Const & CP Bdy
Hay Lane
100
Studley Grange
Farm Bridge
Can Court
Farm
Lower
Salthrop
Chaddington
Lane Bridge
Great Chaddington
Farm
81

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 21: Chaddington Lane Bridge to Hay Lane Bridge

Length: 1.65km **OS Ref: SU 095815 to 110821** **Level: 99.1mAOD (old summit)**

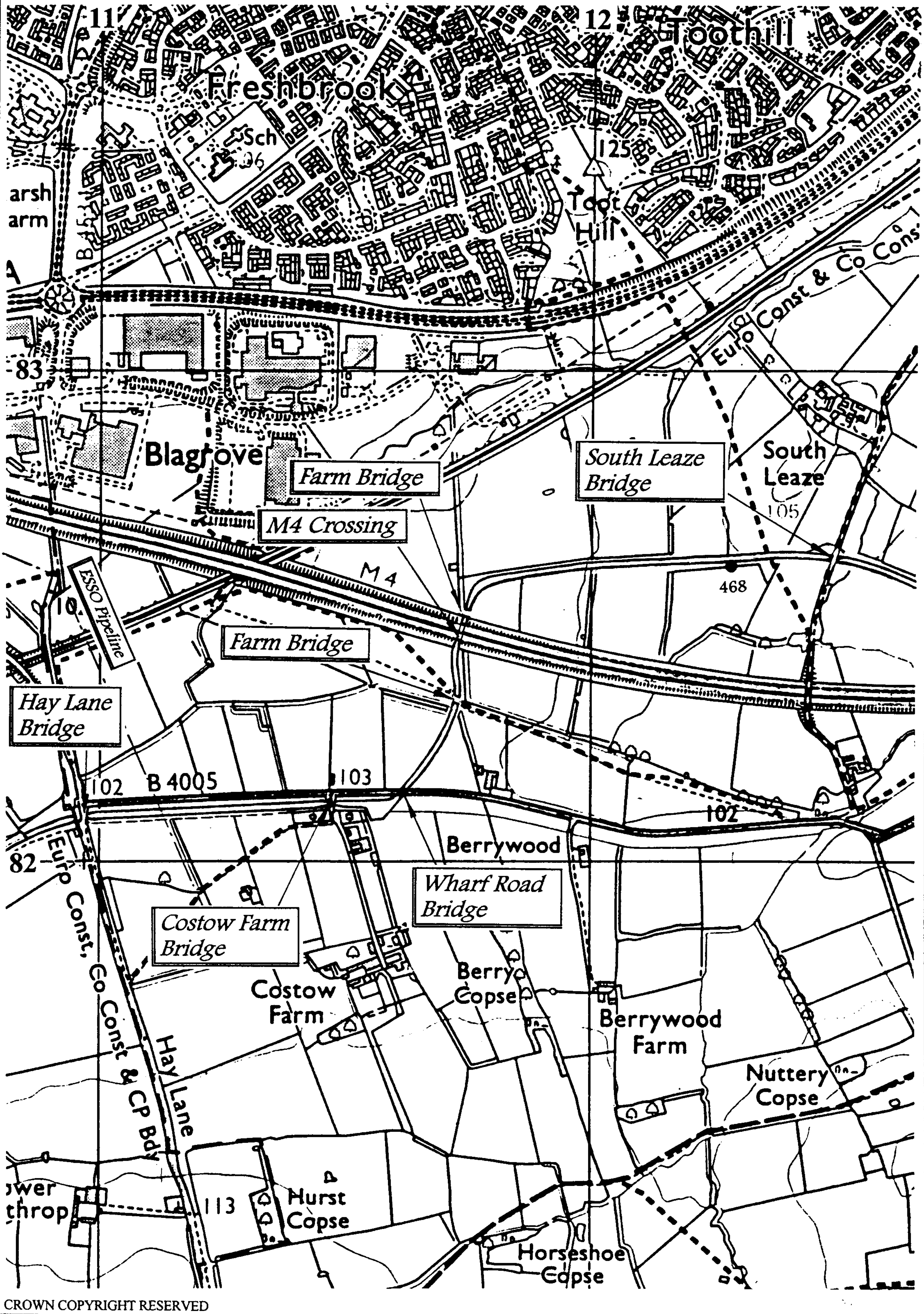
Description: Rural reach through farmland, being restored with the aid of landfill tax from the Studley Grange Landfill site (completion estimated 1999)
Geology: Kimmeridge Clay
Water Resources: Currently no proposals for water resource development in this section.
Navigation, Recreation and Leisure: Garden Centre at Hay Lane
Environmental Features:
Services:
Land Use: Agriculture, Grade 3. Garden/paddock at Hay Lane. Hay Lane forms the boundary between North Wilts DC and Swindon BC

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Currently being restored. Near Chaddington Lane the canal bed is dug out and used as a drainage channel; elsewhere the original route is poorly defined or infilled. A minor diversion may be required at Hay Lane to avoid the garden.	30,000
Services		5,000
Chaddington Lane Arch Bridge	Original bridge demolished. Road at high level. Provide new skew bridge with regrading of approaches and alignment improvements.	100,000
Studley Grange Farm Bridge	Original bridge not visible. Farm bridge required.	50,000
Hay Lane Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	185,000

Notes:

SECTION 22



11
12
Toothill
Freshbrook
Sch
125
Toot Hill
83
Blagrove
Farm Bridge
South Leaze Bridge
South Leaze
105
Euro Const & Co Cons
M4 Crossing
M 4
468
ESSO Pipeline
Farm Bridge
Hay Lane Bridge
102
B 4005
103
102
Berrywood
82
Wharf Road Bridge
Costow Farm Bridge
Euro Const, Co Const & CP Bdy
Costow Farm
Berry Copse
Berrywood Farm
Nuttery Copse
Hay Lane
113
Hurst Copse
Horseshoe Copse

SECTION 22: Hay Lane Bridge to South Leaze Bridge (New Canal)

Length: 1.85km **OS Ref: SU 110821 to 125826** **Level: 99.1mAOD (old summit)**

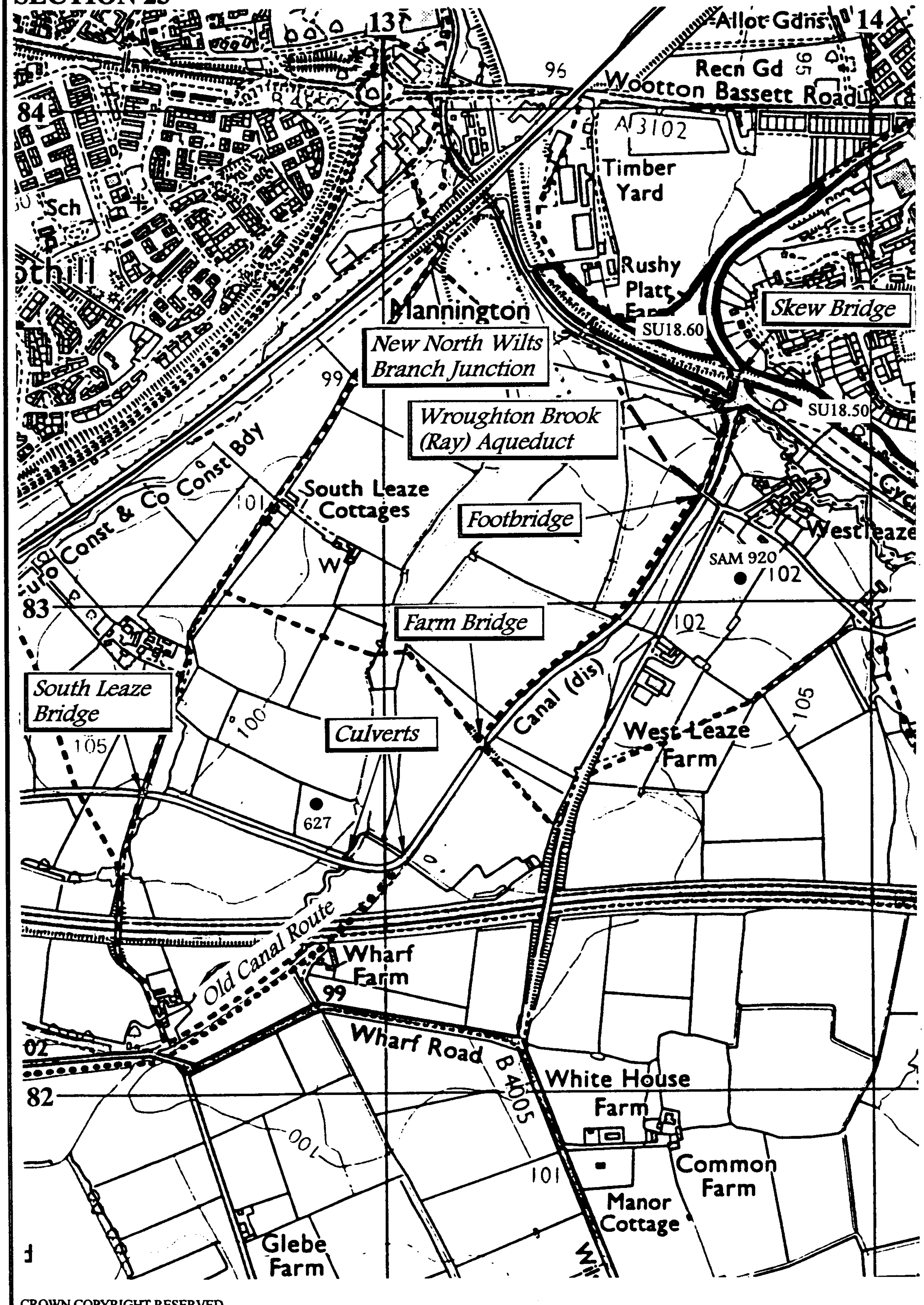
Description: Diversion from the original canal alignment alongside the B4005 Wharf Road is required in order to effect a crossing of the M4
Geology: Kimmeridge Clay
Water Resources: Potential winter abstraction from Chalk aquifer south of the canal
Navigation, Recreation and Leisure:
Environmental Features:
Services: Esso Midline Pipeline crossing between Hay Lane and Costow Farm Bridge
Land Use: Agiculture, Grade 3 to 4

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Some 600m of the original canal route would be restored before deviating into new cut for the M4 crossing. New canal would be through open farmland and largely at existing ground level	430,000
Services		20,000
Hay Lane Bridge	Bridge removed. Infilled. New bridge required with regrading of approaches.	80,000
Esso Midline Pipeline	14" dia steel pipeline laid in 1985. Existing canal route marked by ditch and pipeline crosses under with concrete slab protection. Estimated top of pipe level is 98.79 so local diversion (of pipeline or canal) may be required (contingency item, not priced).	
Costow Farm Bridge	No trace of original structure. A new fixed farm access bridge will be required.	60,000
B4005 Wharf Road Bridge	There is adequate clearance for the crossing without change in vertical alignment of the road but allow for skew crossing.	85,000
Farm Bridge	Fixed farm bridge, also for right of way.	50,000
M4 Crossing	Thrust bored canal culvert through motorway embankment	2,250,000
Farm Bridge	Allow for a farm bridge close to the M4 due to canal severence.	50,000
South Leaze Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	3,025,000

Notes:
Bridge for Costow Farm could be avoided by commencing diversion before this point.

SECTION 23



13
14
Allot Gdns
Recn Gd
96
95
Wootton Bassett Road
A 3102
Timber Yard
84
Sch
Rushy Platt
Mannington
Skew Bridge
SU18.60
New North Wilts Branch Junction
99
SU18.50
Wroughton Brook (Ray) Aqueduct
Co Const & Co Const Bdy
South Leaze Cottages
101
Footbridge
West Leaze
SAM 920
102
83
Farm Bridge
102
South Leaze Bridge
100
Culverts
Canal (dis)
105
West Leaze Farm
105
627
Old Canal Route
Wharf Farm
99
Wharf Road
B 4005
02
82
White House Farm
100
101
Common Farm
Manor Cottage
Glebe Farm

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 23: South Leaze Bridge (New Canal) to Skew Bridge

Length: 1.80km **OS Ref: SU 125 826 to137834** **Level: 99.1mAOD (old summit)**

Description: End of the M4 diversion new cut, joining a largely restored original section of canal on the outskirts of Swindon

Geology: Kimmeridge Clay, Alluvium at the Wroughton Brook (R.Ray)

Water Resources: Currently no proposals for water resource development in this section. A spring from Swindon Hill currently emerges under the Skew Bridge.

Navigation, Recreation and Leisure:

Environmental Features:

Services:

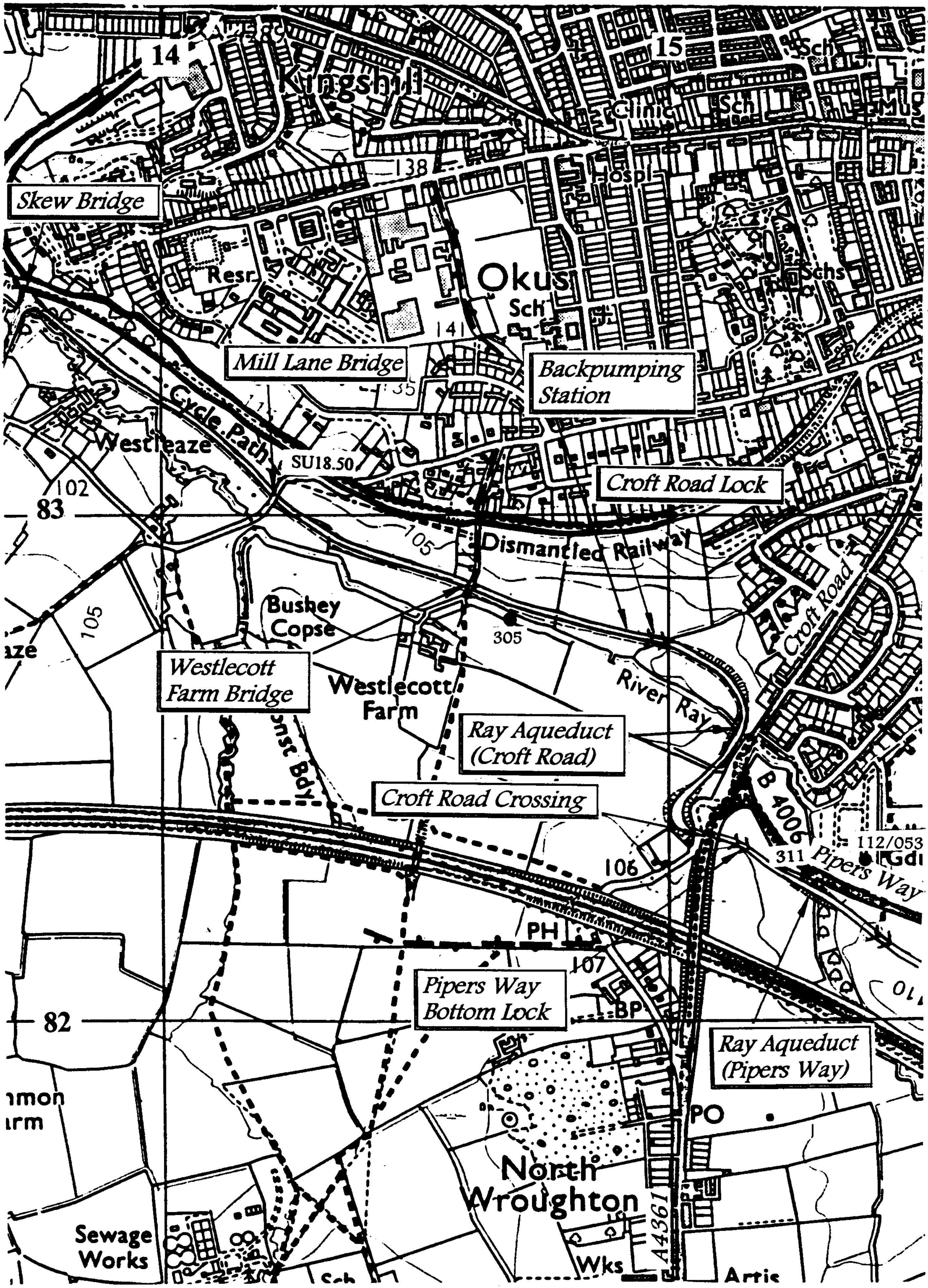
Land Use: Agriculture, Grade 4 to Urban

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	0.55km of new canal cut through farmland before rejoining the original canal alignment north of Wharf Farm. Much of the remainder of this reach is already restored and in-water. A Lottery application has been made to link through the two isolated restored sections through Skew Bridge. The restored section north of Skew Bridge would not be made navigable, there being no room for a winding hole at the termination of this section.	180,000
Services		20,000
South Leaze Bridge	Provide a fixed farm access bridge, also for right of way	75,000
Culvert	Tributary of the River Ray	20,000
Culvert	Existing; condition unknown. Allow for replacement	8,000
Bridge	Original bridge removed, canal infilled and culverted. Allow for new farm bridge, also for right of way.	50,000
Footbridge	Original bridge removed, canal infilled and culverted. Allow for new footbridge for existing bridleway.	50,000
New North Wilts Branch Junction	*See Section 201*	0
New junction	Start of new canal route around the south of Swindon	0
Wroughton Brook Aqueduct	Existing structure in good condition. Minor works to fully restore	5,000
Skew Bridge	Existing bridge under the old M&SWJR, now a cycleway, restored and in excellent condition	0
	ESTIMATED TENDER PRICE FOR RESTORATION	408,000

Notes:

SECTION 24



Skew Bridge
Mill Lane Bridge
Backpumping Station
Croft Road Lock
Westlecott Farm Bridge
Ray Aqueduct (Croft Road)
Croft Road Crossing
Pipers Way Bottom Lock
Ray Aqueduct (Pipers Way)
Kingshill
Okus
Westleaze
Cycle Path
Dismantled Railway
Bushey Copse
Westlecott Farm
River Ray
Croft Road
B 4006
Pipers Way
North Wroughton
Sewage Works
SU18.50
112/053
305
311
A4361

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 24: Skew Bridge to Ray Aqueduct (Pipers Way) (New Canal)

Length: 2.30km **OS Ref: SU 137834 to 153822** **Level: 99.1 to 103.4mAOD; 2 locks**

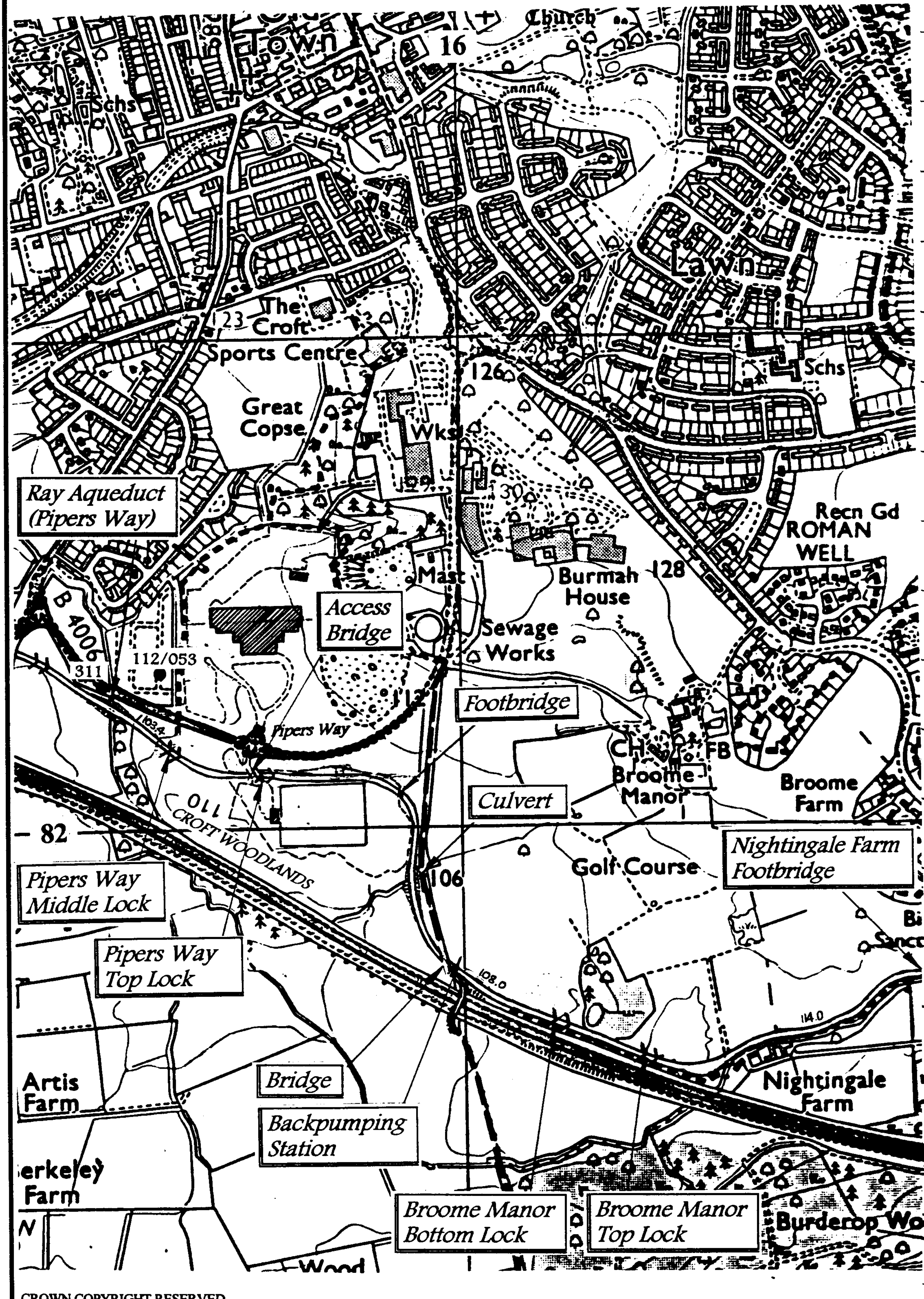
Description: First part of proposed new canal south of Swindon, following the base of Swindon Hill north of the River Ray before turning south across the river and then east to pass under the A4361Croft Road
Geology: Kimmeridge Clay and Alluvium of the River Ray; potetial problem soils at the base of Swindon Hill (e.g. running sands) depending on exact line and level of canal
Water Resources: Currently no proposals for water resource development in this section. Wroughton sewage works 1.5 km south of canal. Potential for re-use of treated urban runoff from Wroughton.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Urban to Agricultural, Grade 4 to 3. Land parcel between Croft Road and Pipers Way proposed for Park and Ride scheme; this is not incompatible with canal provision.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Some engineering problems anticipated along the base of Swindon Hill, allow for ground stabilisation and drainage works. The slope may require low retaining structures (eg gabion walling) which will warrant careful aesthetic treatment. Culverts for spring issues from the slopes may be required.	1,035,000
Services		30,000
Mill Lane Bridge	Minor road bridge which will require careful consideration because of the steepness	70,000
Westlecott Farm Bridge	Fixed farm access bridge, steepness again a consideration. Also a public right of way.	65,000
Backpumping Station	Required for lockage conservation. Rising main length 1100m discharging above Pipers Way Top Lock	180,000
Croft Road Lock	New lock lifts canal to provide adequate clearance for crossing the River Ray. Assumed lift 2.0m to 101.1mAOD	180,000
Ray Aqueduct (Croft Road)	Box culvert of similar capacity to that under adjacent Croft Road required	40,000
A4361 Croft Road Crossing	40m canal culvert including access road and dual carriageway	300,000
Pipers Way Bottom Lock	New lock assumed lift 2.3m to 103.4mAOD giving adequate clearance for the second crossing of the Ray.	190,000
Ray Aqueduct (Pipers Way)	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	2,090,000

Notes:
A4361 crossing could alternatively be located further south, to pass under the approach road to the motorway crossing. Similar total cost.

SECTION 25


Church
Town
16
Schs
The Croft
123
Sports Centre
Great Copse
Wks
126
129
130
Lawn
Schs
Recn Gd
ROMAN WELL
128
Ray Aqueduct (Pipers Way)
Burmah House
Mast
Access Bridge
Sewage Works
B 4006
311
112/053
112
Footbridge
Pipers Way
CH
FB
Broome Manor
Broome Farm
Culvert
110
CROFT WOODLANDS
82
106
Golf Course
Nightingale Farm Footbridge
Pipers Way Middle Lock
Pipers Way Top Lock
108.0
114.0
Artis Farm
Bridge
Backpumping Station
Nightingale Farm
Farm
Broome Manor Bottom Lock
Broome Manor Top Lock
Burderop Wo
Wood

SECTION 25: Ray Aqueduct (Pipers Way) to Nightingale Farm (New Canal)

Length: 2.10km **OS Ref: SU 153822 to 169817** **Level: 103.4 to 114.0mAOD; 4 locks**

Description: Second part of proposed new canal south of Swindon, passing through the northern part of the Croft Woodlands site (Nationwide cricket field /public open space) then following the southern edge of Broome Manor Golf Course.

Geology: Kimmeridge Clay; entering Greensand beyond Nightingale Farm

Water Resources: Currently no proposals for water resource development in this section. Swindon (south) sewage works 500 m north of canal.

Navigation, Recreation and Leisure: Croft Woodlands and Golf Course

Environmental Features:

Services:

Land Use: Agricultural, Grade 3. Recreation and Leisure use

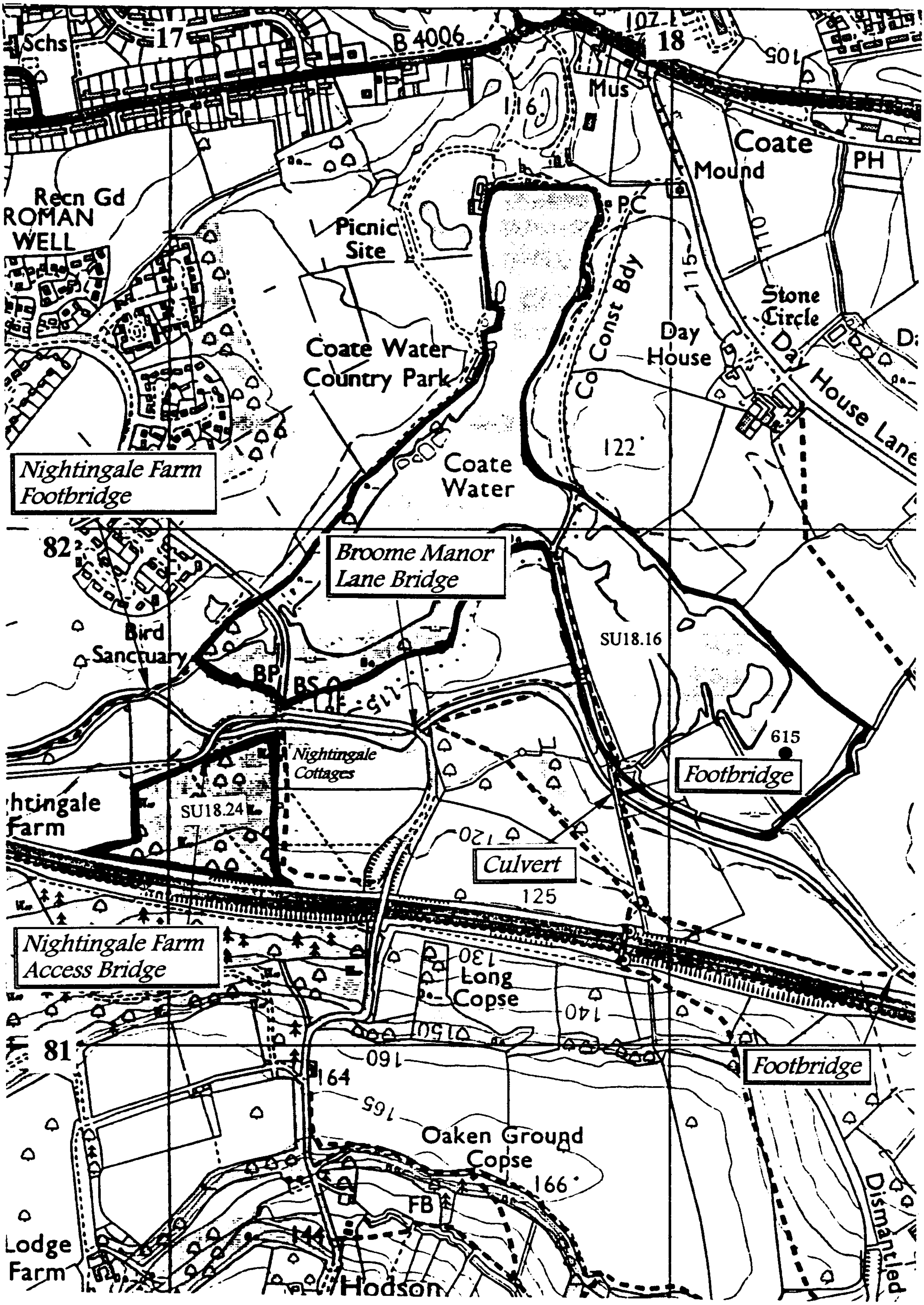
Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	The canal could significantly enhance the Croft Woodlands site although disruption during construction will be an issue. The reach involves a climb of some 10m and hence earthworks will be of some significance with cuts up to 3m deep approaching locks and embankments up to 2.5m high. Canal would run alongside the cricket pitch at approximately the same level.	1,050,000
Services		20,000
Ray Aqueduct (Pipers Way)	Allow for a box culvert	25,000
Pipers Way Middle Lock	New lock assumed lift 2.3m to 105.7mAOD giving adequate clearance for Cricket Pavilion access bridge which will ensure road alignment off the Pipers Way roundabout will not be affected	190,000
Cricket Pavilion Access Bridge	Fixed bridge constructed immediately below Top Lock, probably as part of the same structure.	50,000
Pipers Way Top Lock	New lock assumed lift 2.3m to 108.0mAOD giving adequate clearance for the second crossing of the Ray.	190,000
Footbridge	To allow for maintaining the existing footpath circuit of the Croft Woodlands site	25,000
Culvert	Minor watercourse	10,000
Bridge	Fixed bridge for bridleway	50,000
Backpumping Station	Required for lockage conservation,rising main length 450m discharging above Broome Manor Top Lock	95,000
Broome Manor Bottom Lock	New lock assumed lift 3.0m to 111.0mAOD	210,000
Broome Manor Top Lock	New lock assumed lift 3.0m to 114.0mAOD	210,000
Nightingale Farm Footbridge	*See next section*	
Services		
	ESTIMATED TENDER PRICE FOR RESTORATION	2,125,000

Notes:

Should a route through the northern part of the Croft Woodlands site prove unacceptable, the fall back solution will be routing to the south, alongside the M4.

SECTION 26


Schs
17
B 4006
107
18
105
116
Mus
Coate
Mound
PH
Recn Gd
ROMAN
WELL
Picnic
Site
PC
Stone
Circle
Day
House
Day House Lane
Coate Water
Country Park
Co Const Bdy
115
110
Coate
Water
122
Nightingale Farm
Footbridge
82
Broome Manor
Lane Bridge
Bird
Sanctuary
BP
BS
SU18.16
615
Nightingale
Cottages
Footbridge
SU18.24
120
Culvert
125
Nightingale Farm
Access Bridge
130
Long
Copse
140
150
81
160
164
165
Footbridge
Oaken Ground
Copse
166
FB
Lodge
Farm
Hodson
Dismantled

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 26: Nightingale Farm to Green Hill (New Canal)

Length: 1.80km **OS Ref: SU 169817 to 184811** **Level: 114.0mAOD**

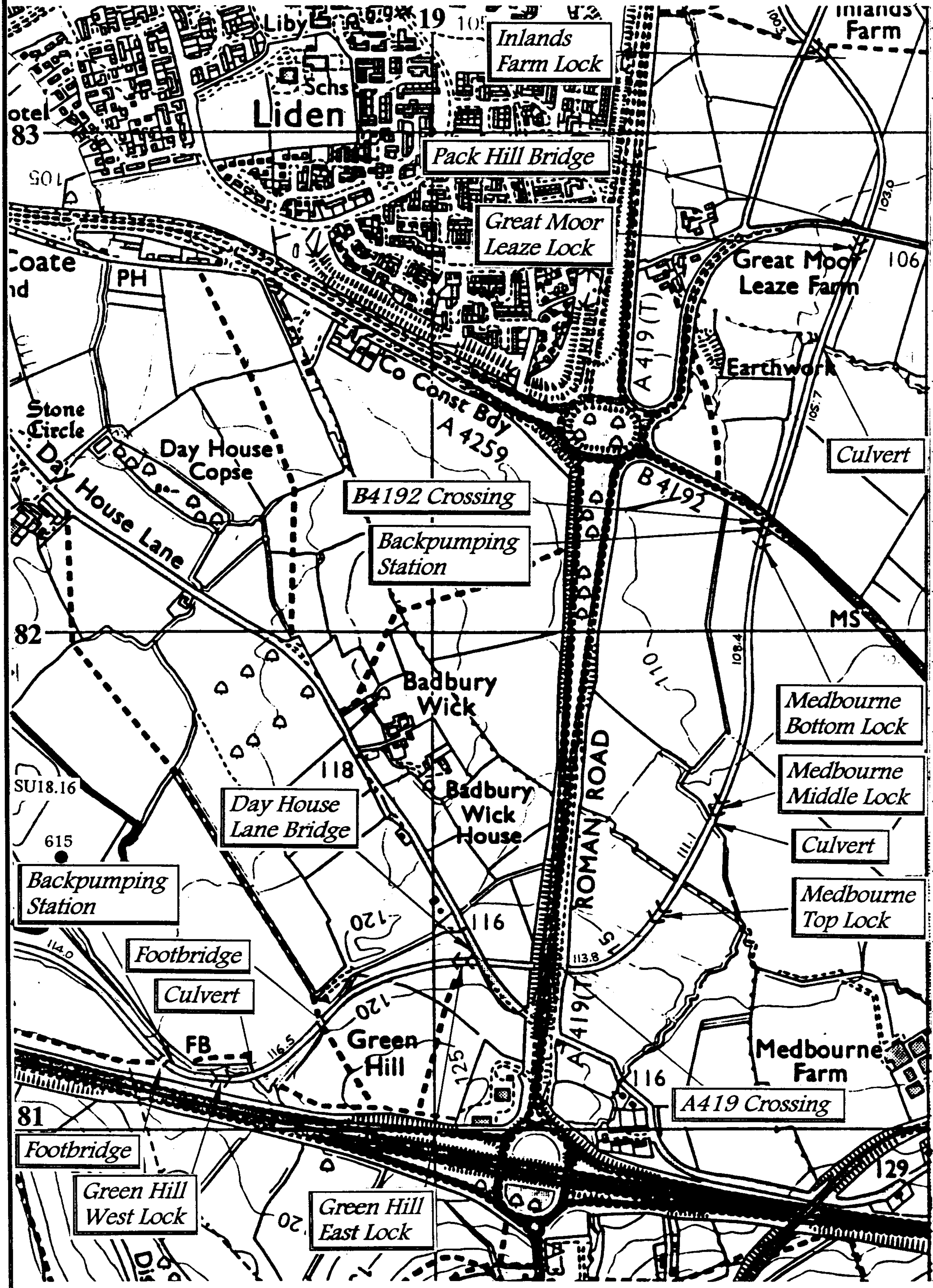
Description: Third part of proposed new canal south of Swindon, skirting around the southern edge of Coate Water
Geology: Gault Clay; Lower Greensand close to Coate Water
Water Resources: Currently no proposals for water resource development in this section.
Navigation, Recreation and Leisure: Coate Water Country Park
Environmental Features: Coate Water SSSI; Bird Sanctuary
Services:
Land Use: Agricultural, Grade 3. Recreation and Leisure and conservation; agriculture

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Predominantly through farmland, some allowance for engineering problems with greensand	630,000
Services		10,000
Nightingale Farm Footbridge	For right of way, links to Coate Water.	25,000
Nightingale Farm Access Bridge	A traditional design may be possible here. Would also accommodate right of way	90,000
Broome Manor Lane Bridge	Road level at crossing point 117mAOD so vertical realignment not necessary. Fixed bridge required	65,000
Culvert	Minor watercourse feeding Coate Water	10,000
Footbridge	For right of way	25,000
Footbridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	855,000

Notes:
Should a route through the northern part of the Croft Woodlands site prove unacceptable, the fall back solution will be routing to the south, alongside the M4.

SECTION 27


Inlands Farm Lock
Pack Hill Bridge
Great Moor Leaze Lock
Culvert
B4192 Crossing
Backpumping Station
Medbourne Bottom Lock
Medbourne Middle Lock
Culvert
Medbourne Top Lock
Day House Lane Bridge
Backpumping Station
Footbridge
Culvert
A419 Crossing
Footbridge
Green Hill West Lock
Green Hill East Lock
Liden
Schs
Lib
19
83
82
81
Coate
PH
Stone Circle
Day House Copse
Day House Lane
Co Const Bdy
A 4259
B 4192
A 419 (T)
ROMAN ROAD
Great Moor Leaze Farm
Earthwork
Inlands Farm
106
MS
Badbury Wick
Badbury Wick House
118
116
120
125
Green Hill
FB
Medbourne Farm
129
SU18.16
615

SECTION 27: Green Hill to Inlands Farm (New Canal)

Length: 2.60km **OS Ref: SU 184811 to 197831** **Level: 114.0 to116.5 and 103.0mAOD**

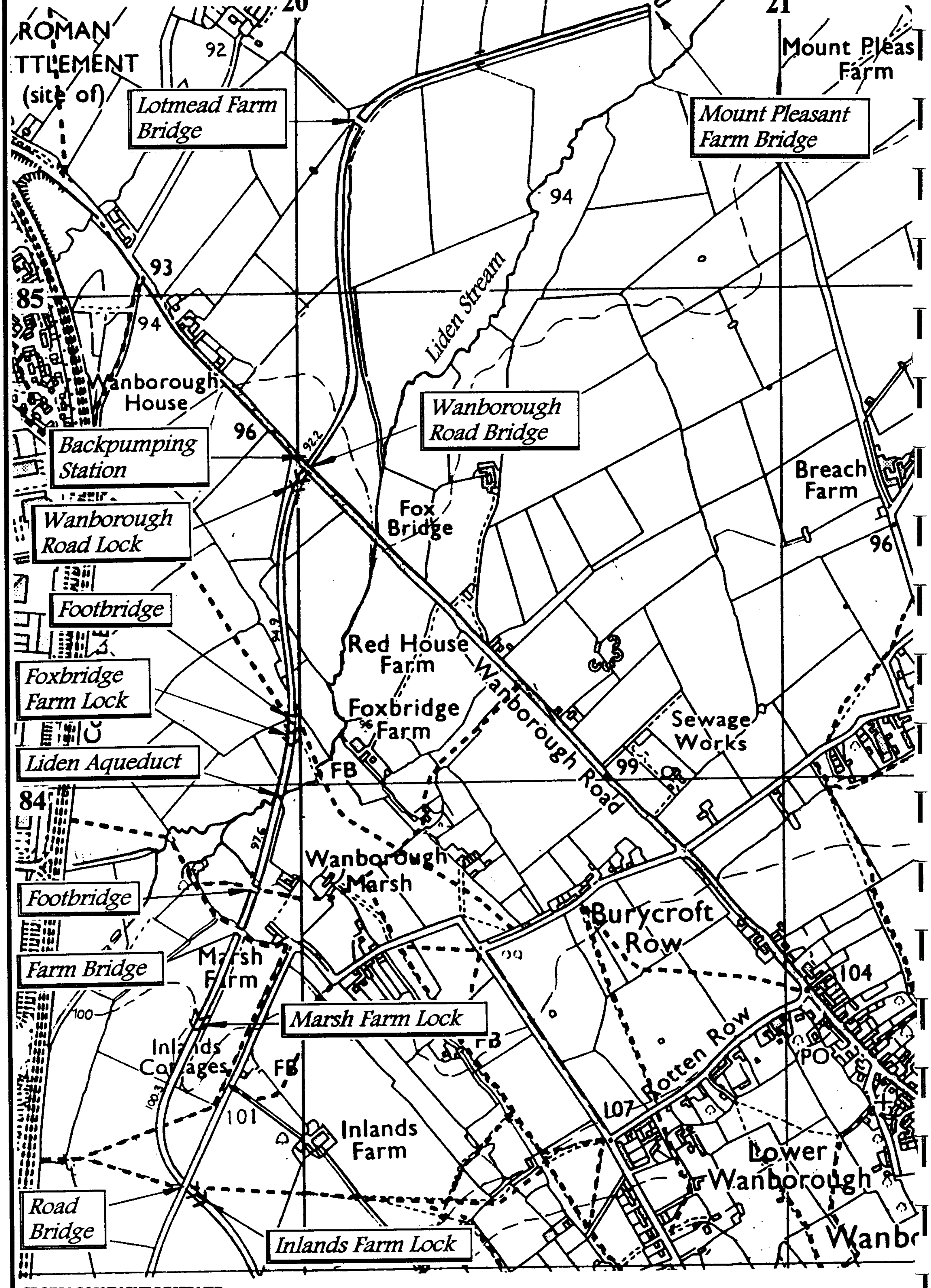
Description: Fourth part of proposed new canal south of Swindon, crossing the A419 at Green Hill, then turning north commencing the descent towards Acorn Bridge.
Geology: Gault Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features: Area of Outstanding Natural Beauty between A419 and B4192
Services:
Land Use: conservation; agricultural, Grade 3 to 4 to 3.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Predominantly through farmland and an AONB, some allowance for engineering problems alongside the old brickworks spoil heap.	1,040,000
Services		60,000
Footbridge	For right of way	25,000
Backpumping Station	Required for lockage conservation and to maintain short summit pound. Rising main length 60m discharging above Green Hill West Lock	47,000
Green Hill West Lock	Lock lift assumed 2.5m to 116.5mAOD	195,000
Culvert	Minor watercourse feeding Coate Water	10,000
Footbridge	For right of way	25,000
Green Hill East Lock	Lock fall assumed 2.7m to 113.8mAOD	200,000
Day House Lane Bridge	Fixed minor road bridge required; no realignment required	75,000
A419 Crossing	Thrust bore; also under sliproad (minor raising of sliproad)	1,750,000
Medbourne Top Lock	Lock fall assumed 2.7m to 111.1mAOD	200,000
Culvert	Minor watercourse, fed by springs at Medbourne	20,000
Medbourne Middle Lock	Lock fall assumed 2.7m to 108.4mAOD	200,000
Medbourne Bottom Lock	Lock fall assumed 2.7m to 105.7mAOD enabling the B4192 to be crossed with minimal realignment	200,000
Backpumping Station	Required for lockage conservation and to maintain short summit pound. Rising main length 1300m discharging above Green Hill East Lock	183,000
B4192 Crossing	Fixed bridge with minor raising/regrading of approaches	100,000
Culvert	Minor watercourse fed by spring at Liddington	20,000
Great Moor Leaze Lock	Lock fall assumed 2.7m to 103.0mAOD enabling Pack Hill to be crossed with minimal realignment	200,000
Pack Hill Bridge	Fixed minor road crossing with minor raising/regrading of approaches	75,000
Inlands Farm Lock	*See next Section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	4,625,000

Notes:
A short summit pound is proposed through Green Hill, the additional locks likely to be more economic than a deeper cut, and less problems likely with the adjacent spoil heap.

SECTION 28



20
21
ROMAN
TTLEMENT
(site of)
Mount Pleas
Farm
Lotmead Farm Bridge
Mount Pleasant Farm Bridge
92
94
93
85
94
Liden Stream
Wanborough House
96
92.2
Wanborough Road Bridge
Backpumping Station
Wanborough Road Lock
Fox Bridge
Breach Farm
96
Footbridge
Red House Farm
Wanborough Road
Foxbridge Farm Lock
Foxbridge Farm
Sewage Works
Liden Aqueduct
FB
99
84
97.6
Wanborough Marsh
Footbridge
Burycroft Row
Farm Bridge
Marsh Farm
104
100
Marsh Farm Lock
Inlands Cottages
FB
Rotten Row
PO
101
107
Inlands Farm
Lower Wanborough
Road Bridge
Inlands Farm Lock
Wanb

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 28: Inlands Farm to Mount Pleasant Farm(New Canal)

Length: 2.30km **OS Ref: SU 197831 to 207855** **Level: 103.0 to 92.2mAOD; 4 locks**

Description: Penultimate section of new route south of Swindon, steady descent towards Acorn Bridge, including crossing of the Liden Stream.

Geology: Gault Clay changing to Kimmeridge Clay just south of Wanborough Road. Alluvium of the Liden Stream

Water Resources: Potential abstraction from Corallian aquifer west of canal in the vicinity of Stratton St Margaret. Potential for re-use of treated urban runoff from Swindon.

Navigation, Recreation and Leisure:

Environmental Features: Site of Roman Settlement within 0.5km

Services:

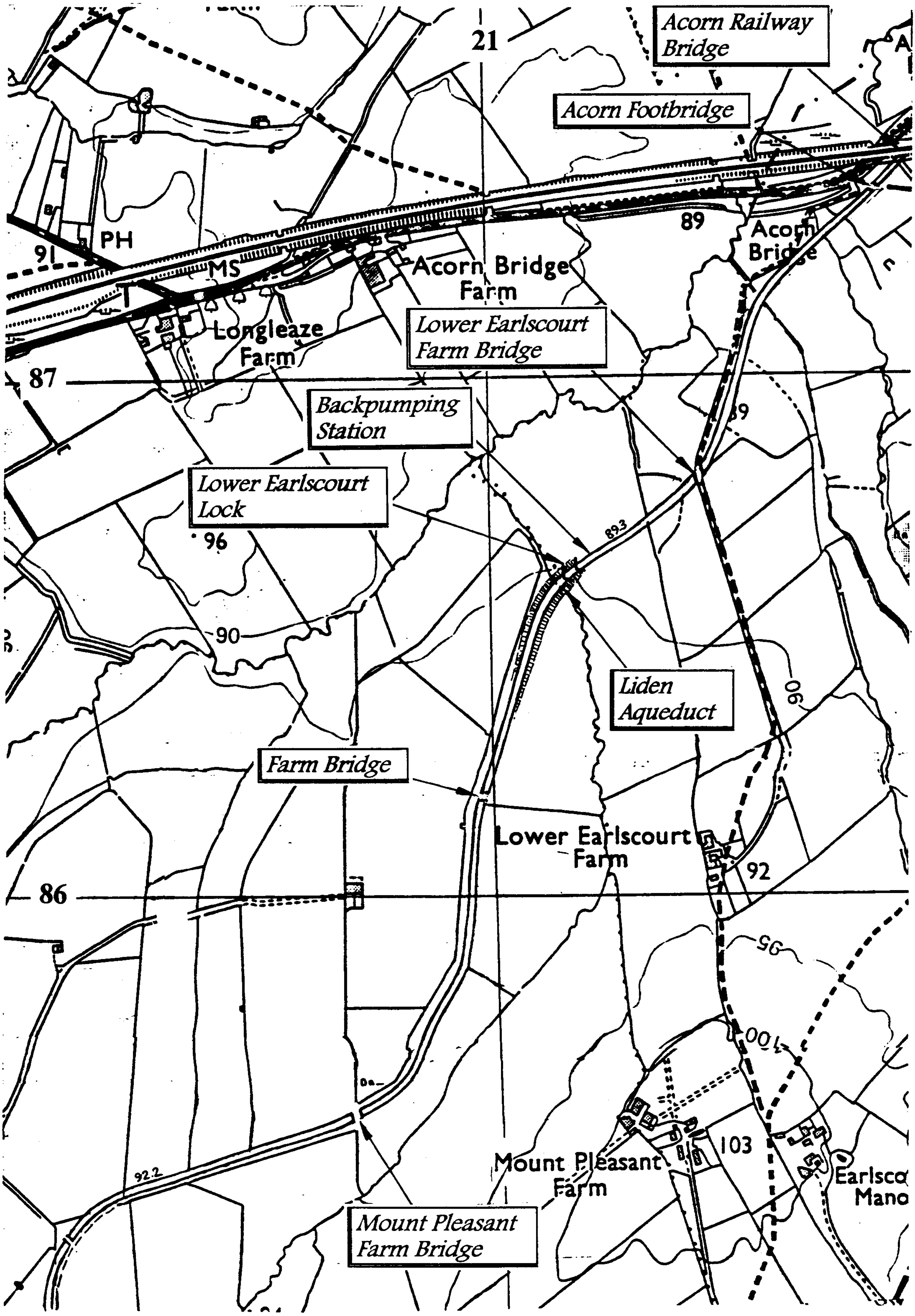
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Straightforward engineering, canal cut through clays. Some local field drainage will be intercepted, culverting not practicable.	805,000
Services		10,000
Inlands Farm Lock	Lock fall assumed 2.7m to 100.3mAOD	200,000
Bridge	Public road fixed bridge required with minor regrading of approaches	75,000
Marsh Farm Lock	Lock fall assumed 2.7m to 97.6mAOD	200,000
Farm Bridge	Allow for fixed farm bridge, also for right of way	60,000
Footbridge	Footbridge for right of way	25,000
Liden Aqueduct	Crossing the head of the Liden Stream	20,000
Foxbridge Farm Lock	Lock fall assumed 2.7m to 94.9mAOD. Including fixed farm access bridge also for right of way.	225,000
Footbridge	Footbridge for right of way	25,000
Wanborough Road Lock	Lock fall assumed 2.7m to 92.2mAOD. Enables Wanborough Road to be crossed without vertical realignment.	200,000
Wanborough Road Bridge	Fixed bridge required.	75,000
Backpumping Station	Required for lockage conservation. Rising main length 2100m discharging above Great Moor Leaze Lock	270,000
Lotmead Farm Bridge	Allow for fixed bridge due to canal severence	60,000
Mount Pleasant Farm Bridge	*See next Section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	2,250,000

Notes:

SECTION 29



21
Acorn Railway Bridge
Acorn Footbridge
89
Acorn Bridge
PH
91
MS
Acorn Bridge Farm
Longleaze Farm
Lower Earlscourt Farm Bridge
87
Backpumping Station
89
Lower Earlscourt Lock
96
89.3
90
Liden Aqueduct
90
Farm Bridge
Lower Earlscourt Farm
92
86
95
100
92.2
103
Mount Pleasant Farm
Earlsco Mano
Mount Pleasant Farm Bridge

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 29: Mount Pleasant Farm to Acorn Railway Bridge (New Canal)

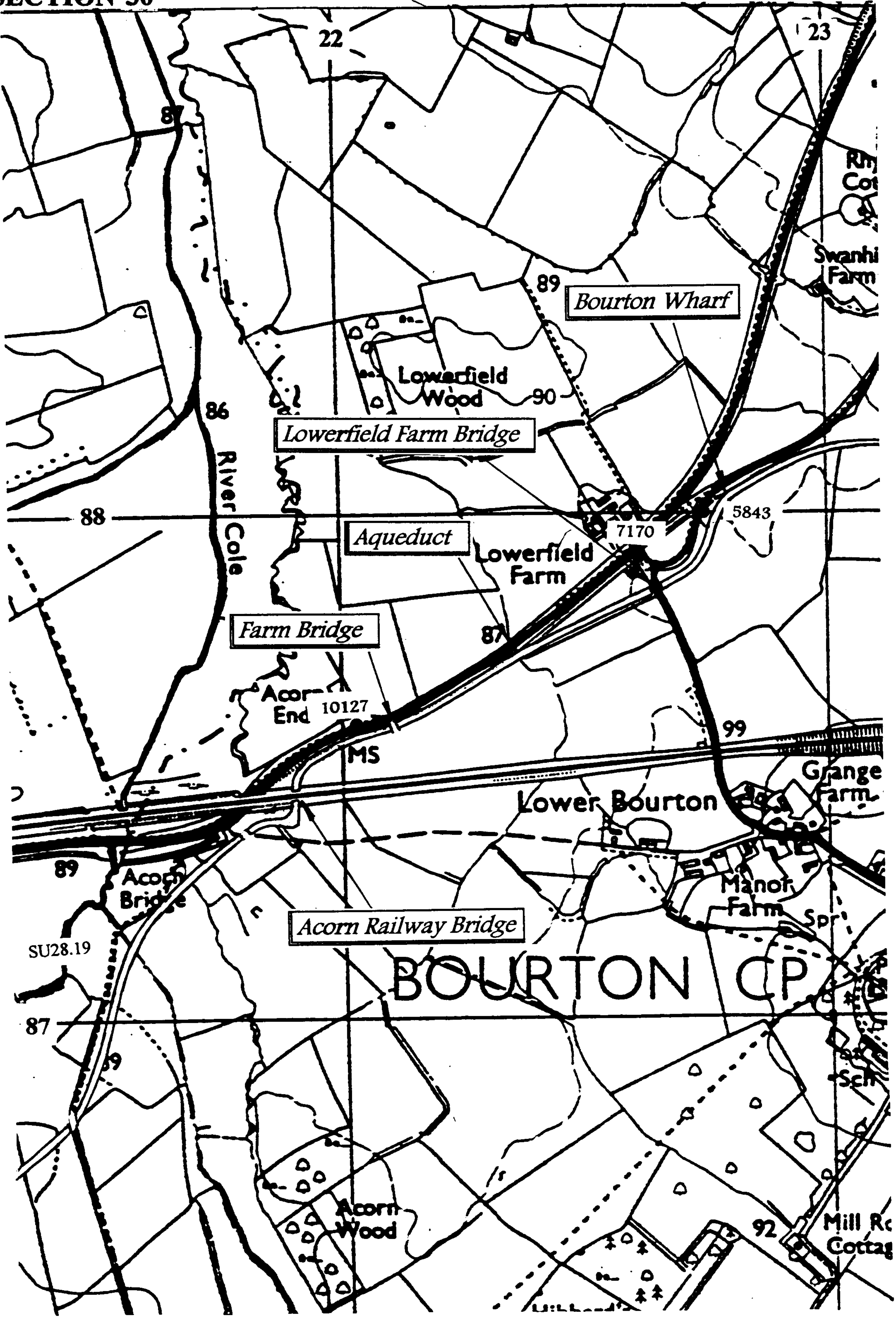
Length: 2.30km **OS Ref: SU 207855 to 218874** **Level: 92.2 to 89.3mAOD; 1 lock**

Description: Final section of new route south of Swindon, rejoining the original alignment at Acorn Bridge, including second crossing of the Liden Stream.
Geology: Kimmeridge Clay to Lower Earlscourt Farm, then Alluvium of the River Cole
Water Resources: Currently no proposals for water resource development in this section. South Marston sewage works (2 No.) about 1.5 km north west of canal.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Some local field drainage will be intercepted, culverting not practicable.Embankment up to 2m high to effect crossing of the Liden	700,000
Services		5,000
Mount Pleasant Farm Bridge	Allow for fixed bridge due to canal severence	60,000
Farm Bridge	Allow for fixed bridge due to canal severence	60,000
Liden Aqueduct	Second crossing of the Liden Stream	30,000
Lower Earlscourt Lock	Lock fall assumed 2.9m to 89.3mAOD	205,000
Backpumping Station	Required for lockage conservation. Rising main length 60m discharging above Lower Earlscourt Lock	75,000
Lower Earlscourt Farm Bridge	Fixed bridge required for access to farm, with regrading of approaches. Also for right of way.	50,000
Acorn Footbridge	Bridge for existing bridleway	50,000
Acorn Railway Bridge	*See next Section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,235,000

Notes:
An alternative route would be to remain on the east side of the Liden thus avoiding two aqueducts. There is considerable scope for canal routing on this reach to find the most economic and acceptable solution.


22
23
87
89
Bourton Wharf
Lowerfield Wood
90
86
Lowerfield Farm Bridge
River Cole
88
Aqueduct
7170
5843
Lowerfield Farm
Farm Bridge
87
Acorn End
10127
MS
99
Grange Farm
Lower Bourton
89
Acorn Bridge
Manor Farm
Acorn Railway Bridge
SU28.19
BOURTON CP
87
Acorn Wood
92

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 30: Acorn Railway Bridge to Bourton Wharf

Length: 1.15km **OS Ref: SU218874 to 228880** **Level: 89.3mAOD**

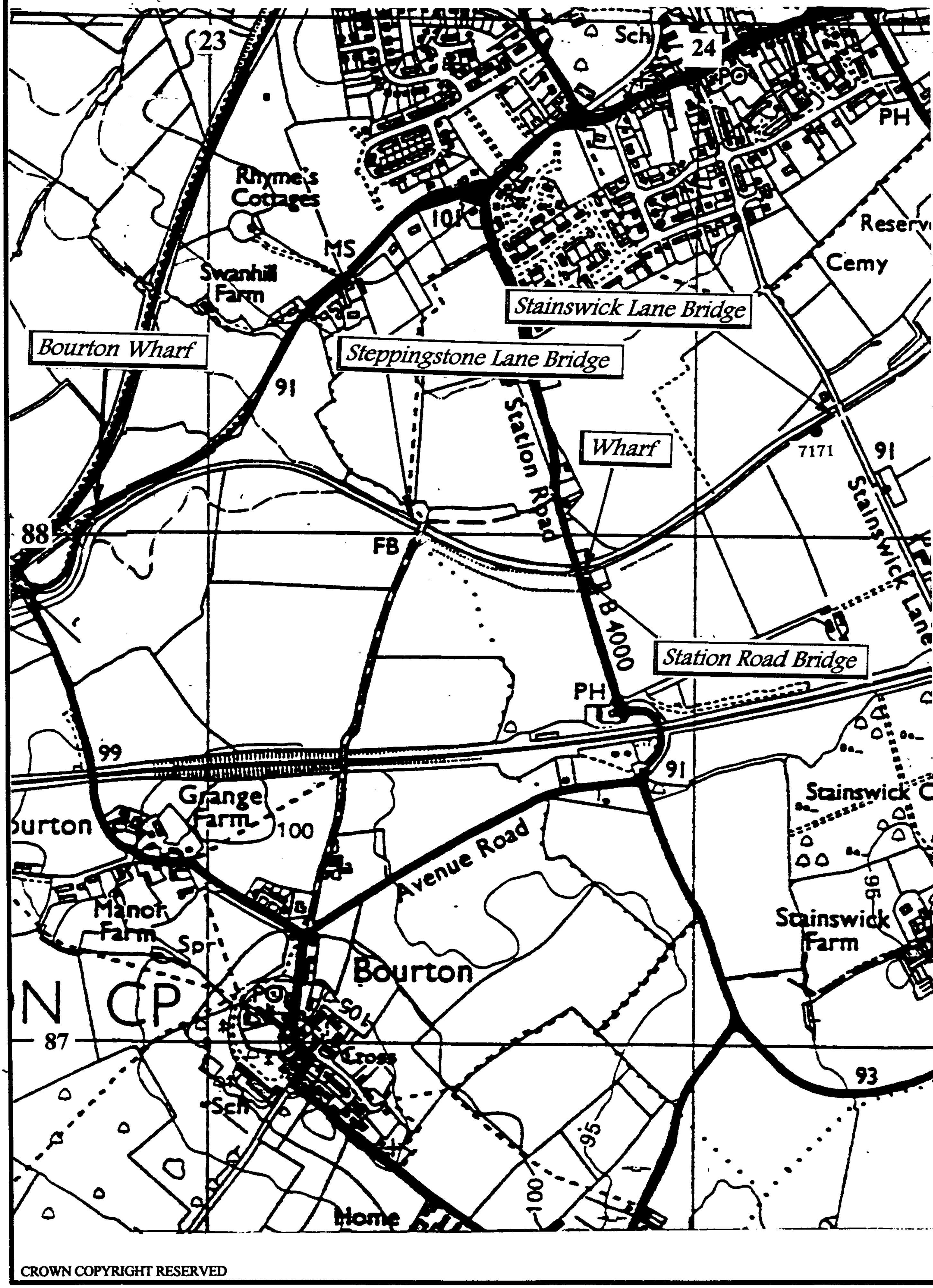
Description: Section includes crosssing of the GWR (new thrust bore required). A minor diversion is proposed at Lowerfield Farm to facilitate road crossing and avoid property.
Geology: Kimmeridge Clay; Alluvium of the River Cole at Acorn Bridge
Water Resources: Potential winter abstraction from River Cole in the vicinity of Acorn Bridge.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agricultutal, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	**Description**	**Cost(£)**
Canal Reach	The bed is infilled and overgrown with a hedge each side, for the first 200m from the railway bridge, and infilled through to the Bishopstone Brook aqueduct. 600m new canal cut at Lowerfield Farm.	230,000
Services		10,000
Acorn Railway Bridge	Existing skew bridge under the GWR in good condition. However, the A420 now uses the canal arch. Allow for a thrust bored canal culvert east of original line. Canal to approach square.	1,750,000
Milestone 31 miles.	Original canal feature (mileage to Semington)	0
Farm Bridge	Field entrance; no trace of any original structure. Allow for new fixed farm bridge.	70,000
Aqueduct	Bishopstone Brook; original structure not visible, provide new culvert	30,000
Lowerfield Farm Crossing	New fixed bridge for public road with regrading of approaches	75,000
Bourton Wharf	*See next section.*	
	ESTIMATED TENDER PRICE FOR RESTORATION	2,165,000

Notes:
Possible future road link north of railway could allow canal restoration through Acorn Bridge, saving £1.7 million

SECTION 31


Bourton Wharf
Steppingstone Lane Bridge
Stainswick Lane Bridge
Wharf
Station Road Bridge
Rhyme's Cottages
Swanhill Farm
MS
Station Road
B 4000
Stainswick Lane
Cemy
PH
Sch
PO
FB
Grange Farm
Avenue Road
Manor Farm
Spr
Bourton
Cross
Stainswick Farm
Home
N CP
23
24
88
87
91
99
100
101
93
95
7171

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 31: Bourton Wharf to Stainswick Lane Bridge

Length: 1.65km **OS Ref: SU 228880 to 243882** **Level: 89.3mAOD**

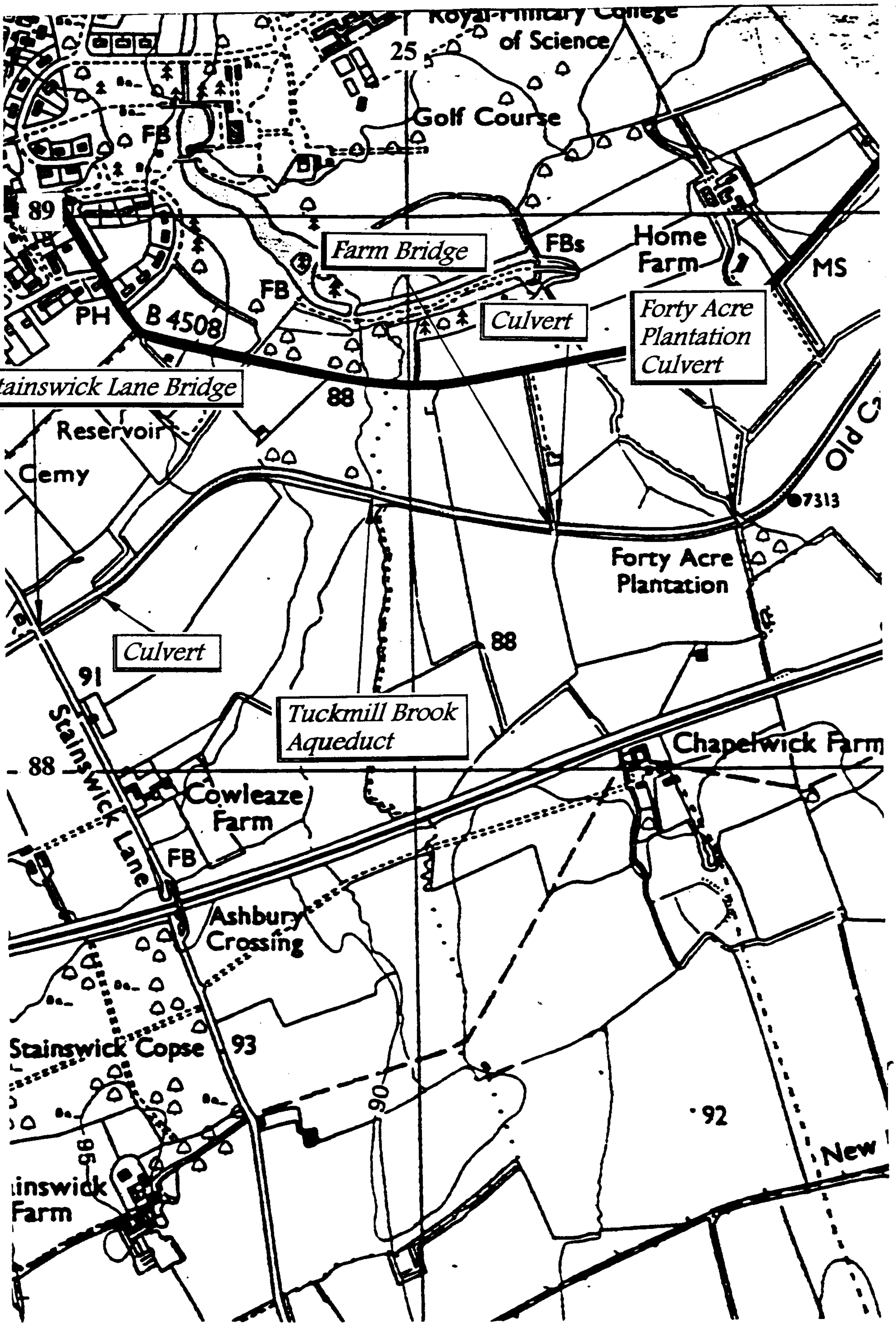
Description: Rural reach just south of Shrivenham, undergoing restoration, substantially in-water.
Geology: Kimmeridge Clay; outcrop of Upper Corallian Sand in vicinity of canal east of Station Road
Water Resources: Potential abstraction from Lower Greensand aquifer south east of Bourton. Potential for re-use of treated urban runoff from Shrivenham.
Navigation, Recreation and Leisure: Shrivenham town facilities 1km north of canal. Victoria PH 300m south of canal along B4000 Station Road
Environmental Features:
Services:
Land Use: Agriculture, Grade 4 to 3

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Relatively minor work to complete restoration	50,000
Services		5,000
Bourton Wharf	Under domestic garage. Redevelopment potential	0
Steppingstone Lane Bridge	Original bridge removed, canal infilled and culverted. New bridge required for right of way / bridleway	50,000
Wharf	There may have been a small wharf next to Station Road, now buried. Redevelopment potential.	0
Station Road Bridge	Original canal structure (also known as Shrivenham Arch Bridge) in good condition, still in use	0
Stainswick Lane Bridge	*See next Section*	
Services		
	ESTIMATED TENDER PRICE FOR RESTORATION	105,000

Notes:

SECTION 32


Royal Military College
of Science
25
Golf Course
FB
89
Farm Bridge
FBs
Home
Farm
MS
FB
PH
B 4508
Culvert
Forty Acre
Plantation
Culvert
Stainswick Lane Bridge
88
Reservoir
Cemy
Old C
7313
Forty Acre
Plantation
Culvert
88
91
Tuckmill Brook
Aqueduct
Stainswick Lane
88
Cowleaze
Farm
Chapelwick Farm
FB
Ashbury
Crossing
Stainswick Copse
93
90
92
New
Stainswick
Farm

SECTION 32: Stainswick Lane Bridge to Forty Acre Plantation

Length: 1.40km **OS Ref: SU 243882 to 256884** **Level: 89.3mAOD**

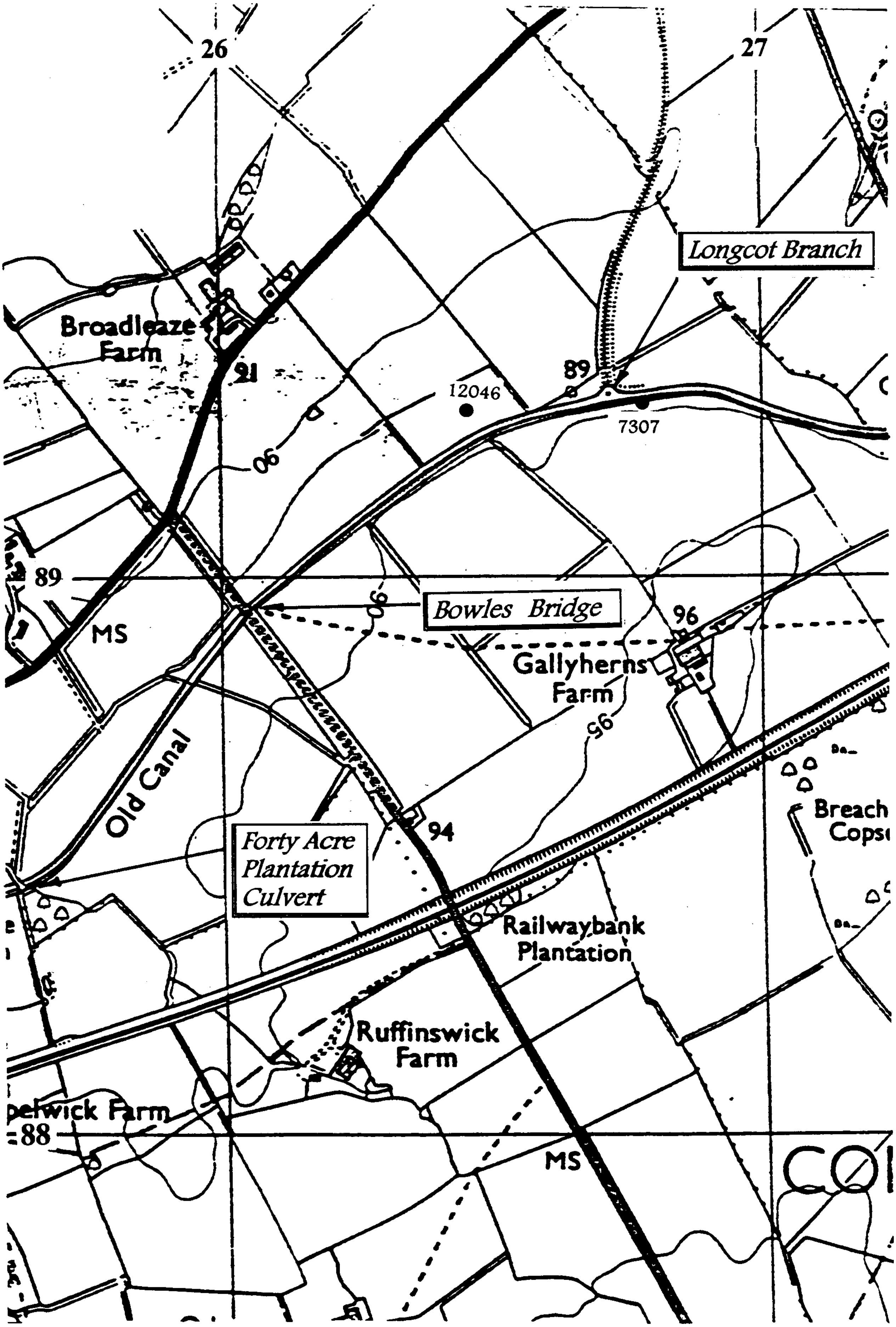
Description: Readily recoverable reach through farmland SE of Shrivenham.
Geology: Kimmeridge Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services: O/H cables at Stainswick Lane Bridge 2No to be raised
Land Use: Agriculture, Grade 4

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	About 50m either side of the Stainswick Lane, the bed has been filled. East of the bridge this was the village tip. Otherwise canal bed is reasonably clear and intact	135,000
Services		5,000
Stainswick Lane Bridge	Original lift bridge removed, infilled and culverted. A slight hump in the road is still visible. New development in close proximity to canal crossing point, also access to grain storage shed. Provide new bridge with regrading of approaches, plus access to grain store.	85,000
Culvert	Condition unknown/blocked; alow for culvert into canal	5,000
Tuckmill Brook Aqueduct	Original structure (single 7ft arch) demolished. Provide new box culvert over 2m wide brook	55,000
Farm Bridge	Allow for a farm bridge to replace existing farm crossing causeway	60,000
Culvert	Believed to carry a ditch under the towpath into the canal bed, approx DN300	5,000
Forty Acre Plantation Culvert	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	350,000

Notes:

SECTION 33



26
27
Longcot Branch
Broadleaze Farm
91
89
12046
7307
90
89
MS
Bowles Bridge
96
Gallyherns Farm
95
Old Canal
Forty Acre Plantation Culvert
94
Breach Copse
Railwaybank Plantation
Ruffinswick Farm
88
MS

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 33: Forty Acre Plantation to Longcot Branch

Length:1.40km **OS Ref: SU 256884 to 267893** **Level: 89.3mAOD**

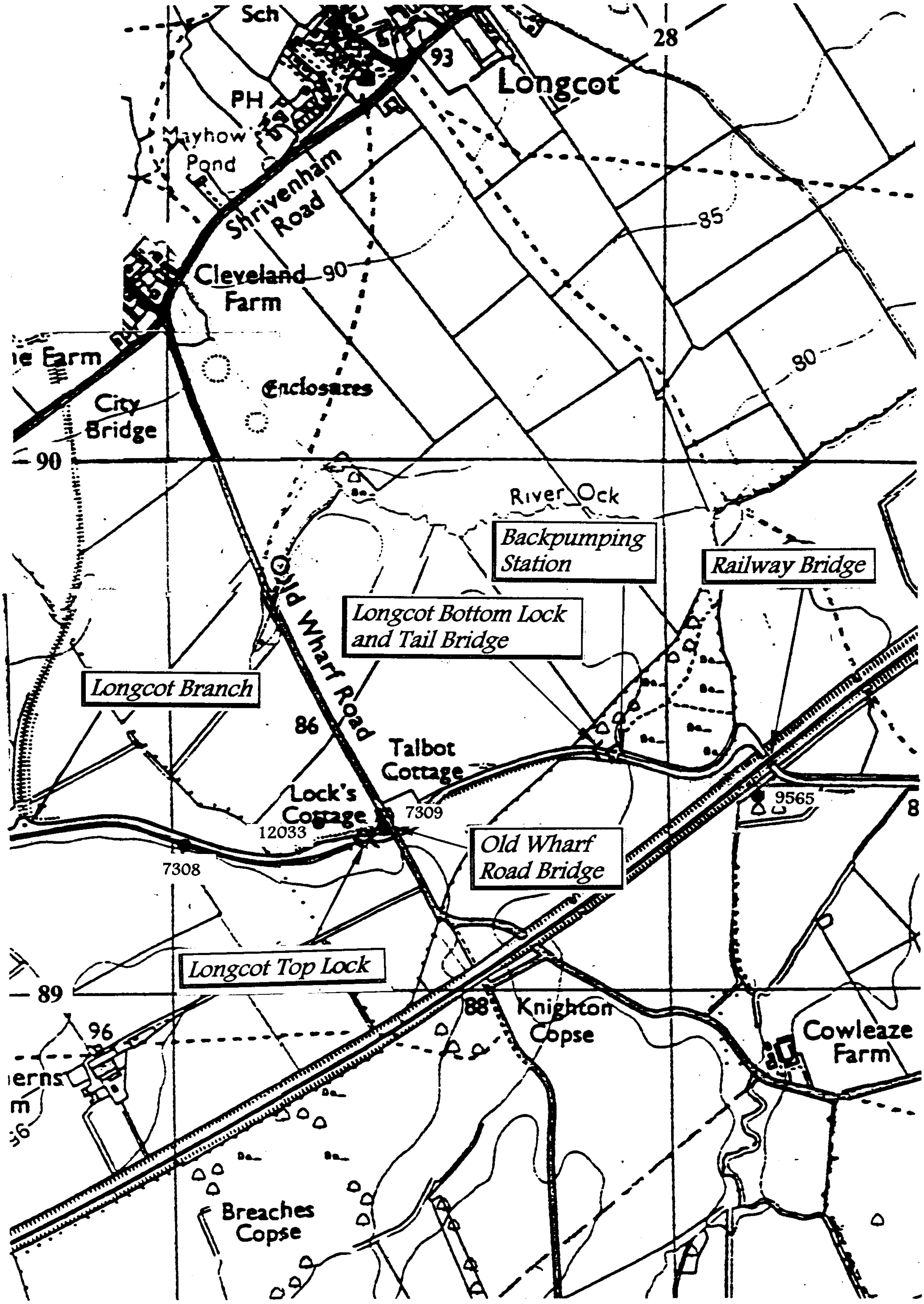
Description: Generally clear rural reach, infilled and obstructed at Bowles Bridge
Geology: Kimmeridge Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services: O/H power lines to be raised at Bowles Bridge
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	**Description**	**Cost(£)**
Canal Reach	General condition - very good, silted but in water approaching Bowles Bridge, very little scrub Infilled 100m each side of Bowles Bridge, with permanent trailer home on canal bed (relocate)	195,000
Services		5,000
Forty Acre Plantation Culvert	Original culvert dug out, now only a ditch through the canal bed. Provide new culvert	10,000
Bowles Bridge	Road rises at original crossing point; original bridge (a lift bridge) lost. Provide new fixed bridge and regrade approaches	75,000
Culvert	Condition - Ok still runs, repair.	1,000
Longcot Branch	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	286,000

Notes:

SECTION 34



Sch
28
93
Longcot
PH
Mayhow's Pond
Shrivenham Road
85
Cleveland Farm
90
80
Farm
Enclosures
City Bridge
90
River Ock
Backpumping Station
Railway Bridge
Old Wharf Road
Longcot Bottom Lock and Tail Bridge
Longcot Branch
86
Talbot Cottage
Lock's Cottage
7309
12033
9565
7308
Old Wharf Road Bridge
Longcot Top Lock
89
96
88
Knighton Copse
Cowleaze Farm
Breaches Copse

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SECTION 34: Longcot Branch to Railway Bridge

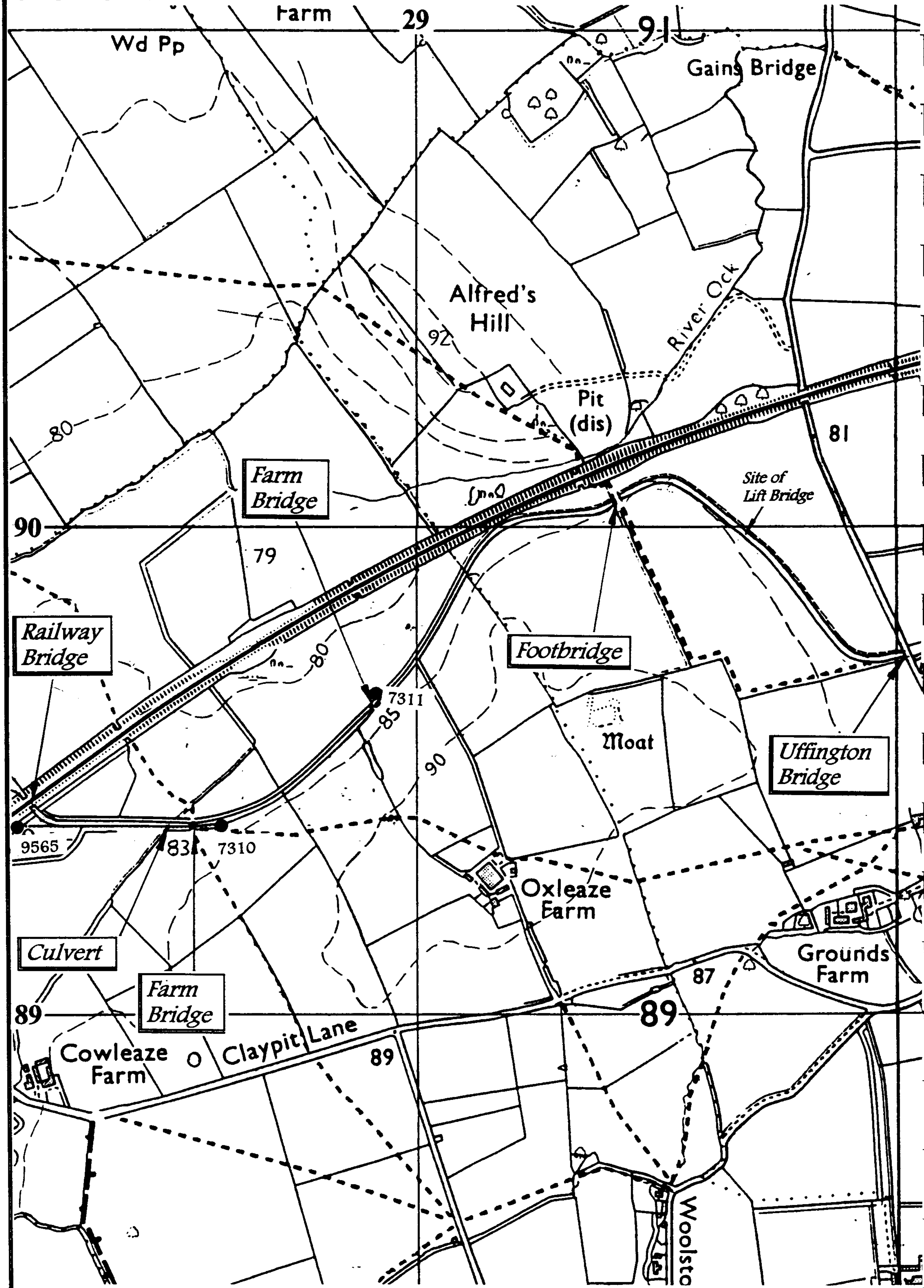
Length:1.45km **OS Ref: SU 267893 to 282894** **Level: 89.3 to 83.6mAOD; 2 locks**

Description: Rural reach including the two Longcot Locks descending into the 'Seven Mile Pound' No public rights of way.
Geology: Kimmeridge Clay
Water Resources: Potential for winter abstraction from the Chalk aquifer north east of Ashbury.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal generally clear, some local infill and silted up. Private residences (Lock's Cottage and Talbot Cottage) prevent road raising at original crossing point of Old Wharf Road, so minor realignment to the south is proposed. Also minor realignment to allow straight crossing of the railway	165,000
Services		5,000
Longcot Branch	Very poor condition. Canal and arm in water. Restoration of Longcot branch not considered in this study	0
Longcot Top Lock	Infilled as village tip - condition unknown. Large basin clear. Original Lock fall 2.79m to 86.7mAOD. Allow for complete rebuild (slightly to south)	205,000
Old Wharf Road Bridge	Infilled. Provide new bridge slightly to south of original, regrade approaches	75,000
Longcot Bottom Lock	Condition very poor. Original Lock fall 2.92m to 83.8mAOD. Allow for complete rebuild.	210,000
Longcot Bottom Lock Tail Bridge	Now infills canal. Allow for new footbridge	25,000
Backpumping Station	Required for lockage conservation. Rising main length 600m discharging above Longcot Top Lock	110,000
Railway Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	795,000

Notes:


Farm
29
91
Wd Pp
Gains Bridge
Alfred's
Hill
92
River Ock
Pit
(dis)
81
80
Farm
Bridge
Site of
Lift Bridge
90
79
Railway
Bridge
80
Footbridge
7311
85
Moat
Uffington
Bridge
90
9565
83
7310
Oxleaze
Farm
Culvert
Grounds
Farm
87
Farm
Bridge
89
89
Cowleaze
Farm
Claypit Lane
89
Woolsto

SECTION 35: Railway Bridge to Uffington Bridge

Length: 2.25km **OS Ref: SU 282894 to 300898** **Level: 83.6mAOD**

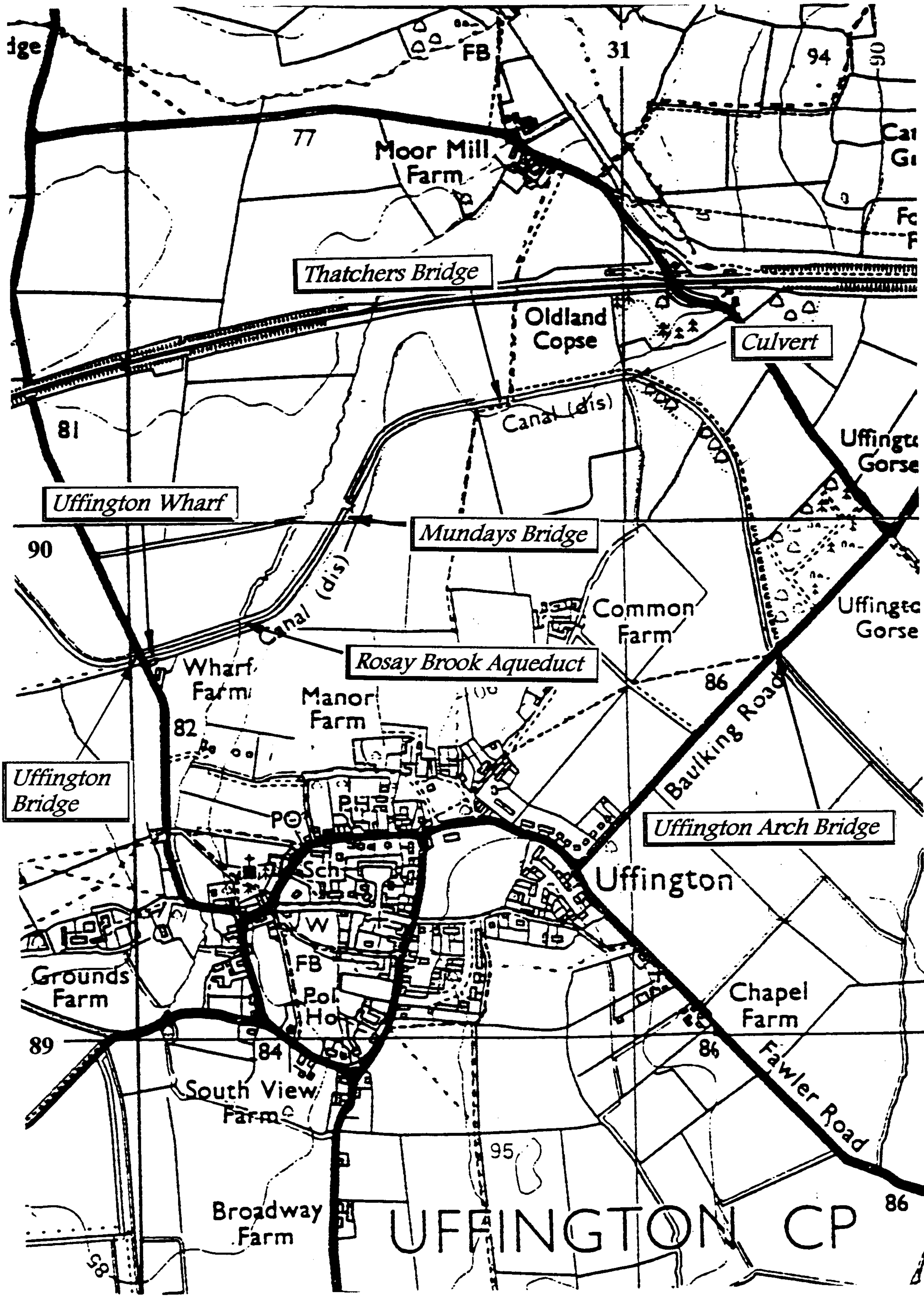
Description: Rural section, the eastern end of the Seven Mile Pound, readily recoverable; the principal engineering problem is the railway crossing.
Geology: Kimmeridge Clay to Alfred's Hill; then Lower Greensand
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services:
LandUse: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Most of the reach has been ploughed in, much of it having been originally on a slight embankment. Lining required through Greensand to minimise excessive leakage (Cost £143,000)	593,000
Services		5,000
Railway Bridge	There are no signs of the original skew railway bridge, which is likely to have been demolished and infilled. Allow for a new thrust bored canal culvert slightly to the north east	1,750,000
Culvert	Approx 1.2m diameter, good condition, clear.	1,000
Farm Bridge	Also for right of way	60,000
Farm Bridge	Site of old lift bridge, removed and infilled. Allow for new fixed farm bridge	65,000
Footbridge	For right of way	25,000
(Lift Bridge)	Site of lift bridge, assumed no longer required	0
Uffington Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	2,499,000

Notes:
There is an existing farm crossing (also taking the right of way) under the railway some 200m north east of the original canal crossing which could probably be utilised, saving £1.7 million. Its use would depend on closing off vehicle access and finding/agreeing an alternative.

SECTION 36



Moor Mill Farm
FB
31
94
77
Thatchers Bridge
Oldland Copse
Culvert
Canal (dis)
81
Uffington Gorse
Uffington Wharf
Mundays Bridge
90
Canal (dis)
Common Farm
Rosay Brook Aqueduct
Wharf Farm
Manor Farm
86
82
Baulking Road
Uffington Bridge
PO
Uffington Arch Bridge
Sch
Uffington
W
Grounds Farm
FB
Pol Ho
Chapel Farm
89
84
86
Fawler Road
South View Farm
95
Broadway Farm
UFFINGTON CP
86

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 36: Uffington Bridge to Uffington Arch Bridge

Length: 1.90km **OS Ref: SU 300898 to 313898** **Level: 83.6mAOD**

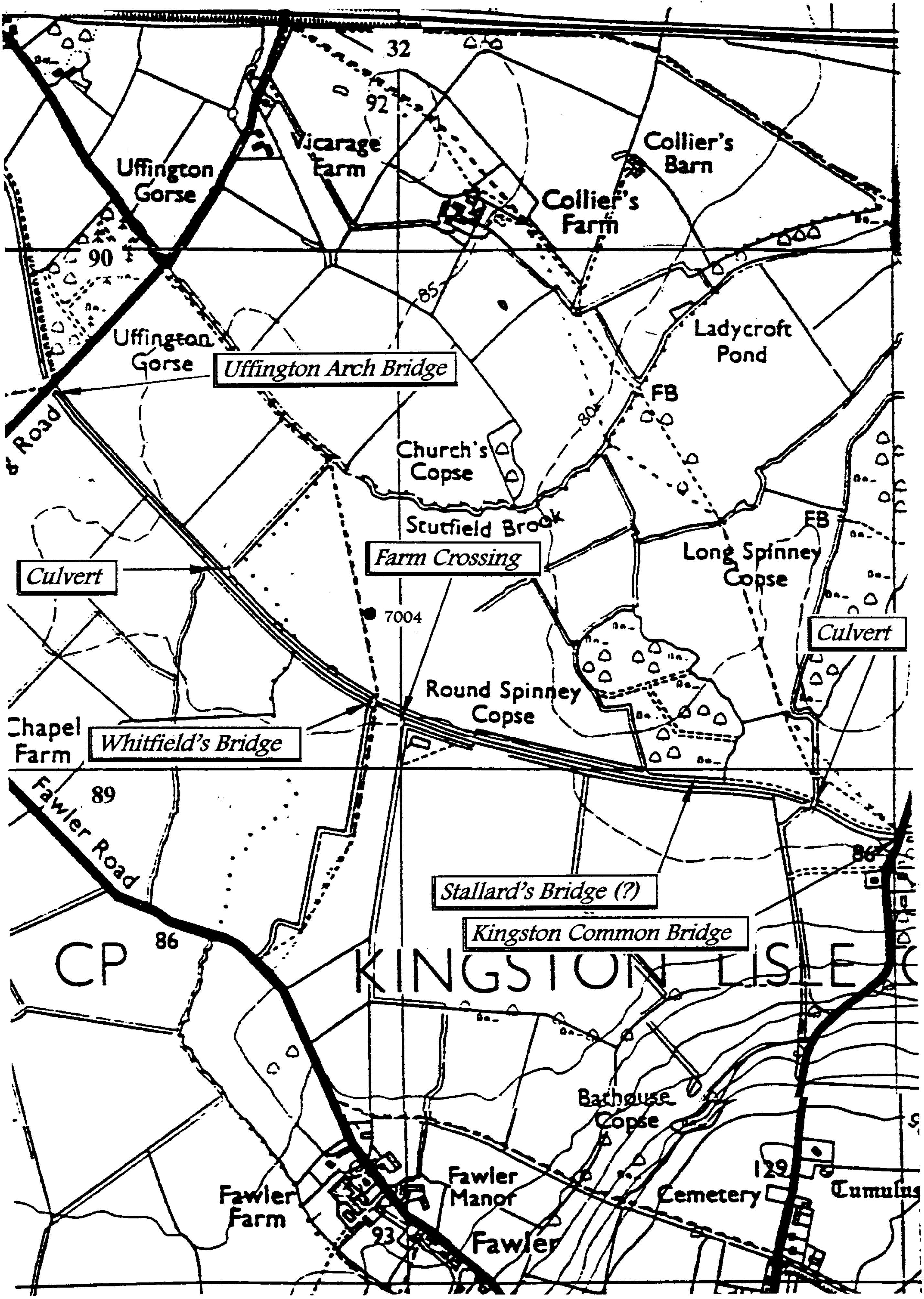
Description:; Very attractive and readily recoverable rural section with some public rights of way.
Geology: Lower Greensand to Oldland Copse, then Gault Clay
Water Resources: Potential for winter abstraction from unnamed tributary of the River Ock north of Uffington. Potential for abstraction from Lower Greensand/Corallian aquifers north of canal, with potential for winter abstraction from Chalk aquifer south of Uffington.
Navigation, Recreation and Leisure: Uffington centre within 500m (White Horse PH)
Environmental Features: Uffington Gorse; County Wildlife Site (38E03/1); Woodland Trust Nature Reserve.
Services:
Land Use: Agricultural, Grade 3 to 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	The bed is initially on embankment, changing to cutting beyond Thatcher's Bridge, and appears generally intact and holding water in places. Private garden and some sheds on the line near Uffington Bridge, minor diversion to the north feasible to avoid. Some domestic rubbish tipping by Uffington Arch Bridge. Lining required through Greensand to minimise excessive leakage (Cost £325,000)	550,000
Services		5,000
Uffington Bridge	Road rises at original crossing point.New bridge with mionor regrading of approaches	75,000
Uffington Wharf	Infilled. Redevelopment potential	0
Rosay Brook Aqueduct	7 ft arch, in good condition but holed into brook. Restore	5,000
Mundays Bridge	Originally a lift bridge, canal infilled for 15m. Allow for new farm crossing	50,000
Culvert	Existing broken culvert. Assumed to be local drainage, can be fed into canal.	1,000
Thatchers Bridge	Originally a lift bridge, some remains visible. Abutments fair, fixed deck of railway sleepers poor. New footbridge adjoining. Allow for new canal footbridge	25,000
Uffington Arch Bridge	*See next Section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	711,000

Notes:

SECTION 37



32
92
Vicarage Farm
Collier's Barn
Uffington Gorse
Collier's Farm
90
85
Ladycroft Pond
Uffington Gorse
Uffington Arch Bridge
FB
80
Church's Copse
Stutfield Brook
FB
Farm Crossing
Long Spinney Copse
Culvert
7004
Culvert
Round Spinney Copse
Chapel Farm
Whitfield's Bridge
89
Fawler Road
86
Stallard's Bridge (?)
Kingston Common Bridge
86
CP
KINGSTON LISLE
Bathouse Copse
129
Fawler Farm
Fawler Manor
Cemetery
Tumulus
93
Fawler

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 37: Uffington Arch Bridge to Kingston Common Bridge

Length:2.10km **OS Ref: SU313898 to 330889** **Level: 83.6mAOD**

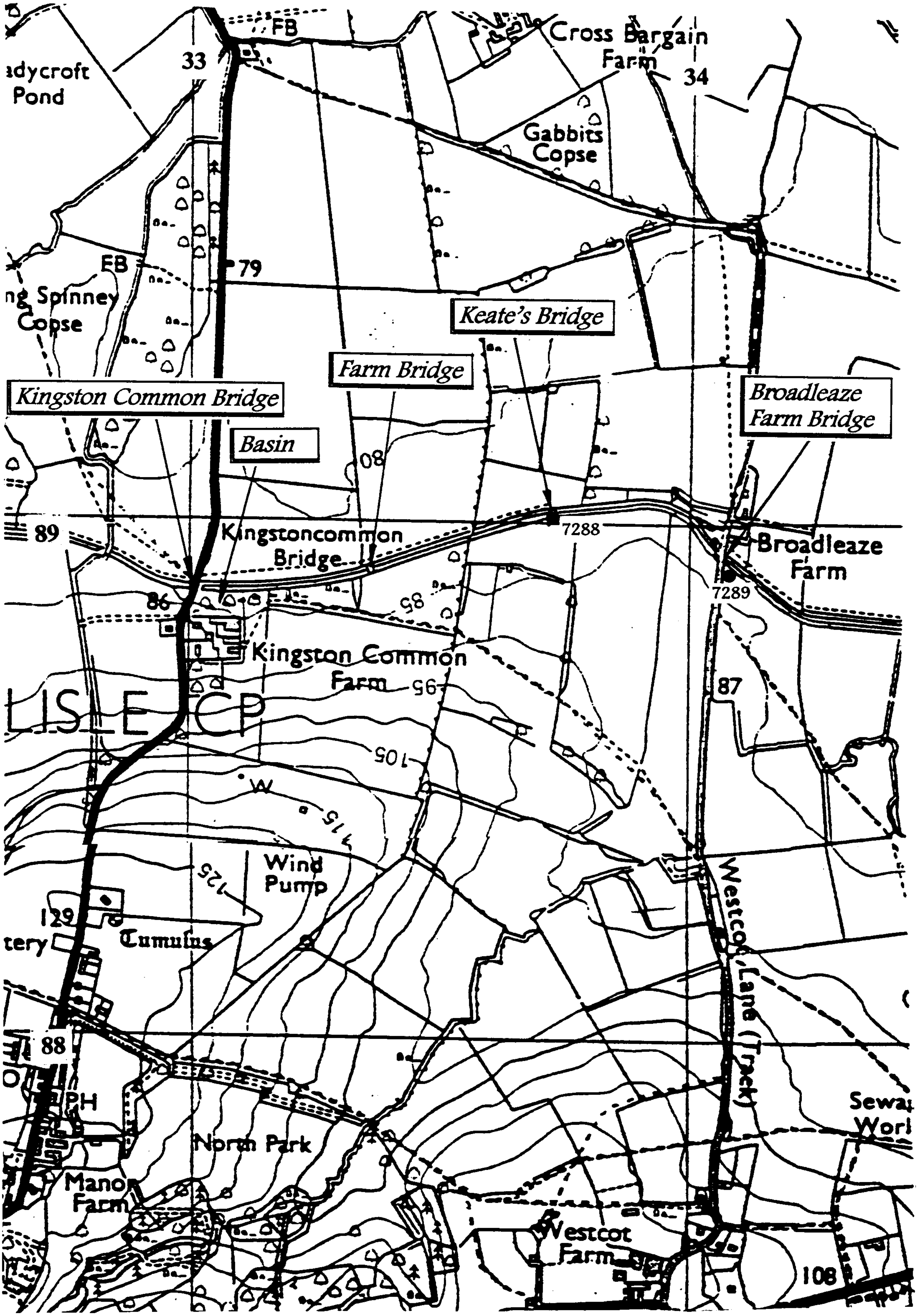
Description: Section largely on embankment, towpath accessible but not a right of way. No major restoration problems.
Geology: Gault Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features: Uffington Gorse; County Wildlife Site (38E03/1); Woodland Trust Nature Reserve. Long Spinney Copse, County Wildlife Site (38J02); semi-natural ancient woodland
Services:
Land Use: Agriculture, Grade 4

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Reach mainly on embankment except at ends There will be perhaps 4 small culverts to build or reinstate taking local ditch drainage into the canal, and several causeways to remove, in addition to a 100m infilled length east of Stallard's Bridge. Bed channel generally good but overgrown, holding water close to Stutfield Brook, but large trees on the towpath east of here.	270,000
Services		5,000
Uffington Arch Bridge (Baulking Road)	Bridge levelled, parapet about ground level. Road rises at original crossing point. New bridge required with slight regrading of approaches	70,000
Milestone 38	Original canal feature	0
Culvert	Stutfield Brook tributary from the Fawler area. Culvert dug out 2.0m high, 1.5m wide. Difficult obstruction, replace	30,000
Whitfield Bridge	Original lift bridge levelled, archivault stones about. Allow for new footbridge for right of way. (Might be possible to combine with farm crossing)	25,000
Farm Crossing	Infill for farm crossing. Allow for new fixed bridge	60,000
Stallards Bridge	Possible remains at 326890, not shown on the 1875 survey. Allow for a farm bridge, but east of (and clear of) the Spinney, possibly a lift bridge.	65,000
Culvert	Culvert ditch under canal	10,000
Milestone 39	Original canal feature	0
Kingston Common Bridge	*See next Section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	535,000

Notes:

SECTION 38



Keate's Bridge
Farm Bridge
Kingston Common Bridge
Basin
Broadleaze
Farm Bridge
Cross Bargain
Farm
Gabbits
Copse
Pond
FB
Copse
Kingstoncommon
Bridge
Kingston Common
Farm
Broadleaze
Farm
7288
7289
Wind
Pump
Tumulus
North Park
Manor
Farm
Westcot
Farm
Westcot Lane (Track)
PH
33
34
79
89
86
87
88
129
108

SECTION 38: Kingston Common Bridge to Broadleaze Farm Bridge

Length: 1.10km **OS Ref: SU 330889 To 340890** **Level: 83.6mAOD**

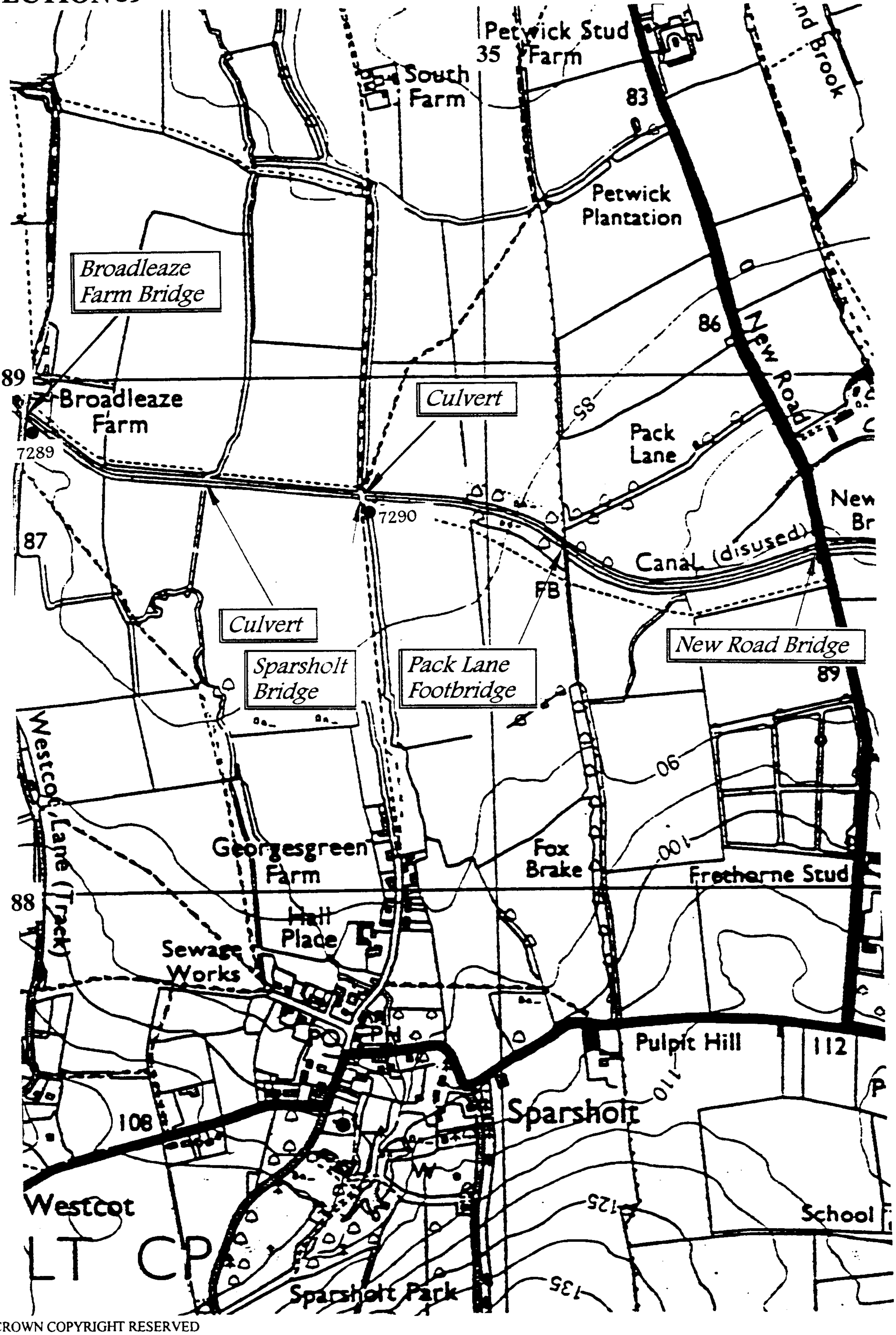
Description: Short reach between two farms. No public right of way.
Geology: Gault Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:.
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	30m infill at Kingston Common Farm. Elsewhere somewhat overgrown but holding water. Some dredging / clearance work has been done by Broadleaze Farm.	120,000
Services		5,000
Kingston Common Bridge	Levelled and infilled, but road rises at original crossing point. Skew bridge required with regrading of approaches and alignment improvements; also regrading of farm access.	95,000
Basin	70m long, overgrown. Large trees in water.	0
Farm Crossing	Allow for a farm crossing, possibly a lift bridge	65,000
Keate's Bridge	Original swing bridge, infilled and levelled. Allow for new farm crossing, possibly a lift bridge.	65,000
Broadleaze Farm Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	350,000

Notes:

SECTION 39



Petwick Stud Farm
35
South Farm
83
Brook
Petwick Plantation
Broadleaze Farm Bridge
86
New Road
89
Broadleaze Farm
7289
Culvert
Pack Lane
7290
87
Canal (disused)
FB
New Br
Culvert
Sparsholt Bridge
Pack Lane Footbridge
New Road Bridge
89
Westcot Lane (Track)
90
Georgesgreen Farm
Fox Brake
100
Fretherne Stud
88
Hall Place
Sewage Works
PO
Pulpit Hill
112
110
108
Sparsholt
Westcot
125
School
LT CP
135
Sparsholt Park

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 39: Broadleaze Farm Bridge to New Road Bridge

Length:1.70km **OS Ref: SU 340890 To 357887** **Level: 83.6mAOD**

Description: Rural section 1km north of Sparsholt. The deep cutting approaching New Road has particular character

Geology: Gault Clay

Water Resources: Potential winter abstraction from unnamed tributary of Stutfield Brook south east of Broadleaze Farm. Two field drains enter the canal cut approaching New Road. Sparsholt sewage works about 1.0 km south of canal.

Navigation, Recreation and Leisure:

Environmental Features:

Services:

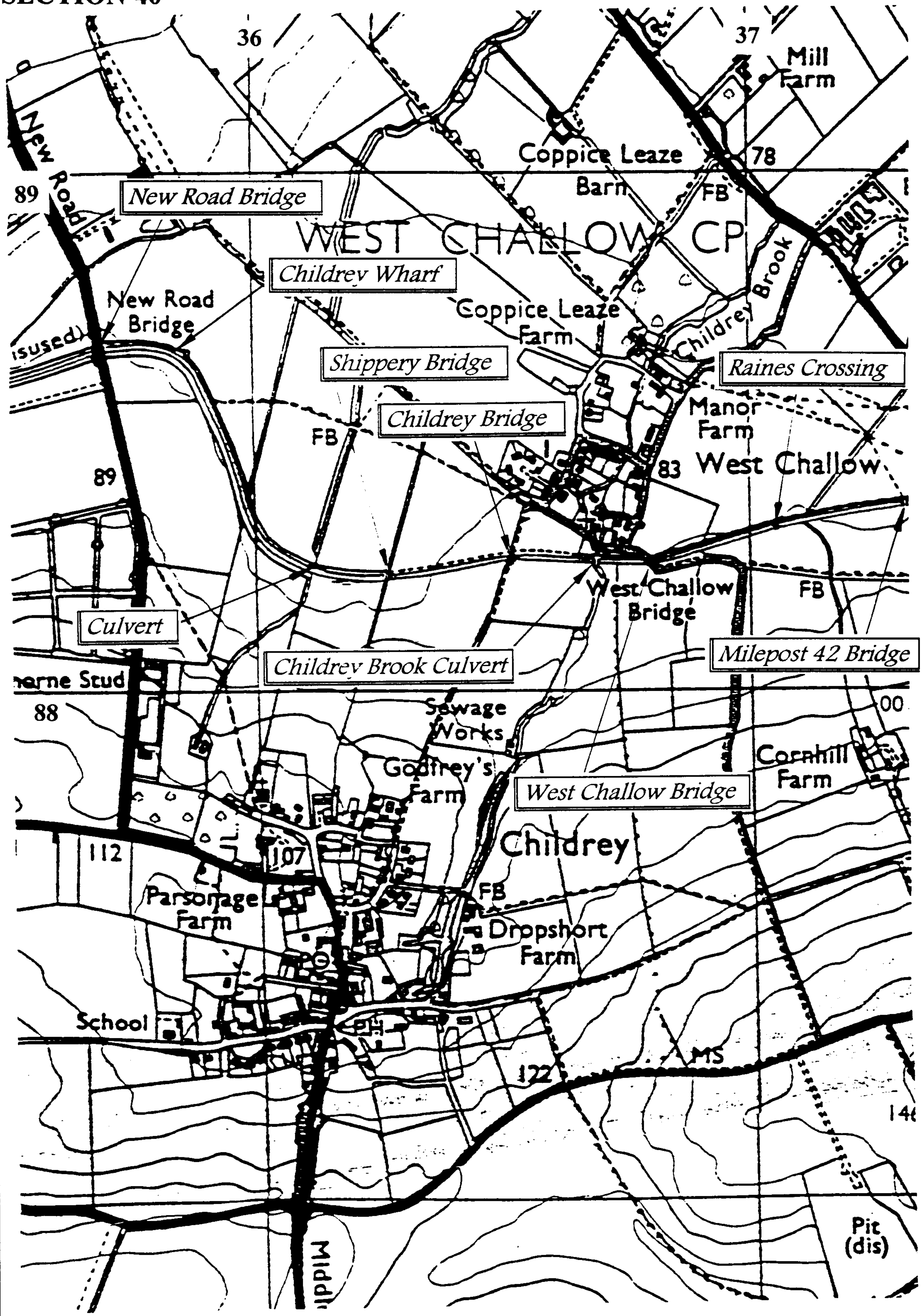
Land Use: Agriculture, Grade 3 to 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Bed profile good, in water, light scrub. Canal goes into deep cutting to cross the B4001 New Road. Some large trees to end of Pack lane. Partial infilling of canal cut approaching new road but channel clear.	190,000
Services		5,000
Broadleaze Farm Bridge	Infilled and levelled. May be culverted. New bridge required with regrading of approaches and farm access	80,000
Culvert	Working, operates as a siphon - may have leak in mid bed. This watercourse takes the effluent from Sparsholt sewage works. Allow for renewal	10,000
Milestone 40	Original canal feature	0
Sparsholt Bridge	Original lift bridge infilled and levelled. Allow for new farm type bridge for bridleway (possibly a lift bridge dependent on usage)	65,000
Culvert	For Georges Green Stream which runs along the east side of the bridleway. Working, but allow for renewal.	10,000
Pack Lane Footbridge	Allow for a footbridge for existing footpath, though not a right of way.	25,000
New Road Bridge (B4001)	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	385,000

Notes:

SECTION 40



New Road Bridge
Childrey Wharf
Shippery Bridge
Childrey Bridge
Raines Crossing
Culvert
Childrey Brook Culvert
Milepost 42 Bridge
West Challow Bridge
36
37
Mill Farm
Coppice Leaze Barn
78
89
New Road
FB
WEST CHALLOW CP
Childrey Brook
New Road Bridge
(disused)
Coppice Leaze Farm
Manor Farm
West Challow
83
89
West Challow Bridge
FB
Stud
88
Sewage Works
Godfrey's Farm
00
Cornhill Farm
Childrey
112
107
Parsonage Farm
FB
Dropshort Farm
School
MS
122
146
Pit (dis)
Middl

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SECTION 40: New Road Bridge to Milepost 42 Bridge

Length: 1.90km **OS Ref: SU 357887 to 373883** **Level: 83.6mAOD**

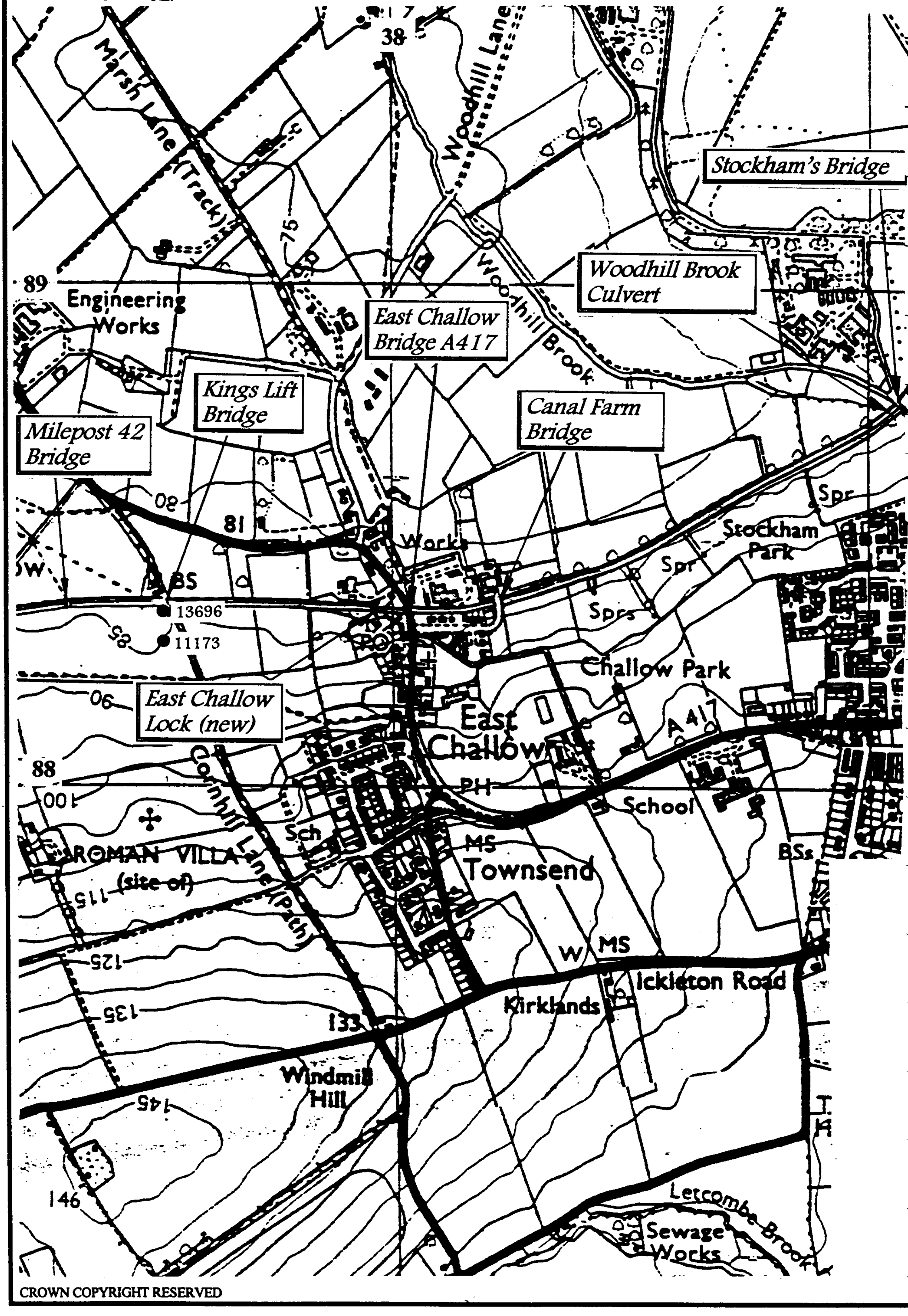
Description: Reach passing between villages of West Challow and Childrey, studied in detail by the W&BCAG; restoration action plan prepared and in progress.
Geology: Gault Clay
Water Resources: Currently no proposals for water resource development in this section. Childrey sewage works about 500 m south of canal.
Navigation, Recreation and Leisure: Village facilities.
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Bed mainly cleared and in water. 155m infilled stretch 361833 to 363883. Tip at B4001 entrance, will require disposal to licenced site.	240,000
Services		10,000
New Road Bridge (B4001)	Original bridge levelled, infilled and culverted. Road rises at original crossing point. Allow for new bridge with regrading of approaches and alignment improvements. Also regrade access to farm (2No) and stud farm.	100,000
Childrey Wharf	Partially rebuilt, being restored.	0
Culvert	For existing small watercourse which presently cuts through the canal (unless intreception permitted)	5,000
Shippery Bridge	Original lift bridge, infilled, top of abutment visible. Allow for replacement farm bridge, possibly a lift bridge.	65,000
Childrey Bridge	Culverted. Allow for new fixed bridge for bridleway/ right of way	50,000
Childrey Brook Culvert	Good condition. Operates as a siphon. Allow for some repairs.	5,000
West Challow Bridge	Infilled and culverted. Original crossing on sharp right and left hand bends. Provide new bridge with regrading of approaches and alignment improvements, also regrading of farm access.	100,000
Raines Crossing	Farm crossing formed by breaching banks. Allow for farm bridge.	65,000
Milepost 42 Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	640,000

Notes:
Two further farm bridges might be required at field boundaries west of Shippery Bridge, £120,000 contingency.

SECTION 41


Stockham's Bridge
Woodhill Brook Culvert
East Challow Bridge A417
Kings Lift Bridge
Milepost 42 Bridge
Canal Farm Bridge
East Challow Lock (new)
Marsh Lane (Track)
Woodhill Lane
Woodhill Brook
Engineering Works
Stockham Park
Challow Park
East Challow
Townsend
School
Ickleton Road
Kirklands
Windmill Hill
Cornhill Lane (Path)
ROMAN VILLA (site of)
Sewage Works
Letcombe Brook
13696
11173
89
88
38

SECTION 41: Milepost 42 to Stockham's Bridge (East Challow section)

Length: 1.85km **OS Ref: SU 373883 To 390888** **Level: 83.6m to 83.0mAOD; 1 lock**

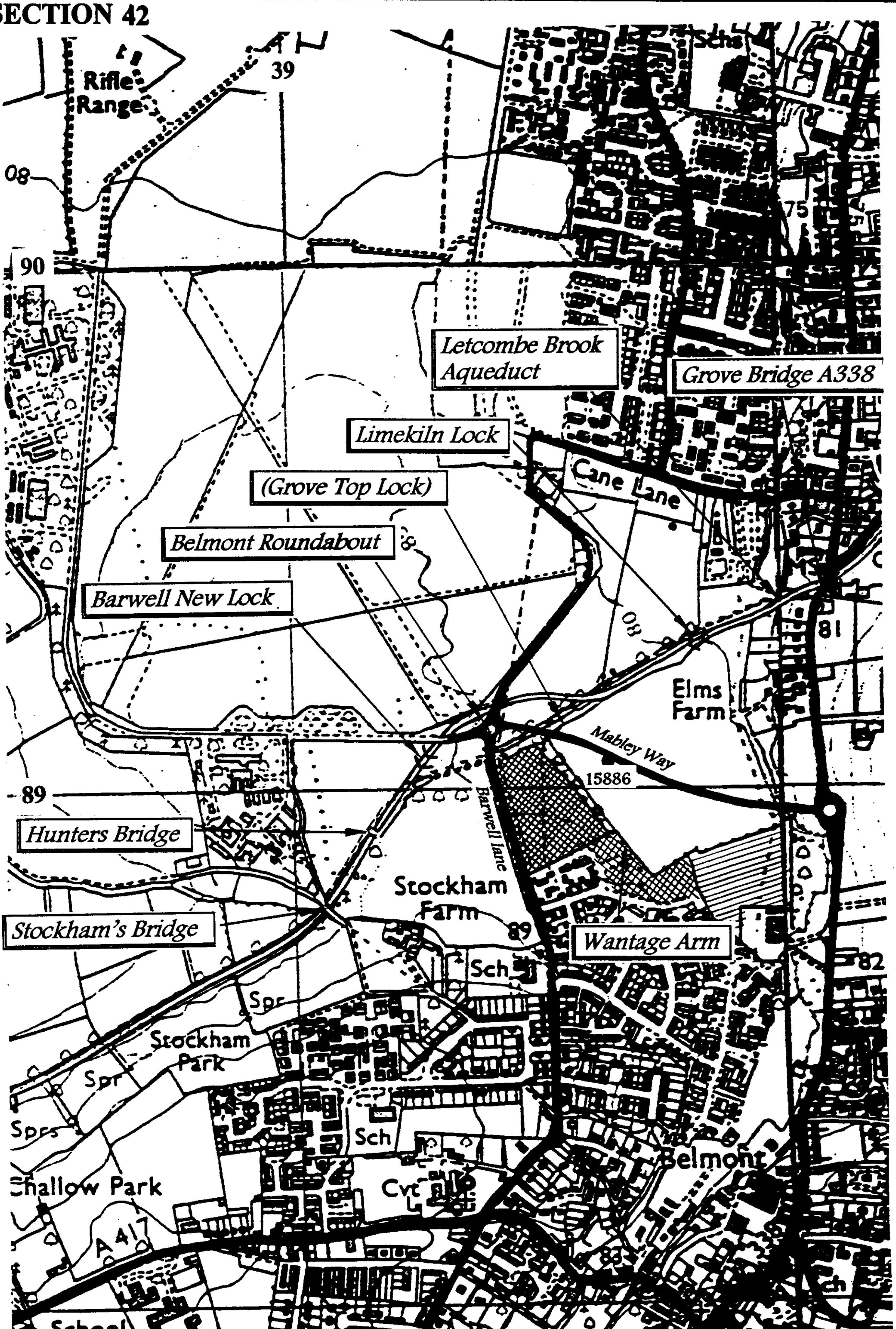
Description: This section contains the major obstruction of East Challow. A public footpath runs the entire length. W&BCAG restoration action plan in hand.
Geology: Gault Clay; Upper Greensand spring line 100m to the south of the canal.
Water Resources: Currently no proposals for water resource development in this section. 8 springs from the south side supply the dredged and cleared section. Letcombe sewage works about 1.5 km south of canal.
Navigation, Recreation and Leisure: East Challow facilities
Environmental Features:
Services:
Land Use: Agriculture, Grade 4. Residential at East Challow. 1 property acquisition (Ivanhoe); land take from rear gardens along Canal Way (12 No) and Longs Cottages (2 No).

Schedule of Features and Restoration Costs:

Feature / Name	**Description**	**Cost(£)**
Canal Reach	Infilled for 200m around East Challow Bridge with a bungalow immediately beside the canal line west of the bridge. East of the bridge 130m is infilled, the first 30m forming a car park (suspected contaminated ground), the balance forming rear gardens to properties along the south side of the canal (there is also a sub station), whilst on the north side is a private access road to the Canal farm complex. Allow for a narrow channel with vertical banks plus new access to canal farm. Balance of reach mostly dredged and in water. Lower bed by circa 0.6m from proposed new lock to Grove Top.	750,000
Services		50,000
Milepost 42 Bridge	(Assigned name) Original arched accommodation bridge demolished. The OS plan shows a footpath going north from this point, but not a right of way. Assume no longer required	0
Milepost 42	Original canal feature approx 50m beyond bridge.	0
Kings Lift Bridge (Cornhill Lane)	Abutment visible. Currently a fixed wooden bridge. Allow for new lift bridge	65,000
East Challow Lock (New)	Alow for a new lock to facilitate A417 crossing; lock fall 0.6m to 83.0mAOD (provisional).	140,000
Backpumping Station	For lockage conservation at the new lock.	30,000
East Challow Bridge (A417)	Original bridge demolished and infilled. Road rises at original crossing point, approx 85.3mAOD. Road to be raised by about 0.6m to achieve clearance (in combination with new lock).	100,000
Canal Farm Bridge	Allow for new access bridge and road extension from Canal Way	100,000
Woodhill Brook Culvert	Existing structure still in use.	0
Stockham's Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,235,000

Notes:
Further detailed study essential to confirm feasibility of this crossing. A diversion to the north of the village is possible as a fall back solution.

SECTION 42



Rifle Range
39
08
90
Letcombe Brook Aqueduct
Grove Bridge A338
Limekiln Lock
(Grove Top Lock)
Cane Lane
Belmont Roundabout
Barwell New Lock
08
81
Elms Farm
Mabley Way
15886
89
Barwell lane
Hunters Bridge
Stockham Farm
Stockham's Bridge
89
Wantage Arm
Sch
Spr
Stockham Park
Spr
Sch
Belmont
Challow Park
Cvt
A 417
School

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 42: Stockham's Bridge to Grove Bridge A338

Length:1.25km **OS Ref: SU390888 to 401894** **Level: 83.0 to 78.0m AOD; 2 locks**

Description: The eastern end of the original Seven Mile Pound (now proposed to be split by a lock at East Challow), this reach included the junction with the Wantage branch. The major obstacle to restoration is the Belmont Roundabout.

Geology: Gault Clay; Upper Greensand spring line approx 100m to the south

Water Resources: Currently no proposals for water resource development in this section. Spring and housing drainage enter via pipe just below Grove Top. Potential for re-use of treated urban runoff from Wantage & Grove.

Navigation, Recreation and Leisure: Facilities of Grove and Wantage

Environmental Features:

Services:

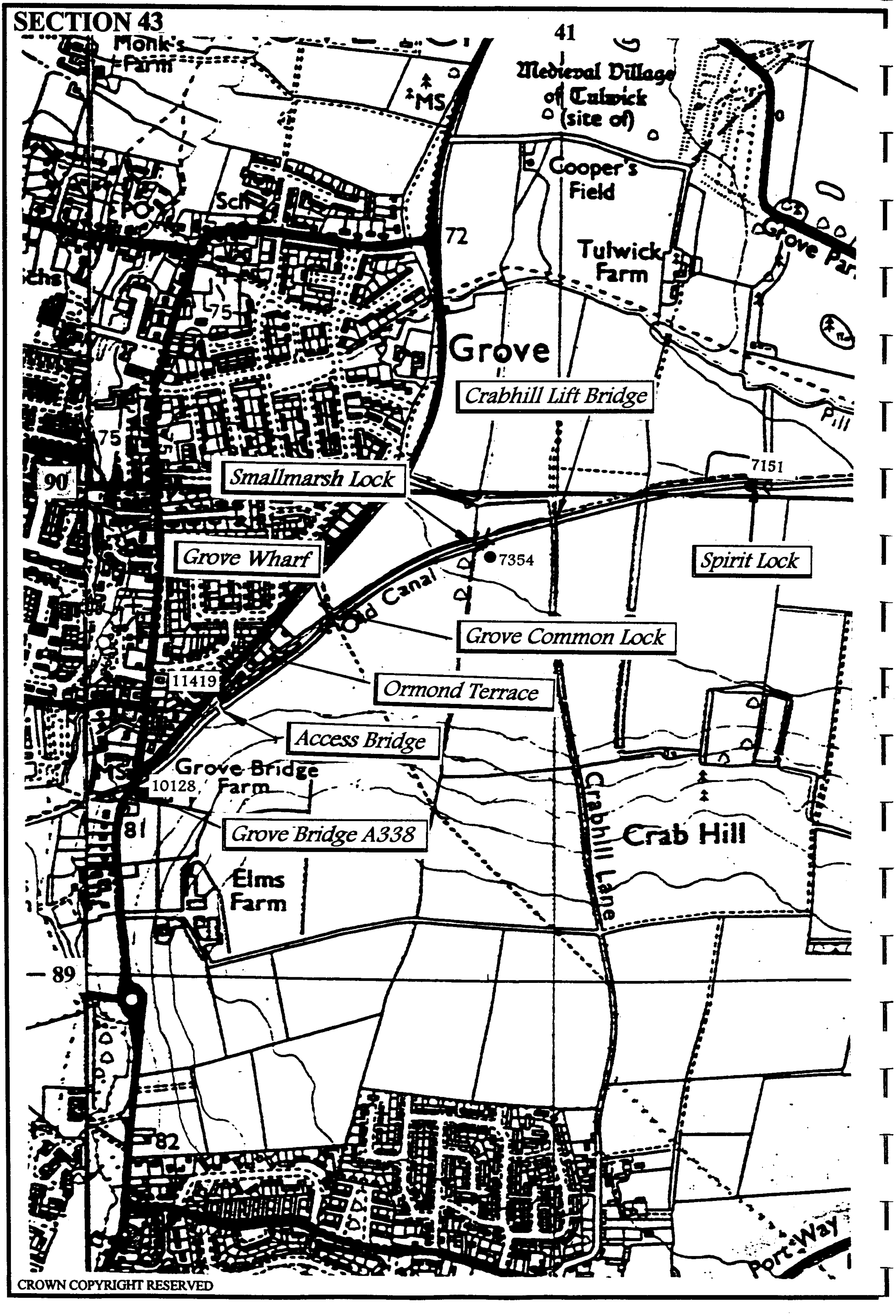
Land Use: Agriculture, Grade 3. Also 50m of garden locally at Grove Bridge.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	A minor diversion to the north side of Belmont Roundabout is recommended, with the original Grove Top Lock abandoned and a new lock located west of the Roundabout. From Hunters Bridge to Grove Top the canal is infilled, used as Wantage Town tip,and is believed to contain rubble from the Grove airfield clearance. Also infilled from Limekiln Lock to Grove Bridge. Remaining sections are in-water.	300,000
Services		40,000
Stockham's Bridge	Demolished, infilled and levelled. Carries a tarmac farm road up to Hunter's Bridge. Allow for new bridge, regrade approaches.	75,000
Hunters Bridge	Arch bridge, infilled, but abutments visible. Restoration as an arch bridge considered feasible at this location, under consideration by the W&BCAG.	60,000
Wantage Arm	Infilled. Restoration not considered in this study.	0
Barwell New Lock	Lock fall 2.0m to 81.0mAOD, replacement for Grove Top.	180,000
Belmont Roundabout West Crossing	The west crossing is the access road to the Technology Park; provide new bridge with minor regrading of approaches; also farm access.	85,000
Belmont Roundabout North Crossing	Denchworth Road; new bridge with minor regrading of approaches. O/H cables to be raised.	75,000
(Grove Top Lock)	The original lock is just to the east of the Mabley Way crossing; no longer required.	0
Limekiln Lock	Original lock fall 2.74m to 78.2mAOD. Lock in poor condition. Allow for new lock to the east side, slightly greater fall 3.0m to 78.0mAOD to minimize impact at Grove Bridge. Tailbridge required for nearby right of way.	215,000
Letcombe Brook Aqueduct	One wall restored. The aqueduct operates submerged as a siphon. Assume this remains satisfactory and allow for restoration. If there were any objection to this, Limekiln Lock might be moved eastwards and the Brook diverted to cross above the lock.	45,000
Grove Bridge A338	*See next Section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,075,000

Notes:

The original route might be followed on the south side of the roundabout, but working space and clearances are more problematic, and a lower level may be required ot of Limekiln Lock


41
Monk's Farm
MS
Medieval Village of Tulwick (site of)
Cooper's Field
Sch
72
Tulwick Farm
Grove Park
75
Grove
Crabhill Lift Bridge
75
90
Smallmarsh Lock
7151
Grove Wharf
7354
Spirit Lock
Old Canal
Grove Common Lock
11419
Ormond Terrace
Access Bridge
Grove Bridge Farm
10128
MS
81
Grove Bridge A338
Crabhill Lane
Crab Hill
Elms Farm
89
82
Port Way

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 43: Grove Bridge A338 to Spirit Lock

Length:1.50km **OS Ref: SU 401894 to 414900** **Level: 78.0 to 72.4mAOD; 2 locks**

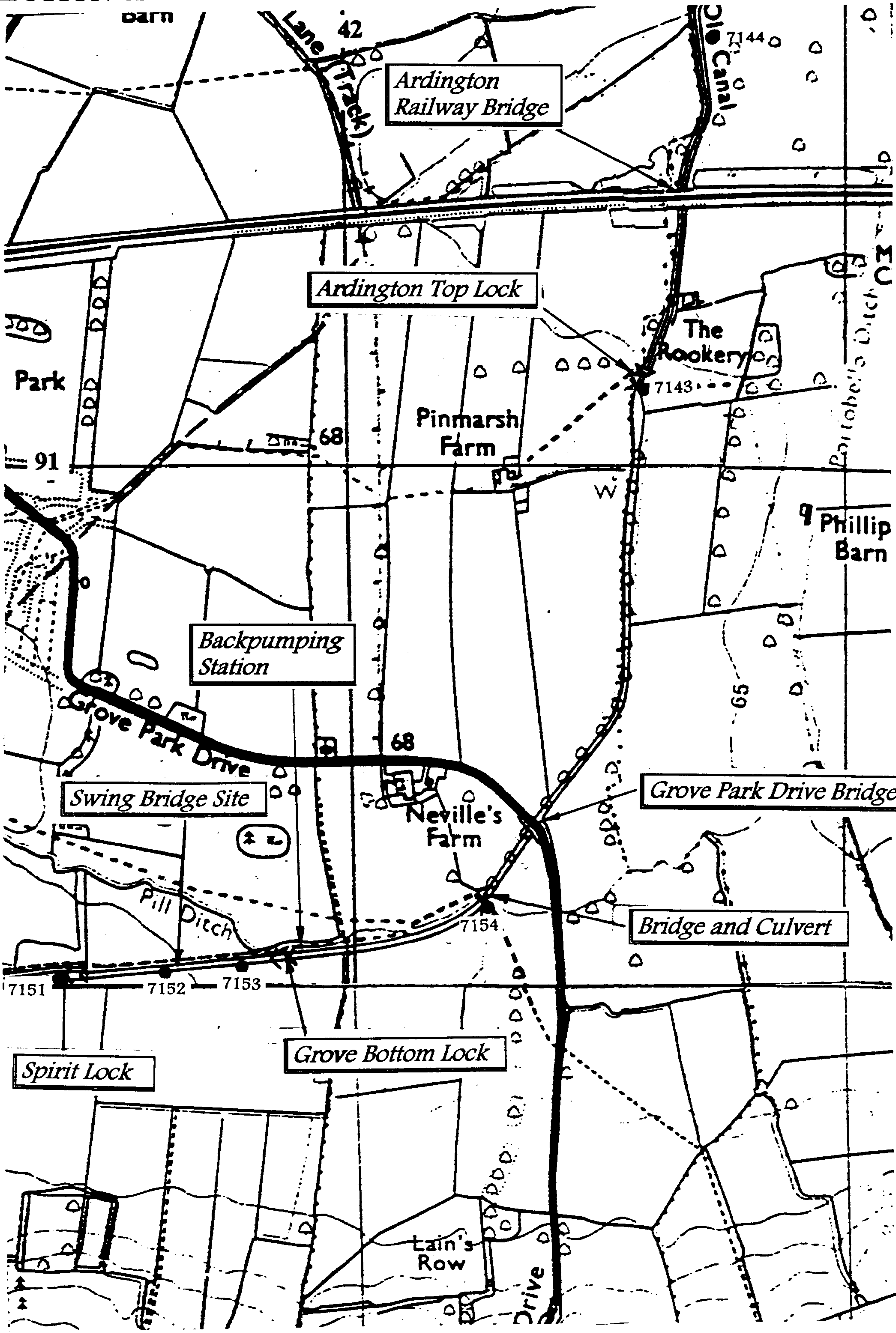
Description: Middle section of the Grove Lock flight
Geology: Gault Clay
Water Resources: Currently no proposals for water resource development in this section. Potential for re-use of treated urban runoff from Grove.
Navigation, Recreation and Leisure: Facilities in Grove
Environmental Features:
Services:
Land Use: Agriculture, Grade 3.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	The original route is incorporated into rear gardens along Ormond Terrace. A local diversion is proposed to avoid interference. Canal exists as a ditch (in-water) between Grove Bridge and Ormond Terrace.	240,000
Services		15,000
Grove Bridge A338	Infilled and levelled. Road level at crossing is 80.9mAOD. Provide new bridge with minor regrading of approaches. Also regrading of farm access and remodelling of road junction	150,000
Access Bridge	Canal infilled to form a farm crossing. Allow for new bridge.	60,000
Grove Common Lock	Fair condition, overgrown; tail bridge partially restored. Restore lock, and tailbridge for right of way, but allow for lowering of top level. Original lock fall 2.9m to 75.3mAOD; restored lock fall 2.7m	120,000
Grove Wharf	Infilled, overgrown. Redevelopment potential	0
Smallmarsh Lock	Fair condition, but rubbish filled. Original lock fall 2.9m to 72.4mAOD. Restore	110,000
Crabhill Lift Bridge	Crabhill Lane crossing. Some remains, infilled and culverted. Allow for new fixed bridge suitable for vehicles, with regrading of approaches. The lane is also a right of way. A less costly structure could be used if not a vehicle crossing.	65,000
Spirit Lock	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	760,000

Notes:

SECTION 44



Ardington Railway Bridge
Lane (Track)
42
7144
Ardington Top Lock
The Rookery
7143
Park
Pinmarsh Farm
68
91
Phillip Barn
Backpumping Station
Grove Park Drive
68
Swing Bridge Site
Grove Park Drive Bridge
Neville's Farm
65
Pill Ditch
Bridge and Culvert
7154
7151
7152
7153
Spirit Lock
Grove Bottom Lock
Lain's Row
Drive

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 44: Spirit Lock to Railway Bridge SU426916

Length:2.35km **OS Ref: SU 414900 to 427916** **Level: 72.4 to 63.8mAOD; 3 locks**

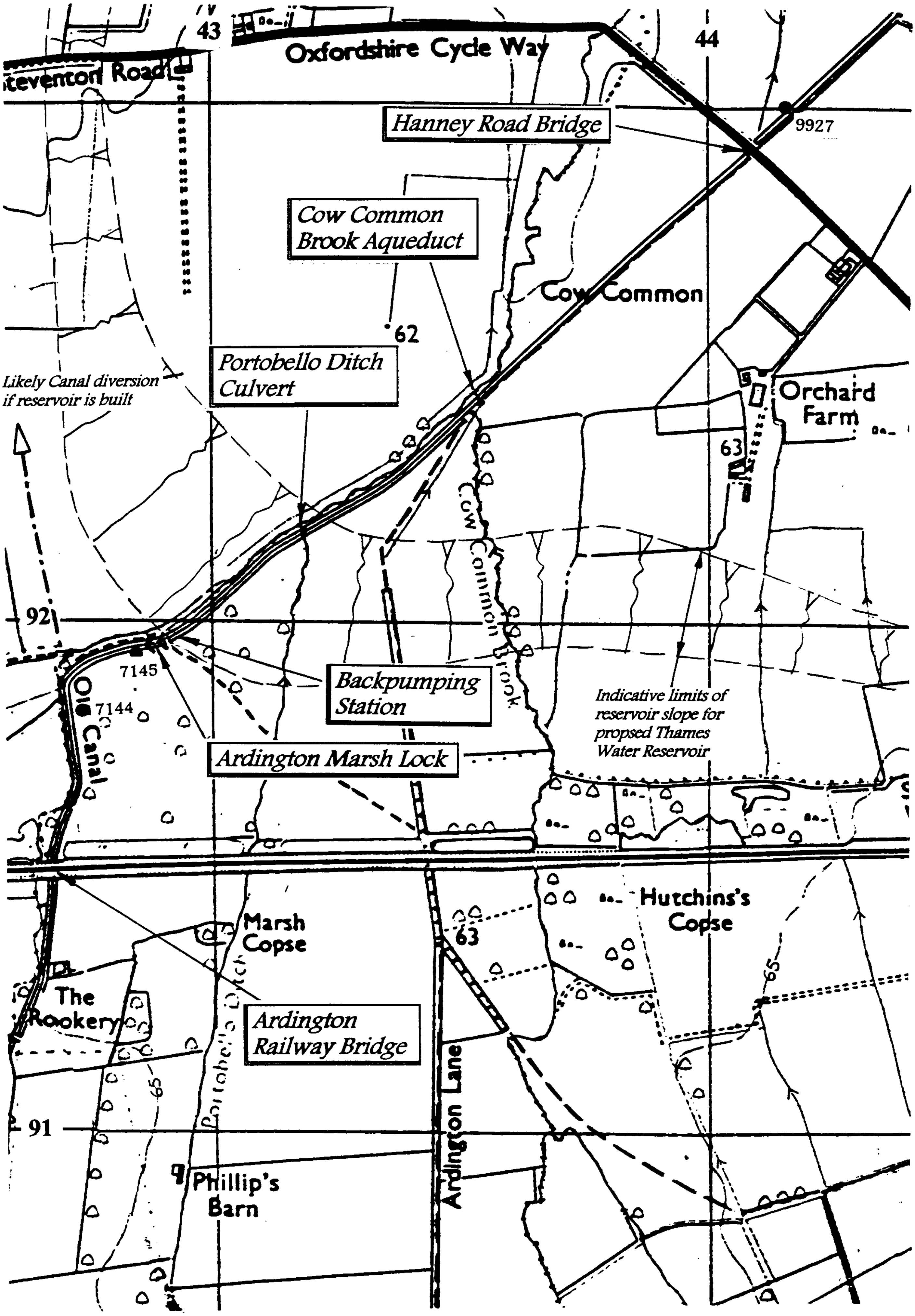
Description: Bottom end of the Grove Lock flight, entering the remote rural reach before Abingdon.
Geology: Gault Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features: The Cuttings, County Wildlife Site (49F01). Wetland, woodland, scrub and ponds.
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	300m infilled between Grove Bottom and Pill Ditch. Reduced to a ditch in some parts, and heavily overgrown	290,000
Services		5,000
Spirit Lock	Infilled but some remains visible. Believed to be in poor condition. Original lock fall 2.6m to 69.8mAOD. Rebuild/restore	160,000
Swing Bridge Site	Abutments visible. Assume no longer required.	0
Grove Bottom Lock	Good condition. Original lock fall 3.05m to 67.7mAOD. Restore	100,000
Backpumping Station	Allow for a single station to serve the Grove flight. Rising main length 2500m discharging above the new top lock (Barwell New Lock), static lift 17m.	260,000
Pill Brook Bridge and Culvert	Original bridge removed and infilled. Culvert for the Pill Brook still used. Allow for new footbridge for right of way and new culvert	40,000
Grove Park Drive Bridge	Infilled and culverted, some large trees. Steep hump on bend. Provide new bridge with regrading of approaches.	75,000
Ardington Top Lock	Excellent condition. Lock Cottage demolished. Original lock fall 2.90m to 63.8mAOD. Provide tailbridge for right of way to replace existing bridge at this location.	130,000
Ardington Railway Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,060,000

Notes:

SECTION 45


43
44
Oxfordshire Cycle Way
Steventon Road
Hanney Road Bridge
9927
Cow Common
Brook Aqueduct
Cow Common
62
Portobello Ditch
Culvert
Orchard
Farm
Likely Canal diversion
if reservoir is built
63
92
Cow Common Brook
7145
7144
Old Canal
Backpumping
Station
Indicative limits of
reservoir slope for
propsed Thames
Water Reservoir
Ardington Marsh Lock
Hutchins's
Copse
Marsh
Copse
63
The
Rookery
Ardington
Railway Bridge
65
Portobello Ditch
Ardington Lane
65
91
Phillip's
Barn

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 45: Ardington Railway Bridge to Hanney Road Bridge

Length: 2.15km **OS Ref: SU 427916 to 441929** **Level: 63.8 to 61.1mAOD; 1 lock**

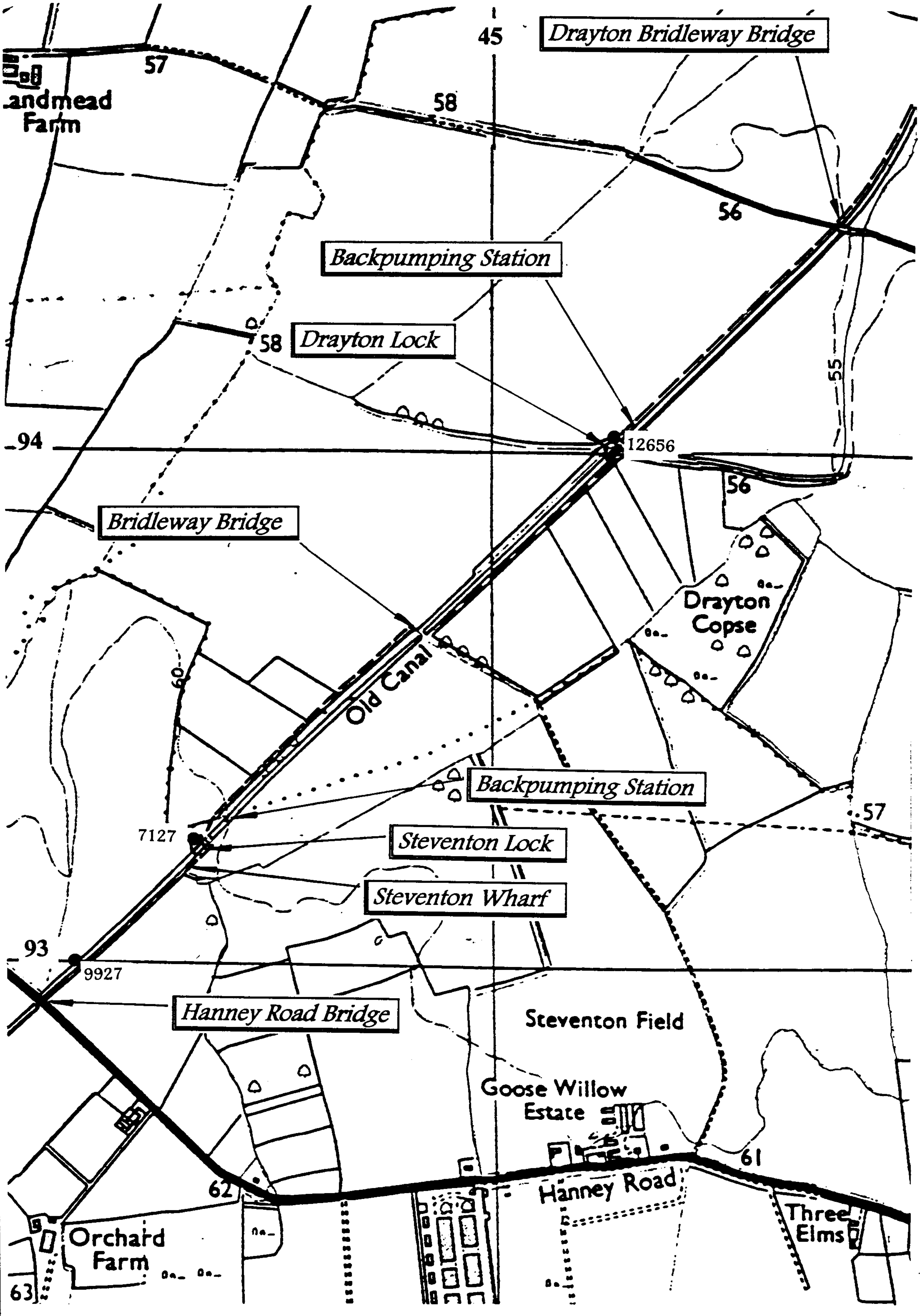
Description: This reach commences at the southern limit of the proposed Thames Water Reservoir site. A diversion would be required from above Ardington Marsh Lock, most likely around the west side.
Geology: Gault Clay in south, isolated Lower Greensand outcrop, then Kimmeridge Clay in north
Water Resources: Currently no proposals for water resource development in this section. Sewage works west of Steventon about 1.0 km south east of canal.
Navigation, Recreation and Leisure: Reservoir may become a significant leisure amenity.
Environmental Features: The Cuttings, County Wildlife Site (49F01). Wetland, woodland, scrub and ponds. A Badger Sett (49SS5), a badger sett.
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Infilled for 750m from Cow Common Brook to Hanney Road, elsewhere a little overgrown.	370,000
Services		5,000
Ardington Railway Bridge	Bridge opening narrowed and canal culverted. The adjacent farm access could be used for the canal; there is an alternative farm access 180m to the west.	50,000
Ardington Marsh Lock	Excellent condition. One tail gate remains and top gate balance beam. Original lock fall 2.74m to 61.1mAOD. Restore. Include for tailbridge for right of way.	90,000
Backpumping Station	For lockage conservation. Rising main length 1000m discharging above Ardington Top Lock.	140,000
Portobello Ditch Culvert	The culvert originally passed under the canal but now drains into the bed. Allow for a new culvert (unless interception permitted)	10,000
Cow Common Brook Aqueduct	No trace of original structure. Provide new culvert.	20,000
Hanney Road Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	685,000

Notes:
Add £1,700,000 should a thrust bore be needed under the railway.

SECTION 46



Drayton Bridleway Bridge
45
57
Landmead Farm
58
56
Backpumping Station
58
Drayton Lock
55
94
12656
56
Bridleway Bridge
Drayton Copse
60
Old Canal
Backpumping Station
57
7127
Steventon Lock
Steventon Wharf
93
9927
Hanney Road Bridge
Steventon Field
Goose Willow Estate
61
62
Hanney Road
Three Elms
Orchard Farm
63

SECTION 46: Hanney Road Bridge to Drayton Bridleway Bridge

Length: 2.20km **OS Ref: SU 427916 to 457944** **Level: 61.1 to 55.2mAOD; 2 locks**

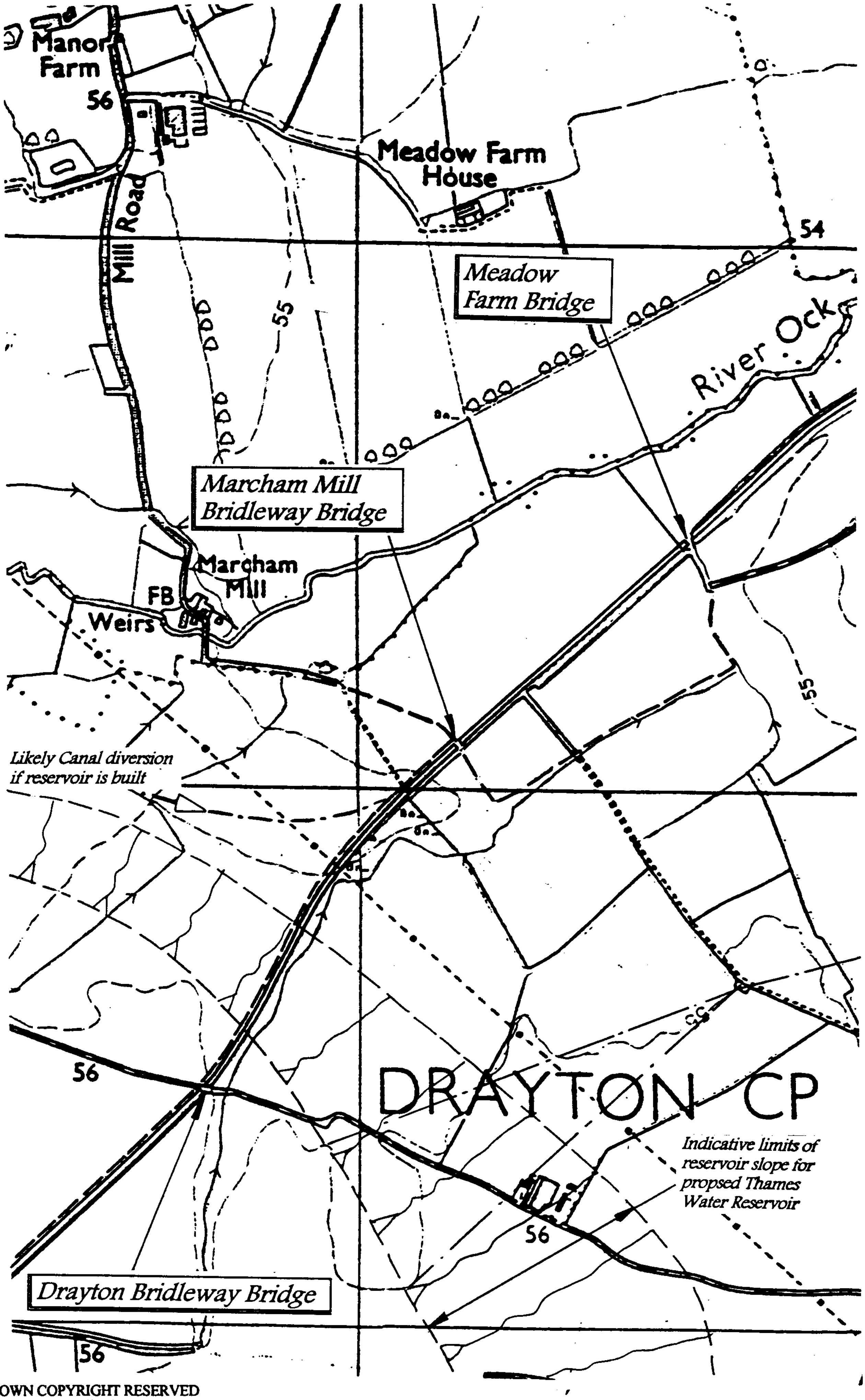
Description: Rural section through farmland which would be entirely lost and submerged under the proposed Thames Water Reservoir. A public bridleway follows the canal route through this reach.
Geology: Kimmeridge Clay with some clay-rich River Terrace deposits
Water Resources: Currently no proposals for water resource development in this section.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Approximately half infilled	440,000
Services		5,000
Hanney Road Bridge	Originally a stone arch bridge, demolished in 1965 and infilled. New bridge required, regrade approaches, regrade and realign farm access.	90,000
Steventon Wharf	Infilled.	0
Steventon Lock	Buried. Original lock fall 2.84m to 58.2mAOD. Allow for rebuilding.	190,000
Backpumping Station	For lockage conservation. Rising main length 60m discharging above Steventon Lock.	60,000
Lift Bridge	Removed and infilled. Allow for new bridleway bridge	50,000
Drayton Lock	Fair, but rubbish filled. Tail bridge removed and infilled. Restore, including tailbridge for bridleway. Original lock fall 3.02m to 55.2mAOD.	130,000
Backpumping Station	For lockage conservation. Rising main length 60m discharging above Drayton Lock.	70,000
Drayton Bridleway Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,035,000

Notes:
Steventon Lock might be rebuilt west of Hanney Road to ensure clearance; requires deepening by 2-2.5m over 200m, perhaps an extra £150,000.

SECTION 47



Manor Farm
56
Mill Road
Meadow Farm House
54
Meadow Farm Bridge
55
River Ock
Marcham Mill Bridleway Bridge
Marcham Mill
FB
Weirs
55
Likely Canal diversion if reservoir is built
56
DRAYTON CP
Indicative limits of reservoir slope for propsed Thames Water Reservoir
56
Drayton Bridleway Bridge
56

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 47: Drayton Bridleway Bridge to Meadow Farm Bridge

Length: 1.40km **OS Ref: SU457944 to 466955** **Level: 55.2mAOD**

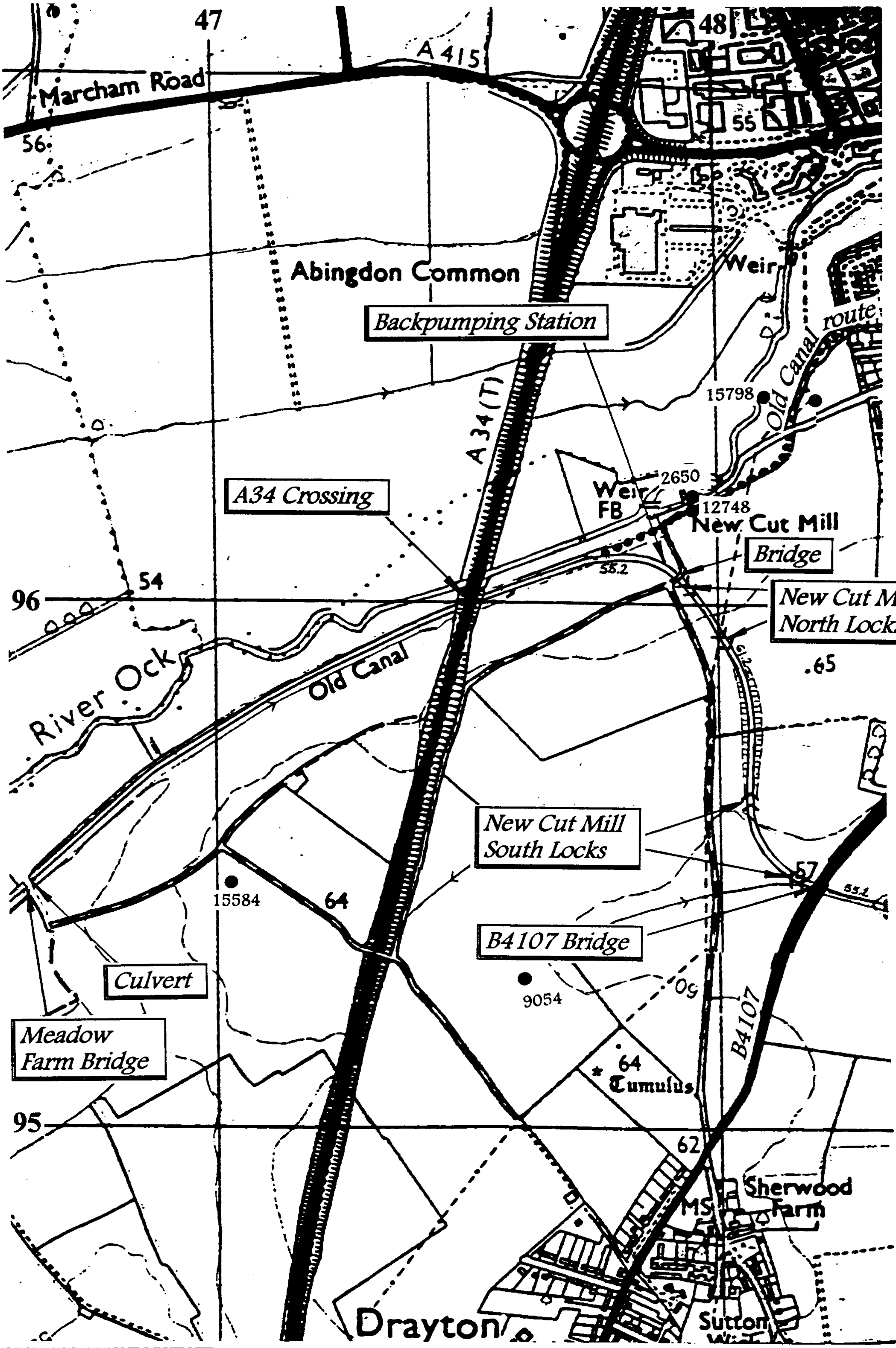
Description: This reach commences at the northern limit of the proposed Thames Water Reservoir site. A diversion would be required from Marcham Mill, most likely around the west side.
Geology: Thin, clay-rich River Terrace deposits overlying Kimmeridge Clay
Water Resources: Currently no proposals for water resource development in this section.
Navigation, Recreation and Leisure: Reservoir may become a significant leisure amenity.
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal line remains as a ditch. There is a private acces road (concrete) along the canal alignment between the bridge sites. Realign canal or access road.	380,000
Services		5,000
Drayton Bridleway Bridge	Original lift bridge removed and infilled. New bridge required with regrading of approaches.	50,000
Marcham Mill Bridleway Bridge	Original lift bridge removed and infilled. New bridge required with regrading of approaches.	50,000
Meadow Farm Bridge	*See next section*	50,000
	ESTIMATED TENDER PRICE FOR RESTORATION	530,000

Notes:

SECTION 48



47
48
A 415
Marcham Road
56
55
Abingdon Common
Weir
Backpumping Station
Old Canal route
15798
A 34 (T)
A34 Crossing
2650
Weir
FB
12748
New Cut Mill
55.2
Bridge
96
54
New Cut Mill North Locks
.65
River Ock
Old Canal
New Cut Mill South Locks
57
55.1
15584
64
B4107 Bridge
Culvert
9054
09
Meadow Farm Bridge
B4107
64
Tumulus
95
62
Sherwood Farm
MS
Drayton
Sutton

SECTION 48: Meadow Farm Bridge to B4017 Bridge

Length: 2.10km **OS Ref: SU466955 to 482954** **Level: 55.2 to 61.2 to 55.2mAOD; 4 locks**

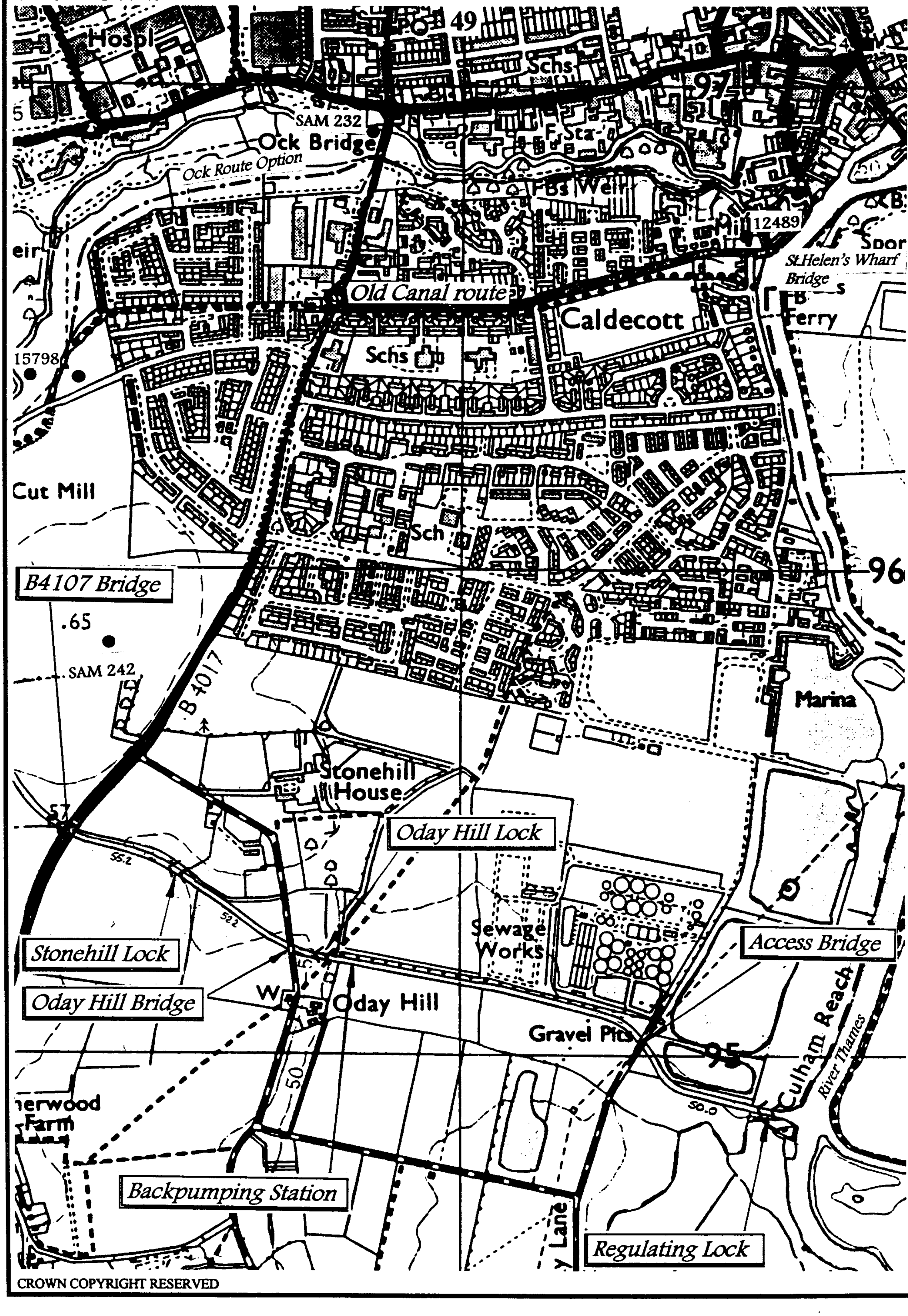
Description: Reach encompassing the A34 crossing on the outskirts of Abingdon. The route option south of Abingdon is assumed from this point as the most likely option of those considered.
Geology: River Terrace deposits overlying Kimmeridge Clay; possibility of made ground presence in urban areas
Water Resources: Currently no proposals for water resource development in this section.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	The original alignment up to and a little beyond the A34 is in good condtion but overgrown, and readily recoverable (1.3km total). Turning south at New Cut Mill, new canal cuttings up to 4m deep (to water level) will be required.	1,050,000
Services		20,000
Meadow Farm Bridge	New bridge required with regrading of approaches.	50,000
A34 Trunk Road	Canal infilled for road construction. Allow for a thrust bored canal culvert	1,750,000
New Cut Mill Bridge	New bridge required for bridleway with minor regrading of approaches.	75,000
Backpumping Station	Required for lockage conservation and to maintain the intermediate summit pound. Rising main length 200m.	65,000
New Cut Mill North Locks	Pair of locks to lift the canal to a local summit on the intervening ridge of high land. Each lock lift 3.0m, lifting to summit 61.2mAOD	420,000
B4017 Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	3,430,000

Notes:
A cut and cover crossing of the A34 would be significantly cheaper than a thrust bore if circumstances permit, saving perhaps £750,000.

SECTION 49



Hospl
49
Schs
97
SAM 232
Ock Bridge
Ock Route Option
F Sta
FBs Weir
12489
St.Helen's Wharf Bridge
Old Canal route
Caldecott
FB
Ferry
15798
Schs
Cut Mill
Sch
96
B4107 Bridge
.65
SAM 242
B 4017
Marina
Stonehill House
Oday Hill Lock
57
Sewage Works
Access Bridge
Stonehill Lock
Oday Hill Bridge
Oday Hill
Gravel Pits
95
Culham Reach
River Thames
50
Backpumping Station
Regulating Lock

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 49: B4017 Bridge to River Thames

Length: 1.65km **OS Ref: ST 925679 to 926689** **Level: 55.2 to 49.5mAOD; 3 locks**

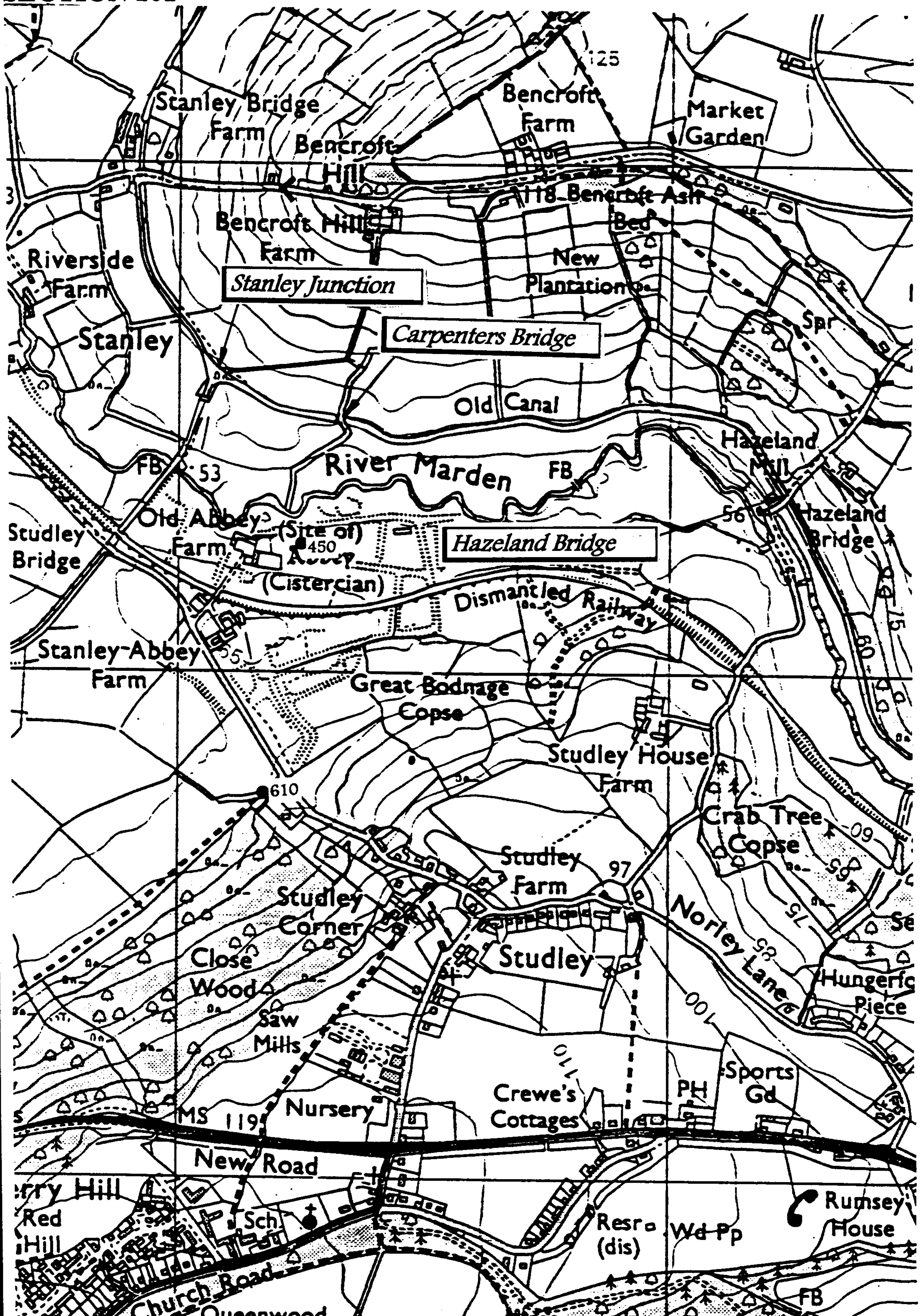
Description: This route option south of Abingdon is assumed to be the most likely option of those considered
Geology: River Terrace deposits overlying Kimmeridge Clay; possibility of made ground.
Water Resources: Currently no proposals for water resource development in this section. Abingdon sewage works adjacent to route.
Navigation, Recreation and Leisure: Marina potential at old gravel workings.
Environmental Features:
Services:
Land Use: Agriculture (Stonehill Farm); gravel extraction and landfill sites from here to the Thames, and Abingdon STW

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Allow for some potential difficult ground conditions to be encountered on this reach.	825,000
Services		25,000
B4107 Bridge	New bridge with regrading of approaches to raise by approx 1m.	100,000
Stonehill Lock	New lock, fall 3.0m to 52.2mAOD	210,000
Oday Hill Bridge	Fixed bridge, canal level indicated should allow road to maintain existing alignment. Road is a bridleway.	60,000
Oday Hill Lock	New lock, fall 2.2m to 50.0mAOD. Including a pedestrian tailbridge for right of way	195,000
Backpumping station	For lockage conservation. Rising main length 700m discharging at New Cut Mill summit pound.	115,000
Bridge	Bridleway and access to Sewage Works. Significant regrading of approaches required since canal and road level similar; if traffic sufficiently light a lift bridge would be more appropriate.	120,000
Regulating Lock	At the new junction with the Thames, mean fall 0.5m to 49.5mAOD	135,000
	ESTIMATED TENDER PRICE FOR RESTORATION	1,785,000

Notes:

SECTION 101



Stanley Bridge Farm
Bencroft Hill
Bencroft Farm
Market Garden
125
118 Bencroft Ash Bed
Bencroft Hill Farm
Riverside Farm
New Plantation
Stanley Junction
Carpenters Bridge
Stanley
Spr
Old Canal
Hazeland Mill
FB
53
River Marden
FB
Old Abbey Farm
(Site of) Abbey (Cistercian)
450
Hazeland Bridge
56
Hazeland Bridge
Studley Bridge
Dismantled Railway
Stanley Abbey Farm
55
Great Bodnage Copse
Studley House Farm
610
Crab Tree Copse
Studley Farm
97
Studley Corner
Norley Lane
Close Wood
Studley
Hungerford Piece
Saw Mills
110
100
Crewe's Cottages
PH
Sports Gd
Nursery
MS
119
New Road
Red Hill
Sch
Resr (dis)
Wd Pp
Rumsey House
Church Road
Queenwood
FB

SECTION 101:Calne Branch: Stanley Junction to Hazeland Bridge

Length: 1.30km **OS Ref: ST 961726 to 972724** **Level: 60.6mAOD**

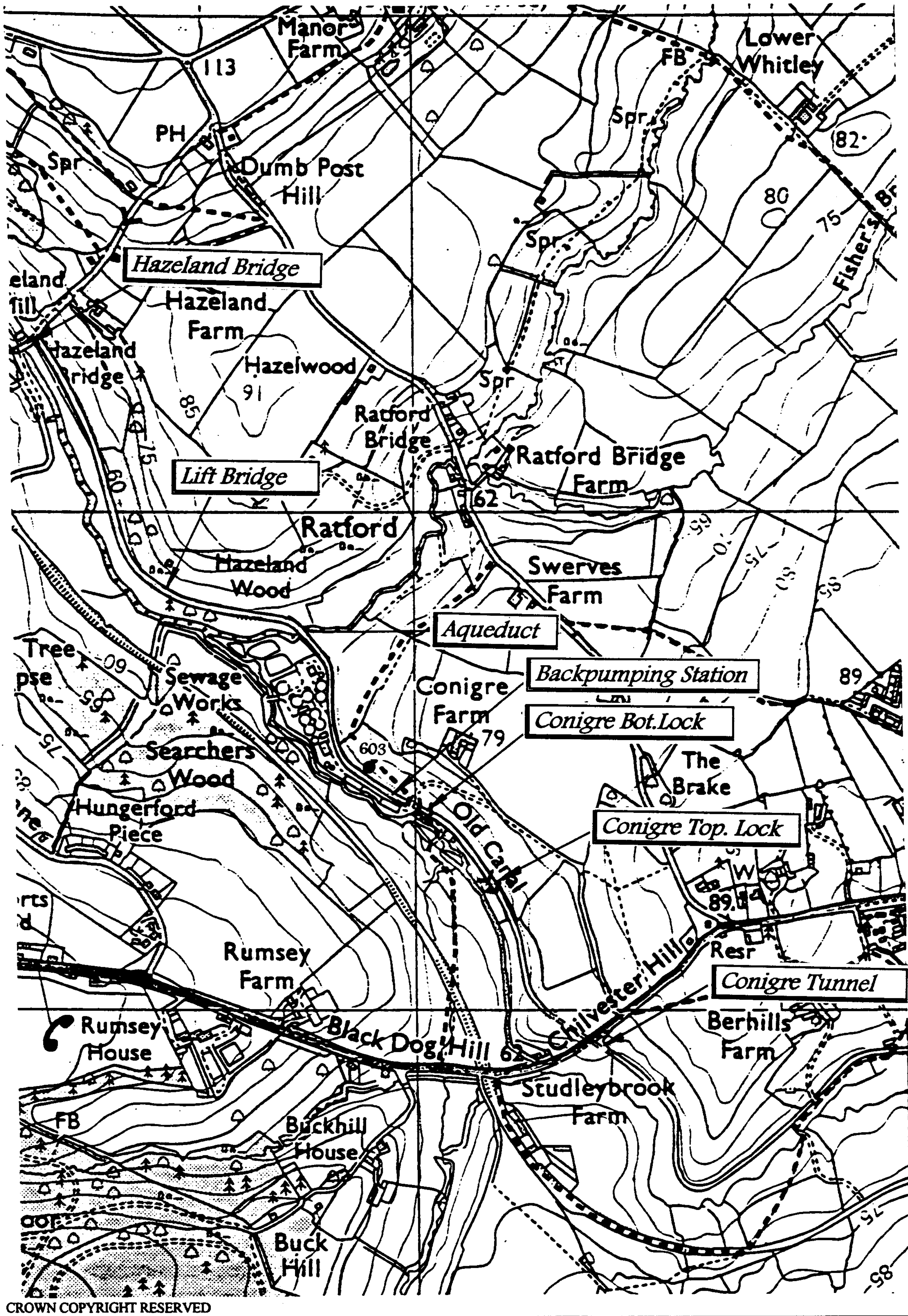
Description: Rural reach on hillside overlooking the River Marden
Geology: Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features: Site of Cistercian Abbey
Services:
LandUse: Agriculture, Grade 3 to 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Bed clear, overgrown and silted.	160,000
Services		5,000
Stanley Junction	See Section 8	0
Carpenters Bridge	Parapets intact. Hole in arch. Remove flat slab farm access bridge and repair/reconstruct original to form new farm bridge.	40,000
Hazeland Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	205,000

Notes:
Canal hugs 60m contour north of the River Marden

SECTION 102



Manor Farm
113
Lower Whitley
FB
Spr
82
PH
Spr
Dumb Post Hill
80
75
Fisher's
Hazeland Bridge
Spr
Hazeland Farm
Hazeland Bridge
Hazelwood
91
85
Spr
Ratford Bridge
Ratford Bridge Farm
Lift Bridge
60
75
62
Ratford
Hazeland Wood
Swerves Farm
Aqueduct
Tree
Sewage Works
Backpumping Station
Conigre Farm
89
Conigre Bot.Lock
603
79
Searchers Wood
The Brake
Hungerford Piece
Old Canal
Conigre Top. Lock
89
Resr
Rumsey Farm
Chilvester Hill
Conigre Tunnel
Rumsey House
Black Dog Hill 62
Berhills Farm
Studleybrook Farm
FB
Buckhill House
Buck Hill
75
85

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SECTION 102: Calne Branch: Hazeland Bridge to Conigre Tunnel

Length:1.85km **OS Ref: ST 972724 to 983710** **Level: 60.6 to 64.9mAOD; 2 locks**

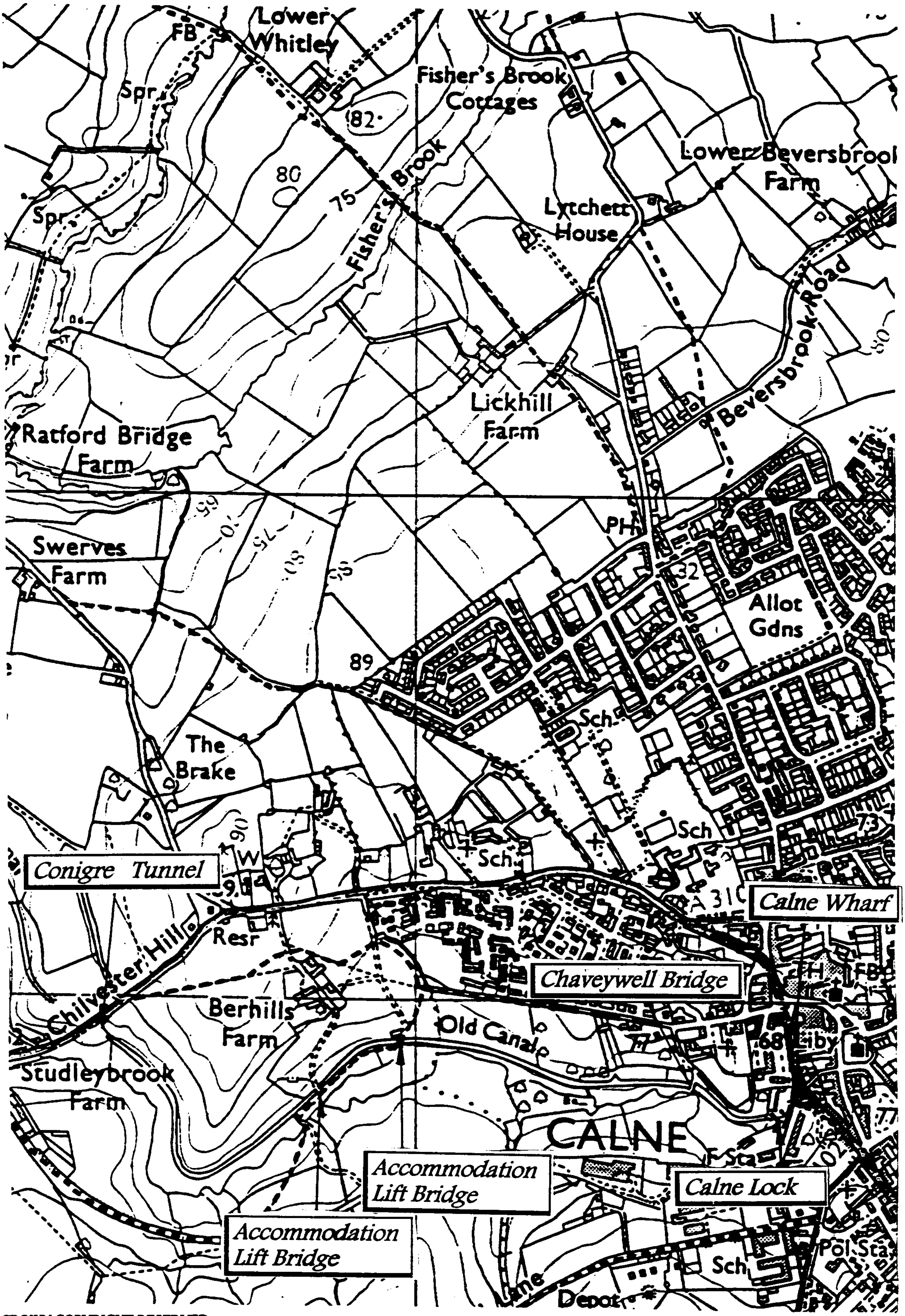
Description: Rural reach on hillside overlooking the River Marden; skirts Calne Sewage Works
Geology: Oxford Clay; Alluvium at Fishers Brook
Water Resources: Potential winter abstraction from Fishers/Cowage Brook at Swerves Farm, with reservoir storage. Calne sewage works within 200 m of canal; effluent discharge supporting river during low flow stages.
Navigation, Recreation and Leisure:
Environmental Features:
Services:
LandUse: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Canal bed generally clear but heavily overgrown, eg 40ft willow tress growing in bed. Infilled approaching the tunnel.	280,000
Services		5,000
Hazeland Bridge	Removed and bed infilled. Provide new bridge. Road is steep, so minor diversion of canal nothwards to give clearance is recommended; alternatively a lift bridge may be appropriate.	75,000
Lift Bridge	Abutments remain. Assume no longer required.	0
Fishers Brook Aqueduct	Demolished; provide new aqueduct (culvert)	40,000
Backpumping Station	Required for lockage conservation. Rising main length 300m to discharge above Conigre Top Lock	75,000
Conigre Bottom Lock and bridge	Buried, one wall remains replaced by infill. Canal bed clear. Original lift bridge lost and infilled. Access road crosses near bottom of lock: incorporate new access bridge over new/restored lock. Original lift estinmated at 7' (2.13m) to 62.7mAOD	150,000
Conigre Top Lock	Partly buried, one wall remains. Rebuild lock. Original lift estinmated at 7' (2.13m) to 64.9mAOD	130,000
Conigre Tunnel	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	755,000

Notes:

SECTION 103



Lower Whitley
FB
Spr
Fisher's Brook Cottages
82
80
75
Fisher's Brook
Lower Beversbrook Farm
Lytchett House
Spr
Beversbrook Road
Lickhill Farm
Ratford Bridge Farm
Swerves Farm
PH
32
Allot Gdns
89
Sch
The Brake
Sch
Conigre Tunnel
Sch
Resr
Calne Wharf
A310
Chilvester Hill
Chaveywell Bridge
FB
Berhills Farm
Old Canal
68
Liby
Studleybrook Farm
CALNE
Sta
Accommodation Lift Bridge
Calne Lock
Accommodation Lift Bridge
Sch
Pol Sta
Depot

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 103: Calne Branch: Conigre Tunnel to Calne Wharf

Length: 1.7km **OS Ref: ST983710 to 997709** **Level: 64.9 to 67.0mAOD**

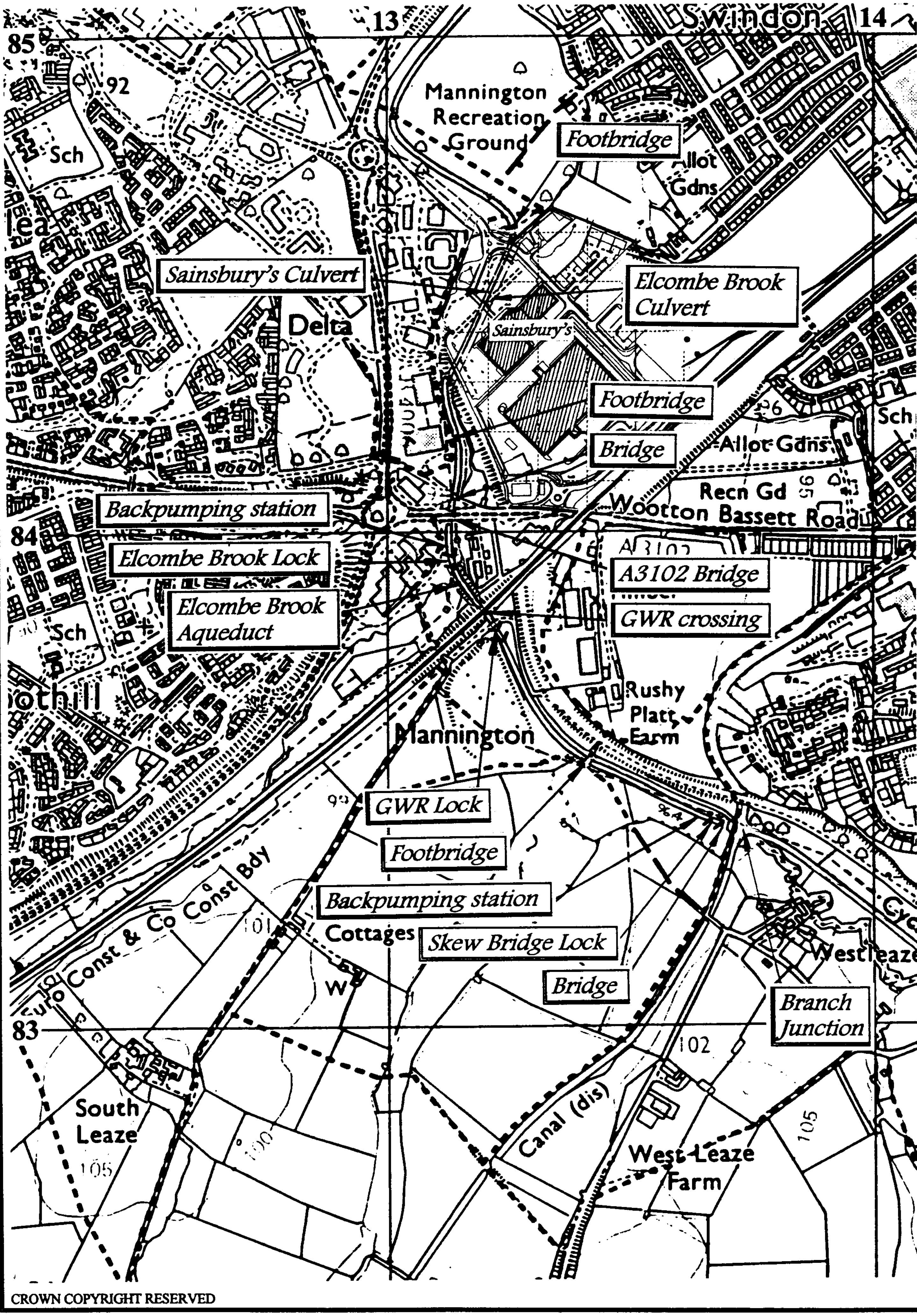
Description: Terminal reach into the centre of Calne; Calne Lock lifts the canal into the River Marden which is canalised to form Calne Wharf. Partly restored (in-water) section.
Geology: Corallian; Alluvium approaching Calne
Water Resources:
Navigation, Recreation and Leisure: Calne town facilities
Environmental Features:
Services:
LandUse: Agriculture. Grade 4 to Urban

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Restored (dredged and in water) for approx 1km up to Calne Lock. this section is badly choked with duckweed. Balance of reach is generally infilled and/or heavily overgrown. There is space and development potential for day moorings or marina facilities below Calne Lock, with vehicle access across the river from the south. Contaminated waste material from the former meat factory may have been dumped in the canal or tunnel.	150,000
Services		20,000
Conigre tunnel	100m tunnel, condition unknown; both ends largely buried. Tunnel certainly backfilled in places. An exploratory dig commencing at the western end is recommended. At the A4 strength considerations may dictate a new road bridge, with the tunnel restored from a new portal to the west. If the tunnel is not restorable, there is room for a new tunnel to the north.	1,500,000
Lift Bridge	Original removed, replaced by causeway for farm access. Provide new farm accommodation bridge.	65,000
Lift Bridge	Original removed, replaced by causeway for farm access. Provide new farm accommodation bridge, also to preserve right of way.	65,000
Chaveywell Bridge	Restored. Very good condition.	0
Calne Lock	Chamber largely intact. A large diameter storm sewer passes N-S through the lock chamber to discharge into the river. Not necessary to restore lock for navigation puposes (see below), but a cosmetic restoration should be considered. Original lift estimated at 7' (2.13m).	0
Calne Wharf	Wharf Area redeveloped for housing. Wharf Office remains. Insufficient water depth for navigation, and to create sufficient depth would be problematic. Also no turning facility or space to provide same. Hence navigation recommended to terminate below Calne Lock.	0
	ESTIMATED TENDER PRICE FOR RESTORATION	1,800,000

Notes:

SECTION 201



Swindon
13
14
85
84
83
Mannington Recreation Ground
Footbridge
Allot Gdns
Sch
Sainsbury's Culvert
Elcombe Brook Culvert
Delta
Sainsbury's
Footbridge
Bridge
Allot Gdns
Recn Gd
Wootton Bassett Road
Backpumping station
Elcombe Brook Lock
A3102
A3102 Bridge
Elcombe Brook Aqueduct
GWR crossing
Sch
Rushy Platt Farm
Mannington
GWR Lock
Footbridge
Backpumping station
Cottages
Skew Bridge Lock
Bridge
Const & Co Const Bdy
Branch Junction
West Leaze
South Leaze
Canal (dis)
West Leaze Farm
102
105

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 201: N.Wilts: Skew Bridge to Mannington Rec. Ground

Length: 1.60km **OS Ref: SU137834 to 132846** **Level: 99.1 to 92.0mAOD; 3 locks**

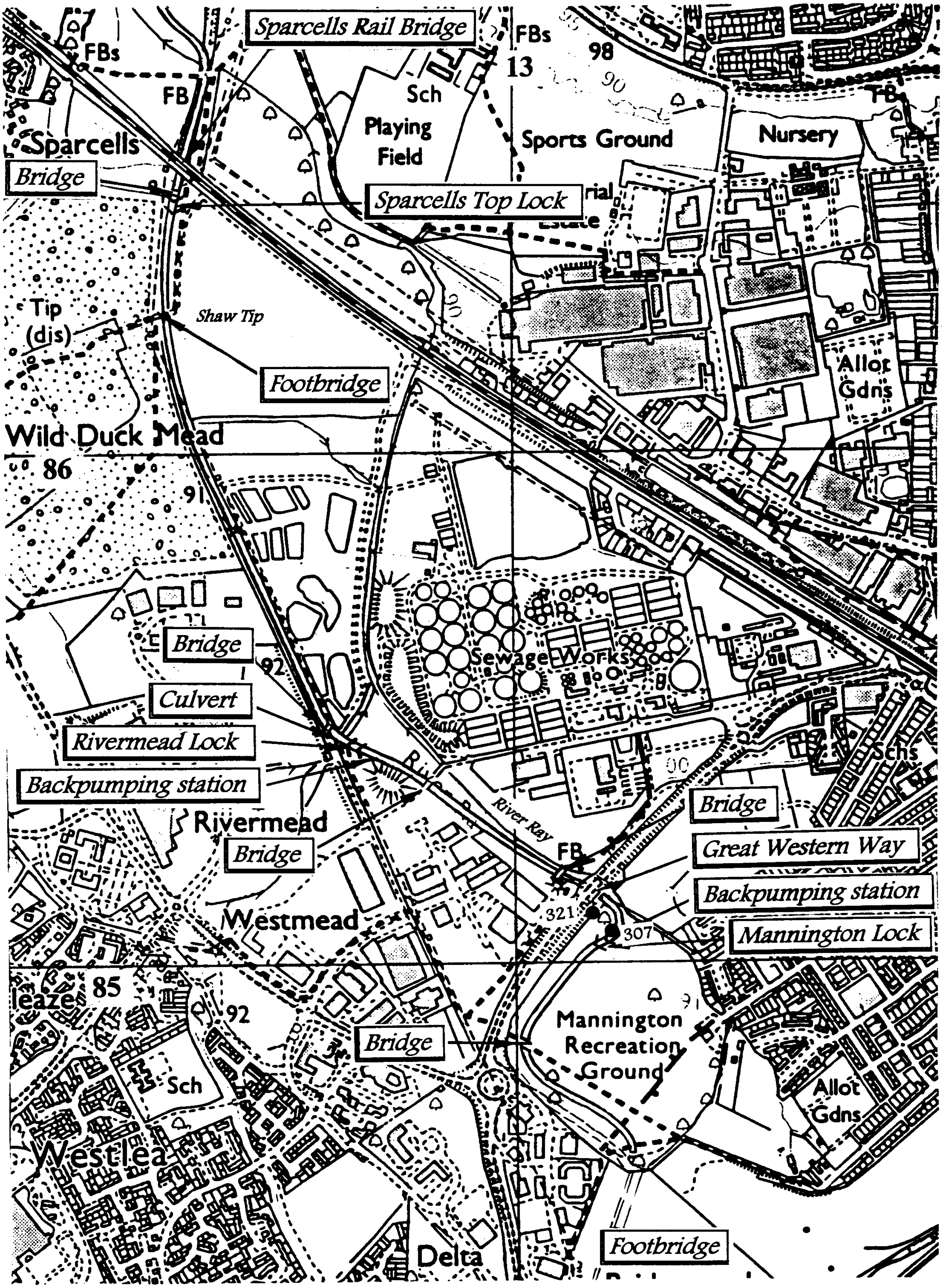
Description: First section of the difficult canal diversion necessary to recover the North Wilts branch.
Geology: River Alluvium over Kimmeridge Clay in the south, and over Corallian in the north. Made ground at Bridgemead (under Sainsbury's)
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure: Navigation constraint if Elcombe Brook culvert under Sainsbury's is utilised. Local town facilities.
Environmental Features:
Services:
Land Use: Flood plains / flood storage areas (Mannington, Elcombe Brook); commerce/industry (Bridgemead)

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	All new cut, route avoids use of the Elcombe Brook / River Ray. Short embankment section to cross the Elcombe Brook.	380,000
Services		200,000
Branch Junction	Costs included above	0
Bridge	For cycleway and right of way. Associate with adjacent new lock	50,000
Skew Bridge Lock	Lock fall 2.7m.	201,000
Backpumping Station	Rising main length 60m discharging above Skew Bridge Lock	45,000
Footbridge	For right of way	25,000
GWR Lock	Lock fall 2.2m. Including cycleway tailbridge.	196,000
GWR Crossing	Thrust bore canal culvert through railway embankment	1,750,000
Elcombe Brook Aqueduct	To provide similar capacity to Wootton Basset Road bridge opening.	75,000
Elcombe Brook Lock	Lock fall 2.2m. Pedestrian tailbridge.	190,000
Backpumping Station	Rising main length 250m discharging above GWR lock.	68,000
Wootton Bassett Road Bridge (A3102)	Canal utilises existing river bridge (soffit 94.46mAOD). Deepen channel under bridge for navigation. Provide new culvert to the east to take dry weather flow from Elcombe Brook (circa DN750). Possibly provide new culvert for cycleway also (not priced).	150,000
Bridge	For Cycleway; also dry weather flow culvert for Elcombe Brook	60,000
Footbridge	For towpath	25,000
Sainsbury's Culvert	Use existing Elcombe Brook culvert for canal: Remove disused railway embankment and smaller diameter culvert beneath; lower invert of culvert for navigation clearance.	350,000
Elcombe Brook Culvert	provide new dry weather flow culvert under Sainsbury's; assume circa DN750, installed by microtunnelling technique.	600,000
Footbridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	4,365,000

Notes:
As an alternative to use of the existing Sainsbury's culvert, install a new canal culvert by cut and cover techniques (limit working area to say 50m sections to minimize impact on trade). This would be the preferred solution, saving around £500,000 (budget cost £450,000, but avoids a new culvert for the Elcombe Brook) but it depends on the co-operation and agreement of Sainsbury's.

SECTION 202



Sparcells Rail Bridge
FBs
FB
Sch
Playing Field
FBs
13
98
Sports Ground
Nursery
FB
Sparcells
Bridge
Sparcells Top Lock
Tip (dis)
Shaw Tip
Footbridge
Allot Gdns
Wild Duck Mead
86
91
Bridge
92
Sewage Works
Culvert
Rivermead Lock
Backpumping station
Schs
Rivermead
Bridge
River Ray
FB
Great Western Way
Backpumping station
321
307
Mannington Lock
Westmead
Leaze
85
92
Bridge
Mannington Recreation Ground
91
Sch
Allot Gdns
Westlea
Delta
Footbridge

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 202: N.Wilts: Mannington Rec. Ground to Sparcells Rail Bridge

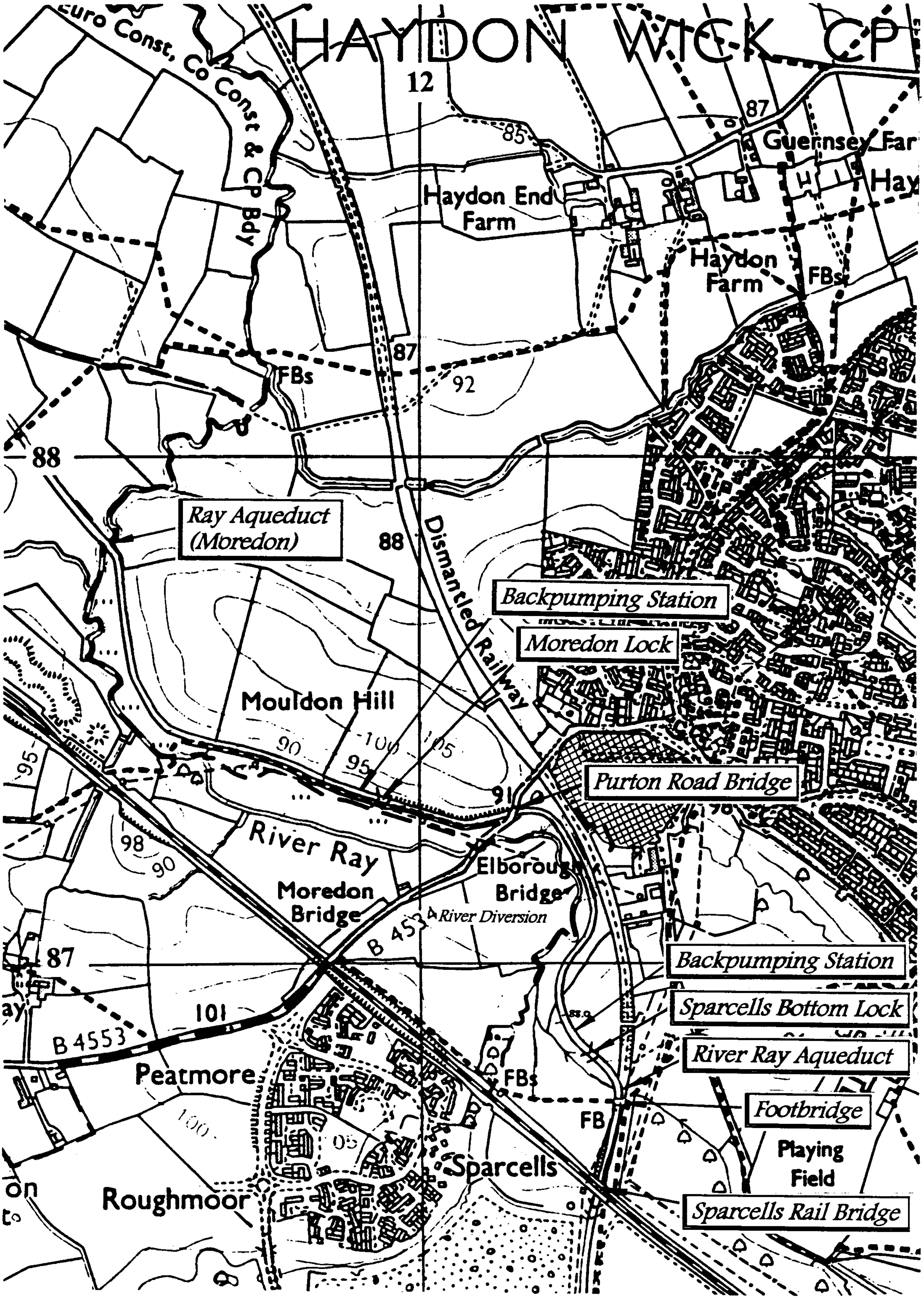
Length: 2.50km **OS Ref: SU 132846 to 123865** **Level: 92.0 to 90.0mAOD; 3 locks**

Description: Middle section of the North Wilts branch diversion in Swindon; makes use of the old M&SWJR line (now a cycleway) through Shaw Tip, maintaining sufficient width for cyleway and towpath by creating a local summit pound through this section. The River Ray is not used.
Geology: River Alluvium over Kimmeridge Clay in the south, and over Corallian in the north
Water Resources: Potential abstraction from Corallian aquifer west of the canal in the vicinity of Lydiard Millicent. Swindon (east) sewage works within 200 m of the canal; effluent discharges support River Ray during low flow stages.
Navigation, Recreation and Leisure: Shaw Tip is being capped and developed as a recreation and leisure facility (Forest Park); some sports pitches at Mannington Recreation Ground will need to be relocated, but this would afford opportunity for landscaping and additional parkland.
Environmental Features:
Services:
Land Use: Urban park; cycleway corridor,river corridor; landfill.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	All new canal, following the western edge of Mannington Recreation Ground (cut up to 3m deep; embankment up to 1.5m high). On fill for most of the route through Shaw Tip. Allow for new cycleway as well as towpath.	790,000
Services	Manholes for tip toe drains will need raising. Other diversions also.	200,000
Footbridge	For right of way	25,000
Bridge	For cycleway and right of way	50,000
Mannington Lock	Lock fall 2.8m to 89.2mAOD	205,000
Backpumping station	Rising main length 60m discharging above Mannington Lock	45,000
Great Western Way B4006	Canal utilises existing River Ray bridge (soffit 91.51mAOD). Provide new box culvert to the east to take dry weather flow from River Ray . Deepen channel under bridge for navigation.	125,000
Bridge	For cycleway and right of way	50,000
Bridge	Modify existing 'causeway' bridge for cycleway over the flood plain to give canal clearance	80,000
Backpumping station	To maintain local summit pound above Rivermead Lock. 60m pipeline.	45,000
Rivermead Lock	Lock lift 2.4m to local summit pound 91.6mOAD through Shaw Tip	195,000
Culvert	For River Ray tributary.	20,000
Bridge	For cycleway and right of way	50,000
Footbridge	For right of way	25,000
Sparcells Top Lock	Lock Fall 1.6m	170,000
Bridge	Vehicle access and cycleway bridge, regrade approaches	75,000
Sparcells Railway Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	2,150,000

Notes:


HAYDON WICK CP
Euro Const, Co Const & CP Bdy
12
85
87
Guernsey Far
Hay
Haydon End Farm
Haydon Farm
FBs
87
FBs
92
88
Ray Aqueduct (Moredon)
88
Dismantled Railway
Backpumping Station
Moredon Lock
Mouldon Hill
90
100
105
95
95
Purton Road Bridge
91
98
River Ray
98
90
Moredon Bridge
Elborough Bridge
B 4553
River Diversion
87
Backpumping Station
Sparcells Bottom Lock
101
B 4553
River Ray Aqueduct
Peatmore
FBs
Footbridge
FB
100
Playing Field
Sparcells
Roughmoor
Sparcells Rail Bridge

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 203: N.Wilts: Sparcells Rail Bridge to Ray Aqueduct (Morden)

Length: 2.00km **OS Ref: SU123865 to 114878** **Level: 90.0m to 86.5mAOD; 2 locks**

Description: Final section of the North Wilts Branch diversion through Swindon, rejoining the original canal route at Mouldon Hill. Existing restoration site at Moreden.

Geology: Corallian limestones in the south, Oxford Clay in the north. Canal crosses River Alluvium along several stretches of this section.

Water Resources: Potential abstraction from deep Great Oolite aquifer west of the canal in the vicinity of Purton.

Navigation, Recreation and Leisure: Mouldon Hill Country Park

Environmental Features:

Services:

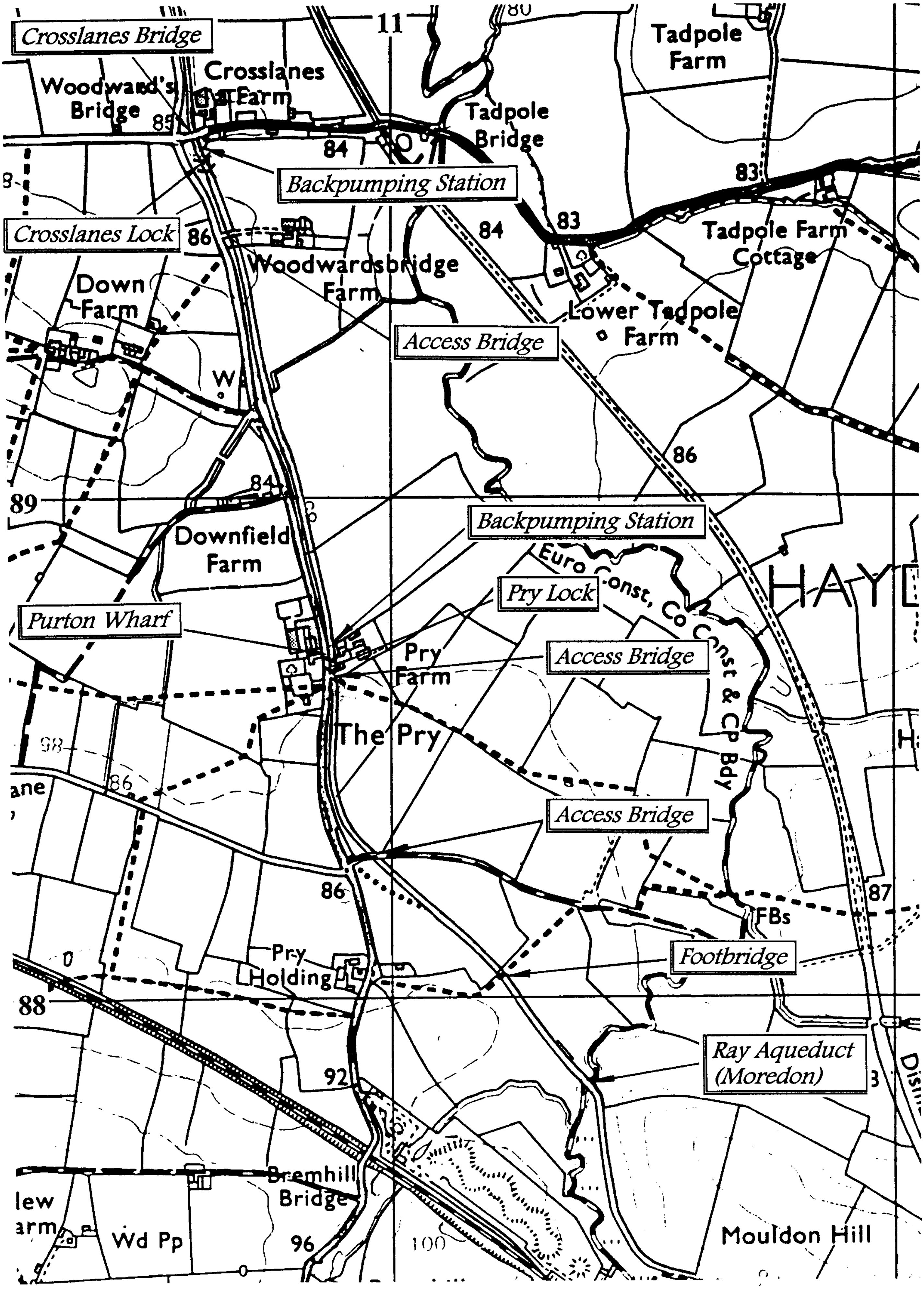
Lnd Use: Urban to Agricultural, Grade 3 to 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	New canal up to Elborough bridge.The River Ray will require (sympathetic) diversion for about 200m to allow the canal to fit between the old railway and the river.	420,000
Services		20,000
Sparcells Rail Bridge	Twin span structure in good condition. Route canal through one span, other retained for towpath/cycleway.	60,000
Footbridge	For right of way	25,000
River Ray Aqueduct	Existing aqueduct under the old railway line in good condition. Extend westwards for canal crossing	50,000
Sparcells Bottom Lock	Lock fall 2.0m to 88.0mAOD	180,000
Backpumping station	To maintain local summit pound above Sparcells Top Lock. 300m pipeline.	75,000
Purton Road Bridge B4534	No trace visible of original structure. Provide new bridge with regrading of approaches. Jack up existing River Ray road bridge.	150,000
Moredon Lock	Mostly removed. Allow for new lock, fall 1.5m to 86.5mAOD	165,000
Backpumping station	For lockage conservation. Rising main length 60m discharging above Moredon Lock	45,000
River Ray Aqueduct (Moreden)	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,190,000

Notes:

SECTION 204



Crosslanes Bridge
Crosslanes Farm
Woodward's Bridge
Tadpole Farm
Tadpole Bridge
Backpumping Station
Crosslanes Lock
Woodwardsbridge Farm
Tadpole Farm Cottage
Down Farm
Lower Tadpole Farm
Access Bridge
Downfield Farm
Backpumping Station
Euro Const, Co Const & CP Bdy
Pry Lock
HAYD
Purton Wharf
Pry Farm
Access Bridge
The Pry
Access Bridge
FBs
Footbridge
Pry Holding
Ray Aqueduct (Moredon)
Bremhill Bridge
Wd Pp
Mouldon Hill

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 204: N.Wilts: Ray Aqueduct (Morden) to Crosslanes Bridge

Length: 2.15km **OS Ref: SU 114878 to 106897** **Level: 86.5 to 83.2mAOD; 2 locks**

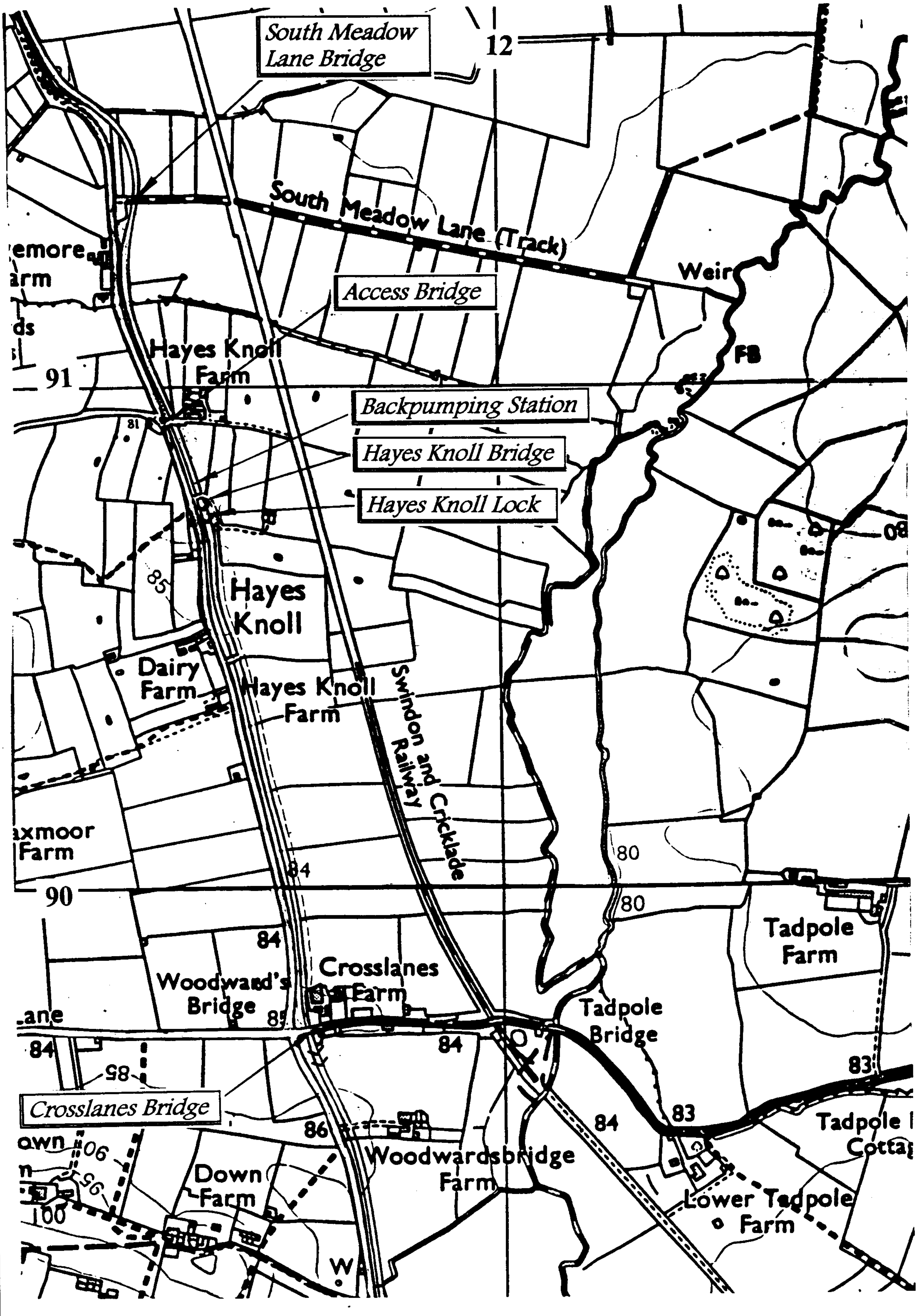
Description: The original route runs immediately to the east of the B4553 Purton Road and is largely infilled.
Geology: Corallian limeston south of Pry Holding, with overlying River Alluvium in places; Oxford Clay in the north.
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Mostly infilled. Allow for a farm access track to the east of the restored canal between Pry Farm and Woodwards Fridge Farm due to canal severance.	640,000
Services		10,000
River Ray Aqueduct	Good condition but deteriorating. Restore	50,000
Footbridge	Original bridge lost. New footbridge for right of way	25,000
Access bridge	New farm bridge with regrading of approaches.	50,000
Farm Access bridge	New lift bridge required for Pry Farm: insufficient space to make road raising practicable. Combine with pedestrian right of way	70,000
Pry Lock	Partly visible. Restore. Original lock fall 1.6m to 84.9mAOD.	90,000
Backpumping station	For lockage conservation. Rising main length 60m discharging above Pry Lock.	45,000
Purton Wharf	Buildings renovated	0
Farm Access Bridge	New bridge required for Woodwardsbridge Farm. Lift bridge, or minor canal diversion to permit regrading of track and fixed bridge.	65,000
Crosslanes Lock	Allow for new lock on slightly diverted canal line to facilitate Crosslanes crossing. Original lock fall 1.7m to 83.2mAOD	170,000
Backpumping station	For lockage conservation. Rising main length 60m discharging above Crosslanes Lock.	45,000
Crosslanes Bridge	*See next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	1,260,000

Notes:
Canal diversion from Woodwardsbridge Farm following the Swindon Cricklade railway could be a viable alternative, particularly for the next section.

SECTION 205


South Meadow Lane Bridge
12
South Meadow Lane (Track)
Weir
Access Bridge
FB
Hayes Knoll Farm
91
Backpumping Station
Hayes Knoll Bridge
Hayes Knoll Lock
81
85
Hayes Knoll
Dairy Farm
Hayes Knoll Farm
Swindon and Cricklade Railway
axmoor Farm
80
84
90
80
Tadpole Farm
84
Crosslanes Farm
Woodward's Bridge
85
ane
84
84
Tadpole Bridge
85
Crosslanes Bridge
83
86
84
83
Tadpole Cotta
Woodwardsbridge Farm
Down Farm
Lower Tadpole Farm
90
95
100
emore arm
ds
08

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 205: N.Wilts: Crosslanes Bridge to South Meadow Lane Bridge

Length: 1.70km **OS Ref: SU 106897 to 102914** **Level: 83.2 to 81.5mAOD; 1 lock**

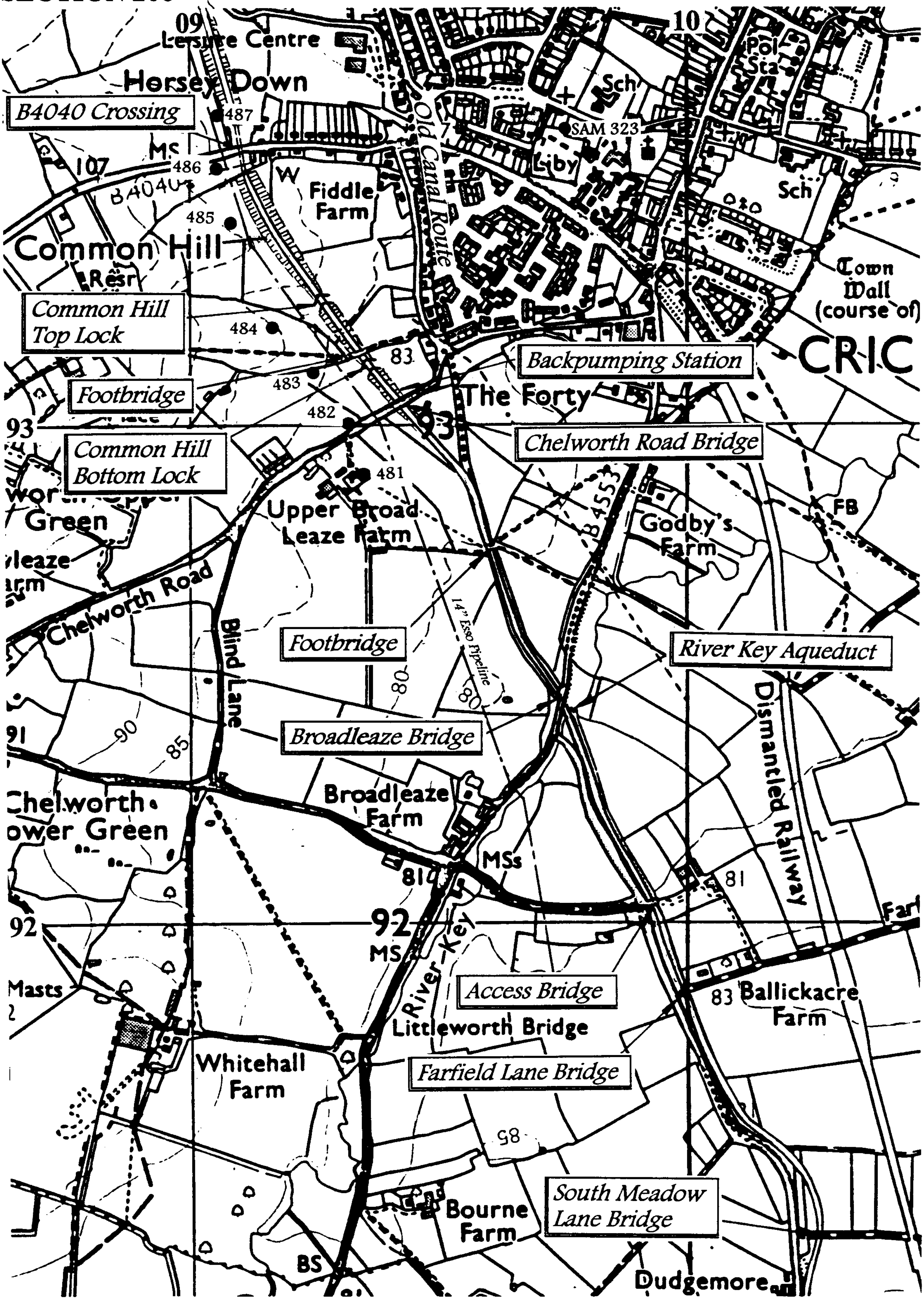
Description: Rural reach which runs immediately to the east of the B road and some 200m west of the Swindon Cricklade railway and is largely infilled.
Geology: Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure:
Environmental Features:
Services:
Land Use: Agriculture, Grade 3 to 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Mostly infilled. Allow for a farm access track to the east of the restored canal between Crosslanes and Hayes Knoll Farm due to canal severance.	490,000
Services		15,000
Crosslanes Bridge	Divert canal slightly to west of original line at Crosslanes Farm and realign road junction to create sufficient space to raise road approx 1.2m for navigation clearance.	150,000
Hayes Knoll Lock	Abutments remain. Rebuild lock. Original lock fall 1.7m to 81.5mAOD.	120,000
Hayes Knoll Bridge	Bridge destroyed, partly visible. Provide new fixed farm bridge as tailbridge to lock	30,000
Backpumping station	For lockage conservation. Rising main length 60m discharging above Hayes Knoll Lock.	45,000
Access Bridge	New farm access bridge for Hayes Knoll farm. Fixed bridge with regrading of approaches (minor canal diversion), or lift bridge if acceptable	65,000
South Meadow Lane Bridge	*see next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	915,000

Notes:
Canal diversion from Woodwardsbridge Farm following the Swindon Cricklade railway could be a viable alternative.

SECTION 206



B4040 Crossing
Common Hill Top Lock
Footbridge
Common Hill Bottom Lock
Backpumping Station
Chelworth Road Bridge
River Key Aqueduct
Footbridge
Broadleaze Bridge
Access Bridge
Farfield Lane Bridge
South Meadow Lane Bridge
Leisure Centre
Horsey Down
Common Hill
Resr
Fiddle Farm
Old Canal Route
Sch
Pol Sta
SAM 323
Liby
Town Wall (course of)
CRIC
The Forty
Upper Broad Leaze Farm
Godby's Farm
Chelworth Road
Blind Lane
14" Esso Pipeline
Dismantled Railway
Broadleaze Farm
Chelworth Lower Green
River Key
Littleworth Bridge
Whitehall Farm
Ballickacre Farm
Bourne Farm
Dudgemore
Masts
B4040
B4553
FB
MS
MSs
BS
487
486
485
484
483
482
481
83
81

SECTION 206: N.Wilts: South Meadow Lane Bridge to Horsey Down

Length: 2.50km **OS Ref: SU 102914 to 091935** **Level: 81.5 to 88.5mAOD; 2 locks**

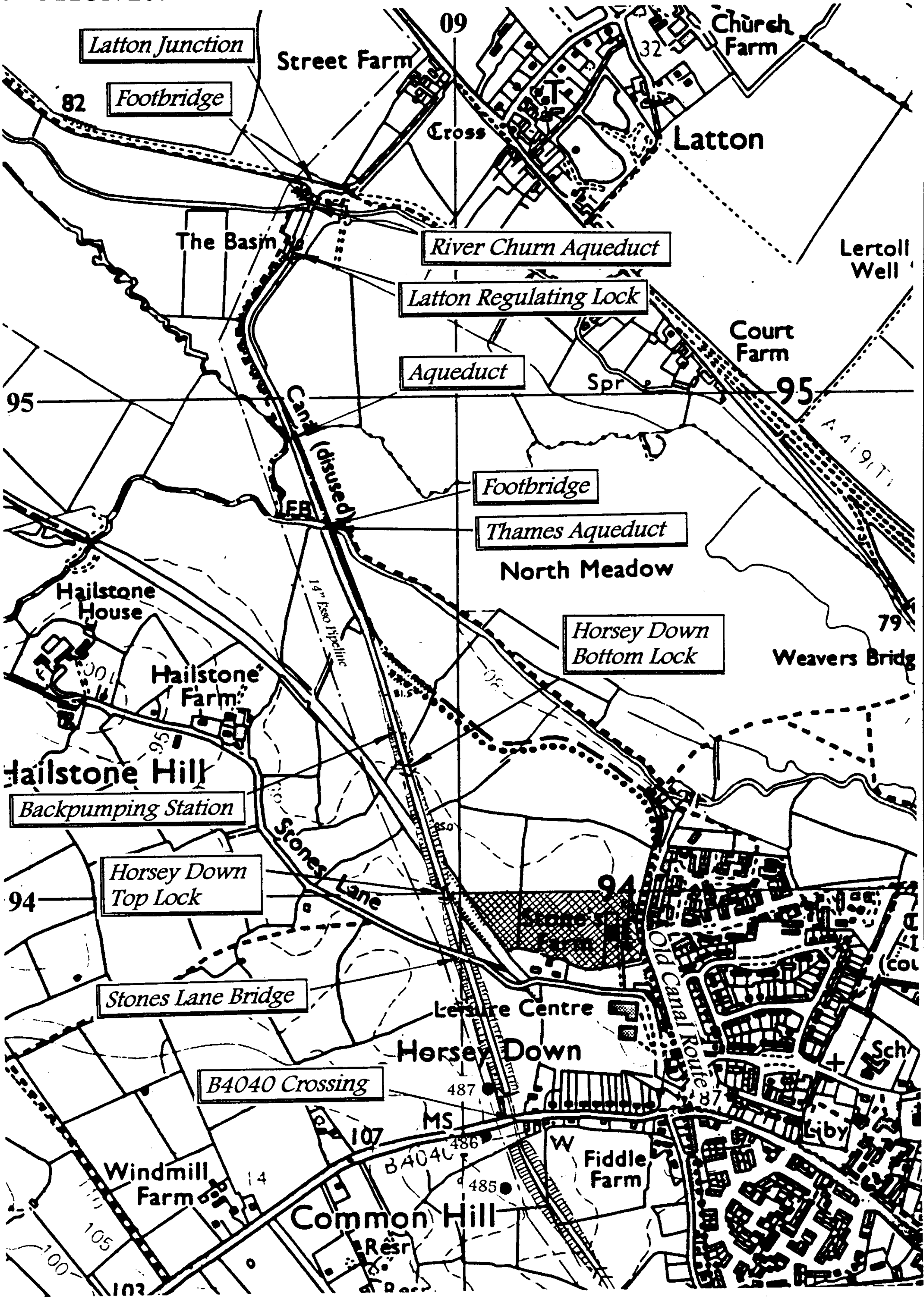
Description: Rural reach approaching Cricklade, with the first section of the Cricklade diversion.
Geology: Head deposits and Alluvium through the River Key floodplain, elsewhere Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure: Cricklade town facilities
Environmental Features:
Services: 14" Esso oil pipeline in proximity to proposed route
Land Use: Agriculture, Grade 3 to 4.

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	Mostly infilled. Minor diversion at South Meadow Lane to facilitate road crossing. New cut through Horsey Down (clays) up to 6m deep at crest. Canal on embankment across the River Key valley.	1,080,000
Services		15,000
South Meadow Lane Bridge	New bridge with regrading of approaches	75,000
Farfield Lane Bridge	Fixed bridge required with minor regrading of approaches	70,000
Access Bridge	New farm access bridge, Ballickacre Farm. Lift bridge proposed since canal slightly on embankment at this point (alternative access to farm off Farfield Lane)	65,000
River Key Aqueduct	Good condition. Allow for some remedial/restoration works	35,000
Broadleaze Bridge B4553	Road rises at original crossing point. New bridge required with significant regrading of approaches to raise level by about 2.5m. Also regrading of minor road junction south of the crossing.	150,000
Footbridge	For right of way	25,000
Chelworth Road Bridge	New bridge required with minor regrading of approaches.	75,000
Backpumping station	For lockage conservation and to maintain local summit pound. Rising main length 250m discharging above Common Hill Top Lock.	80,000
Common Hill Bottom Lock	New lock, lift 3.5m to 85.0mAOD	225,000
Footbridge	For right of way	25,000
Common Hill Top Lock	New lock, lift 3.5m to 88.5mAOD	225,000
B4040 crossing	*see next section*	
	ESTIMATED TENDER PRICE FOR RESTORATION	2,145,000

Notes:
Option of canal diversion from Woodwardsbridge Farm following the Swindon Cricklade railway could rejoin the original alignment at the River Key aqueduct. Across Horsey Down, the alignment may be shared with an extension of the railway restoration to Cirencester, and any canal restoration plans must be co-ordinated accordingly. This would almost certainly require diversion of the Esso pipeline. If the railway restoration were not to proceed, the option of a canal diversion east of Cricklade may be more economic.

SECTION 207



Latton Junction
Footbridge
River Churn Aqueduct
Latton Regulating Lock
Aqueduct
Footbridge
Thames Aqueduct
Horsey Down Bottom Lock
Backpumping Station
Horsey Down Top Lock
Stones Lane Bridge
B4040 Crossing
Street Farm
Church Farm
Cross
Latton
The Basin
Lertoll Well
Court Farm
Spr
North Meadow
Hailstone House
Hailstone Farm
Hailstone Hill
Weavers Bridg
Stones Lane
Canal (disused)
14" Esso Pipeline
Old Canal Route
Leisure Centre
Horsey Down
Windmill Farm
Fiddle Farm
Common Hill
Resr
Liby
Sch
MS
B4040
09
95
94
82
79
107
103

RESTORATION OF THE WILTS & BERKS CANAL - Feasibility Study

SECTION 207: N.Wilts: Horsey Down to Latton Junction

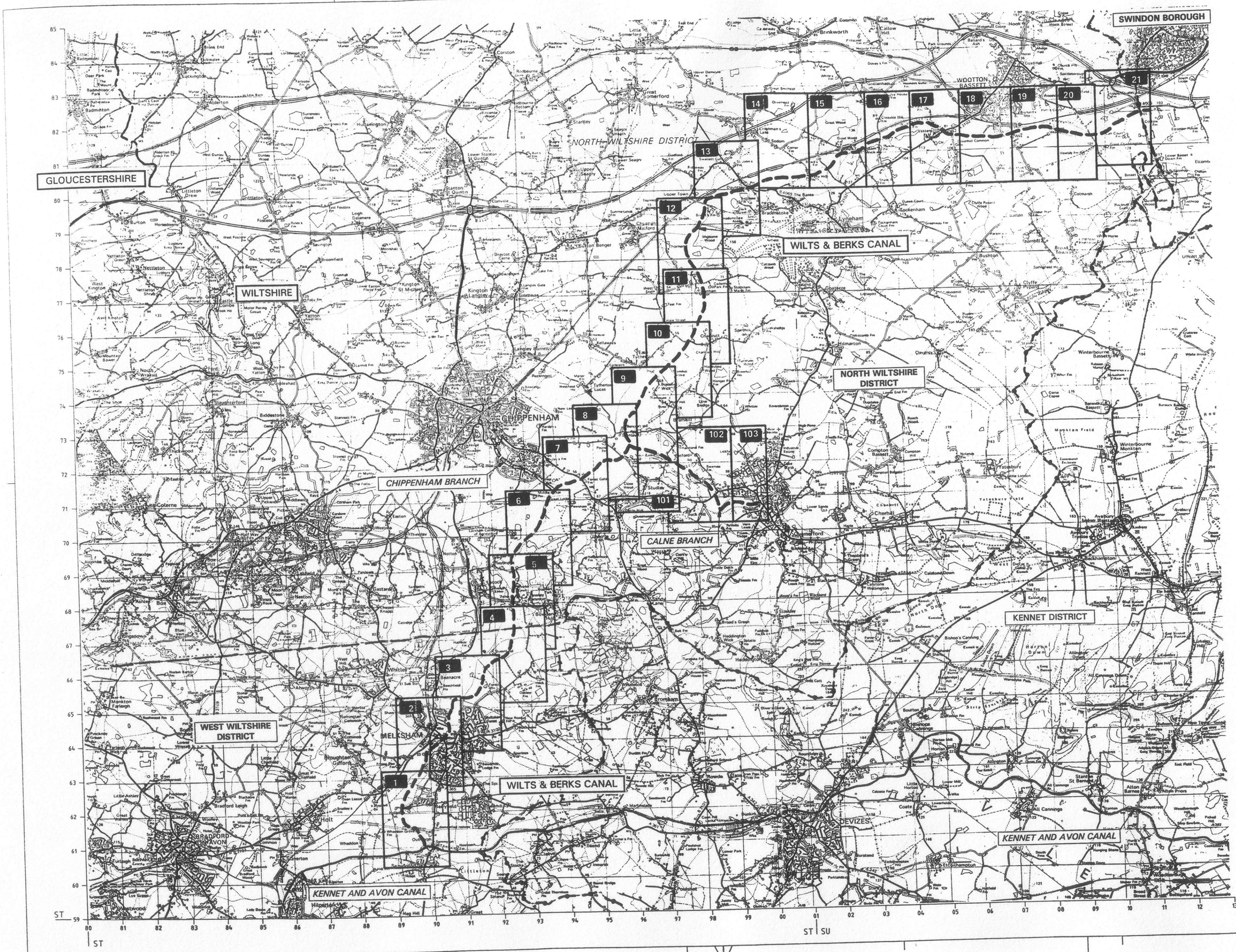
Length: 2.00km **OS Ref: SU 091935 to 087954** **Level: 88.5 to 81.5mAOD; 2 locks**

Description: Rural reach leaving Cricklade, with the end section of the Cricklade diversion. End of the North Wilts Branch, joining the Thames and Severn Canal at Latton
Geology: Head deposits and Alluvium through the River Key floodplain, elsewhere Oxford Clay
Water Resources: Currently no proposals for water resource development in this section
Navigation, Recreation and Leisure: Cricklade town facilities
Environmental Features:
Services: 14" Esso oil pipeline in proximity to proposed route
Land Use: Agriculture, Grade 3 to 4. Garden (Lock Cottage)

Schedule of Features and Restoration Costs:

Feature / Name	Description	Cost(£)
Canal Reach	New cut through Horsey Down (clays) up to 6m deep at crest. Remaining 1km on original alignment, mostly infilled. Latton Basin in good condition, dry.	1,380,000
Services		15,000
B4040 crossing	Canal in deep cut with ample clearance. Provide canal culvert	80,000
Stones Lane Bridge	New bridge required with minor regrading of approaches.	65,000
Horsey Down Top Lock	New lock, fall 3.5m to 85.0mAOD	225,000
Old railway line	No allowance, but note that a restored railway through to Cirencester will need to cross the canal at some point along the diversion.	0
Horsey Down Bottom Lock	New lock, fall 3.5m to 81.5mAOD	225,000
Backpumping station	For lockage conservation and to maintain local summit pound. Rising main length 350m discharging above Common Hill Top Lock.	95,000
Thames Aqueduct	Foundations of original structure visible. Allow for new aqueduct; this will be a significant structure.	250,000
Footbridge	For right of way	25,000
Aqueduct	Provide replacement culvert for minor watercourse.	25,000
Latton Regulating Lock	Fair condition, partly filled. Rebuild.	90,000
Lock Cottage	Renovated and extended	0
River Churn Aqueduct	Abutments partly visible. Reconstruct	100,000
Footbridge	For right of way	25,000
Latton Junction		
	ESTIMATED TENDER PRICE FOR RESTORATION	2,600,000

Notes:
Across Horsey Down, the proposed alignment may be shared with an extension of the railway restoration to Cirencester, and any canal restoration plans must be co-ordinated accordingly. This would almost certainly require diversion of the Esso pipeline. If the railway restoration were not to proceed, the option of a canal diversion east of Cricklade may be more economic.



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KEY

DISTRICT COUNCIL BOUNDARY

COUNTY BOUNDARY

ROUTE PLAN SECTION

ORIGINAL CANAL ROUTE NOT IN THIS STUDY

FINAL REPORT				A
Revision Details	By	Chk	Date	S'fix

DBKEP/001 Revision A

RESTORATION OF THE WILTS & BERKS CANAL

OVERALL ROUTE PLAN SHEET 1/3

Scale 1:50000 AT A1 SIZE

Drn SMB	Det		App'd GW
Chk	Tech Chk	Det Chk	Date 21/1/98.

Scott Wilson Kirkpatrick

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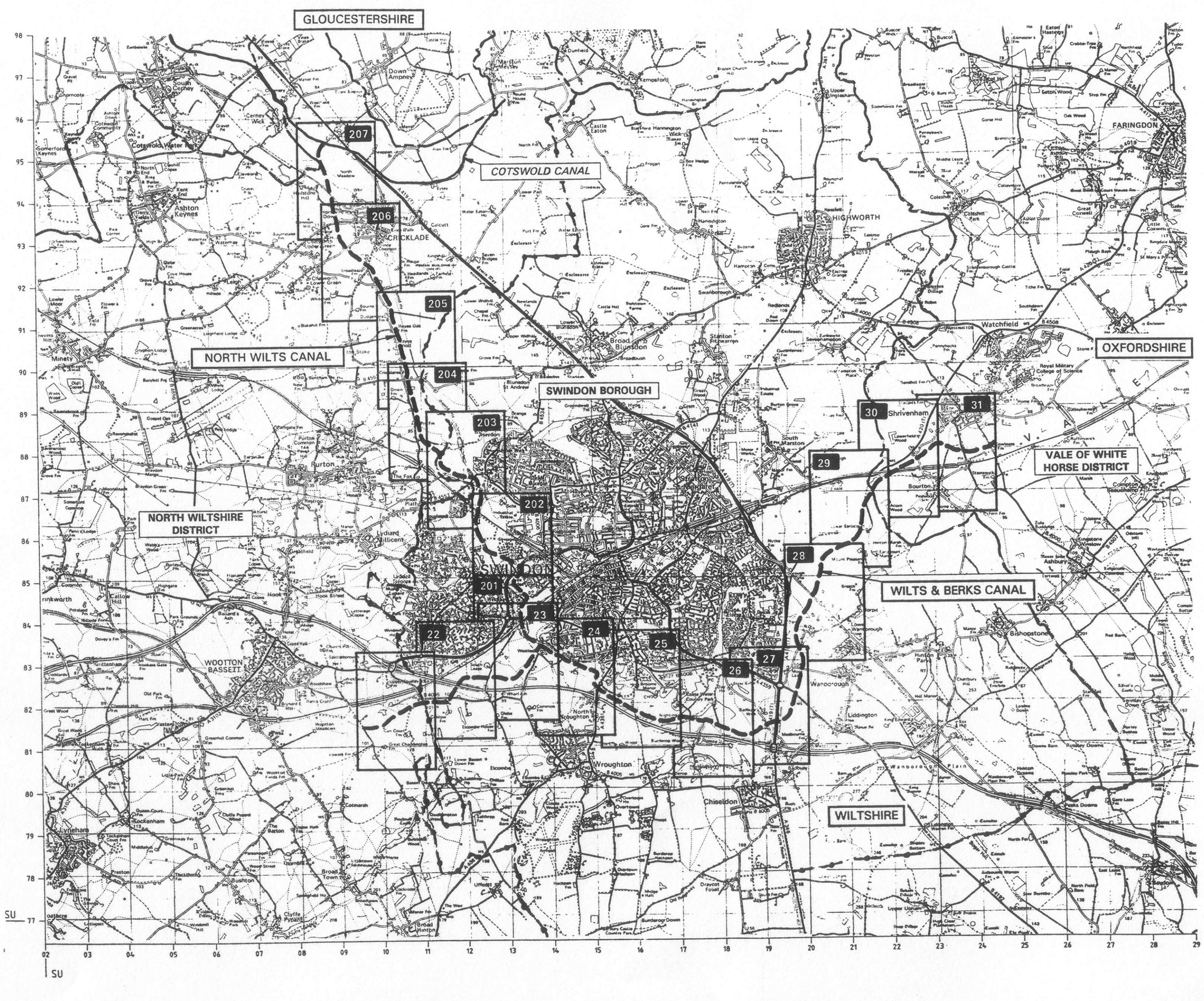
CAD REF NO | PLOT DATE



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FINAL REPORT A

Revision Details | By | Chk | Date | S'tix

Revision

DBKEP/002

RESTORATION OF THE WILTS & BERKS CANAL

OVERALL ROUTE PLAN SHEET 2/3

Scale 1:50000 AT A1 SIZE

Drn SMB | Det | Appd

Chk | Tech Chk | Det Chk | Date 21/1/98

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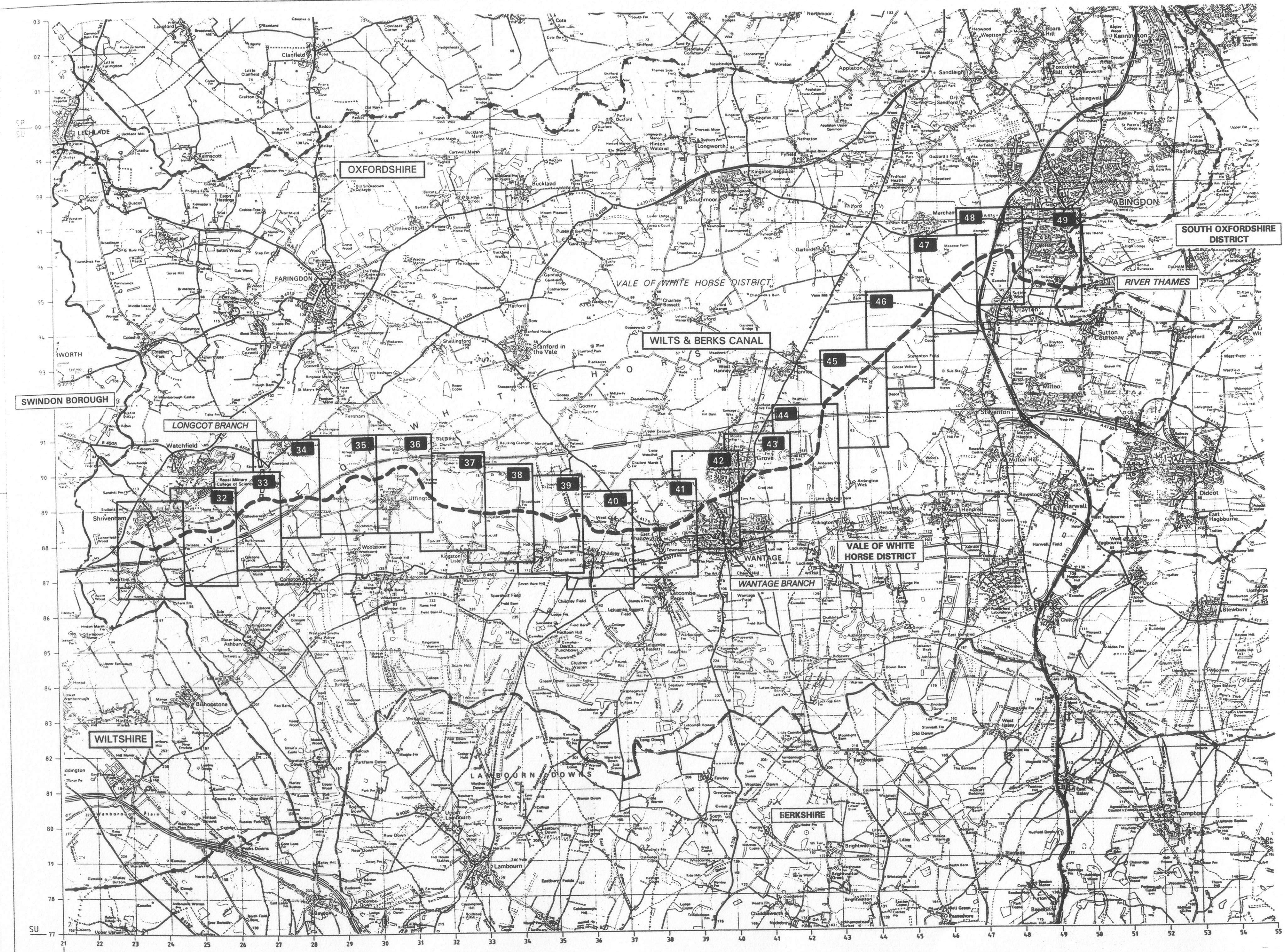
CAD REF NO A002P | PLOT DATE



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KEY

DISTRICT COUNCIL BOUNDARY

COUNTY BOUNDARY

ROUTE PLAN SECTION

ORIGINAL CANAL ROUTE NOT IN THIS STUDY

FINAL REPORT				A
Revision Details	By	Chk	Date	S'fix

Revision

DBKEP/003

RESTORATION OF THE WILTS & BERKS cANAL

OVERALL ROUTE PLAN SHEET 3/3

Scale 1:50000 AT A1 SIZE			
Drn SMB	Det		Appd
Chk	Tech Chk	Det Chk	Date 21/1/98

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CAD REF NO	PLOT DATE
A003P	

Appendix E Example calculation of surface water catchment flows

Calculation of Surface Water Flows for Catchment Using the UK Low Flow Estimation Procedures of Gustard et al (1992)

Using Gustard et al (1992), the Q95(1) value can be derived as follows:

1. Calculate the fraction of each soil association in the catchment
2. Extract the Q95(1) value for each soil association from tables in Gustard et al (1992)
3. Calculate the mean catchment Q95(1) by weighting each association Q95(1) by the fractional area of that association; the Q95(1) calculated is expressed as a percentage of the mean flow.
4. Estimate flow duration curve using the Type Curve procedure as follows,
   - the type curve is determined solely by the value of Q95(1), and is taken from a table of Flow Duration Type Curves
   - plot flow duration curve, interpolating between type curves if necessary, and using a gauged mean flow from a similar, adjacent catchment to obtain actual flow estimates.
5. Using the equation representing the above curve, calculate the Q20 and Q25 flows. These flows are used by the assumptions in estimating potential surface water yields.

An example for sub-catchment TO6 is attached.

Example calculation of surface water flows for catchment TO6
Using the UK Low Flow Estimation Procedures

A. Assessment of Type Curve

Soil association	Unit name	Geology	Surface Area (km2)	Characteristic $Q_{95}(1)$ for Soil Association (m^3/s)	Q95(1) as % of Mean Flow	
343h	ANDOVER 1	Chalk	0.5	41.6	3.0	
342a	UPTON 1	Chalk	1.0	40.8	5.8	
342c	WANTAGE 1	Chalk	3.0	41.7	17.9	
571i	HARWELL	Cretaceous glauconitic sand, loam and clay	2.0	12.1	3.5	
512e	BLOCK	Chalky drift	0.5	6.5	0.5	
712b	DENCHWORTH	Jurassic and Cretaceous clay	0.0	1.1	0.0	
711j	KINGSTON	Cretaceous and Jurassic interbedded sand and clay	0.0	20.4	0.0	
		Total Catchment Area =	***7.0***	***Total =***	***30.6***	***which gives a Type Curve of 15***

B. Calculation of Flow Duration Curve

Flow percentile	Calculated flow (m^3/s)
Q2	0.56
Q5	0.45
Q50	0.16
Q80	0.10
Q90	0.08
Q95	0.06
Q99	0.04

Curve equation: $y = -1E-06x^3 + 0.0003x^2 - 0.0199x + 0.6$

C. Potential Yield Calculation

25 Percentile	0.274 m^3/s
20 Percentile	0.314 m^3/s
Abstraction rate possible for 20% time	0.040 m^3/s
Total possible annual abstraction over 20% time period	249923 m^3
20% possible abstraction over 20% time period	49985 m^3
Reservoir diameter; assumed circular & 2 m fluctuation	178 m
Average abstraction rate for 2 months per year	40 l/s
Daily winter abstraction for 2 months per year	3.4 Ml
Capacity	50 Ml

Appendix F Coding System for Potential New Water Supplies

Main Catchment	Code	Sub-catchment	Code	Surface Water Sources	Code	Groundwater Sources	Code
River Thames	T	River Ray	R			Chalk south west of Wroughton	TRgw1
						Lower Greensand north of Wroughton	TRgw2
						Corallian west of Swindon	TRgw3
						Great Oolite near Purton	TRgw4
		River Cole	C	South of Acorn Bridge	TC4	Chalk north east of Ashbury	TCgw1
						Lower Greensand south east of Bourton	TCgw2
						Corallian near Stratton St. Margaret	TCgw3
		River Ock	O	South east of Broadleaze Farm	TO6	Chalk south of Uffington	TOgw1
				Downstream of Uffington	TO9	Lower Greensand/Corallian north of Uffington	TOgw2
				Downstream of Cowleaze Farm	TO10		
River Avon	A	Upper Avon		East of Greenhill Common Farm	AU1	River Gravels near Great Somerfield	AUgw1
				South west of Stockham Marsh Farm	AU4	Chalk near Broad Hinton	AUgw2
						Corallian near Tockenham	AUgw3
						Great Oolite near Bradenstoke	AUgw4
						Great Oolite north of Callow Hill	AUgw5
		River Marden	M	Swerves Farm	AM1	River Gravels near West Tytherton	AMgw1
						Lower Greensand near Heddington	AMgw2
						Corallian near Calne	AMgw3
						Great Oolite near Christian Melford	AMgw4
		Lower Avon	L	South of Forest Farm	AL2	River Gravels west of Bowden Hill	ALgw1
				North of Bowerhill Lodge Farm	AL3	Lower Greensand near Bowden Hill	ALgw2
				South of Chippenham	-	Great Oolite west of Derry Hill	ALgw4

Appendix G Groundwater Yield Assessment Report Commissioned from British Geological Survey

British Geological Survey

Hydrogeology Group
Maclean Building
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OX10 8BB

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Direct line +44(0)1491 69
Fax +44(0)1491 692345
E-mail hydro@bgs.ac.uk
http://www.nkw.ac.uk/bgs/w3/hydro/index.htm

7 October 1997

Scott Wilson Kirkpatrick & Co Ltd.
Scott House
Basing View
Basingstoke
Hampshire
RG21 4JG

Attention Dr MA Jones

Dear Sir

Groundwater Yield Assessments

Thank you for your letter of 22 September regarding the borehole yield prognoses for 5 sites in the Swindon Devizes area and your cheque for the pro-former invoice. Detailed below are the geological and hydrogeological assessments.

1. Grid Reference: ST 940 710 - West of Derry Hill, near Great Lodge Farm Our Ref: RE/ST97/7181

The ground elevation at the site is estimated to be approximately 53 metres above Ordnance Datum. The geological sequence beneath the site is expected to be as follows:

Oxford Clay and Kellaways Beds (shaley clay)	*40 to 50 m thick*
Cornbrash (rubbly limestone with clay)	*1 to 4 m thick*
Forest Marble (clay with limestone)	*15 - 20 m thick*
Great Oolite Limestone (shelly limestone with some clay)	*about 30 m thick*
Fuller's Earth (clay with limestone)	*$\geq$30 m*

The strata have a shallow dip of <10° to the east and the Oxford Clay and Kellaways Beds thin out to the west. The Great Oolite Limestone is an important aquifer and there may be contributions from the limestone beds in the Cornbrash and Forest Marble. The Fuller's Earth strata are mainly impermeable and separate groundwater from the Great Oolite Series above and the Inferior Oolite Series beneath.

The rest water level in a borehole penetrating this sequence should lie within 20 m of the ground surface and may show a seasonal variation.

Groundwater is mainly stored in and flows through fractures and solution channels in the limestone beds. The success of a borehole will depend on the number of such features penetrated and their size. Our records suggest that a 200 mm diameter borehole drilled to the base of the Great Oolite Limestone would have a 50% chance of obtaining 0.5 Ml/day for a drawdown of 10 m.

The National Well Record Archive does include information on ground water quality in these rocks 3 to 4 km to the west and south west. The total hardness is in the range 300 to 350 mg/l. Chloride ion concentration are in the range 25 to 65 mg/l, with sulphate about 60 mg/l. Iron is up to 1.5 mg/l and fluoride is 1.1 mg/l. In general I would expect the quality to deteriorate to the south east and it is not possible to guarantee that it would be potable at your site.

This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ and your attention is drawn to the exclusion of warranty on the back of the invoice, which includes the standard NERC terms of contract. While we may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, South West Region.

2. Grid Reference: SU 040 780 - South of Tockenham Our Ref: RE/SU07/7179

The ground elevation at the site is estimated to be 100 metres above Ordnance Datum. The geological sequence beneath the site is expected to be as follows:

Coral Rag (rubbly limestones with sands and clays)	*probably less than 10 m thick*
Lower Calcareous Grit (sandstone)	*<5 m thick and maybe absent*
Oxford Clay and Kellaways Beds (shaley clay)	*up to 170 m thick*

The strata have a shallow dip of <5° to the east and Coral Rag thins out to the west of the proposed borehole site. The Coral Rag and Lower Calcareous Grit of the Corallian may contain useful sources of groundwater, although they vary vertically and laterally in thickness and in their hydrogeological properties.

The rest water level in a borehole penetrating the Corallian should lie within a few metres of the ground surface, but may show a significant seasonal variation. The probable limited saturated thickness available is unlikely to yield a significant proportion of your requirement. Our records suggest that the probable yield of a borehole fully penetrating the Corallian would be between 6.5×10^{-3} and 3.9×10^{-2} Ml/day. However, the success of a borehole will depend on the degree of fracturing in the saturated sequence. Fine grained running sands may cause technical difficulties in drilling and the screening borehole.

The Oxford and Kellaways Beds beneath the Corallian possess poor hydrogeological properties and may be considered as aquicludes. The Great Oolite Limestone is at a considerable depth and is likely to contain poor quality water.

The National Well Record Archive does include information on ground water quality in this area. In the unconfined zone, we would expect groundwater to be hard and of good chemical quality. There may be a problem with iron-rich water locally. Our records for a borehole nearby indicate the composition of groundwater to be average to poor, although this may not be representative of the aquifer as a whole:

Sodium	50-100 mg/l	Calcium	100 mg/l
Chloride	75 mg/l	Total Hardness (as $CaCO_3$)	250 - 300 mg/l
Sulphate	500 mg/l		

This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ and your attention is drawn to the exclusion of warranty on the back of the invoice, which includes the standard NERC terms of contract. While we may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, South West Region.

3. Grid Reference: SU 070 880 - West of Purton Our Ref: RE/SU08/7182

The ground elevation at the site is estimated to be approximately 89 metres above Ordnance Datum. The strata have a dip of about 20° to the south and east. The geological sequence beneath the site is expected to be as follows:

Oxford Clay and Kellaways Beds (shaley clay)	*about 150 m thick or greater*
Cornbrash (rubbly limestone)	*$\leq$ 5m thick*
Forest Marble (clay with shelly limestone)	*about 25 m thick*
Great Oolite Limestone (shelly limestone with clay)	*about 30 m thick*
Fuller's Earth (clay with limestone)	*$\geq$ 30 m*

The site is at the south-eastern periphery of the outcrop of Oxford Clay and we would expect the thickness of the unit to be near a maximum. The Cornbrash, limestone beds in the Forest Marble and Great Oolite Limestone should contain useful sources of groundwater.

The rest water level in a borehole penetrating the Great Oolite Limestone is not known in this area but I would expect it to lie within 10 m of the ground surface.

Our records suggest that a borehole fully penetrating the Great Oolite Limestone would produce a yield of about 0.1 Ml/day for a drawdown of about 50 m. The archive does not contain any information on groundwater quality in the Great Oolite Limestone in this area but I would expect it to be brackish or saline at this distance from outcrop and depth of burial.

This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ and your attention is drawn to the exclusion of warranty on the back of the invoice, which includes the standard NERC terms of contract. While we may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, South West Region.

4. Grid Reference: SU 175 875 - Stratton St Margaret Our Ref: RE/SU18/7180

The geological and hydrogeological conditions are similar here as at the site south of Tockenham.

The ground elevation at the site is estimated to be 110 metres above Ordnance Datum. The geological sequence beneath the site is expected to be as follows:

Coral Rag *(rubbly limestones with sands and clays)*	*approximately 10 m thick*
Lower Calcareous Grit *(silt and sand)*	*approximately 5 m thick and maybe less or absent*
Oxford Clay and Kellaways Beds *(shaley clay)*	*greater than 120 m thick*

The strata have a shallow dip of <5° to the south east and the Coral Rag thins out to the west of the proposed borehole site. The Corallian strata vary vertically and laterally in thickness in their hydrogeological properties.

The rest water level in a borehole penetrating this sequence should lie between 2 and 8 m below the ground surface and may show a significant seasonal variation. The probable limited saturated thickness of Coral Rag and Lower Calcareous Grit are unlikely to yield a significant proportion of your requirement. We have records which suggest that the probable yield of a borehole in these Corallian rocks would be in the order of 0.04 Ml/day. However, the success of a borehole will depend on the saturated thickness available and the degree of fracturing in the limestone. Fine grained running sands may cause technical difficulties drilling and screening the borehole.

The Oxford and Kellaways Beds beneath the Corallian possess poor hydrogeological properties and may be considered as aquicludes. The Great Oolite Limestone at depth is likely to contain only poor quality water.

The National Well Record Archive does include information on ground water quality in this area although its content is limited. In the unconfined zone of the Corallian we would expect the groundwater to be hard and of good chemical quality. There may be a problem with iron-rich water locally. Our records indicate that the total hardness should be in the range 150 to 350 mg/l (as $CaCO_3$) and the chloride ion concentration should be less than 40 mg.l (as Cl).

This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ and your attention is drawn to the exclusion of warranty on the back of the invoice, which includes the standard NERC terms of contract. While we may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, South West Region.

5. Grid Reference: SU 237 857 - South East of Bourton Our Ref: RE/SU28/7183

The ground elevation at the site is estimated to be 97 metres above Ordnance Datum. The geological sequence beneath the site is expected to be as follows:

Gault Clay (blue-grey clay and marl)	*a few metres thick if present*
Lower Greensand (sand or ferruginous sands)	*probably up to 10 m thick*
Purbeck and Portland Beds (limestones, sandstones and clay)	*probably absent but maybe up to a few metres thick*
Kimmeridge Clay (shaley clay)	*about 60 m thick*
Corallian (limestone, sand and clay)	*about 20 m thick*

The Gault and Kimmeridge Clays act as impermeable units effectively isolating the Lower Greensand and the Corallian strata both of which may contain useful sources of groundwater. The thickness of the Lower Greensand will vary laterally because its upper and lower contacts are unconformable and so the thickness given is an estimate of the thickness at this location.

The rest water level in a borehole completed in the Lower Greensand should lie within 5 metres of the ground surface, but the seasonal variation may be significant, such that the saturated thickness at the end of a long dry period may be only a few metres. We have no records of wells in the Lower Greensand from which to estimate yields in this area. The optimum yield from a fully penetrating borehole is only likely to be a small part of your requirement, possibly 3.0×10^{-3} Ml/d.

A slightly higher yield may be achieved if the Purbeck and Portland beds are present between the Lower Greensand and the Kimmeridge Clay, but they are probably absent.

The National Well Record Archive does not include information on ground water quality in the Lower Greensand in this area but I would expect the total hardness to be less than 250 mg/l (as $CaCO_3$) and the chloride ion concentration to be less than 50 mg/l (as Cl). Iron concentrations may be high, in excess of 0.2 mg/l.

A borehole fully penetrating the Corallian may have an optimum yield of about 1.0×10^{-2} Ml/d and this may decline with time as storage is depleted due to slow recharge through the overlying clays. I do not have any information on groundwater quality in this area, but I would expect it to be brackish due to the distance from outcrop. If a borehole were to be constructed a sand screen would be needed to prevent the ingress of fine grained material into the well.

This interpretation is based on the information available in the surrounding area. Due to natural geological variation the conditions encountered on drilling may differ and your attention is drawn to the exclusion of warranty on the back of the invoice, which includes the standard NERC terms of contract. While we may assess the groundwater potential at this site, the prerogative of granting a licence rests with the Environment Agency, South West Region.

Yours faithfully

PD Merrin pp RJ Martin

Appendix H Water Quality Data

Water quality data for groundwater and rain water, from IGS (1978) and Hem (1992). Used as raw data in estimation of potential water quality for the Wilts & Berks Canal.

Water Source	pH	TDS	Na+K	Ca	Mg	HCO_3	Cl	SO_4	NO_3
River Sands & Gravels	7.8	594.6	27.6	124	8	305	28.4	76.8	24.8
Chalk	8	442.3	6.9	100	8	274.5	21.3	19.2	12.4
Lower Greensand		489.9	115	22	6	262.3	46.15	38.4	0
Corallian	7.5-8	776.1	41.4	154	18	390.4	63.9	96	12.4
Great Oolite	8.1	1140	387.5	15	6.2	411	295	25	0.2
Rainwater	6	9.1	0.5	1.2	0.8	4.3	0.5	1.44	0.434

Appendix I River Corridor Surveys

RIVER RAY: **SECTION 27-(ii),OP REACH 0248/00/9a,NGR:SU13138406 to SU13108390**

(Westlea Brook) **250m of new operation reach through marsh.**

DATE **17.05.93.**

GENERAL **Surveyed Left Bank mainly from Comet car park.**

RIVER PHYSICAL FEATURES

1.	Broad Nature	Naturally winding through a marsh, the river has indistinct banks with adjacent "land" being reed beds and wet land merging with slightly higher land from water margin.(open water)
2.	Dimensions	Almost impossible to assess accurately as channel winds its way through reed beds and marshland vegetation.
3.	Substrate	mineral soil derived from clay and silt particles and organic soil derived from marshland detritus (incipient development of potential fen peat?)
4.	Bank Type	LB: non existent RB: non existent

LAND USE

LB: marsh giving way laterally to road and then Comet superstore with further upstream a car park serving same store and built on stilts partly above sections of the marsh.

RB: narrower marshy area (compared with other bank) merging with waste ground (grassy with tall herbs) beyond which laterally railway embankments where active railway meets old course of disused railway.
Further upstream is a carr area.

VEGETATION

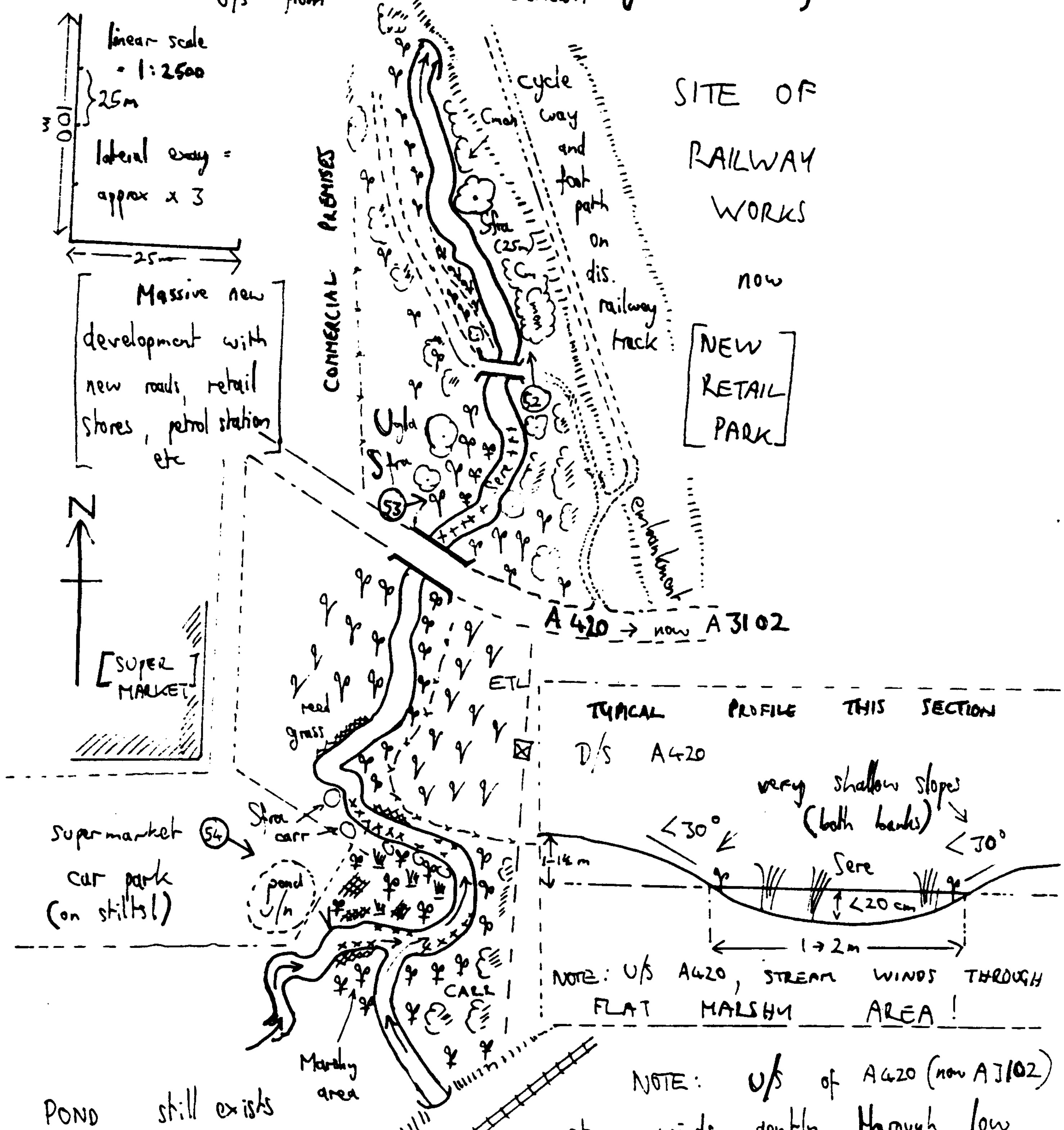
1.	Banks and Margins	LB/RB; *Glyceria maxima* at wettest margins gives way to *Filipendula ulmaria* and *Epilobium hirsutum* and on slightly less damp land, *Urtica dioica* and *Symphytum officinale* with in several wet depressions *Phragmites australis* and *Glyceria maxima*. *Caltha palustris* may be present(?)
2.	Channel	*Typha latifolia* very common.

3. Adjacent Land	LB: continuation of bankside vegetation but with increasing amounts of carr species such as *Salix fragilis* (young saplings) and *Salix caprea* with *Silene dioica, Armoricia rusticana.*
	RB: similar to other bankside but rising a little higher to give drier habitats with meadow grasses, drier types of herb, more trees esp salix species.
POINTS OF INTEREST	Excellent wet habitats in marshy area.
RECOMMENDATIONS	Every effort should be made to conserve the wet habitats for what must be a first class location for wildlife. Some curtailment of spreading salix carr species may be desirable in the short to medium term future.

R. RAY (Wootton stream) : SECTION 21 OP REACHES 8c + 9a , 500m

0248 OC/8c+9a NGR:- SU 1313 8429 to SU 1310 8390.

u/s from culvert beneath former railway works.



POND still exists underneath car park for supermarket, built on stilts.

NOTE: U/S of A420 (now A3102) stream winds gently through low marshy area. NO banks – instead water margin is a transition from a perennially water covered course to damp land.

EXCELLENT WILDLIFE HABITATS.

Tlat in "channel"
Pcom on margins (not always)
Gmax, Fulm, Soff in CARR + Salix spp.

Appendix J Sensitivity of aquatic plants to boat movements

Species	Maximum no. boat movements/year (bm/y) at which recorded
Very sensitive species - <2000 bm/y	
Ceratophyllum demersum	1230
Chara sp	1110
Moderately sensitive species (2000-4000 bm/y)	
Alisma plantago-lanceolata	3000
Butomus umbellatus	3750
Elodea nuttalli	3500
Galium palustre	2400
Iris pseudacorus	3800
Lemma triscula	2000
Myriophyllum spicatum	3300
Nitella sp	3020
Nuphar lutea	2500
Phragmites australis	3200
Potamogeton berchtoldii	3020
P. obtusifolius	2100
P. perforliatus	3000
Typha latifolia	2700
Resistant species (4000-6000 bm/y)	
Apium nodiflorum	4200
Berula erecta	5790
Equisetum fluviatile	5500
Lemna minor	4000
Myosotis scorpioides	5600
Nymphaea alba	5800
Very resistant species - >6000 bm/y	
Agrostis stolonifera	8250
Carex acutiformis	9500
Elodea canadensis	7700
Epilobium hirsutum	7900
Glyceria maxima	10600
Juncus effusus	8240
Lycopus europaeus	6000
Mentha aquatica	6280
Nuphar lutea (without floating leaves)	8200
Phalaris arundinacea	8000
Polygonum amphibium	7600
Potamogeton crispus	9500
P. natans	7200
Rumex hydrolapathum	8000
Sagittaria sagittifolia	7500

Species	Maximum no. boat movements/year (bm/y) at which recorded
Sparganium emersum	6600
S. erecta	7200
Stachys palustris	5500
Veronica beccabunga	7500

Appendix K The GQA and WQO Standards

There are four schemes of assessment under the GQA scheme, namely chemical, biological, nutrient and aesthetic, however only the chemical and biological schemes are currently in use. The chemical assessment is derived from the measurement of three determinands: dissolved oxygen (DO), biochemical oxygen demand (BOD) and Ammonia, and is graded as follows:

Water Quality	Grade	Dissolved Oxygen	Biochemical Oxygen Demand (ATU[1])	Ammonia
		(%-saturation) 10-percentile	(mg/l) 90-percentile	(mgN/l) 90-percentile
Good	A	80	2.5	0.25
	B	70	4	0.6
Fair	C	60	6	1.3
	D	50	8	2.5
Poor	E	20	15	9.0
Bad	F[2]	-	-	-

[1] as suppressed by adding alkyl thio-urea

[2] i.e. quality that does not meet the requirements of grade E in respect of one or more contaminants

As for a biological water quality, the assessment is based upon the Biological Monitoring Working Party (BMWP) score system. This method of assessment is based upon a three minute kick-sample of the macroinvertebrate fauna of river substrate and margins. The macroinvertebrates are identified to family level, and each one is assigned a score which is directly related the species' tolerance to pollution. The lower its tolerance, the higher the score and vice versa. The total of all the family scores is known as the BMWP score, and this is further refined by dividing it by the number of families identified to provide an average score per taxon (ASPT). In order to calculate the biological GQA score a further level of assessment is made. Using a mathematical model which can predict the macroinvertebrate fauna which would be present in an unpolluted river of similar physical characteristics (River Invertebrate Prediction and Classification System [RIVPACS]), the assessor can predict the probable assemblage of families for the reach of river assessed. The ratio between the two is called the Ecological Quality Index (EQI), and is the basis of the biological GQA scheme. Two ratios are used, ASPT and the number of taxa, to determine which grade the reach falls into. As with the chemical assessment, all of the limits must be satisfied in order for the reach to be classed within a certain grade. In the Upper Thames Catchment Management Plan, the Biological GQA scheme has not been used, instead the BMWP score is presented within a set range, with the inference that the higher the score, the higher the water quality. The grading criteria for the biological component of the GQA scheme is as follows:

Water Quality	Grade	Ratio ASPT	Ratio Taxa
Very Good	A	>1.0	>0.85
Good	B	0.9	0.7
Fairly Good	C	0.77	0.55
Fair	D	0.65	0.45
Poor	E	0.5	0.3
Bad	F	<0.5	<0.3

Water quality objectives, WQOs for the River Ecosystem use class are graded from 1 to 5 based upon the potentially achievable use of the reach of watercourse assessed. The grades and description for each are as follows:

RE Class	Description
RE1	Water of very good quality suitable for all fish species
RE2	Water of good quality suitable for all fish species
RE3	Water of fair quality suitable for high class coarse fish populations
RE4	Water of fair quality suitable for coarse fish populations
RE5	Water of poor quality which is likely to limit coarse fish populations

Each grade has a fixed set of parameters to which it must conform in order to pass the grade. As with the GQA, all parameters must be satisfied for the reach of river to attain the grade. The standards for the River Ecosystem use classes are presented in Appendix L.

Appendix L Standards for river ecosystem use classes

(from the Upper Bristol Avon Catchment Management Plan Consultation Report: Appendix 1.1. June 1994)

Use Class	DO % sat 10%ile	BOD (ATU) mgN/l 90%ile	Total Ammonia mgN/l 90%ile	Un-ionised Ammonia mgN/l 95%ile	pH 5%ile & 95%ile	Hardness mg/l $CaCO_3$	Dissolved Copper µg/l 95%ile	Total Zinc µg/l 95%ile	Class Description
1	80	2.5	0.25	0.021	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	30 200 300 500	Water of very good quality suitable for all fish species
2	70	4.0	0.6	0.021	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	30 200 300 500	Water of good quality suitable for all fish species
3	60	6.0	1.3	0.021	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	300 700 1000 2000	Water of fair quality suitable for high class coarse fish populations
4	50	8.0	2.5	-	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	300 700 1000 2000	Water of fair quality suitable for coarse fish populations
5	20	15.0	9.0	-	-				Water of poor quality which is likely to limit coarse fish populations

Appendix M Details of archaeological finds

Appendix M: Records of Scheduled Ancient Monumnmets and Various Finds and Cropmarks associated with the Wilts Berks canal

Route Corridor	Route Option	NGR	SMR Find No.	Location	Period	Comments
Semington to Melksham	Melksham B	ST 89726143	623	W. of Outmarsh Farm	U	Undated earthwork, possibly a low mound
	Melksham B	ST 89266267	619	N.W. of Berryfield Cottages	U	Undated circular earthworks
	Melksham B	ST 89596282	635	Berryfield	U	Undated rectangular enclosure
	Melksham B	ST 89566301	634	Circular Feature, Berryfield	U	Undated ringditch
	Melksham B	ST 89586292	633	Circular Feature, Berryfield	U	Undated ringditch
	Melksham B	ST 89566295	632	Circular Feature, Berryfield	U	Undated ringditch
	Melksham B	ST 89546283	631	Circular Feature, Berryfield	U	Undated ringditch
	Melksham B	ST 89436282	630	Circular Feature, Berryfield	U	Undated ringditch
	Melksham B	ST 899638	001		PA	Flint tool
East of Melksham	Melksham H	ST 939622	525	Settlement, Mitchells Farm	PM	Farmstead with post medieval origins
	Melksham H	ST 933629	600	S.W. of Tanhouse Farm		Undated cropmarks
	Melksham G	ST 926620	453	Settlement E.of Loves Farm	LM	Medieval settlement features on A.P.
	Melksham G	ST 926634	452		LM	Medieval settlement: pottery fragments
	Melksham G/ H	ST 928638	305		RB	Pottery fragments
	Melksham G/ H	ST 925644	461		LM	Farmstead with Medieval origins
Calne Spur		ST 979715	603	E. of Conigre Farm		Undated linear earthworks
Derry Hill to Foxham		ST 96187176	610	W.&S.W. of Stanley Abbey Farm		Broad undated earthen bank
		ST 96257225	450	Stanley Abbey Farm	LM	Site of Cistercian Abbey, with well preserved earthworks
		ST 96957454	460		LM	Maud Heaths Causeway
			454	No record		No record
Foxham to South Swindon		ST 934701	055		ME	Mesolithic flint implements and wastes
		ST 932703	056		ME	Mesolithic flint implements and wastes
		ST 98197714	454	Settlement-Lower Cadenham Farm	LM	Medieval moated farmstead
		SU 03678166	616	N. of Tockenham Bridge		Undated field system
		SU 10978222	612			Undated linear earthworks
		SU 12868260	627			Small undated rectangular mound
		SU 123826	468		LM	Medieval earthworks of a probable farm
		SU13738305	SAM 920	West Leaze	LM	Shrunken Medieval Village with house sites and streets visible.

Period Codes: PA = Palaeolithic,ME = Mesolithic, NE = Neolithic, BA = Bronze Age, IA = Iron Age, RB = Romano British, EM = Early Medieval, LM = Later Medieval, PM = Post Medieval.

Appendix M: Records of Scheduled Ancient Monumnmets and Various Finds and Cropmarks associated with the Wilts Berks canal

Route Corridor	Route Option	NGR	SMR Find No.	Location	Period	Comments
		SU 14708280	305	S. of Belmont Crescent	RB	Mettled surface of a probable RB road
Swindon - Cricklade		SU 13088425	314	W. of Mannington House	RB	RB pottery fragments: single find
	Swindon F/G	SU 13158510	321		RB	Pottery fragments
	Swindon F/G	SU 13198506	307		RB	Pottery fragments
	Cricklade A/B	SU 0938929	481	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade A	SU 0932930	482	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade A	SU 0926931	483	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade A	SU 0917932	484	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade A	SU 0910934	485	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade A	SU 0907935	486	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade A	SU 0905936	487	W. of Fiddle Farm	LM	Medieval pottery fragments
	Cricklade C	SU 09759359	**SAM 323**	Cricklade Saxon Town Wall	EM/RB	Evidence of Saxon town and Roman port
Swindon South and East Options		SU 15308230	311	Trackway R.Ray	RB	Section of possible Roman road
		SU 154823	112/053	Croft Campus Site	ME	Mesolithic activity revealed during watching brief / limited trenching
		SU 18258155	615	W. of Badbury Wick House		Undated linear cropmarks
S.W. of Shrivenham to N. of Uffington		SU 22028760	10127		PM	Milestone
		SU 22608793	7170		PM	Bourton Wharf
		SU 22738800	5843	S. of Old Canal, Lower Field Farm	PM	Interval stone
		SU 24258822	7171			Undated stone
		SU25708850	7313			Undated stone
		SU 26458930	12046		B	Ringditch
		SU 26788932	7307		PM	Drawbridge

Period Codes: PA = Palaeolithic,ME = Mesolithic, NE = Neolithic, BA = Bronze Age, IA = Iron Age, RB = Romano British, EM = Early Medieval, LM = Later Medieval, PM = Post Medieval.

Appendix M: Records of Scheduled Ancient Monumnmets and Various Finds and Cropmarks associated with the Wilts Berks canal

Route Corridor	Route Option	NGR	SMR Find No.	Location	Period	Comments
		SU 27038929	7308			Undated stone
		SU 27298934	12033			Ringditch-period uncertain
		SU27438932	7309		PM	Longcot Lock
		SU 28178938	9565			Earthwork/Barrow - date uncertain- jet ornament, shale ring, bronze pin
		SU 28598939	7310			Undated stone
		SU 28918964	7311		PM	Drawbridge
E. of Uffington to East Challow		SU 31958931	7004	900m S.E. Uffington Arch	PM	Swingbridge
		SU 33728902	7288		PM	Swingbridge
		SU 34088893	7289		PM	Swingbridge
		SU 34758876	7290		PM	Swingbridge
		SU 37528830	11173		RB	Pottery find
		SU 37528836	13696	Cornhill Lane crossing	PM	Swingbridge
N. of Wantage to Drayton copse		SU 39648905	15886		RB	Enclosures: features and finds
		SU40128942	10128		PM	Milestone
		SU 40308960	11419	Beside W&B Canal	PM	Terrace of 4 houses c.1810: Lock Keeper, Carpenter, Smithy and Stable.
		SU 40878990	7354		PM	Smallmarsh Lock
		SU 41429002	7151		PM	Spirit Lock
		SU 41629003	7152		PM	Swingbridge
		SU 41779004	7153		PM	Grove Bottom Lock

Period Codes: PA = Palaeolithic,ME = Mesolithic, NE = Neolithic, BA = Bronze Age, IA = Iron Age, RB = Romano British, EM = Early Medieval, LM = Later Medieval, PM = Post Medieval.

Appendix M: Records of Scheduled Ancient Monumnmets and Various Finds and Cropmarks associated with the Wilts Berks canal

Route Corridor	Route Option	NGR	SMR Find No.	Location	Period	Comments
		SU 42269015	7154		PM	Swingbridge
		SU 42609115	7143		PM	Ardington Top Lock
		SU 42739185	7144			Stone - undated
		SU 42859194	7145		PM	Ardington Marsh Lock
		SU 44159300	9927	Field drain N.W. of W&B canal	RB	Pottery Sherds found in field drain
		SU 44419323	7127		PM	Steventon Lock
		SU 45259402	12656	Abandoned lock on W&B canal	PM	Drayton Lock
Abingdon Route Options	Route C	SU 48309585	**SAM 242**		RB/BA /IA/NE	Complex of enclosures and field markings. Finds: Roman and Iron Age pottery; Neolithic flints and Bronze Age/Neolithic flints and flakes
	Route B	SU 47039547	15584		BA/NE	Fairly concentrated lithic scatter
	Route B	SU 476953	9054	Sutton Wick Field	BA/NE	Flint flakes
	Route A	SU 47939621	2650	New Cut Mill	EM	Saxon Sword Hilt
	Route A	SU 47939619	12748	End of Mill Lane	PM	New Cut Mill form 1757 and before
	Route A	SU 482964			M	Pill Boxes
	Route A	SU 481964	15798	R. Ock, Abingdon	M	Anti-tank obstacles- Dragons Teeth
	Route A	SU 48839691	**SAM 232**	R. Ock, Abingdon	LM	Ock Bridge and site of 14C hospital
	Route A	SU 496967	12489	R. Ock, Abingdon	RB	Pottery fragments over river alluvium

Period Codes: PA = Palaeolithic,ME = Mesolithic, NE = Neolithic, BA = Bronze Age, IA = Iron Age, RB = Romano British, EM = Early Medieval, LM = Later Medieval, PM = Post Medieval.

Appendix N Materials requiring disposal

Quantities of material requiring disposal

Total length of proposed restoration (km)	108.4
Approx length of original canal route which has been infilled (km)	22.0
Approx length of original canal route which has been (or is being) restored(km)	8.0
Balance of original canal route which has not been infilled (km)	47.3
Length of new canal (km)	29.1
Length of river navigation (km)	2.0
Dredging	
Length of canal that will be dredged (km)	10
Quantity of material dredged from channel (m^3) (assuming channel is 50% choked)	50,000
Assume no dredgings are reused and that all require disposal	
Excavation	
Material excavated from original route	529,000
Material excavated for new route	810,000
Total quantity of material excavated from old and new route excluding dredgings (m^3)	1,339,000
Composition of excavation spoil	
Assume that 95% of excavated natural ground is not contaminated	
Quantity of excavated natural ground that is not contaminated (m^3)	769,500
Assume that 5% of excavated natural ground is contaminated	
Quantity of excavated natural ground that is contaminated (m^3)	40,500
Assume that 95% of infill is inert	
Quantity of infill that is inert (m^3)	502,550
Assume that 5% of infill is non inert	
Quantity of infill that is non inert (m^3)	26,450
Total quantity of contaminated spoil (m^3)	66,950
Total quantity of inert spoil (m^3)	1,272,050
Total quantity of excavation spoil (m^3)	1,339,000
Reuse of excavation spoil	
Quantity of excavated material used for fill to new canal embankments (m3)	95,000
Quantity of excavated material used in landscaping (assume 15%) (m3)	190,808
Quantity of excavated material used in forming new surface water reservoirs	300,000
Total reuse	585,808
Disposal of excavation spoil	
Quantity non contaminated excavated material requiring disposal (m^3)	686,243
Quantity contaminated excavated material requiring disposal (m^3)	66,950
Disposal of both dredgings and excavated material	
Total disposal requirement (assuming no dredgings are reused) (m^3)	803,193
Assumed mean bulk density of spoil (tonne/m^3)	1.5
Total disposal requirement (assuming no dredgings are reused) (tonne)	1,204,789
Assume average cost of disposal to landfill is £8 per tonne	12,550,012
(plus landfill tax at £2 per tonne for inactive waste and £7 per tonne for active waste)	

Appendix O Receptors sensitive to noise and dust emissions

Location	NGR (of residence)	Distance (m)	Section Sheet
Outmarsh Farm	899614	250	1
Holbrook Farm	889622	200	1
Berryfield	895624	200	1
Boundary Farm	896628	200	1, 2
Rusty Lane Farm	938621	x	1A
Craysmarsh Farm	936626	x	1A, 2
Tanhouse Farm	935631	x	1A, 2
Melksham	913642	x-200	2, 3
School, Melksham	917643	100	2
Blackmore Farm	926644	x	2A, 3A
School, Blackmore Farm	927645	x	2A, 3A
Forest Farm	917657	200	3
Near Rhotteridge Farm	927660	100	3A, 4
Strode Farm	925678	150	4, 5
Lacock Wharf	925681	x	5
Bewley Crescent	927682	x-150	5
Bewlew Court	926685	50	5
Rey Mill	925689	50	5
Green Lane Farm	947718	x	7, 8
Stanley Bridge Farm	959730	x	8, 9, 101
Hazeland Mill	973724	100	9, 101, 102
Wick Bridge Holdings	969747	x-150	10
Charlcutt Hill Farm	980756	150	10, 11
Cadenham Manor	982771	x	11
Lock Farm	982774	x	11, 12
Foxham Locks	981776	x	11, 12
Elm Farm	977777	150	12
Dauntsy Lock	995802	x-150	13
Trow Lane Farm	026812	x-150	15, 16
Hart Farm	042818	50	16, 17
Vastern	052816	x	17
Hunts Mill Farm	056816	x	17, 18
Wootton Bassett	070816	x-150	18, 19
Chaddington Lock House	092816	x	20
Morningside Farm	093818	150	20
Berrywood	118822	100	22
Near Wharf Farm	125822	50	22, 23
Wharf Farm	128823	x	23
West Leaze Farm	136828	100	23
Westleaze	138832	150	23, 24
Swindon (Near Westleaze)	143833	50	23, 24
Rushy Platt Farm	133838	50	23
Bridgemead	131843	50	23
Westlecott Farm	145828	100	24
Near North Wroughton	132824	50	24, 25
Nightingale Farm	167817	x	25

Broome Farm	170819	100	26
Nightingale Cottages	173817	x	26
Great Moor Leaze Farm	194827	50	27
Acorn Bridge	216873	25	29, 30
Acorn End	220877	25	30
Station Road	238880	50	31
Stainswick Lane	243881	150	31, 32
Cleaveland Farm	269903	100	34
Old Wharf Road	274894	x	34
Wharf Farm	301897	25	36
Stallards Bridge	320890	25	37
Kingston Common Farm	331888	50	37, 38
Broardleaze Farm	341890	50	38, 39
West Challow Bridge	367884	50	40
East Challow	380883	x-150	41
Stockham's Bridge	390889	50	41, 42
Near Stockham's Bridge	390885	100	41, 42
Grove	400894	x-150	42, 43
The Rookery	427913	25	44, 45
Steventon Road	430931	50	45
Caldecott	490965	x-150	49
Stonehill House	487955	100	49
Stonehill Farm	486955	50	49
Sewage Works (Abingdon)	493952	50	49
Sewage Works (Searchers Wood)	978716	25	102
Conigre Farm	981716	100	102
Berhills Farm	988710	100	103
Calne	995707	x-150	103
Swindon (Even Swindon), Delta	130846	50	201
Swindon (Even Swindon), Westmead	129852	50	201
Swindon (Even Swindon), Sewage Works	128857	100	201
Swindon (Even Swindon), Near Sewage Works	129861	50	201
Swindon, School	128867	x	202
Elborough Bridge	124872	x	202
Swindon, Moredon	124875	x-150	202
Pry Holding	109881	150	203
Pry Farm	108887	x	203
Woodwardsbridge Farm	118896	100	204
Crosslanes Farm	117898	x	204
Dairy Farm	115904	x	204
Hayes Knoll Farm	115909	50	204
Dudgemore Farm	112912	25	204
Ballickacre Farm	100920	25	205
Upper Broard Leaze Farm	093929	25	205
Horsey Down	093936	x	205, 206
Stone's Farm	092938	x	206

Appendix P Economic Benefit Assessment

Wilts & Berks Canal

Economic impact - Option 1

Baseline

(At June 1997 prices)

CYCLING

Nominal level of cycling assumed - Bridleway stretches are limited alongside the waterways (estimated at 4km)		
Total cyclists p.a.	2500	assumed
% cyclists on day trip	78%	BW Informal Visitors to Waterway Towing Path 1996
% cyclists on overnight trip	22%	BW Informal Visitors to Waterway Towing Path 1996

Day trippers

No. of visitors on day trip	1,950	
% day visitors from total who would not have made trip but for canal	24%	BW Informal Visitors to Waterway Towing Path 1996
Visitor spend per trip (incl. travel/permits)	£1.09	BW Informal Visitors to Waterway Towing Path 1996
Total Day Cycling Visit Spend	**£511**	

Holiday visits

No. of visitors on holiday visit	550	
% day visitors from total who would not have made trip but for canal	24%	
Visitor spend per day (incl. travel/permits)	£25.40	West of England Tourist Board - av spend / night
Total Holiday Cycling Visit Spend	**£3,353**	

TOTAL CYCLING VISIT SPEND	**£3,864**	

INFORMAL VISITORS

Nominal numbers of informal visits assumed - Footpath/bridleway stretches are limited alongside the waterways (estimated at 12km)		
Estimated number informal visits p.a.	10,000	
From BW surveys overall proportion of visitors on holiday estimated at 22%		
% visitors on day trip	78%	BW Informal Visitors to Waterway Towing Path 1996
% visitors on overnight trip	22%	BW Informal Visitors to Waterway Towing Path 1996

Day trippers

No. of visitors on day trip	7,800	
% day visitors from total who would not have made trip but for canal	24%	BW Informal Visitors to Waterway Towing Path 1996
Visitor spend per trip (incl. travel/permits)	£3.20	BW Informal Visitors to Waterway Towing Path 1996
Total Day Visit Spend	**£5,997**	

Holiday visits

No. of visitors on holiday visit	2,200	
% day visitors from total who would not have made trip but for canal	24%	BW Informal Visitors to Waterway Towing Path 1996
Visitor spend per day (incl. travel/permits)	£25.40	West of England Tourist Board - av spend / night
Total Holiday Visit Spend	**£13,411**	

TOTAL INFORMAL VISIT SPEND	**£19,408**	

Economic impact - Option 1

Baseline

(At June 1997 prices)

SUMMARY **(£,000s)**		
	Cyclists	**£4**
	Informal day visitors	**£6**
	Informal holiday visitors	**£13**
TOTAL	**Gross visitor spend**	**£23**

Income retained in local economy

derived from Scottish Tourism Multiplier Study 1992 - Rural model

Total income retained @ 40%	**£9**

Employment Estimate

derived fromScottish Tourism Multiplier Study 1992 - Rural model

Totlal Employment Generated (FTE's) @ 1 FTE per £25,000 gross spend	**1**

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Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline

(At June 1997 prices)

BOATING

CRUISING BOATS

Boats on passage

Assume:- 2,000 passages per year ex.Abingdon; 1,000 ex.K&A		
This traffic gives rise to 2,500 movements on main line; 1,000 on N.Wilts branch.only		
Assume 40:60 split hire : private boats		
Boat movements p.a. - Main line	2500	
Boat movements p.a. - N.Wilts	1000	
Waterway length: Abingdon - K&A (Km)	89	
Locks: Abingdon - K&A	65	
Waterway length: N.Wilts (Km)	14	
Locks: N.Wilts	15	
Av. boat speed (Km/hr)	5	assumed
Time to pass through locks (Mins)	10	assumed
Av. hours cruised per day	3.6	ex. BW Log Book Survey, 1993
Boat-days per boat	9.4	
Boat-days per year	32991	
Mean spend/person/day - hire	£11.59	ex Hire Boat Survey, 1990
Av. number people per boat - hire	4.1	ex Hire Boat Survey, 1990
Mean spend/person/day - private	£8.01	ex. BW Log Book Survey, 1993
Av. number people per boat - private	3.0	ex. BW Log Book Survey, 1993

Total Cruising Spend per year - visiting boats	**£1,102,802**	

Cruising boats - based on W&B

No. of private boats - K&A	1071	BW licensing stats.
K&A - Waterway length (Km)	138	
Boats / Km	7.8	
Assume boats on the main line & Calne branch at same density as K&A; at half density on N.Wilts branch.		
Waterway length: main line / Calne branch (Km)	94	
Estimated boats based on main line / Calne branch	730	
Waterway length: N.Wilts (Km)	14	
Estimated boats based on N.Wilts	54	
Total boats based on canal	784	
1, 2 & 3-4 day trips by W&B-based boats assumed to take place entirely within the waterway		

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline

(At June 1997 prices)

1-day trips per boat per year	3.5	ex. BW Log Book Survey, 1993
2-day trips per boat per year	1.9	ex. BW Log Book Survey, 1993
3/4-day trips per boat per year	1.9	ex. BW Log Book Survey, 1993
Boat-days per boat	14	
Boat-days per year	10946	
Mean spend/person/day	£8.01	ex. BW Log Book Survey, 1993
Av. number people per boat	3.0	ex. BW Log Book Survey, 1993

Total Cruising Spend per year - canal-based boats	**£263,154**	

MOORED BOATS
Non-cruising visits
Subsistence spend

Number of boats	784	
Non-cruising visits per boat per year	6	ex. BW Log Book Survey, 1993
Duration of non-cruising visits (man-days)	1.5	ex. BW Log Book Survey, 1993
Non-cruising visits - spend per head	£9.61	ex. BW Log Book Survey, 1993
Occupancy - non-cruising visits	2	ex. BW Log Book Survey, 1993
Total Non-cruising Spend	**£135,589**	

Travel costs

All travel to/from boats assumed by car. *Travel costs for trips less than 20 miles assumed spent locally.*		
% trips less than 20 miles	60%	ex. BW boat ownership data
Vehicle cost/mile (full car costs)	£0.42	ex. RAC data
Av dist. travelled (round trips - trips less than 20 miles)	15	ex. Kennet & Avon Canal Boating Survey, 1990
Cruising plus non-cruising visits per year	14.4	
Total Travel Spend	**£42,900**	

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline
(At June 1997 prices)

Boat-related expenditure

Annual boat running costs	£1,771	ex. Private Boating Price-Demand Study, 1997 (BW/EA) (BW boats only)
Average length of boat ownership (years)	5.9	ex. Private Boating Price-Demand Study, 1997 (BW/EA) (BW boats only)
Average estimated purchase cost per boat	£19,055	ex. Private Boating Price-Demand Study, 1997 (BW/EA) (BW boats only)
Total annual boat running Costs	**£1,388,195**	
Total annual boat purchase Costs	**£2,531,563**	

SUMMARY

Moving Boats	**£1,365,956**	
Moored Boats	**£4,098,246**	
Total	**£5,464,202**	

HIRE BOATS

	Additional expenditure from moving boats included above		
	No.hire boats - K&A	57	
	Boats / Km K&A	0.4	
	No. Hire boats W&B - main line	39	based on locations on Main Line only
	Estimate hire boats	26	Assume only two-thirds will locate without N.Wilts.
Holiday cost	Av.cost/hire(£s)	£726	shoulder rates for 7-day hire of 4-berth boat
	Hires per year	23	assumed, based on 1-week hires

Total hire boat spend	**£432,212**	

TRIP BOATS

Boat traffic	No.of boats	5	as proposed through Scheme
	Passengers per boat	40	Based on average size trip boat
	Occupancy Rate	0.70	assumed
	No.trips per year	450	assumes 25 week season-2 trips per day; 4 trips per weekend day

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline
(At June 1997 prices)

	Total number of passengers carried	63000	
Trip spend	Av.cost per trip	£3.09	Average cost based on BW System
	Av.visitor spend per trip	£4.34	K&A Trip Boat Survey, 1991
	Total trip spend	**£468,090**	
Travel	*10% travel to boats on foot, remainder car/public transport* *Travel costs for trips less than 20 miles assumed spent locally*		
	% trips less than 20 miles	0.75	K&A Trip Boat Survey, 1991
	Vehicle cost/mile (full car cost)	£0.42	ex. RAC data
	Av. distance travelled (less than 20 miles)	9	K&A Trip Boat Survey, 1991
	Av. trippers per car/bus	5	K&A Trip Boat Survey, 1991
	Total travel spend	**£36,450**	
	Total spend	**£504,540**	

DAY BOATS **Boat traffic**	No. of additional boats	15	assume 1/2 operators
	Average days spent on canal	115	assumed 5 days per week with 23 week season
	Average craft occupancy	4.1	ex. BW Hire Boat Survey, 1990
Canalside spend	Cruising spend per person per day	£4.34	K&A Trip Boat Survey, 1991
	Boat hire cost per day	£44.29	Based on Day boat operations on BW system
Travel	Assumed spent outside local area		
Total spend	Boat movement	£30,668	
	Boat hire	£76,400	
	TOTAL SPEND	**£107,069**	

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline

(At June 1997 prices)

HOTEL BOATS

Boat Traffic

Assume development will support 1 hotel boat operation with 2 boats		
No. of Boats	2	
Passengers per boat	10	assumed
Occupancy rate	100%	assumed
No. of trips pa	26	1 week trips assumed

Trip Spend

Av. cost per trip	£995	based on existing operation on Cam / Ouse

Daily spend per person	£6.53	assumed as for leisure day trip visits (ex.UKDVS, 1996)

Total trips spend	£517,400	
Total daily spend	£23,770	

TOTAL SPEND (£'s)	**£541,170**	

RESTAURANT BOATS

Boat Traffic

Assume development will support 2 restaurant boat operations - possibly Swindon & Lacock		
No. of Boats	2	
Passengers per boat	40	Average over BW system
Occupancy rate	80%	assumed
No. of trips - High season	312	26 week high season with 12 trips per week
No. of trips - Low season	78	26 week low season with 3 trips per week

Trip Spend

Av. cost per trip	£25	assumed

TOTAL SPEND (£'s)	**£624,000**	

CANOEING

Canoe hire

No. of boats	50	assumes 1 or 2 bases, totaling 50 boats

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline
(At June 1997 prices)

	1-day hires per boat per year	78	assumed at 3 hires per week per boat for 26 weeks
	2-day hires per boat per year	26	assumed at 1 hire per week per boat for 26 weeks
	Total 1-day hires per year	3900	
	Total 2-day hires per year	1300	
Spend	Visitor spend 1-day hire	£11.53	£5 cost per hire plus UKDVS average visitor spend
	Visitor spend 2-day hire	£61	2 nights overnight spend plus 2-days hire
	Total spend	**£124,008**	

Casual canoeing		
Visits per km	700	assumed as for K&A
Waterway length - main line & Calne Branch	94	
Waterway length - N.Wilts branch	14	
Visits per year	70700	assume N.Wilts density half that for main line
Visitor spend per visit	£2.73	BW Owners of Unpowered Boats Survey, 1995
Total spend	**£192,976**	

Total additional canoeing spend	**£316,983**	

ANGLERS

Visits per km	800	assumed as for K&A
Waterway length - main line & Calne Branch	94	
Waterway length - N.Wilts branch	14	
Visits per year	80800	assume N.Wilts density half that for main line

Spend

Visitor spend per trip (incl. travel/permits)	£5.68	BW Survey of Individual Anglers, 1996

TOTAL SPEND	**£458,564**	

CYCLING

Cycle hire		
No. of bikes	200	assumes 1 or 2 bases with 200 bikes total

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline

(At June 1997 prices)

	1-day hires per bike per year	78	assumed at 3 hires per week per bike for 26 weeks
	2-day hires per bike per year	26	assumed at 1 hire per week per bike for 26 weeks
	Total 1-day hires per year	15600	
	Total 2-day hires per year	5200	
Spend	Visitor spend 1-day hire	£11.53	£5 cost per hire plus UKDVS average visitor spend
	Visitor spend 2-day hire	£67	2 nights overnight spend plus 2-days hire
	Total spend	**£528,895**	

Casual cycling

Development of route links will increase long-distance tourist cycling.
Day cycling will increase through development of access to/from towns
Assume 30km developed as cycleways

	Visits per km	3400	assumed as for K&A
	Waterway length	30	assumed
	Visits per year	102000	
Day trippers		79,560	78:22 ratio day trippers : holiday visitors
	% day visitors from total who would not have made trip but for canal	24%	BW Informal Visitors to Waterway Towing Path 1996
	Visitor spend per trip (incl. travel/permits)	£1.09	BW Informal Visitors to Waterway Towing Path 1996
	Total Day Cycling Visit Spend	**£20,847**	
Holiday visits	No. of cyclists on holiday visit	22,440	assumed additional cyclists
	Trip duration (days)	1.0	short-breaks assumed; ie. 2 or 3 nights
	Visitor spend per day (incl. travel/permits)	£25.40	West of England Tourist Board - av spend / night
	Total Holiday Cycling Visit Spend	**£569,976**	
	Total additional cycling spend	**£1,119,718**	

INFORMAL VISITORS

Visits per km	43470	assumed at 90% K&A level.
Waterway length - main line & Calne Branch	94	
Waterway length - N.Wilts branch	14	

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline
(At June 1997 prices)

	Visits per year	4491900	assume N.Wilts density two-thirds that for main line
Day trippers	No. of day trippers	3,503,682	78:22 ratio day trippers : holiday visitors
	% day visitors who would not have made trip but for canal	24%	
	Visitor spend per trip (incl. travel/permits)	£3.20	BW Informal Visitors to Waterway Towing Path 1996
	Total Day Visit Spend	**£2,693,603**	
Holiday visits	Baseline - No. of visitors on holiday visit	988,218	
	% day visitors from total who would not have made trip but for canal	24%	
	Visitor spend per day (incl. travel/permits)	£25.40	West of England Tourist Board - av spend / night
	Total Holiday Visit Spend	**£6,024,177**	
SUMMARY	**Total additional informal visitor spend**	**£8,717,780**	

SUMMARY (£,000s)		
	Private powered boats	**£5,464**
	Hire boats	**£432**
	Trip boats	**£505**
	Day boats	**£107**
	Hotel boats	**£541**
	Restaurant boats	**£624**
	Canoes / unpowered boats	**£317**
	Anglers	**£459**
	Cyclists	**£1,120**
	Informal day visitors	**£2,694**
	Informal holiday visitors	**£6,024**
TOTAL	**Gross visitor spend**	**£18,286**

Income retained in local economy

Wilts & Berks Canal

Economic impact - Scenario 1
Full re-opening, without link to Cotswold Canals

Additional income c/w Baseline

(At June 1997 prices)

derived from Scottish Tourism Multiplier Study 1992 - Rural model

Total income retained @ 40%	**£7,314**

Employment Estimate

derived fromScottish Tourism Multiplier Study 1992 - Rural model

Totlal Employment Generated (FTE's) @ 1 FTE per £25,000 gross spend	**731**

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15-Oct-97

Wilts & Berks Canal

Economic impact - Scenario 2
Full re-opening, with link to Cotswold Canals

Additional income c/w Scenario 1
(At June 1997 prices)

BOATING
CRUISING BOATS
Boats on passage

Assume:- 2,000 additional passageson N.Wilts; 1,000 on main line.		
Assume 40:60 split hire : private boats		
Boat movements p.a.	1000	
Waterway length: Abingdon - K&A (Km)	89	
Locks: Abingdon - K&A	65	
Boat movements p.a.	2000	
Waterway length: N.Wilts (Km)	14	
Locks: N.Wilts	15	
Av. boat speed (Km/hr)	5	assumed
Time to pass through locks (Mins)	10	assumed
Av. hours cruised per day	3.6	ex. BW Log Book Survey, 1993
Boat-days per boat	9.4	
Boat-days per year	9426	
Mean spend/person/day - hire	£11.59	ex Hire Boat Survey, 1990
Av. number people per boat - hire	4.1	ex Hire Boat Survey, 1990
Mean spend/person/day - private	£8.01	ex. BW Log Book Survey, 1993
Av. number people per boat - private	3.0	ex. BW Log Book Survey, 1993

Total Cruising Spend per year - visiting boats	**£337,208**	

Cruising boats - based on W&B

No. of private boats - K&A	1071	
K&A - Waterway length (Km)	138	
Boats / Km	7.8	

Assume boats on N.Wilts branch at same density as main line		
Waterway length: N.Wilts	14	
Estimated boats based on N.Wilts	54	

Wilts & Berks Canal

Economic impact - Scenario 2
Full re-opening, <u>with</u> link to Cotswold Canals

Additional income c/w Scenario 1
(At June 1997 prices)

1, 2 & 3-4 day trips by W&B-based boats assumed to take place entirely within the waterway		
1-day trips per boat per year	3.5	ex. BW Log Book Survey, 1993
2-day trips per boat per year	1.9	ex. BW Log Book Survey, 1993
3/4-day trips per boat per year	1.9	ex. BW Log Book Survey, 1993
Boat-days per boat	14	
Boat-days per year	759	
Mean spend/person/day	£8.01	ex. BW Log Book Survey, 1993
Av. number people per boat	3.0	ex. BW Log Book Survey, 1993

Total Cruising Spend per year - canal-based boats	**£18,238**	

MOORED BOATS
Non-cruising visits
Subsistence spend

Number of boats	54	
Non-cruising visits per boat per year	6	ex. BW Log Book Survey, 1993
Duration of non-cruising visits (man-days)	1.5	ex. BW Log Book Survey, 1993
Non-cruising visits - spend per head	£9.61	ex. BW Log Book Survey, 1993
Occupancy - non-cruising visits	2	ex. BW Log Book Survey, 1993
Total Non-cruising Spend	**£9,397**	

Travel costs

All travel to/from boats assumed by car. *Travel costs for trips less than 20 miles assumed spent locally.*		
% trips less than 20 miles	60%	ex. BW boat ownership data
Vehicle cost/mile (full car costs)	£0.42	ex. RAC data
Av dist. travelled (round trips - trips less than 20 miles)	15	ex. Kennet & Avon Canal Boating Survey, 1990
Cruising plus non-cruising visits per year	14.4	
Total Travel Spend	**£2,973**	

Boat-related expenditure

Annual boat running costs	£1,771	ex. Private Boating Price-Demand Study, 1997 (BW/EA) (BW boats only)
Average length of boat ownership (years)	5.9	ex. Private Boating Price-Demand Study, 1997 (BW/EA) (BW boats only)
Average estimated purchase cost per boat	£19,055	ex. Private Boating Price-Demand Study, 1997 (BW/EA) (BW boats only)

Wilts & Berks Canal

Economic impact - Scenario 2
Full re-opening, <u>with</u> link to Cotswold Canals

Additional income c/w Scenario 1
(At June 1997 prices)

Total annual boat running Costs	**£96,212**	
Total annual boat purchase Costs	**£175,455**	

SUMMARY

Moving Boats	**£355,446**	
Moored Boats	**£284,037**	
Total	**£639,483**	

HIRE BOATS

Additional expenditure from moving boats included above		
No.hire boats - K&A	57	
Boats / Km K&A	0.4	
No. Hire boats N.Wilts	6	based on N.Wilts
Additional boats on main line	12	due to additional cruising opportunities
Av.cost/hire(£s)	£726	shoulder rates for 7-day hire of 4-berth boat
Hires per year	23	assumed, based on 1-week hires

Holiday cost

Total hire boat spend	**£296,934**	

TRIP BOATS

Boat traffic

No.of boats	1	assumed at Cricklade
Passengers per boat	40	Based on average size trip boat

Wilts & Berks Canal

Economic impact - Scenario 2
Full re-opening, <u>with</u> link to Cotswold Canals

Additional income c/w Scenario 1
(At June 1997 prices)

	Occupancy Rate	0.70	assumed
	No.trips per year	450	assumes 25 week season-2 trips per day; 4 trips per weekend day
	Total number of passengers carried	12600	
Trip spend	Av.cost per trip	£3.09	Average cost based on BW System
	Av.visitor spend per trip	£4.34	K&A Trip Boat Survey, 1991
	Total trip spend	**£93,618**	
Travel	*10% travel to boats on foot, remainder car/public transport* *Travel costs for trips less than 20 miles assumed spent locally*		
	% trips less than 20 miles	0.75	K&A Trip Boat Survey, 1991
	Vehicle cost/mile (full car cost)	£0.42	ex. RAC data
	Av. distance travelled (less than 20 miles)	9	K&A Trip Boat Survey, 1991
	Av. trippers per car/bus	5	K&A Trip Boat Survey, 1991
	Total travel spend	**£7,290**	
	Total spend	**£100,908**	

DAY BOATS

No additional boats assumed	**0**	

HOTEL BOATS

No additional boats assumed	**0**	

RESTAURANT BOATS

No additional boats assumed	**0**	

CANOEING

Wilts & Berks Canal

Economic impact - Scenario 2
Full re-opening, with link to Cotswold Canals

Additional income c/w Scenario 1
(At June 1997 prices)

Canoe hire

No additional canoe hire assumed	**0**	

Casual canoeing

Visits per km	700	assumed as for K&A
Waterway length - N.Wilts branch	14	
Additional visits per year	4900	assume N.Wilts density at main line level
Visitor spend per visit	£2.73	BW Owners of Unpowered Boats Survey, 1995
Total spend	**£13,375**	

Summary

	Baseline	Option 1	Option 2	Option 1 c/w Base	Option 2 c/w Base
Gross visitor spend (£m)	£0.02	£18.29	£19.79	**£18.26**	**£19.77**
Income retained (£m)	£0.01	£7.31	£7.92	**£7.31**	**£7.91**
Permanent jobs generated	1	731	791	**730**	**790**

Appendix Q Wilts & Berks Canal Feasibility Study: Responses To Utilities Enquiries

Item	Title		Source	Date Rec'd	Comments
	Southern Electric				
101	ST89516146	H.V.	Southern Electric	28.8.97	All 1:2500 scale prints
102	ST89516146	L.V.	Southern Electric	28.8.97	
103	ST89456268	H.V.	Southern Electric	28.8.97	
104	ST89456268	L.V.	Southern Electric	28.8.97	
105	ST90436385	H.V.	Southern Electric	28.8.97	
106	ST90436385	L.V.	Southern Electric	28.8.97	
107	ST90926515	H.V.	Southern Electric	28.8.97	
108	ST90926515	L.V.	Southern Electric	28.8.97	
109	ST90926618	H.V.	Southern Electric	28.8.97	
110	ST90926618	L.V.	Southern Electric	28.8.97	
111	ST91866748	H.V.	Southern Electric	28.8.97	
112	ST91866748	L.V.	Southern Electric	28.8.97	
113	ST92406876	H.V.	Southern Electric	28.8.97	
114	ST92406876	L.V.	Southern Electric	28.8.97	
115	ST94016182	H.V.	Southern Electric	28.8.97	
116	ST94016182	L.V.	Southern Electric	28.8.97	
117	ST95376304	H.V.	Southern Electric	28.8.97	
118	ST95376304	L.V.	Southern Electric	28.8.97	
119	ST92936394	H.V.	Southern Electric	28.8.97	
120	ST92936394	L.V.	Southern Electric	28.8.97	
121	ST92406516	H.V.	Southern Electric	28.8.97	
122	ST92406516	L.V.	Southern Electric	28.8.97	
123	ST92946675	H.V.	Southern Electric	28.8.97	
124	ST92946675	L.V.	Southern Electric	28.8.97	
125	ST93006746	H.V.	Southern Electric	28.8.97	
126	ST93006746	L.V.	Southern Electric	28.8.97	
127	ST92606874	H.V.	Southern Electric	28.8.97	
128	ST92606874	L.V.	Southern Electric	28.8.97	
129	ST92487000	H.V.	Southern Electric	28.8.97	
130	ST92487000	L.V.	Southern Electric	28.8.97	
131	ST93587117	H.V.	Southern Electric	28.8.97	
132	ST93587117	L.V.	Southern Electric	28.8.97	
133	ST95277231	L.V.	Southern Electric	28.8.97	
134	ST95277231	H.V.	Southern Electric	28.8.97	
135	ST97027241	L.V.	Southern Electric	28.8.97	
136	ST97027241	H.V.	Southern Electric	28.8.97	
137	ST98687154	L.V.	Southern Electric	28.8.97	

Item	Title	Source	Date Rec'd	Comments
138	ST98687154 H.V.	Southern Electric	28.8.97	
139	ST98917116 L.V.	Southern Electric	28.8.97	
140	ST98917116 H.V.	Southern Electric	28.8.97	
141	ST96237358 L.V.	Southern Electric	28.8.97	
142	ST96237358 H.V.	Southern Electric	28.8.97	
143	ST97347478 L.V.	Southern Electric	28.8.97	
144	ST97347478 H.V.	Southern Electric	28.8.97	
145	ST98477607 L.V.	Southern Electric	28.8.97	
146	ST98477607 H.V.	Southern Electric	28.8.97	
147	ST98477723 L.V.	Southern Electric	28.8.97	
148	ST98477723 H.V.	Southern Electric	28.8.97	
149	ST98297841 L.V.	Southern Electric	28.8.97	
150	ST98297841 H.V.	Southern Electric	28.8.97	
151	ST98707962 L.V.	Southern Electric	28.8.97	
152	ST98707962 H.V.	Southern Electric	28.8.97	
153	SU00438056 L.V.	Southern Electric	28.8.97	
154	SU00438056 H.V.	Southern Electric	28.8.97	
155	SU02298083 L.V.	Southern Electric	28.8.97	
156	SU02298083 H.V.	Southern Electric	28.8.97	
157	SU03968168 L.V.	Southern Electric	28.8.97	
158	SU03968168 H.V.	Southern Electric	28.8.97	
159	SU05758147 L.V.	Southern Electric	28.8.97	
160	SU05758147 H.V.	Southern Electric	28.8.97	
161	SU07488139 L.V.	Southern Electric	28.8.97	
162	SU07488139 H.V.	Southern Electric	28.8.97	
163	SU09338149 L.V.	Southern Electric	28.8.97	
164	SU09338149 H.V.	Southern Electric	28.8.97	
165	SU11228199 L.V.	Southern Electric	28.8.97	
166	SU11228199 H.V.	Southern Electric	28.8.97	
167	SU12598249 L.V.	Southern Electric	28.8.97	
168	SU12598249 H.V.	Southern Electric	28.8.97	
169	SU13088343 L.V.	Southern Electric	28.8.97	
170	SU13088343 H.V.	Southern Electric	28.8.97	
171	SU13278463 L.V.	Southern Electric	28.8.97	
172	SU13278463 H.V.	Southern Electric	28.8.97	
173	SU13018592 L.V.	Southern Electric	28.8.97	
174	SU13018592 L.V.	Southern Electric	28.8.97	
175	SU12618683 H.V.	Southern Electric	28.8.97	
176	SU12618683 L.V.	Southern Electric	28.8.97	
177	SU11938782 H.V.	Southern Electric	28.8.97	
178	SU11938782 L.V.	Southern Electric	28.8.97	
179	SU11528878 H.V.	Southern Electric	28.8.97	
180	SU11528878 L.V.	Southern Electric	28.8.97	

Item	Title		Source	Date Rec'd	Comments
181	SU11169002	H.V.	Southern Electric	28.8.97	
182	SU11169002	L.V.	Southern Electric	28.8.97	
183	SU10319119	H.V.	Southern Electric	28.8.97	
184	SU10319119	L.V.	Southern Electric	28.8.97	
185	SU09999249	H.V.	Southern Electric	28.8.97	
186	SU09999249	L.V.	Southern Electric	28.8.97	
187	SU09999374	H.V.	Southern Electric	28.8.97	
188	SU09999374	L.V.	Southern Electric	28.8.97	
189	SU08699377	H.V.	Southern Electric	28.8.97	
190	SU08699377	L.V.	Southern Electric	28.8.97	
191	SU08579460	H.V.	Southern Electric	28.8.97	
192	SU08579460	L.V.	Southern Electric	28.8.97	
193	SU14308291	H.V.	Southern Electric	28.8.97	
194	SU14308291	L.V.	Southern Electric	28.8.97	
195	SU16008189	H.V.	Southern Electric	28.8.97	
196	SU16008189	L.V.	Southern Electric	28.8.97	
197	SU17668166	H.V.	Southern Electric	28.8.97	
198	SU17668166	L.V.	Southern Electric	28.8.97	
199	SU19398170	H.V.	Southern Electric	28.8.97	
200	SU19398170	L.V.	Southern Electric	28.8.97	
201	SU19998293	H.V.	Southern Electric	28.8.97	
202	SU19998293	L.V.	Southern Electric	28.8.97	
203	SU20068422	H.V.	Southern Electric	28.8.97	
204	SU20068422	L.V.	Southern Electric	28.8.97	
205	SU20518534	H.V.	Southern Electric	28.8.97	
206	SU20518534	L.V.	Southern Electric	28.8.97	
207	SU21458658	H.V.	Southern Electric	28.8.97	
208	SU21458658	L.V.	Southern Electric	28.8.97	
209	SU22198778	H.V.	Southern Electric	28.8.97	
210	SU22198778	L.V.	Southern Electric	28.8.97	
211	SU24008805	H.V.	Southern Electric	28.8.97	
212	SU24008805	L.V.	Southern Electric	28.8.97	
213	SU25648849	H.V.	Southern Electric	28.8.97	
214	SU25648849	L.V.	Southern Electric	28.8.97	
215	SU27388927	H.V.	Southern Electric	28.8.97	
216	SU27388927	L.V.	Southern Electric	28.8.97	
217	SU29028978	H.V.	Southern Electric	28.8.97	
218	SU29028978	L.V.	Southern Electric	28.8.97	
219	SU30749000	H.V.	Southern Electric	28.8.97	
220	SU10319119	H.V.	Southern Electric	28.8.97	
221	SU10319119	L.V.	Southern Electric	28.8.97	
222	SU09999249	H.V.	Southern Electric	28.8.97	
223	SU09999249	L.V.	Southern Electric	28.8.97	

Item	Title		Source	Date Rec'd	Comments
224	SU09999374	H.V.	Southern Electric	28.8.97	
225	SU09999374	L.V.	Southern Electric	28.8.97	
226	SU08699377	H.V.	Southern Electric	28.8.97	
227	SU08699377	L.V.	Southern Electric	28.8.97	
228	SU08579460	H.V.	Southern Electric	28.8.97	
229	SU08579460	L.V.	Southern Electric	28.8.97	
230	SU14308291	H.V.	Southern Electric	28.8.97	
231	SU14308291	L.V.	Southern Electric	28.8.97	
232	SU16008189	H.V.	Southern Electric	28.8.97	
233	SU16008189	L.V.	Southern Electric	28.8.97	
234	SU17668166	H.V.	Southern Electric	28.8.97	
235	SU17668166	L.V.	Southern Electric	28.8.97	
236	SU19398170	H.V.	Southern Electric	28.8.97	
237	SU19398170	L.V.	Southern Electric	28.8.97	
238	SU19998293	H.V.	Southern Electric	28.8.97	
239	SU19998293	L.V.	Southern Electric	28.8.97	
240	SU20068422	H.V.	Southern Electric	28.8.97	
241	SU20068422	L.V.	Southern Electric	28.8.97	
242	SU20518534	H.V.	Southern Electric	28.8.97	
243	SU20518534	L.V.	Southern Electric	28.8.97	
244	SU21458658	H.V.	Southern Electric	28.8.97	
245	SU21458658	L.V.	Southern Electric	28.8.97	
246	SU22198778	H.V.	Southern Electric	28.8.97	
247	SU22198778	L.V.	Southern Electric	28.8.97	
248	SU24008805	H.V.	Southern Electric	28.8.97	
249	SU24008805	L.V.	Southern Electric	28.8.97	
250	SU25648849	H.V.	Southern Electric	28.8.97	
251	SU25648849	L.V.	Southern Electric	28.8.97	
252	SU27388927	H.V.	Southern Electric	28.8.97	
253	SU27388927	L.V.	Southern Electric	28.8.97	
254	SU29028978	H.V.	Southern Electric	28.8.97	
255	SU29028978	L.V.	Southern Electric	28.8.97	
256	SU30749000	H.V.	Southern Electric	28.8.97	
	British Telecom				
257	ST8861-8961		SWAC(Bristol)	05.09.97	All reduced size paper prints various original scales, Melksham, Calue, Wooton Bassett and Swindon areas.
258	ST8862-8962		SWAC(Bristol)	05.09.97	
259	ST8863-8963		SWAC(Bristol)	05.09.97	
260	ST9063-9163		SWAC(Bristol)	05.09.97	

Item	Title	Source	Date Rec'd	Comments
261	ST9064-9164	SWAC(Bristol)	05.09.97	
262	ST9065-9165	SWAC(Bristol)	05.09.97	
263	ST9066-9166	SWAC(Bristol)	05.09.97	
264	ST9067-9167	SWAC(Bristol)	05.09.97	
265	ST9261-9361	SWAC(Bristol)	05.09.97	
266	ST9262-9362	SWAC(Bristol)	05.09.97	
267	ST9263-9363	SWAC(Bristol)	05.09.97	
268	ST9264-9364	SWAC(Bristol)	05.09.97	
269	SU0892-0992	SWAC(Bristol)	05.09.97	
270	SU0893-0993	SWAC(Bristol)	05.09.97	
271	SU0894-0994	SWAC(Bristol)	05.09.97	
272	SU1087-1187	SWAC(Bristol)	05.09.97	
273	SU1088-1188	SWAC(Bristol)	05.09.97	
274	SU1089-1189	SWAC(Bristol)	05.09.97	
275	SU1090-1190	SWAC(Bristol)	05.09.97	
276	SU1091-1191	SWAC(Bristol)	05.09.97	
277	SU1093-1193	SWAC(Bristol)	05.09.97	
278	SU1094-1194	SWAC(Bristol)	05.09.97	
279	SU1282-1382	SWAC(Bristol)	05.09.97	
280	SU1383 NW	SWAC(Bristol)	05.09.97	
281	SU1383 NE	SWAC(Bristol)	05.09.97	
282	SU1383 SE	SWAC(Bristol)	05.09.97	
283	SU1384 NW	SWAC(Bristol)	05.09.97	
284	SU1384 NE	SWAC(Bristol)	05.09.97	
285	SU1285-1385	SWAC(Bristol)	05.09.97	
286	SU1385 SW	SWAC(Bristol)	05.09.97	
287	SU1286 - 1386	SWAC(Bristol)	05.09.97	
288	SU1287 NW	SWAC(Bristol)	05.09.97	
289	SU1287SW	SWAC(Bristol)	05.09.97	
290	SU1287 SE	SWAC(Bristol)	05.09.97	
291	SU1482-1582	SWAC(Bristol)	05.09.97	
292	SU1483 SW	SWAC(Bristol)	05.09.97	
293	SU1481-1581	SWAC(Bristol)	05.09.97	
294	SU1582 NW	SWAC(Bristol)	05.09.97	
295	SU1582 SW	SWAC(Bristol)	05.09.97	
296	SU1582 SE	SWAC(Bristol)	05.09.97	
297	SU1681-1781	SWAC(Bristol)	05.09.97	
298	SU1881-1981	SWAC(Bristol)	05.09.97	
299	SU1882-1982	SWAC(Bristol)	05.09.97	
300	SU1883-1983	SWAC(Bristol)	05.09.97	
301	SU1884-1984	SWAC(Bristol)	05.09.97	
302	SU2084-2184	SWAC(Bristol)	05.09.97	
303	SU2085-2185	SWAC(Bristol)	05.09.97	

Item	Title	Source	Date Rec'd	Comments
304	SU2086-2186	SWAC(Bristol)	05.09.97	
305	SU2087-2187	SWAC(Bristol)	05.09.97	
306	SU2889-2989	SWAC(Bristol)	05.09.97	
307	SU2890-2990	SWAC(Bristol)	05.09.97	
308	SU3089-3189	SWAC(Bristol)	05.09.97	
309	SU3288-3388	SWAC(Bristol)	05.09.97	
310	SU3289-3389	SWAC(Bristol)	05.09.97	
311	ST9066-9166	SWAC(Bristol)	05.09.97	
312	ST9067-9167	SWAC(Bristol)	05.09.97	
313	ST9068-9168	SWAC(Bristol)	05.09.97	
314	ST9265-9365	SWAC(Bristol)	05.09.97	
315	ST9266-9366	SWAC(Bristol)	05.09.97	
316	ST9267-9367	SWAC(Bristol)	05.09.97	
317	ST9268-9368	SWAC(Bristol)	05.09.97	
318	ST9269-9369	SWAC(Bristol)	05.09.97	
319	ST9270-9370	SWAC(Bristol)	05.09.97	
320	ST9271-9371	SWAC(Bristol)	05.09.97	
321	ST9471-9571	SWAC(Bristol)	05.09.97	
322	ST9472-9572	SWAC(Bristol)	05.09.97	
333	ST9671-9771	SWAC(Bristol)	05.09.97	
334	ST9672-9772	SWAC(Bristol)	05.09.97	
335	ST9673-9773	SWAC(Bristol)	05.09.97	
336	ST9674-9774	SWAC(Bristol)	05.09.97	
337	ST9677-9777	SWAC(Bristol)	05.09.97	
338	ST9678-9778	SWAC(Bristol)	05.09.97	
339	ST9675-9775	SWAC(Bristol)	05.09.97	
340	ST9870&9970	SWAC(Bristol)	05.09.97	
341	ST9871&9971	SWAC(Bristol)	05.09.97	
342	ST90876-9976	SWAC(Bristol)	05.09.97	
343	ST9877-9977	SWAC(Bristol)	05.09.97	
344	ST9878-9978	SWAC(Bristol)	05.09.97	
345	ST9879-9979	SWAC(Bristol)	05.09.97	
346	ST9880-9980	SWAC(Bristol)	05.09.97	
347	SU0080-0180	SWAC(Bristol)	05.09.97	
348	SU0280-0380	SWAC(Bristol)	05.09.97	
349	SU0281-0381	SWAC(Bristol)	05.09.97	
350	SU0481&0581	SWAC(Bristol)	05.09.97	
351	SU0681-0781	SWAC(Bristol)	05.09.97	
352	SU0881-0981	SWAC(Bristol)	05.09.97	
353	SU1081-1181	SWAC(Bristol)	05.09.97	
354	SU1082-1182	SWAC(Bristol)	05.09.97	
355	SU0891-0991	SWAC(Bristol)	05.09.97	
356	Berks 13-5	SWAC(Bristol)	05.09.97	

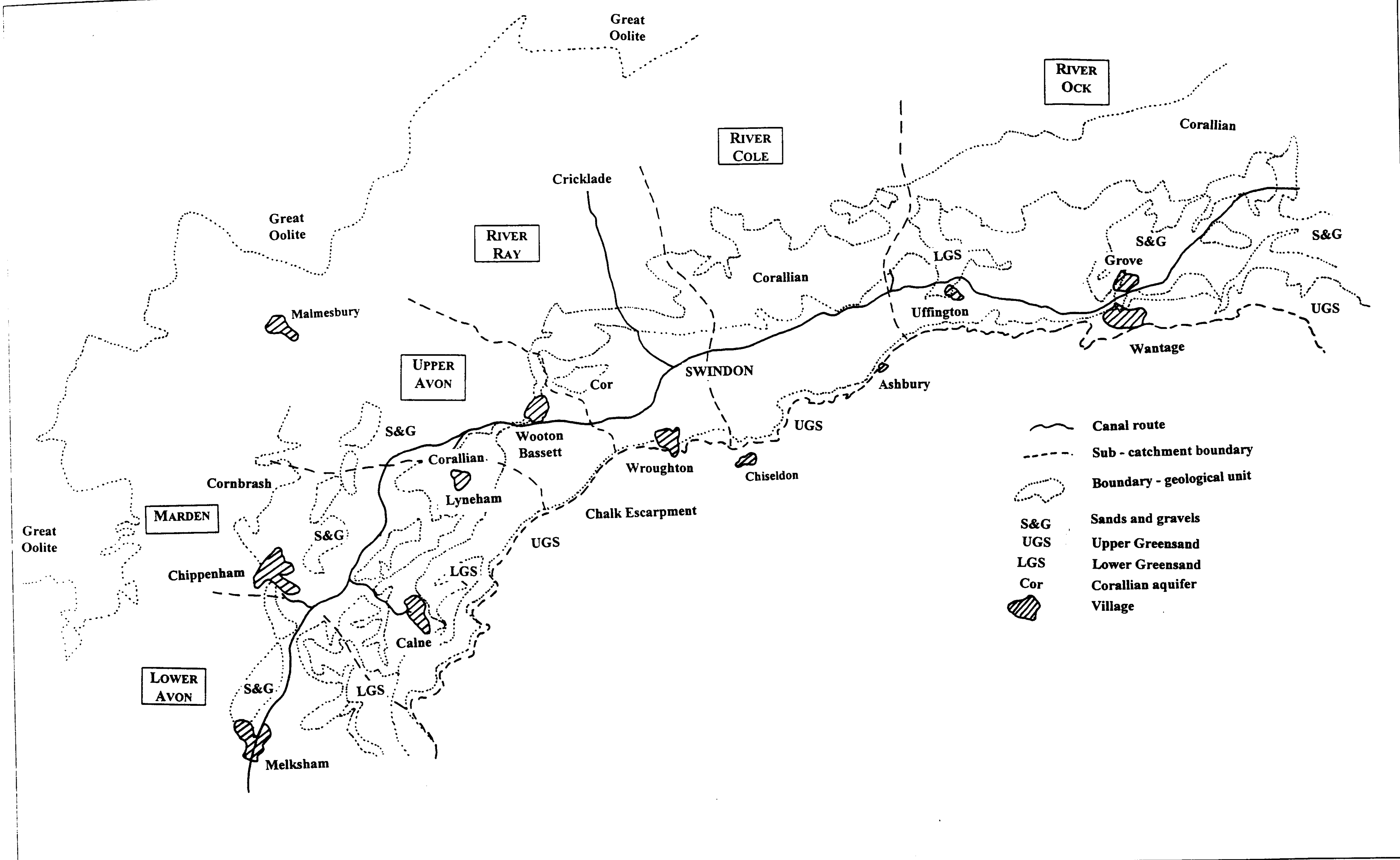
Item	Title	Source	Date Rec'd	Comments
357	Berks 12-11	SWAC(Bristol)	05.09.97	
358	Berks12-12	SWAC(Bristol)	05.09.97	
359	Berks13.S.W	SWAC(Bristol)	05.09.97	
360	Berks 12-14	SWAC(Bristol)	05.09.97	
361	Berks 12-15	SWAC(Bristol)	05.09.97	
362	Wilts 16-9	SWAC(Bristol)	05.09.97	
363	Wilts 16-13	SWAC(Bristol)	05.09.97	
364	SU4896NW	SWAMP(Cambs)	05.09.97	All reduced size paper prints, various original scales, Wantage and Abingdon areas.
365	SU4896NE	SWAMP(Cambs)	05.09.97	
366	SU4996NW	SWAMP(Cambs)	05.09.97	
367	SU4996NE	SWAMP(Cambs)	05.09.97	
368	SU4696-4796	SWAMP(Cambs)	05.09.97	
369	SU4695-4795	SWAMP(Cambs)	05.09.97	
370	SU4896	SWAMP(Cambs)	05.09.97	
371	SU4996	SWAMP(Cambs)	05.09.97	
372	SU4894-4994	SWAMP(Cambs)	05.09.97	
373	SU4495-4595	SWAMP(Cambs)	05.09.97	
374	SU4695-4795	SWAMP(Cambs)	05.09.97	
375	SU4295-4395	SWAMP(Cambs)	05.09.97	
376	SU4495-4595	SWAMP(Cambs)	05.09.97	
377	SU4294-4394	SWAMP(Cambs)	05.09.97	
378	SU4493-4593	SWAMP(Cambs)	05.09.97	
379	SU4494-4594	SWAMP(Cambs)	05.09.97	
380	SU4293-4393	SWAMP(Cambs)	05.09.97	
381	SU4292-4392	SWAMP(Cambs)	05.09.97	
382	SU4492-4592	SWAMP(Cambs)	05.09.97	
383	SU4291-4391	SWAMP(Cambs)	05.09.97	
384	SU4291-4391	SWAMP(Cambs)	05.09.97	
385	SU4290-4390	SWAMP(Cambs)	05.09.97	
386	SU4090-4190	SWAMP(Cambs)	05.09.97	
387	SU4089-4189	SWAMP(Cambs)	05.09.97	
388	SU3889-3989	SWAMP(Cambs)	05.09.97	
389	SU3488-3588	SWAMP(Cambs)	05.09.97	
390	SU3288-3388	SWAMP(Cambs)	05.09.97	
391	SU3489-3589	SWAMP(Cambs)	05.09.97	
392	SU3488-3588	SWAMP(Cambs)	05.09.97	
393	SU3289-3389	SWAMP(Cambs)	05.09.97	
	Transco			
394	SU0681	Transco (Bristol)	03.09.97	1:1250 scale paper

Item	Title	Source	Date Rec'd	Comments
				plots, Melksham, Calue, Wooton Bassett, Swindon
395	ST9971NW	Transco (Bristol)	03.09.97	
396	ST9971SW	Transco (Bristol)	03.09.97	
397	ST9268SE	Transco (Bristol)	03.09.97	
398	ST9265SE	Transco (Bristol)	03.09.97	
399	ST9065	Transco (Bristol)	03.09.97	
400	SU0994SW	Transco (Bristol)	03.09.97	
401	SU1483	Transco (Bristol)	03.09.97	
402	SU0993	Transco (Bristol)	03.09.97	
403	ST9268SW	Transco (Bristol)	03.09.97	
404	SU2387	Transco (Bristol)	03.09.97	
405	ST9063NW	Transco (Bristol)	03.09.97	
406	SU1582	Transco (Bristol)	03.09.97	
407	SU1382	Transco (Bristol)	03.09.97	
408	ST9363	Transco (Bristol)	03.09.97	
409	ST9166NW	Transco (Bristol)	03.09.97	
410	ST9970NW	Transco (Bristol)	03.09.97	
411	ST9970NE	Transco (Bristol)	03.09.97	
412	ST9264NE	Transco (Bristol)	03.09.97	
413	ST9871SE	Transco (Bristol)	03.09.97	
414	SU0781	Transco (Bristol)	03.09.97	
415	SU1081	Transco (Bristol)	03.09.97	
416	SU1082SE	Transco (Bristol)	03.09.97	
417	ST9064	Transco (Bristol)	03.09.97	
418	SU1781	Transco (Bristol)	03.09.97	
419	SU1984NE	Transco (Bristol)	03.09.97	
420	SU2084NW	Transco (Bristol)	03.09.97	
421	SU2187	Transco (Bristol)	03.09.97	
422	SU2287NW	Transco (Bristol)	03.09.97	
423	SU2287SE	Transco (Bristol)	03.09.97	
424	SU2488NE	Transco (Bristol)	03.09.97	
425	SU1383	Transco (Bristol)	03.09.97	
426	SU1384	Transco (Bristol)	03.09.97	
427	SU1385SW	Transco (Bristol)	03.09.97	
428	SU1285	Transco (Bristol)	03.09.97	
429	SU1287	Transco (Bristol)	03.09.97	
430	SU1187	Transco (Bristol)	03.09.97	
431	SU1188SW	Transco (Bristol)	03.09.97	
432	SU1088	Transco (Bristol)	03.09.97	
433	SU0992	Transco (Bristol)	03.09.97	
434	SU1093	Transco (Bristol)	03.09.97	

Item	Title	Source	Date Rec'd	Comments
435	SU4089-4189	Transco (Didcot)	07.09.97	Paper prints of plans at various scales, for Grove and Abingdon.
436	SU3889-3989	Transco (Didcot)	07.09.97	
437	SU4695-4795	Transco (Didcot)	07.09.97	
438	SU4996	Transco (Didcot)	07.09.97	
439	SU4896	Transco (Didcot)	07.09.97	
	Serco Gulf Eng. Ltd.			
440	Route Plan marked with Service Locations Sheet 1/3	Serco Gulf Eng	03.09.97	Marked copies of SW 1:50,000 scale plans, to show approx. route of Government Oil Pipelines, crossing at Chippenham, Wooten Bassett and Common Platt (North Wilts Canal)
441	Route Plan marked with Service Locations Sheet 2/3	Serco Gulf Eng	03.09.97	
442	Route Plan marked with Service Locations Sheet 3/3	Serco Gulf Eng	03.09.97	
	Pipeline Management			
443	1:50,000 OS Map Showing pipeline location (Melksham)	Pipeline Management	28.08.97	
444	1:50,000 OS Map Showing pipeline location (Swindon)		28.08.97	
445	Safe Working in close proximity to high pressure oil pipelines		28.08.97	
446	Fawley - Avonmouth pipeline route plan Sheet 1		28.08.97	Various skecthes and maps to show pipline crossings at Melksham (K & A) and Swindon (W & B and possibly the North Wilts Canal)
447	Fawley - Avonmouth pipeline Route Plan Sheet 2		28.08.97	
448	Midline Pipeline project Route Alignment		28.08.97	
	Mercury Communications			
449	Location of services within the vicinity of the site	Mercury Comms	05.09.97	1:5000 scale plan of crossing at Westleaze area, Swindon.
	FINA PLC			
450	Location plan of "FINA LINE"	Fina PLC	05.09.97	No pipelines in vicinity

Item	Title	Source	Date Rec'd	Comments
	BT			
451	SU4996NE	BT SWAMP	15.9.97	All reduced size paper prints, various original scales Wantage and Abingdon areas
452	SU4996NW	BT SWAMP	15.9.97	
453	SU4896NE	BT SWAMP	15.9.97	
454	SU4896NW	BT SWAMP	15.9.97	
455	SU4896	BT SWAMP	15.9.97	
456	SU4696-4796	BT SWAMP	15.9.97	
457	SU4695-4795	BT SWAMP	15.9.97	
458	SU4695-4795	BT SWAMP	15.9.97	
459	SU4694-4794	BT SWAMP	15.9.97	
460	SU4494-4594	BT SWAMP	15.9.97	
461	SU4493-4593	BT SWAMP	15.9.97	
462	SU4695-4795	BT SWAMP	15.9.97	
463	SU4292-4392	BT SWAMP	15.9.97	
464	SU4291-4391	BT SWAMP	15.9.97	
465	SU4493-4593	BT SWAMP	15.9.97	
466	SU4492-4592	BT SWAMP	15.9.97	
467	SU4291-4391	BT SWAMP	15.9.97	
468	SU4290-4390	BT SWAMP	15.9.97	
469	SU4090-4190	BT SWAMP	15.9.97	
470	SU4089-4189	BT SWAMP	15.9.97	
471	SU3688-3788	BT SWAMP	15.9.97	
472	SU3688-3788	BT SWAMP	15.9.97	
473	SU3488-3588	BT SWAMP	15.9.97	
474	SU3488-3588	BT SWAMP	15.9.97	
475	SU3288-3388	BT SWAMP	15.9.97	
476	SU3489-3589	BT SWAMP	15.9.97	
477	SU3289-3389	BT SWAMP	15.9.97	
478	SU3889-3989	BT SWAMP	15.9.97	
	National Grid			
479	Location plan showing national grid services within the vicinity of the site.	N G Didcot	18.09.97	Sketch of OHTL near Melksham

Drawings



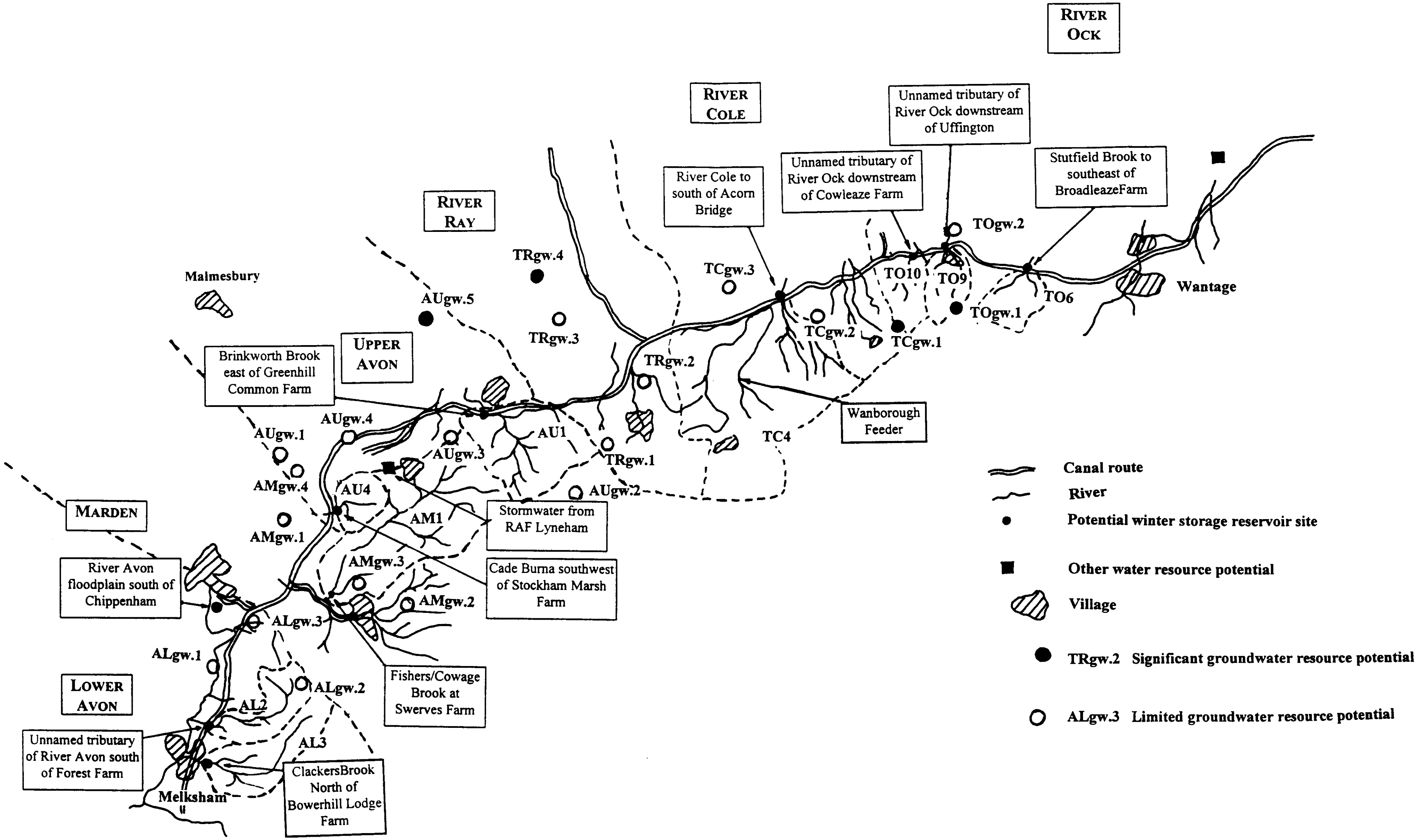
RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY

Defined sub-catchments and geology
along the Wilts & Berks Canal.

DBKEP/004/01		
Scale at A3 : 1:200000		
Drn JR	Appd	Revised
Chk	Date	Date SEPT 97

Scott Wilson

DB3



RESTORATION OF THE WILTS & BERKS CANAL FEASIBILITY STUDY	DBKEP/004/02		
Locations for surface water abstraction and storage, and potential areas for groundwater abstraction.	Scale at A3 : 1:200000		
	Drn JR	Appd	Revised
	Chk	Date	Date SEPT 97

Scott Wilson

DB3