Wilts & Berks Canal Trust

Study for Wilts & Berks Canal Restoration East Challow to Grove

Final Report

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Ove Arup & Partners Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

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		Signature	D Sapin	B. Trifunovics	Clon Ulrick
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Executive Summary

The Wilts and Berks Canal is being restored to re-establish the original connection between the River Thames at Abingdon to the East and the Kennet and Avon canal at Semington to the West. Since its closure through an Act of Parliament in 1914 the canal routes have been lost in several significant locations where main roads have been established: the A417 crosses the canal at the East Challow Road Bridge, and the A338 crosses the canal at Grove Bridge; and three developers currently have Planning Applications submitted or approved for major developments along the route of the canal. However much of the route in other areas is clearly visible and in some locations still in water.

The purpose of this study is to consolidate and/or amend the proposed route of the 2005 Arup study to produce an outline engineering report. We have identified the principal issues and determined the feasibility design parameters in accordance with the Trust's brief. The scope of this study covers the canal chainage from -100m (west of East Challow) to +3100m (Grove Common Lock) comprising some 3.2km in length.

Geotechnical Desk Study

The ground conditions expected during construction works along the canal restoration section have been identified through published geological mapping and from the results of nearby ground investigations in the Stockham Bridge / airfield area. Although these have provided useful preliminary information they have been commissioned in relation to residential house developments and more specific information on the ground conditions will be required for design of canal cutting slopes, retaining walls, bridge foundations and other structures. Further ground investigation will be required along the canal route to investigate the following issues: thickness and characteristics of Made Ground deposited during airfield construction; cut slope stability; natural slope stability; bearing capacity; excavatability; permeability and groundwater levels.

Environmental Desk Study

Desk studies and site walkovers were conducted to appraise the relevant ecological issues; however no formal ecological surveys were undertaken. The habitats along the canal are characterised by open water, emergent vegetation on the edges of the canal, overhanging vegetation on the opposite bank to the towpath and numerous large mature trees. Recommendations have been made as to next steps for the Trust including: tree surveys; consultation as to hedgerow status; and flora and fauna surveys particularly thought pertinent for water vole, great crested newts, badgers, bats and breeding birds. These will be restricted to specific times of the year, and generally speaking the surveys and EIA will take a year to prepare, so if the Trust intend to submit a planning application, the earliest this could be done is likely to be Q1 2015. Potential funding opportunities are discussed as the restoration of the canal will present opportunities to provide wider community and ecological benefits.

Engineering Feasibility – Pinch Point 1 A417 East Challow

The approach to the A417 from the west has required careful consideration as it was not possible to avoid land take in entirety for this section of canal. Immediately west of the A417, complete purchase of the Ivanhoe property is

recommended to provide access for the construction. Leading on from our consultation with the Oxfordshire County Council (OCC) in 2005 and more recently in 2013, it was clear that raising the level of the road at this pinch point was not a feasible solution due to issues regarding sight lines and the impact on adjoining properties.

We have reviewed different options for the crossing of East Challow Road Bridge including lock down, sump pound, drop lock and diversion. When reviewing these options, we have considered amongst others, the land take required downstream and the relative cost of each option. Locking down will require high volumes of excavation and the practicalities required to integrate this scheme with the various Planning Applications en route have meant this option is not preferred. Of the sump lock and drop lock, a drop lock is presented as a preferred solution due to the reduced time to wait whilst navigating through the lock. However there is only one other known example of a drop lock, which is the Dalmuir Drop Lock on the Forth & Clyde Canal. The Trust is advised to follow up with the operators of the canal to learn more about the operational constraints and issues.

The proposed Nalder Estate development by Bewley Homes to the east of the A417 provides a good opportunity to move the alignment of the canal slightly north compared to the Arup 2005 proposal, thereby avoiding land take of the gardens of the majority of the adjoining properties to the south of the canal. However, some land take will be required from the three most eastern properties to the south of the canal to avoid a navigational kink in the canal route.

Engineering Feasibility – Pinch Point 2 Mably Way Roundabout

Our proposals include the rebuilding of a bridge at the historical location of Stockham Bridge. Our work in 2005 concluded that the best solution for the canal to pass Mably Way roundabout and the roads branching off it was to deviate from the historical route and pass north of the roundabout. We believe that this is still the case. In order to pass under Downsview Road and subsequently Denchworth Road, the canal will have to be lowered to +80.12mOD. This will require a total canal drop of 3.68m. This will be done through a lock staircase comprising two locks which could possibly share a lock gate. This section will also incorporate a cycle underpass. Our proposals include consideration of gradients, ramps, sightlines and provide a costing for a wider road crossing.

Engineering Feasibility – Pinch Point 3 A338 Grove Bridge

When determining the canal levels for passing under the Mably Way Roundabout, we have ensured that the canal remains sufficiently high to pass over the Thames Water foul sewer with suitable clearance allowances.

The canal in this section is the only area requiring fill (the remainder of the canal requires excavation) around the proposed mooring basin prior to the Letcombe Brook culvert crossing and proposed New Lime Kiln Lock.

The EA was consulted with regards to Letcombe Brook, and as a result of our consultation with the EA, we have proposed the removal of the existing culvert and the construction of a culvert/bridge for the canal to pass over Letcombe Brook. The next steps for this section are for the Trust to hydraulically model this section of the canal in order to refine the consultation with the EA and answer some of the key questions surrounding the implications on design water levels once the existing culvert is removed.

The recommended scheme also shows the purchase of the Wayside property as this will be required for ease of construction access, navigational space and allowing more room for a cycle pass under Grove Road crossing.

Beyond the road crossing, Grove Common Lock and Small Marsh Lock will bring the canal levels down to the existing ground levels and to the historic water level. Land take for this section of the canal has been positioned to the east of the historical canal route as this will only involve one agricultural landowner and will be easier to obtain than from the numerous properties to the west.

Capital Cost Estimates

We have prepared an indication of costs to a standard and accuracy appropriate to concept design stage, which does not include allowances for contingency, contractor preliminaries, overheads or profits.

Section of route / item	Chainage (m)	Estimated construction cost (£)	Average cost per metre
Pinch Point 1: East Challow	-100 - 1350	3,230,100	2,228
Pinch Point 2: Mably Way Roundabout	1350 - 2365	5,766,700	5,681
Pinch Point 3: Grove Road	2365 - 3100	3,388,900	4,611
TOTAL		**£12.39M**	**3,870**

Stakeholder Consultations

Stakeholder consultation has been carried out as per the Trusts brief, but in some instances has been hampered by the lack of detailed engineering design undertaken at this stage of work.

Consultation with Thames Water, in agreement with the Trust, was not carried out at this stage and will need to be done at detailed design stage.

Consultation with the Environment Agency has highlighted an urgent need to hydraulically model the Letcombe Brooke area before deciding on the optimal solution for the canal crossing; it is recommended that this is taken forwards with some urgency. Friends of Letcombe Brook were interested mainly in the outcomes of the discussion with the EA.

Consultation with Oxfordshire County Council has again indicated the fact that raising any of the roads under question will be very unlikely. However, if the Persimmon Airfield development receives planning permission, and Mably Way Roundabout realignment works take place, there is a good opportunity for the Trust to enable construction the underpass works proposed. Arup have also consulted with OCC over the Persimmon Ltd (Airfield site) outline planning

application and Mably Way Roundabout realignment potential, should this development receive planning application at a later date.

We have not consulted with the Vale of White Horse as this will only need to be done once at pre-planning application stage.

Arup have not consulted with Grove Park Properties Ltd as this is being taken forwards by the Trust.

Arup have consulted with Dandara Ltd (developers of the Stockham Farm Housing development) around the issues of canal integration adjacent to the development, which has received planning permission.

Arup have consulted with Bewley Homes Plc. (developers of the Nalder Estate, East Challow) to integrate the canal proposals with the proposed development, which has received planning permission.

Construction and Implementation Programme

The Wilts and Berks Canal Trust have a successful record of carrying out canal restoration works using volunteer groups. However the scale and nature of the proposed works will require a different approach including the appointment of a civil engineering contractor of at least mid-range size and capability. It is assumed that the main civil works would be let as a single contract; this is likely to give better value because of more competitive pricing, reduced mobilisation costs and more efficient use of resources. It is thought there would be benefits in awarding the main contract as Design and Build.

For the four road crossings we have assumed at this stage that the road crossing box culverts will be constructed conventionally in open excavation while the affected road is closed and associated traffic diverted. A traffic management plan will need to be developed following consultation with OCC Highways department.

There will be a substantial surplus of cut over fill, and removing material off site to landfill will be expensive. It would be very beneficial if the works could be linked to the development of one of the adjacent sites which could make use of the surplus material.

The construction programme will primarily be driven by progress with planning applications for adjacent development areas and the accompanying release of funding for the development of the canal. Outline programme, once funding and consents are in place would typically be:

- Land acquisition and design development, consents and licences: 12 months.
- Enabling works: Finding and diverting utilities, preparatory traffic management works, clearance of vegetation and initial environmental mitigation: 6 months.
- Main construction works: 18-24 months.
- Landscape maintenance contract: 3 years.

1 Introduction

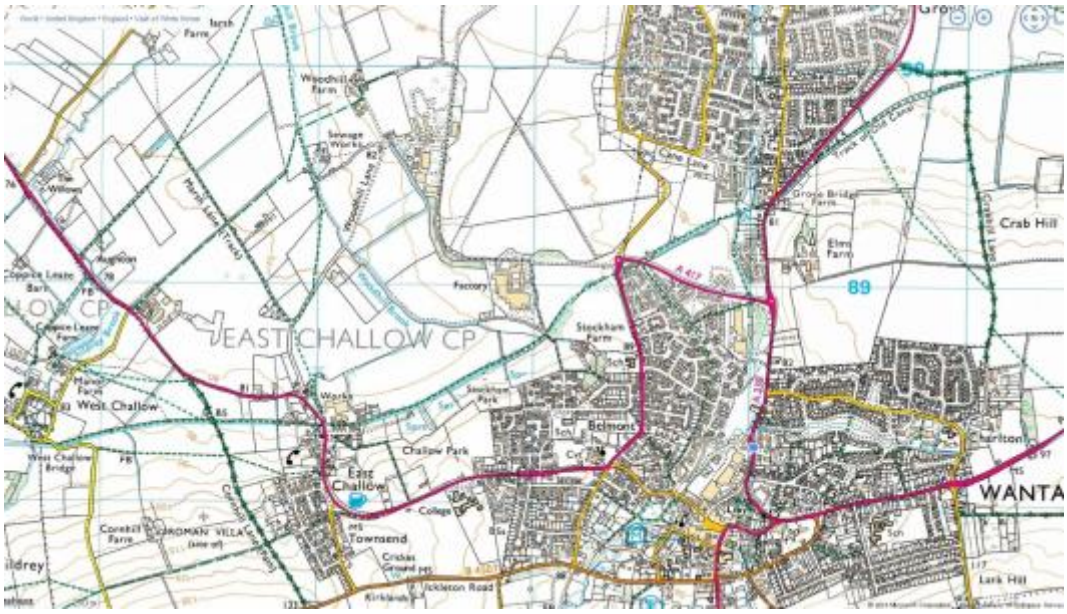
1.1 Background

The Wilts and Berks Canal is being restored to re-establish the original connection between the River Thames at Abingdon to the East and the Kennet and Avon canal at Semington to the West. Since its closure through an Act of Parliament in 1914 the canal routes have been lost in several significant locations. However much of the route in other areas is clearly visible and in some locations still in water.

Whilst there is on-going a restoration programme to complete substantial components of the canal route by 2014 it is not anticipated that the full W&BC network will be fully operational until 2025.

The Wilts and Berks Canal Trust (WBCT) have acknowledged that a number of critical areas have yet to have a fully engineered design solution. Such a section is the section from East Challow to Wantage. As such, the WBCT have chosen a target section of canal from just west of the A417 at East Challow to just east of the A338 at Wantage where the project aims to fully restore this 3.2km section, refer to Figure 1.

Figure 1 – OS Snapshot



1.2 Purpose of Study

This study has been largely based on the wider Scott Wilson 'Restoration of the Wilts & Berks Canal, Feasibility Study' dated 1998 (refer to Appendix A), the Arup report 'Grove and Wantage Section, Outline Engineering Proposals' dated 2005 (not repeated here for brevity) and the topographical survey carried out by Glanville in 2004 and minor survey updates made in 2013 (refer to Appendix B).

The purpose of this study is to consolidate and/or amend the proposed route of the 2005 Arup study to produce an outline engineering report. We have identified the

principal issues and determined the feasibility design parameters in accordance with the Trust's brief.

The scope of this study covers the canal chainage from -100m (west of East Challow) to +3100m (Grove Common Lock) as defined in the Glanville Survey, refer to Appendix B1.

1.3 Constraints and Opportunities

Since abandonment in 1914 by Act of Parliament, several key changes have occurred to the landscape:

- Main roads have been established: the A417 crosses the canal at the East Challow Road Bridge, and the A338 crosses the canal at Grove Bridge
- Three developers currently have Planning Applications submitted or approved for major developments along the route of the canal:
  - Bewley Homes PLC: Planning Application details for Nalder Estate.
  - Dandara Ltd: Planning Application for the Stockham Farm development.
  - Persimmon Ltd: Planning Application for the Grove Airfield development.

1.4 Study Outline

The outline of this interim report includes:

- Geotechnical Desk Study, refer to Section 2,
- Environmental Desk Study, refer to Section 3,
- Basis of Design, refer to Section 4,
- Engineering Feasibility, refer to Section 5,
- Capital Cost Estimates, refer to Section 6,
- Stakeholder Consultations, refer to Section 7, and
- Construction and Implementation Programme, refer to Section 8.

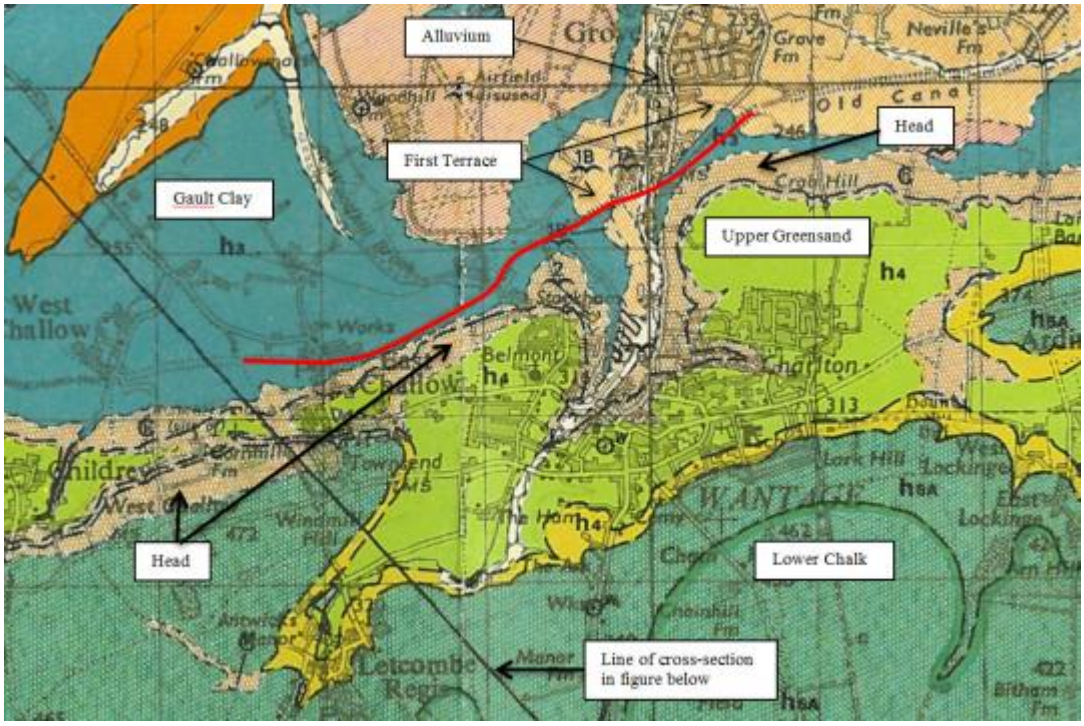
2 Geotechnical Desk Study

2.1 Geology

2.1.1 Geological Mapping

The geology of the area is shown on geological maps published by the British Geological Survey (BGS). An extract from the 1:63,360 scale map 'Sheet 253 (Drift) Abingdon' is presented in Figure 2 and this shows both the superficial drift deposits and the underlying solid geology. The canal route is shown in red and grid squares are 1 km across.

Figure 2 – Extract from BGS Sheet 253 Abingdon Drift



A cross section along a north-west to south-east line, which passes between West Challow and East Challow, is shown on Figure 3 and this shows the general arrangement of the local strata. The approximate alignment of the canal is shown on this figure.

The map and the cross section show that for most of the study section the canal was constructed along the Gault Clay outcrop which lies below the higher ground formed in the Upper Greensand and Lower Chalk. A thin cover of Head deposits mantles the slopes south of the canal and in the area between East Challow and Stockham Bridge is marked as terminating adjacent to the canal alignment.

In the central part of the study section First Terrace deposits and Alluvium associated with the Letcombe Brook overlie the Gault Clay, and the canal passes through these strata. The First Terrace is divided into 1A and 1B units. Older Second Terrace deposits are found further from the brook in the airfield area but not along the canal alignment. The Terrace deposits are assumed to be derived

from the Letcombe Brook when, during the pluvial periods of the Pleistocene, it is likely to have been a much larger watercourse and carrying higher flows.

East of Grove the canal again cuts through the Gault Clay until at the far-east end of the study section there is a short length where the First Terrace again overlies the Gault.

The BGS Regional Geology memoir 'London and the Thames Valley' provides descriptions of the various strata. These are shown in Table 1 together with strata descriptions from nearby ground investigations.

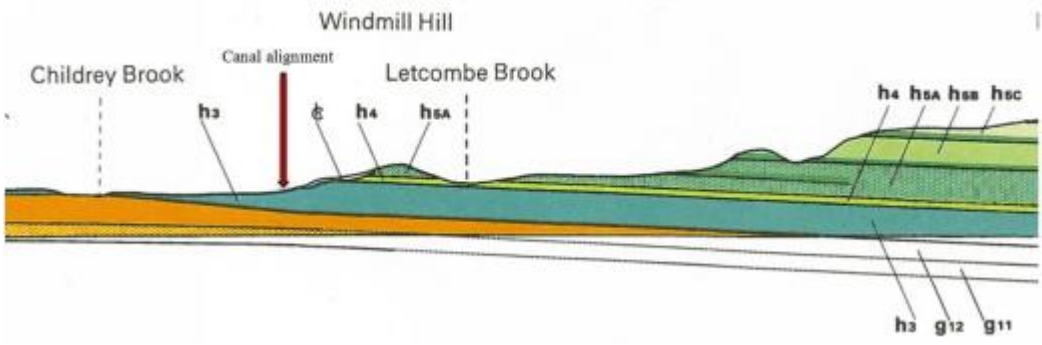
2.1.2 Geology and Topography

From West Challow the canal runs west to east as far as East Challow and then approximately south-west to north-east for the rest of the section to the east of Grove. It is aligned along the base of an escarpment which rises to the south, forming the scarp face of the Berkshire Downs.

Locally the Letcombe Brook drains the higher ground along the downs and has cut down into the Lower Chalk within the scarp face exposing the Upper Greensand below. As the brook is aligned south-west to north-east within the escarpment the incision has left a remnant area of high ground called Windmill Hill, at an elevation of approximately +145 mOD. Windmill Hill is located around 1 km south of the west end of the canal study section.

In the central section of the study area, between Stockham Bridge and Grove the canal extends across the Letcombe Brook alluvial plain, where the escarpment has retreated to the south in an embayment and the Gault Clay is covered by the First Terrace and Alluvium deposits. East of Grove the escarpment slope is again closer to the canal alignment.

Figure 3 – Geological Cross Section (BGS Geological Map Sheet 253)



2.1.3 Site Investigation Data

Existing site data in report format is available for three development areas along the canal route. The reports were downloaded from the Vale of White Horse District Council planning website for review and these contain desk study findings and / or the results of intrusive ground investigation work including engineering geological logs and laboratory test results. These provided a very useful source of background information on the ground conditions along the canal section. Descriptions of the strata based on the logs provided in these reports have been included within Table 1.

2.1.3.1 Nalder Estate, East Challow (Bewley Homes)

A Phase 1 geo-environmental assessment report was prepared by WSP for Bewley Homes in 2011. A ground investigation was not carried out as part of this study, although it was one of the recommendations from WSP, and further data may become available in future. The report was intended to highlight any geo-environmental aspects which could potentially arise as liabilities associated with the re-development of the site, and was based on a desk study review. A summary of the main findings in relation to restoration of the canal are as follows:

- The Nalder Estate is immediately east of the A417 and north of the canal in East Challow.
- The site lies on the Gault Clay but due to previous industrial activities and phases of site re-development it is likely that this is covered by a variable thickness of Made Ground.
- Previous uses of the site include an iron works, metal pressing, storage depot and car repair and re-spraying. Asbestos is potentially present. There are a number of above ground storage tanks and drums (oil /diesel) and an electricity sub-station.
- There was a recorded 'Significant Incident' in 2006 involving the release of 'Oils and Fuel' at the site.
- Direct discharge from surface water drainage may be present from the site to the canal.
- The site was assessed as being of medium to high risk with respect to contaminated land issues arising from previous uses of the site. However, an intrusive investigation with chemical testing would help to refine this assessment.
- The risk of any contaminants migrating off-site (i.e. towards the canal) was considered to be low due to the low permeability of the Gault Clay but if there was found to be notable thicknesses of Made Ground at the site and in the area between the site and the canal then there would be potential for contaminant migration. Any Made Ground could also contain ground gases and volatile vapours.

2.1.3.2 Stockham Farm (Dandara Ltd)

A desk study and ground investigation was carried out by Hydrock Consultants on behalf of Dandara Ltd in 2011-12 in connection with a residential housing development at Stockham Farm. Hydrock's report provides the exploratory borehole logs and laboratory test results together with an interpretation of the ground conditions, conclusions and recommendations. The report was available from the Vale of White Horse District Council planning website.

The main focus of the investigation was the 'triangle' of land south of the canal and west of the A417 (including along the infilled canal section) but six trial pits were also located adjacent to the factory buildings north-west of Stockham Bridge. The Hydrock exploratory hole location plan is reproduced in Figure 4 below and shows the 12 window sampler holes (maximum depth of 4.45m bgl)

and 29 trial pits (maximum depth of 3.6m bgl). (Note that WS = Window Sampler, TP = Trial Pit).

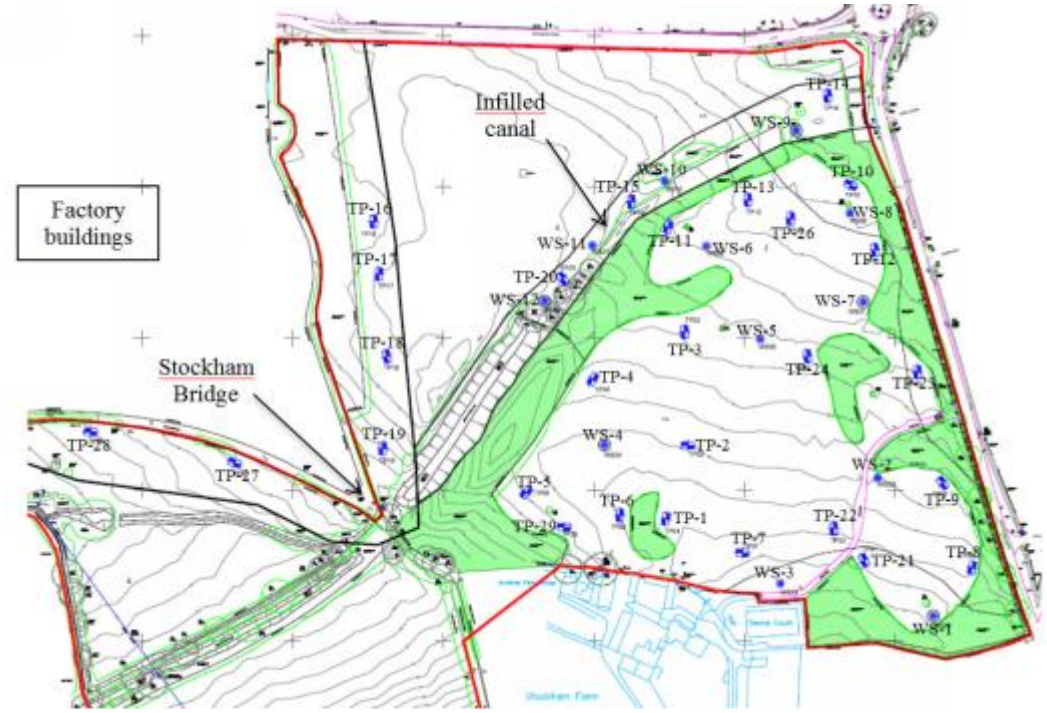
The main findings of the investigation are summarised below:

- The Made Ground infilling the canal was encountered to a maximum depth of 3.8m bgl in WS-10 and WS-11 and in WS-10 to 2m bgl. Made Ground of a similar composition was also encountered but the full thickness not proved in TP-15 (3.6m) and TP20 (2.5m).
- The base of the former canal was encountered in a few exploratory holes and comprised spongy amorphous peat and soft brown-grey and black slightly organic clays (TP-14 from 1.0 -1.4m; WS-9 from 1.4-1.8m; WS-12 from 2-3m).
- WS-12 was located at the former site of Hunter's Bridge. Below the canal base peat encountered from 2 to 3m depth the hole was drilled through a 1m thickness of brick, presumably related to the bridge or associated construction.
- Brown asbestos (amosite) fibres were found in the Made Ground infilling the canal at TP-15, TP-20 and WS-11 and white asbestos (chryotile) fibres were also found in TP-15.
- Elevated levels of lead, petroleum hydrocarbon, copper, nickel and zinc were found in the Made Ground in WS-11 and TP-15. Only the lead levels (up to 1500 mg/kg) constituted a potential risk to human health, and only if the infilled canal is opened up.
- Site screening with an alpha & beta meter and a gamma meter was carried out on the spoil arising from the trial pits located adjacent to the current factory building (TP-16 to -19; TP-27 and -28) but radiation greater than background levels was not detected. The factory was formerly a radioactive isotope research facility until the late 1960s.
- In the exploratory holes south of the canal the soil profile was mostly as expected from the BGS geological mapping but there were differences in the extent of the outcrops shown by the mapped strata boundaries. Head deposits were found overlying the Gault Clay at locations adjacent to the canal and to depths of between 0.6 and 1.9m below ground level, the greatest thicknesses being in the north-east corner of the site, just south of the Mably Way roundabout.
- Terrace deposits were not found near the canal and were mainly in the south of the site and along the eastern boundary adjacent to Denchworth Road.
- The Upper Greensand was found in the south of the site overlying the Gault Clay but the strata descriptions were not as expected and rather than sands and sandstones appear to be locally comprised of clays and mudstones, and very similar to the Gault Clay.
- The Gault Clay changes with depth from a soft / firm clay to a stiff clay and in many of the holes to an extremely weak mudstone rock. The top part of the clay appears to be weathered.

- Groundwater was encountered in some of the exploratory holes at shallow depth (between 0.7m and 2.4m). Hydrock indicate that this is perched water at the Terrace deposit / Gault Clay boundary, as well as slight seepages at depth in the Gault Clay. However infiltration tests carried out in the Gault Clay were abandoned due to insufficient drainage of water from the test pits.
- The infill material in the canal has the potential to generate ground gas and this was assessed for the risk level to houses within the development. Gas monitoring in the window sampler holes recorded no methane and low concentrations of carbon dioxide. Hydrock assessed the risk level as Low.
- TP-5 was terminated at 0.6m due to '*potential archaeological interest*'. No further explanation of this is provided in the Hydrock report.

Descriptions of the strata encountered during the investigation are shown in Table 1.

Figure 4 – Location of Boreholes at Stockham Farm



2.1.3.3 Airfield (Persimmon Homes)

Brookbanks Consulting were commissioned in 2010 by Persimmon Homes / Taylor Woodrow to prepare a geo-environmental appraisal report in relation to proposed development of the Grove airfield site for residential housing, a community centre and three schools. Brookbanks report includes a report from an earlier ground investigation carried out in 2006 by Geotechnical Engineering with Faber Maunsell as consulting engineer.

This investigation comprised 8 cable percussion boreholes to a maximum depth of 10.45m bgl and 38 trial pits to a maximum depth of 4.9m bgl. However these were distributed across the airfield site and only those at the southern end, towards

the canal alignment, were reviewed. This included BH-6, BH-7, TP-27, TP-29, TP-34 and TP-35.

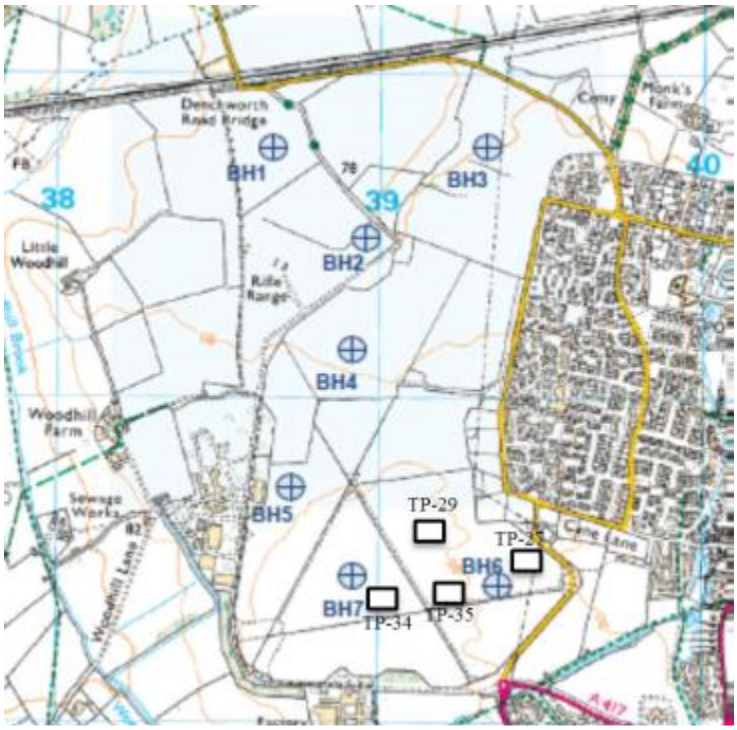
The BGS published geological mapping for this site indicates that Second Terrace deposits overlie the Gault Clay across most of the site, apart from in the south-east corner. At the extreme south-east end the Gault Clay is overlain by First Terrace deposits.

The exploratory hole logs generally confirm this sequence and summarised descriptions are shown in Table 1. TP-34 is slightly different to the other holes with a sand horizon from 2.6 to 4.2m together with groundwater seepage and sidewall instability. BH-7 and TP-35 nearby did not encounter this sand horizon.

At the south end of the site only TP-34 has any form of groundwater entry (seepages in sand horizon) and across the whole site groundwater was only encountered in BH-1 at the north end. Seepages were encountered in 8 of the 38 trial pits at depths between 1.3 and 3.5m bgl.

Contamination testing showed elevated levels of copper and arsenic but Brookbanks identified the risk from this as Low. Elevated levels of carbon dioxide were also detected.

Figure 5 – Airfield Borehole Location Plan



2.1.4 Summary of Ground Conditions

A summary of the strata descriptions is given in Table 1.

Table 1 – Summary of Ground Conditions

Strata shown on geological map	Description in BGS regional memoir	Description from Hydrock ground investigation report	Description from Geotechnical Engineering GI report
Made Ground	Not provided (site specific)	North of canal: grey brown slightly sandy gravelly clay with pockets of sandy gravel and gravel size fragments of concrete. Infilled canal: Variable material from grey sandy clay with mudstone gravel to sandy gravel of ash and clinker with fragments of glass, metal, pottery, bricks and occasional remnants of incinerated asbestos cement boarding.	Firm slightly sandy clay with flint, limestone and siltstone gravel and gravel / cobble size fragments of concrete and brick
Alluvium	Silts and clays with seams of sands and gravel and occasional peat	Not encountered – lies to the east of the area of investigation	
First / Second Terrace deposits	Sands and gravels, occasional clay lenses.	Loose to medium dense light grey slightly clayey sandy gravel. (Summertown – Radley Sand & Gravel Member)	Clayey sandy gravel of quartzite, chalk and flint
Head Deposits	Poorly bedded deposit of variable character resulting from downslope movement of frost weathered material.	Soft to firm light brown and grey gravelly clay.	
Lower Chalk	'Chalk Marl' comprising a calcareous mudstone with sponge beds overlying the 'Glauconitic Marl' at the base, a glauconite rich sandy calcareous mudstone.	Not encountered – forms the high ground at the top of the escarpment to the south	
Upper Greensand	Interbedded sands and sandstones, commonly speckled with glauconite. Pale grey chert concretions in places.	Greenish grey very sandy clay to extremely weak light grey brown mudstone.	
Gault Clay	Grey mudstones with variable silt content. Can contain phosphatic nodules. In places becoming a sandy clay / mudstone.	Firm to stiff grey brown clay grading into an extremely weak light brown and dark grey mudstone (calcareous in places).	Firm becoming very stiff with depth thinly laminated dark grey fissured clay with sandy pockets in places. Occasional gypsum crystals and shell fragments. Possibly re-worked at top of horizon.

2.2 Site History

Information on the history of the area along and adjacent to the canal study section was obtained from a review of historical Ordnance Survey (OS) mapping provided within the Envirocheck site report (1:10,560 and 1:2500 scale maps). A short summary of the findings is given below.

1883: Mostly green-fields divided by hedgerows although East Challow is well developed with the Nalder Estate area containing several large buildings. Barwell Bridge is shown crossing the canal near the current Mably Way roundabout. Denchworth Road is shown as Barwell Lane.

Letcombe Brook appears to be formed of two channels at the junction with the canal. The current A338 running north from Grove is shown as Wantage Tramway.

1900: Swing bridge marked on Cornhill Lane, Challow Works shown at Nalder Estate. Claypit House and Cottages to north of East Challow together with sewage filter beds. Watercress Beds shown on south side of canal to east of East Challow. Challow Park extended. Stockham, Hunter's and Barwell Bridges all marked.

Letcombe Brook appears to be formed of two channels at the junction with the canal and the aqueduct is marked. Cane Mill (corn) is shown at Grove to north of canal.

1913: No major changes to surrounding area but canal now shown as disused. Cane Mill at Grove now shown as disused.

1938: No major changes to surrounding area or canal.

1960: Airfield has been constructed but is not shown on the mapping. Watercress Beds no longer marked. Wantage has spread towards the canal but no other major changes.

1966: Airfield and buildings ('Works') to north-west of Stockham Bridge now marked. Airfield shown as disused.

1973-77: Houses constructed on south side of canal in East Challow (Canal Way). New configuration of buildings at Nalder Estate. Canal infilling south of airfield is more clearly marked than on previous maps. Buildings to north-west of Stockham Bridge now shown as Wantage Research Laboratory. Coal Depot shown adjacent to Barwell Bridge. Further spread of Wantage towards canal and new estate at south end of East Challow. Some field boundary changes adjacent to canal. New housing developments at Grove.

1983: Wantage Research Laboratory now completely re-developed with new building configuration and marked as 'Factory'. Hunter's Bridge no longer marked. Coal depot / yard still shown at Barwell Bridge. Further development on west edge of Wantage. Some field boundaries removed to north of canal and east of East Challow.

1986: Mably Way / Denchworth Road roundabout constructed.

1995-97: Houses along Canal Way in Wantage constructed over coal depot site.

2006: Changes to building layout at Nalder Estate. Sections of canal in water are highlighted, together with springs and spring-lines from slopes to south. Letcombe Brook clearly shown as one channel (possibly earlier but difficult to tell).

2.3 Aerial Photo Interpretation

A national collection of historical aerial photography is maintained by English Heritage and the photographs are available to view at the archive in Swindon. Photography for the East Challow to Grove section of the canal and the surrounding areas dates back to 1942 and over 210 vertical images are held. A visit to the archive was undertaken on 23rd April 2013 to review these photographs. Due to a change in resources at English Heritage it is no longer possible to obtain high quality laser prints of selected photographs at the time of viewing but lower resolution photocopies were made of selected photographs for further review in the office. Copyright restrictions also mean that these photocopies cannot be reproduced. If WBCT require any of the aerial photographs to be included an application must be made to English Heritage to obtain digital scans as well as permission to publish them in this report. This takes around three weeks.

The following photography was reviewed during the visit to the archive:

Table 2 – English Heritage Photo Review

Year	Date	No. of photos copied	Note
1942	14th Feb	2	No coverage at west end of study section
1942	1st June	0	Imagery too dark – no copies made
1943	8th Sept	1	Some cloud cover at East Challow end
1944	30th Jan (?)	1	Covers eastern half of study section
1946	12th Apr	2	No coverage at extreme western end
1946	7th June	2	
1946	6th Sept	2	
1947	18th Jan	2	
1951	2nd July	0	Too much cloud cover – no copies made
1951	31st July	2	No coverage western half of study section
1951	3rd Sept	4	No coverage for eastern third of study section
1952	4th Feb	1	No coverage at east end of study section
1952	12th Feb	1	No coverage at west end of study section
1964	17th May	3	
1967	14th June	2	
1968	13th June	2	No coverage at west end of study section
1971	12th Apr	0	Similar to 1968, Grove section only, no copies made.
1974	21st June	2	Marked as oblique but appear to be vertical. No coverage west of Wantage branch junction
1995	21st Apr	2	
1996	17th June	1	No coverage western half of study section

The following features were noted in the aerial photographs:

At the Grove end the earlier photographs during the Second World War clearly show the alignment of the Letcombe Brook, and there are possibly two separate channels crossing the canal alignment, which meet further north. There is little development around the canal although the houses at the road / canal junction are present. Major development around this area starts between the 1952 and 1964 photography and by 1968 is well advanced. The canal here appears to be infilled.

The earlier photographs taken during and immediately after the Second World War show the development of the airfield with the establishment of the runways across original field boundaries by topsoil stripping, compaction and surfacing (either tarmac or concrete). The current alignment of Denchworth Road south of the canal follows a former road but north of the canal the old road has been re-routed eastwards around the airfield to join Cane Lane in Grove. This road is shown as Barwell Way on the historical mapping with Barwell Bridge carrying the road over the canal. The canal passes close to the southern end of the airfield between Stockham Bridge and the current Mably Way roundabout and earthmoving activities in this area are evident with large quantities of spoil being

used to raise ground levels adjacent to the canal and infilling of the canal just to the west of the Wantage branch junction. There are a number of aircraft dispersal bays in this area, and this may also have been an area for re-fuelling aircraft. The current factory buildings immediately to the north-west of Stockham Bridge were constructed between February 1942 and September 1943 and are assumed to be part of the airfield facilities.

The Wantage branch of the canal is clearly seen on the earlier photographs cutting across green fields prior to the development of the new housing estates. The houses are present in the 1995 photography but there is a break in the photography cover back to 1974 when still green fields and the exact date of this development cannot be identified from the available photography.

The slopes to the south of the canal between East Challow and Stockham Bridge were looked at for indications of any slope instability but no significant features were identified.

In East Challow the houses along Canal Way first appear in the 1995 photographs but there is a long time gap in the photographic cover with the next earliest photograph showing this area being the 1967 photographs. The 1964 coverage of this area is very clear and the canal along this section looks to have been infilled by this date.

There have been several changes to the building layouts on the north side of the canal in the Nalder Estate boundary.

There are no major changes adjacent to the canal for the section west of the A417 in East Challow. The two houses either side of the canal next to the road are not visible on the 1951 photography. The house on the south side (Ivanhoe) appears in the 1964 photograph and the house on the north side (Suntrap) in the 1995 photograph.

2.4 Unexploded Ordnance (UXO)

The risk level from buried WW2 unexploded ordnance is indicated to be Low on the Zetica UXB risk map for West Berkshire (although the site is within Oxfordshire). Low risk is defined as '…regions with a bombing density of up to 10 bombs per 1000 acres. These areas are considered to have a significant but low UXB risk. In general, further action to mitigate the risk is considered prudent, although not essential. Care is required when assessing the risk for specific sites where the risk may be higher because of local wartime activity'.

The presence of the airfield, which would have been a more specific wartime target, means that a more site specific approach will need to be taken before any excavation in this area.

A detailed search for UXO was carried out for Persimmon Homes at the airfield site by Zetica using geophysical surveys (metal detection) but no UXO was found.

2.5 Walkover Survey

A walkover survey of the 3 km canal section between East Challow and Grove was undertaken on Friday 5th April 2013 in conjunction with the Arup

Environmental Scientist and the WBCT representative (Eddie Thomas). The main observations from this walkover are summarised below:

- Between East Challow and Stockham Bridge on the south side of the canal the lower slopes of the escarpment are quite close to the canal alignment and in places terminate at the canal. Spring lines and gulley heads were observed in these fields to the south and during wet conditions these are likely to carry some flows downhill and into the canal. Land drains were also noted, discharging into the canal (which contains water along this section).
- There were no indications of major slope instability (mass movement) in these areas apart from the presence of slightly hummocky ground towards the base of the slope. These may represent the degraded remains of shallow slope movement debris (solifluction, colluvial deposits) and Head Deposits are shown in this area on the geology map.
- East of Stockham Bridge the results of the earthmoving works associated with the development of the wartime airfield are quite clear and there is a steep slope up from the canal to the land on the north side.
- Burrows (presumed to be rabbit) were noted in the canal banks in this area.
- The canal has been infilled east of the former Hunter's Bridge location but in places there are some water filled bowl shaped depressions along the former alignment.

2.6 Summary of Findings

- The geology of the area is given on published mapping from the BGS which shows that for most of the study section the canal is founded in the Gault Clay at the foot of the Upper Greensand / Chalk escarpment. Head deposits mantle these slopes to the south of the canal and may extend further to the north than shown on the geological map, crossing the canal alignment and overlying the Gault Clay.
- In the central section along the Letcombe Brook 'valley' the Gault Clay is overlain by Terrace deposits and Alluvium. The Letcombe Brook may at one time have run through two channels or been diverted along a new route (historic maps and air photographs). It is possible therefore that infilled alluvial channels may be present near Grove.
- The superficial deposits are relatively thin and Gault Clay is typically encountered by around 1 to 1.5m depth below ground level.
- The Gault Clay is of lower strength at the top of the horizon and in places appears weathered / disturbed. The strength increases quickly with depth and Hydrock's logs suggest that in places it becomes an extremely to very weak rock (mudstone) at shallow depth (by 4m). However the Geotechnical Engineering boreholes at the southern end of the airfield did not show this change to mudstone.
- The Upper Greensand appears to be more similar to the Gault Clay in this area than the geological memoir indicates (interbedded sands and

sandstones). However this is only of minor significance as the canal passes to the north of the Upper Greensand outcrop.

- Made Ground was encountered along the infilled canal between Stockham Bridge and Mably Way roundabout during the ground investigation for the Dandara development. This was a variable material containing clay, gravel, ash, clinker, brick, glass, metal, pottery and rare incinerated asbestos boarding. Elevated levels of lead, petroleum hydrocarbon, copper, nickel and zinc were detected although only the lead concentration and presence of asbestos were significant with respect to human health.
- Low levels of ground gas (carbon dioxide) were detected in the Made Ground during both the airfield and Stockham farm investigations. This is unlikely to be an issue in large open excavations but may be in smaller confined spaces.
- Potential ground contamination was also noted at the Nalder Estate site due to previous industrial uses but migration of contaminants is restricted through the Gault Clay due to low permeability and unless contaminants are present immediately adjacent to the proposed canal alignment is unlikely to present a high risk to the canal.
- The aerial photography identified that ground levels in the area to the south of the airfield and north of the canal had been raised during construction of the airfield, presumably using spoil from the earthmoving works. The composition of the Made Ground in this area has not really been investigated although three trial pits were excavated by Hydrock on the east side of the factory where the Made Ground was comprised of sandy gravel and clay with concrete fragments.
- Groundwater was encountered at shallow depth at the base of the Made Ground and the First Terrace deposits (at the Dandara site). Flows were only reported to be minor and in places as slight seepages, but this could vary seasonally. Where excavations are to be made through the superficial soils methods of dealing with any groundwater inflows will need to be considered, but this may only require sump pumping.
- Where groundwater flows / seepages were encountered during trial pit excavation through the Terrace deposits (clayey sands and gravels) Hydrock reported that the pits were subject to sidewall instability and this will need to be considered for the canal cuttings, either through support or battered side slopes.
- The risk level from buried unexploded ordnance is indicated to be Low on the Zetica UXB risk map (West Berkshire). However the presence of the airfield, which would have been a more specific target, means that a more site specific approach will need to be taken before any excavation in this area. A detailed search for UXO was carried out for Persimmon Homes at the airfield site by Zetica using geophysical surveys but no UXO was found.
- No major slope instability features along the escarpment slopes to the south were noted during the walkover survey, other than the presence of degraded hummocky ground which may be related to the Head deposits. However the canal runs close to the foot of the slope in places and if any

major excavation work is required in these areas then the ground conditions must be suitably investigated. Reactivation of relic shallow slips is possible even on relatively gentle slopes.

2.7 Recommendations

The ground conditions expected during construction works along the canal restoration section have been identified through published geological mapping and from the results of nearby ground investigations in the Stockham Bridge / airfield area. Although these have provided useful preliminary information they have been commissioned in relation to residential house developments and more specific information on the ground conditions will be required for design of canal cutting slopes, retaining walls, bridge foundations and other structures.

Further ground investigation will be required along the canal route to investigate the following issues:

Thickness and characteristics of Made Ground

The section between Stockham Bridge and the Mably Way roundabout will pass through Made Ground deposited during the airfield construction. If it is similar to the Made Ground used to infill the canal then there are potential issues with side slope stability and contamination (ground and gas). Shallower slopes in the Made Ground will require more land take and may be better supported by retaining walls.

Cut slope stability

Gault Clay is typically stiff fissured highly plastic over consolidated clay which is susceptible to seasonal shrink / swell behaviour through moisture content changes, as well as swelling due to stress relief (following excavation of overlying strata) and landslipping. Sections of the M11, M40, M25 and M26 motorways have been constructed along the Gault Clay outcrop and the earthworks (cuttings and embankments) have been subject to on-going side slope instability which can develop many years after construction through equilibration of pore pressures as well as seasonal wetting and drying of the surface layers.

Previous studies (e.g. Perry, 1989) have looked at the failure rates in motorway cutting slopes in different geologies across the UK. In order to reduce failures to less than 1% of slopes within 22 years of construction the maximum slope angles recommended in the Gault Clay are as follows.

Table 3 – Maximum Angles of Repose in Gault Clay

Slope height	**< 2.5m**	**2.5 to 5.0m**	**>5.0m**
Slope angle	1:3.5 (16°)	1:4 (14°)	1:5 (11°)

Much depends on the level of slope management that will be employed including drainage maintenance and vegetation control and there will be a balance between safe slopes and cost (both capital and operating)

If the Gault Clay becomes more of a weak rock at shallow depth then it may be possible to increase side slope angles and the change in strength with depth will need to be better determined in areas where significant cutting slopes are planned.

Natural slope stability

The Gault Clay is highly susceptible to landslipping, both deep seated and shallow failures, and particularly where it is found on large natural slopes with the Upper Greensand and / or the chalk. Before any detailed design of the canal restoration works is undertaken, further investigation of the escarpment slopes to the south of the canal in the East Challow – Stockham Bridge section is required in order to confirm the geological profile and the geotechnical properties of the strata forming the slopes. This will be necessary not just adjacent to the canal but upslope away from the canal as well. This information can be input to slope stability programmes together with slope topography data in order to model the existing conditions and the stability with a new canal cutting along the toe.

Trial pits are a good method for investigating the near surface deposits and to identify features such as periglacial shearing, seepages and disturbance to the upper layers of the Gault.

Bearing capacity

Where heavier structures (bridge abutments) are required to found on the Gault Clay then an assessment of the allowable bearing pressure will need to be made. This needs to be specific to location and required depth as this could vary significantly. Plate load tests would be useful for this.

Excavatability

There are not expected to be any issues with excavatability of the Gault Clay with conventional machine excavators (JCB type), even when it is encountered as an extremely / very weak mudstone.

Permeability

In-situ tests to determine the permeability of the Gault Clay and any overlying superficial strata are recommended to ensure that there are no significant water losses from the canal. Minor seepages were encountered in the Gault Clay during the Dandara investigation.

Groundwater

The depth to the groundwater table is not known and only the perched minor aquifer at shallow depth was identified during the Dandara investigation. Deeper boreholes for this purpose would also be helpful for determining the local thickness of the Gault Clay.

3 Environmental Review

3.1 Introduction

This review covers the area illustrated in the plan below; see Figure 6. It is based on the results from a desk based review of data (including the Envirocheck Report), environmental reports from planning applications for developments located along close to the route of the canal and data held by other parties such as the Environment Agency and a site visit. It discusses the issues associated with the proposed canal and then identifies the actions required by the WBCT for planning or prior to any construction works.

Figure 6 – Envirocheck Area

3.2 Planning Applications

3.2.1 Stockham Farm, Wantage

3.2.1.1 Phase 1 Ecology and Habitat Surveys

The following excerpts are taken from the Executive Summary of the Stockham Farm, Wantage Extended Phase 1 Ecological Appraisal May 2012 Rev A, prepared by FPCR Environment & Design Ltd. The site is circa 9.7ha entirely in a field situated to the south of the Wilts and Berks Canal route; proposals for the development comprise 200 residential units. Details of the survey methodology may be found within this report and included statutory and non-statutory consultation, ordnance survey and aerial mapping and was based on Phase 1 survey techniques as recommended by Natural England (JNCC, 2003).

"Proposals for the site comprise the construction of 200 residential units.

Statutory and non-statutory sites of nature conservation interest are isolated from the proposed development site. The scheme will not adversely affect the conservation status of such sites.

An extended Phase 1 and protected species survey was undertaken across the proposed development site and adjacent habitats within the site owners holding in April and June 2011. Targeted protected species surveys undertaken included surveys of waterbodies present within and adjacent to the site for great crested newt (GCN) in May and June 2011, and again in April and May 2012; breeding bird surveys in June and July 2011, and badger surveys in June 2011 and February 2012. Bat transect surveys are scheduled to be undertaken over April to June 2012, the results of which will be submitted separately following their completion. It is considered unlikely however that the presence of notable or protected species within the site will be a statutory constraint to the proposed development.

Habitats within the proposed development site comprise semi-improved grassland of recent origin (former arable land) and immature native tree planting of Site ecological value, a corridor of mature native woodland that supports an outlier badger sett and is of Local ecological value, and an adjacent water-filled section of the former Wilts and Berks Canal that supports water vole and a Medium sized GCN population that is of at least District value. A neighbouring large GCN population lies approximately 200m to the east of the site but is separated from it by two busy roads with kerb stones and gullies (the A417/Denchworth Road and A417/ Mably Way) and by an area of residential development. Due to these significant barriers to dispersal this waterbody is not considered to be a potential source of GCN into the development area.

The site development will result in the loss of areas of semi-improved grassland and immature tree planting. The removal of semi-improved grassland habitat is not considered to be a significant loss to the value of the site or wider local nature conservation resource as adjacent areas will be retained, however this habitat is likely used by foraging species including birds, bats and badgers resident within the local area, and GCN during their terrestrial phase. Trees throughout the immature woodland are still relatively small and immature though may support nesting birds and are considered to be of Local ecological value.

Crown lifting works will be undertaken on a group of trees to be retained to the west of the site close to the canal. To avoid disturbance to breeding birds, any removal of woody vegetation will be undertaken outside of the bird-breeding season (March to September inclusive). If this is not possible, vegetation will be checked prior to removal by an experienced ecologist.

Recommendations are provided within the separate Breeding Bird Survey Report (FPCR 2012) for the protection of retained habitats including canal-side woodland. Tree works will be informed by the results of the bat transect surveys.

Recommendations are provided [sic. within Section 4] of this report for creation of areas of new planting and the enhancement of retained habitats within the site to mitigate for the above losses and to contribute to the aims of the National Policy Planning Framework. Site enhancement works include the provision of:

- *New areas of native tree and shrub planting linking to retained areas of existing trees;*
- *Continuous corridors of species-rich tussock-forming wildflower grassland (Emorsgate EM10 mix or similar) along the length of the canal corridor, throughout the western corner of the site and along the southern site boundary;*

- *Three attenuation ponds within the above grassland corridors, to be created with shallow sloping banks and planted with native emergent and marginal species, and*
- *A series of hibernacula and log piles suitable for use by GCN and other amphibians within the above wildlife corridors.*

Habitat corridors and adjacent areas of tussock-forming wildflower grassland that are to be retained and enhanced with specific regard to GCN total c.22% of the total site area coverage.

A Natural England development licence will be obtained if appropriate should works have potential to adversely affect any confirmed bat tree roost.

A Natural England licence will be required to be in place prior to any works that may result in potential impacts to habitats that may support GCN. No ground works are proposed within 50m of the badger sett, or 30m of the canal fragment."

Figure 7 – Phase 1 Habitat Plan, Stockham Farm

3.2.1.2 Breeding Bird Survey Report, May 2012

The following is excerpts from the Summary of the Breeding Bird Survey conducted by FPCR Environment and Design Ltd Rev A May 2012.

"A total of 41 bird species were recorded during the surveys within the application site and adjacent fields, of which 17 are either protected under Schedule 1 of the WCA 1981 (as amended); appear on the RSPB BoCC as declining (red or amber lists); and/or are listed as UK BAP or LBAP priority species. Nine of these 17 species were recorded within the proposed development site: bullfinch Pyrrhula pyrrhula, dunnock Prunella modularis, whitethroat

Sylvia communis, red kite Milvus milvus, swallow Hirundo rustica, green woodpecker Picus viridis, starling Sturnus vulgaris, willow warbler Phylloscopus trochilus and kestrel Falco tinnunculus. A tenth priority species, song thrush Turdus philomelos, was recorded immediately adjacent to the site boundary.

Twelve of the 41 recorded species within the site and wider survey area were confirmed as breeding. Two of these - bullfinch and dunnock - are BoCC Amber-list species (medium conservation concern) and UKBAP priority species. The remaining ten species confirmed as breeding were BoCC green-listed species (low conservation concern). A further seven species were considered probable breeders, including two notable species: common whitethroat and willow warbler.

Habitats present within the site that are of greatest value to foraging and breeding birds include the semi-improved grassland (kestrel, red kite and barn owl Tyto alba foraging/hunting habitat (barn owl has not been recorded on site but is known to roost/nest at Stockham Farm adjacent to the southern site boundary)), immature tree planting (dunnock, blackcap Sylvia atricapilla, blackbird Turdus merula) and mature woodland (bullfinch, song thrush and green woodpecker).

The existing species assemblage is likely to change in composition and diversity with the proposed development, to the benefit of birds of urban environs. In addition, habitat creation throughout the site will provide opportunities for other species of conservation concern currently absent from the site, e.g. mistle thrush. The resultant bird assemblage will likely be at least equivalent in value to that recorded therefore there will be no more than a site level impact through habitat change upon the assemblage of birds through the breeding season in the long term, i.e. a slight effect of no significance.

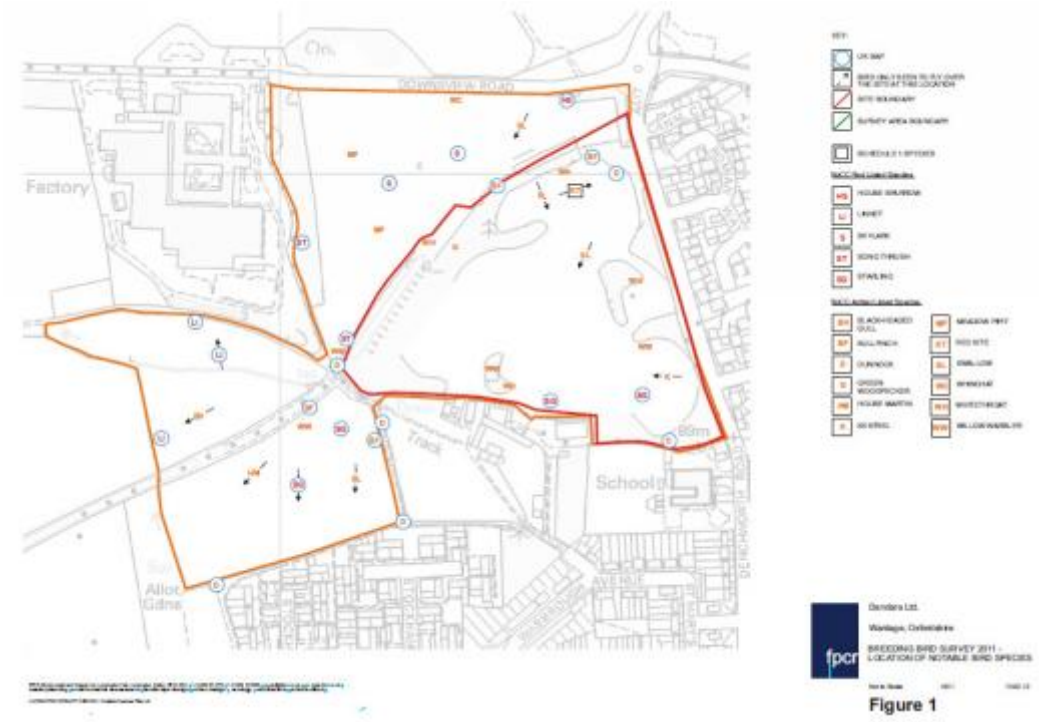
Of the 17 notable species present within the site and wider survey area, six (dunnock, green woodpecker, house sparrow Passer domesticus, starling and swallow) will readily utilize new residential garden habitat and open green space. The remaining species include those typically associated with woodland edge (bullfinch, kestrel and song thrush) and grassland (meadow pipit and skylark). Any loss of woodland or grassland habitats within the proposed development has potential to adversely affect the status of species that utilise such habitats.

The majority of existing established woodland will be retained within the development proposals. Site enhancement for birds could be achieved via the planting of trees and shrubs throughout areas of public open space, with preference given to native plants of value to local bird populations, e.g. berry- and fruit bearing species. It is further recommended that an element of rough grassland-type habitat be created within the GI development proposals. Design consideration should be given where feasible within the proposed development to the provision of additional enhancements for the local bird population including the installation of bird boxes on retained mature trees. The provision of such enhancements would be in accordance with local and national planning policy.

To avoid disturbance to breeding birds, vegetation should be removed outside of the bird-breeding season (March to September inclusive). If this is not possible, vegetation should be checked prior to removal by an experienced ecologist. If active nests are found, vegetation should be left untouched and suitably buffered from works until all birds have fledged. Specific advice will be provided prior to undertaking the clearance. This would be a statutory requirement due to the

protection of all nesting birds and their nests under the Wildlife and Countryside Act, 1981."

Figure 8 – Summary Notable Species Breeding Bird 2011 Survey



3.2.1.3 Tree Survey and Arboriculture Assessment

The following is excerpts from the results summary of the Mature Tree and Arboriculture report by FPCR Environment and Design Ltd conducted on the 25th and 17th April 2012. The methodology used was that as outlined in the British Standard 5837:2012 5837.

"Trees have been divided into one of four categories based on Table 1 'Cascade chart for tree quality assessment' within the British Standard. These are classed as U, A, B & C and are included in section 4.5 of British Standard 5837:2012. The categorisation of each tree or group gives an indication as to the tree's overall condition, value, quality and importance in relation to the site and wider local landscape in the current context. This assists informal decisions concerning which trees should be removed or retained should development occur.

For a tree to qualify under any given category it should fall within the scope of that category's definition (see below). Categories A, B & C cover trees that should be a material consideration in the development process, each with three further sub-categories (i, ii, iii) which are intended to reflect arboricultural, landscape and cultural (nature conservation) values. Category U trees are those which would be lost in the short term for reasons connected with their physiology or structural condition. They are, for this reason not considered in the planning process. In assigning trees to the A, B or C categories the presence of any serious disease or tree – related hazards are taken into account. If the disease is considered fatal and / or irremediable, or likely to require sanitation for the protection of other trees it may be categorised as U, even if they are otherwise of considerable value".

"The mature tree stock found within the assessment was dominated by common ash which was largely situated on the boundaries of the site to the east along Denchworth Road and the west along the route of the canal. The canal provided areas of wet ground along which a number of mature ash trees were growing; however many of the specimens were displaying signs of decline due to their mature age being within the final 1/3rd of their life and their exposed position making them vulnerable to south westerly winds.

T1 was a mature common ash Fraxinus excelsior exhibited three main stems emanating from stool each with a diameter of approx.360mm. The ivy that extended into the crown had been severed during previous tree surgery that had taken place in the recent past. Despite the evidence of tree surgery through the presence of small pruning wounds observed on branches overhanging the road some minor deadwood remained in the crown. New asphalt had been laid within 1.5m of the base indicating possible ground disturbance within the RPA. The stem to the north east displayed a significant lean over the road junction and was of considerable weight to justify action in the short term. This may involve the use of cobra bracing system to reduce the chance of failure or its reduction in height to reduce the lever affect at the base of the stem or removal of the stem back to the base. T1 was considered retention category B.

TG1 was a group of six mature common ash specimens that provided the principle boundary vegetation in the south eastern corner of the site. Ivy had also been severed in preparation for its removal. Some minor pruning wounds had left branch stubs to the road side possibly to avoid vehicular impact. Recent pruning wounds were noted in the crowns. Ivy at the bases occluded the stems, restricting the ability of inspection at the base. TG2 was considered retention category T3 was a mature crack willow salix fragilis that displayed a tag number 0794 and multiple pruning wounds tears, splits and stubs within the crown. Some major deadwood was also present within the crown which extended to 8m in a northerly direction. The base of the stem was situated in close proximity to a farm outbuilding. Drainage inspection cover was located within 1m of main stem. T3 was considered retention category C due to its poor overall form and potential to fail.

T4 was a mature sycamore Acer pseudoplatanus that supported dense ivy cover up to a height of 9m. A wire fence was included in the main stem at the base. Both minor and major dead wood was evident within the crown. T4 was considered retention category C.

T5 was an ash that also supported significant amount of dense ivy cover in the crown. This mature specimen was twin leadered from 2.5m above ground level with some past pruning evident over the adjacent field. T5 was considered retention category B.

One specimen positioned amongst TG9 and centrally to the redundant line of the canal was considered retention category A, namely T10. The specimen was an English oak Quercus robur approximately 12m in height which displayed an even and well developed crown form. Only a relatively small number of defects including some crown dead wood were noted and as such T10 was afforded the highest retention category for its future life expectancy and current good condition.

T11 ash, presented three main stems that emanated from a mature stool. Each stem was measured at approx 500mm in diameter and ivy covered their forms to a height of 7m. Some minor and major dead wood was evident within the crown. Exposed roots were noted in the poached ground at the base of the stem. This specimen was considered retention category B.

T12 was a mature crack willow that displayed a heavy lean to the south east. The gradual collapse of the ground at base appeared to have halted due to vertical branch growth from main stem. This specimen was considered retention category C.

T194 was a mature European Larch Larix decidua that stood approximately 20m in height and contained several large pieces of deadwood within the crown. This specimen was considered to be visually noticeable in the landscape due to its crown structure and was considered retention category B for its overall condition.

Throughout the site were numerous young or early mature trees, namely T2, T6, T7, T8, T9, T14 and TG2 - TG6, many of which had been purposefully planted although a proportion were of selfseeded nature. It would be considered from an arboricultural perspective that there is sufficient justification for these particular trees to be allocated retention category C status, despite the general absence of major defects, due to the categorisation method set out in BS5837.

Several areas around the boundaries of the field compartment had been planted up with trees approximately ten to fifteen years ago. The style and nature of the planting, as well as the absence of any aftercare had meant that the planting blocks were overcrowded in places and would require a phased thinning process to manage the trees to their mature forms.

Trees T15 – T76 and T89 – T194 were assessed individually to identify the quality and suitability of their forms in their current context. Trees were generally found to be in moderate condition for their situation with little in the way of defects or pruning wounds due to their unmanaged forms. Few category U specimens were noted.

TG9 – TG11 stood to the west of the assessment area along the line of the disused canal.

TG9 was a group of mature ash that displayed some minor defects that included minor dead wood that would be considered a natural shedding of branches. The stem was situated in an area of sunken ground on the line of the old canal.

TG10 was a group of crack willow that stood on the steep sloping side to the east of the canal. Basal cavities were observed throughout the group with woodpecker holes present further up the stems within the crowns. Several failed limbs were also evident within the crowns. This group was considered retention category C due to the conditions.

TG11 was a group of mature multi stemmed ash that stood on the banks of the canal. A fungal fruiting body Pleurotus spp noted at base of one of the stems. Dense ivy was present throughout the group. TG11 was considered retention category B.

TG14 was a group of mature common alder Alnus glutinosa that stood on edge of watercourse and supported dense ivy cover throughout the interlocked crowns.

Minor and major dead wood was also present through storm damage. Splits were noted in a number of stems. TG14 was considered retention category B''.

Figure 9 – Tree Location, Quality and Constraints Plan

Figure 10 – Tree Retention and Removal Plan

3.2.2 East Challow Environmental Assessment

The following are excerpts from the summary conclusions from the Aspect Ecology May 2012 Ecology Survey and Assessment Report which comprises a development site containing 71 new dwellings and associated access and landscaping. The site was surveyed in February 2012 based around extended Phase I methodology to ascertain the general ecological value of the land contained within the boundaries of the site and to identify the main habitats and associated plant species, with notes on fauna utilising the site. In addition, specific inspection survey work was undertaken in respect of bats.

*"**Ecological Designations**. The site itself is not subject to any statutory or non-statutory nature conservation designations. The nearest such designation to the site is Letcombe Reed Swamp LWS, located approximately 1.4 km south of the site which, along with all other identified ecological designations, is well separated from the site, such that it is unlikely to be adversely affected by the proposals.*

***Habitats**. The southern part of the site is dominated by buildings and hardstanding, which support negligible vegetation and as such their loss to the proposals would be of no ecological importance, whilst in any event they will be replaced with similar habitats along with additional new vegetated areas. The north of the site is dominated by grassland, which in the main supports a limited array of common species and is similarly of little ecological importance. Habitats offering limited ecological interest within the site are largely associated with the site boundaries and include a number of hedgerows and semi-mature to mature trees. These habitats will be largely retained under the proposals, whilst new landscape planting incorporating native species will provide compensation for any losses. Further, recommendations have been set out to strengthen and enhance these habitats in order to contribute to UK and local BAP targets, as well as increasing their potential value for wildlife where possible.*

***Faunal Species**. The habitats present within the site appear to offer potential terrestrial opportunities for amphibians and common reptiles, whilst a number of offsite water bodies are present within the vicinity of the site which appear to provide potential breeding opportunities for amphibians. Accordingly, specific survey work for these protected species groups is ongoing during the appropriate seasonal period in 2012 and will be fully reported elsewhere, along with the proposed mitigation measures in respect of these species. Nonetheless, it is noted that the presence of a low population of Great Crested Newt has been recorded, centred on the offsite ponds and accordingly, the proposals have been specifically revised to incorporate a considerable corridor of suitable habitats for these groups around the entire northern boundary. The presence of a Pipistrelle bat roost has been recorded within building B1 at the site. This building (and accordingly, the roost) will be fully retained, whilst it is recommended that suitable mitigation be put in place to safeguard bats in the long term at the site. In addition, the site offers opportunities for nesting birds and accordingly, this group is fully considered within this report and suitable mitigation and protection measures are set out where appropriate. Accordingly, subject to the recommendations set out, the proposed redevelopment of the site is unlikely to result in any significant adverse effects on any protected, rare or notable faunal species.*

***Ecological Enhancements**. A number of ecological enhancements have been recommended which will provide biodiversity benefits at the site, including*

strengthening of the existing boundary features and improving connectivity through native planting as well as a range of other benefits at the site.

***Conclusion**. In conclusion, based on the evidence obtained from detailed ecological survey work and with the implementation of the recommendations set out in this report, including specific mitigation in regard to amphibian and reptile species as detailed elsewhere within the separate accompanying report (to follow once the final survey results are available), there is no evidence to suggest that the proposed redevelopment of the site would lead to any significant effects on any known protected species or ecological features of value at the national, county or local level. As such, subject to the implementation of the measures and recommendations set out within this report, it is considered that there is no evidence to suggest that there are any overriding ecological constraints on the proposed residential development at the site."*

Figure 11 – Habitats, Ecological Features and Photographs

3.2.3 Persimmon Airfield Ecological Assessment

The following is extracts from Results and Assessment Chapter of the Creswell Associates Ecological Assessment of Grove Airfield, Version 6 dated October 2010.

*"**Desk Study***

The desk study revealed that there are no statutory designated sites of nature conservation value within the survey area or within a 2km radius of the survey area. The closest European designated site is Hackpen Hill Special Area of Conservation (SAC), just over 5km to the south-west of the application site. This site also forms the Hackpen, Warren and Gramp's Hill Downs Site of Special Scientific Interest (SSSI). It is not envisaged that the development proposals will

have any impact on these designated sites. Desk study records exist for water voles on the section of the disused Wiltshire and Berkshire Canal within the study area, on the Letcombe Brook close to the south-eastern corner of the study area, and also to the north-east of the airfield site. Water voles have also been recorded on water features (watercourses and sections of the disused Wiltshire and Berkshire Canal) to the south and west of the study area. Common pipistrelle (Pipistrellus pipistrellus) bats have been recorded in the 1km Ordnance Survey grid square that the south-eastern part of the survey area falls within. Part of the village of Grove is also located within this grid square (it is likely therefore that this record refers to roosts within buildings in the village). No further records for protected species or species of conservation concern within the study area have been received.

There is a record of brown long-eared bats (Plecotus auritus) from a roost of unknown size in the northern part of Grove. Bats have also been recorded foraging over a pond that is 1.8km south-west of the study area. These include Daubenton's (Myotis daubentonii), noctule (Nyctalus noctula), common pipistrelle and brown long-eared bats. In addition, Leisler's bats (Nyctalus leisleri) have been recorded in the 1km Ordnance Survey grid square that is 50m west of the study area. Natterer's bats (Myotis nattereri) have been recorded in the 1km Ordnance Survey grid square that is 1.5km east of the study area. There are also several other records of 'grounded' bats of these species and whiskered bat (Myotis mystacinus) in and around Grove.

Desk study information provided within Hankinson Duckett Associates' assessment of land to the north-east of the study area, identified several notable bird records for the former airfield site, including the following species during winter: lapwing (Vanellus vanellus), golden plover (Pluvialis apricaria), fieldfare (Turdus pilaris), redwing (Turdus iliacus), and foraging flocks of finches including Goldfinch (Carduelis carduelis), Linnet (Acanthis cannabina), Greenfinch (Carduelis chloris) and Chaffinch (Fringilla coelebs). Records of migrant species using trees along the canal on passage were also provided, and included nightingale (Luscinia megarhynchos), lesser whitethroat (Sylvia curruca), blackcap (Sylvia atricapilla) and willow warbler (Phylloscopus trochilus). No further records regarding protected or notable species in the vicinity of the site have been received, or were reported in the most recent county bird report (OOS, 2005).

UK BAP

The Environment Agency has identified the Letcombe Brook as a chalk river, and is therefore a Priority Habitat under Rivers, as identified in the UK Biodiversity Action Plan (BAP). Several habitats occurring within the study area are also listed as Priority Habitats under the UK BAP, including: arable field margins, hedgerows, and ponds.

Reptile and amphibian species present within the application site which are listed as Priority Species on the UK BAP include great crested newt, common toad and common lizard. Noctule bats, brown long-eared bats and soprano pipistrelle (Pipistrellus pygmaeus) bats, water voles, otters and brown hares are also UK BAP Priority Species. Bird species present within the study area which are listed in the UK BAP include skylark (Alauda arvensis), linnet, cuckoo (Cuculus canorus), yellowhammer (Emberiza citrinella), corn bunting (E. calandra), reed bunting (E. schoeniclus), grasshopper warbler (Locustella naevia), Eurasian

curlew (Numenius arquata), house sparrow (Passer domesticus), tree sparrow (P. montanus), dunnock (Prunella modularis), bullfinch (Pyrhulla pyrhulla), starling (Sturnus vulgaris), song thrush (Turdus philomelos) and lapwing.

Oxfordshire LBAP

The Oxfordshire BAP identifies Conservation Target Areas (CTAs) for the maintenance, restoration and creation of BAP habitats within the county. There are 19 UK BAP Priority Habitats within the county of Oxfordshire, and 2015 biodiversity targets have been created for these habitats within the CTAs. Whilst the study area is not within or in close proximity to any of the identified CTAs (the closest CTA is the Berkshire Downs Escarpment, located approximately 5km south-west of the study area), there are several UK BAP habitats and species relevant to the study area, as described in paragraph 3.1.4 and 3.1.5 (above).

In addition, national and regional policies relevant to the study area include Planning Policy Statement 9 (PPS9): Biodiversity and Geological Conservation and the Vale of White Horse Local Plan (adopted July 2006).

Vale of White Horse Local Plan (adopted July 2006)

The following policies from the Vale of White Horse Local Plan are relevant to the site and development proposals:

Policy L14 states that: Development which would cause demonstrable harm to the essential character of the Wilts and Berks Canal or to its setting, or would be likely to prevent or impair the restoration of the canal, or would result in the loss of any buildings, locks or other structures associated with the original waterway function of the canal will not be permitted. Development on or close to the route of the canal will be required to facilitate development of its recreational potential and/or protect its nature conservation and heritage value. Development that would prevent the restoration of the canal on its historic alignment as shown on the proposals map will only be permitted if arrangements for the reinstatement of the canal on a viable alternative route can be secured by the developer.

Policy NE1 states that: Applications for development which are likely to affect a known or potential site of nature conservation value will not be permitted unless they are accompanied by an ecological appraisal which enables a proper assessment to Cresswell Associates be made of the impact of the proposed development on the ecological value of the site.

Policy NE2: Protection of sites of Special Nature Conservation Importance states that: Development will not be permitted if it would result in the destruction of or damage to any Special Area of Conservation, National Nature Reserve or Site of Special Scientific Interest.

Policy NE4 states that: Development likely to harm a site of nature conservation importance not covered in policies NE2 and NE3 will not be permitted unless it can be clearly demonstrated that the reason for the development clearly outweighs the need to safeguard the nature conservation value of the site and adequate compensatory habitats will be provided.

Policy NE5 states that: Development likely to have an adverse effect on a specially protected species will not be permitted unless the adverse effects, either directly or indirectly, can be prevented or acceptably minimised or adequate alternative habitats can be provided.

Policy DC6 states that: All proposals for development will be required to include hard and soft landscaping measures designed to:

- *protect and enhance the visual amenities of the site and its surroundings including, where appropriate, existing important landscape features; and*
- *maximise the opportunities for nature conservation and wildlife habitat creation.*

Field Surveys

The results of the updated Phase 1 habitat survey are presented in map form on Figure 12*. Protected species Target Notes are shown on* Figure 13*. The main characteristics of the study area are described in the following sections, with sites or features of particular conservation value detailed as appropriate. Hedgerow numbers are identified as green dots on* Figure 12 *and the results of the hedgerow assessment are presented as green Target Notes.*

Figure 12 – Phase 1 Species

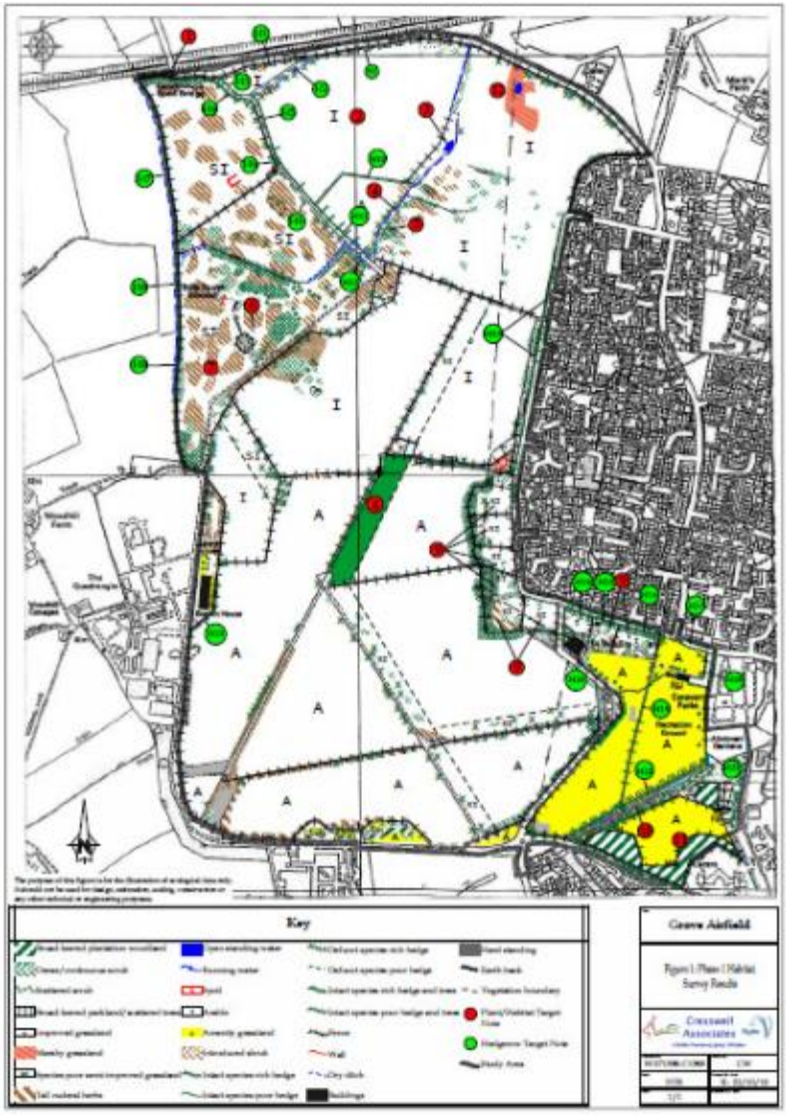
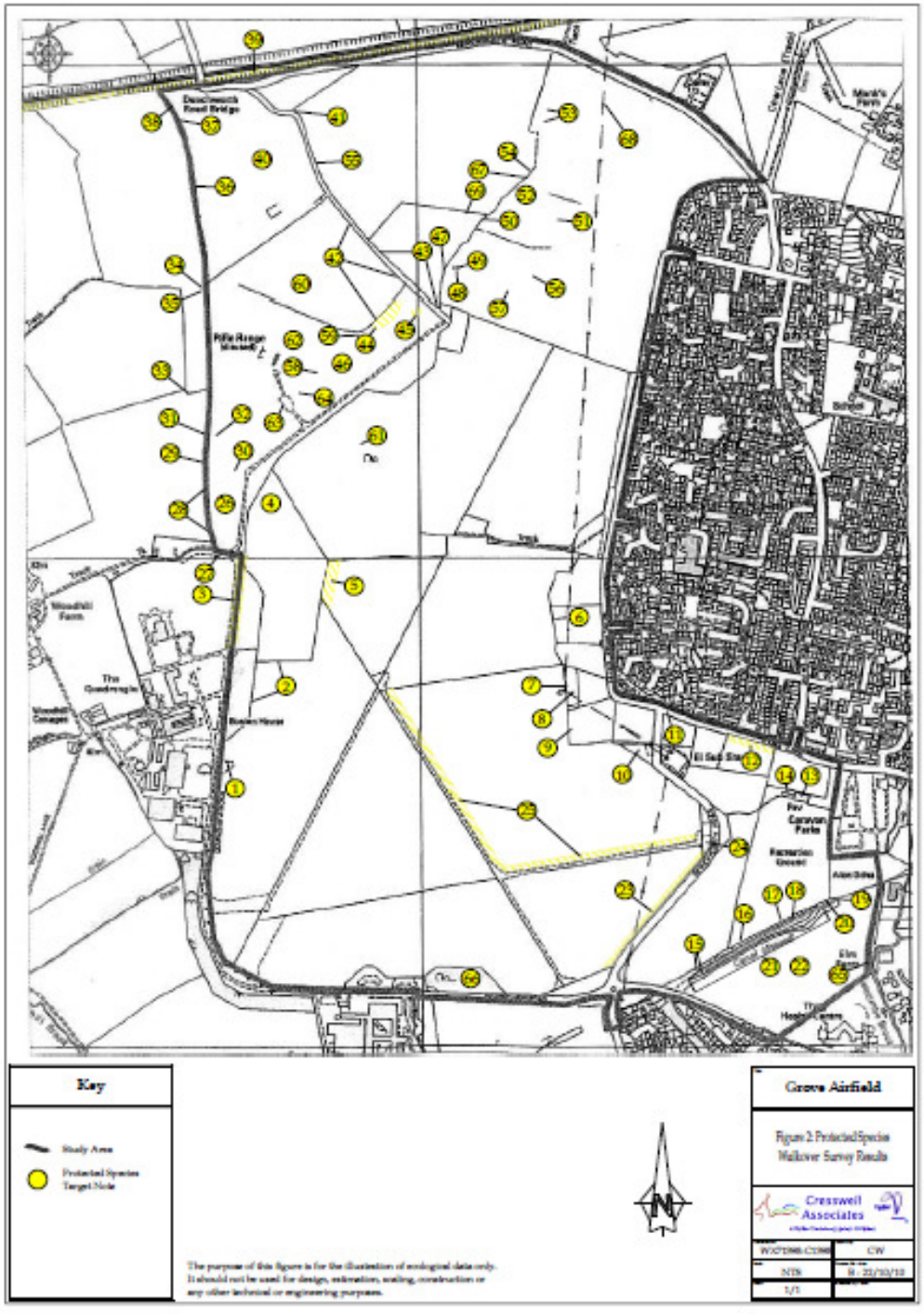


Figure 13 – Protected Species



3.3 Ecology Along the Wilts and Berks Canal

At this stage no formal ecological surveys have been undertaken. However observations from the site walkover along with documentary evidence from other planning applications have been used as the basis for this section of the report.

3.3.1 Habitats

The habitats along the canal are characterised by open water, emergent vegetation on the edges of the canal, overhanging vegetation (e.g. hawthorne and blackthorn) on the opposite bank to the towpath and numerous large mature trees, many of which have trunks that are covered in ivy.

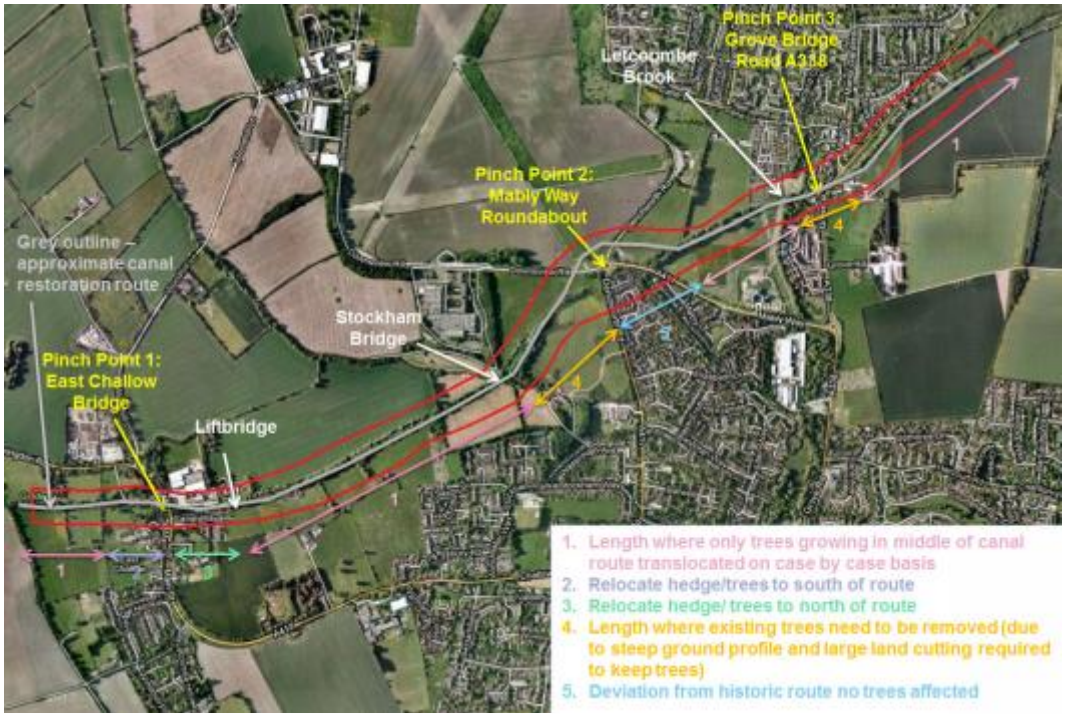
3.3.2 Trees and Hedgerows

Almost the entire length of the existing canal is lined with mature trees. Due to their age and setting in the wider landscape many are designated with Tree Preservation Orders. They also provide an important habitat for birds and otters (for details see below).

Hedgerows are present along a significant proportion of the canal's length; predominately on the bank opposite to the towpath. High quality hedgerows can be designated and afforded protection under Hedgerow Regulations 1997 (for countryside hedges) and Section 97 of Environment Act, 1995.

Figure 14 illustrates where it may be necessary to remove or translocate trees and hedgerow, pending results of an arboculture study.

Figure 14 – Tree Impact Mitigation Measures



Recommendations regarding trees and hedgerows

As part of the planning application it will be necessary to commission tree surveys undertaken in line with BS5837.

Where trees will be completely removed an impact assessment will be required and replacement planting strategy prepared (in line with the requirements of BS5837). An impact assessment may also be required, along with the identification of construction management measures, for the protection of trees that will remain. This should also be carried out prior to any planning submission.

The Local Planning Authority should be consulted regarding the status of the hedgerows, particularly where it is proposed that the hedge line is moved. Where the hedgerow is designated further consent will be required and specific assessment and replacement planting measures developed.

Once planning and any other consents are approved it is recommended that vegetation clearance and replanting is undertaken between October and the end of February to avoid the most sensitive times of year for protected species and to meet the optimal time of year for replanting /translocating. Where possible this should be undertaken in advance of the main construction works to allow the replacement planting to establish as early as possible.

3.3.3 Water Voles

The limited flow, overhanging vegetation and channel cross sections of the existing sections of canal indicate that the existing sections of canal have potential to contain water vole. This is also supported by findings for the ecology surveys for development at Stockham Farm.

It is illegal to harm water voles or destroy their habitats which consist of burrows into the banks of streams, rivers and canals. Therefore anywhere along the route of the canal where construction activity may occur adjacent to existing reaches of canal as well as directly impact on it (e.g. constructing the diversions and dealing with the pinch points) will require water vole surveys.

Recommendations regarding water voles

As part of the planning application commission water vole surveys at the points along the canal that will connect into the proposed construction work. These surveys should be undertaken between March and October.

These surveys will need to be included as part of any future planning application.

Depending on the findings from the surveys it may also be necessary, post planning, to prepare construction method statements and obtain the relevant licences from Natural England before works commence on site.

3.3.4 Otters

Otters may be active along the canal, however no evidence of otter holts or lay-ups were identified. This may be due in part to a lack of fish in the canal and the level of disturbance from people using the canal towpath for recreational activities.

Recommendations regarding otters

The nature of the habitat and the existing levels of disturbance mean that otters do not present a significant risk.

However, prior to construction it is recommended that a qualified ecologist undertake a pre-start walkover to confirm that otters are still not significant.

3.3.5 Great Crested Newts

A lack of fish and the presence of emergent aquatic vegetation in the existing sections of canal indicate the potential for newts, including great crested newts (GCN), to be using the existing sections of canal as breeding ponds. This is also borne out by the results from surveys undertaken as part of the Stockham Farm planning application which assessed the existing sections of canal has having a high suitability for GCN. This was confirmed by surveys which conclude that there is a medium sized population in this area.

It is also likely that the remaining sections of canal to the east and west of the Stockham Farm also contain GCN.

Due to the close proximity of the proposed development (within 500m) to water bodies confirmed to be used by breeding GCN and the potentially suitable terrestrial habitat present within this area, a Natural England licence will be required to be in place prior to any works that may result in potential impacts to habitats that may support GCN.

Recommendations regarding great crested newts

GCN surveys at the locations where construction works will occur (to include all waterbodies within 500m). Surveys from March to June.

If a planning application is envisaged before June 2014 then these surveys should be commissioned as soon as possible to ensure that they are completed within the survey window for this year.

If GCNs are present suitable mitigation measures should be designed and agreed with Natural England to support obtaining a licence for the works. This needs to be obtained and the mitigation measures implemented prior to construction works commencing. If the mitigation includes trapping waterbodies only then this can only be undertaken between March and June. If newt terrestrial trapping is also required this can be undertaken from March to October

3.3.6 Badgers

A badger survey has not been undertaken as part of this scheme. However a sett has been found within the boundary of the Stockham Farm development. As a result there is the potential for further setts to be present. It is illegal to disturb or undertake works within 30m of a sett without a Natural England licence.

Recommendations regarding badgers

Undertake badger survey at locations where physical construction works are proposed to identify where setts are within 30m of the temporary and permanent works. The

resulting survey results and recommendations will be required for any subsequent planning application.

If badger setts are present where possible the scheme works should be designed to avoid impacts. If this is not feasible then following planning a license should be obtained for works within 30m of a sett, and ideally it should aim to avoid loss of the sett. If this cannot be avoided a replacement sett will have to be constructed as part of the scheme and this would have to form part of the planning application

3.3.7 Reptiles

Habitats within the site were considered to be generally sub-optimal for use by reptile species, being dominated by recently converted arable land, but with habitats present at the edges of areas of immature tree planting and along the canal corridor with a low potential to support small numbers of reptiles. It is illegal to kill or injure any reptiles.

Recommendations regarding reptiles

Prior to construction works commencing measure to minimise the risk of harm to reptiles should be implemented following the guidance of a suitably qualified ecologist. This might include directional strimming from the works area in the direction of any habitats to be retained and the site perimeter. Passive displacement methods should also be employed.

3.3.8 Bats

Bats and their habitats are protected under the Wildlife and Countryside Act 1981 (as amended) and by the Conservation of Habitats and Species Regulations 2010. In summary this makes it an offence to damage destroy or obstruct any place used by bats for breeding and shelter, disturb a bat, or kill, injure or take a bat.

The entire length of the existing canal is lined by mature trees that appear to contain fissures, cracks and are well covered with Ivy. Furthermore, the canal itself provides suitable habitat for commuting and foraging bats. Where any of the proposed works are likely to result in the removal of trees there is a risk that bats could be disturbed or killed and their habitat lost.

Recommendations regarding bats

Before any planning application is submitted an assessment of bat roost potential of any trees that could be felled, lopped or trimmed will be required. If this identifies a risk of bats being present then emergence surveys will also be required to inform the planning application. If summer roost and activity surveys are required they have to be undertaken from April to October.

If bats are present in trees that will be felled or trimmed as a result of the scheme a licence will have to be obtained from Natural England. Mitigation for the lost habitat will have to be provided and a method statement prepared and agreed with Natural England.

3.3.9 Breeding Birds

All nesting birds and their nests are protected under the Wildlife and Countryside Act, 1981 (as amended). The mature trees lining the canal all have potential to contain breeding birds. Records and the Stockham Farms surveys also identify that bullfinch *Pyrrhula pyrrhula* and dunnock *Prunella modularis* (both BoCC Amber List), linnet *Carduelis cannabina*, song thrush *Turdus philomelos*, house sparrow *Passer domesticus*, skylark *Alaudaarvensis*, and starling *Sturnus vulgaris* (all BoCC Red List) may breed in the area. Where possible trees and existing habitats should be retained.

Recommendations regarding birds

Prior to any planning submission it is recommended that a breeding bird survey is undertaken of any trees and other habitats that could be lost as a result of the works.

Impacts on breeding birds can be managed by implementing the following measures.

Any removal of woody vegetation including immature woodland should therefore occur outside of the bird-breeding season (March to August inclusive) to minimise the risk of disturbance to breeding birds.

If this is not possible, such vegetation should be checked prior to removal by a suitably experienced ecologist. If active nests are found, vegetation should be left untouched and suitably buffered from works until all birds have fledged. Specific advice should be sought prior to undertaking the clearance.

3.4 Heritage

This review is concerned with the potential effects on designated heritage features. None of the canal features are listed structures or scheduled monuments. However some of the properties adjacent to the canal are listed.

Recommendations regarding heritage

Prior to any planning application the Local conservation officer should be consulted to confirm whether there are any specific issues to be concerned about.

3.5 Public Rights of Way

Public rights of way run almost continuously along the route of the canal and help to connect East and West Challow. It is also used for amenity walkers and as a result is of value to the local community. It is also an important feature of the canal and maintaining public access is an important part of restoring the canal.

Recommendations regarding public rights of way

It may be necessary to apply for a temporary diversion of the footpath to allow construction access. This can be done following any planning application.

An application for a permanent diversion will also be required, particularly where the canal deviates from its original alignment.

3.6 Water Quality

Water supply is not explicitly covered within the scope of this report. This section is concerned with water quality and the Water Framework Directive. The canal is currently classified as an artificial waterbody with Good Ecological Potential. Under the WFD any works to the waterbody will have to ensure that the 'Good Ecological Potential' of the waterbody will not deteriorate as a result of the works.

Letcombe Brook is also designated as having Good Ecological Status. Likewise the WFD requires that works will not result in deterioration in the status of the brook.

Recommendations regarding water quality

The Environment Agency will require the proposals to be able to demonstrate that they will not result in a lower status of the existing sections of canal and Letcombe Brook will not deteriorate as result of the proposals before they will approve or provide the necessary consents for the scheme (e.g. Land Drainage consent).

It is recommended that a WFD compliance assessment is undertaken to assess whether the proposals do comply and if not what measures will be required to ensure that it does comply.

3.7 Potential Funding Opportunities

The restoration of the canal presents an opportunity to provide wider benefits as a consequence of the works. In some cases these opportunities may also allow third party funds to be obtained. Some opportunities are described below.

3.7.1 Water Framework Directive Enhancements

Both the Canal and Letcombe Brook have Good Status or Good Potential respectively. This means that in terms of their ecology, morphology and chemical quality are at the optimum and do not require works to improve their quality under the Directive. As result the project cannot apply for capital to fund improvement works from the Environment Agency's Catchment Restoration Fund.

3.7.2 Heritage Lottery Fund

The Heritage Lottery Fund (HLF) provides funding for projects that protect and enhance heritage as well as helping to educate and train people. The funds are managed through a number of programmes. Based on a review of these programmes it is recommended that the Trust consider making funding applications to the:

- Sharing Heritage (funds projects from £3,000 to £10,000)
- Our Heritage (funds projects from £10,000 to £100,000)
- Heritage Grants (grants over £100,000)
- Heritage Enterprise (funds projects from £100,000 to £5million)
- Skills for the Future (funds projects from £100,000 to £1million)

Some of these grants will be better suited to making contributions towards the operation of the canal (e.g. Sharing Heritage could be used to fund the provision of information; such as interpretation boards, for the canal or to fund community engagement events that help to share knowledge about the historic role of the canal). Further information about the individual funds, the information that HLF require and the outcomes the projects should provide can be found on http://www.hlf.org.uk

3.7.3 District and County Council

Other organisations, such as Vale of White Horse District Council and Oxfordshire County Council may also have funds that could be accessed, particularly for projects with multiple benefits such as this (e.g. heritage benefits and potential public rights of way benefits by providing an alternative to crossing roads for walkers and cyclists).

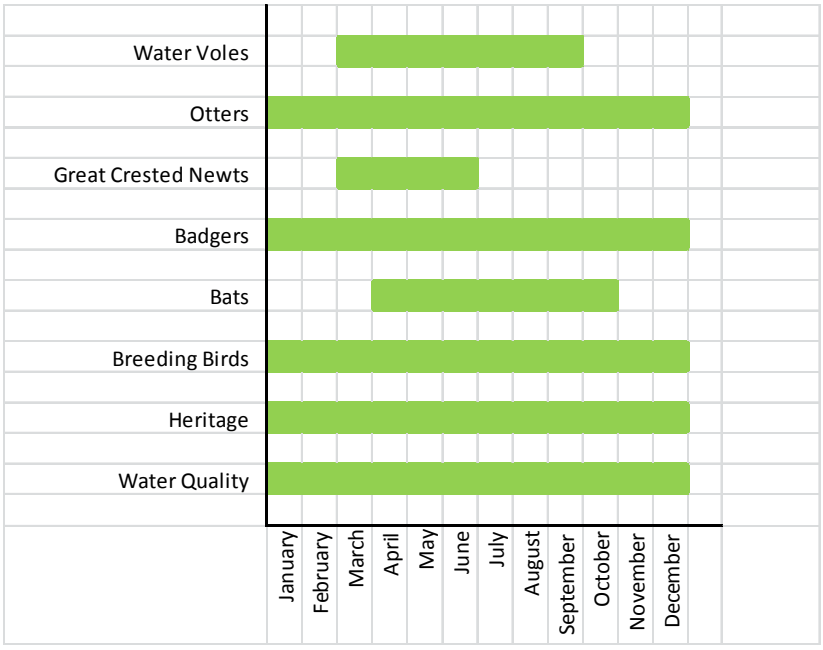
3.7.4 Societies for Connectivity

Sustrans, the Ramblers and the British Horse Society may also have an interest in the project given that it could help to improve access and reduce road crossing for pedestrians, horse riders and cyclists using the current towpath. However, it should be noted that these organisations tend not to have access to large funds and are more likely to be able to provide advice on how to meet the needs of the rights of way users that they represent.

3.8 Summary

The environmental and ecological recommendations are summarised below in Figure 15, which should be undertaken leading up to a Planning Application (showing time windows in which surveys may take place)

Figure 15 – Timeline for Ecological Surveys



4 Basis of Design

4.1 Historical Alignment

The historical alignment is clearly visible along this length where hedgerows and trees have established themselves since closure of the canal in 1914. There are extensive historical features along the canal route in question (refer to Scott Wilson report excerpts in Appendix A) including:

- A lift bridge (Kings Lift Bridge),
- Wharf sites at East Challow and Grove Wharf,
- Four bridge crossings (East Challow Bridge, Stockham Bridge, Hunters Bridge, and Grove Bridge),
- Four locks (Grove Top Lock, Limekiln Lock, Grove Common Lock and Smallmarsh Lock),
- One aqueduct crossing at Letcombe Brook.

4.2 Historical Water Levels

Historical canal levels are based on Scott Wilson Report's interpretation of the Royal Commission (1907) and LJ Dalby (1986). Scott Wilson noticed some discrepancies between the two sources of data; for the stretch of canal between Longcot Top and the end of Grove Locks, these discrepancies range up to 0.4m. The Scott Wilson report recommends the use of the adjusted Dalby (1986) figures for this stretch of canal. We have therefore based our historic canal levels on these values as shown in Table 4.

Table 4 – Historical Canal Levels

Lock	Water Level	Lock Fall
Longcot Bottom Lock	86.72 mOD	2.92m Fall
Grove Top Lock	83.8 mOD	2.86m Fall
Lime Kiln Lock	80.94 mOD	2.74m Fall
Grove Common Lock	78.2 mOD	2.90m Fall
Smallmarsh Lock	75.3 mOD	2.90m Fall
	72.4 mOD	

Water balance and supply for this section of canal is discussed in the Scott Wilson report. Spring lines probably fed the canal along this route (these springs can still be seen today).

4.3 Topography Data

The levels of the existing towpath, utilities and road crossings are based on the Glanville Survey of 2004. The Glanville survey levels are based on Newlyn Datum, using OSGM02 transformation of co-ordinates, refer to Appendix B1.

In the area around Mably Way roundabout, Arup have also used the survey data obtained from the Stockham Farm Planning Application data (refer to Appendix

B2) which provides an area of topographic survey information to supplement the Glanville Survey data.

In addition Glanville were commissioned to survey additional cross sections along the route during writing of this report; for details of this survey refer to Appendix B3.

Glanville also re-confirmed details regarding Letcombe Brook to be as follows:

- Concrete culvert length 5 metres, although slightly skewed relative to this surrounding brick head wall,
- Approximate diameter 1.05m (+/-0.05m),
- Top of brick head wall +78.66m OD, obvert of culvert +77.31m OD, bed level +76.41m OD.

In addition Glanville have updated utility and service records from their 2004 work, which also may be seen in Appendix B3.

4.4 Design Standard

The following parameters were assumed throughout the feasibility design of this section of canal. The intention is that the restored canal becomes part of the overall cycle path network and has been designed for this wherever possible. It has not been specifically designed for bridleway usage. In addition access to the canal should be as complaint with DDA requirements as possible, but this is not feasible in all locations.

Table 5 – Basis of Design for Canal Restoration

Item	Requirement	Source
Design Vessel	Length 22m, 2.13m beam, 1.0m draft i.e. standard narrow boat dimensions	Restoration of the Wilts & Berks Canal Feasibility Study, Final Report, January 1998, Scott Wilson
Channel Size	Bed width 4.27m minimum, 5.33m preferred	
	Depth of Water 1.37m minimum, 1.5m preferred	
	Freeboard 0.3m	
	Waterway area 10m2 minimum, 13m2 preferred	
Locks	Width 2.2m minimum	
	Length 22.6m minimum	
Bridge Crossing	Width 2.4m minimum, 2.7m preferred	
	Air draft 2.3m minimum, 2.7m preferred	
Water velocity	0.37m/s maximum	
Towpath	Width 2.0m minimum	
	Headroom 2.0m minimum, 2.3m preferred for pedestrians	Guidance for Towpath Design, British Waterways January 2012
Cyclepaths	Headroom 2.4m minimum 2.7m minimum for subway lengths longer than 23m	Sustrans[1]
Wheelchair Access	Ramp slopes not exceeding 10m, maximum gradient 1:20, maximum rise 500mm Ramp slopes not exceeding 5m, maximum gradient 1:15, maximum rise 333mm Ramp not exceeding 2m, maximum gradient 1:12, maximum rise 167mm	Department of Transport's Inclusive Mobility - A Guide to Best Practice
	Width >900mm single wheelchair or 1.8m for passing two wheelchairs. Wheelchair turning space 1.4m square.	Metric Handbook Planning and Design Data, Second Edition 2002

1. http://www.sustrans.org.uk/sites/default/files/documents/junctions20and20crossings.pdf

5 Engineering Feasibility

5.1 Drawing List

The following drawings accompany this report and may be found in Appendix C.

Table 6 – Drawing List

Drawing	Scale	Title	Date
226259-001-05	1:5000@A1/ 1:10,000@A3	Proposed Canal Alignment Key Plan	09/01/14
226259-002-05	1:2000@A0/ 1:100@A0	Proposed Canal Plan Long Section and Sections, 1 of 3	09/01/14
226259-003-05	1:2000@A0/ 1:100@A0	Proposed Canal Plan Long Section and Sections, 2 of 3	09/01/14
226259-004-05	1:2000@A0/ 1:100@A0	Proposed Canal Plan Long Section and Sections, 3 of 3	09/01/14
226259-005-04	1:2000@A3	Detail of Pinch Point 1 East Challow Crossing	09/01/14
226259-006-04	1:2000@A3	Detail of Pinch Point 2 Mably Way Roundabout	09/01/14
226259-007-04	1:1000@A3	Detail of Pinch Point 3 Grove Road Crossing	09/01/14
226259-008-02	Various	Locks, Winding Holes and Pedestrian/ Vehicular Swing Bridge	02/08/14
226259-009-05	1:20 Hor 1:200 Vert @A3	Summary of Water Level Changes	09/01/14

Refer to Drawing 001 for the full layout of the proposed canal and to Drawing 009 for an overview of the proposed canal water levels and ground levels.

The following section of the report discusses the optioneering that was undertaken to arrive at the final proposed layout of the canal with special focus on the pinch points at East Challow (Pinch Point 1), Mably Way Roundabout (Pinch Point 2) and Grove (Pinch Point 3).

5.2 Pinch Point 1 – East Challow Road Bridge

Please refer to Drawings 002 and 005 for this section of canal.

5.2.1 Approach to the A417 from the West

The approach to the A417 from the west has required careful consideration as, due to the narrowness of available land, it was not possible to avoid land take in entirety for this section of canal. Nevertheless, efforts were made to minimise the amount required and the number of landowners which will be affected.

Immediately west of the A417, a large amount of land take from Ivanhoe will be unavoidable in order to accommodate the drop lock. The complete purchase of the

Ivanhoe property is recommended to provide access for the construction of the road crossing, refer below.

5.2.2 Lock Options

As the canal passes through East Challow, it will need to pass the A417. The road level at the point of crossing is +85.22mOD, while the canal will be approaching it at historic water level of +83.80mOD. There is insufficient clearance for the canal to remain at historical water level and pass the existing road. In order to pass this obstacle, either the road must be raised, a lift bridge installed, or the canal lowered to pass under the road with sufficient clearance.

Leading on from our work in 2005 and our consultation with the OCC at the time and more recently in 2013, it was clear that raising the level of the road at this pinch point was not a feasible solution due to issues regarding sight lines and the impact on adjoining properties. The canal will therefore have to pass under the existing road at the road's current level. Based on an assumed structural depth of the road and culvert roof of 0.7m and an air draught of 2.5m, the water level for the canal to pass under the A417 will need to be +82.02mOD. This will be subject to a later check on utilities running along the road.

We have reviewed different options for the lowering of the canal to pass under the A417 crossing of East Challow Road Bridge, refer to Table 7 below. When reviewing these options, we have considered amongst others, the land take required downstream and the relative cost of each option.

Table 7 – Pinch Point 1 Options

Option	Description	Pro's	Con's
1 Lock down	Lock down the canal prior to the road (+82.02mCD), and maintain this water level until the new Mably Way Lock as per the recommended solution in 2005 study.	This solution has the benefit of only requiring one lock for this pinch point.	It requires more land take between East Challow and Mably Way roundabout due to the canal being in deep cutting (or higher expense due to highly engineered side slopes to minimise land take). The difference in levels between the canal towpath level and the land either side of it will range from 2.0m up to 6.0m at the point of deepest cutting.
2 Sump pound	Lock down the canal prior to the road (+82.02mCD), and re-raise the canal to historic water level (+83.80) with another lock east of East Challow road bridge.	This solution means that the canal can be at a higher level between East Challow and Mably Way roundabout, reducing the amount of land take required and volume of cut material. Almost no cutting and land take will be required for the section of the canal which is currently in water between East Challow and Stockham Bridge (890 metres)	This solution requires two locks at East Challow for this pinch point, and would require two pumps to operate. An additional lock would also be required at Mably Way roundabout to accommodate the large change of level from historic water level to pass under Downsview Road and Denchworth Road (total lock fall of 3.88m)
3 Drop lock	Build a drop lock to pass the A417. Similarly to Option 2, this lock would drop the level of the canal to +82.02mOD) immediately before the A417 and re-raise it immediately afterwards to historic water level. However, it will do this in one lock rather than two.	As for Option 2, this solution allows the canal to be at a higher level between East Challow and Mably Way roundabout, reducing the amount of land take required and volume of cut material. Almost no cutting and land take will be required for the section of the canal which is currently in water between East Challow and Stockham Bridge (890 metres).	This solution requires a large pump to pump the equivalent volume of water of three regular locks out of the sump lock within a reasonable time frame every time the lock is used. An additional lock would also be required at Mably Way roundabout to accommodate the large change of level from historic water level to pass under Downsview Road and Denchworth Road (total lock fall of 3.88m
4 Divert canal around East Challow	Divert canal away from historic route and take to the north or south of East Challow Road Crossing.	No benefits perceived, apart from having a crossing at a safer point on the A417.	Increased length of canal becomes more expensive, canal route moves away from safeguarded route (the historical alignment) and a road crossing is still required.

In order to decide which of these options should be used, the amount of cut required for Option 1, lock down, was calculated and compared to the amount of cut required for Options 2 and 3, sump pound and drop lock. Table 8 below summarises the results of these calculations.

Table 8 – Summary of Cut/ Fill Volumes

Option	**Net Cut Volume (m^3)**	**Notes**
1 Lock down	192,000	The greater volume relative to Options 2 or 3 is due to the deeper cutting that would be required from East Challow to the New Mably Way Lock.
2 or 3 Sump pound or Drop Lock	130,000	Calculated for Option 3 Drop Lock. The cut volume for an alignment that used a sump pound with two separate locks would be marginally larger.
Difference	62,000	

Furthermore, consultation with Dandara Ltd (refer to Section 7.8) made it clear that there would be insufficient space in plan for the canal to be in deep cutting along Stockham Farm due to areas allocated to Phase 2 Great Crested Newt mitigation and public open space.

If it was in deep cutting, the canal would have to be in between two high retaining walls (5-6m high at some points) for the length of canal from the point of deviation from the historical route to Downsview Road. This bring up the relative cost of Option 1 and this would have led to negative perceptions of the canal by the public and by those using it, as well as impeding the integration of the canal with its surroundings.

The difference in cost between the two variations was estimated, taking into account, amongst others, the difference in cut volumes, lengths and heights of retaining wall and lock requirements, etc. For full details of the cost differences between the two variations, refer to Section 6.3 and Appendix E. The comparison in costs excludes the cost of the additional land purchase due to the deep cuttings in Option 1 and also excludes the cost of landfill tax on disposed material. The outcome of this costing is that Option 1 is estimated to be £1.03million more expensive than Options 2 or 3. Based on this cost difference and the practicalities of integrating the canal with the Stockham Farm development, we recommend the use of either a sump pound or a drop lock.

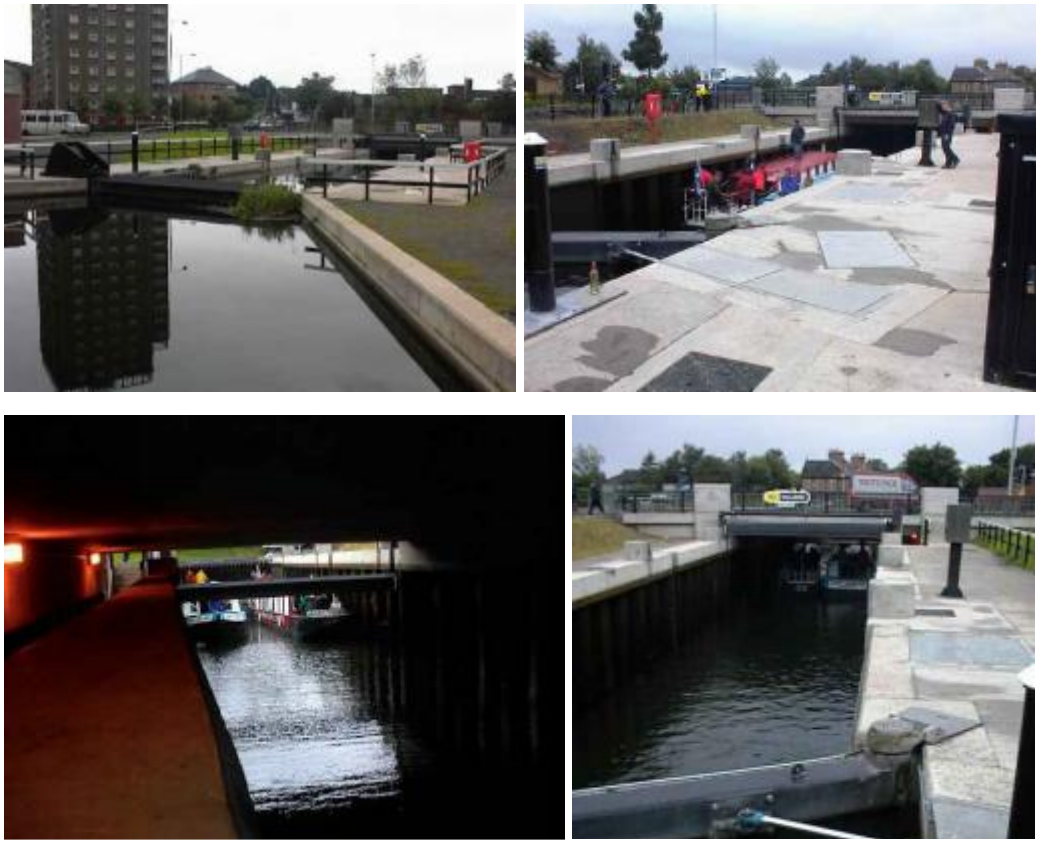
A drop lock allows for the gravitational water feed of the canal to be unrestricted when the lock is not in operation by simply leaving the gates open. For a sump pound a bypass pipe would be required through which all of the water demand of the downstream canal would have to pass. There is a risk that maintenance and clogging issues of the by-pass pipe could interfere with the canal supply.

A drop lock would also be quicker to pass than the two sets of locks of a sump pound. Although a drop lock requires pumping a larger volume of water in total, it requires less opening and closing of gates than a sump pound and therefore is a faster operation overall than a lock on either side.

In order to ensure continued water supply to the canal downstream and to minimise the total time required to pass the A417, we recommend the use of a drop lock.

There is currently only one existing drop lock in the world. It is the Dalmuir drop lock on the Forth & Clyde Canal. This lock was installed in 2000 to overcome exactly the same constraints as found at East Challow. Namely, the impossibility of raising a busy A-road due to sight lines and road classification as well as the impossibility of installing a lift bridge due to the interruption to traffic. See photographs in Figure 16 below for pictures of the lock in operation and Figure 17 for a schematic explaining the operation sequence of the lock.

Figure 16 – Photos of the Dalmuir Drop Lock in operation. © James Gentles

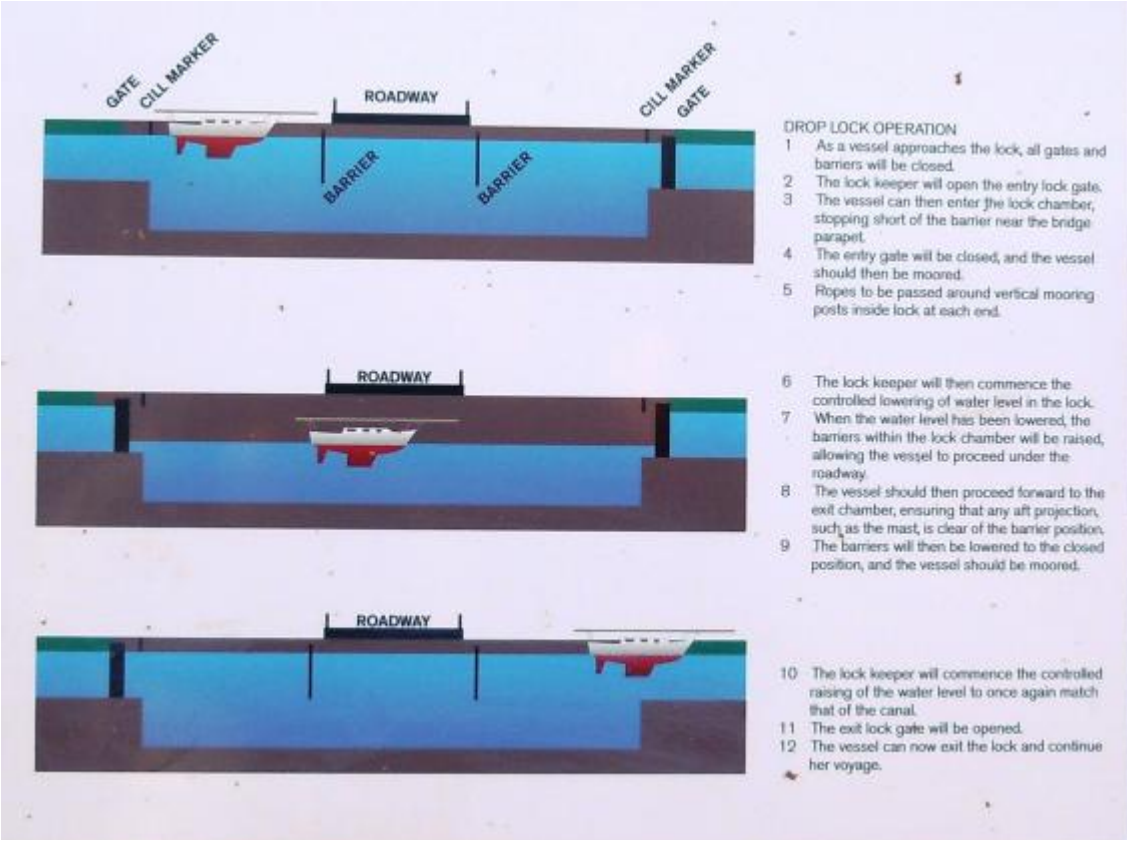


The main problem associated with using a drop lock is the large amount of water that must be removed from the lock to empty it at every usage. This can be done in two ways:

1. The most economical way, although very wasteful in terms of water supply for the canal system is to drain the lock into a nearby watercourse. This should only be done when water supply to the canal downstream is sufficiently high as this method interrupts the supply of water to the canal downstream.

2. The other way, is to pump the water out of the lock into the canal downstream. This ensures that the supply of water for the canal downstream is maintained. However, this uses a lot of electricity and is more costly.

Figure 17 – Schematic explaining the operation sequence of Dalmuir Drop Lock



The Dalmuir drop lock is capable of both methods of emptying the lock. The appropriate method is selected depending on water supply at the time of the operation. A similar combined method for the East Challow drop lock is recommended, with the lock draining into Woodhill Brook when water supplies are plenty and pumping out into the canal downstream when water supply is low.

In order to maintain the gravitational feed of the canal water supply when the lock is not in use, both lock gates' default position should be 'open'. This ensures that the flow is only momentarily interrupted when the lock is in operation.

Another aspect to consider when detailing a drop lock is the time it takes to pass the lock as each operation requires the emptying and filling of a volume of water roughly three times as big as a conventional lock. The full operation of the Dalmuir Drop Lock takes approximately 40 minutes. However, the proposed East Challow Drop Lock is considerably smaller than the Dalmuir Drop Lock. Table 9 below summarises the differences in dimensions between the two locks.

Table 9 – Dalmuir Drop Lock and East Challow Drop Lock comparison

	Dalmuir Drop Lock	East Challow Drop Lock
Length (m)	81	62
Width (m)	6	2.2
Lock drop (m)	2.5	1.78
Air draught	3.0	2.5
Volume of water emptied per usage (m^3)	≈ 2,000 (1215)*	< (300)

* Dalmuir Drop Lock website indicates 2000m3 of water being emptied, however our estimates are nearer 1215m3 – this should be clarified at later stages.

As can be seen from the above, the East Challow Drop Lock will need to empty considerably less water per usage than the Dalmuir Drop Lock. This will enable the pumps to be smaller than those used at Dalmuir and/or the waiting time to be shorter. The size of pumps should be chosen to balance the cost of the pumps (both capital and operational) compared to the anticipated vessel throughput of the lock at peak times to ensure waiting times are not too long.

The main drawback of the drop lock, or lock down, solution is the increased operational cost. Apart from pumping costs, the Dalmuir drop lock is manned and if this is required for the East Challow Drop lock this will be a significant ongoing expense. Inspection and maintenance costs will be higher as the system relies on mechanical equipment for pumping and operation of moving ship barriers.

We have had some discussions with Scottish Canals regarding the Dalmuir drop lock. Initial feedback is that the drop locks works well although it is long to operate and the pumping costs are considerable.

5.2.3 East of the A417

The proposed Nalder Estate development by Bewley Homes to the east of the A417 provides a good opportunity to move the alignment of the canal slightly north compared to the Arup 2005 proposal, thereby avoiding land take of the gardens of the majority of the adjoining properties to the south of the canal. However, some land take will be required from the three most eastern properties to the south of the canal.

The Northern edge of the canal has been kept south of the boundary of the Nalder Estate development. Consultation with Bewley Homes' agent, Ken Dijksman, has provided Arup with the latest layout of the Nalder Estate development.

We have assumed vehicular access to the Canal House housing group would ideally be provided through Nalder Estate development. However, this is subject to ongoing consultation between the WBCT and Bewley Homes. An alternative solution, as shown on our drawings, would be to provide a bascule pedestrian and single lane vehicular bridge across the canal at the end of Canal Way. The preferred solution should be to negotiate road access through Nalder Estates and if this is not possible addition of a bascule bridge.

A winding hole has been added within the curve of the road to allow boats to turn back in the event of an emergency / malfunction of the drop-lock. All land within the curve of this road will need to be purchased from the owner at the same time

as the canal route. Land extra to the winding hole requirements has been annotated as the 'WBCT depot site' which may contain trail-boat slipway, canoe club landing or other facilities. To facilitate this space, the road has been realigned slightly to provide a tighter access curve and a straight through the bridge section.

A Lock-Keeper's office and pump house has been shown on the land currently used as parish council car-park adjacent to Canal Way. This is to minimise noise disturbance from residential properties.

Recommendations regarding Pinch Point 1 (refer Drawing 005)

This section of the canal is proposed to be at historic water level (+83.80mOD) throughout except when passing under the A417 where a drop lock will be required. At this point the canal is lowered to +82.02mOD before being raised again to +83.80mOD immediately downstream of the A417. In addition, the following features are recommended to be incorporated:

- A winding hole prior to the narrowing down of the canal as it approaches East Challow from the West (and a sister winding hole is recommended towards the end of this short section of canal) which also serves as a waiting area for narrow boats with ancillary mooring points and fenders,
- Some landtake from the properties on the southern edge of the canal as it approaches the A417. The amount of landtake required from the Ivanhoe property is such that we recommended the full purchase of the property. This will also provide construction access.
- A new drop lock structure to pass under the A417 with accompanying pedestrian bridge incorporated into the upstream lock to allow the towpath to change from north to south of the canal. The drop lock will incorporate a double lane road crossing by conventional cut and cover methods, comprised of a reinforced concrete box culvert on piled foundations,
- A ramp from the towpath up to road level to facilitate both pedestrians and cyclist users on both sides of the drop lock,
- A small area of landtake on the south side from house owners gardens of the three easternmost properties along the southern edge of the canal opposite Canal House to avoid a navigation 'bottleneck',
- Road (vehicular) access to the Canal House and similar by provision of a bascule bridge, ideally this will be replaced by an alternative road route through the Nalder Estate development to accommodate emergency egress/ access for ambulances/ fire engines etc.
- A depot site adjacent to the sister winding hole including recreational facilities.
- A lock-keepers office and pump house.

5.3 Variation to Pinch Point 1

As discussed above, a secondary option for Pinch Point 1 would be to use a conventional lock and to have the canal leaving the Nalder Estate area at a low level (+82.02) after crossing the A417. The benefits of this option are:

- Lower operational and maintenance cost of canal (no pumps, no drop lock operators)
- Less number of locks required.

However, as discussed above, having the canal in deep cutting for large sections downstream is more expensive in terms of capital costs and would also reduce the integration of the canal with its environment.

5.4 Pinch Point 2 – Mably Way Roundabout

Please refer to Drawings 003 and 006 for this section of canal. As the proposed solution at Pinch Point 1 is a drop lock, the canal will be at historical water level (+83.80mOD) from East Challow to Mably Way roundabout.

Our proposals include the rebuilding of a bridge at the historical location of Stockham Bridge. A wide conventional bridge structure (gravity concrete headwalls supporting a bridge on bearings with handrails and DDA compliant access ramps and steps on ones side of the bridge) along with a cycle path ramp to connect to the towpath side giving access to the King Alfred Secondary School have been costed for.

Slightly east of the approximate location of the historical Hunters Bridge a winding hole has been added to allow boats to turn back in the occurrence of any emergency or malfunction prior to the staircase locks.

Examination of the Stockham Farm topography (Appendix B2) shows that the land adjacent of the proposed canal is high, which has required careful consideration of side slopes and encroachment on the Stockham Farm development. Discussions were held with Dandara Ltd to ensure that a strip of land was set aside for the canal in their Planning Application for Phase 2 of the Stockham Farm development. Dandara indicated that a 20m strip was the maximum they could be set aside for the canal due to their other planning constraints. These discussions have led to a reworking of the slopes and retaining walls for the section of canal between Stockham Bridge and Mably Way roundabout. Drawing 003 and 006 shows where 1:3 slopes will be achievable to the side of the canal and where vertical retaining walls will be required to make up the difference in levels. (Note this is slightly inconsistent with Table 3, but an adequate assumption for this stage of work).

Our work in 2005 concluded that the best solution for the canal to pass Mably Way roundabout and the roads branching off it was to deviate from the historical route and pass north of the roundabout. Our reasoning for this is outlined below.

Table 10 – Pinch Point 2 Options

Issue	**Historic Route (South of roundabout)**	**Arup 2005 Route (North of roundabout)**
Number of landowners affected	Three	One
Space in plan for canal and cutting	Little space available	Space available and landowner in favour of this canal route
Status of roads being crossed (especially relevant for construction methodology required)	A417 – closure of this road for construction will be difficult and will require government authorisations	Denchworth Road (north), B –road and Downsview Road, C – road.
Navigational aspects	Bend required in narrow canal section.	Relatively large bend, with wide canal

In order to pass under Downsview Road and subsequently Denchworth Road, the canal will have to be lowered to +80.12mOD. This will require a total canal drop of 3.68m. This will be done through a lock staircase comprising two locks which could possibly share a lock gate. An alongside weir distributing flow to the bottom of the lock flight has been proposed adjacent to the staircase locks to avoid excess water being discharged in a potentially dangerous and wasteful manner. A similar detail may be found at the staircase locks at the beginning of the Caldon Canal.

This section will also incorporate a cycle underpass and our proposals include consideration of gradients, ramps, sightlines and provided a costing for a wider road crossing.

At the Downsview Road crossing, the air draught is 3.0m and the towpath headroom 2.7m .The minimum depth of water of 1.37m has been taken deeper to 1.5m water depth to allow for siltation and accretion of organic matter at the bottom of the canal (promising a less frequent maintenance dredging requirement). Dedicated waiting bay areas with mooring bollards are provided on either side of the locks.

At Section K-K (between the two road crossings) a retaining wall is added on the northern towpath side to avoid land take from Grove Properties Ltd. On the south side, natural side slopes are used complemented by sheet piling to protect the carriageway. The towpath level has been raised to +600mm above water level in this short section to minimise excavation, although at later stages the overall towpath levels and gradients combined with drainage measures will need to be studied in more detail.

At the Denchworth Road crossing, the air draught is the minimum (2.3m) but to achieve the headroom on the cycle path requested by the WBCT (2.7m) the towpath level is lowered and separated by a concrete parapet from the water level as requested by the Trust. However this arrangement is not ideal as it cannot discharge stormwater under gravity and will need artificial support (e.g. pumped solution), hence this drainage detail should be confirmed and checked at a later stage.

At the suggestion of the WBCT we have included provision for a pedestrian bridge to continue a public footpath past the historic Grove Top Lock as well as temporary Wantage visitor moorings on land owned by vale District Council.

Discussions were held with the Oxfordshire County Council (OCC) regarding the future plans for Mably Way roundabout in light of the predicted increased traffic due to the Persimmon's Airfield development. It was concluded that, should the planning application be granted, the proposed plans for the realignment of the roundabout would not affect the proposed canal route. See Section 7 for more details.

Recommendations regarding Pinch Point 2 (refer Drawing 006)

This section of the canal is proposed to be at +83.80m OD falling after the new Mably Way Lock Staircase to +80.12m OD which is required to lower the canal underneath Downsview Road and Denchworth Road. In addition the following features are recommended to be incorporated:

- A winding hole then waiting area prior to the New Mably Way Lock structure

with suitable moorings,

- A new 2 no. lock staircase structure with towpath on the north side and DDA compliant ramp/cycle path including an alongside overflow weir,
- A double lane road crossing at Downsview Road by conventional cut and cover methods, comprised of a reinforced concrete box culvert on piled foundations,
- A ramp from the towpath up to road level to facilitate both pedestrians and cyclist users on either side of Downsview Road,
- A double canal boat width vertical edged section between the two road crossings,
- A double lane road crossing at Denchworth Road by conventional cut and cover methods, comprised of a reinforced concrete box culvert on piled foundations,
- Relocation of the airplane structure,
- A pedestrian bascule bridge towards Historic Grove Top Lock plus addition of visitor mooring basin,
- Grove Top Lock (already restored) is to remain in place as a feature but won't be part of the navigable canal route.

5.5 Variations to Pinch Point 2

A possible variation is that if Downsview Road might in the future be raised or realigned due to the Persimmon Homes Ltd airfield site development, the lock could be moved forwards in between the two road crossing to minimise excavation and cutting costs.

5.6 Pinch Point 3 – Grove Bridge

Please refer to Drawings 004 and 007 for this section of canal.

We have shown a proposed branch going south from the main canal route (which will double as a winding hole) at which a future terminal basin will be located. The terminal basin would be located close to the existing Mably Way pedestrian underpass and the footpaths leading into Wantage. The design of the terminal basin and the junction is outside of the scope of this study. Until the junction and the terminal basin are built, there will be a requirement for visitor moorings along this length of canal.

When determining the canal levels for passing under the Grove Road Bridge, we have ensured that the canal remains sufficiently high to pass over the foul water sewer with suitable clearance allowances. We have shown a reinforced concrete channel in this section, but consultation with Thames Water at a later stage may allow the use of excavated sides slopes, depending on the placement and distance required between manholes.

The canal in this section is the only area requiring fill (the remainder of the canal requires excavation) around the proposed mooring basin prior to the Letcombe Brook culvert crossing and proposed New Lime Kiln Lock.

At the behest of the Trust a narrow section has been added at the western end of the embankment (immediately east of the junction/winding hole) with slots for

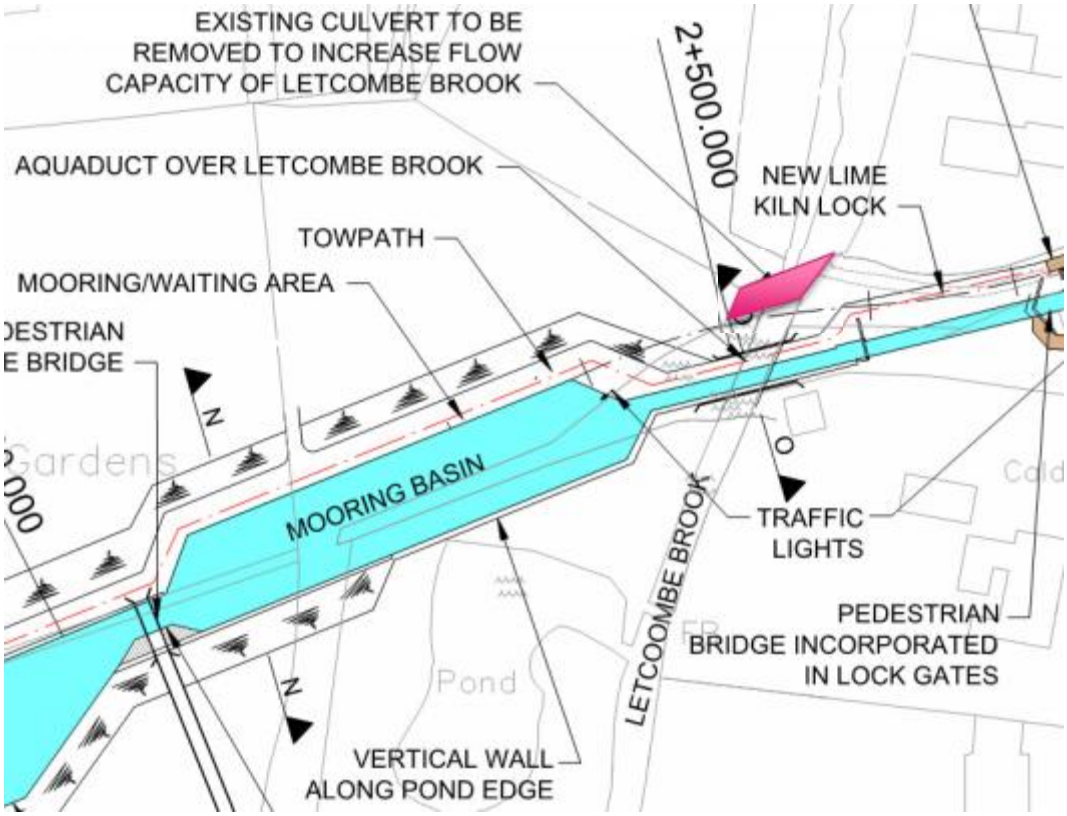
emergency stop planks to allow water to be held back in the event of a breach of the main embankment, thus protecting the Letcombe Brook from any accidental discharge. The eastern end of the embankment is protected by the lock gates. A pedestrian bascule bridge is also proposed here.

5.6.1 Letcombe Brook Aqueduct

Due to constraints in plan downstream of the Letcombe Brook crossing it will not be possible for the crossing of Letcombe Brook to be at the same position as the existing culvert. Instead, the crossing is proposed south of the existing culvert as shown in Figure 18 below.

The EA were consulted with regards to this crossing. For details of the consultation with the EA, refer to Section 7.3. As a result of our consultation with the EA, we have proposed the removal of the existing culvert and the construction of a culvert/bridge for the canal to pass over Letcombe Brook.

Figure 18 – Letcombe Brook Aqueduct



Currently, significant ponding occurs upstream of the existing culvert when flood flows exceed its capacity causing artificially high flood levels. The removal of this culvert will significantly reduce the flood levels upstream.

At the location of the Letcombe Brook culvert, the canal structural underside will need to be at +78.05m OD (assuming a 500mm thick reinforced concrete base). The top of towpath level will be +80.22m OD compared to the existing peak flood level (1:100 year +20% allowance for climate change) of +78.84m OD.

The flood flows and levels of Letcombe Brook after the removal of the existing culvert will need to be modelled in order to establish the required level of the soffit of the clear span bridge.

As per the 2005 Arup study, shortly downstream of Letcombe Brook, a new Lime Kiln Lock will drop the canal to the required level to pass beneath the A338. The Arup 2005 proposed canal route proposed raising the A338 by approximately 0.5m to allow the canal to pass underneath it. We have not repeated this suggestion as discussions with the OCC have made it clear that raising the A-road is unlikely to be accepted.

The recommended scheme also shows the purchase of the Wayside property as this will be required for ease of construction access, navigational space and allowing more room for a cycle pass under Grove Road crossing.

Beyond the road crossing, Grove Common Lock and Small Marsh Lock will bring the canal levels down to the existing ground levels and to the historic water level. Land take for this section of the canal has been positioned to the east of the historical canal route as this will only involve one agricultural landowner and will be easier to obtain than from the numerous properties to the west.

Recommendations regarding Pinch Point 3 (refer Drawing 007)

This section of the canal is proposed to be at +80.12mOD until the New Lime Kiln Lock where water levels drop to +78.07m OD. In addition the following features are recommended to be incorporated:

- A short section of reinforced concrete channel crossing the Foul Water Sewer (possible reduced to natural excavated and side sloped canal depending on discussions with Thames Water),
- A section of fill to construct the mooring basin and provide a mooring/ waiting area with towpath on the north side (this will require consideration of public footpaths and access to use of playing fields and allotments at later stages),
- A possible branch off to the a future terminal basin (location to be decided outside of this study),
- An area of fill revetment would impact on the existing pond which would decrease flood storage capacity; it is therefore proposed to construct vertical retaining walls alongside the pond as opposed to embankments. Details of this will be confirmed following detailed modelling of flood flows and levels of Letcombe Brook,
- The removal of the existing Letcombe Brook culvert,
- A clear span bridge crossing over Letcombe Brook,
- The New Lime Kiln Lock structure with traffic lights prior to the road crossing and pedestrian/ cycle swing bridge,
- A long narrow section of canal in a deep cutting to traverse Grove Road,
- Emerging on the east side of the road crossing a second set of traffic lights and a side mooring waiting area.

5.7 Summary

A summary of recommendations is given in Table 11, outlining the historical features versus which new infrastructure is proposed, and in addition what has been costed for in terms of a capital estimate refer to Section 6.

A summary of historic versus proposed lock and water levels is given in Table 12.

Table 11 – Summary of Historical versus Proposed New Features

Historical Features	**Proposed New Features**
Kings Lift Bridge	Outside scope, not costed
	New winding area, costed (Ch-100 start of costing)
	East Challow Lock (new)
East Challow Wharf	
East Challow Bridge	Road crossing A417 Drop Lock
Canal Farm Bridge	Single lane vehicular bascule bridge
Stockham Bridge	Not restored as humpback, replaced by approx. 45m span fixed bridge structure
Site of Hunters Bridge	Not restored or costed
	New Mably Lock Staircase
Grove Top Lock	Already restored as feature, adjacent to canal
Site of Limekiln Lock	Shifted to after Letcombe Brook
Letcombe Brook Aqueduct	New Limekiln Lock
Grove Bridge	Road crossing A338
Site of Grove Wharf	End of costing Ch+3100 assume to be restored
Grove Common Lock	Location and signposts, but not costed as restored
	New winding area not costed
Smallmarsh Lock	Not costed

Table 12 – Summary of Proposed Canal Water Levels

Historic			Proposed		
Lock	Water Level	Lock Fall	Lock	Water Level	Lock Fall
Longcot Bottom	86.72 mOD	2.92m	Out of scope		
			East Challow Drop Lock	83.8m OD	0m
			New Mably Way Staircase	83.80m OD	3.68m
Grove Top	83.8 mOD	2.86m			
Lime Kiln	80.94 mOD	2.74m	New Lime Kiln	80.12m OD	2.05m
Grove Common	78.2 mOD	2.9m	Grove Common	78.07m OD	2.77m
Smallmarsh	75.3 mOD	2.9m	Smallmarsh	75.30m OD	2.90m
	72.4 mOD			72.70m OD	

6 Cost Estimate

6.1 Introduction

We have prepared an indication of costs to a standard and accuracy appropriate to concept design stage.

Using the topographical information available, and therefore an inherent level of uncertainty, we have calculated the cut and fill volumes of the proposed solution and significant variations.

We have not negotiated with landowners for land or building purchase costs and will not be including these costs in our estimates. Other key exclusions and assumptions that were used can be found in Section 6.4 and Section 6.5.

6.2 Preferred Alignment

The estimated construction cost of the 3.2km scheme is £12.39M, as detailed in Table 13. This is equivalent to an average £3,870 per metre of canal.

A full breakdown of the capital cost estimate and the unit rates that were adopted and derived are given in Appendix E. **The estimate does not include allowances for contingency, compensation, contractor preliminaries, or overheads and profits. Also excluded are legal and design fees and any land acquisition or VAT if applicable. These are 2013 prices.**

Table 13 – Summary of the Estimated Capital Cost

Section of route / item	Chainage (m)	Estimated construction cost (£)	Average cost per metre
Pinch Point 1: East Challow	-100 - 1350	3,230,100	2,228
Pinch Point 2: Mably Way Roundabout	1350 - 2365	5,766,700	5,681
Pinch Point 3: Grove Road	2365 - 3100	3,388,900	4,611
TOTAL		**£12.39M**	**3,870**

The estimate was prepared assuming the channel cross sections detailed in Table 14.

Table 14 – Cross Sections Assumed for Costing Purposes

Cross section	Start chain-age (m)	Finish chain-age (m)	Length	Description of assumed cross section	Estimated capital cost (£)
PP1 East Challow					**3,230,100**
WA	-100	-25	75	Refer to Typical Winding Area detail. For channel depth and levels refer to section AA.	82,000
BB	-25	75	100	Refer to section BB.	240,200
CC	75	200	125	Refer to section CC.	276,200

Cross section	Start chain-age (m)	Finish chain-age (m)	Length	Description of assumed cross section	Estimated capital cost (£)
DD Drop Lock	200	270	70	Refer to section DD.	1,239,600
EE	270	400	130	Refer to section EE.	292,200
GG1	400	425	25	As GG2 except existing ground level assumed constant at 84.10mOD (i.e. historic canal assumed filled-in) and no standing water. Winding hole included.	99,200
FF Bascule Bridge	425	450	25	Refer to section FF Bascule Bridge	302,300
GG2	450	900	450	Refer to section GG.	219,500
GG3	900	1350	450	As GG2, except surrounding existing ground level assumed to be 0.4m lower.	479,000
PP2 Mably Way Roundabout					**5,766,700**
Stockha -m New Bridge	1350	1365	15	Large span (40-50m) fixed pedestrian and cycle bridge at existing ground level with canal in cutting passing underneath. Access from bridge to canal towpath.	800,000
HH1	1365	1550	185	Refer to section HH.	444,400
HH2	1550	1675	125	As HH1, except existing ground level assumed to be 1.7m higher and concrete retaining walls used to limit cutting total width to 20m. Winding hole included at junction between historic and new canal route.	721,100
II New Mably Way Double Lock	1675	1735	60	Refer to section II and Typical Lock Detail. Lock staircase includes overflow weir.	867,100
JJ	1735	1765	30	Refer to section JJ.	645,700
KK	1765	1865	100	Refer to section KK.	448,500
LL	1865	1895	30	Refer to section LL.	568,600
SS1	1895	2100	205	As SS3, except existing ground level assumed to be 2.1m higher	521,900

Cross section	Start chain-age (m)	Finish chain-age (m)	Length	Description of assumed cross section	Estimated capital cost (£)
SS2	2100	2365	265	As SS3, except existing ground level assumed to be 1.25m higher. Mooring area included.	749,500
PP3 Grove Road					**3,388,900**
MM	2365	2445	80	Refer to section MM. Winding hole included.	563,000
NN	2445	2510	65	Refer to section NN. In addition southern embankment assumed to be retained on the landside by a 2m high concrete retaining wall for 50% of the chainage.	239,200
OO	2510	2540	30	Vertical sheet pile wall channel with 1:2 side slope embankments, channel 3m wide, top of embankments 2m wide. Assumed existing ground level 78.3mOD, water level 80.12mOD, top of embankment level 80.42mOD. Footpath elsewhere.	567,600
New Lime Kiln Lock	2540	2570	30	See Typical Lock Detail.	374,600
PP	2570	2605	35	Refer to section PP.	160,900
QQ	2605	2640	35	Refer to section QQ.	718,000
RR1	2640	2705	65	Refer to section RR.	347,500
SS3	2705	2900	195	Refer to section SS.	259,600
SS4	2900	3080	180	As SS1, except average existing ground level assumed to be 78.70m.	126,800
RR2	3080	3100	20	Assumed towpath level and average existing ground level 78.43mOD, water level 78.07mOD. 13m wide channel, natural slope on north bank, vertical sheet pile wall for south bank.	31,800

6.3 Alternative PP1 and PP2 Vertical Alignment

The capital cost of the scheme would be increased if the elevation of the channel was lowered from west of East Challow to the proposed New Mably Way Lock

(between chainage -25m to 1635m). This alternative alignment would put the channel in a deeper cutting for this length (with a water level of 82.02mOD rather than 83.80m) but would remove the need for a drop lock at the East Challow A417 road crossing.

The additional cost associated with this non-drop lock alignment has been estimated to be around £1.03million, increasing the total cost of the 3.2km scheme to £13.42million. This is equivalent to £4190 per metre of canal.

The alternative cross sections that were used to price this alternative option are described in Table 15.

Table 15 – Cross Sections assumed for Variations

Cross section	Start chain-age (m)	Finish chain-age (m)	Length	Description of assumed cross section	Estimated capital cost (£)
PP1 East Challow					**4,184,000**
WA	-100	-25	75	As main alignment proposal, see previous section.	82,000
New East Challow Lock	-25	5	30	Refer to typical lock detail. Reduces canal water level from 83.80mOD to 82.02m OD	384,600
BBb	5	75	70	As section BB except height retained by north bank sheet pile wall is greater and additional natural side slope on south bank links to existing ground levels.	218,300
CCb	75	200	125	As section CC except height retained by north bank sheet pile wall is greater and additional natural side slope on south bank links to existing ground levels.	359,400
DDb	200	245	45	As section DD except no lock keepers walkway.	587,600
EEb	245	400	155	As EE except south sheet pile retains greater height and additional concrete retaining wall north of footpath.	656,200
GG1b	400	425	25	As GG2b except existing ground level assumed constant at 84.10mOD (i.e. historic canal assumed filled-in), no standing water, reinforced concrete retaining wall north of footpath rather than slope, and 1:2 slope rather than 1:3 slope for south bank.	78,400

Cross section	Start chain-age (m)	Finish chain-age (m)	Length	Description of assumed cross section	Estimated capital cost (£)
FF Bascule Bridge b	425	450	25	As FF Bascule Bridge except water level lower	324,100
GG2b	450	900	450	As section GG except channel assumed to be in natural 1:3 side slope cutting with 3m benching immediately wither side of the canal.	655,600
GG3b	900	1350	450	As GG2b, except surrounding existing ground level assumed to be 0.4m lower.	837,800
PP2 Mably Way Roundabout					**5,842,900**
Stockha-m New Bridge b	1350	1365	15	As Stockham New Bridge except additional height required to span deeper cutting.	1,000,000
HH1b	1365	1550	185	As HH1 except in deeper cutting.	463,500
HH2b	1550	1675	125	As HH2 except in deeper cutting.	909,800
II New Mably Way Lock b	1675	1735	60	Refer to section II and Typical Lock Detail. Single lock that reduces canal water level from 82.02mOD to 80.12mOD.	535,400
JJ	1735	1765	30	As main alignment proposal, see previous section.	645,700
KK	1765	1865	100	As main alignment proposal, see previous section.	448,500
LL	1865	1895	30	As main alignment proposal, see previous section.	568,600
SS1	1895	2100	205	As main alignment proposal, see previous section.	521,900
SS2	2100	2365	265	As main alignment proposal, see previous section.	749,500
PP3 Grove Road					
As main alignment proposals, see previous section.					

6.4 Cost versus Land Take Comparison

The choice of cross section for a given length of canal can have a significant impact on the cost and land take required for it. This is because retaining wall structures are more expensive, but require a smaller footprint, than 'natural' side slopes if the canal is in a cutting. To illustrate this comparison has been produced for the HH1 length of canal between chainage 1365m and 1500m, adjacent to the proposed Stockham Farm development. The HH1 cross section (as used for the main cost estimate), which uses natural side slopes, is shown in Figure 19, whilst an alternative cross section "HH1-X", which uses retaining walls to reduce land take, is shown in Figure 20. Please note the 1 in 3 side slopes shown are slightly inconsistent with Table 3, any subsequent further work should incorporate recommendations from Table 3. The land take for 'natural side slopes' in which case would be more than shown below,

Figure 19 – Cross section HH: Natural Side Slopes

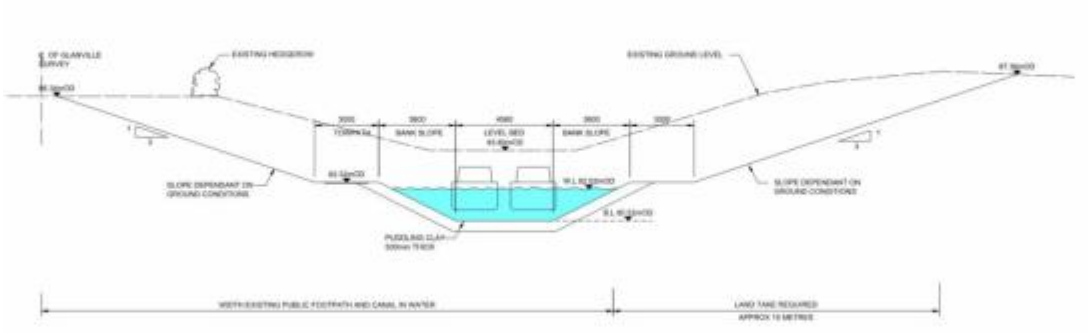


Figure 20 – Alternative Cross Section HH1: Vertical Retaining Walls

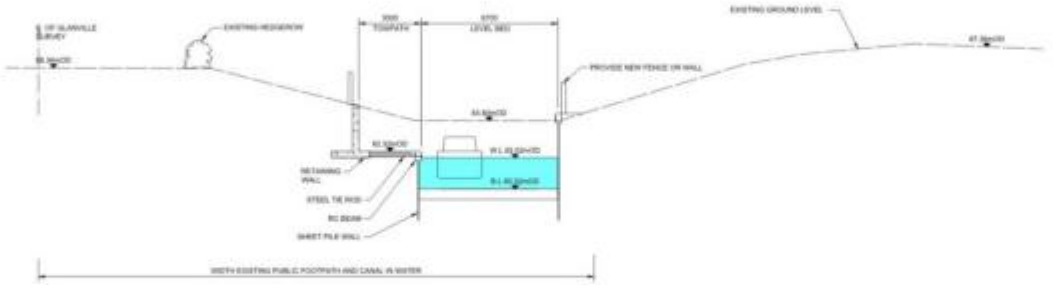


Table 16 – Comparison between Engineering Canal Edges

Option	Description	Cost (£ per m chainage)	Minimum Permanent Land Take (m per m chainage)
Main option, HH1	Natural side slopes and cutting slopes	2114	45.0

Alternative option, HH1-X	Vertical sheet pile and reinforced concrete retaining walls	3581	15.0

6.5 Exclusions

- Contingency (suggested 20% at this stage, could be reduced later).
- Contractor's preliminaries (suggested 15%).
- Contractor's overheads and profit (suggested 10%).
- Professional fees (suggested 5%).
- Site investigation costs or surveys.
- Temporary works (including temporary excavations).
- Insurances.
- Land purchase costs.
- Consent and licences.
- Road possession charges.
- Charges associated with disposal of excavated material.
- Signage and markings on canal and towpath and at pedestrian road crossing.
- Access paths (including steps and slopes) to the canal towpath.
- Environmental mitigation and compensation measures.
- Drop lock lock-keepers office and pump house.
- WBCT depot site and recreational facilities.
- Pump operational costs.
- Drainage.
- Mooring ancillary facilities (bollards, safety equipment, public amenities).
- Flood protection measures including emergency stop planks and associated recessed slots.

6.6 Assumptions

- The assumed unit rates used to produce the cost estimate are given in Appendix E.
- Lock cost estimates are based on a single 'all in cost' estimate for a lock structure, lock gates, mechanics and excavation.
- All land that must be cleared is wooded.

- No hazardous materials.
- The first 2m of all excavations are in soil, thereafter in stiff Gould clay unless specified otherwise.
- All open areas are landscaped 75% with grass seed, 25% with herbaceous plants. All planting assumed to be on 10-45 degrees sloped ground.
- Hedge rows are assumed to be 1m wide in section and require 2no. shrubs and 0.1no. tree per 1m chainage.
- Reinforced concrete road underpass boxes are assumed to have 4% steel reinforcement.
- Services and services routing in road underpass boxes not included.
- Reinforced concrete capping beams for sheet pile walls are assumed to be 0.6m wide x 0.5m deep, 2% steel reinforcement.
- Reinforced concrete retaining walls are assumed to have:
  - 1:2/3 stem height (retained height) to base length ratio.
  - 0.5m thick bases.
  - 0.3m thick stems if less than 2m high, or 0.5m thick if more than 2m high.
  - 2% steel reinforcement.
- Sheet pile retaining walls are assumed to:
  - Extend double the retained height below the puddling clay.
  - Have a corner pile every 25m
  - Be designed at cantilevers to minimise land take by tie rods and anchor blocks.
- Reinforced concrete piles are assumed to be circular segmental case driven, 8m deep, 1180mm diameter, and to support road underpass boxes in bents of 4 with bents at 2m centres.

7 Stakeholder Consultations

7.1 Landownership Drawings

The following landownership drawings comparing the landownership boundary files received from the WBCT and the proposed new canal overlay to aid consultation at later stages.

Table 17 – Landownership Comparison Plans

Drawing	Scale	Title	Date
226259-011-03	1:500@A1	Land Ownership Plan Sheet 1 of 4	09/01/14
226259-012-03	1:500@A1	Land Ownership Plan Sheet 2 of 4	09/01/14
226259-013-03	1:500@A1	Land Ownership Plan Sheet 3 of 4	09/01/14
226259-014-03	1:500@A1	Land Ownership Plan Sheet 4 of 4	09/01/14

7.2 Thames Water

We have consulted with Thames Water regarding the crossing of the trunk sewer between Grove Top Lock and the A338.

Thames Water charges a fee of £1,300 for the processing of applications to build over a public sewer over 375mm in diameter. In order to reduce costs and avoid having to go through the application process twice, we have agreed with the WBCT that this application is only submitted at a later stage once detailed design is progressed.

7.3 Environment Agency

We have consulted with the Environment Agency over flood risk and flows during extreme return period events around the Letcombe Brook crossing, for full details of this correspondence, refer to Appendix F.

Initial consultation with the EA showed that the EA has carried out (sub-consulted) flood modelling of Letcombe Brook. Based on this modelling, the following observations can be made.

The topography of Letcombe Brook falls downstream towards the culvert and there is a weir and pond prior to the (two) culverts which act as flood storage areas.

For example, during the modelled 1:100 year peak flood flow event (including 20% for climate change), the EA believes the peak flood level is +78.84m OD with a flow of 13.15m^3/s. This falls dramatically after the culvert decreasing to levels between +77.39m OD and 76.53m OD and flows between 5.17m^3/s and 4.56m^3/s.

Figure 21 – Existing Letcombe Brook culvert

Arup have consulted regarding the accuracy and frequency of cross section directly upstream and directly downstream of the culvert and also how the culvert was modelled e.g. which diameter and length had been assumed. The EA response was as follows:

- *'The cross sections for the Letcombe Brook 2009 Model were modelled at approximately 100m intervals and at main structures along the watercourse.*
- *Structures were inputted to the model manually, this includes the survey cross-sections, long sections and photographs provided. Generally, culverts were modelled using the ISIS CONDUIT unit with INLET and OUTLET units to model losses, or the ORIFICE unit for short (<10m) culverts. We cannot provide any details about the diameter used for the pipe.'*

The EA has also provided planning guidance on aqueduct structures, both for clear span bridges and new culverts with the generic recommendation that a clear span bridge would be preferred by the EA.

We therefore consulted further with the EA regarding the proposed canal crossing. Plan constraints downstream (approaching the A338 crossing) mean that the crossing will have to be slightly upstream (relative to Letcombe Brook) of the existing culvert as shown in Figure 18. Based on this crossing position, the EA made the following observations (for details of the full correspondence, refer to Appendix F).

Firstly, they confirmed that as the canal crossing is independent of the existing culvert, there would be no obligation to remove or enlarge the latter. However, the EA indicated that they are looking for opportunities to remove the existing culvert and are likely to be much more receptive to solutions which take this into account.

Secondly, they reiterated that the proposed canal crossing would have to be a bridge in accordance with their design standards. The EA's design standards require that the hydraulic capacity of the watercourse should be able to accept a 1 in 100 year flood flow plus an additional 20% for climate change. Based on the EA's hydraulic model of Letcombe Brook, the required flow capacity for the crossing will be roughly $13m^3/s$. Based on a water velocity of 1.5 to 2.5m/s, the cross-sectional area required will be between 5.2 to $9m^2$. This will be easily achievable with a clear span bridge structure.

Another requirement of the EA's design standard is that "the soffit of the bridge should be set 600mm above the maximum flood water level to allow clearance from debris and wave action, and a further 300mm to allow for changes in water level due to climate change".

This would not be possible for the existing flood water levels, which are high due to the ponding which occurs upstream of the existing culvert when it exceeds its capacity. We would therefore recommend the removal of the existing culvert, which will lead to lower flood water levels at the point of crossing. This may not reduce the flood levels sufficiently to adhere to the design standards above, but will be approaching them and demonstrate efforts by the WBCT to compromise with the EA over the crossing.

Finally, the EA expressed concerns that the abutments of the bridge and the embankments of the canal upstream of the crossing will reduce the amount of flood storage. We therefore recommend using vertical walls for the section of the canal along the flooding pond, see Drawing 007.

To summarise, our recommended solution for the Letcombe Brook crossing in light of the consultation with the EA, is to have a clear span canal crossing upstream and separate of the existing culvert. We also recommend removing the existing culvert (although this is not mandatory) as this will reduce the 1:100 year flood level at the proposed crossing location and the EA are likely to be more receptive to this solution.

Detailed flood flows and levels will need to be modelled for the scheme to be approved. The output flows and levels will drive the design and the approvals process for the Letcombe Brook crossing.

7.4 Friends of Letcombe Brook

We have consulted with Friends of Letcombe Brook regarding the aqueduct structure passing over Letcombe Brook via telephone. Initial feedback was that FoLB would like to hear the Environment Agency's opinion before commenting formally.

The contact details for this consultation are Sally Wallington, Letcombe Brook Project, C/o Vale and Downland Museum, Church Street, Wantage, OXON, OX12 8BL, Tel: 01235 771447, letcombebrook@hotmail.com.

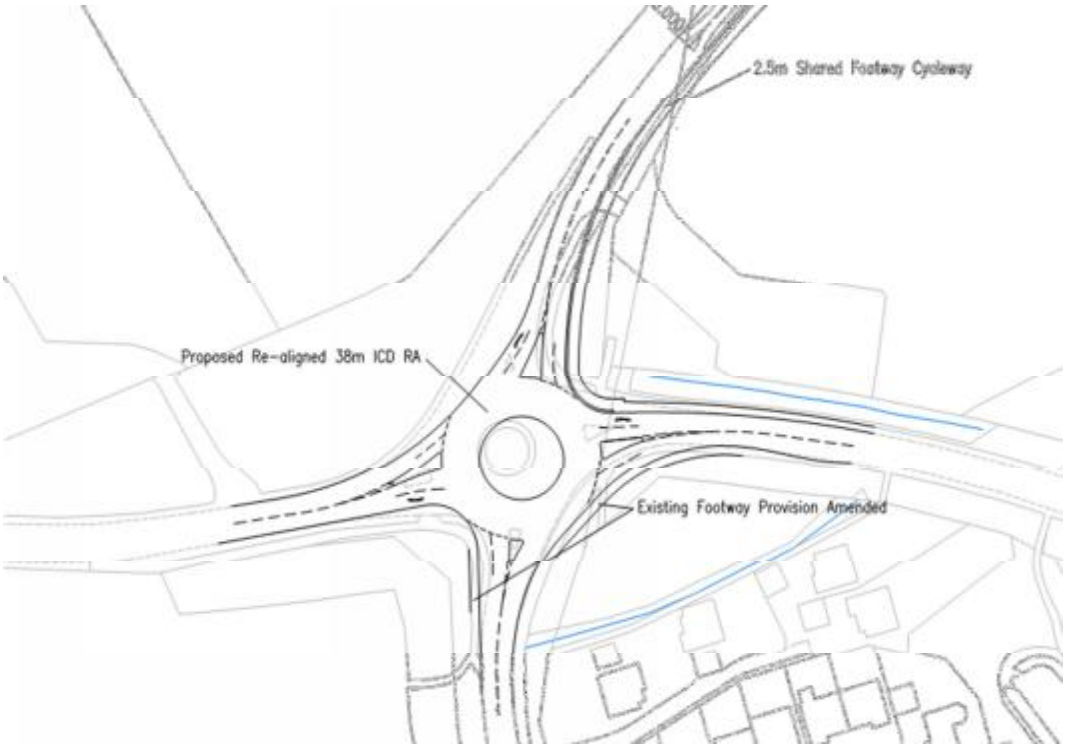
7.5 Oxfordshire County Council

We have consulted with the Oxfordshire County Council regarding the current status and future local highway plans and road/canal interaction.

In our consultation with the OCC in 2005, the OCC categorically refused any options of raising the A417 going through East Challow and the A338 going through Grove due to the impact it would have on sight lines and adjoining properties. The OCC also refused to consider options of constructing a lift bridge at either of these locations due to the high traffic volumes and the interruption to traffic it would cause. Since 2005, the A417 and the A338 have gotten busier and there are no plans to declassify either of the roads. It has therefore been assumed that the OCC would still be against raising these roads of constructing a lift bridge.

Discussions were held regarding the realignment of the Mably Way roundabout with David Groves, tel: 01865 816042 who is Transport Development Control Manager at the OCC and who was involved in the planning application for the Persimmon's Airfield development. The plans for the realignment of the roundabout, which were shared by David Groves are shown in Figure 22. The realignment of the roundabout will only go ahead if the Persimmon's Airfield development goes ahead.

Figure 22– Proposed realignment of Mably Way Roundabout if Persimmon's Airfield goes ahead



The realignment shown in Figure 22 will not impact the proposed canal route. However, the works for the realignment present a good opportunity for the Trust to carry out some of the underpass works at the same time and this should be discussed with Persimmon and David Groves at a later stage.

7.6 Vale of White Horse District Council

Pre-application planning advice will need to be obtained from the Vale of White Horse District Council. This has not been carried out yet to avoid paying the processing fee twice, and we suggest that our final report and associated Drawings are used to obtain pre-planning advice from the Vale of White Horse.

The Local Plan 2029 was issued for consultation Draft in February 2013. Policy 39 relates to the Wiltshire and Berkshire Canal, repeated below.

Core Policy 39: The Wiltshire & Berkshire Canal

The council will continue to safeguard a continuous route for restoration of the Wiltshire & Berkshire Canal using the historic line and the diversion south of Abingdon-on-Thames to be identified on the Adopted Policies Map.

The council will support schemes for restoration of the canal in line with the delivery plan identified in the Wiltshire Swindon & Oxfordshire Canal Partnership Strategy by:

i. *ensuring that development protects the integrity of the canal alignment and its associated structures*

ii. *ensuring that where the canal is affected by development, the alignment is protected or an alternative alignment is provided, and*

iii. *ensuring associated infrastructure of development does not prejudice the delivery of the canal.*

Proposals will be permitted that are designed to develop the canal's recreational and nature conservation potential, in particular, the use of the old line of the canal for walking and cycling.

Proposals for the reinstatement of the canal along these historic alignments will need to demonstrate that the cultural, historic and natural environment will be protected and enhanced, with no overall adverse effect, and that potential impacts on ecology, landscape, flood risk, water resources (abstraction) and water quality have been fully assessed and taken into account. Proposals for the reinstatement of discrete sections of the canal will also need to demonstrate that the potential environmental impacts of the restoration project as a whole have been assessed and taken into account.

7.7 Grove Park Properties Ltd

Arup have not consulted with Grove Park Properties Ltd, the landowner of the strip of land between the airfield and Mably Way roundabout as we understand this is being taken forward by the Trust directly.

The Outline Proposal Drawings issued as part of this report will enable the WBCT to consult with this landowner in more detail.

7.8 Dandara Ltd

Dandara Ltd is the developer of Stockham Farm Housing and Child Care Centre. They have received planning permission dated 28th March 2013 Application No: P12/V1240/FUL for a 9.04ha site *'residential development to provide 200 new homes across private and affordable tenures, with public open space and play space, the protection of the existing route of the Wilts and Berks Canal and the*

provision of land to allow for a realigned route, on-site car and cycle parking and improvements to site access and egress.'

A condition of the planning permission is that *'the legal agreement makes provision for a contribution towards the restoration or realignment of the Wilts and Berks Canal the route of which runs to the northern boundary of the site.'*

Dandara Ltd is also planning to develop a second phase of the development on the Northern side of the canal. Discussions were held with Dandara Ltd regarding the route of the canal along Stockham Farm with special consideration of the next stages of the development, Stockham Farm Phase 2 and 3.

A meeting was held at Dandara Ltd's offices, which was attended by Arup, the Wilts and Berks Canal Trust and Dandara Ltd. The outcomes of this meeting are summarised below.

- The option to have the canal in deep cutting around Stockham Farm would be very difficult to accommodate within the space available and would require large vertical retaining walls rather than slopes either side of the canal. The option to lock up after crossing the A417 at East Challow would greatly improve the appearance of the canal in this section and its integration with the development.
- It was agreed Dandara Ltd will keep a strip with a minimum width of 20m free between the two development phases for the canal to pass through. This will not be sufficient for the slopes which would be required to the side of the canal. Some vertical retaining walls will be required.
- Due to the narrowness of the 20m strip, there will be insufficient space between Stockham Farm Phase 1 and Phase 2 developments for the canal to be in its typical natural slope cross section. Vertical sheet piled walls will be required, and the canal will be kept at 6.7m wide throughout the section between Stockham Bridge and Downsview Road.
- The possibility of constructing a mooring area west of Stockham Bridge was also discussed. Dandara expressed no objection to the idea and will try to incorporate it into their plans if possible. This will depend on the requirements for public open space and ecological mitigation areas set upon them in the planning application for Phase 2 and 3 of the Stockham Farm development.

Figure 23 – Stockham Farm canal plan interface

7.9 Bewley Homes

Bewley Homes PLC are the developers of Nalder Estate, East Challow, and have received planning permission dated 28th March 2013 Application No: P12/V1261/FUL for *'demolition of existing industrial buildings. Proposed residential development comprising 71 new dwellings, new landscaped open space and access. Refurbishment of the existing listed office building'.*

The Northern edge of the canal has been kept south of the boundary of the Nalder Estate development. Consultation with Bewley Homes' agent, Ken Dijksman, has provided Arup with the latest layout of the Nalder Estate development. This layout includes a footpath which runs between the southernmost properties of the development and the canal edge. It is proposed that this becomes a shared footpath/ towpath/ cyclepath when the canal is constructed. A shared use agreement will need to be put in place with the Nalder Estates owners for the shared use of the towpath.

The Nalder Estates proposal includes a wall along its southern boundary. In order to provide better integration of the canal with Nalder Estates, it is recommended that this wall is removed when the canal is constructed. This will provide easy access to the canal for Nalder Estates residents as well as views onto the canal from the adjacent properties.

We have assumed vehicular access to the Canal House housing group would ideally be provided through Nalder Estate development. However, this is subject

to ongoing consultation between the WBCT and Bewley Homes. An alternative solution, as shown on our drawings, would be to provide a bascule pedestrian and single lane vehicular bridge across the canal at the end of Canal Way.

The preferred solution should be to negotiate road access through Nalder Estates and if this is not possible addition of a bascule bridge.

7.10 Persimmon Ltd

Persimmon Ltd is the developer of the Airfield site, Grove. Persimmon Ltd submitted an outline planning application P12/V0299/O for a 2,500 dwelling housing development on the old airfield site including secondary and primary schools and the realignment of Denchworth Road and the Mably Way roundabout. This Planning Application is currently under consideration.

As discussed in Section 7.5, the OCC have provided Arup their plans for the realignment of the roundabout should the Airfield development go ahead. The proposed plans, shown in Figure 24, would not affect the proposed canal route. However, it would be beneficial to open discussions with Persimmon Ltd regarding the possibility of preliminary works to facilitate the construction of the canal when they are realigning the roundabout. As the road is likely to be closed for the duration of these works and work will be done to the road layout, it will be a good opportunity to install the culvert required for the Denchworth Road crossing.

Figure 24 – Planned realignment of Mably Way roundabout

Furthermore, discussions should also look at the possibility of raising Denchworth road even if only by, say, half a metre. This would reduce the amount of cutting required downstream and would provide further clearance at the Letcombe Brook

Aqueduct. The OCC have stated that they would have no objections in raising this road. However, Persimmon Ltd would be under no obligation under their planning application to carry out this road raising. A cost-share for the works may be the best way forward. The cost of raising the road and constructing the culvert at the same time as the roundabout realignment would be outweighed by the savings it would lead to in terms of cutting reduction and ease of access for construction.

8 Construction and Programme

8.1 Construction Procurement

The WBCT have a successful record of carrying out canal restoration works using volunteer groups. However the scale and nature of the proposed works will require a different approach including the appointment of a civil engineering contractor of at least mid-range size and capability.

It is assumed that the main civil works would be let as a single contract; this is likely to give better value because of more competitive pricing, reduced mobilisation costs and more efficient use of resources. For instance, movement of materials from areas of cut to areas of fill would be more efficient. However, if only parts of the site become available or full funding isn't available at the outset, it would be feasible to split the canal site into more than one contract.

There are options to award enabling works and landscape maintenance works under separate contracts.

There may be benefits in awarding the main civil contract as design and build; since there are alternative forms of construction, for e.g. retaining walls and culverts, which could vary to suit individual contractor's resources and skills.

8.2 Construction Techniques

Because of substantial earthmoving in clay soils, works will be weather dependent. Significant works would be dedicated to providing temporary all weather road access along the site and to providing temporary drainage. It is likely to be necessary to provide pumping facilities to keep the site dry and possibly dewatering at the bridge sites.

Considerable piling is required through the built up areas. Low vibration and relatively silent piling plant (such as Giken) should be used in sensitive areas.

Parts of the construction sites at pinch pints are in very restricted spaces. In addition to the permanent land take, some additional temporary land would be very beneficial where this is feasible. Additional temporary land will also be required for the contractor's works and storage areas.

Because of the difficult site conditions it would be desirable to prefabricate works off site where possible. This could include elements of bridges and locks, coping beams and retaining walls.

We have assumed at this stage that the road crossing box culverts will be constructed conventionally in open excavation while the affected road is closed and associated traffic diverted. Where there are assets nearby the excavation will need temporary supports to limit the size of the excavation and prevent ground movement affecting the nearby assets. There are alternative options:

- If any particularly close and sensitive assets are found then an alternative 'top down' construction of the box culvert would reduce the risk of damage to these assets. In this case, the side walls are constructed first from ground level and props are inserted between the walls as excavation takes place down to invert level.

- If the local authority or OCC Highways insist on a very short closure of any of the roads, then an alternative would be to prefabricate the entire box culvert offline and slide it across the road in a short possession. This would significantly reduce disruption to road users.

Either alternative would significantly increase the costs of the crossings.

There will be a substantial surplus of cut over fill, and removing material off site to landfill will be expensive. It would be very beneficial if the works could be linked to the development of one of the adjacent sites which could make beneficial use of the surplus material.

8.3 Traffic Management Plan

There will be considerable impact on road traffic during construction of the canal road crossings. The traffic management plan will be developed following consultation with OCC Highways department.

The key issues to be discussed and agreed are:

- What diversion options are acceptable while the roads are closed for construction of the bridge crossings.
- Whether there will be time restrictions that would be imposed on the duration of the diversions.
- Provision to be made for pedestrians and cyclists crossing from one side of the site to the other.

8.4 Implementation Programme

The programme will primarily be driven by progress with planning applications for adjacent development areas and the accompanying release of funding for the development of the canal.

Outline programme, once funding and consents are in place would typically be:

- Land acquisition and design development, consents and licences: 12 months
- Enabling works: Finding and diverting utilities, preparatory traffic management works, clearance of vegetation and initial environmental mitigation: 6 months
- Main construction works: 18-24 months.
- Landscape maintenance contract: 3 years

If possible, the timing of contract award for the main construction contract at the end of winter/beginning of spring should assist the contractor in minimising major excavation works through the winter period.

Appendix A

Previous Work by Scott Wilson, 1998

Appendix B

Topography Data

B1 Glanville Survey 2004

B2 Dandara Survey

B3 Glanville 2013 Survey

Appendix C

Proposed Outline Design of Canal

Appendix D

Landowner Canal Overlay Drawings

Appendix E

Capital Cost Estimates

Appendix F

Environment Agency Consultation

Appendix G

Stockham Farm Consultation

Appendix H

Nalder Estate Consultation

Appendix I

Oxford County Council
Consultation

Appendix J

Thames Water Consultation