Physical and biological monitoring of STREAM restoration projects

Monitoring Protocol

Natural England

November 2007
Final Protocol
LIFE05 UK/NAT/000143
9S0459

STREAM

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Document title	Physical and biological monitoring of STREAM restoration projects Monitoring Protocol
Status	Final
Version	04
Date	November 2007
Project name	River Avon STREAM Monitoring
Project number	9S0459
Client	Natural England
Client reference	LIFE05 UK/NAT/000143
Reference	9S0459/R01/JLE/Hayw

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Date/initials check	November 2007	HRD
Approved by	Helen Dangerfield	
Date/initials approval	November 2007	HRD

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1 INTRODUCTION

1.1 The Avon STREAM Restoration Project

Demonstrating Strategic Restoration and Management (STREAM) is a LIFE nature funded project being undertaken by Natural England (English Nature) to improve river habitat conditions along a number of reaches of the River Avon Special Area of Conservation identified in **Table 1.1** and **Figure 1.1**.

Table 1.1 Location of river restoration sites within the Avon catchment

Site name	Watercourse	Upstream limit	Downstream limit
1.1 Upper Woodford	River Avon	SU 13183755	SU 12603723
1.2 Fovant	River Nadder	SU 00213059	SU 00663072
1.3 Seven hatches	River Wylye	SU 09243304	SU 09833178
1.4 Amesbury	River Avon	SU 15834257	SU 15624195
1.5 Hale	River Avon	SU 17401889	SU 16351791
1.6 Blashford	Dockens Water	SU 15410828	SU15300826

Outline design of the restoration works to be undertaken is provided within the English Nature's LIFE bid document (English Nature, 2005).

1.2 Physical and Biological Monitoring

As part of the STREAM project, Royal Haskoning has been commissioned by Natural England to undertake physical and biological monitoring at each of the six restoration sites.

Monitoring will involve one pre-restoration and one post-restoration survey at each site. These surveys will be used to document the restoration works and to identify the possible influence of the works on ecology within the reach. Reach-scale mapping and repeat photography techniques will be used to monitor change at all restoration sites. It is not possible to undertake detailed survey at all sites due to resource constraints and practical limitations. Therefore two of the sites will also be subject to more detailed survey and the use of control sites.

1.3 Structure of the Monitoring Protocol

The purpose of this monitoring protocol is to outline the monitoring framework and survey methods to be used. **Section 2** describes the monitoring framework including relationships between the different physical and biological survey techniques that will be used for detailed survey and rapid assessment. **Section 3** contains details of methods that will be conducted for all six sites. **Section 4** describes the methods to be used only at the detailed survey sites (**Table 1.2**), including how initial investigations during the inception stage have been used in selecting the sites that will be subject to detailed survey. The proposed programme of activities is contained in **Section 6**, including more detail for 2006.

Figure 1.1 Location of STREAM restoration sites within the Avon Catchment

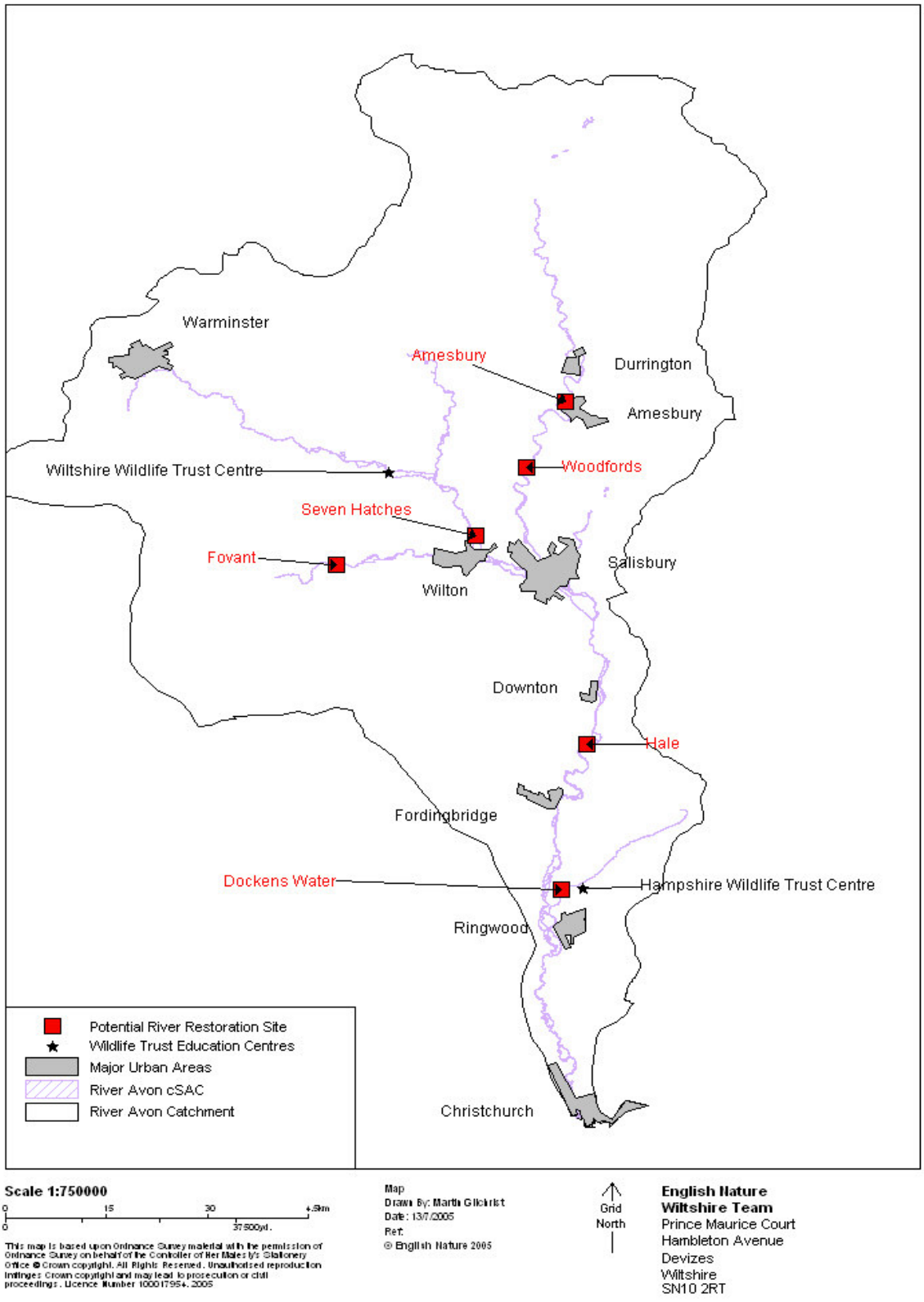


Table 1.2 Survey methods described within the monitoring protocol

Methods to be applied at all sites
Physical biotope mapping
River Corridor Survey
Repeat photography survey
Additional methods to be applied at detailed survey sites (2 sites)
Macrophyte survey
Fisheries survey
Cross-sectional survey
Depth, Velocity, Substrate (DVS) survey

2 MONITORING FRAMEWORK

2.1 Rationale

The purpose of this project is to record physical and biological conditions pre- and post-restoration at each of the restoration sites. The surveys will document physical changes that are implemented as part of the restoration works and provide a baseline for further monitoring. By tying physical surveys to biological survey, it may also be possible to infer links between the physical and biological characteristics of the river at each restoration site relating to the works.

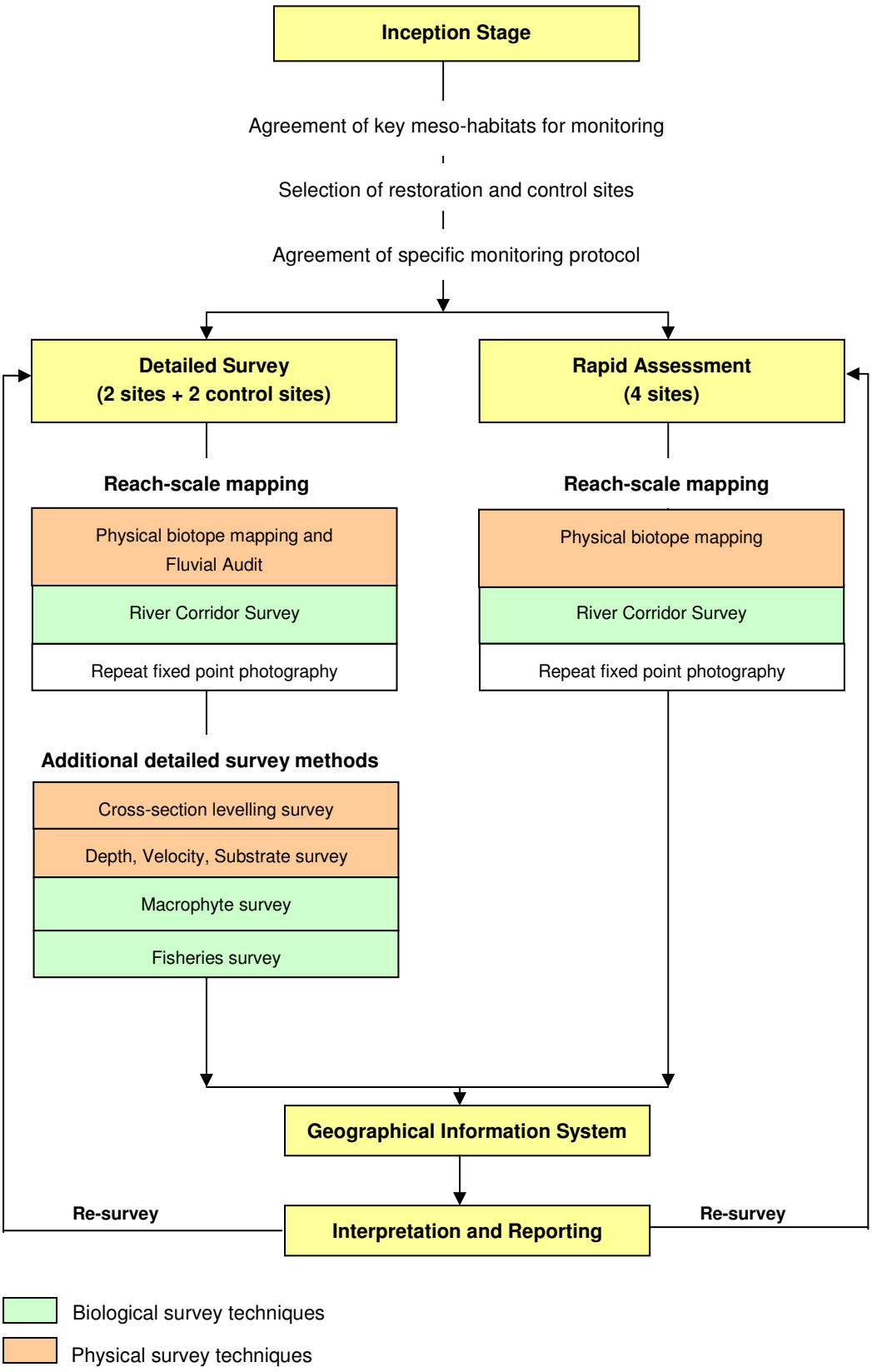
It is important to recognise that the monitoring framework has been developed within the constraints of the project. The following statements define the purpose and limitations of the monitoring framework.

- The pre-restoration survey will establish a record of biological and physical conditions at the site prior to restoration
- The post-restoration survey will record modifications to the channel after restoration
- The surveys will both provide snapshots pre- and post-restoration. It is important to recognise that there is a limitation to the comparisons that can be made over this short duration and it will not be possible to identify temporal trends.
- The relationship between physical and biological conditions will be analysed at each site. Comparisons will be drawn taking into account other factors and processes that may influence relationships.
- The limitations of the control sites will prevent direct comparison of the restoration reaches with the control sites. The purpose of using the control site is to compare the relationship between physical and biological conditions at recorded at both sites on a given day rather than to compare the magnitude of change of either physical or biological parameters between sites. Comparisons will therefore be made between pre-restoration and post-restoration surveys at each individual site. Inference may be drawn about changes in each parameter and in the relationship between physical and biological character.
- This monitoring framework will establish a documented baseline in order that repeat surveys of both physical and biological conditions can be made over longer time periods.

2.2 Overview of survey techniques

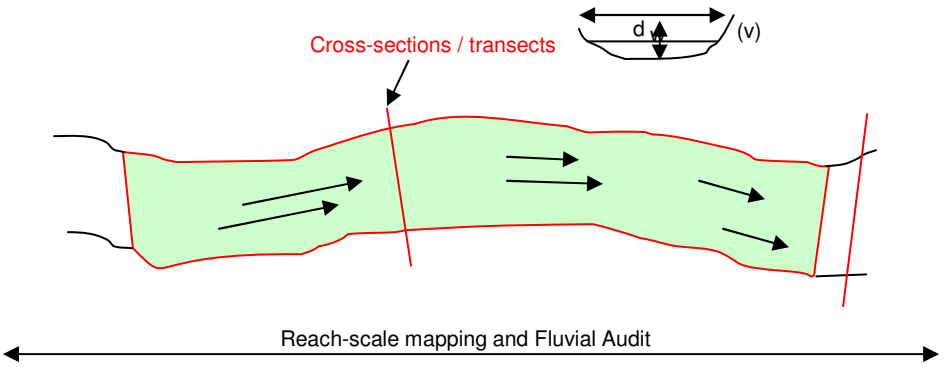
An overview of the monitoring framework is provided in **Figure 2.1**. This figure illustrates which surveys are to be undertaken at the detailed and rapid assessment survey sites. Rapid assessment will consist of reach-scale mapping.

Figure 2.1 **Proposed monitoring framework**



Detailed survey will include additional physical and biological surveys relating to cross-sections, transects and meso-habitats (indicated in red within **Figure 2.2**).

Figure 2.2 Schematic showing different survey methods



2.3 Reach-scale mapping

Reach-scale mapping will be undertaken using Physical Biotope Mapping and River Corridor Survey at all river restoration and control sites. Reach-scale mapping provides spatial data that can be used to identify the approximate aerial extent and distribution of different features. Comparison of pre and post-restoration mapping will show how the approximate spatial extent and distribution of these features has changed between the two surveys, recognising that these changes may not be a result of restoration works and may relate to other controlling factors.

Reach-scale mapping will be undertaken along the entire length of all restoration and control sites. The surveys will be undertaken in tandem using the same base maps so that the physical and biological data produced can be readily overlaid. These surveys will be used to inform the location of cross-section/transect based surveys (see Section 3.1.2). Reach-scale mapping will be supplemented by repeat geo-referenced photographical survey to provide visual representation of the reach and the associated physical and biological habitats present.

2.4 Additional detailed survey methods

Channel cross-sectional survey techniques provide accurate data on channel dimensions which can be used to produce quantitative data relating to channel size and shape. The channel will be surveyed using standard levelling techniques and Depth, Velocity and Substrate (DVS) measurements.

Biological information will be collected using macrophyte survey transects located to tie in with cross-sections. Repeat photographic survey will also be tied into survey cross-sections at detailed survey restoration and control sites.

Fisheries survey will provide information that relates to particular meso-habitats within the channel. Meso-habitats will be identified using reach-scale mapping techniques (see **Section 3.1**). Fisheries surveys will subsequently be conducted to represent different meso-habitats within the restoration and control reaches at detailed survey sites.

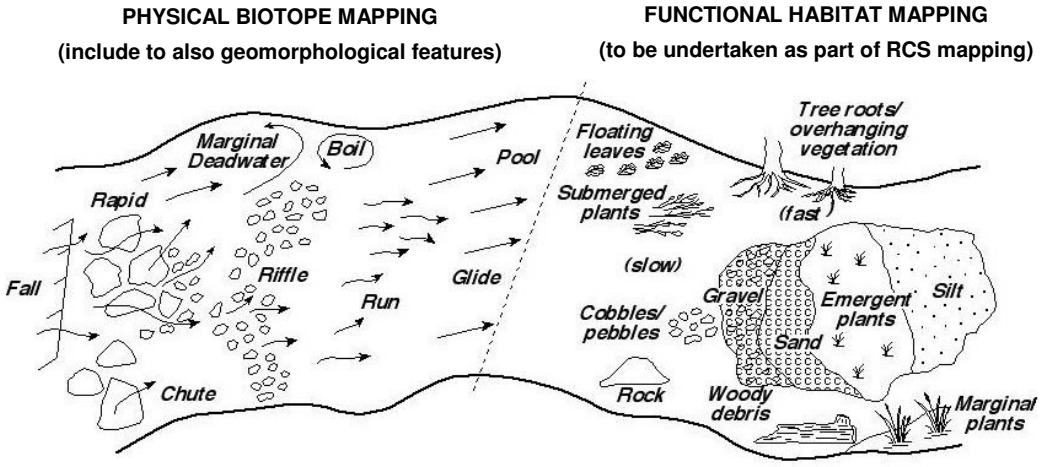
3 RAPID ASSESSMENT (ALL SITES)

Rapid assessment will consist of reach-scale mapping techniques. Physical biotope mapping, River Corridor Survey and repeat photography survey will be conducted simultaneously at all sites. Two ecologists and a geomorphologist will conduct these surveys.

3.1 Physical Biotope Mapping and Fluvial Audit

It is proposed that geomorphological reach-scale data is collected through Physical Biotope Mapping. This will be undertaken by a geomorphologist and will involve mapping of physical biotopes at a scale of 1:2500 using the mapping key illustrated in the left hand side of **Figure 4.1.**

Figure 3.1 Physical biotope and meso-habitat mapping techniques



Source: Newson and Newson, 2002

Referenced from the Applied Guidebook of Fluvial Geomorphology, Sear et.al., 2003

The physical biotopes shown relate to the flow-types defined within the established River Habitat Survey (RHS) methodology and definitions of biotopes that have been used in Fluvial Audit for several catchments (Dangerfield et al, 2004). Using definitions contained within established methods will help ensure that the survey is compatible with other survey methods. Site visits undertaken during the inception stage indicate that many of the restoration sites are likely to be glide dominant but that the glides present vary in terms of flow velocity. It is therefore considered appropriate to sub-divide the glide biotope to represent differences in flow velocities. Geomorphological features will be recorded on the map.

It is proposed that physical biotope mapping is accompanied by Fluvial Audit to gather background data relating to the physical condition of the reach. This will enable changes in external factors to be recorded. The proposed data collection form is that developed for the Environment Agency for use on the Salmon Rivers project (Dangerfield et al, 2004) (See **Appendix A**). The reference sheet within Appendix A contains relevant definitions, including definitions of the physical biotopes.

3.2 River Corridor Survey (RCS)

The River Corridor Survey will provide mapping of biological plant communities and broad vegetation structure that can be tied in to the Physical Biotope Mapping. River Corridor Survey is a widely used and well established ecological survey method. The survey will be undertaken continuously using the standard survey key (National Rivers Authority, 1992) and the same 1:2500 mapping that is used for the Physical Biotope Mapping. The River Corridor Survey method will be extended to include mapping of in-channel vegetation / meso-habitats (see right-side of **Figure 4.1**) as the basis for the more specific macrophyte survey (Section 4.3).

3.3 Repeat Fixed Point Photography

Photography will be undertaken in alongside Physical Biotope Mapping, River Corridor Survey and macrophyte surveys to record features of the channel and river corridor on the day of survey for comparison. All features of relevance will be recorded using fixed point photography. Photographs will be taken using a digital camera without using zoom so that the angle of the view is the same every time. A compass will be used to record the orientation of the photograph in degrees as well as noting orientation in relation to the river (e.g. upstream/downstream). A tripod will be used to ensure that the photograph is taken from a fixed height. Where possible the photographs will be taken at the same time of day on each survey so that the direction of lighting is similar influencing the position of shadows and general appearance of the site. Following each survey the photographs will be fully labelled including date and location. The position of digital photographs will be recorded using a 12 figure grid reference using GPS (Global Positioning Systems) and managed on an electronic file structure that will enable hot-linking within a GIS (Geographical Information System).

At detailed survey sites, fixed photography points will be tied to physical and/or biological survey cross-sections that are established to facilitate repeatability and tie the photographs with measured changes.

4 DETAILED SURVEY METHODS

4.1 Detailed survey site selection

A number of factors were taken into account in selecting the two detailed survey sites. The key considerations were:

- Detailed survey of a range of different restoration techniques as required by English Nature
- Practical considerations
- Location of suitable control sites

Through the STREAM project, Natural England (English Nature) aim to demonstrate the use of low budget techniques in river restoration. One of the considerations in selecting sites for detailed survey was Natural England's (English Nature's) requirement that the two sites should include different river restoration techniques. During the inception stage, further details of the proposed river restoration works were collated to inform detailed survey site selection. Table 4.1 provides a summary of the proposed works and the character of the watercourse at each site. Further details can be found in English Nature's LIFE Bid Document (English Nature, 2005).

Table 4.1 Summary of proposed works and watercourse characteristics

Site name	Outline of river restoration works	Stage of design	Year of works	Approx width (m)	Approx depth (m)
1.1 Upper Woodford	• 5 small mid-channel islands • 60 degree upstream facing groynes • Gravel causeway • "D" shaped berms • "V" shaped deflectors • Brushwood revetment	Detailed design	2006	25 to 30	0.5 to 1
1.2 Fovant	• 60 degree upstream facing timber groynes with brushwood & vegetation infills from ditch network • Selective tree felling • Modification of hatch operation downstream	Detailed design	2006	20	0.5 to 1
1.3 Seven hatches	• Modification of hatch operation (Seven Hatches) • Tree felling for use as in-channel woody debris • Reintroduction of gravel and wood debris • Channel narrowing and deflectors	Outline design	2007	10	1 to 1.5
1.4 Amesbury	• Excavation and screening of gravel for use in-stream • Reprofiling of channel banks • Tree felling of poplars for use as in-channel woody debris	Outline design	2008	12 to 20	1 to 1.75
1.5 Hale	• Groynes to narrow channel • Tree planting • Spawning riffle sections • Tree felling for use as in-channel woody debris	Outline design	2007	25 to 30	2
1.6 Blashford	• Reprofiling of channel banks • Tree felling to open canopy • Creation of sinuous channel	Outline design	2008	4 to 5	0.5 to 1

An initial site visit was undertaken during the inception stage in order to view each of the sites. In addition to the nature of the proposed river restoration works factors, practical considerations had to be taken into account in selecting detailed survey sites, including the depth of channel and site access. Location of suitable control sites was difficult for all of the restoration sites as each of the restoration sites has been selected due to its specifically degraded condition. It is therefore difficult to find similar sites that are similar in character and not part of the restoration project. The nature of restoration works and practical considerations were therefore the primary factors in selection of the detailed survey sites. Table 4.2 summarises the issues that were considered and discussed with English Nature for each site.

Table 4.2 Considerations in detailed survey site selection

Site name	Considerations / potential issues	Suitability for detailed survey
1.1 Upper Woodford (River Avon)	• Water depth of 0.5 to 1m should allow bed visibility and feasibility of detailed survey techniques. • Wide variety of river restoration techniques proposed • Good access via fisherman's path, including car park.	Yes
1.2 Fovant (River Nadder)	• Water depth of 0.5 to 1m should enable bed visibility and feasibility of cross-sectional survey. • Range of proposed river restoration methods limited and similar to those proposed at Seven Hatches / Upper Woodford. • Narrow site access through heavily padlocked and barbed wired gate.	Yes
1.3 Seven hatches (River Wylye)	• Water depth of up to 1.5 should enable bed visibility and feasibility of cross-sectional survey. • Wide variety of river restoration techniques proposed • Fluvial audit and ecological monitoring data (Wessex Water) available which could aid analysis of change.	Yes
1.4 Amesbury (River Avon)	• Downstream reaches at the site are open to public access which may present public safety issues during monitoring. • Water depth of up to 1.75m may limit bed visibility and feasibility of detailed survey techniques. • Hazardous access due to electricity sub-station	No
1.5 Hale (River Avon)	• Water depth of up to 2m may limit bed visibility and feasibility of detailed survey techniques.	No
1.6 Blashford (Dockens Water)	• Limited restoration works are planned under the EU LIFE project	No

Further to the assessment and consultation with English Nature, the sites at Upper Woodford (River Avon) and Seven Hatches (River Wylye) were selected for detailed survey. Rapid assessment only will be undertaken at the remaining four restoration sites.

4.2 Identification of detailed survey and control reaches at selected restoration sites

The Upper Woodford restoration reach is approximately 700m long, while the Seven Hatches restoration reach is approximately 2500m long. Due to resource constraints, it is not possible to undertake detailed survey along the entire reach at site. Detailed survey will therefore focus on sections of the reach approximately 500m. This approach is designed to complement both the standard methods of macrophyte survey and River Corridor Survey, which are also based on 500m reaches.

It is proposed that control sites are monitored alongside the detailed survey sites to enable comparison of:

a) physical and biological conditions pre- and post-restoration works at a reach where no intervention has been undertaken

with

b) physical and biological conditions pre- and post-restoration works within a reach where restoration works have been implemented

Control sites have been selected for both the Upper Woodford and Seven Hatches sites based on the similarity of reach characteristics to the reach selected for restoration, site access and other external factors that may potentially result in differences between the sites. Parameters identified in Trainor and Church (2003) were among those used to visually compare the similarity of the control and restoration reaches during the initial site visit. Reach parameters considered included:

- Depth variability
- Width variability
- Physical biotopes present
- Bed substrate
- Bank profile
- Landuse
- Channel and bank modifications

Quantitative data were not available for use in assessing the similarity of the control and restoration reaches during the inception stage.

4.2.1 Upper Woodford (River Avon)

The location of the restoration reach and proposed control reach at Upper Woodford is illustrated in **Figure 4.1**. The 500m detailed survey section within the restoration reach has been defined based on the extent of proposed river restoration works. This will enable the local, reach-scale physical and biological changes associated with the restoration works to be recorded.

The River Avon is over-wide and over-deep at Upper Woodford, reflected in the fact that the reach is locally known as “The Broads”. The reach is also impounded downstream due to a structure operated to maintain water levels. It is therefore difficult to identify a reach that has the same characteristics as the restoration section. It is undesirable to site the control site far upstream of the restoration site or on a different watercourse as

environmental factors other than physical habitat, e.g. water quality, are likely to result in biological differences between the sites.
The proposed control reach is immediately upstream of the restoration reach. Table 4.3 provides a comparison between the restoration and control reach in terms of the key parameters used for comparison, based on visual survey during the initial site visit and data derived from the Ranunculus River Habitat Survey conducted in 2000 (Geodata, 2000).

Figure 4.1 Location of restoration and control reaches at Upper Woodford

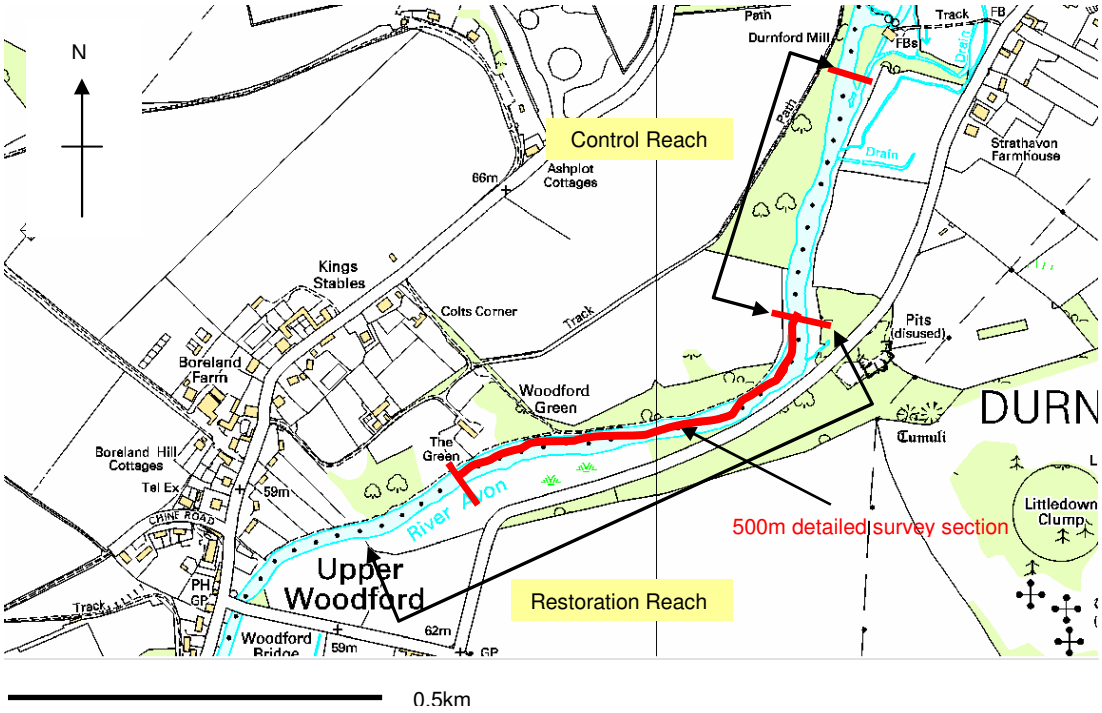


Table 4.3 Comparison of restoration and control reaches at Upper Woodford

Parameter	Restoration Reach	Control Reach
Depth variability	Bank height approx 0.5 – 1.0m Water depth approx 0.5 – 0.7m	Bank height 0.5 – 0.7m Water depth 0.2 – 0.3m
Width variability	25 – 30m	25 – 30m
Physical biotopes present	Glide dominated	Glide dominated
Bed substrate	Gravel overlain by silt	Gravel
Bank profile	Steep	Steep
Landuse	RHB – fisheries path LHB – woodland	RHB – fisheries path LHB – woodland
Channel and bank modifications	Impounded at downstream end Small islands installed in channel	Small islands installed in channel

There are a number of limitations associated with the selection of this control reach that will need to be taken into account when analysing the survey data obtained, including:

- Water depth within the control reach is generally shallower than within the restoration reach, largely due to impoundment resulting from the hatch structure downstream. Depth of the channel increases with distance downstream therefore the proposed control reach is more similar to the upper end of the restoration reach.
- The control reach is not heavily silted like the restoration reach
- The control reach is only approx 350m long due to the presence of Durnford Mill upstream.

The characteristics of the restoration reach change throughout the reach, in particular in terms of channel depth and degree of impoundment. Due to the differences between the control reach and the restoration reach it will be important to focus on the comparison of the physical and biological conditions **within** each of the reaches, pre-restoration and post-restoration, rather than directly comparing either physical or biological changes between the control and restoration reaches.

4.2.2 Seven Hatches (River Wylye)

The location of the restoration reach and proposed control reach at Seven Hatches is illustrated in **Figure 4.2**.

The initial site visit undertaken during the inception stage of this project indicated that the restoration reach can be loosely divided into four sub-reaches. The upstream sub-reach is impounded by the large modern radial sluices (known as Seven Hatches), which results in impoundment upstream. Downstream of the sluice the Wylye has been dredged and re-profiled, resulting in slow, smooth flow and uniform habitat conditions. This second sub-reach is also impounded upstream of footings of the railway bridge. The third sub-reach reverts back to a more natural system, before flowing into sub-reach four, which has been re-profiled and impounded by rail footings and a low weir at the downstream limit of the restoration reach. The focus of in-channel restoration work will be within the second sub-reach downstream of the structure at Seven Hatches and upstream of the railway bridge. The 500m detailed survey site has therefore been defined within this section of the restoration reach.

The proposed control reach is located a distance upstream of the planned restoration works (Figure 4.2). This includes an impounded reach and a re-profiled river channel. Localised habitat restoration has been carried out above the hatches (beyond their impounding influence) over the past 5 years, with a low level vegetated walkway being constructed. The selection of an appropriate control site is constrained by the fact that the Wilton Fly Fishing Club intend to implement further enhancement measures directly upstream of the Seven Hatches in 2006. This proposed control reach is upstream of the extent of these proposed enhancements

Figure 4.2 Location of restoration and control reaches at Seven Hatches

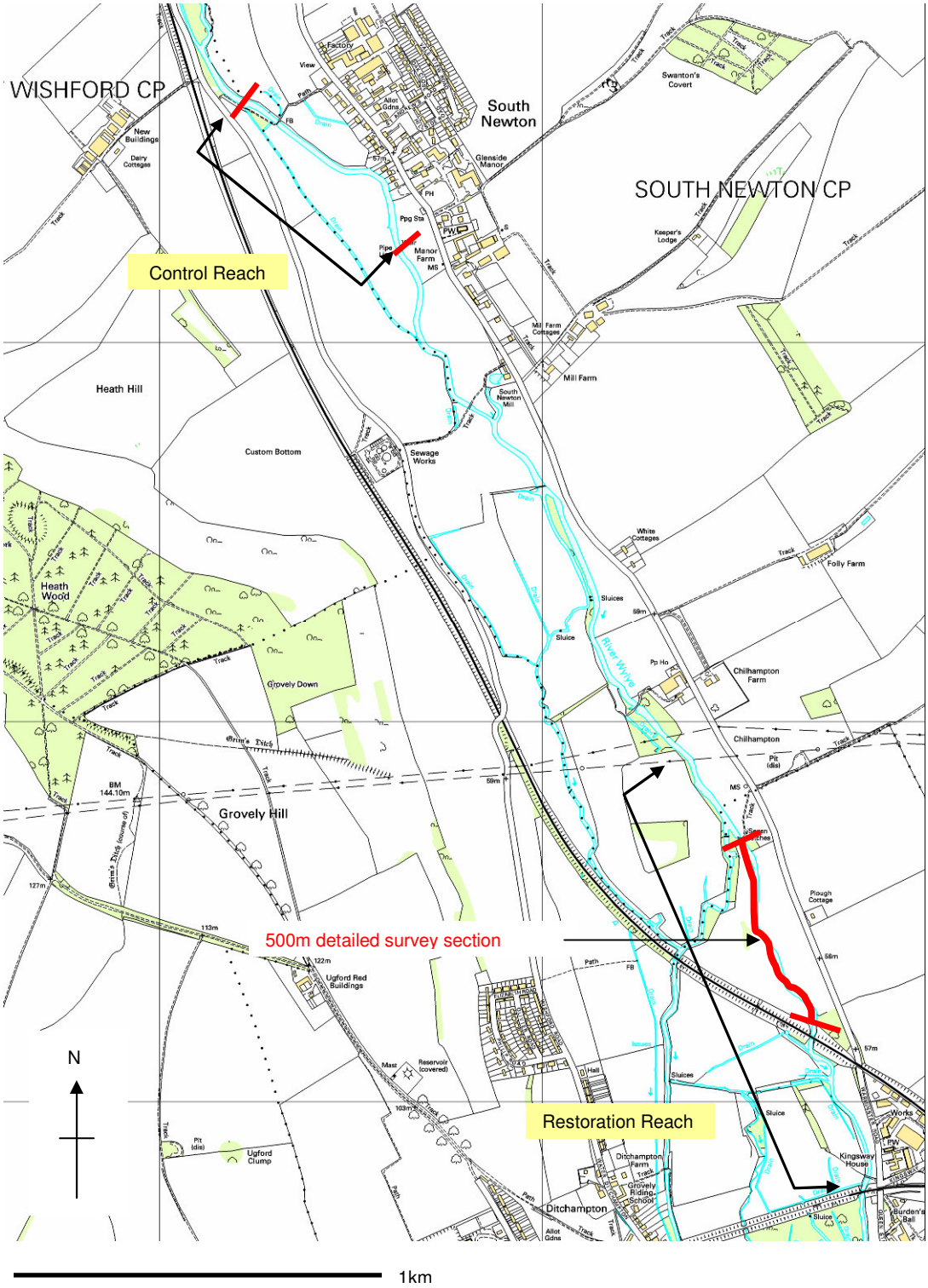


Table 4.4 provides a comparison between the restoration and control reach in terms of the key parameters used for comparison, based on data derived from the Ranunculus River Habitat Survey conducted in 2000 (Geodata, 2000).

Table 4.4 Comparison of restoration and control reaches at Seven Hatches

Parameter	Restoration Reach	Control Reach
Depth variability	Bank height approx 1 – 1.25m Water depth approx 0.1 – 0.9m	Bank height 0.5 – 1.5m Water depth 0.3 – 0.4m
Width variability	13 – 13.5m	14m – 17.5m
Physical biotopes present	Glide, impounded by rail bridge	Glide/riffle, impounded by weir
Bed substrate	Gravel overlain by silt	Gravel
Bank profile	Steep, reprofiled	Steep, reprofiled?
Landuse	Grazed land	Grazed land/arable
Channel and bank modifications	Impounded at downstream end Dredged – resectioned.	Impounded at downstream end Vegetated walkway installed

There are a number of limitations associated with the selection of this control reach that will need to be taken into account when analysing the survey data obtained, including:

- Enhancement works have already been undertaken within the proposed control reach.
- The control reach already contains more varied physical biotopes and meso-habitats that the restoration reach
- The control reach is upstream of a site of where Wilton Fly Fishing Club intend to implement enhancement works. These works could potentially have an impact on the restoration site downstream.

Due to the differences between the control reach and the restoration reach it will be important to focus on the comparison of the physical and biological conditions **within** each of the reaches, pre-restoration and post-restoration, rather than directly comparing either physical or biological changes between the control and restoration reaches.

4.3 Macrophyte survey

The macrophyte survey will be undertaken alongside the River Corridor Survey, based on the methods identified in Monitoring *Ranunculion fluitantis* and *Calitricho-Batrachion* Vegetation Communities (**Life in UK Rivers, 2003**). The River Corridor Survey mapping (1: 2500) will be extended to include in-channel vegetation and meso-habitats to provide the basis for the macrophyte survey.

The macrophyte survey will employ the recently developed rapid assessment outlined in the SAC Monitoring Protocol (**Life in UK River, 2003**) and excludes species quadrat survey. This involves recording the percentage cover of macrophyte species for 10 metre transects across the river located approximately every 100 metre along a 500 metre section.

Physical biotope mapping and River Corridor Survey will identify suitable and representative locations for the location of macrophyte survey transects within the 500m section that has been selected for the site (**Section 5.1**). This will ensure that transects are taken within representative physical biotopes / meso-habitats. Cross-sectional

levelling survey and Depth, Velocity, Substrate (DVS) measurements will subsequently be tied to the macrophyte survey transects in order to maximise the linkages between physical and biological data collected.

The following sections of the monitoring protocol have been developed after completion of the reach-scale mapping surveys and macrophyte survey at Upper Woodford and Seven Hatches restoration and control sites. These surveys were undertaken between the 7th and 10th of August 2006. The findings have been used to inform the protocol relating to cross-section levelling, measurement of Depth Velocity and Substrate (DVS) and fisheries survey.

4.4 Cross section levelling survey

The purpose of the cross-section levelling survey is to monitor and quantify physical cross-sectional change at selected locations within the restoration and control reaches. **Appendix B** contains scanned copies of the reach-scale physical biotope mapping which have been annotated to show the proposed location of survey cross-sections. These locations have been selected to represent different physical biotopes / meso-habitats and to tie up with the location of transects used in the macrophyte survey. The macrophyte survey transects are marked on the reach-scale maps and labelled MS01 to MS05 for each reach.

The number of cross-sections that can be monitored is practically limited to the number of cross-sections that can be surveyed within one day. It has been estimated through consultation with the levelling survey contractor that it should be possible to survey 8 cross-sections within a day. Five cross-sections have been identified to tie in with the macrophyte survey transects. A further three cross-sections have been identified to cover different physical biotopes / meso-habitats in between these cross-sections and distribute the additional measurements at intervals throughout the monitoring reach.

The cross-sections will be tied to Ordnance Survey datum. Cross-sections will extend at least 5m into the riparian zone and readings will be taken to reflect bankfull, water surface elevation, breaks in slope and habitat features. The survey will be set out with appropriate survey control stations to ensure that the same cross-sections can be re-surveyed. This will take into account the nature of the restoration works and the likelihood of disturbance of any markers that are used. Each of the established cross-sections will be surveyed twice during the monitoring programme; once pre-restoration and once post-restoration.

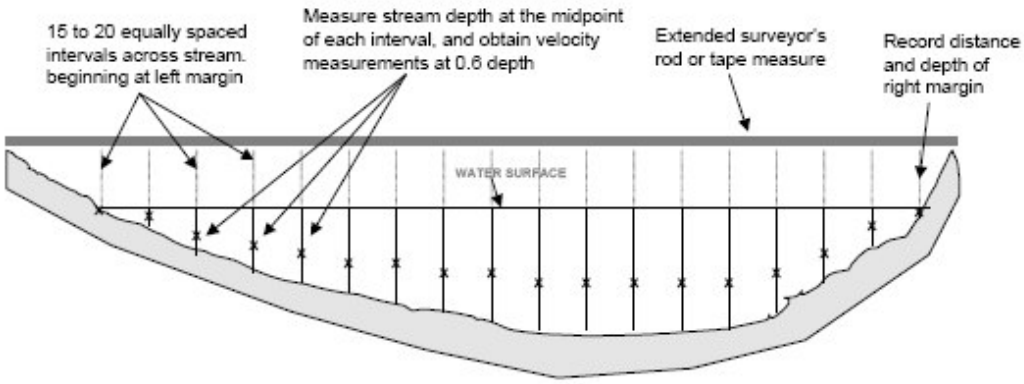
Cross-sectional survey will be undertaken by a team comprising a member of the core Royal Haskoning project team and professional surveyors from Prosurvey. Prosurvey will provide the survey equipment from which levelling results can readily be downloaded and provided in an Excel spreadsheet, with grid references tied to Ordnance Survey datum. The Royal Haskoning team member will work with the survey team on-site to ensure that the appropriate cross-sectional points are taken in order to capture appropriate detail along the cross-sectional profile.

4.5 Physical Habitat Survey

In addition to the cross-sectional survey, measurements of depth, depth-averaged velocity and substrate (DVS) will be taken at the established cross-sections throughout the survey reach.

It is proposed that depth and depth-averaged velocity measurements will be undertaken using a current meter at locations across each of the 8 cross-sections surveyed at each site (see **Figure 4.3**). The cross-section will be divided into equally spaced units. Depth-averaged velocity will be measured at points in the middle of these units at 0.6 water depth below the water surface. A measuring tape will be stretched across the channel and used to identify the locations for depth-averaged velocity measurements. Application of this method will allow an approximation of discharge to be calculated using the velocity-area method (BS EN ISO: 748).

Figure 4.3 Illustration of depth-averaged velocity measurement technique



(Source: United States Environmental Protection Agency (2006))

An assessment of channel bed substrate will be undertaken at five points across the cross-section at channel centre, both channel margins and intervening points. An assessment of grain size will be made based on the standard River Habitat Survey classification scheme.

It was previously proposed that more depth, depth-averaged velocity and substrate (DVS) would be taken throughout the monitoring reach. However, in order to effectively tie these measurements into the monitoring framework, the cross-sections would need to be surveyed into Ordnance Datum in a similar way to the levelling survey cross-sections. It is therefore proposed that a greater number of measurements are focussed at each levelling survey cross-section.

The measurements of depth, depth-averaged velocity and substrate described above will be undertaken pre-restoration and post-restoration at each cross-section.

4.6 Fisheries assessment

4.6.1 Purpose of the fisheries assessment

The purpose of the fisheries assessment will be to monitor populations of four Annex II species (bullhead *Cottus* gobio, Atlantic salmon *Salmo salar*, sea lamprey *Petromyzon marinus*, brook lamprey *Lampetra planeri*) before and after the restoration works. The method is suitable for extension into a longer term monitoring programme if funding becomes available at a later date.

4.6.2 Location of the fisheries assessment

Meso-habitat types have been identified at each of the restoration and control sites. As mentioned in **Section 2.4**, meso-habitats are determined by using reach-scale mapping techniques and integrating both the physical and ecological habitats. At each site, two or three of these key meso-habitat types have been selected for fisheries survey (identified in **Appendix B**). A list of the selected key meso-habitats and a summary of the physical and ecological characteristics is provided in **Table 4.5**.

Table 4.5 Meso-habitats identified for the fisheries survey

Site	Meso-habitat reference number	Summary of the physical and ecological characteristics.
Upper Woodford Control (UWC)	UWC-F01	Glide section, turbulent flow. Gravel substrate. ~40% bed vegetation cover (*Ranunculus* predominantly). Reed/sedge/herb bank vegetation.
Upper Woodford Control (UWC)	UWC-F02	Run section, rippled flow. Gravel substrate. ~60% bed vegetation cover (*Ranunculus* predominantly). Reed/sedge/herb bank vegetation.
Upper Woodford Restoration (UWR)	UWR-F01	Run section, rippled flow. Gravel substrate. ~5-10% bed vegetation cover (*Zannichellia* and *Ranunculus*). Reed/sedge/herb bank vegetation.
Upper Woodford Restoration (UWR)	UWR-F02	Glide section, turbulent flow. Gravel substrate (some siltation evident). ~10% bed vegetation cover (*Zannichellia* and *Ranunculus*). Reed/sedge/herb bank vegetation, overhanging *Alnus* LHB.
Upper Woodford Restoration (UWR)	UWR-F03	Glide section, laminar flow. Gravel substrate with superficial silt. <1% bed vegetation cover (some *Potamogeton pectinatus*). Reed/sedge/herb bankside vegetation.
Seven Hatches Control (SHC)	SHC-F01	Glide section, turbulent flow. Gravel substrate, some siltation. <1% bed vegetation cover (*Ranunculus*). Reed/sedge/herb bank vegetation.

Site	Meso-habitat reference number	Summary of the physical and ecological characteristics.
Seven Hatches Control (SHC)	SHC-F02	Glide section, laminar flow, impounded. Silt substrate. <1% bed vegetation cover (*Potamogeton pectinatus*). Reed/sedge/herb bank vegetation, overhanging *Salix*.
Seven Hatches Restoration (SHR)	SHR-F01	Glide section, laminar flow. Silt substrate. 10% in-channel vegetation cover (*Sparganium erectum*). Tree shading on LHB, grazed reed/ herb vegetation on RHB.
Seven Hatches Restoration (SHR)	SHR-F02	Glide section, laminar flow, impounded. Silt substrate. 10% in-channel vegetation cover (*S. erectum* and *Ranunculus*). Tree shading on LHB, grazed reed/ herb vegetation on RHB.

These key meso-habitats have been selected on their representation of the reach characteristics; relevance to the Annex II species; practicalities of applying the proposed electro-fishing methods; and the availability of adequate habitat area to support the survey technique to be applied. The key environmental conditions at the time of survey will be recorded on the form attached in **Appendix C**.

4.6.3 Fish survey techniques

Electro-fishing is considered the most suitable survey technique for assessing population status of bullheads, salmonids and lamprey (**Cowx IG and Harvey JP, 2003a; Cowx IG and Harvey JP, 2003b; Cowx IG and Fraser D, 2003**). The electro-fishing techniques are based upon the methods explained in Conserving Natura 2000 Rivers Monitoring Series numbers 4, 5 and 7 (**Cowx IG and Harvey JP, 2003a; Cowx IG and Harvey JP, 2003b; Cowx IG and Fraser D, 2003**).

The lamprey and salmonid/bullhead surveys will be conducted consecutively on the same day for each site. Constraints on the fish survey programme, available resources and the welfare of the fish mean that lamprey surveys will not be carried out on separate days to the salmon and bullhead surveys at each reach. To run the lamprey and salmonid/bullhead surveys on the same site, at the same time, there are four potential options for surveying:

a) Use the sweep and quadrat techniques identified in the monitoring guidance, and survey for all three species concurrently. This is not feasible because each sweeping sample run needs to continue at the same rate and be identical in technique. Temporarily halting to survey a quadrat would create inconsistencies between runs and would provide less reliable data.

b) Only apply the sweep technique. This survey technique can be adapted for sampling lamprey (Conserving Natura 2000 Rivers Monitoring Series No. 5) and used to electro-fish the difficult areas and sub-optimum habitats, however it is not recommended to be used as a stand alone method. Furthermore, the adapted sweep technique applied to lamprey survey is not suitable for salmonid

survey. Accessible, optimum habitat should be surveyed with the quadrat method and salmonid/bullhead surveys will apply the appropriate technique.

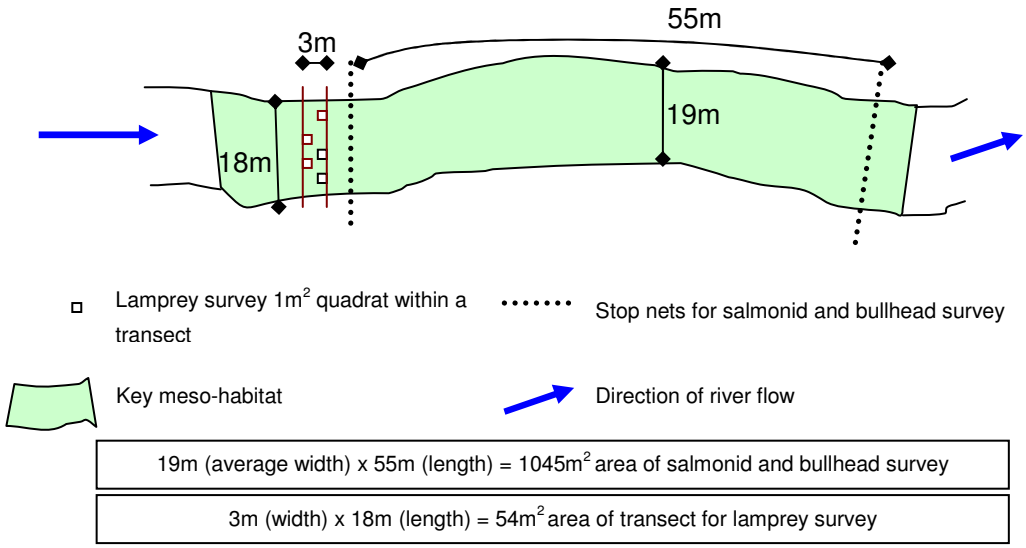
c) Carry out the sweep, followed by the lamprey quadrat survey technique once all caught fish are out of the netted area. Awareness would be needed to collect lamprey ammocoetes stunned during the sweep as they are small and can easily be overlooked. The lamprey caught during the sweep would be included with those taken during the quadrat sampling. Bullhead or salmon stunned during the quadrat should be noted but not included for population analysis, as the technique of collection is inconsistent with the depletion survey method. This method is not preferable because the sweep technique is not the same for lampreys as it is for salmon and bullhead surveying. In addition, the quadrat sampling sites would already be disturbed from the sweep survey and depletion survey would not be possible.

d) The lamprey survey area is separate from the salmonid and bullhead survey area. The same meso-habitat types could be surveyed, and all would be within the applicable reach. The salmonids and bullheads would be surveyed initially followed by the lamprey survey, whilst the other fish are still removed from the river. The lamprey survey would be undertaken upstream of the stop-netted salmonid/bullhead area in order to prevent disturbance and stirred sediments reducing visibility.

Option 'd' is the most suitable for the purpose of this study because it applies suitable techniques, whilst not needing to re-visit reaches that have already been surveyed. Re-visiting the same areas will place additional stress on fish that have already been caught. It is better practice to minimise the number of surveys carried out on a stretch of river, either as part of the same study or in-combination with others. Fish within the Seven Hatches control site have the potential to be caught on three separate occasions within two months in 2006, however the method has considered the best practice and the same area will not be electro-fished more than once.

The area of meso-habitat available for each survey is constrained as it will be split by the two different techniques; however the reaches (and required meso-habitat space) are large enough to accommodate this. The layout of this method is demonstrated in **Figure 4.4**, which relates to the shaded meso-habitat sampling area shown in **Appendix B**.

Figure 4.4 **Layout of the fisheries survey area at the key meso-habitats.**



Bullhead and salmonid survey

Electro-fishing will be conducted systematically across the channel working downstream to upstream. The hand-held anode will consist of a pole with a switch and handle at one end and submersible, positively charged hoop on the other end. The anode will be operated in an upstream direction and will sweep the wetted area of river ensuring adequate coverage of the entire meso-habitat area that has been selected for survey. The anode will not be operated too close to the riverbed (within 30mm), as this may result in immobilisation of bullheads in the substrate and make capture difficult (**Cowx IG and Harvey JP, 2003a**).

Stop-nets will span the river at the upstream and downstream extents of the selected area of meso-habitat to prevent startled fish leaving the survey area. This will be particularly necessary due to the lack of vegetation and other refuge at most sites, which salmonids would otherwise retreat to. Electro-fishing will be conducted over at least 1000m2 per meso-habitat, with a maximum river length of 100 m (as recommended in **Cowx IG and Harvey JP, 2003b**). This will ensure a suitably sized habitat area is available to sample a sufficient population size for analysis. The area of surveyed meso-habitat will be assessed and recorded.

In order to fulfil the requirements of depletion analysis, the salmonid survey will require multiple runs at each meso-habitat. This will involve at least three runs, unless the second catch is very much smaller than the first and the field estimates of population size indicate

a) that the population size exceeds 200; and
b) that the probability of capture of an individual fish is greater than 0.6.

Under these circumstances a third fishing need not be carried out **www**[1]).

Cowx and Harvey (2003a) say that depletion survey is not necessarily recommended for bullhead survey, due to reasons relating to catch efficiency. This is particularly the case where fish populations were high and the number of fish stunned is above the number that can be physically removed and counted, resulting in the a poor representation of the

age structure and population size (**Cowx and Harvey, 2003a**). The sample taken during the first run will be used as an indicative, semi-quantitative value and subsequent captures will be discounted.

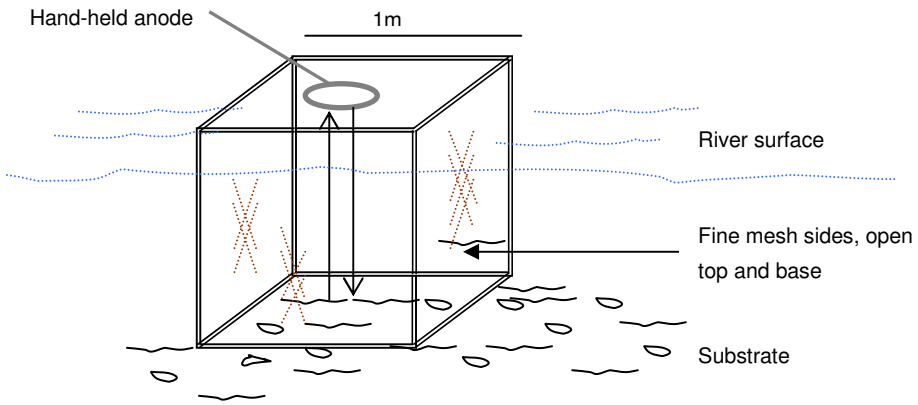
Salmonid and bullhead surveys will run concurrently, as the required electro-fishing techniques and recommended sample area size are the same.

Lamprey survey

The method for lamprey survey will follow the guidelines in Conserving Natura 2000 Rivers Monitoring Series No. 5 (**Cowx IG and Harvey JP, 2003b**), which is summarised by the following method.

A three dimensional $1m^2$ mesh quadrat will be used to survey optimal habitat, as sketched in **figure 4.5**.

Figure 4.5 Quadrat apparatus for lamprey surveying.



Optimal habitat for surveying is defined as the preferred substrate and physical environment, and areas without obstructions to the quadrat method (e.g. tree roots). A transect across the river will be identified upstream of the salmonid and bullhead surveying area, but still within the same meso-habitat type. The five quadrats will be placed along the transect over the optimal habitat. The transect location will tie in with the cross section, velocity and substrate surveys. This will further contribute to the analysis of the meso-habitat that supports populations of lamprey.

During the post restoration survey the quadrats will not necessarily be relocated precisely, as certain features may prevent this (such as the creation of islands) but it is intended they will be placed along the same transect line. Depending on the restoration works that are undertaken at the site, it may be that the transect no longer includes appropriate habitat for lamprey survey e.g. due to the location of deflectors or mid-channel islands. A review of the implemented restoration works will be undertaken prior to the post-restoration survey to identify if this may be the case and an appropriate approach agreed with Natural England. Following identification of the survey area (optimal and sub-optimal habitat) the mesh quadrat will be placed and left for five minutes to allow any disturbed sediment to settle. The anode will be placed under the water surface but not directly onto the substrate surface (about 10–15 cm above the surface) as this may immobilise lamprey in the sediment. The anode will be energised for 20 seconds, and then turned off for approximately five seconds. The anode will be

switched on and off in this way for approximately two minutes. This method of energising the anode reduces the risk of immobilising lamprey in the sediment and making their capture difficult. Furthermore, the on-off cycle draws lamprey out of their burrows into the water column.

The anode operator will be helped by an assistant who removes immobilised fish using a fine-mesh hand net (for example, a net used for sampling invertebrates). The captured lamprey will be transferred to a suitable water-filled container. Once the survey period of two minutes has elapsed, the electric fishing gear will be switched off (following Environment Agency procedures). For depletion sampling purposes the process will be repeated a minimum of three times, with a resting period of five minutes between each sample. Ammocoetes and transformers (the juvenile lamprey) will be placed in a separate water-filled container for each sample. Five quadrat samples will be taken per meso-habitat in optimum habitat. Five quadrats will be sufficient to ensure a robust assessment, whilst any more would be too resource intensive in the available timeframe. The remaining area will be surveyed as-per sub-optimum habitat. Following completion of the sample the lamprey will be identified and measured.

The rigid quadrat framework will then be moved to the next sampling point and left to allow any disturbed sediment to settle while the first sample catch is processed. The sub-optimal habitat within the transect, which will include the remaining area of riverbed or in-stream vegetation, debris and tree roots, will be carried out using the upstream sweeping technique applied to Bullhead and Salmonids. The same electric fishing gear used for the quadrat-based fishing will be used, but the power turned on and off frequently to draw the ammocoetes out of their burrows or from concealed locations. The area sampled will be measured accurately so the number of lamprey per unit area can be determined as a minimum estimate of density.

Recording of other fish species

In addition to recording data relating to the Annex II fish species for which the River Avon SAC is designated (bullhead, salmon and lamprey), the following data will be recorded for all species of fish observed during the electrofishing survey: number caught, number of removals and occurrence of external anomalies or parasites.

4.6.4 Data analysis

Salmonid will be recorded both as total number and as number per m^2, where possible derived as an absolute estimate using a depletion model on successive catches. Trials have revealed quantitative sampling (using multi-run depletion estimates) is appropriate for salmonids population assessment (**Cowx IG and Fraser D, 2003**), and will provide a robust indication of the population density at each of the meso-habitats surveyed.

Length-frequency histograms will be plotted to determine the age structure. The mean length at age, including standard deviation, will be derived from length-frequency histograms which will be related to known values for the Avon catchment. The analysed data will be reported as quantitative values of age structure (0+ and 1+ age groups) and population size for each meso-habitat.

Bullhead will be recorded from the first run of the survey both as total recorded number and as number per m^2, derived as a relative measure in terms of numbers caught per

unit area. Age structure will be determined applying the same analysis method as for the salmonids.

The results for ammocoete and transformer lamprey species (sea lamprey *Petromyzon marinus* and brook lamprey *Lampetra planeri*) will be presented separately for each meso-habitat sampled. Quantitative data will be obtained from the multi-run survey, and analysed using depletion modelling as per the salmonid survey. The analysed data will show the relative density of ammocoetes per m^2.

4.6.5 Limitations

The survey methods explained in Conserving Natura 2000 Rivers Monitoring Series No. 4, 7 and 1 (**Cowx IG and Harvey JP, 2003a; Cowx IG and Harvey JP, 2003b; Cowx IG and Fraser D, 2003**) have been adapted to suit the level of detail required and feasibility of survey. The relatively short length of reach (as little as 300 metres) and lack of survey repetition creates limitations to the quantitative analysis of the data obtained. Therefore the techniques have been modified to gain the optimum information in the given timescale and within the limited area.

Ideally, there would be a programme running for several years to account for natural variability. The constraints on the fish survey programme and resources do not allow for this, therefore an indicative snap-shot survey method with best-fit control sites has been chosen. Each key meso-habitat type will be surveyed once, which will provide an indication of the fish populations present, however without repeated surveys of identical habitat and/or the same habitat statistical comparison will not be possible.

The bullhead count will be run only once, which will be of limited value in determining a reliable value of population density. However, the run will give a presence or absence of bullhead and an indication of the population size.

The lamprey survey will be carried out across a relatively narrow transect across each key meso-habitat. This area is considered to be too small for reliable statistical analysis; however the data (presence/absence and indicative population density) will be closely tied into and the physical habitat recorded at the same locations. This will contribute towards characterising the habitat thereby supporting the lamprey survey.

The methods for fisheries survey (particularly for the lamprey and bullhead) will not be sufficiently robust to allow direct comparisons between surveys across time scales or control/restoration reaches. However, the results will inform an indicative baseline of population density for the reaches at the different meso-habitats when surveyed before and after the restoration works.

Further justification for the simplification of the survey methods is provided in **section 2.1**.

5 PROGRAMME

5.1 Survey Programme

The overall programme is contained in **Appendix D1**. The refined programme of surveying for 2006 is contained in **Appendix D2**. In subsequent years (2007, 2008 and 2009) the refined programme for the year will be submitted to the Natural England (English Nature) project officer with the quarterly report produced in June for each year.

5.2 Changes to the survey programme

The surveys that will be undertaken for the monitoring project can be affected by adverse environmental conditions, such as poor water visibility or high flows. Adverse conditions can affect the standard of results, pose a threat to the health and safety of surveyors, or cause undue suffering of the sampled specimen (e.g. electro-fishing in excessively high water temperatures. In response to adverse surveying conditions it may be necessary to alter the timing of survey. Any changes in the timing of the survey will be run through the Natural England (English Nature) Project Officer, who will make the necessary contact with landowners for access.

6 HEALTH AND SAFETY RISK ASSESSMENT

A Health and Safety Risk Assessment for undertaking the initial reach-scale mapping and macrophyte surveys at Upper Woodford (River Avon) and Seven Hatches (River Wylye) is contained in **Appendix E**.

English Nature has also provided Health and Safety Plans for the sites at Upper Woodford (River Avon) and Seven Hatches (River Wylye) which have been reviewed and will be communicated to and followed by the survey team, the exception being that buoyancy aids will be used in place of a throw line whilst working near the river.

Further Health and Safety Risk Assessments will be undertaken and copies provided to the English Nature Project Officer prior to the rapid assessment and detailed surveys at the remaining restoration sites.

7 REFERENCES

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www[1]
http://fame.boku.ac.at/downloads/D4_6_metrics_and_sampling_procedure.pdf#search=%22CEN%20Sampling%20of%20Fish%20with%20Electricity%3AWork%22

APPENDIX A

Fluvial Audit data collection sheet

Part I: SURVEY CONDITIONS R02

See relevant 1:25000 mapping and watercourse summary sheet for watercourse name and Reach ID code					
Catchment	Watercourse	Reach ID	NGR Start		Surveyor
			NGR End		
Date	Time	Flow (tick): ☐ Low/base	☐ Above low	☐ High	
Conditions influencing survey quality:	LHB ☐ RHB ☐	Reason for upstream reach boundary:	Record photo NGR (GPS) and mark on map	No. of Photos	

Part II: SEDIMENT SOURCES

*Tally fine and coarse sediment sources, place totals in final box (e.g. F2, C4). * = Take GIS reading and mark on map*
Diffuse sources: tally with F for fine and C for coarse under Micro, Meso or Macro and direct from slope or indirect e.g.through creep

Point Sources

	Fine	Coarse	Totals		Fine	Coarse	Totals
Tributaries*				Scour at structure			
Field drain/mill leat*				Tree fall			
Tipped Material*				Footpath			
Collapsed building/wall*				Burrowing			
Vehicle access				Poaching			
Outfalls				Fishing platforms			

Diffuse Sources

Fluvial erosion	Micro	Meso	Macro	*Geotechnical failure*	Micro	Meso	Macro
Toe scour				Toe undermining			
Eroding cliff				Translational			
				Rotational slip			
Hillslope supply	Micro	Meso	Macro	Complex failure			
direct				Channel weathering			
indirect							

Part III: SEDIMENT TRANSPORT

Tally each morphological form observed along the reach, most likely to be in sequences according to associated gradient (e.g. pool-riffle)

Morphological Forms

	Tally	Total		Tally	Total
Waterfall			Boil		
Chute			Glide		
Rapid			Pool		
Riffle			Ponded reach		
Run			Marginal deadwater		

Part IV: SEDIMENT SINKS

Tally fine and coarse sediment sources, place totals in final box (e.g. F2, C4)

Point Sinks

	Fine	Coarse	Totals
Weirs*			
Dams			
Fords			
Bridge			
Large woody debris			

Ad-hoc Fisheries Improvements

	Tally	Totals
Dredged pools		
Submerged vanes		
Boulder placement		
Deflectors		
Minor weir		
Vegetation management		

Diffuse Sinks Recent flood chaos? ☐ Yes ☐ No

	Permanent			Semi-permanent			Temporary		
	Micro	Meso	Macro	Micro	Meso	Macro	Micro	Meso	Macro
Floodplain deposits									
Splays									

Channel Deposits

Tally and total permanent, semi-permanent and temporary sediment deposits Micro = <10m^2, Meso = 10-150m^2, Macro = < 150m^2
Tick types of storage present, place an E on right of box if extensive (>33%) - do not tally isolated boulders

	Permanent			Semi-permanent			Temporary		
	Micro	Meso	Macro	Micro	Meso	Macro	Micro	Meso	Macro
Boulder/cobble									
Cobble/gravel									
Fine material									

Type of Storage

☐	Mid channel bar	☐	Berms	☐	Isolated boulders
☐	Side bars	☐	Mature Islands		
☐	Point bars	☐	Toe accummulation		

Part V: VALLEY OVERVIEW R02

Landuse codes:Coniferous Woodland (CW), Broadleaf Woodland (BL), Scrub (SH), Wetland (WL), Moorland Heath (MH), Grazing (G), Tilled land (TL), Standing water (SW), Road/Track (RT), Suburban/urban (SU), Recreational (RE)

Valley Form (tick one)

- ☐ Shallow Vee
- ☐ Deep Vee
- ☐ Gorge
- ☐ Concave/Bowl
- ☐ Terraced valley floor
- ☐ Not visible

Landuse (dominant type)

	5m	50m
LH		
RH		

Floodplain (tick one) Width (tick one)

		LH	RH	
☐	None	☐	☐	< 1 river width
☐	One bank	☐	☐	1-5 river widths
☐	Alternate	☐	☐	5-10 river widths
☐	Both banks	☐	☐	> 10 river widths

Riparian Buffer Strip (tick one)

LH	RH		Width of strip (tick one) LH	RH		Bank top vegetation (tick one) LH	RH	
☐	☐	None	☐	☐	None	☐	☐	Uniform
☐	☐	Indefinite	☐	☐	< 1 river width	☐	☐	Simple
☐	☐	Fragmentary	☐	☐	1-5 river widths	☐	☐	Complex
☐	☐	Continuous	☐	☐	> 5 river widths	☐	☐	Diseased alders?
						☐	☐	Invasive species?

Connectivity

Channel disconnected from floodplain? (no out of bank flow)

- ☐ Yes
- ☐ No

Terraces (tick one) — *Insert no. of terraces*: LH ____ RH ____

LH	RH	
☐	☐	None
☐	☐	Indefinite
☐	☐	Fragmentary
☐	☐	Continuous

Levees (tick if present)

LH	RH	
☐	☐	None
☐	☐	Natural
☐	☐	Man Made
☐	☐	Continuous
☐	☐	Fragmented

Trashlines (tick one)

- ☐ LH
- ☐ RH

If Yes: *Estimate height (m)*: ____

Other features (e.g. palaeochannels)

Part VI: CHANNEL GEOMETRY

Planform (tick one)

- ☐ Straight
- ☐ Sinuous
- ☐ Irregular meanders
- ☐ Regular meanders
- ☐ Braided
- ☐ Anastomosed
- Y/N Realigned? *Ring Y/N*

Cross-section (tick one)

- ☐ Rectangular/Trapezoidal
- ☐ U-shaped
- ☐ Two stage
- ☐ Multi-stage
- Y/N Resectioned? *Ring Y/N*
- Y/N Culverted? *Ring Y/N*
- Est. length of culvert (m): ____

Channel Dimensions

Width	Depth	Symmetry	(tick one)
☐	☐	☐	Uniform
☐	☐	☐	Variable with planform
☐	☐	☐	Variable without planform

			Estimate (m)
		Qbf Min	
		Qbf Max	
		Qbf Mean	

Gradient (tick one) (use look back test)

- ☐ High
- ☐ Medium
- ☐ Low

Velocity (tick one)

- ☐ Uniform
- ☐ Varied
- ☐ Highly varied

Part VII: BOUNDARY CONDITIONS

BED

Bed Material (tick all present, E if > 33%)

☐	Obscured	☐	Cobble
☐	Fine material	☐	Boulder
☐	Fine gravel	☐	Bedrock
☐	Coarse gravel	☐	Artificial

Bed Characteristics: (tick all applicable, E if > 33%)

Sorting:	☐	Sorted	☐	Unsorted		
Debris:	☐	None	☐	Natural	☐	Man made
Sphericity:	☐	Angular	☐	Sub-angular	☐	Rounded
Imbrication:	☐	None	☐	Imbricated	☐	Armoured
Diversity:	☐	Uniform	☐	Non-uniform		

Channel Vegetation: % cover ____

☐	Submerged in-channel vegetation	☐	Filamentous algae
☐	Surface floating vegetation	☐	Moss/lichen/liverworts
☐	Emergent reeds/sedges/rushes	☐	Exposed tree roots

BANKS

Bank material (tick if present, E if > 33%)

LH	RH	
☐	☐	Obscured
☐	☐	Clay
☐	☐	Silt
☐	☐	Sand
☐	☐	Fine gravel
☐	☐	Coarse gravel
☐	☐	Cobble
☐	☐	Boulder
☐	☐	Bedrock
☐	☐	Artificial
Y/N	Y/N	Cohesive?

Profile (tick if present, E if > 33%)

LH	RH	
☐	☐	Cliff/Vertical
☐	☐	Stepped
☐	☐	Graded

Protection (tick if present, E if > 33%)

☐	☐	None
☐	☐	Toe
☐	☐	Full
☐	☐	Walled
☐	☐	Concrete
☐	☐	Wooden
☐	☐	Rip rap
☐	☐	Other……

Tree lining (tick one for each bank)

LH	RH	
☐	☐	None
☐	☐	Isolated/scattered
☐	☐	Reg. spaced/singular
☐	☐	Occasional clumps
☐	☐	Semi-continuous
☐	☐	Continuous
Y/N	Y/N	Recent tree planting

Bank face vegetation (tick one for each bank)

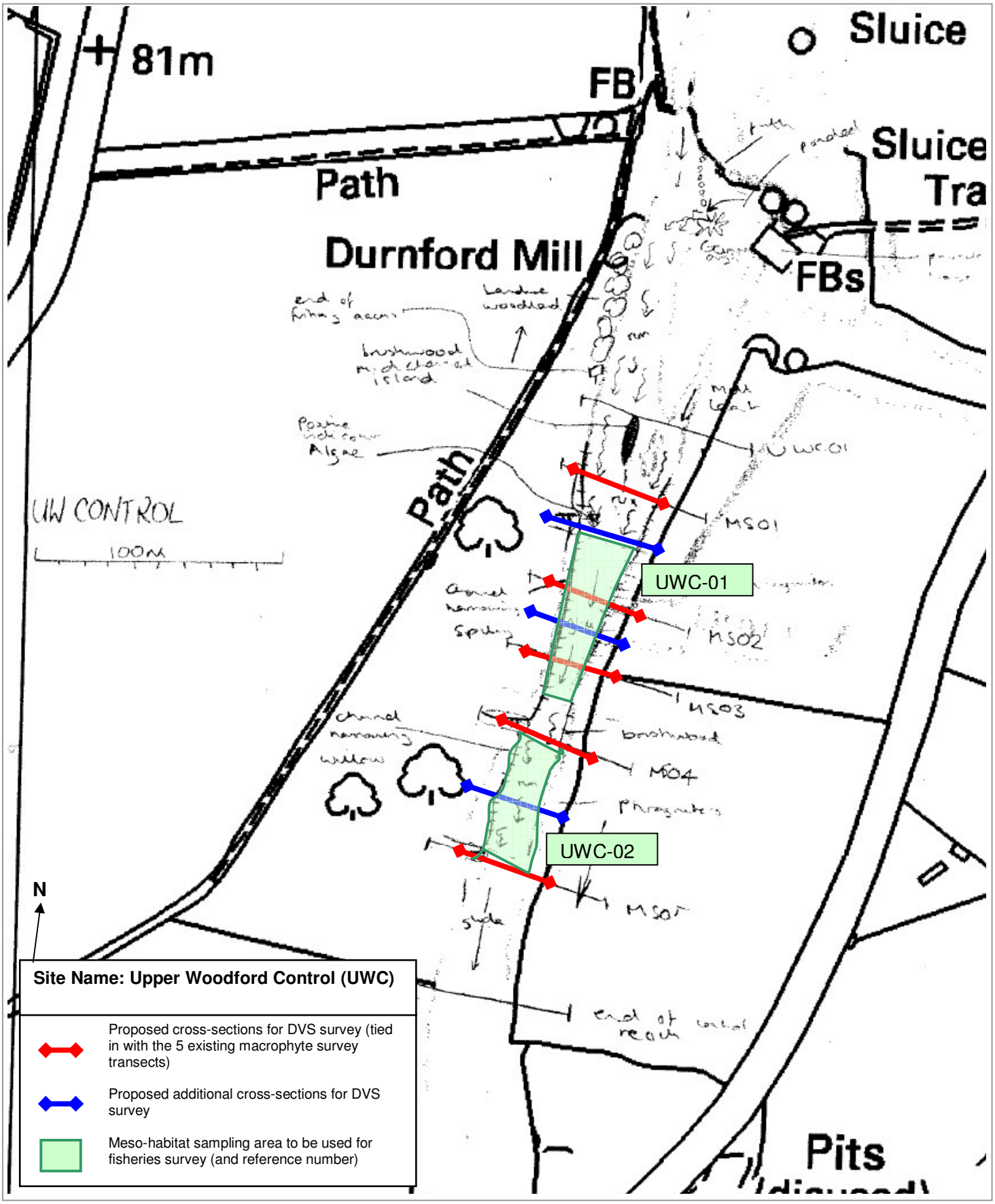
LH	RH	
☐	☐	None
☐	☐	Uniform
☐	☐	Simple
☐	☐	Complex

ROYAL HASKONING

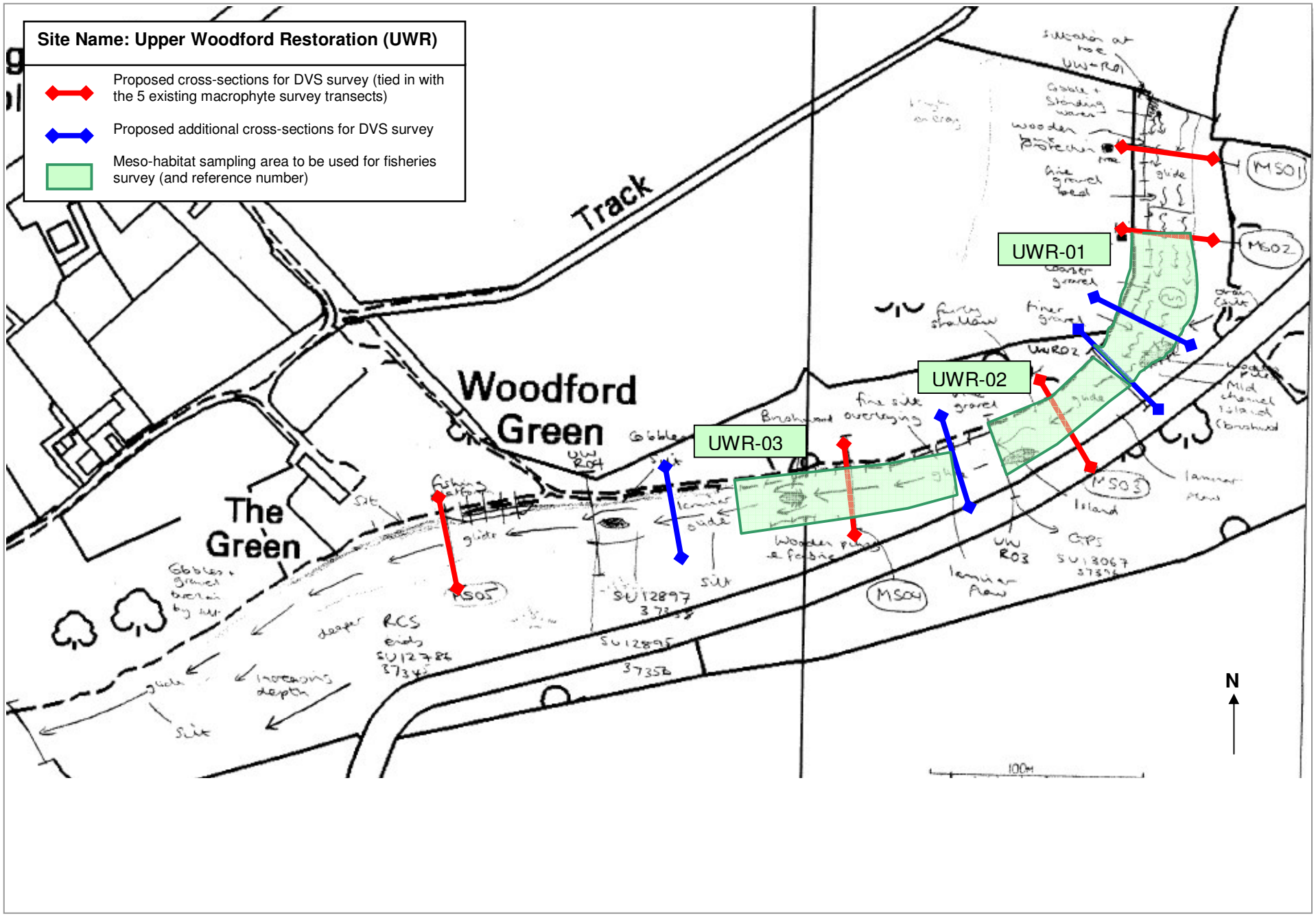
APPENDIX B

Detailed assessment maps

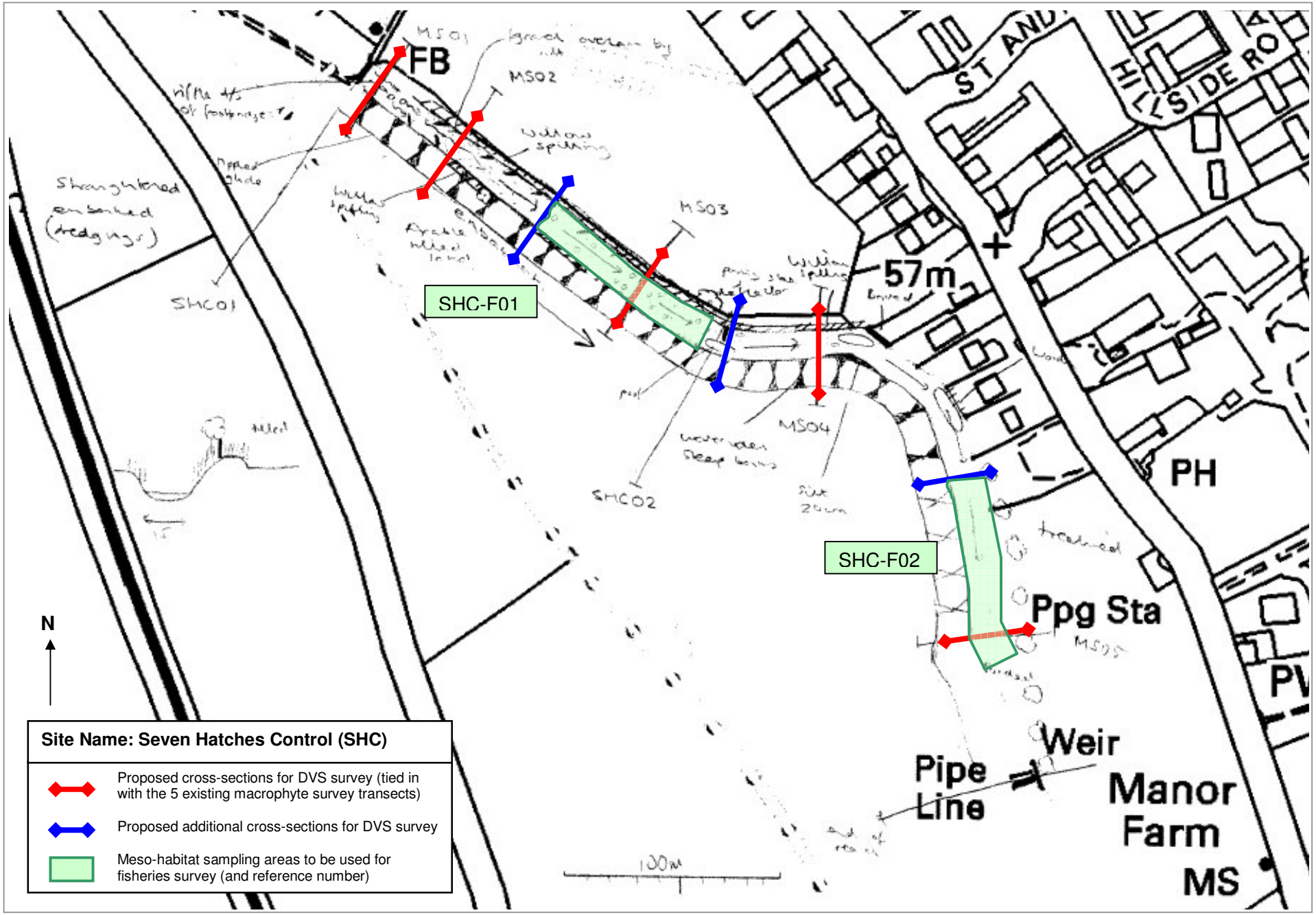
Appendix B1


81m
FB
Path
Durnford Mill
Sluice
Sluice
Tra
FBs
UW CONTROL
100M
Path
UWC-01
UWC-02
MS01
MS02
MS03
MS04
MS05
N
Site Name: Upper Woodford Control (UWC)
Proposed cross-sections for DVS survey (tied in with the 5 existing macrophyte survey transects)
Proposed additional cross-sections for DVS survey
Meso-habitat sampling area to be used for fisheries survey (and reference number)
Pits

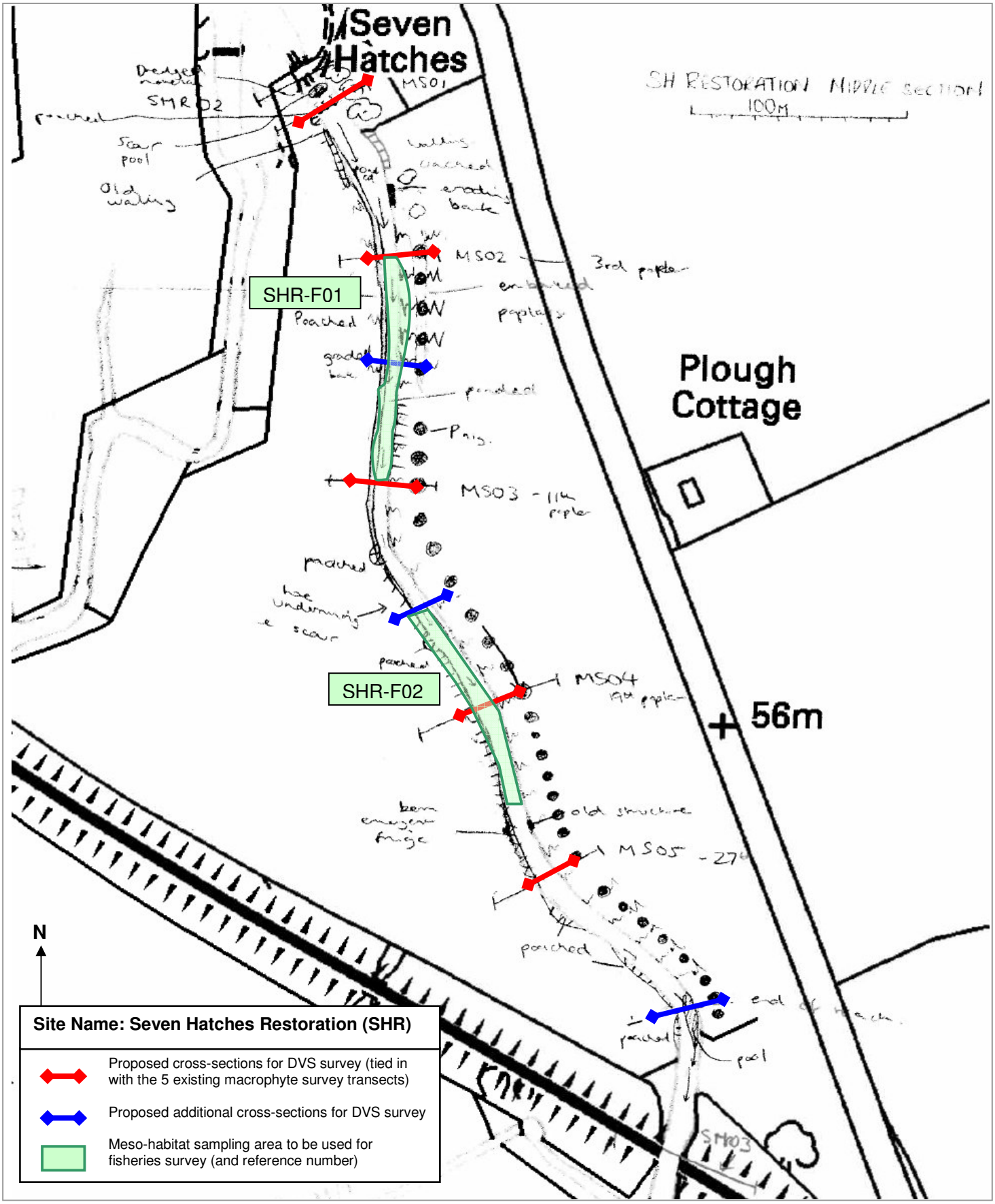
Appendix B2


Site Name: Upper Woodford Restoration (UWR)
Proposed cross-sections for DVS survey (tied in with the 5 existing macrophyte survey transects)
Proposed additional cross-sections for DVS survey
Meso-habitat sampling area to be used for fisheries survey (and reference number)
Track
Woodford Green
The Green
UWR-01
UWR-02
UWR-03
MSO1
MSO2
MSO3
MSO4
MSO5
N
100m

Appendix B3


FB
MS01
MS02
MS03
MS04
SHC01
SHC02
SHC-F01
SHC-F02
57m
PH
Ppg Sta
Weir
Pipe Line
Manor Farm
MS
ST AND
HILLSIDE RO
N
100M
Site Name: Seven Hatches Control (SHC)
Proposed cross-sections for DVS survey (tied in with the 5 existing macrophyte survey transects)
Proposed additional cross-sections for DVS survey
Meso-habitat sampling areas to be used for fisheries survey (and reference number)

Appendix B4


Seven Hatches
Plough Cottage
SH RESTORATION MIDDLE SECTION
100M
SHR-F01
SHR-F02
MS01
MS02
MS03
MS04
MS05
56m
N
Site Name: Seven Hatches Restoration (SHR)
Proposed cross-sections for DVS survey (tied in with the 5 existing macrophyte survey transects)
Proposed additional cross-sections for DVS survey
Meso-habitat sampling area to be used for fisheries survey (and reference number)

APPENDIX C

Fisheries survey data collection sheet

Sampled meso-habitat, location and staff

Date		Time of the day	Start of sampling	
			End of sampling	
Catchment name		River name		
Fishing staff leader and crew members				
Meso-habitat code		NGR	Upstream	
Fishing method	Sweeping / boat / quadrat		Downstream	

Equipment and prerequisites

Manufacturer		Current (A)		
Model		Anode type	Ring	
Mobility	Portable / non-portable		Anode diameter	
Pulse type	DC or PDC		Number	
Pulse frequency (Hz)				
Voltage (V)		Use of stop-nets		Yes / no

Environmental conditions

Water level		Temperature of water (ºC)	
Air temperature		Cloudiness	
Precipitation		Windiness	
Resistance or conductivity value of water (µS cm-1)		Visibility (colour and/or turbidity of the water)	

Meso-habitat sampling area

Notes at the time of survey			
Fished area (m2)			
Photograph reference	Description	Photographic reference	Description

Catch

Common name	Scientific name	Number caught	Number of removals	External anomalies or parasites
bullheads	***Cottus gobio***			
salmonids	***Salmo salar***			
brook lamprey	***Lampetra planeri***			
sea lamprey	***Petromyzon marinus***			

Fork length / body length (to the nearest mm)

bullheads	salmonids	brook lamprey	sea lamprey

ROYAL HASKONING

APPENDIX D

Programme

D1 Overall Programme

D2 Detailed Programme for 2006

Appendix D1

River Avon STREAM Monitoring Project

Overall Programme

ROYAL HASKONING

YEAR	2006									2007												2008												2009								
Task	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Inception Stage																																										
Data Review																																									
Identification of key meso-habitats																																									
Site selection (inc site visit)																																									
Inception meeting																																									
Finalisation of monitoring programme																																									
Detailed Monitoring																																									
Physical Biotope Mapping & RCS																																									
Cross-section survey																																									
Macrophyte survey																																									
Fisheries survey																																									
Repeat Photographic survey																																									
Rapid Assessments																																									
Physical Biotope Mapping & RCS																																									
Repeat photography																																									
Analysis & Reporting																																									
Data analysis and GIS																																									
Annual Reports (3)																																									
Final Report (1)																																									
QA Report Review																																									
Management																																									
Meetings (5)																																									

Quarterly reports

30th Nov

30th Nov

30th Nov

Appendix D2
River Avon STREAM Monitoring Project
Detailed Programme - 2006

ROYAL HASKONING

Month	Staff	Days	July		August				September				October					November				December			
Week commencing			24th	31st	7th	14th	21st	28th	4th	11th	18th	25th	2nd	9th	16th	23rd	30th	6th	13th	20th	27th	4th	11th	18th	25th
Detailed Monitoring - UPPER WOODFORD AND SEVEN HATCHES PRE-RESTORATION																									
Geomorphological, habitat survey, RCS and photography	3RH + SP	4			7-10th																				
Cross-section survey - Upper Woodford	1RH + Prosurvey	2							6-8th																
Cross-section survey - Seven Hatches	1RH + Prosurvey	2									18-19th														
Fish survey - Upper Woodford	1RH + Kingcombe	2								13-14th															
Fish survey - Seven Hatches	1RH + Kingcombe	2										27-28th													
Rapid Assessments - AMESBURY AND FOVANT PRE-RESTORATION																									
Feature inventory survey	2RH	1					24th																		
Basic habitat mapping							24th																		
Repeat photography							24th																		
Reporting																									
Data analysis and GIS																									
Annual Report																									
Management																									
Inception Meeting			27th																						
Quarterly Report																									
Annual Meeting																									