POST WORKS ASSESSMENT OF THE STREAM RESTORATION PROJECT SITES AT FOVANT

(R. NADDER)

Summary of post works assessment following final site visit on 9th July 2009

R. Nadder, Fovant – Pre Scheme

R. Nadder, Fovant – Post Scheme

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1. Introduction

Introduction

The majority of the perennial River Avon catchment and part of one of the winterbournes (River Till) in Hampshire is designated as a Special Area of Conservation (SAC). The River Avon is one of the UK's most bio diverse, with over 180 species of aquatic plants, 37 species of fish and a wide range of aquatic invertebrates. The headwaters of the main river are a network of clay streams fed by chalk springs. These converge to form a chalk river, which is then joined by the main tributaries around Salisbury developing into a large calcareous river. It then flows over more acid sands and clay as it passes the New Forest and the Dorset Heaths. The SAC also includes the Dockens Water, a largely unmodified acid stream draining New Forest heathlands.

The River Avon has a high baseflow input from the chalk aquifer. In the upper reaches of the system, the rivers support outstanding chalk stream fisheries, and the surrounding land is mainly grazed or arable. In the lower reaches of the Avon, the river is known for its coarse fishery and the floodplain is of international importance for wintering wildfowl and waders. The river is highly valued throughout for its flora and fauna, and is the subject of a range of conservation, fishery and agricultural initiatives.

The SAC designation is due to the inherent richness of flora and fauna of the River Avon. Specifically the reviser is designated for the following internationally rare or vulnerable species and habitat underpin the designation.

- Water courses of plain to montane levels with *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation (classic chalk stream habitat)
- Population of Atlantic salmon (*Salmo salar*)
- Population of bullhead (*Cottus gobio*)
- Population of brook lamprey (*Lampetra planeri*) and sea lamprey (*Petromyzon marinus*)
- The river and adjoining land a habitat for populations of Desmoulin's whorl snail (*Vertigo moulinsiana*)

The River Avon SAC is subject to a water level management plan, and an action plan for the SSSI's restoration needs was completed as part of the Environment Agency (EA) assessment of the cost to meet the Public Service Agreement (PSA) target for river morphology (EA 2008).

1.1 STREAM Project Background

1.1.1 Project Specification

The STREAM project was a £1 million four-year conservation project centered on the River Avon and the Avon Valley in Wiltshire and Hampshire. The River Avon and its main tributaries are designated as a Special Area of Conservation (SAC), and the Avon Valley is designated as a Special Protection Area (SPA) for birds. The STREAM project has undertaken strategic river restoration activities and linked management of the river and valley to benefit the river habitat

including water crowfoot and populations of Atlantic salmon, brook and sea lamprey, bullhead, Desmoulin's whorl snail, gadwall and Bewick's swan.

A Conservation Strategy for the River Avon Special Area on Conservation (2003) identified the main issues affecting the ecological health of the River Avon *SAC*, and agreed on a range of actions required to address them. It also highlighted the complex relationship between the river and the Avon valley.

In December 2002, work began on securing substantial new funding to do the following:

- Restore, to favourable condition, the River Avon Special Area of Conservation/Special Site of Scientific Interest (SSSI) and the Avon Valley Special Protection Area/SSSI.
- Tackle wider biodiversity issues outside the European protected sites including additional priority species and associated habitats, and
- Improve public access, awareness and support for the natural heritage importance of the river and valley.

The project identified 6 sites where conservation-led restoration of the watercourse habitat is required, and which could subsequently be used to demonstrate techniques and disseminate knowledge and experience of this work. For the application submission, an outline design for each site has been drawn up.

1.1.2 Restoration

The approach to the restoration works is to reinstate the physical form and diversity of the river channel, creating dynamic habitats that are sustained by the river's natural flow regime. The aim of the works was to demonstrate novel and appropriate restoration techniques for the chalk river types within the River Avon SAC, but the approach should be applicable to other rivers supporting *Ranunculion fluitantis /Callitricho-Batrachion* communities.

Works included bank re-profiling to a more natural slope, non-native tree felling and native tree planting, reconnecting the river to its floodplain, and enhance currently poor marginal habitat, which is known to be critical to fish and invertebrates in lowland rivers.

The key objective of the restoration work was to demonstrate a range of bio-engineering techniques useful for the narrowing of river channels. The range of techniques should then provide a 'tool-box' that fishing clubs could carry out themselves to help integrate the needs of riparian ecology with fishery management.

1.2 Monitoring Requirements

The project bid identified a number of actions which were identified. These fell into a number of categories including;

- Preparatory actions (Actions A)
- Purchase/lease of land and/or rights (Actions B)
- Non-recurring management (Actions C)
- Recurring management (Actions D)

- Public Awareness and dissemination of results (Actions E)
- Overall project operation and monitoring (Actions F)

Of the overall project operation and monitoring actions (see Table 1.1), action F8 relates to monitoring.

Table 1.1 Overall project Operation and Monitoring Actions

Code	Title and Actions	Objectives
F1	Appointment of Project Management Team	Set up an effective LIFE project team
F2	Project Management, including management of Project Staff	Ensure all project actions are executed to fulfil the objectives of the LIFE project within the allocated budget
F3	Project Reporting	Reporting progress of project to the EU
F4	Management of the Project actions and budget by Project Working and Steering Group	To provide overall direction to the project.
F5	Purchase equipment	To equip the LIFE team so they can effectively carry out the project
F6	Purchase car	Allow the LIFE team to travel around the catchment and liaise with key stakeholders
F7	Project Initiation Workshop	To launch the project and facilitate a good working relationships between all partners.
F8	Monitoring Programme	To monitor success of the river restoration work and disseminate findings.
F9	Assessment of River Restoration Sites	Compare the River Restoration project outcomes with the original objectives
F10	Production of After-LIFE Conservation Plan	To set out future conservation management continuing and developing the actions in this Project

1.2.1 Detailed Monitoring

Royal Haskoning were commissioned by Natural England to undertake physical and biological monitoring at each of the restoration sites. A monitoring protocol was developed for the river restoration works. This combined detailed monitoring at a limited number of sites, with a more rapid assessment of the remainder. The full detailed monitoring was carried out and Upper Woodford and Seven Hatches sites. At Fovant and Hale only the rapid assessment was carried out, but was also conducted at Upper Woodford and Seven Hatches. The rationale behind this was to minimise costs while ensuring basic assessment of the effects of the range of restoration techniques carried out by the Project.

All sites were monitored pre and post restoration. Detailed monitoring was carried out on two restoration sites, each with a control site. The control sites had comparable physical characteristics to the restoration sites prior to the works; however, no restoration works were carried out on the control sites. The remaining restoration sites were subject to a less detailed monitoring assessment. Field mapping was converted into a suitable digital GIS format to allow calculation of the areas of habitats within the reaches from which it was possible to monitor change following repeat surveys. The GIS recorded physical and ecological features, sample and cross-section locations and any other spatial data collected in the field.

The pre-restoration surveys were intended to establish a record of biological and physical conditions at the site prior to restoration. The post-restoration surveys were to record modifications to the channel after restoration. The surveys both provided snapshots pre- and post-restoration. It should however be recognised that there is a limitation to the comparisons that can be made over this short duration and it was not possible to draw any conclusions regarding changes in conditions at a site pre / post-restoration. The relationship between physical and biological conditions were analysed at each site and comparisons drawn concerning the relationships identified at each site at the time of survey, taking into account other factors and processes that might have influenced relationships.

The detailed monitoring comprised the following techniques;

- Geomorphological and habitat baseline surveys;
- Cross section surveys;
- In channel macrophyte survey;
- Fisheries surveys;
- Fixed point photography.

Geomorphological and Habitat Baseline

Geomorphological and Habitat Baseline survey included the river bed, banks and a riparian zone not less than 5 m from the bank edge (subject to the nature of the adjacent habitats). Thus the mapping extended beyond 5m where an adjacent habitat is specifically a riverine wetland or where the restoration works restore connections between the floodplain and the channel.

Geomorphological mapping was at a suitable scale, and covered the detail of the channel geomorphology, evidence of geomorphological processes, bed materials and vegetation cover. Habitat mapping included the vegetation structure and species composition recorded in a way that allows comparative assessment in subsequent years following colonisation of the restored or modified reaches**.**

Cross-section Survey

Cross-section surveys will be undertaken through each reach at a maximum spacing of three bankfull channel widths for a maximum length of 1000m. Survey within each cross-section will seek to capture habitat boundaries and morphologically defined features in addition to water surface elevation.

In-channel Macrophyte Survey

A Macrophyte survey (to include *Ranunculus spp*, *Callitriche spp* and associated community) was undertaken with relevant spatial data presented in GIS formats. This will include;

- Cross sectional survey of vegetation cover (%);
- Species quadrats at 5 cross-sections at each site ;
- Reach-based overview maps.

Fish Survey
Fishery survey for *Salmo salar, Petromyzon marinus, Lampetra planeri* and *Cottus gobio* were undertaken within the restored and control reaches. The survey design will reflect the complexity of the riverine environment, with sampling from within different habitats within the watercourse. The sampling framework will be based on the habitat mapping.

It is intended that any fish survey would be undertaken completely within the field, with no specimens taken and all material returned to the river. Species and size classes will be identified.

Fixed Point Photography
Repeat photography was undertaken at each reach from fixed point locations. These survey points needed be re-locatable and were thus be recorded by a 12 figure grid reference together with the bearing of the view established by a Geographical Positioning System (GPS). Such data was provided as a GIS point layer with an appropriate file structure to allow for hot-linking within a GIS.

As well as the detailed mapping, rapid assessment techniques were also employed at all the sites. The rapid assessment of the remaining restoration sites will use the following techniques;

- Feature inventory survey;
- Basic habitat mapping;
- Fixed point photography.

Feature Inventory Survey
The remaining restoration sites were audited using a standard feature inventory form. This approach was been developed and deployed on the River Cole restoration project and used to estimate physical habitat diversity (Sear *et al*. 1998). A tally of all physical habitat features within the channel (pool, riffle, eroding cliff etc.) is recorded. This survey was undertaken at the same time as the main monitoring programme during the autumn when vegetation has died back.

Basic Habitat Mapping
The watercourse habitat and surrounding terrestrial habitats were mapped using UK biodiversity habitat types.

Fixed point photography
Fixed Point photography was undertaken as for the detailed monitoring sites.

1.2.2 Rapid Assessment Surveys

In addition to the Royal Haskoning monitoring, the River Restoration Centre (RRC) also carried out a series of rapid assessment surveys. The surveys were planned to be carried out pre, during, just after (as built) and post the restoration works. Examples of the RPPA forms can be seen in Appendix A. The project was divided into physically distinct reaches each of which was assessed separately. The reaches include one or more upstream of the restoration (recording upstream impact) and one or more downstream of the restoration (again recording any subsequent impact). Repeat photography was also carried out and a set of maps showing the location of the photographs is produced (see Section 2).

The pre project assessment includes a précis of the objectives and background information, the reach characteristics including width, depth, bank and bed material, vegetation, land use and quality of ecological habitat along with the short and long term potential impacts of the restoration work.

The 'during construction' proforma includes information about the contractor and a technical site plan. The form also includes a summary of predicted short and long term impacts (both positive and negative). There are then a number of questions relating to the construction programme and costs and a section related to changes to the original design.

The post and as-built assessment forms additionally an inventory of restoration techniques and an assessment of the number of different aspects of the project including;

- Visual and social elements;
- Physical characteristics;
- Vegetation;
- Fish & Aquatic Invertebrates, and;
- Mammals, terrestrial invertebrates and birds

The potential changes, both short (recovery from the physical works) and long (beyond the lifetime of the project) term, are then identified and an appraisal of the techniques used is carried out. The overall project was then assessed and future improvements and management requirements identified along with the potential for adaptive management and future restoration opportunities.

Rationale for Expert Judgment Rapid Assessment Techniques

The RRC has produced a rapid assessment methodology for assessing the potential, actual and possible future effects of the restoration work. This is a relatively new, expert judgment based tool to assess multi-disciplinary objectives and determine a project's successes and failings. The methodology allows the incorporation of any additional quantitative or qualitative analysis undertaken for particular elements. It also requires a subjective assessment of likely future success and identifies adaptive management potential whereby future phases of the current project and future new projects can utilize the results and lessons learnt from the current scheme. It should be noted that the repeat photographs are an important part of this process as they give a visual record of the works and their success and or failure as well as allowing a comparison between before and after restoration to be made. The method is cost affective and helps to deliver LIFE requirements for monitoring and assessment within the often short timescales associated with such projects. The assessment also highlights changes that have occurred between the design stage of the project and the works which were actually carried out and why these adjustments were necessary to implement the scheme.

1.3 Aims and Objectives for the River Nadder at Fovant

The channel of the River Nadder at Fovant had been over widened (20m) with respect to the current range of flows flow regime. The bed was relatively homogeneous, with a mix of poorly sorted gravel, sand and silt overlying clay. There was little submerged vegetation, with small stands of unbranched bur-reed *Sparganium emersum* being the dominant species present.

A sluice at the downstream limit of the reach (see

) was operated in a semi-closed position during low flow periods in order to retain water depth for angling, thus compounding the reduction in water velocity and the deposition of fine sediment. Mature riparian trees heavily shade the south bank (see

). The river planform was relatively straight and the channel incised, with eroding sections of bank present. The angling club had created a short length of low level marginal shelf, using faggot bundles which had colonised with emergent vegetation and had helped to stabilise the bank and increase habitat diversity.

The objectives of the restoration work are to;

- Narrow the channel to re-establish a sinusoidal channel of appropriate cross-section area appropriate to the present flow regime of the river;
- Increase the sorting of substrate;
- Promote the development of vegetated low-level marginal shelves;
- Reduce shading of the channel;
- Increase the amount of large woody debris in the channel in order to increase both the availability of this habitat type and morphological diversity of the channel;
- Modify the operational regime of the downstream sluice in order to optimise upstream habitat quality for SAC species and habitats, in particular:
    - Bullhead (increased diversity of hard bed, particularly pools during winter and insertion of large flints in new riffle/fast glides during summer and increased shading / large woody debris for particularly, juveniles).
    - Salmon (a more usable migration route, viable spawning sites, and appropriate habitat for fry and parr).
    - Brook lamprey (increased availability of well sorted, fine sediment in shaded, marginal areas with large woody debris for ammocoetes and gravel/sand dominated shallows <40cm deep for spawning adults.
    - Desmoulin's whorl snail in the marginal zone of all channels.
    - The *Ranunculus* community as a result of increased heterogeneity in velocity and bed morphology.

Figure 1.1 River Nadder at Fovant

Plate I Sluice Structure at Downstream section of Reach F6

Plate II Tree Shaded River Reach F3

2. Scheme Assessment

2.1 Site Description

The River Nadder at Fovant was historically dredged and over sized compared to flow. As a result, hatches have to be used to maintain water levels, leading to slow flows and heavy siltation. The object of the work was to modify the channel to a more appropriate width and shape, allowing the impoundment to be reduced, improving in-channel and marginal habitats.

The sluice structure, located at SU 000 306, close to Teffont Mill and upstream of the restoration works (see Plate III) has been taken as the most upstream point that might be affected by the restoration works planned on the R. Nadder near Fovant.

Between the upstream extent of the proposed restoration works and the sluice structure at Mill Farm three 'assessment units' were identified according to changes in geomorphological features, riparian land use, vegetation or floodplain characteristics:

- Reach 1 Teffont Mill mill pond, immediately downstream of the sluice structure near Mill Farm;
- Reach 2 meandering channel, downstream of the mill pond and upstream of confluence with side channel, and;
- Reach 3 straight channel, downstream of confluence with side channel, immediately upstream of proposed restoration site.

Over the whole upstream section the geomorphological features of the river varied from the mill pond (Reach 1); through a more natural sinuous reach (Reach 2 see Plate V) which exhibited pool and riffle sequences and gravel bars; into a wide, straightened reach (Reach 3 see Plate VI) with no flow variation. The instream ecological characteristics of each reach were a reflection of the physical features, the sinuous reach (Reach 2) which had a diversity of geomorphological features is known to provide spawning areas for trout; on the day of the site visit both roach and trout were sighted in this reach. The other two reaches, which were geomorphologically less diverse, were perceived to have poorer instream habitat for fish and aquatic invertebrates.

Over the whole of the upstream section of Reach 3 the right bank (RB) was typically dominated by woodland, causing over-shading in parts, whilst the left bank (LB) was dominated by open grassland. Bank cover was typically high (90-95%), the proportion of marginal vegetation varied widely (5-90%) and the percentage of in-channel cover was typically low (2-5%). A water vole survey had not been carried out on this section of the site but their presence had been recorded further downstream, within the restoration reach. A high number of dragonflies and damselflies were observed on the day of the site visit. The dense woodland, which dominates the RB, should provide good habitat for birds.

Figure 2.1 Reaches 1 to 3

Plate III Sluice Structure at Tefford Mill

Plate IV Eroding Bank at top of Reach 2

Plate V Sluice Meandering Reach 2

Plate VI Straightened channel in Reach 3

The target reach has been divided into three 'assessment units', identified according to changes in geomorphological features, riparian land use, vegetation or floodplain characteristics;

- Reach 5 straight channel, downstream of Reach 3 with dense shade on right bank, and;
- Reach 6 straight channel, downstream of Reach 5, no tree cover on right bank or left bank, impounded by downstream sluice.

The reach of the R. Nadder that falls within the restoration works was fairly uniform in its characteristics; Reaches 5 and 6 were only differentiated due to the change in riparian land use on RB (from dense woodland to scrub). This reach of the river was straightened, widened and deepened with no geomorphological features present, little variation in flow and negligible stream power. The bed substrate was dominated by silt with small amounts of gravel in places. The physical characteristics of the reach were reflected in the ecological community that it was seen to support. Fish species were present, however the current conditions were more suited to

coarse fish rather than salmonids. The dense shading in Reach 5 and low diversity in flow throughout the reach will have altered the aquatic invertebrate community composition found in this reach in comparison to reaches upstream or downstream.

Over the whole target reach the left bank was dominated by open grassland and stands of emergent vegetation in the wider floodplain (Reach 4) whilst the right bank varied between dense woodland (Reach 5 see **Plate VIII**) and scrub (Reach 6 see **Plate IX**). The average bank cover was typically high (90-95%), apart from on the RB in Reach 5 where dense shade had prevented bankside vegetation from growing; this niche has been filled by trailing vegetation. The proportion of emergent vegetation ranges from 15-40%, whilst the percentage of in-channel vegetation ranged from 60-80%, much higher than in the upstream units. The dense woodland in Reach 5 provided good habitat for birds.

The network of ditches within the water meadow (Reach 4 see **Plate VII**) was, at the time of the assessment, fairly dry with no flow of water and few aquatic species present. The area had been identified as potential habitat for Desmoulin's whorl snails. Whilst these ditches were not part of the original STREAM bid as the ditches were within the floodplain and not in the river or riparian zone, however it was suggested that they could be a good source of infill material and aquatic emergent vegetation.

Figure 2.2 Reaches 4, 5 and 6

Plate VII Ditch System in Reach 4

Plate VIII Shaded Silted Channel Reach 5

Plate IX Wide Deep Silted Channel Reach 6

Plate X Reach 6 Just Upstream of Hatches

The bridge where Ford Lane crosses the R. Nadder, located at SU 009 306, downstream of the restoration works was taken as the most downstream point that might be affected by the restoration works.

Between the downstream limit of the restoration works and the bridge three 'assessment units' were identified according to changes in geomorphological features, riparian land use, vegetation or floodplain characteristics;

- Reach 7 main channel splits into two, flowing around an island immediately downstream of sluice
- Reach 8 straight, sluggish channel, downstream of Reach 7
- Reach 9 a more typical chalk stream channel with variations in flow and good instream habitat

Over the whole downstream section the geomorphological features of the river varied, from a pool and split channel immediately downstream of the sluice (Reach 7 see **Plate XII**); through a straightened, sluggish reach with few geomorphological features; into a good quality chalk river habitat with *Ranunculus* and spawning gravels. The physical features of the units were reflected in their instream ecological characteristics. The final unit (Reach 9 see **Plate XIV**), which had a diversity of geomorphological features and variation in flow conditions, provides spawning areas for fish and good habitat for aquatic invertebrates; the unit immediately downstream of the sluice (Reach 7) exhibited some of these ecological characteristics but to a lesser extent. The central unit (Reach 8 see **Plate XIII**), which were geomorphologically less diverse than units Reach 7 and Reach 9, appears to have limited suitable habitat for fish and aquatic invertebrates.

The downstream section was characterised by a mixture of tree cover and open space on both the LB and RB, some locations would benefited from an increase in the amount of tree cover. The vegetative bank cover varies from 30-90%, the proportion of marginal vegetation varied from 5-30% and the instream cover varied from 30-60%. This section of the river was observed to support a diversity of wildfowl including mallards, swans and moor hens.

Figure 2.3 Reaches 7, 8 and 9

Plate XI Weir Pool Downstream of the Hatches

Plate XII Looking Upstream past the Island in Reach 7

Plate XIII Slow Flow and Silted Channel Reach 8

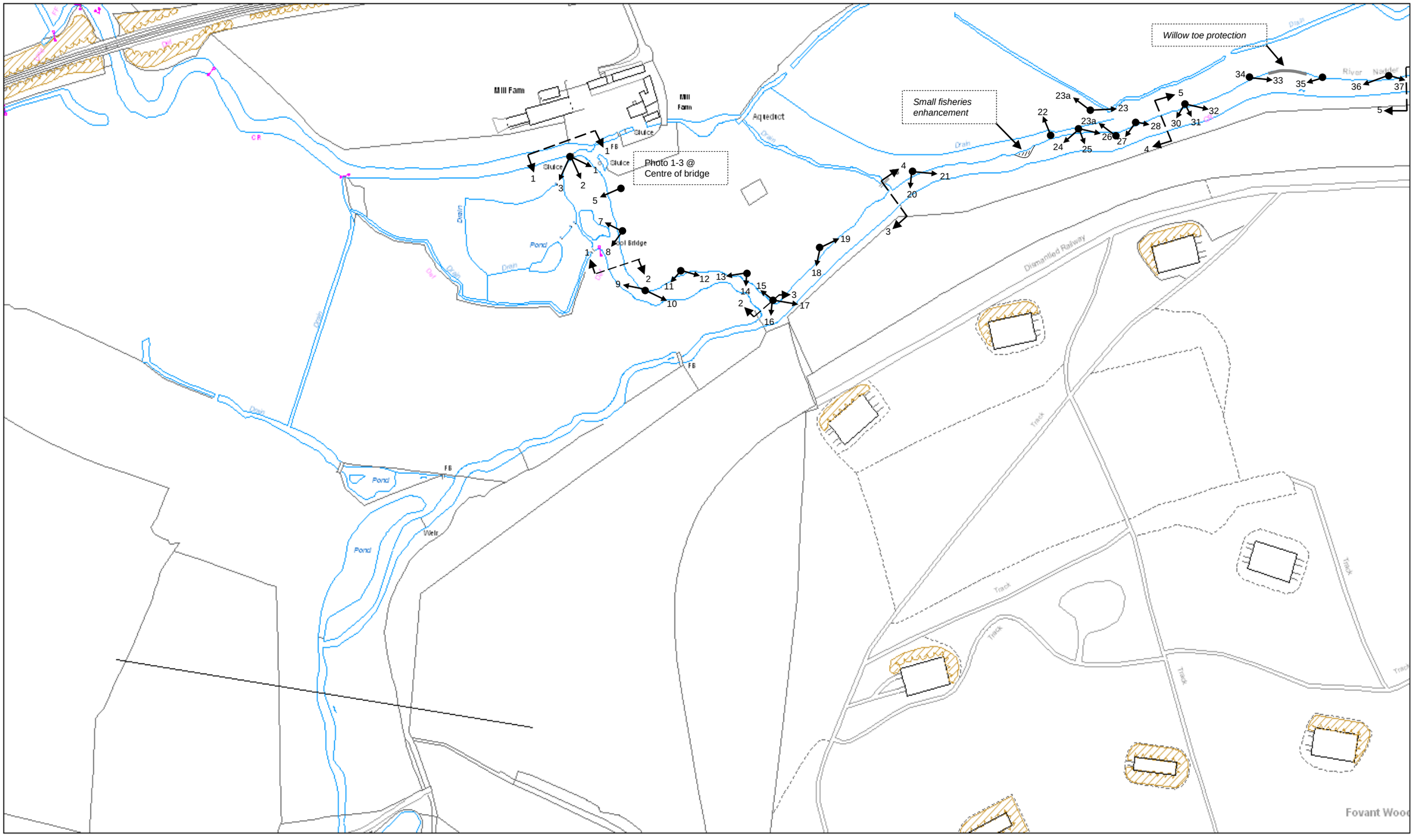
Plate XIV Riffle in Reach 9

2.2 Proposed Restoration Works

A range of restoration techniques were proposed which included;

- Selective tree felling to reduce shading;
- Redistribution of silt laden gravel from the right bank to the centre of the channel bed to improve substrate quality;
- 60 degree upstream facing timber groynes with brushwood and vegetation infills from ditch network, and;
- Modification of hatch operation downstream.

Figure 2.4 Fovant Reaches 1 to 5 – Photo Locations



Scale 1:2500

0 50 100 150m

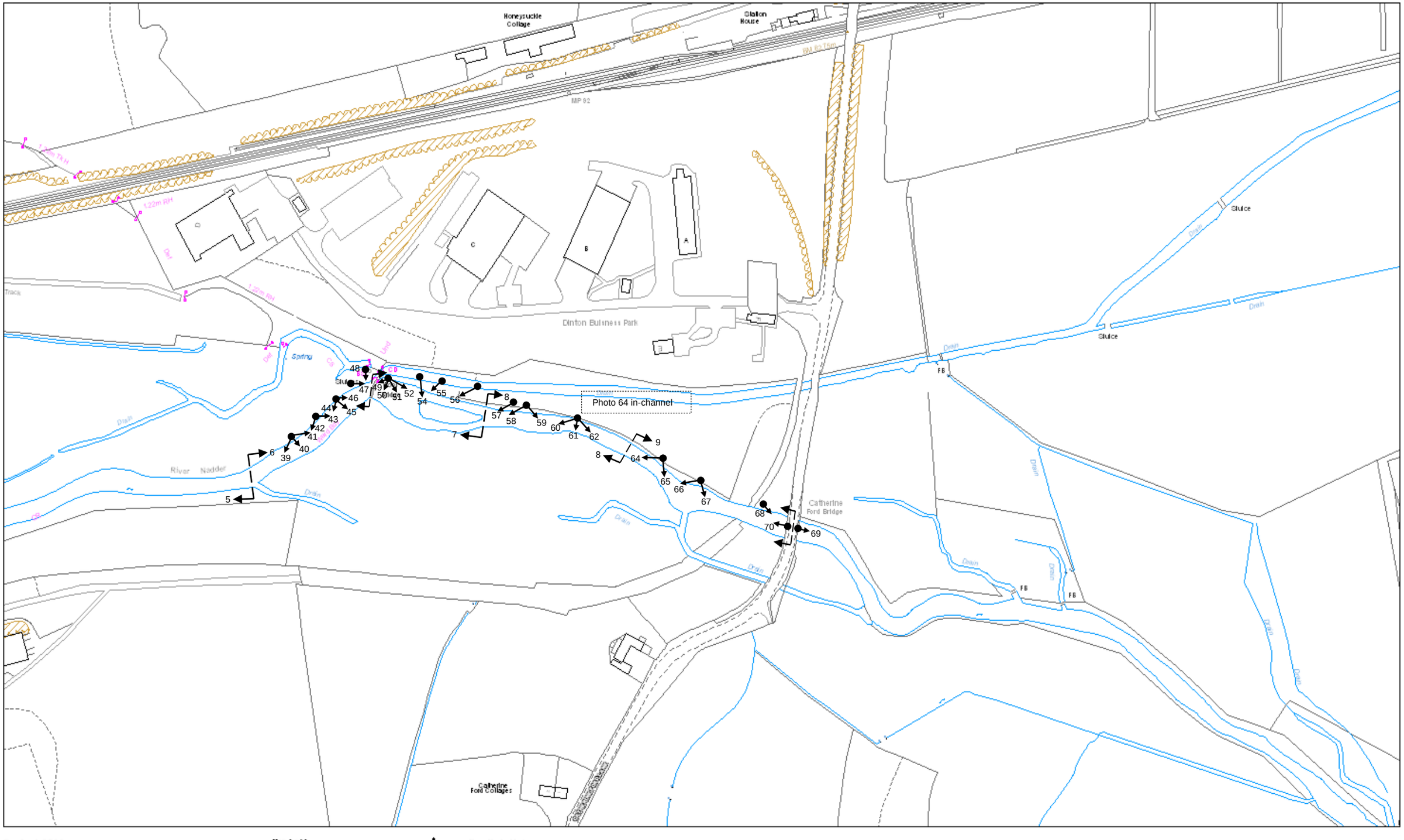
0 125 250 375m.

Map 1 of 4
Drawn By: J Wheeldon
Date: 24/7/2006
Ref: rz99990005

Grid North

English Nature
STREAM

Figure 2.5 Fovant Reaches 6 to 9 – Photo Locations



3. Assessment of Proposed Restoration and Likely Outcomes

The hatch operation changes were expected to have a significant effect in as much as raising the hatches would lower the upstream water levels upstream. The tree felling on the right bank would allow much more light to get to the river promoting aquatic weed growth. The timber and woody debris from the tree felling was to be used to construct 60 degree upstream facing deflectors with brushwood being placed on the downstream side. The deflectors were expected to slow flows locally and allow silt to be deposited on the downstream side. The brush was expected to aid in the entrapment of silts. The silt deposition was expected to narrow the channel in the long term.

The first method was to fell selected trees on the right bank. The felled trees would then be placed in the water between 5 to 10m apart to create upward facing groynes which would protrude into the channel for up to one third of the width of the channel. The length of the groynes would vary in order to create a meandering profile to the channel. The areas between the groynes would be infilled with the brushwood derived from the felling activity. Additionally sedge turf from the planned excavation of ditches on the left bank would also be placed between the groynes.

The operation of the triple metal sluice gates at the downstream end of Reach 6 were to be altered so that no impounding of water occurred. This would be implemented through consultation with the Environment Agency, Natural England and the local fishing club.

It was initially proposed that adjacent wet ditches would be used to provide vegetative material to plant the restoration works. However, due to the meadow being in an agri-environment scheme and landowner concerns about ground disturbance and compaction in wet conditions, this was not possible. As an alternative, mats pre-planted with local appropriate vegetation were secured to the structures. A new product (reedfelt) made of recycled British textiles was purchased and used to vegetate 50% of the structures. Another supplier then donated a sample of pre-planted coir fibre matting to cover two structures. A combination of un-planted, reedfelt and coir mattress structures resulted, enabling us to observe how they perform, which will be fed back to the wider river restoration community

Site visits were carried out on 25th July 2006(pre works), 16th October 2006(during works), 18th May 2007 (as built) and 9th April 2009 (post works)). The reaches (see map Figure 2.4 and Figure 2.5) can be summarised as;

- Reach 1 - Teffont Mill pond
- Reach 2 - Downstream reach from mill pond
- Reach 3 - Upstream of restoration works
- Reach 4 - Ditches within floodplain (no restoration work carried out here)
- Reach 5 - Tree felling and deflectors
- Reach 6 - Deflectors, changes to hatch operation
- Reach 7 - Downstream of hatches

- Reach 8 - Downstream of island
- Reach 9 – Upstream of bridge

3.1 Pre Works

Reach 1: - The most upstream area (Reach 1) was the mill pond at Teffont Mill. This reach had dense tree cover on the right bank and low herbs and riparian emergent vegetation on the left bank. The mill pond itself was deep with a large weir structure at the upstream end, shallowing out at the downstream end. This reach along with Reaches 2 and 3 were upstream of the proposed restoration works. Expected effects included changes in water levels resulting from the narrowing and introduction of large woody debris (LWD) into the channel and alterations to the management regime of the downstream sluice and changes in flow velocity resulting from changes in management of the downstream sluice. These impacts may in turn affect the availability of fish spawning areas, either positively or negatively depending on the outcome of the works; any negative impact would mainly be a concern in the sinuous section (Reach 2). The possible negative impacts were generally not perceived to be of significant concern as their effect would likely be minimal.

Reach 2: This reach consisted of a meandering channel downstream of the mill pond with a vertical outside bank and a pool and riffle sequence which is potential fish spawning habitat. Willow trees line the right bank with grassland on the left bank. The expected impact on this reach is the same as for Reach 1.

Reach 3: Reach 3 was a straight channel with dense shade on the right bank and grazing on the left bank. The expected impact on this reach is the same as for Reach 1.

Reach 4: This reach consisted of the ditch system within the floodplain on the left bank of the River Nadder. It was considered to be potential Desmoulin's whorl snail habitat. The ditches had aquatic vegetation in the centre of the channel but at the time of the time of visit there was no water in the ditches. The works within the main river channel were not expected to impact on this site. The works within the ditches were expected to disrupt the aquatic habitat in the short term, but ultimately have a positive effect in that habitat suitable for Desmoulins whorl snail and change the in channel habitat to a more predominantly aquatic type.

Reach 5: The channel within this reach was deep and straight, with dense shade along the right bank and water meadow along the left bank. Some in channel vegetation and fish were observed at the time of the site visit. The right bank was steep, and the left bank had wide margins in sections. This reach, along with Reach 6, fell within the area covered by the restoration therefore the predicted impacts, which might occur as a result of the proposed restoration works, could include short term disruption to instream, bankside and floodplain habitat whilst the restoration works are being carried out. In addition channel narrowing and increased sinuosity was expected as a result of the introduction of LWD. It was also expected that increased flow velocity and variation in flow would result from the changes to the channel planform. Decreased silt deposition in the main flow path due to the increased flow velocity was also an expected positive effect. Increase in marginal habitat as a result of channel narrowing and changes in ecological species composition due to changes to the physical characteristics of the channel were also perceived to be positive impacts of the restoration. The possible negative impacts were generally not perceived to be of significant concern as their effect was likely to be minimal

Reach 6: This reach was similar in character to Reach 5 except for the tree cover on the right bank. The impacts of the proposed restoration works were expected to be the same as for Reach 5.

Reach 7: This reach was downstream of the hatches. A deep pool had developed just downstream of the structure then the channel split into two flowing either side of an island. Downstream of the island the channel was wide and straight with a silty substrate. Predicted impacts on these downstream reaches that may occur as a result of the proposed restoration works included increase in the amount of silt being deposited as a result of the restoration works, this is of particular concern in unit Reach 9 which contains clean spawning gravels. Possible increases in vegetative bars as a result of the increase in silt depending on how the silt distributes in the channel was also a potential negative impacts. These possible negative impacts were generally not perceived to be of significant concern as their effect is likely to be minimal if best practice precautions are followed regarding silt interception, in particular.

Reach 8: Within this reach the channel was straight and the flows sluggish. There was little or in channel variation and the channel was silted and vegetated with pondweed. The expected outcome of the works was the same as for Reach 7.

Reach 9: This was the most downstream reach and though straight, the water here was fast flowing and consisted of a pool and riffle sequence. *Ranunculus* was growing in channel. The restoration works were expected impacts for this reach were the same as those for Reach 7.

3.2 During Construction

Reach 1: No positive or negative impacts were observed

Reach 2: It was noted that water levels were slightly lower than the previous site visit which is construed as a positive impact and may be the result of raising of the downstream hatches. No negative impacts were observed.

Reach 3: As with the upstream reach, water levels were lower than at the previous site visit which may be due to the hatches being raised. Large amounts of silt were present in the water as a result of the works which were on going at the time of the visit. No positive short term effects were observed and it was not possible to comment on the full impact of the works as all the structures had not been installed.

Reach 4: No works were carried out in the ditches as the site was too waterlogged. Thus no negative or positive impacts were observed.

Reach 5: Significant amounts of silt were observed in the watercourse as a result of the works. Water levels were lower as a result of the weir management. It was not possible to comment on the full impact of the works as all the structures had not been installed.

Reach 6: In this reach exposed wooden piling and bare earth was observed on the left bank due to the drop in water level. It was not possible to comment on the full impact of the works as all the structures had not been installed. No positive impacts were observed.

Reach 7: It was observed that straw bales had been placed downstream of the weir pool to act a s a sediment trap; however, the effectiveness of these was questionable. The water was cloudy due to the upstream works which was the only negative impact observed. No positive impacts were observed.

Reach 8: The water in this reach was silt laden and there was a concern for the potential long term negative impact that this may have with regard to siltation. No positive impacts were observed.

Reach 9: As with Reach 8, the water was observed to be silt laden and there was a concern for the potential long term negative impact that this may have with regard to siltation, particularly on the gravel riffles. No positive impacts were observed.

3.3 As Built

The work was carried out by the Environment Agency's own workforce. They had little or no previous experience of this type of project and their involvement has added greatly to the expertise available within the EA.

The fishing club were intimately involved in the construction, being present on site daily. Again, the involvement of the club was invaluable in ensuring that their knowledge of the river was incorporated and that they are satisfied with, and committed to maintaining the works. A management agreement between the club and Natural England has been drawn up for the site.

Reach 1: No positive or negative effects were observed.

Reach 2: No positive or negative effects were observed.

Reach 3: In stream vegetation had gone and the tree maintenance had opened up the channel to light.

Reach 4: The maintenance work on the ditches was not carried out because conditions were too wet and the landowner was concerned about heavy plant going onto the feels in such conditions.

Reach 5: - Structures on the first part of Reach 5 were very uniform and there was doubt as to whether they would create habitat diversity. At the lower end of the reach the deflectors (numbers 25 to 30) were longer, extending into the channel by one third of the channel width. *Ranunculus* had been planted in the middle of the reach where photograph F25 was taken. Some increase in marginal habitat on the deflectors. Water voles were still in evidence and significant amounts of fish were seen.

Reach 6: Some increase in marginal habitat on the deflectors (see Figure 3.1). Water voles still in evidence and a significant amount of fish were. The deflectors in both reach 5 and 6 were constructed as V shapes rather than just the upstream facing groynes which were originally planned.

Reach 7: No positive or negative effects were observed.

Reach 8: No positive or negative effects were observed.

Reach 9: Less *Ranunculus* was seen than previously and there appeared to be more silt on the gravels.

Figure 3.1 Deflectors Construction

Plate XV Initial Phase of Deflector Construction

Plate XVI Completed Deflector

Plate XVII Deflectors in Situ in Reach 5

Plate XVIII wood piling interwoven with brushwood faggots (previously done by fishing club)

3.4 Post Project

Reach 1: - Mill pool below mill weir reportedly some 2cm deeper than previously (pers comm. Mill owner). This is likely to be the result of increased sedimentation from flood flows of 2007/2008)

Reach 2: No positive or negative effects were observed.

Reach 3: No positive or negative effects were observed.

Reach 4: No positive or negative effects were observed.

Reach 5: Structures are vegetating well despite not being planted up, and silt bars are developing between the deflectors with emergent vegetation starting to colonise the silt between the deflectors. The 'D' deflector on the left bank just upstream of where photograph 24 was taken has silted up and is now well vegetated narrowing the channel (See Section 5). In the upper part of Reach 5 all the deflectors are on the right bank and some erosion is now occurring on the left bank as a result. The central channel gravels were better exposed as the narrowed channel has created faster velocities, the silt clearance may also be as a result of flood events in 2007 and 2008. In the lower section of Reach 5 the 'V' deflectors were all on the left bank. Some of the deflectors were being undercut creating holding pools and cover for fish.

Reach 6: - Deflectors on both banks have created flow variability and sinuosity. They are well vegetated, though sit out of the water.

Reach 7: No positive or negative effects were observed.

Reach 8: No positive or negative effects were observed.

Reach 9: No positive or negative effects were observed.

Table 3.1 Summary of the Assessment of Scheme Outcomes

	Pre Works – 25th July 2006		During Works – 16th October 2006		As Built – 18th May 2007		Post Works – 9th April 2009	
	Expected Positive Effects	**Expected Negative Effects**	**Positive Effects**	**Negative Effects**	**Positive Effects**	**Negative Effects**	**Positive Effects**	**Negative Effects**
Reach 1	Very little positive effects were expected for the reach upstream of the construction works.	Potential change in water level.	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed
Reach 2	Very little positive effects were expected for the reach upstream of the construction works.	Potential change in water level might drown out pools and riffles	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed	Instream vegetation has gone	No noticeable changes were observed	No noticeable changes were observed
Reach 3	Raising the hatches expected to lower water levels and reduce impounding effect	Changes in water level could pond this reach	Water levels are lower which is affecting velocities and flow variability.	Water is silt laden as a result of the works	Shallower faster flowing water as a result of hatches being opened	No negative effects were observed in this reach	No noticeable changes were observed	No noticeable changes were observed
Reach 4	Increased habitat for Desmoulin's whorl snail	Short term disruption to aquatic habitat whilst works carried out	No noticeable changes were observed (ditch works not carried out)	No negative effect expected (ditch works not carried out)	No noticeable changes were observed	No negative effect expected	No noticeable changes were observed	No noticeable changes were observed
Reach 5	Increase velocity and a decrease in siltation expected in the medium term with the long term effect being channel narrowing, increased marginal habitation and increased sinuosity	Short term disturbance by works expected	Water levels are lower which is affecting velocities and flow variability. NB structures had not been fully installed at time of site visit	Very silty due to in channel works	Shallower faster flowing water, structures creating flow variability, evidence of siltation occurring between deflectors	Structures all very uniform	Channel narrowed by 'D' deflector on LB. Deflectors on RB creating flow variability. More sinuosity, siltation between deflectors, more emergent vegetation	No noticeable changes were observed
Reach 6	Increase velocity and a decrease in siltation expected in the medium term with the long term effect being channel narrowing, increased marginal habitation and increased sinuosity	Short term disturbance by works expected. Increase in macrophytes resulting from reduced shading could choke river at times of low flow.	Deflectors installed on right bank, flow variability in evidence as a result	Very silty due to in channel works	Flow variability as a result of deflectors. Some increase in marginal vegetation. Less silt in central channel	No noticeable changes were observed	Channel narrowed by 'D' deflector , more emergent vegetation, much less silt in centre channel , silt accumulating on margins, variable flow created by RB deflectors	No noticeable changes were observed
Reach 7	No positive effect expected.	Potential increased siltation as a result of construction work in the short term. Siltation increase post works due to increased velocities upstream of the hatches	No noticeable changes were observed	Silt collecting in pool d/s of hatches, this will be flushed out at high flows	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed	No noticeable changes were observed
Reach 8	Potential increase in vegetative bars, this will depend on .	Potential increased siltation as a result of construction work in the short term. Siltation increase post works due to increased velocities upstream of the hatches	No noticeable changes were observed	Water silty, possible long term silt effects	No noticeable changes were observed	Increase in silt	No noticeable changes were observed	No noticeable changes were observed
Reach 9	No positive effect expected.	No negative effect expected.	No noticeable changes were observed	Water silty, possible long term silt effects	No noticeable changes were observed	Increase in silt	No noticeable changes were observed	No noticeable changes were observed

	Upstream of restoration reaches
	Restoration reaches
	Downstream of restoration reaches

3.5 Reasons for Changes from Original Planned Works

The final works differed from those proposed in the original bid as shown in the table below. The changes made during the design process ensured that the objectives of the works as proposed in the bid document were met, and best environmental-cost benefit.

Table 3.2 Changes to Original Planned Works

Works proposed in bid	Alternative (constructed)	Reason for change
Current deflectors to restore approximately 300 m of channel	Double original length treated (700m)	In order for fishing club to reduce impoundment, works had to extend up to the hatches.
Transplanting of local wetland vegetation	Covered structures with pre-planted mats- reed-felt and coir used.	Timing of works and risk of damage to wet meadow, which is in an agri-environment scheme.
Upstream facing log deflectors to be set in the bank at an angle of 60 degrees	'V' shaped deflectors created which were covered in pre planted coir and reed-felt.	

It was initially proposed that adjacent wet ditches would be used to provide vegetative material to plant the restoration works. However, due to the meadow being in an agri-environment scheme and landowner concerns about ground disturbance and compaction in wet conditions, this was not possible. As an alternative, mats pre-planted with local appropriate vegetation were secured to the structures. A new product (reed-felt) made of recycled British textiles was purchased and used to vegetate 50% of the structures. Another supplier then donated a sample of pre-planted coir fibre matting to cover two structures. A combination of un-planted, reed-felt and coir mattress structures resulted, enabling us to observe how they perform, which will be fed back to the wider river restoration community

4. Pre and Post Project Monitoring

The monitoring protocol designed by Royal Haskoning included rapid assessment techniques for the Fovant site and included repeat photographs, fluvial audit and river corridor survey to give physical biotope, sediment. and biological characteristics. The survey work was carried out within the restoration reaches before and after the work had been completed..

For the photography the channel narrowing was clearly evident as was the creation of areas of more variable flow. Siltation on the downstream side of the 'V' shaped deflectors had meant that emergent/marginal vegetation had increased.

In terms of the physical biotope the reduction of impoundment due to the opening of Iron Hatches has resulted in increased flow velocities and lower water levels throughout the reach. These improvements in flow conditions, together with in-channel restoration works, had created more diverse physical biotopes in contrast to the uniform, ponded glide that was observed in 2006. The most significant restoration action has been the reduction of impoundment, as these physical biotopes would not have been able to develop without improved flow conditions. The deflectors and associated vegetation are, however, contributing to narrowing of the channel and creation of further diversity.

In term of changes in substrate sediment the reduction of impoundment has resulted in a fundamental difference in the sediment regime in this reach. Prior to the restoration works, silt deposition was occurring on the channel bed in response to the impounded conditions. The majority of fine sediment is now likely to be transported through the reach. Localised deposition of fine sediment is occurring between the deflectors and subsequent vegetation is effectively narrowing the channel. Localised bank erosion that was evident in 2006 has been stabilised as a result of lower water levels and increased marginal vegetation.

Changes in biological characteristic were in evidence when comparing pre and post scheme surveys. The extent of in-channel vegetation had increased significantly since 2006, with extensive coverage of brook-water crowfoot (*Ranunculus pencillatus* spp. *pseudofluitans*) throughout the reach. This is likely to be a result of the increased flow velocities that have occurred since impoundment was reduced.

Reed sweet grass (*Glyceria maxima*) remains the dominant emergent species on the left hand bank and shading from trees was less limiting on the right hand bank due to selected tree felling. The extent and variety of marginal vegetation coverage on both banks has also been increased as a result of the installation of marginal groynes, which have subsequently trapped silt and become vegetated, thus improving the hydrological transition zone.

Summary of physical and biological relationships;

- Opening Iron Hatches has resulted in increased flow velocities, lower water levels and creation of varied physical biotopes in contrast to the uniformly laminar glide.
- Growth of brook-water crowfoot (*Ranunculus pencillatus* spp. *pseudofluitans*) has significantly increased as a result of the improved flow conditions.
- The combination of lower water levels and installation of groynes has improved the hydrological transition zone between the channel and the banks. This has resulted in

greater coverage of marginal fringe species, such as water mint (*Mentha aquatica*).

- Shading along the right hand bank has been reduced and is less of a limiting factor on the diversity of riparian and emergent macrophyte species along this bank. Groynes that are not within the tree lined section are, however, better vegetated than those within it.

5. Assessment of Methods Used

5.1 'V' Shaped 'Dragons Teeth' Deflectors

The 'V' shaped deflectors installed in Reach 5 are shown in Figure 5.1 and **Error! Reference source not found.**. In Figure 5.1 the amount of siltation which has occurred between the deflectors and resulting growth of emergent vegetation is clear. The river has been narrowed down by some 1 to 1.5 m. The deflector itself has become well vegetated (see also **Figure 5.2 Plate XXI**).

Figure 5.2 Plate XX shows the drop in water level as a result of the hatches being raised compared to the pre works. In Plate X the post works photo shows that bare bank has largely been overgrown. Both Figures 5.1 and 5.2 show the evidence of tree thinning and demonstrate that more light is now filtering through to the river channel.

Figure 5.2 also demonstrates that the deflectors in this reach are protruding out of the water rather than sitting at or just under the mean low water mark. This has meant that at high flows the high velocity of water passing over the structures has scoured some of them out (see Figure 5.3 **Plate XXVII**).

Plate XXVIII in Figure 5.3 demonstrates how the larger deflectors at the downstream part of Reach 6 create more flow variability, suggesting that the larger deflectors were more successful in achieving the objectives of the STREAM project for the Fovant site.

Figure 5.1 Photo Site 36 'V' Deflectors on Left Bank and Brush Clearance

Plate XIX Pre Works

Plate XX During Works

Plate XXI As Built

Plate XXII Post Works

Figure 5.2 Photo Site 30 – Reach 5

Plate XXIII Pre Works

Plate XXIV During Works

Plate XXV As Built

Plate XXVI Post Works

Figure 5.3 Reach 6 Deflectors and Hatch Operations

Plate XXVII 'V' Deflector Showing Scour

Plate XXVIII Larger Deflectors Creating More Flow Variability

Plate XXIX Hatches Closed

Plate XXX Hatches Open

5.2 Modification of Hatch Operation

The raising of the hatches proved to have a major effect on the two reaches immediately upstream (See Figure 5.1, Plates XIX and Plate XX). In the latter plate the bare bank exposed as a result of the drop in water level is clear. Plate XXX in Figure 5.3 shows the hatches fully open; however it is clear that the sill of the hatches is still having an impounding effect because the cascade of water created as it flows over the sill and drops down on the other side can clearly be seen.

6. Discussion and Recommendations

6.1 Discussion

Fovant demonstrates the significant improvement in river processes and habitat value that can be achieved by changing the operation of structures (as compared with the more restricted success of Seven Hatches). Bankside location, sizing and depth relative to summer water level are all key elements of successful silting of deflectors. The construction method used at Fovant was to create a solid structure to block the rivers flow path (rather than a simple (more 'leaky') pinned log to alter velocity) to induce flow variation. This approach can work well where there is concern that the installed deflector may be subject to scouring flows and is at risk of being washed away.

Dropping the impoundment has completely altered the flow conditions, reduced depth, speeding up the velocity to remove deposited silt and keep the gravels 'clean', and providing for the full range of flow types from low flow to overbank events.

The restoration techniques the employed at the site were able to work with this newly released energy and further reverse the decline in the watercourse (resulting from heavy management in the past, dredging, widening and other modifications).

The 'dragons teeth' deflectors generally succeeded in reducing channel width at low to moderate flows, defining different velocity zones (eddies and faster flowing runs) enabling the river to deposit silt load in the slow flowing zones and clear (and subsequently keep clear) the central flow path. The 'dragons teeth' also provided a source of vegetative material to start the colonisation of these marginal silt berms. They appear to be well spaced such that they produce a lengthy 'tail' of silt deposition that just about links with the placement of the next. This maximises the benefit and reduces the cost of placing unnecessary additional deflectors.

Tree removal to reduce shading has had a considerable effect on opening up the river and should aid the colonisation and establishment of a Ranunculus type habitat. In addition, it is clear from a small number of deflectors which were located in shaded areas, that the colonisation of the silt berms by macrophytes is far more successful where light is not a limiting factor. The reuse of this material for the 'dragons teeth' also demonstrates how to minimise unsustainable importation of material to site and limits the need for on-or off0site disposal of waste materials.

The gravel redistribution has also worked to speed up the physical process of transportation of gravel and deposition in the lee of the deflectors. Such minor reworking of a mobile gravel bed has been undertaken elsewhere where physical or hydraulic modifications have previously reduced the ability of the river channel to develop appropriate features on its own.

The impact of the original sluice impoundment ended at around the start of the deflectors, such that the upper reaches (1, 2 and 3) have had no perceptible changes to their morphology, hydrology or habitat potential.

With respect to the SAC species the channel narrowing, resulting in increased velocities, has clean the silt from the mid channel area. These exposed gravels are now suitable spawning areas for salmon, lamprey and bullhead, and habitat for bullhead juveniles. The silty areas which are developing between the 'dragons teeth' deflectors are good habitat for adult bullhead and brook lamprey. The emergent vegetation cover now developing in the silty margins has created

additional habitat suitable for Desmoulin's whorl snail. The shallower faster flowing water is suitable for *Ranunculus* and the tree thinning which has reduced shading of the river channel will also promote *Ranunculus* growth.

6.2 Lessons Learnt

For this site potential for major restoration was always limited by the presence and need for continued existence of the Iron Hatches structure. Its removal and subsequent bed re-grading could have further improved the success of the restoration work, allowing clearer fish passage to the upper reach, but only as far as the start of Reach 1 at the Teffont Mill. However, this work would have been significantly more costly and the benefit in relation to the cost to the SAC interest more difficult to quantify.

At Fovant some of the deflectors are obviously set too high and there has been erosion of the top surface and may eventually lead to disintegration of the structure (though the presence of a river keeper ensures that periodic repairs can be carried out before the structure becomes too unstable).

Some deflectors were located in inappropriate locations: heavily shaded thus negating the ability of macrophytes to colonise the deflector and silt berms which would lead to their stabilisation. Here the deflector will eventually fall apart and any collected silt will then wash away without vegetation to prevent this.

The two deflectors (the final two to be installed) in Reach 6, just above the hatch, are perhaps the most appropriately sized of all the deflectors and provide a significant reduction in flow width (approx. one third reduction). Practically, the workforce are always likely to get better at installing the same structure at each subsequent attempt, so the fact that the last two were the best sized is not surprising. This really just highlights the benefit of using experienced contractors to implement technical works.

6.3 Recommendations

This assessment shows that the immediate changes (opening of impounding sluices and constructed flow deflectors) are easy to see and quick to have a major impact. The more subtle changes to the river (gravel reworking and shading management) could take many more years to reach the desired end result as they rely on succession colonisation. The STREAM project has aimed to work with natural riverine processes, altering the channels in small ways rather than large scale engineering works (which are more costly and increase ecological disturbance). This approach is going to require more 'vision' in terms of immediate works versus long term results.

The wood deflectors install in the downstream part of Reach 6 demonstrated that larger deflectors were more effective. In addition alternating the deflectors on the left and right banks would have created a much more sinuous flow; however the anglers preferred the structures on the right bank so they did not impede fishing.

The deflectors were originally planned to be upstream facing logs, but when the installation was in progress it was decided to alter the structures to the 'dragons teeth' design. Many of the deflectors were protruding out of the water too far, so at high flows they were not drowned out and scouring was occurring resulting in the cross logs getting exposed and in some instances the matting was rolled up (see **Plate XXVII**).

The sill of the hatches continued to act as an impoundment and ideally the entire structure should be removed to allow the free passage of water. Concerns have been raised by local fisherman that removing all the weirs would mean that at times the river would dry up; however this would only occur in a severe drought and even with the structures during such climatic conditions the river would not be flowing, rather it would be a series of isolated ponded reaches.

The originally planned ditch works would create ideal habitat for Desmoulin's whorl snail and other wetland aquatic species. It is therefore suggested that when appropriate conditions prevail the works should be carried out.

7. References

Environment Agency, Estimating costs of delivering the river restoration element of the SSSI PSA target, 2008.

Natural England, Physical and biological monitoring of STREAM restoration projects – Year Three Report, April 2009.

Natural England, STREAM 4th Annual Report, Dec 2008

Natural England, River Avon SAC STREAM Interim Report, June 2008.

Appendix A
River Restoration Rapid Assessment Forms

the **RIVER RESTORATION CENTRE**

Project Assessment Form – Pre works Section 1:
Project Objectives and Background information

NOTES: This Project Assessment should be completed in conjunction with photographic monitoring through fixed point photography, the location and orientation of each fixed point photograph should be marked on a site map.

This section (page 1) of the assessment form should be completed prior to going on site.

Objectives

Please outline each of the project objectives for this site and state the category into which they fall:
HG – Hydro geomorphology; V – Vegetation; FA - Fish & Aquatic Invertebrates; M – Mammals; T- Terrestrial Invertebrates; B - Birds; VS – Visual & Social

Objective category	Objective

Background information

	Any survey information?	Any indicator species present? - specify	Any species specific objectives? - specify
Hydro geomorphology			
Vegetation			
Fish			
Aquatic invertebrates			
Mammals			
Terrestrial invertebrates			
Birds			

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Project Assessment Form – Pre works Section 2:
Unit description, reach, vegetation and landuse characteristics[1]

NOTE: An assessment needs to be completed for each 'assessment unit' - identified according to geomorphological features, changes in riparian landuse, vegetation & floodplain characteristics. The location of each unit must be marked on a site map.

Date: Surveyor: GPS point:

River name: Assessment Unit: Weather conditions:

Unit description

Reach Characteristics

Code: LB - Left Bank; RB-Right Bank; Cl – Clay; H-High; M-Medium; L-Low; NF-No perceivable Flow; Y-Yes; N-No

Bankful width (m) Bankful depth (m) Bank slope range (°) LB RB

Av. riffle water depth (m) Av. pool water depth (m) Av. water depth (m) - no pool/riffle sequence

Bank Material (LB) – D= dominant, tick others:	Cobble	Gravel	Cl	Sand	Silt	Artificial
Bank Material (RB) – D= dominant, tick others:	Cobble	Gravel	Cl	Sand	Silt	Artificial
Bed Material– 'D'= dominant, tick others:	Cobble	Gravel	Cl	Sand	Silt	Artificial

If there is any artificial bank or bed material please state the % and provide brief details:

% LB % RB % Bed Details:

Has it got any geomorphological features? Please note, and estimate spacing for pool / riffle sequence.

Sinuosity (H/M/L) Bars (Y/N) Bed variation (Y/N) Width variation (Y/N)

Deposition (Y/N) Bank Erosion (Y/N) Pools / riffles (Y/N) Approx. spacing (m):

Is there any variation in flow? (Y/N) What is the average stream power? (H/M/L/NF)

Please sketch the typical reach X-section, labelling LB and RB. Include main features, floodplain characteristics & flow conditions.

Vegetation

Av. in-channel cover (%): Av. Marginal cover (%): Av. Bank cover (%): LB RB

Av. tree cover (%): LB RB Is the vegetation typical / native to the river? (Y/N):

Are there any invasive species present (Y/N) Specify……

Landuse

Please tick main type of landuse – for 'Farmland' please delete arable or grazing as appropriate

LB	RB		LB	RB		LB	RB		LB	RB	
		Urban			Industrial			Parkland			Farmland: arable/grazing
		Private garden			Wetland			Woodland			Other……

[1]'Reach Characteristics', 'Vegetation' & 'Landuse' have been adapted from 'Geomorphological Sensitivity Assessment Sheet', *Detailed Catchment Baseline Review,* Environment Agency & University of Southampton, 2000.

Project Assessment Form – Pre works Section 3: Assessments of ecological habitats & Section 4: Potential Impacts of restoration works

Please comment on the quality of the ecological habitat:

Vegetation: Is there diversity in veg. types - In-channel: emergent, marginal, floating & submerged; Bankside: bryophytes, herbs or grasses, scrubs or shrubs & trees; and Riparian?

Fish & Aquatic Invertebrates: Is there sufficient flow & diversity in flow types? Is there a diverse river bed (substrate and structure)? Is there adequate cover, shelter & shading? Is there clear fish passage? Is there lateral diversity between the river & floodplain? Are there food sources?

Mammals: Is there cover & shelter? Is there sufficient flow & diversity of flow? Is there lateral diversity between river & floodplain? Are there food sources?

Terrestrial Invertebrates: Is there suitable diversity in emergent, bankside & riparian vegetation? Is there lateral diversity between the river & floodplain?

Birds: Is there adequate cover, shelter & shading? Is there lateral diversity between the river & floodplain? Are there food sources?

Project Assessment Form – Pre works Section 4: Potential Impacts of restoration works

Comment on potential impacts of restoration works & identify perceived degree of impact – High, Medium, Low, Negligible.

Short Term

	+ve	H/M/L/N	-ve	H/M/L/N
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Long Term

	+ve	H/M/L/N	-ve	H/M/L/N
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Additional notes:

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Project Assessment Form – During construction Section 1: Contractor's information, Budget, Site plans and Summary of Predicted Impacts

NOTES: This Project Assessment should be completed in conjunction with photographic monitoring through fixed point photography, the location and orientation of each fixed point photograph should match those taken as part of the 'Pre works assessment'. Any additional fixed point photographs considered to be necessary should be marked on a site map.

This section (page 1) of the assessment form should be completed prior to going on site.

Contractor

Company name | Name of Foreman:

Contact details:

Budget

What is the budget for this project?

Technical site plans

Have sites plans been supplied? (Y/N)

Any other technical specification details:

Summary of Predicted Impacts (from 'Pre works' assessment)

Short Term

	+ve	H/M/L/N	-ve	H/M/L/N
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Long Term

	+ve	H/M/L/N	-ve	H/M/L/N
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Project Assessment Form – During construction Section 2: Project implementation

Project implementation – site overview

Weather conditions:

Is the project running to the predicted time schedule? (Y/N)

If no, what are the reasons for the changes?

Is the project running to budget? (Y/N) If no is it expected to be: Under Over By how much?

What are the reasons for the changes to the expenditure?

Have there been any problems encountered whilst implementing the project – please provide details?

If any problems have been encountered how have they been overcome? Have there been any changes made to the original design?

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Project Assessment Form – Pre works Section 3:
Unit description and Potential Impacts of restoration works

NOTE: An assessment needs to be completed for each 'assessment unit' - identified in the 'Pre works assessment' according to geomorphological features, changes in riparian landuse, vegetation & floodplain characteristics. The location of each unit must be marked on a site map.

Date:		Surveyor:		GPS point:	
River name:		Assessment Unit:			

Unit description

Potential Impacts of restoration works

Refer to predicted impacts from 'Pre Works assessment' (summarised on page 1 of this document) and comment on any changes to these predictions that have occurred as a result of the on-site works, for each identify the perceived degree of impact – High, Medium, Low, Negligible.

Short Term

	+ve	H/M/L/N	-ve	H/M/L/N
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Long Term

	+ve	H/M/L/N	-ve	H/M/L/N
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Additional notes:

the **RIVER RESTORATION CENTRE**

Project Assessment Form[1] – Post works section 1:
Basic Project details, Project Objectives, Background information and Inventory of River Restoration Techniques used

NOTES: This section (pages 1 and 2) of the assessment form should be completed prior to going on site.

Basic Project details

Project name:

Start date: Finish date: Length (km):

Catchment type: Urban / Rural, Upland / Lowland (delete as applicable) Catchment Geology:

Objectives

Please outline each of the project objectives for this site and state the category into which they fall:
HG – Hydro geomorphology; V – Vegetation; FA - Fish & Aquatic Invertebrates; M – Mammals; T- Terrestrial Invertebrates; B - Birds; VS – Visual & Social

Objective category	Objective

Background: Pre and post project information

	Any survey information? (Yes/No)		Any indicator species present? - specify		Any fixed point photography? (Yes/No)	
	Pre	Post	Pre	Post	Pre	Post
Hydro geomorphology						
Vegetation						
Fish						
Aquatic invertebrates						
Mammals						
Terrestrial invertebrates						
Birds						

[1] Sections 1, 2 and 4 of this Project Assessment form were adapted from L. de Smith, Post-River Restoration Assessment (PRRA), ***The development of the 'post river restoration assessment' for evaluating river restoration pro****jects*, 2005.

Inventory of River Restoration Techniques

Which of the following river restoration techniques were implemented within the project - please tick.

* (MAJOR: the main/primary focus of the project; MINOR: secondary consideration/incidental)

		MAJOR*	MINOR*
	Rehabilitation of watercourse features		
1	Reach re-meandered (>500m)		
2	Reach re-meandered (<500m)		
3	Culverted reach re-opened (state approximate length)		
4	X-sectional habitat enhancement (>500m) – two–stage channel profiles etc		
5	Long section habitat enhancement (>500m) – pool/riffle sequences etc. restored		
6	River narrowing due to depleted flows or previous over-widening		
7	Backwaters and pools established/reconnected with watercourse		
8	Bank re-profiling to restore lost habitat type and structure/armouring removed		
9	Boulder etc. imported for habitat enhancement		
10	Gravel and other sediments imported/managed for habitat enhancement		
11	Fish cover established by other means		
12	Current deflectors/concentrators to create habitat and flow diversity		
13	Sand, gravel and other sediment traps to benefit wildlife		
14	Tree/shrub planting along bankside (only if covers >500m of bank or >0.5ha)		
15	Artificial bed/bank removal and replaced by softer material (>100m)		
16	Establishment of vegetation for structure/revetment (e.g. use of willows)		
17	Eradication of alien species		
18	Provision of habitat especially for individual species – otter, kingfisher etc		
19	Fencing along river banks; fencing floodplain habitats for management		
20	Aquatic/marginal planting		
21	Removal of floodbanks		
22	Other (please specify)		
	Restoration of free passage between reaches		
23	Obstructing structure replaced by riffle		
24	Obstructing structure replaced by meander		
25	Obstructing structure modified/removed to enable fish migration		
26	Obstructing structure retained, but riffle/meander structure established alongside		
27	Culverted reach re-opened/daylightened		
28	Obstruction within culvert (e.g. lack of depth, vertical fall) redresses		
29	Dried river reach has flow restored		
30	Other measures taken to restore free animal passage		
31	Other (please specify)		
	River floodplain restoration		
32	Water table levels raised or increased flooding achieved by		
33	Unspecified means/rationalised control		
34	Watercourse re-meandering		
35	Raised river bed level		
36	Weirs established specifically to increase floodplain flooding/water-table		
37	Termination of field drains to watercourse		
38	Feeding floodplain with water (Sluice feeds, water meadow restoration)		
39	Narrowing watercourse specifically to increase floodplain wetting		
40	Lakes, ponds, wetlands established (maybe flood storage areas)		
41	Lakes, ponds, wetlands, old river channels restored/revitalised)		
42	Vegetation management in floodplain		
43	Riparian zone removed from cultivation		
44	Substantial floodplain tree/shrub planting		
45	Other (please specify)		

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Project Assessment Form[1] – Post works Section 2: Assessment of visual elements and social value, physical characteristics and ecological characteristics

NOTE: An assessment needs to be completed for each 'assessment unit' - identified according to geomorphological features, changes in riparian landuse, vegetation & floodplain characteristics. The location of each unit must be marked on a site map.

Date:		Surveyor:		GPS point:	
River name:		Assessment Unit:		Weather conditions:	

Unit description

Part 1: Assessment of visual elements and social value in this unit

Landuse 'Landuse' assessment table adapted from Geomorphological Sensitivity Assessment, *Detailed Catchment Baseline Review* Environment Agency & University of Southampton, 2000

Code: LB - Left Bank; RB-Right Bank

Please tick main type of landuse – for 'Farmland' please delete arable or grazing as appropriate

LB	RB		LB	RB		LB	RB		LB	RB	
		Urban			Industrial			Parkland			Farmland: arable/grazing
		Private garden			Wetland			Woodland			Other……

Please also consider the following questions:

	Y/N
Is the visual appearance of the river harmonizing with the locations surroundings?(e.g. urban/rural)	
Are the river restoration techniques or practices still visible?	
If Yes, do they blend in with the natural environment?	
Is there a need for monitoring?	
Is there visual evidence of the following:	
Unnatural features to the river or bankside? (e.g. sudden changes in bank slope, sharp corners etc.)	
Hard engineering/man made materials? (e.g. concrete, steel, etc.)	
Litter or unsightly objects? (e.g. trolleys, tyres, sewage pipes etc.)	
Vandalism or graffiti?	
Is there sufficient public access to the river site? (e.g. footpaths, bridges, gates etc.)	
Is there any evidence of public use? (e.g. dog walkers, cyclists etc.)	
Has the project incorporated recreational opportunities & educational interest? (e.g. playground, paths, display boards, maps)	
Are there any safety considerations or health hazards, which have not been identified? (e.g. steep bank sides, hard material)	

Any other comments on the visual elements and social value:

Overall score of Section 2 Part 1:	**1 - Poor**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 - Excellent**

Level of confidence in Answers for Section 2 Part 1:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

Part 2: Assessment of physical characteristics in this unit

Reach Characteristics 'Reach Characteristics' assessment tables adapted from Geomorphological Sensitivity Assessment, *Detailed Catchment Baseline Review* Environment Agency & University of Southampton, 2000

Code: LB - Left Bank; RB-Right Bank; Cl – Clay; H-High; M-Medium; L-Low; NF-No perceivable Flow; Y-Yes; N-No

Bankful width (m) ☐ Bankful depth (m) ☐ Bank slope range (°) ☐ LB ☐ RB

Av. riffle water depth (m) ☐ Av. pool water depth (m) ☐ Av. water depth (m) - no pool/riffle sequence ☐

Bank Material (LB) – D= dominant, tick others:	☐	Cobble	☐	Gravel	☐	Cl	☐	Sand	☐	Silt	☐ Artificial
Bank Material (RB) – D= dominant, tick others:	☐	Cobble	☐	Gravel	☐	Cl	☐	Sand	☐	Silt	☐ Artificial
Bed Material– 'D'= dominant, tick others:	☐	Cobble	☐	Gravel	☐	Cl	☐	Sand	☐	Silt	☐ Artificial

If there is any artificial bank or bed material please state the % and provide brief details:

☐ % LB ☐ % RB ☐ % Bed Details:

Has it got any geomorphological features? Please note, and estimate spacing for pool / riffle sequence.

☐ Sinuosity (H/M/L) ☐ Bars (Y/N) ☐ Bed variation (Y/N) ☐ Width variation (Y/N)

☐ Deposition (Y/N) ☐ Bank Erosion (Y/N) ☐ Pools / riffles (Y/N) Approx. spacing (m): ☐

Is there any variation in flow? (Y/N) ☐ What is the average stream power? (H/M/L/NF) ☐

Please sketch the typical reach X-section, labelling LB and RB. Include main features, floodplain characteristics & flow conditions.

Please also consider the following questions:

	Y/N
Does the river experience High flows?	
If Yes, does the river channel pose a flood risk? (e.g. low flood banks, close proximity to housing, choked channel etc.)	
Does the river experience Low/Depleted flows?	
If Yes, does the river have a distinct low flow channel?	
Are the bank profiles structurally diverse?	
Are the bank profiles performing naturally as accustomed to the river catchment type? (compared to u/s and d/s river reaches of same order in the same ecoregion)	
Is the substrate conventional to the river catchment type?	
Is there diversity of in-channel features?	

Any other comments on the physical characteristics:

Overall score of Section 2 Part 2:	**1 - Poor**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 - Excellent**

Level of confidence in Answers for Section 2 Part 2:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

Part 3a: Assessment of ecological characteristics in this unit - Vegetation

Vegetation 'Vegetation' assessment tables adapted from Geomorphological Sensitivity Assessment Sheet, *Detailed Catchment Baseline Review* Environment Agency & University of Southampton, 2000

Av. in-channel cover (%): ☐ Av. Marginal cover (%): ☐ Av. Bank cover (%): ☐ LB ☐ RB

Av. tree cover (%): ☐ LB ☐ RB Are there any invasive species present (Y/N) ☐ Specify……

Please also consider the following questions:

	Y/N
Is there diversity of vegetation types:	
In-channel? (e.g. emergent, marginal, floating and submerged)	
Bankside? (e.g. bryophytes, short herbs, tall herbs or grasses, scrubs or shrubs and trees)	
Riparian? (e.g. mixed woodland, coniferous plantation, orchard, heath, scrub, pasture, wetland and urban development)	
Is the vegetation native/natural/? (compared to u/s and d/s or river reaches of same order in the same ecoregion)	
Is there a need for monitoring/maintenance?	
Has there been any planting or seeding?	
If Yes, has it taken well?	

Any other comments on the ecological vegetation characteristics:

Overall score of Section 2 Part 3a:	**1 - Poor**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 - Excellent**

Level of confidence in Answers for Section 2 Part 3a:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

Part 3b: Assessment of ecological characteristics in this unit - Fish & Aquatic Invertebrates

Please consider the following questions:

	Y/N
Are the following habitat characteristics present:	
Diversity of flow types?	
Diverse river bed? (substrate and structure)	
Stream cover, shelter and shading?	
Resting places and refuge?	
Clear fish passage and habitat connectivity between u/s and d/s?	
Lateral diversity between the river and floodplain?	
Food sources? (e.g. bankside trees, bushes and scrub – a source of terrestrial invertebrates)	
Was an improvement in fisheries part of the initial aim of the river restoration project?	
If No, has the river restoration project been beneficial to fisheries?	
Is there any evidence of fish using the habitat?	

Any other comments on the ecological Fish and Aquatic Invertebrate habitat:

Overall score of Section 2 Part 3b:	**1 - Poor**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 - Excellent**

Level of confidence in Answers for Section 2 Part 3b:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

Part 3c: Assessment of ecological characteristics in this unit – Mammals, Terrestrial invertebrates, Birds

Please consider the following questions:	Y/N
Was an improvement in a particular mammal habitat part of the main objectives of the river restoration project?	
Was an improvement in a particular terrestrial invertebrate habitat part of the main objectives of the river restoration project?	
Was an improvement in a particular mammal bird part of the main objectives of the river restoration project?	
Are the following habitat characteristics present:	
Shelter and cover? (e.g. bankside trees, bushes and scrub)	
Diversity in emergent, bankside & riparian vegetation?	
Lateral diversity between the river and floodplain?	

Any other comments on the ecological habitat for mammals, terrestrial invertebrates and birds:

Overall score of Section 2 Part 3c:	**1 - Poor**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 - Excellent**

Level of confidence in Answers for Section 2 Part 3c:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

Project Assessment Form – Post works Section 3: Identification of Potential Impacts of the restoration works

Comment on potential impacts of works on this unit & identify perceived degree of impact (High, Medium, Low, Negligible)

Short Term

	+ve	**H/M/L/N**	**-ve**	**H/M/L/N**
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Long Term

	+ve	**H/M/L/N**	**-ve**	**H/M/L/N**
Hydro geomorphology				
Vegetation				
Fish & Aquatic Invert's.				
Mammals				
Terrestrial Invertebrates				
Birds				
Visual & Social				

Level of confidence in Answers for Section 3:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

Project Assessment Form[1] – Post works Section 4: Appraisal of Techniques and Overall evaluation of the project

Appraisal of Techniques

Please take a photograph of each technique or change implemented, wherever possible; and for each of the 'ticked' practices, please consider the following questions on-site:

	Technique number - taken from table on page 2												
Is the technique: (Y/N)													
Still in place?													
Functioning as intended/producing the desired effect?													
Working with natural processes?													
Appropriate to the river type?													
Score 1-10 (1 = Poor, 10 = Excellent)													

With hindsight, were any of the techniques unnecessary or avoidable? In your view, are there any alternative techniques, which should have been implemented? Please comment:

Overall evaluation of the project

Please consider the following questions for evaluating the project on the basis of your evaluations in Sections 2 & 3:

Overall, is the river restoration project proceeding in the right direction to achieve its objectives?

Is there any evidence of unexpected negative outcomes of the project?

Has the project gained any other benefits?

Are there any areas of the project where further work or regular maintenance may be required?

Overall score for the project[2]:	**1 - Poor**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10 - Excellent**

Level of confidence in Answers for Section 4:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

[2] Please consider scores awarded in Section 2 of this assessment when deciding upon the overall score of the project

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Project Assessment Form – Post works Section 5:
Future improvements and management

Please tick all the issues that still apply to this site:

Artificial banks	☐	Over wide	☐
Artificial bed	☐	Over deep	☐
Choked channel – urban and natural debris	☐	Overgrown riparian trees – too much shade	☐
Culvert blockage	☐	Straightened	☐
CSO or drains present/water quality issue	☐	Unacceptable bank erosion	☐
No amenity value – river cut off from urban area	☐	Unacceptable siltation	☐
No in channel features	☐	Urban debris	☐
No in channel vegetation	☐	In-channel obstruction (e.g. weir)	☐
No tree cover	☐	Other – specify or use to expand on key issues	

Does the river pose a serious flood risk in this location? (Y/N) ☐ If Yes provide details:…….
……...

Potential for adaptive management and future restoration

Please tick all that apply, if you wish to expand on the key potential 'technique' please do so in Additional Comments box

Artificial bank removal – LB	☐	Plant riparian vegetation	☐
Artificial bank removal – RB	☐	Raise bed level e.g. substrate enhancement, woody debris	☐
Artificial bed removal	☐	Re-meander	☐
Fencing	☐	Riparian vegetation management	☐
In channel feature enhancement – pools / riffles	☐	Re-profile banks	☐
Increased in-channel sinuosity (current location)	☐	SUDS or further investigation re. water quality	☐
Local community gain[3] - specify in 'other' box	☐	Urban debris management (local community)	☐
Narrow	☐	Weir removal/lowering	☐
'Natural' bank protection	☐	Flood storage e.g. floodplain re-connection	☐
Plant marginal vegetation	☐	Other – specify	

Additional Comments

Level of confidence in Answers for Section 5:	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100 %**

[3] Such restoration techniques might include improving access by installing bridges and dipping platforms, removing bankside vegetation etc. many of these 'techniques' can be specified under already identified 'techniques', additional suggestions should be specified in the 'Other' box