River Till
Restoration Strategy

NATURAL ENGLAND

Environment Agency

TWEED FORUM

River Till
Restoration Strategy

Natural England
Environment Agency
Tweed Forum

Foreword

The River Till Restoration Strategy

This Strategy provides a guide for protecting the best of the Till river system and for improving those sections which are not currently achieving their potential conservation value. As far as possible, the aim is to assist the river to recover by allowing natural processes to return in areas where these are constrained by human intervention. This will be a long term process.

Human intervention goes back centuries as man has increasingly sought to benefit from the agricultural potential of the catchment. This human need is will continue to grow, influenced strongly by population growth and environmental factors, such as climate change.

Implementing the strategy has to strike a balance between the ideal ecological outcomes and the evolving economic and social needs of the communities which live and work in the catchment. How it is implemented will require consensus, flexibility and adaptability to changing circumstances.

The Till River Restoration Strategy provides a good starting point and direction of travel on which to base the recovery of the Till Rivers SSSI.

Natural England,
Environment Agency,
Tweed Forum

March 2013

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Note. Please refer to the *River Till Restoration Strategy - Technical Report* for all technical information and references to source material.

1. Introduction

1.1 Background & Rationale for Restoration of SSSI Rivers

Background

The River Till is a major tributary of the River Tweed and drains much of north Northumberland and a small area of the Scottish Borders region. The Till flows east from the Cheviot Hills (known here as the Breamish), before flowing north then west onto the Milfield Plain, a former glacial lake and now a significant agricultural area. The river continues northeast to join the Tweed near Coldstream. The principal tributaries are the Glen, which rises as the Bowmont Water in the Yetholm area of the Scottish Borders Region, the Wooler Water, Hetton Burn and Lilburn Burn.

The River Till and its tributaries are some of the best rivers of their type in the UK, supporting a diverse range of plant and wildlife species. In recognition of this they have been designated as the nationally important River Tweed Catchment Rivers (England: Till Catchment) Site of Special Scientific Interest (SSSI) and, because of their international importance, they are also designated as part of the River Tweed Special Area of Conservation (SAC). However, the Till Catchment Rivers have experienced a long history of modification as a result of changes in river and floodplain use. As designated rivers, they should provide favourable habitat conditions for their characteristic biological communities but none of the seven Till SSSI units is currently in 'favourable condition'.

Natural England and the Environment Agency therefore need to identify measures which will improve the physical condition of the rivers to a level that supports river habitats in favourable condition. Because the upper Bowmont Water sub-catchment is in Scotland, responsibility for achievement of favourable condition here lies with the equivalent Scottish organisations (the Scottish Environment Protection Agency and Scottish Natural Heritage). This River Restoration Strategy (RRS) will provide the framework for achieving the necessary improvements. River restoration measures will also contribute to maintaining and, where required, improving the condition of the Till catchment rivers, which is a key environmental objective under the Water Framework Directive.

To help us prepare the strategy, we have developed a good understanding of what physical and geomorphological form and function would be ideal for achieving favourable condition. Actual restoration measures will, however, inevitably be shaped both by what is physically and financially possible and what is acceptable to local stakeholders. The aim of the strategy is to restore as much functionality and characteristic river habitat as possible whilst taking into account the need to protect people and critical infrastructure from flood risk.

The RRS will be used from 2013 onwards to guide the delivery of river restoration measures on the ground and inform decisions about river management activities. During the lifespan of the strategy, the context for delivering actions will be strongly influenced by changing environmental factors, such as climate change, and variations in economic drivers, such as food production. Consequently, how the strategy is implemented will have to adapt to such influences whilst remaining focussed on the ultimate restoration objectives. In this way, over time, restoration of rivers in the Till catchment will improve them for the species and habitats they support and, importantly, will help the rivers become more resilient to future extremes of flow. This will, in turn, benefit the people who live and work in the River Till catchment.

The Rationale for Restoring SSSI Rivers

The UK conservation agencies set conservation objectives for SSSIs/SACs, using agreed national standards, and regularly assess their condition from a nature conservation perspective. Habitats or species are judged to be in 'favourable condition' when they are being adequately conserved, are meeting their 'conservation objectives' and support the characteristic flora and fauna of that habitat type.

The Till Catchment Rivers SSSI sites have been designated on the basis of being the best examples of their type, with the intention of preventing further deterioration and, over time, addressing existing impacts. There is no assumption that these sites were in Favourable Condition at the time of designation.

Setting physical habitat targets for SSSI rivers is heavily influenced by some of the constraints associated with people and the built environment. Consequently, when modifications from natural conditions are identified as an issue, a river restoration plan is developed, tailored to the local situation and cogniscent of immovable constraints.

Central to a sustainable approach to river restoration is the concept of working with natural processes. Implementing improvements requires an understanding of the interactions between flow regimes, sediment movement, habitats and land use. The root causes of any change need to be understood so that appropriate actions can be effectively targeted.

By restoring a more natural balance of the hydrological and geomorphological processes in the river, other significant environmental and social gains can be achieved. These might include enhanced habitats, improved water quality, better understood erosion and sediment regimes and improved flood management. The viability and sustainability of restoration measures is essential and techniques need to be integrated within the catchment landscape, so that river and land management are complementary to each other.

1.2 The Vision for Restoration of the River Till

The aim of the Till River Restoration Strategy (RRS) is to improve the condition of rivers in the Till catchment by taking a catchment-scale approach to tackling the factors which contribute to the current poor status of the river.

The strategy sets out a long-term, aspirational approach to restoring the natural processes necessary to support the whole-river ecosystem of the Till SSSI/SAC rivers whilst achieving a balance with the needs of those living and working in the catchment, particularly communities and farmers who are directly affected by the river.

This 'process-based' approach will aim to restore natural geomorphic processes and reinstate the natural form and function of the river environment. It is a sustainable approach which allows the river to adapt to future changes so that the benefits of restoration can be maintained with minimal intervention over the long term.

The strategy reflects the range of river types in the catchment, how these have been modified, current land uses and the actions needed to achieve 'favourable condition' of the SSSI/SAC. Actions will be designed to assist the natural recovery of the watercourses.

Actions will seek to reduce man made pressures on the river system. They will include removing modifications that are no longer needed and, where appropriate and acceptable, changing in-channel management, improving riparian land management and potentially channel or floodplain restoration.

The rivers directly influence the economic and social well-being of the area and actions to deliver the strategy will take this into account in looking to achieve restoration outcomes. Successful implementation will involve reaching consensus and working with landowners and local communities to develop and implement improvement actions.

The benefits of implementing the Till RRS will include achieving :

- Improvement of the physical and ecological condition of the SSSI/SAC and eventual achievement of favourable condition status.
- Channel activity, morphological diversity and flow regimes which are characteristic of the river types in the catchment and allow it to function as a connected river system.
- A complex mosaic of different habitat types.
- A greater degree of natural channel movement with a reduction in excessive erosion and deposition of sediment.
- Wider understanding and acceptance of how the active river and floodplain system responds more naturally to local and wider catchment processes and events.
- A longer term view of river management which helps landowners plan ahead.
- Opportunities for wider benefits such as reduction in flood risk and soil loss/erosion.
- The provision of evidence to support bids for funding restoration measures..
- Improved resilience to future changes in the catchment caused by factors such as land use policies and climate change.
- Joint delivery of outcomes required by the Water Framework Directive

Table 1 : What does the Vision look like on key river types?

Till & Glen on the Milfield Plain

The channel is able to meander & move laterally in it's corridor (which may be a defined 'erodible corridor' where constraints exist). The floodplain and channel are connected. There is minimal incision and increased stability of the sand/gravel river banks. The riverbed is composed of fine gravel / sand and has a typical riffle, run, pool structure. Flood management & riparian land use are both sensitive to the characteristics of the channel.

Mid sections of Breamish, Bowmont Water & Wooler Water

The channel is able to meander & move laterally in it's corridor (which may be a defined "erodible corridor" where constraints exist). Where there is a floodplain, this is connected to the channel. The riverbed is composed of medium/ coarse gravel & cobbles and natural processes create temporary features such as bars. The impacts of former gravel extraction have been mitigated.

Upper sections of Breamish & Bowmont Water

The channel is able to meander & move laterally in it's corridor (which may be a defined "erodible corridor" where constraints exist). The floodplain and channel are connected. The riverbed is composed of cobble/boulder/coarse gravel, and there are natural patterns of sediment loading, e.g. from tributaries. Riparian management leads to improved bank structure.

1.3 The approach to restoration planning

Understanding what needs to be done

Natural England and the Environment Agency have set out national guidelines for developing river restoration strategies. This approach has been adapted to suit the requirements of developing the Till RRS and involves four main stages :

Data assembly: Collating relevant existing information about the catchment and adding data from new field surveys, to fill gaps. Compiling all data into a Geographic Information System (GIS) to provide a catchment-scale dataset.

Data analysis: Mapping geographic information to identify reaches based on geomorphology and human modifications. Calculating river processes using stream power and sediment inputs, movement and deposition. Deriving measures of impact and sensitivity to change. Mapping the risk of fine sediment inputs.

Interpretation: Identifying reaches where the channel is adversely affected by modifications. Using indexes describing river processes and human pressures, to identify reaches which are sensitive to change and are most impacted.

Planning: Assessing the relative priority of reaches for action. Developing outline restoration options, across the catchment, which will help deliver the aims of the RRS.

Engagement & consultation

The Till RRS is being developed through a partnership between Natural England, the Environment Agency and Tweed Forum. This process has sought to involve others who will have a part to play in helping to develop and deliver the strategy, including land owners and managers, local communities, other statutory bodies and existing initiatives.

The successful delivery of aims of the Till RRS can only be achieved with the support and involvement of landowners and managers, as well as principal agencies such as Northumberland County Council, Northumberland National Park Authority and the Tweed Commission. Ongoing dialogue throughout the life of the RRS will benefit from the leading role of Tweed Forum, a stakeholder-led body with a strong track record of developing catchment plans in partnership.

Natural England and the Environment Agency recognise that the strategy needs to take account of the needs of landowners and the challenges, linked to the river, that face land owners and managers throughout the catchment. These include: loss of crops and/or soil due to flood events; maintaining field drainage; reducing nutrient runoff; the availability of water to abstract for summer irrigation. The agencies want to work with farmers to help them deal with these issues while improving and protecting this internationally important river system.

This strategy offers a means by which farmers can be supported to meet these challenges whilst also improving the condition of the SSSI/SAC. As a high level guide, the RRS could assist in the targeting and uptake of agri-environmental schemes and provide opportunities for farmers to seek financial assistance for adapting their practices; e.g. Environmental Stewardship support to help farmers move to a more sustainable system of land management where fields are subjected to frequent flooding. Similarly the strategy could be used to support grant applications to fund changes in floodplain land management such as woodland planting.

The Till RRS should provide wider benefits for farmers and local communities, including opportunities for:

- More awareness and better management of the risks associated with the changing river environment.
- Improved understanding of sustainable erosion and reducing soil loss.
- Reducing risks to livestock and land caused by sudden failure of floodbanks.
- Better long term planning, with a clear framework for the future approach to river management.
- Greater clarity about responsibility and acceptability of channel management.
- Developing resilience to future pressures such as climate change.
- Obtaining funding through agri-environment schemes such as Environmental Stewardship.
- Improving flood risk management by : (i) reducing the speed of flood flows, e.g. by increasing the length and diversity of the river channel; and (ii) attenuating the conveyance of flood waters downstream, e.g. by allowing the river to inundate its natural floodplain where risk to property and infrastructure is minimal.

During the development of the strategy the views and concerns of a cross section of stakeholders has been sought, including: individual landowners, land managers and farmers; representatives from local communities; relevant public bodies; and delivery partners. Their comments and information have been used to help shape the strategy. Further improvements can be made as consultation and discussion continues with those with an interest and influence on it's delivery. Future detailed discussions with landowners about specific river reaches will be an essential part of developing reach specific restoration projects in the coming years.

1.4 Integration with other initiatives

To be successful, implementation of the Till RRS needs to complement and be integrated with and contribute to delivering the objectives of a number of other programmes and initiatives already underway in the catchment, including:

- Water Framework Directive - River Basin Management Plan
- Catchment Sensitive Farming
- Catchment Flood Management Plan
- Tweed Catchment Management Plan
- Biodiversity Action Plan
- Tweed Foundation Fisheries Management Plan
- Agri-Environment Schemes : Environmental Stewardship
- Cheviot Futures

Water Framework Directive : Improvements to the condition of the SAC/SSSI are required by both the Habitats Directive and the Water Framework Directive (WFD). Because the Till catchment rivers are an SAC, the measures required to meet WFD objectives must be operational by the end of 2012 and the site must be meeting its SAC and WFD objectives by 2015.

Environment Agency Flood Risk Management : Changing priorities mean that, in future, the primary focus of EA flood risk activity will be on reducing flood risk for homes and communities. This means that the EA will seek opportunities to withdraw from the maintenance of uneconomic flood defences, including rural floodbanks. If the EA plans to cease maintaining a floodbank there will be an agreed withdrawal period, to give landowners a chance to consider future options; which may provide an opportunity for a change of approach which helps to deliver the type of measures outlined in this strategy.

1.5 Report framework & Document Structure

The Till RRS package consists of :

- The River Restoration Strategy (RRS) which presents information about the current influences on the condition of the SSSI and SAC and a high-level plan which proposes actions to address those influences.

- A Technical report which details the information used in forming the strategy, the methods employed to interpret and apply this information, key issues and a prioritised approach for potential restoration options / action and possible delivery mechanisms.

- A GIS archive which holds all of the key information. It can be interrogated, provide visual outputs and is capable of being maintained up to date.

- A summary ‘flier’ for wider dissemination.

1.6 Information & Data compilation

Rivers in the Till catchment have been the subject of several studies over the last two decades. A range of data from published reports, field surveys and aerial photos, has been used to develop a detailed understanding of the fluvial processes operating within the river system and impacts on these. Because of the dynamic nature of the rivers, with recent large floods and adjustments to human influences like gravel extraction still occurring, some new field surveys have been carried out to supplement and update earlier information. Details of the data compilation and analysis are in the Till RRS Technical Report.

All data has been compiled into a GIS, in a consistent format, so that it can be analysed at the catchment level. This information has then been used to identify priorities for action and develop potential restoration options.

1.7 Methods Overview

Physical channel processes

To provide a foundation for developing restoration measures that will successfully assist the natural recovery of the channel, it is essential to have a good understanding of how the river system behaves. The main river processes of sediment supply, movement and storage, together with the dynamic behaviour of the channel and the impact of human pressures, have been analysed. These help us to understand the reasons for the current position and condition of the channel and how existing modifications impact on the physical processes. They also give us an insight on what the channel form would be like under non-impacted conditions, what improvement measures may be appropriate and how the river would respond to such restoration actions.

Land use interactions

Not all physical changes to the channel will be caused by factors within the immediate channel corridor. Natural and artificial drainage patterns, soil types, and land use may cause impacts on the rivers through the input of fine sediment from the wider catchment. A catchment-wide assessment has been carried out to find out the risk of fine sediment entering and accumulating in the channel.

Ecology

The focus for the Till RRS is to improve the physical characteristics of the watercourses in the catchment, so that they will support ecological communities typical of the river type. For the Till, key types of restoration measure are justified using a general characterisation of habitat form and function within each river type, combined with an understanding of habitat utilisation by typical biological communities for each type. This general characterisation has then been refined through the geomorphological appraisal and ecological interpretation process. Existing information about the status and distribution of the key SSSI/SAC species has been reviewed but no additional ecological survey work has been undertaken in developing the RRS.

2. Current Condition

2.1 Catchment Characteristics

Introduction

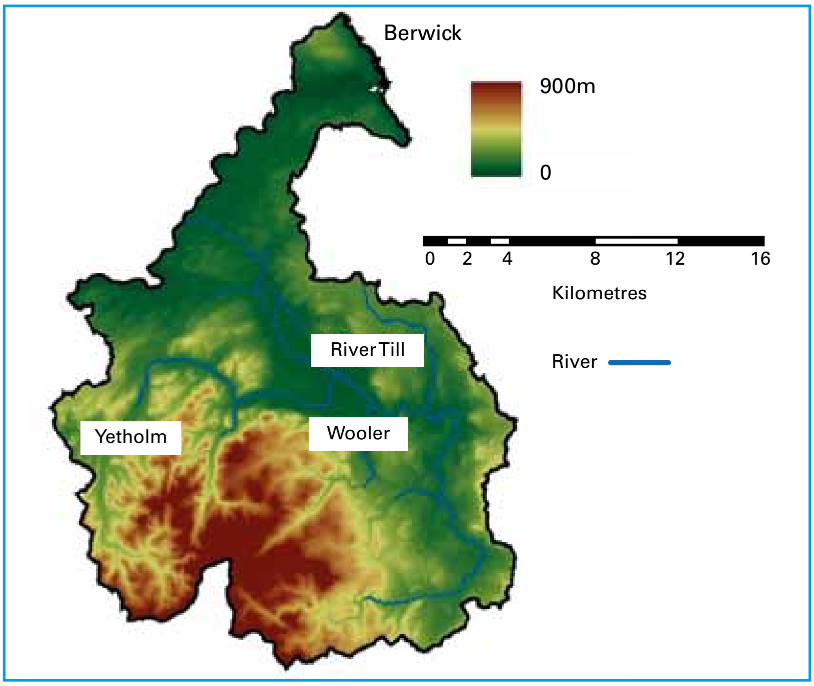
There is a range of factors which affect the Till catchment and influence the present condition of the SSSI/SAC. Understanding the natural characteristics of the catchment is an important starting point for assessing the impact of human activities and for developing measures to address these impacts. The main natural characteristics are summarized in this section.

Geography and hydrology

The River Till catchment is mainly located in northeast England but spans the Scottish border in the subcatchment of the Bowmont Water. It covers an area of c.950km^2, contains c.1250km of principal watercourse and drains to the River Tweed, near Coldstream and thence to the North Sea at Berwick upon Tweed. The chief river is the River Till and it's main tributaries are the River Breamish, the Lilburn Burn, Hetton Burn, Wooler Water and River Glen (called the Bowmont Water upstream of Westnewton).

The land form of the catchment is a mix of uplands, comprising the eastern and northern segments of the Cheviot Hills which rise to 815m above sea level, through to flat lowlands. Figure 1 shows the landform across the catchment.

Figure 1 : Topography of the Till catchment



The average annual rainfall varies from 600m to 1150m, with the highest levels in the upland areas in the south of the catchment. The upland watercourses which drain the impermeable rocks of the Cheviots are typically steep and runoff drains quickly, leading to a rapid increase in flows downstream. Figure 2 illustrates the gradient of principle watercourses and Figure 3 shows the broad split of flows in the three main watercourses in significant flood conditions. A key feature of the lower catchment is the Milfield Plain, a former glacial lake bed where sediments are overlain by glacial drift and alluvial deposits. Here the river has a low gradient and an actively meandering channel with sandy bed and banks.

Figure 2 : Gradient of the principal rivers in the Till catchment.

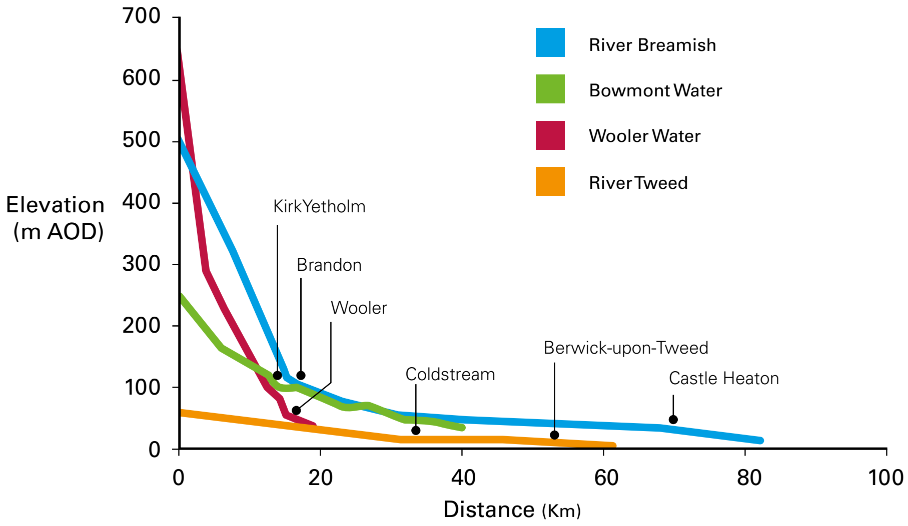
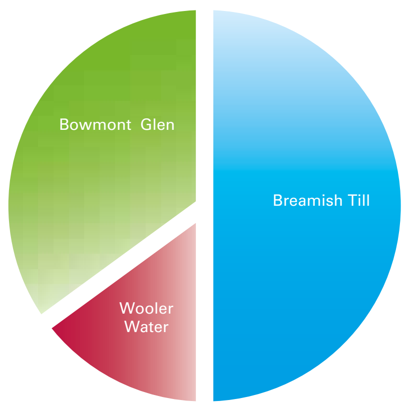


Figure 3 : Till watercourses flow contribution to a significant flood.



Geomorphology

Fundamental to the Till RRS are the natural geomorphological processes of erosion, transport and deposition of sediment by the river. The extensive glacial drift deposits, high weathering rates and loose glacial debris in the upper catchment provide significant sources of coarse sediment to the upland streams. In high flows, the rivers move very large quantities of sediment, which gets deposited downstream changing river bed levels and influencing channel morphology. This movement of sediments results in the dynamic, wandering nature of the middle reaches of most of the rivers. In the more lowland areas, drainage ditches supply fine sediments, eroded from agricultural land, to the main river network altering the nature of the river bed and influencing the ecology of the river.

Land cover & Land use

Land cover and how the land is used and managed has a direct impact on flow regimes and channel characteristics by increasing or decreasing runoff, providing flood storage and through direct impacts on the channel. Existing and future land-use and management practices are important elements of delivering the RRS.

Land cover in the catchment is mainly: upland moorland, some forestry, large areas of managed grassland located to the east and arable agriculture mainly in the north. Forested and woodland areas, mainly on the high ground within the Cheviots and in the lower reaches of the Till, cover about 8% of the catchment. Over 85% of the catchment is agricultural land

Agricultural land-use is predominantly sheep and cattle hill farming in the upper parts of the catchment and a transition to improved pasture, used for dairy and sheep farming, and arable cultivation of cereals and vegetables in the lower-lying areas.

The catchment is sparsely populated (<30 people per km^2) with the largest settlement being Wooler (population 1,900). The local economy is based primarily on agriculture, although there are less than 300 farm holdings.

Ecology

The rivers in the Till catchment are of high conservation and ecological value. There is a natural succession of vegetation types from the mineral-poor upland streams through to communities which are typical of mineral-rich lowland rivers. Beds of water crowfoot (*Ranunculus sp.*) are of international significance and the blooming of a diatom (*Didymosphenia sp.*) in the headwaters draining the Cheviot, is unique in England.

The fish fauna is particularly significant and includes Atlantic Salmon, Sea Trout and Brown Trout, Brook, River and Sea Lampreys and Eels. Other species found throughout the catchment include, Minnows, Three-spined Stickleback, Stone Loach, Pike and Grayling. The latter three species, together with Roach and Signal Crayfish, have been introduced into the system in the past, potentially compromising the Till's conservation value.

Trout or salmon juveniles are present in all tributaries, though sea trout spawn mainly in the upper reaches, and the River Glen is notable for relatively high densities of salmon fry. Low numbers of fry in expected spawning areas potentially indicate tributaries that adult fish may be unable to access due to an obstruction, such as a weir, in the river.

All three species of lamprey are present in the catchment. Although no specific surveys have been done, Brook and River Lampreys have been recorded in the Rivers Till, Breamish, Glen, and the Bowmont Water; a single record for Sea Lamprey suggests the potential for them to occur in these rivers.

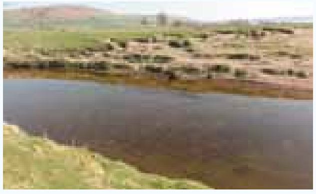
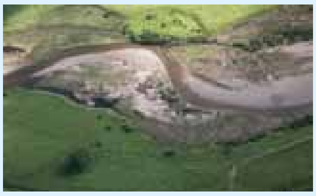
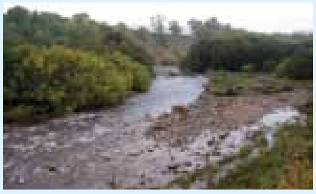
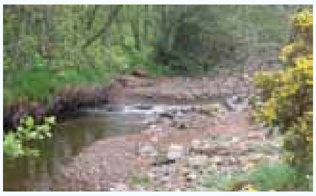
Similarly, there are few records detailing the distribution of Eels but they are considered to be widespread in the catchment. Eels are not listed in the SSSI notification but there is international concern about the recent decline in numbers of Eel in European rivers and UK implementation of the EU Eel Directive requires that improvement actions in the RRS should seek to assist Eel populations where appropriate.

The Till rivers also provide important habitat for otters, which are present throughout the catchment.

Ecological River types

The national conservation agencies use ‘river community types’ as a way of describing and classifying the range of rivers present in the UK. . This classification into ‘river types’ reflects the natural characteristics of British rivers based upon morphology, geology and river macrophyte communities. Table 2 summarises the main ecological river types present in the Till catchment.

Table 2 : Characteristics of the JNCC River Types in the Till catchment.

JNCC river type	Characteristics under conditions of low anthropogenic impact	Till example
Type I: Naturally eutrophic lowland rivers with a high base flow	Streampower is somewhat variable but is generally low. Bed materials are likely to be dominated by silts and sands, with coarser gravels accumulating at riffles to an extent dependent on upstream sources of coarse substrate and the streampower generated by the catchment. Flow patterns are likely to be dominated by glide, with coarser substrates underlying occasional riffles and finer materials underlying deeper pools. Occasional logjams would be expected to generate stretches of ponded water, to an extent depending on exact gradient, providing additional and important habitat variability as well as woody debris for decomposer species. Riverbed gravels or other coarse substrate provide an essential but generally scant habitat for a wide variety of invertebrate and fish species in these river types,	Type I - Lower Till 
Type II: Slow-flowing, naturally eutrophic lowland rivers, dominated by clays		Type 2 - Milfield Plain 
Type VI: Base-rich, mesotrophic rivers in western and northern Britain, with a moderate to fast current.	Tend to have catchments of mid-altitude, intermediate stream gradients and substrates dominated by gravels and pebbles. Outcropping bedrock and boulders are a relatively common feature of the channel, generating a characteristic mosaic of exposed rock and fast-flowing runnels at low-to-intermediate flows, with some upstream ponding of water behind strata particularly resistant to erosion. A mixture of riffles, pools and glides can be expected under conditions of low physical modification. Exposed shingle bars, occurring in mid-channel and along channel sides and both vegetated and non-vegetated, are common features of these types under conditions of low anthropogenic impact, along with sparsely vegetated sandy margins. Riparian trees are important in providing a source of woody debris, leaf litter, and exposed tree root systems as submerged habitat for fish and invertebrates. In sections with a significant floodplain, active meandering can be expected with the creation of vertical cliffs and point bars.	Type 6 – Mid-sections of Breamish & Wooler Water  
Type VIII: Rivers common throughout western Britain over hard rocks	River type has upland catchment of hard rocks such as shales, hard limestone and hard sandstone. They are steep and energetic, dominated by cobbles, boulders and bedrock. They tend to be dominated by bryophytes, with a complex habitat mosaic of exposed rock and swift-flowing runnels ideal for a range of riffle-dwelling invertebrates.	Type 8 - Upper Breamish, College Burn & Wooler Water 

2.2 The Tweed Catchment Rivers (England: Till Catchment) SSSI and SAC

The designated sites

The rivers of the Till catchment are some of the best in the UK and are designated as nationally important Sites of Special Scientific Interest (SSSI) : The Tweed Catchment Rivers - England: Till Catchment SSSI. The SSSI is designated for the following habitats :

- base-rich, mesotrophic rivers in western and northern Britain, with a moderate to fast current.
- rivers common throughout western Britain over hard rocks.
- naturally eutrophic lowland rivers with a high base flow.
- slow-flowing, naturally eutrophic lowland rivers, dominated by clays.

These habitats support some characteristic species :

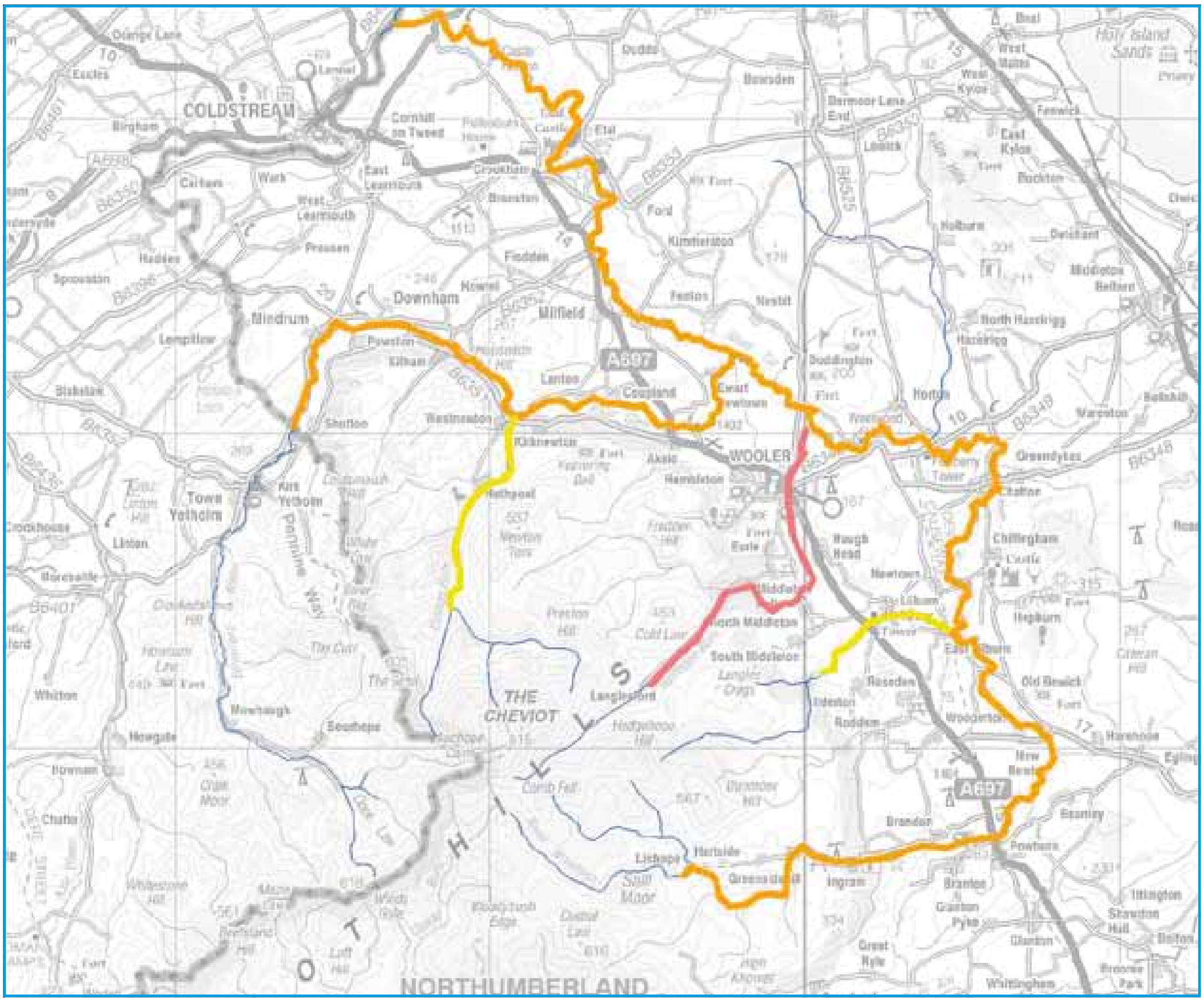
- Sea, river and brook lamprey
- Otter
- Atlantic Salmon
- Combinations of species - other groups (fungi and algae)

Although these species, including SAC species, are included in the site designation, their presence needs to relate only to the extent characteristic of the river habitat type.

The Till catchment rivers are also part of the River Tweed Special Area of Conservation (SAC) which is designated as river habitat that supports certain internationally notable aquatic plant communities, and for populations of sea, river and brook lamprey, Atlantic Salmon and otter.

The Till Catchment Rivers SSSI is approximately 130km in length and comprises the River Till to its confluence with Tweed, River Breamish, Bowmont Water, River Glen, College Burn, Wooler Water and Lilburn Burn. The extent and condition of the seven SSSI management units is shown in Figure 4.

Figure 4 : The River Tweed Catchment Rivers (England: Till Catchment) SSSI/SAC.



Extent & Condition of SSSI
Unfavourable, recovering
Unfavourable, no change
Unfavourable, declining

N

0 2 4 km

The need for restoration

The condition of SSSIs is assessed by Natural England using Common Standards Monitoring. Sites are considered to be in 'favourable condition' if they are being adequately conserved and are meeting their Conservation Objectives. For the Till SSSI these include:

- No excessive siltation – characteristic levels of sediment.
- Predominantly unmodified and characteristic channel form.
- No artificial barriers significantly impairing migratory species.

- Characteristic flow regime.
- Near natural bank and riparian zone structure.
- Appropriate species composition and abundance.
- No impact on native biota from alien or introduced species.

The latest condition assessment for the Till SSSI (October 2010) is summarised in Table 3. Five of the SSSI units are not achieving either 'favourable' or 'unfavourable recovering' condition for a range of reasons, including physical habitat modifications. As a result, Natural England and the Environment Agency must identify measures to improve the physical condition of the river. An agreed river restoration plan (i.e. the Till RRS) must be prepared and implementation progressed on the ground. This action will contribute to England Biodiversity 2020 Strategy targets for SSSI condition, and the Habitats Directive, and Water Framework Directive targets for SACs. Additional actions are underway or will be required to address other issues such as pollution and invasive species which may affect the River Till SSSI.

Table 3 : Tweed Catchment Rivers (England: Till) SSSI condition (Oct 2010).

% area meeting PSA target	% area favourable	% area unfavourable recovering	% area unfavourable no change	% area unfavourable declining	% area destroyed / part destroyed
6.61	0	6.61	86.32	7.07	0

SSSI Unit	Current condition	Reason for failure	Actions in place (maintain in future)	Actions required
1 Breamish	Unfavourable No Change	Inappropriate Weirs Dams And Other Structures, Water Pollution - Agriculture/Run Off	Diffuse Water Pollution Plan (DWP) Catchment Sensitive Farming delivery (CSF)	River restoration project Higher Level Stewardship (HLS)
2 Lilburn	Unfavourable Recovering	Not applicable	DWP, CSF Environmental Stewardship Schemes (ES)	
3 Wooler Water & Harthope	Unfavourable Declining	Inappropriate Weirs Dams And Other Structures, Water Pollution - Discharge	DWP, CSF Environmental Stewardship Schemes (ES)	River restoration project, Revoke/ amend discharge/ PPC consent
4 College Burn	Unfavourable Recovering		DWP, CSF, ES	

SSSI Unit	Current condition	Reason for failure	Actions in place (maintain in future)	Actions required
5 Bowmont & Glen	Unfavourable No Change	Inappropriate Weirs Dams And Other Structures, Invasive Freshwater Species, Water Pollution	DWP, CSF, ELS Invasive species control programme	River restoration project HLS
6 Upper Till	Unfavourable No Change	Inappropriate Weirs Dams And Other Structures, Invasive Freshwater Species, Water Pollution	DWP, CSF, ES Invasive species control programme	River restoration project HLS
7 Lower Till	Unfavourable No Change	Inappropriate Weirs Dams And Other Structures, Invasive Freshwater Species, Other	DWP, CSF, ES Invasive species control programme	River restoration project HLS

The Water Framework Directive

Objectives set for the Tweed (Till Rivers System) under the Water Framework Directive are included in the Solway-Tweed River Basin Management Plan. A number of measures are included in this Plan to improve Till water bodies to good ecological status (GES) or good ecological potential (GEP), and to meet the SAC objectives.

These measures include implementing a "river restoration programme for Protected Areas". Measures to achieve both GES / GEP and the SAC objectives must be in place by December, 2012. The current status of WFD waterbodies in the site is given in Table 4.

Table 4 : Tweed Catchment Rivers (England: Till catchment) SSSI : current WFD status of relevant waterbodies.

SSSI unit	WFD Waterbody	Current status	Reason for failure to achieve GES/GEP
1 Breamish	GB102021073040	Good	✓
2 Lilburn	GB102021072900	Good	✓
3 Wooler Water & Harthope Burn	GB102021072930 (Heavily modified waterbody)	Moderate	Morphology
4 College Burn	GB102021072940	Good	✓
5 Bowmont & Glen	GB102021072950 (Heavily modified waterbody)	Moderate	Morphology
6 Upper Till	GB102021073040	Good	✓
7 Lower Till	GB102021073050	Moderate	Ecology (phytobenthos)

Note : If the SAC objectives are higher than those for the WFD, it is the SAC objectives that must be met. Consequently, although the current WFD status is 'good' for four of the SSSI units, further action is needed to meet the objectives for the SAC.

2.3 Human influences

The main aspects of human activity which affect the physical condition of the rivers in the catchment are channel engineering, weirs and fords, land use and gravel extraction :

Channel engineering

There is a long history of human modification of the river channels and surrounding drainage in the catchment, mainly linked to evolving patterns of agricultural land use. A comparison of current and old maps illustrates how the sinuosity of the channel has declined. The construction of extensive systems of floodbanks to protect agricultural land, often with associated riverbank protection, has influenced much of the river network, particularly the River Glen, the lower Wooler Water, parts of the upper Till and much of the Milfield Plain section of the Till.

In some reaches the channel has been straightened or resectioned to bring areas into easier cultivation and/or improve drainage. Often more localized, but widespread throughout the catchment, is bank erosion protection in the form of stone pitching or rip-rap; particularly significant examples are intended to prevent bank erosion near roads and bridges. Channel 'maintenance' by means of periodic desilting or gravel removal has, until relatively recently, been systematically carried out to improve land drainage.

Weirs & Fords

Weirs restrict the natural geomorphological evolution of the channel, by controlling bed movement, and there is generally associated bank protection which prevents lateral channel migration. There are several significant weirs on the downstream reaches of the Till, constructed in association with mills or for channel stabilisation purposes. Smaller weirs occur throughout the catchment, including on the Wooler Water and Bowmont/Glen. Major bridge footings, such as at Hedgeley on the Breamish, have the same channel impacts as weirs.

The numerous fords throughout the catchment range from those used for informal farm access to formal structures on public highways. Significant fords, such as those on the Wooler Water, have similar impacts to weirs.

Land use/farming

Land management practices directly influence channel characteristics. Stock grazing on riverbanks reduces riparian vegetation cover and bank stability, particularly in parts of the Breamish, Till and Glen, and, in places, heavy grazing has led to a reduction in bank strength. When stock is excluded, re-growth of herb and shrub cover can be rapid and spectacular, creating significant benefits provided that fencing can be maintained and with appropriate vegetation management

Agricultural land use also affects the rate and quantity of runoff to the rivers, mainly related to:

- farm vehicles and machinery compact soils, increasing field surface runoff and soil loss.
- the depth and position of ploughing affects the speed of water movement through the soil and consequently the response time of the catchment.
- artificial drainage, installed below the soil surface or at the field edge, shortens the response time and increases the amount of rainfall reaching watercourses.

Generally, moorland gripping to improve upland drainage is not a widespread feature in the Till catchment. Except where field runoff containing sediment drains onto roads, road and 'urban' runoff are not significant in this rural catchment.

Gravel extraction

At a number of locations the river channel and/or the local floodplain have been commercially exploited as sources of gravel and sand. The Breamish downstream of Brandon and the Wooler Water upstream of Wooler are major locations of former aggregate extraction from the river bed and adjacent corridor during the 20th Century. Gravel removal from the Wooler Water, up to the early 1970s, is estimated to have exceeded 200 times the natural rate of gravel supply to the reach from upstream; and in the Breamish near Powburn over one million tonnes of gravel has been removed from the channel. These works have had a major impact, causing severe incision and destabilisation of the affected rivers, and the recovery/adjustment of the channel is still occurring. Upstream and downstream of Hedgeley Bridge on the Breamish is the principal recent location of sand and gravel extraction from floodplain deposits.

Flood risk & management

Historically, 'river authorities' have constructed flood defences and carried out land drainage works in the catchment. The effects of these works are still evident (see above).

The Environment Agency approach to managing flood risk in the catchment is set out in the Till Catchment Flood Management Plan. The application of policies included in this plan is currently under review. Current flood risk to people and buildings in the Till catchment is mostly classed as 'low" by the Environment Agency. In total throughout the catchment, there are 281 residential and 18 commercial properties at risk from a significant flood. The main location where there is fluvial flood risk to a significant number of homes is Wooler.

Future issues

Whilst the RRS reflects the current pressures facing the rivers in the Till catchment, other influencing factors may arise during the lifespan of the strategy. For example :

- Changing requirements and regulatory control of abstraction from the rivers for irrigation. Whilst, at present, these do not impact on geomorphological character, demands may change as climate and/or farming priorities change.
- Increased demands for abstraction for potable use, drawing water from the aquifer which is partly under the catchment, may create indirect or direct pressures on the river system.
- Increasing pressure for alternative energy generation with direct or indirect implications in the catchment, e.g. hydropower, biomass production, fracking.

2.4 Condition analysis and interpretation

Overview

Information & Data sources

The rivers of the Till catchment have been the subject of numerous surveys and initiatives so a comprehensive review of published and relevant unpublished literature and data was carried out. This has enabled an assessment to be made of the relevance of existing data for the RRS and highlighted gaps needing to be addressed to ensure that the strategy is founded on a good understanding of the catchment.

Compilation of existing data and information

A cornerstone for developing the strategy is the compilation of a comprehensive GIS / geodatabase. This has been used to aid interpretation and analysis of data, assist with gaining a catchment-wide perspective and to form an archive of relevant material. (Full details of the system and a contents guide are included in the Till RRS - Technical Report.)

Integrating datasets

To ensure comparability of data from different sources, the codes and terms used to describe individual features were standardised across all datasets. Sources included field survey notes / photographs, published and unpublished reports, aerial photographs and Ordnance Survey maps. Differences in data collection methods, classification and recording protocols, survey objectives and the age span of the data mean that discrepancies between different sources are inevitable. However, the combined dataset provides a strong basis for understanding the factors influencing channel form and river processes throughout the system.

New field surveys

Where there was no existing data, data was regarded as too historic (>10 years old) or it was known that physical conditions had recently changed due to flooding or significant erosion / deposition, new field surveys were carried out. These were targeted at the main SSSI-designated lengths of river. Carrying out detailed field surveys of the many lengths of 'steep headwater' was considered unnecessary as they are relatively unmodified, however their contribution to sediment movement has been noted where they enter surveyed channels. They also fall within the catchment-wide risk assessment of fine sediments. As a check on this approach, the upstream lengths of some key watercourses were however walked and key physical features recorded. Along the downstream stretch of the Till a simple, field assessment of the main weirs and the adjacent channel was carried out.

All newly collected data is incorporated into the Geographic Information System.

Analysis of geomorphological processes and impacts

Introduction

The main underlying focus governing the Till RRS emphasises the central role of river processes, not just the shape of the channel, and the impacts resulting from channel modifications. Consequently, data analysis and interpretation has focussed primarily on geomorphological characteristics, pressures and impacts, There are four main components to this process : (i) Classification into geomorphically-based river types; (ii) Identification of distinct sub-units (reaches); (iii) Developing a geomorphological process-impacts model; (iv) Assessment of fine sediment impacts.

Reaches as a basis for understanding river characteristics and impacts

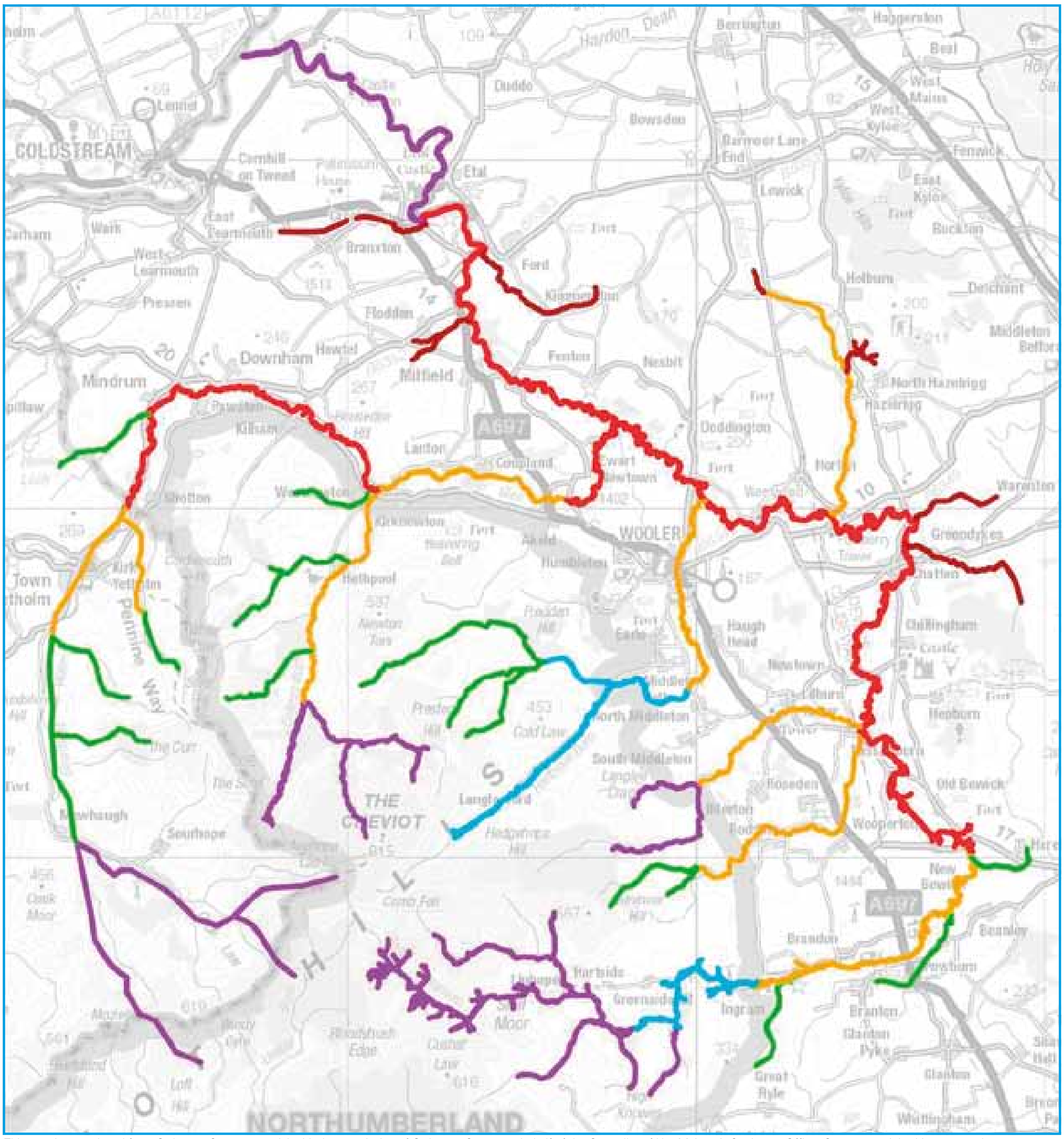
There is no standardised definition of reaches on which to base river restoration strategies. The Till RRS reaches are defined using a bespoke approach, whereby the river system has been split up at an increasingly fine scale as follows:

(a) The Till river types (Figure 5).

(b) Restoration reaches – based on the key pressures (predominantly human modifications) influencing the channel (Figure 6, Table 5 & Appendix 1).

(c) Geomorphological sub-reaches - derived from interpretation of field surveys, aerial photos and LiDAR (see *Till RRS - Technical Report*).

Figure 5 : Till River Types

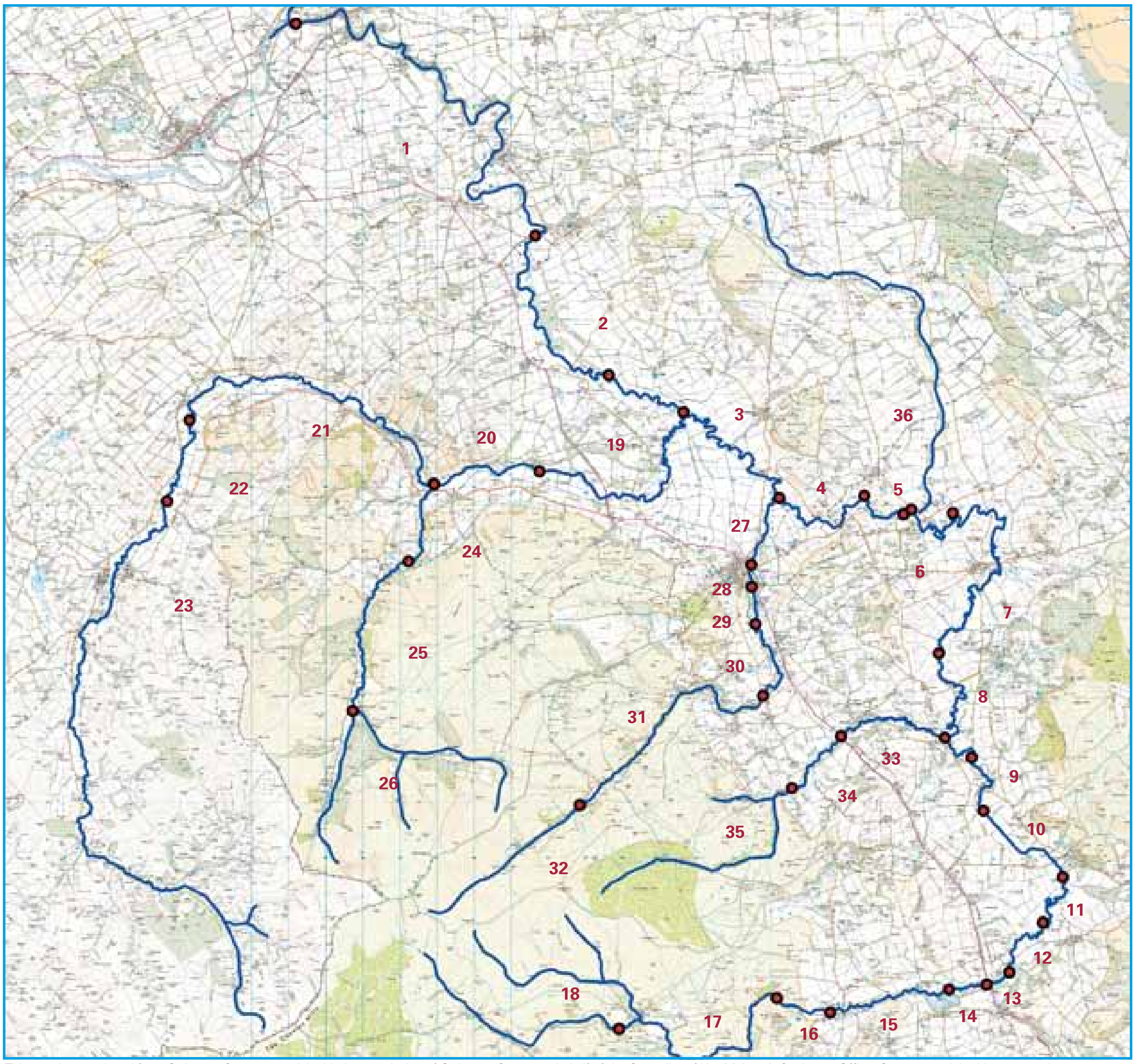


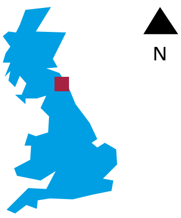
Low gradient active meandering (Milfield Plain)
Wandering, very local braiding (piedmont)
Plane-riffle, pool riffle (montane floodplain)
Step-pool, plain bed (montane confined)
Bedrock, cascade
Agricultural ditch

N

0 2 4 km

Figure 6 : Till Restoration Reaches





Restoration reach limits

Table 5 : Location and modification features of Till Restoration Reaches

Reach No			River	Location	Significant modifications	km	Grid refs (d/s to u/s)	
1	✓		Till	confl with Tweed to Ford	weirs	15	NT870429	NT935373
2	✓	•	Till	Ford to u/s Redscar Bridge		7	NT935373	NT956335
3	✓	•	Till	u/s Redscar Bridge to confl Wooler Water	floodbanks to both sides, some breached (Fenton); minimal engineered banks	8.5	NT956335	NU003302
4	✓	•	Till	Wooler Water to Sweet Haugh	short floodbank on one side and c50% of other side; soft engineered banks	6.5	NU003302	NU025303
5	✓	•	Till	Sweet Haugh to Heathery Hall	no floodbanks or engineered banks etc	2	NU025303	NU035298
6	✓	•	Till	Heathery Hall to u/s Hetton House	floodbanks c50% both sides; hard engineered banks near bridge	4	NU035298	NU049298
7	✓	•	Till	u/s Hetton House to Chillingham Barns	no floodbanks or engineered banks etc	8.5	NU049298	NU044260
8	✓	•	Till	Chillingham Barns to u/s Lilburn confl	floodbanks c80% one side, small lengths both banks; hard engineered banks at two sites	8.5	NU044260	NU053232
9	✓	•	Till	u/s Lilburn confl to u/s Bewick Bridge		2	NU053232	NU058218
10	✓	•	Till	u/s Bewick Bridge to Harehope	floodbanks c75% of both sides and 25% one side only; some hard engineered banks, straightened channel	3	NU058218	NU079200
11	✓	•	Till	Harehope to Beanley	no floodbanks or hard engineered banks (extent of gravel workings)	2.5	NU079200	NU074188
12	✓	•	Breamish	Beanley to Hedgeley	no floodbanks; hard eng banks, gravel workings,	3	NU074188	NU064174
13	✓	•	Breamish	Powburn bridges	road & railway bridges, footings & sills	0.5	NU064174	NU058171
14	✓	•	Breamish	Powburn to d/s Brandon ford	partial floodbank & soft protection; ex gravel workings	1.5	NU058171	NU048169
15	✓	•	Breamish	D/s Brandon ford to Ingram	major hard engineered bank (road) protection and gravel realignment	2.5	NU048169	NU016164
16	✓		Breamish	Ingram to u/s Boulby Wood	hard engineered at roadbridge; soft eng and gravel realignment	2	NU016164	NU002167
17	✓		Breamish	Boulby Wood to SAC limit	local hard bank protection at bridge	6.5	NU002167	NT959159
18	✗		Breamish	u/s SAC limit	post-flood bank realignment	-	NT959159	-
19	✓	• •	Glen	Till confl to Coupland	flood banks to c100% of both sides; sporadic hard toe protection; local soft bank protection	8	NT976325	NT938309
20	✓	•	Glen	Coupland to confl College Burn	floodbanks along c30%; toe protection, gauging weir; soft eng; avulsion	2.5	NT938309	NT909305
21	✓		Bowmont Water	College Burn confl to u/s Mindrum	single bank : 3 short lengths of single-bank floodbank; 1 short lenth of double-bank floodbank.	11	NT909305	NT843324
22	✓		Bowmont Water	u/s Mindrum to SAC limit	1 longer length of single bank floodbank	2.5	NT843324	NT837301
23	✗		Bowmont Water	u/s SAC limit		-	NT837301	-
24	✓	•	College Burn	Glen confl to d/s Hethpool	floodbanks on c5% of length; local hard & soft bank protection; former bridge abutments	2	NT909305	NT902284
25	✓	•	College Burn	d/s Hethpool to SAC limit		4	NT902284	NT887244
26	✗	•	College Burn	u/s SAC limit	several piped fords; local hard bank protection at bridges.	-	NT887244	-
27	✓	•	Wooler Water	Till confl to Wooler	floodbanks along c100% of both sides; regular hard toe protection.	2.5	NU002302	NT995284
28	✓	•	Wooler Water	Wooler	hard engineered banks both sides; weirs & bridges	1	NT995284	NT995278
29	✓	•	Wooler Water	Wooler to Earle Mill	floodbank and some hard protection at campsite	1	NT995278	NT996268
30	✓	•	Wooler Water	Earle Mill to Coldgate Ford	haughhead ford & check weirs; hard engineered; former gravel extraction	2.5	NT996268	NT998249
31	✓		Wooler Water	Coldgate Ford to SAC limit	lengths of rock armour by road	6.5	NT998249	NT949219
32	✗		Harthope Burn	u/s SAC limit		-	NT949219	-
33	✓	•	Lilburn	Till confl to A697 bridge	weir& bridge apron; ford; soft bank works.	2.5	NU046238	NU019238
34	✓	•	Lilburn	A697 bridge to SAC limit	former rail bridge footings	2	NU019238	NU005223
35	✗		Lilburn	u/s SAC limit		-	NU005223	-
36	✗		Hetton Burn	U/s SAC limit (confl Till)	field drainage	-	NU038299	-

Notes
1 Column 2 denotes if reach is within (✓) or outside (✗) the limits of the SAC
2 Column 3 denotes if reach is in priority river types : Milfield Plain (•) Piedmont Wandering (•)

Conceptual model of geomorphological process and impacts

A conceptual model of key physical processes and impacts has been developed to provide an in-depth understanding of the geomorphological characteristics of the Till system. This involved four main elements:

- Initial division of the system into a series of geomorphically defined sub-reaches : to provide a basis for further analysis.
- Working out a sediment budget for the system using indices of sediment input and storage : to provide a continuous description of the relative balance of sediment supply and the capacity of the river to transport that supply (the 'geomorphic process regime').
- Assessing the physical character of the system by analysing stream power in relation to the sediment budget: to help rank the channel activity.
- Quantitative analysis of historic channel change at key locations : to improve our understanding of dynamic channel movement and further refine the process model.

From the analysis, the sediment transport regime (i.e. zones of sediment supply, transfer and storage) and likely morphological adjustment (including lateral migration and avulsion of the channel), particularly in response to extreme flood events, have been predicted. These predictions were then checked, using field data and the analysis of historical maps to measure rates of channel change/migration.

The model was then used to forecast the probable sensitivity of each reach to engineering or other pressures. This, together with information about physical modifications and land use pressures, was combined into an index of engineering and land use impacts on the physical characteristics of the channel.

Summary of key features of geomorphic processes

A catchment overview of the geomorphic process regime (Figure 7) shows zones of sediment supply, transfer and storage, together with the degree of channel dynamic behaviour or stability, providing a strategic understanding of the dominant processes throughout the system. Table 6 provides a summary explanation of the key channel features indicative of these geomorphic processes.

Analysis of historical channel migration

Knowing how the position of the channel has changed over time, due to fluvial processes, helps to establish it's dynamic behaviour and provides further evidence about the degree of channel stability or instability. In turn, this helps us to develop appropriate restoration measures. Where historical channel change has been caused by human engineering intervention the degree of change reflects the extent of channel modification.

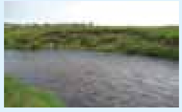
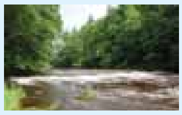
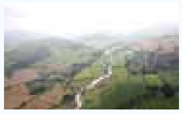
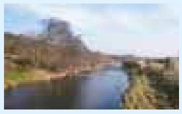
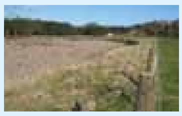
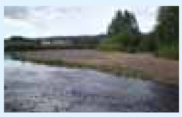
Historic channel migration was assessed in five contrasting areas of the catchment by comparing 2007 data on channel position with that from 1952 (post World

War 2), 1899 and 1860 : River Breamish at Brandon/Ingram; Wooler Water; Rivers Till and Glen on the Milfield Plain; River Glen at Kirknewton; River Till upstream of Weetwood Bridge.

Geomorphic process regime

The relationships between sediment input, sediment storage and specific stream power define the dominant geomorphic process in a reach: whether it is a zone of net sediment supply, transfer or storage, and, by association, the potential rate of morphological adjustment. The volume, dominant size of sediment and rate of sediment input and storage helps us understand how the energy of the river flow is translated into geomorphic ‘work’, dynamic channel behaviour, and the channel morphology that results.

Table 6 : Key features of geomorphic processes in the Till rivers

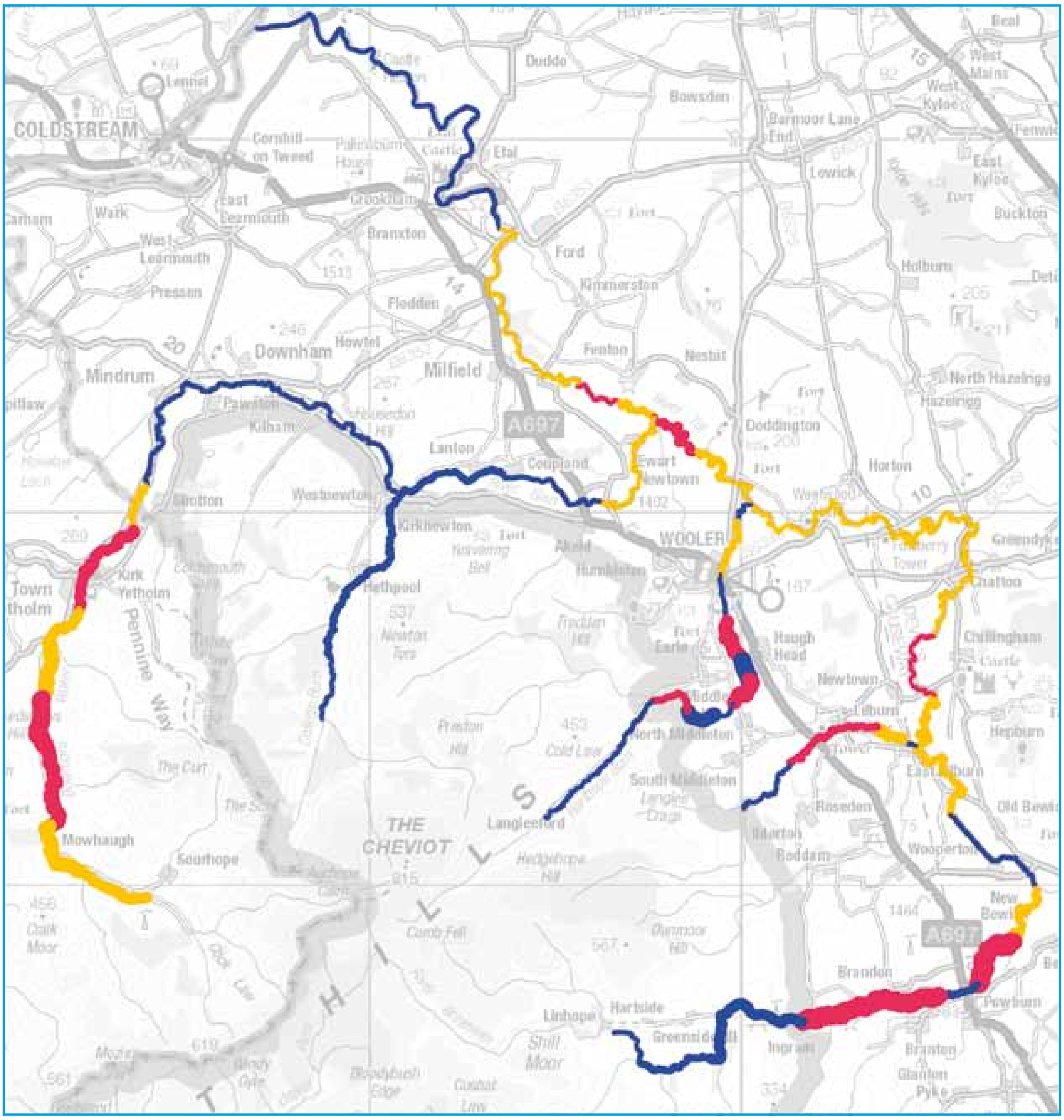
Reaches	Location	Key processes	Example
15, 16	Central Breamish	High levels of sediment storage and relatively low rates of sediment supply - a very **significant sediment storage** zone. Moderately high stream power indicates that sediment is likely to be reworked during floods, making this section of the channel highly dynamic.	
12, 13	Breamish/Till	Increased sediment supply is accompanied by decreased storage, indicating a **predominantly sediment transport** reach. The ratio between sediment supply and storage reflects finer sediment being supplied to the channel, which is easier for the river to transport than the coarser gravels found in the central Breamish.	
2,3	Central Till	Greater sediment input from increased bank erosion and a significant input from the River Glen coincides with a decrease in stream power, resulting in increased sediment storage typified by extensive sand/fine gravel lateral & point bars. These encourage **lateral hydraulic processes, active meandering and channel migration**.	
1	Lower Till	Primarily a sediment transport zone. Sediment storage is negligible, reflecting low rates of sediment input and the high transport capacity resulting from increased stream power in this steep and confined section.	
23,24	Upper Bowmont Water	Sediment input rates and in-stream power are generally moderate/high. The relatively high levels of all three variables results in a dynamic channel with **active sediment supply and transport** processes. Sediment storage is typically temporary and is reworked and moved downstream during floods. Sediment storage drops to a low level downstream of Mindrum reflecting a change to finer substrate, for which ample transport capacity exists.	
21	Glen d/s of College Burn confluence	Stream power is very high, while sediment storage and inputs remain at relatively low levels, indicating that a **high level of excess energy** is generated in this reach during flood events.. The excess stream power in this reach results from artificial channel straightening, realignment and confinement, which have increased channel slope and reduced the width of the active channel zone. This causes significant morphological change during periods of high flow (e.g. 2008 avulsion) through localised erosion and associated reworking of sediments	 
20	Glen Lanton d/s to Till	Stream power reduces whilst sediment input and storage both increase, indicating a change to a **lower energy regime** dominated by fine sediment deposition and active meandering.	
31	Wooler Water	Sediment input and storage show similar fluctuations, increased storage is accompanied by a decrease in stream power. Highest levels of sediment storage are in the central section (Coldgate Mill to Earle Mill) where specific stream power is also high. This implies dynamic behaviour, with sediment reworking and significant morphological adjustment. Stream power drops and storage reaches its maximum towards Earle Mill, forming an **important sediment sink**.	 
29	Wooler Water	Through Wooler the channel has low sediment storage, indicating that **sediment transport** is the dominant process.	
28	Wooler Water d/s Wooler	Downstream of Wooler, to the Till confluence, sediment storage increases as stream power decreases and sediment input increases.	

Geomorphic behaviour was simplified to three processes: sediment transport, sediment supply and sediment storage, with the intensity of each process represented by specific stream power, sediment input index and sediment storage index, respectively. The dominant geomorphic process in each reach was derived from the relative magnitudes of these three values.

The figures for specific stream power, sediment input and sediment storage were then used to calculate a simple measure of 'geomorphic process intensity' for each reach. This was found to relate well to the degree of historic channel movement and was therefore considered to be a good indication of channel dynamic behaviour.

The dominant geomorphic process and the process intensity together provide a quantitative description of the nature of geomorphic behaviour across the River Till system. This is depicted in map form in Figure 7, which indicates zones of sediment supply, transfer and storage, together with the degree of channel dynamic behaviour or stability (i.e. geomorphic process intensity).

Figure 7: Geomorphic Channel Processes



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Geomorphic process intensity
(shown by line width)

0 – 125
125 – 500
500 – 1000
1000 – 2000
2000 – 4000

Supply
Storage
Transport

N

0 1.5 3 km

As expected, the most dynamic reaches are found in the central part of the Breamish, central Wooler Water and the upper Bowmont Water, where sediment storage is also greatest. Less dynamic reaches include the Lilburn Burn, College Burn, the Glen, the upper Till and middle reaches of the Till on the Milfield Plain. The headwaters of most rivers, the downstream-most reaches of the Till and the lower Bowmont Water are typically stable and are dominated by sediment transport. Most of the Till upstream of Ford is dominated by sediment supply due to it's sandy banks that are prone to erosion and incision.

The 'process intensity' index indicates the probable sensitivity of the system to human modifications and natural change (e.g. during a large-scale flood event). Because of the greater propensity of the channel to react in the more dynamic reaches, engineering or land use modifications will have a greater impact on geomorphology here than in less dynamic, more stable, reaches. The level of dynamic behaviour of each reach is, therefore, an important factor for:

- determining its restoration priority (in conjunction with the extent of engineering and land use pressures),
- assessing the likely impacts of engineering and land use pressures,
- determining the geomorphic response to restoration interventions, aiding decisions on suitable restoration options.

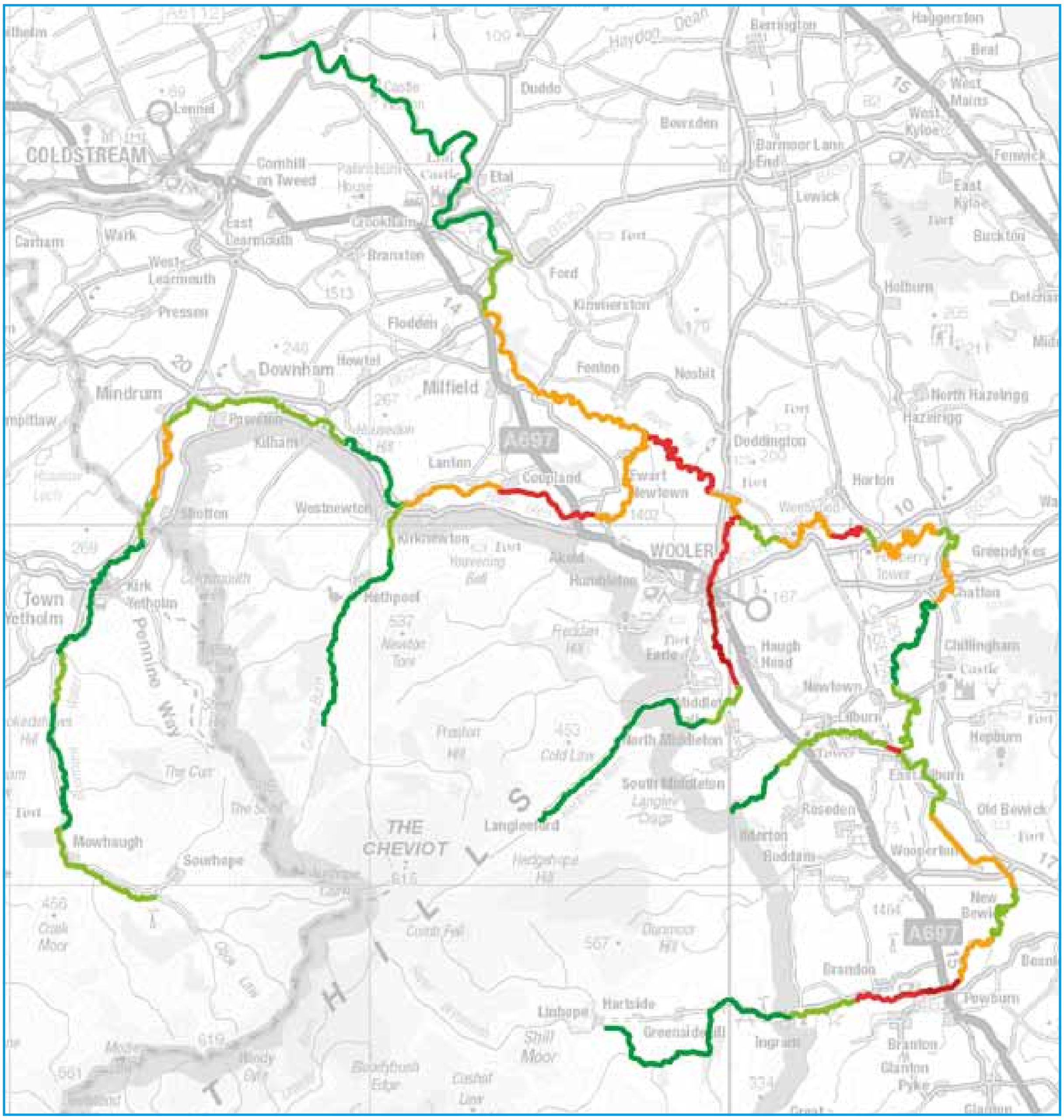
Engineering and land use pressures

Index of engineering and land use impacts

Locations of channel engineering and land use pressures were identified from the GIS and were classified and scored for their severity using a bespoke weighting system. Pressures included bank protection, structures, floodbanks, stock access, historic gravel extraction and incision. The impacts of the weirs on the River Till downstream of Ford, based on a simple field assessment, is incorporated into the overall impact scores for these reaches.

The total scores of engineering and land use impacts in each sub-reach were used to calculate an overall impact score for each reach. The impact scores were also recorded by type of impact (i.e. weirs, other channel engineering, embankments, poaching). Sub-reach impact scores, where the higher scores reflect the most impacted reaches, are shown on Figure 8.

Figure 8: Engineering and land-use reach pressures



Pressure score/reach length

- 0 – 0.2
- 0.2 – 0.6
- 0.6 – 1.2
- 1.2 – 2
- 2 – 3

N

0 2 4 km

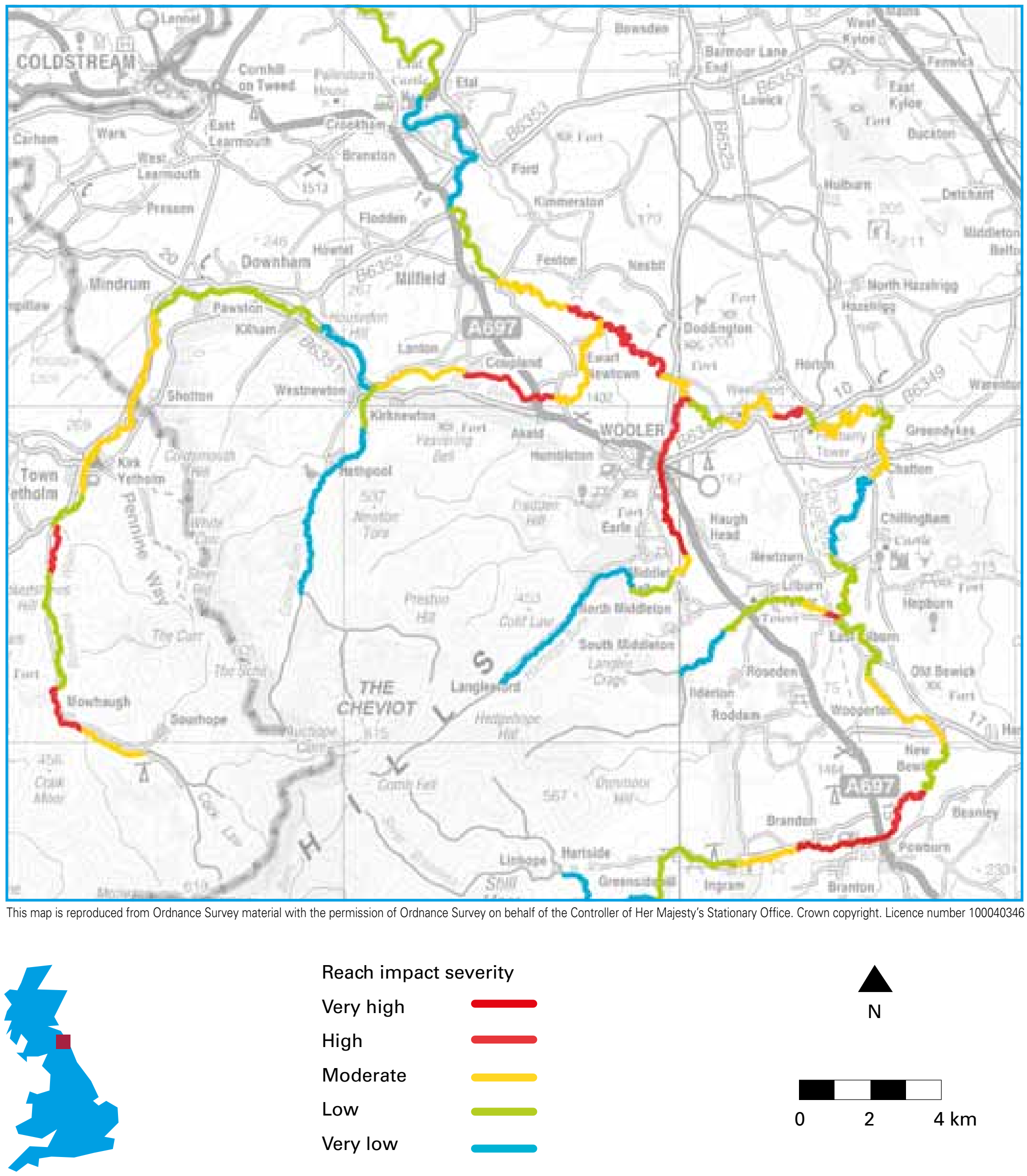
2.5 Summary of impacts

Geomorphic pressures and impacts

The index of engineering and land use impacts identifies the most impacted sub-reaches in the Till system, in terms of the extent, number and severity of impacts. In some cases, where the impacts have been assessed based on limited data, a worst case scenario has been assumed (further data collection may suggest that the impact level needs to be revised).

The scores for the overall impact of engineering and land use pressures and the sensitivity of each reach, the geomorphic 'process intensity index', have been plotted together to identify the most severely impacted reaches. Five categories ranging from very low impact to very high impact are used to compare the overall severity of impacts on each reach in Figure 9.

Figure 9: Reach Impacts



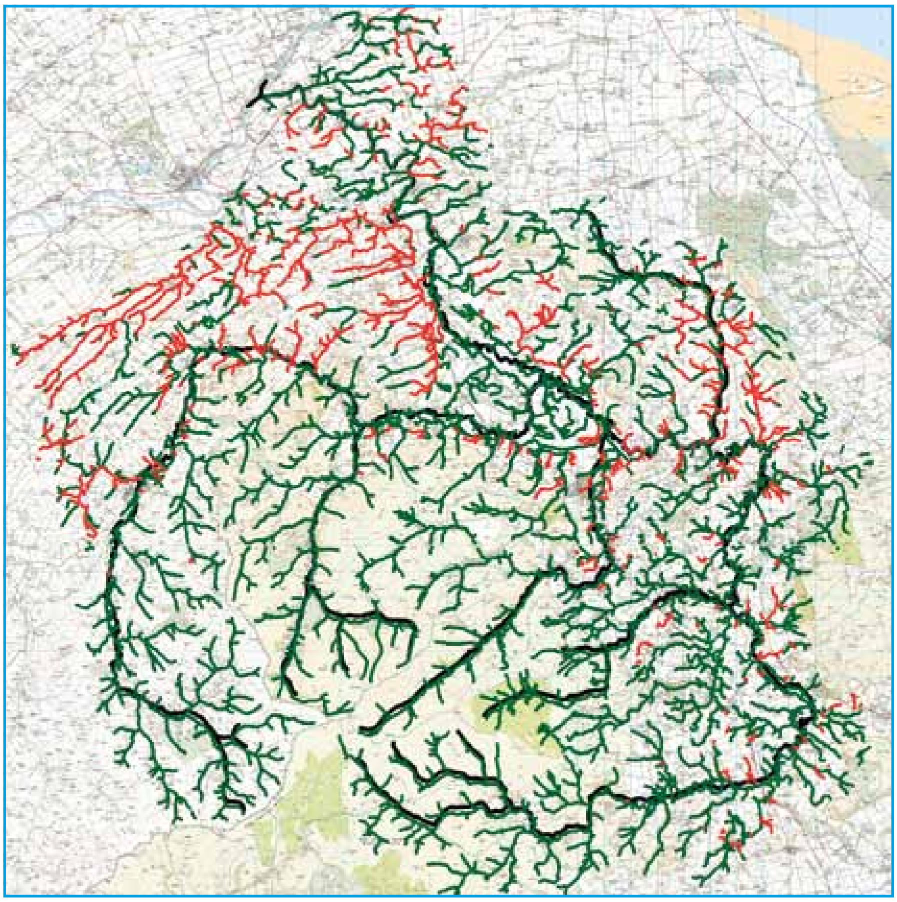
Fine sediment impacts

The information from fluvial audits may not have captured all of the important sediment sources and sinks and, in particular, may miss issues of sediment supply from smaller tributaries other than ‘rogue’ gravel deposits or drapes of fines in the main stem channels. To cover this, a catchment-scale model for assessing fine sediment risk (‘SCIMAP’ - developed by Durham and Lancaster Universities) was used to estimate the relative risk of fine sediment entering the watercourses. This uses a combination of topography, stream gradient, soil types and rainfall intensity to predict the risk of sediment being eroded from land, discharged into the river and accumulating in the channel.

The results derived from SCIMAP (Figure 10) show the relative risk of inputs of fine sediment and it’s deposition in streams across the catchment. Streams at higher risk are those where the potential for sediment accumulation exceeds the likelihood of dispersion. The possible source areas for fine sediment runoff, based on rainfall, soil type, gradient and hydrological connection to a water course, are also predicted using SCIMAP(see *Till RRS - Technical Report*).

This information helps to identify sub-catchments where actions (e.g. creating buffer strips or carrying out contour/ghyll planting) to reduce fine sediment input to the river system would be beneficial. Information from the SCIMAP risk assessment has been integrated with the pressures and impacts assessment derived from fluvial audit data.

Figure 10: Potential fine sediment risk to watercourses



Potential restoration solutions

The suggested restoration options, identified for every sub-reach, reflect the nature of the channel and the pressures on it. Priorities have been assigned according to the degree of impact and the sensitivity of the channel; for example, particularly dynamic wandering gravel-bed reaches were defined as highly sensitive to both pressures and further interventions. The potential degree of improvement to physical processes has been categorised as high, moderate or low, depending on the severity of the impact and the importance of the restored process to the overall functioning of the reach, (using the process model to determine the important processes in the reach). The possible restoration solutions for each reach are summarised in Section 3, table 8.

Using information extracted from Tables 5 & 8, a Reach Information Sheet has been drafted for every reach, see Appendix 1. These include an overview of the main features affecting channel morphology and potential restoration measures (where appropriate).

3. Potential solutions

3.1 Introduction - Delivering the Vision

The Till River Restoration Strategy (RRS) Vision outlines desired outcomes for the SSSI. Decisions about how to resolve the constraints to achieving the vision should start with the key questions :

- why does the impact exist - is the cause of it still relevant ?
- is the reason for a relevant impact valid, compared to restoration objectives for the SSSI ?
- what are the restoration benefits to stakeholders and do these outweigh the disbenefits ?
- can disbenefits be resolved with mitigation measures that are acceptable to those affected?

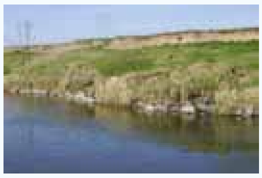
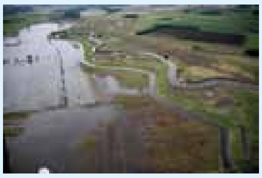
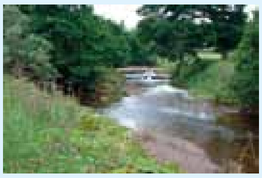
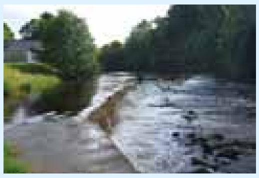
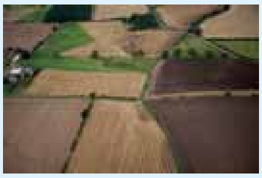
The views of stakeholders are, of course, crucial to the successful delivery of actions. Where there are constraints to improving channel condition, an acceptable way forward can be reached if an appropriate measure can be agreed and the necessary funding or other incentives are in place. If a preferred restoration measure can't be implemented in a reach, there may be a compromise measure that will maintain river/ land use or transform it in innovative ways that are acceptable to those affected and be consistent with achieving Favourable Condition.

Some constraints are genuinely immovable and the only restoration action may be to mitigate the impact on river function and lost habitat. In flood risk areas this may be to re-establish a near-characteristic morphology using soft engineering whilst maintaining flood protection. However, even here, changes in catchment management may be possible (e.g. increased floodplain storage or improved rainfall retention upstream) that would widen the restoration options available.

3.2 Key issues overview

Table 7 overleaf

Table 7 : The principal pressures on the geomorphic condition of Till rivers.

Pressure	Example	
Bank protection Localised, predominantly stone bank protection, intended to reduce erosion/prevent channel movement. Ranges from small installations of stone along the bank-toe up to major bank-height structures to protect roads or other infrastructure. Affects typical flow patterns and bank structure, may exacerbate erosion elsewhere.		
Loss of connection with floodplain Floodbanks increase the amount of water contained in the channel, increasing the rate of flow. Fine sediment, which would otherwise be deposited in the floodplain, remains in the channel, increasing siltation d/s. The sudden breach of a floodbank may cause erosion of fields and riverbank. When floodbanks are over-topped water may be retained increasing the duration of floodplain inundation.		
Loss of channel sinuosity Channel realignment into a straighter course may be linked to land use or intended to improve flow conveyance. Reduces the variation in flow patterns e.g. fast and slow areas and secondary circulations, which affects morphological and habitat diversity. Uniform bank profiles reduce variations associated with local areas of scour/erosion and deposition.		
Weirs Weirs/impoundments increase water levels upstream (to the level of the weir crest) creating slower, deeper reaches, which may increase sediment storage and water temperature, and reduce physical habitat variety and water quality. May cause obstruction to fish passage.		
Obstructions to fish migration* Larger weirs may create a vertical drop which impedes fish movement, particularly the upstream migration of salmon, sea trout, eel, and lamprey. Natural waterfalls may have the same impact. * Fish passage is governed by the Tweed Regulation Order, 2007; see Section 3.4(f).		
Subcatchment land management Agricultural land use may result in excessive runoff of fine sediment from cultivated arable fields, both direct to the main channel and through farm ditches and tributaries in the wider subcatchment,. Where land is grazed, access by stock can severely damage riverbanks, increasing the likelihood of atypical erosion rates.		
Over-deepened (incised) channel Natural channel deepening (incision) reduces floodplain connectivity and increases the channel capacity before the floodplain is inundated. This can result in higher flow velocities than are characteristic of the river type and increase the risk of excessive erosion. Reduced occurrences of floodplain inundation mean that fine sediment, otherwise deposited in the floodplain, causes increased siltation in the channel.		
Degraded bank structure Change in the type of terrestrial vegetation along the river corridor away from that characteristic of the river type, due to land use. May include complete removal due to grazing by livestock and reduced variety and density due to adjacent land use. Increases vulnerability to erosion and may supply high loads of fine sediment and/or dissolved nutrients into the channel.		
Local channel management Channel re-shaping, dredging, realignment, erosion protection and the removal of gravel bars and woody debris to improve water conveyance and land drainage. Leads to future channel readjustment, uniform flow and reduced/atypical morphological diversity.		

3.3 Channel condition improvement priorities

The engineering and land use impact index has been used to identify the geomorphologically most impacted sub-reaches in the Till system (in terms of the extent, number and severity of impact of structures and/or immediate land use pressures) and the sensitivity of the system has been determined from the physical process model. In the reach summaries (Appendix 1) each reach is described, together with an outline of the impacts , proposed solutions and a suggested priority. Priorities have been assigned based on a combination of :

- the sub-reaches with the top five overall impact scores;
- sub-reaches that ranked in the top five scores for each type of impact (weirs, other channel engineering, embankments and poaching);
- sub-reaches where : (a) there are individual features which have a significant impact on a reach, (b) other information sources identify further pressures that are not well represented in the GIS dataset, or (c) the impact of modifications was positively weighted due to high channel sensitivity.

In reaches where the impacts have been assessed based on limited data a worst case scenario has been assumed; these assessments may be revised if additional information becomes available.

3.4 Potential restoration measures

Introduction

The data analysis and interpretation which has identified a range of issues affecting the geomorphological condition of the rivers, provides a scientific basis for the RRS. It helps us understand why the channel is in it's current condition and will inform the selection of measures for ameliorating the effects of anthropogenic pressures on the system. Options for action extend from unique, site-specific measures through to measures which are applicable at a number of sites across the catchment; simple but widely applicable measures, e.g. creating wet woodland, may be the most cost beneficial. All measures will have to be developed in more detail, appropriate to locations, as opportunities for funding and implementation arise or can be created. The range of potential measures, together with anticipated benefits and constraints, is summarised in the following section.

Actions to implement the Till RRS aim to facilitate the restoration of hydromorphological functioning and diversity in the river channels and thereby to also improve aquatic habitats. Delivery of these aims has to strike a balance between ideal restoration outcomes and the constraints associated with the requirements of communities and individuals in the catchment.

The existing situation often involves a range of pressures and negative effects on the channel, consequently many reaches will ideally require a combination of restoration measures to be implemented. Some measures will only be successful if associated impacts are tackled as well; in some cases, work to tackle one impact may pose a high risk of consequent impacts which need to be mitigated either in the short or long term.

The measures suggested are split into 3 broad categories as summarised below.

Channel corridor measures	Riparian measures	In-channel measures
• Creating space for channel adjustment • Realignment / remeandering of the channel • Removal / realignment of flood embankments • Creating wet woodland • Land management to reduce sediment input	• Removal of bank protection / structures • Soft-engineered bank protection • Allowing the recovery of the riparian zone	• Removal or modification of weirs • Installation of fish passes • Removal of redundant in-channel structures • Local gravel risk management • Management & use of large wood

Summary of potential restoration measures

This section summarises the potential measures that could be applied at relevant locations in the catchment. Potential restoration measures range from minimal 'assisted natural recovery' approaches, to direct interventions such as the removal of in-channel structures.

(a) Natural Recovery

Natural recovery		
Outline	**Benefits**	**Constraints**
Natural recovery is an option for restoration of reaches where the channel morphology is actively adjusting towards an optimal natural form, there are no constraints and no active intervention is required. In these reaches the river will have sufficient energy to alter its channel morphology in response to variations in flow and sediment supply.	No direct costs Resulting channel form is entirely natural.	Long timescale. Likely to be structures in channel and/or river corridor which prevent natural channel adjustment.

(b) Assisted Natural Recovery

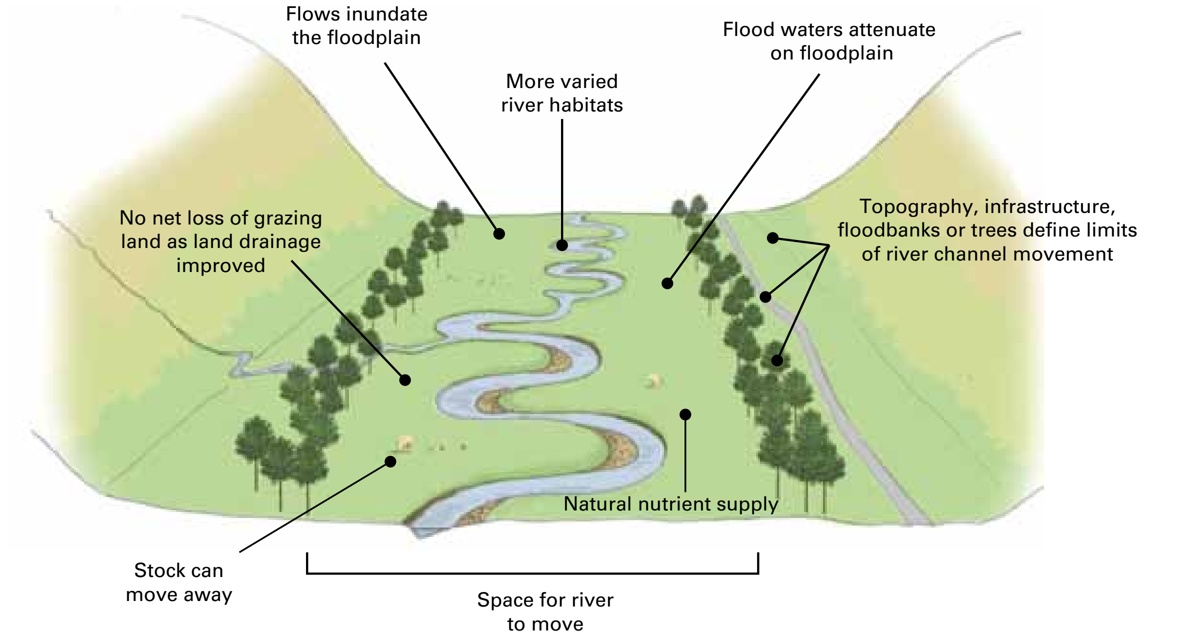
Assisted natural recovery		
Outline	**Benefits**	**Constraints**
Assisted natural recovery is the overarching principle behind the Till RRS. By implementing appropriate restoration measures (e.g. not replacing bank protection when it fails) the river channel is enabled to develop a characteristic morphology through natural adjustment in response to variations in flow and sediment supply.	Restoration achieved in shorter timescale. Resultant channel form is optimal for each reach Implementation can be both programmed and opportunistic.	Cost of actions (from minor e.g. for tree planting to very significant for channel realignment) May require change of land management

(c) Protocols for river management

Protocols for river management By working with relevant stakeholders agreed protocols can be developed in recognition of the need for ongoing river management activities, in certain specific circumstances. These would update/refresh any existing guidance, give clarity on appropriate and pre-agreed actions, and would support the requirement for all river management, other than emergency works, to be consented in advance.		
Outline	**Benefits**	**Constraints**
It will be important to ensure that all future works to the channel and riparian zone are consistent with delivering the aims of the RRS To assist this, agreed protocols should be developed, including : • Emergency 'morning after' flood 'repairs': guidance for responsible institutions and landowners on appropriate approaches for dealing with the effects of floods. • Till Denes & Agricultural Ditches: generic guidelines for land managers to encourage field & ditch management which is sensitive to the risk of sediment dispersal. • Local gravel management plans: agreed plans for managing sediment issues at key infrastructure locations.	Response action can be rapid Local stakeholders have discretion to implement Response is appropriate to the site/ issue Approach and restrictions are agreed beforehand & clear to everyone	Reliance on sensible application of protocol Sets a precedent May need modifying / withdrawal if impacts are different to predicted Multi-agency involvement in emergency 'repairs' (requires an effective single point of contact)

(d) Channel corridor measures

Providing Space for Channel Adjustment		
Outline	**Benefits**	**Constraints**
A corridor is identified within which the channel is permitted to develop relatively unhindered. The corridor width depends on the ideal channel morphology for the river type balanced against anthropogenic constraints (e.g. key infrastructure).	The channel evolves naturally. Wider benefits on channel form (upstream & downstream). Removes perceived need for channel maintenance. Provides landowners with longer term knowledge of effects of river on landuse.	Loss of agricultural land in short/ medium term. Location of public infrastructure. May be regarded as preventing beneficial use of channel corridor. Short-term disturbance. Potential initial costs.



(From Jacobs 2010 : River Kent Catchment – Restoration Vision)

Natural re-meandering of straightened channel (assisted natural recovery)		
Outline	**Benefits**	**Constraints**
Creates the opportunity for a restricted channel to naturally return to it's characteristic meander pattern. May involve tackling constraints, such as floodbanks, hard engineered bank protection, etc.	As for engineered remeandering. Lower costs. Ensures sustainable channel planform. Timescale for changes allows lower impact habitat and landuse adaptation.	Extended time for recovery. Loss of land / impact on land use. Risk of unforeseen channel movement.

Engineered channel remeandering or realignment

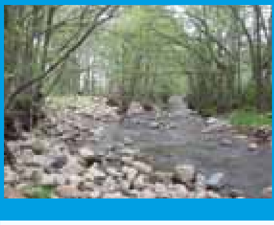
Remeandering may be an option for reaches with a straightened channel, old cut off meanders or where a entirely new channel can be cut (e.g. following culvert removal). Where physical constraints limit space, realignment may be possible.

Outline	Benefits	Constraints
Engineered remeandering will lengthen the channel, re-create sinuosity of flow and create new areas of deposition. Scale depends on space available, including for future channel migration, the extent of previous modification and capacity of the river to respond. Realignment could involve (a) creating a secondary channel - diverting some flow down a new channel while retaining the pre-restoration channel; (b) reconnecting old meander bends, excavating former meanders and retaining or infilling the old channel.	Initiates natural morphological change of channel in response to flow and sediment supply, providing a more natural channel planform and diverse channel morphology. Increase in channel length reduces stream power and transport rates. Increases physical diversity and habitat availability / diversity for a range of species. Reduces d/s flood risk by increasing channel capacity and reducing gradient Minimises need for on-going management.	Costs. Potential loss of land & ownership issues. Management of land & crossings. Effect on the frequency of flooding. Proximity of key infrastructure or services (sewer, water, electricity, gas). Damage/loss of existing habitats in short/medium term. Works within the channel cause short term disturbance. Period of channel adjustment increases the amount and rate of erosion and sediment deposition. Recovery time.

Removal or setting back agricultural floodbanks

Outline	Benefits	Constraints
Flood banks protecting fields (not homes) could be removed, breached or set back, to allow active wandering of channel and/or connectivity of the river to it's floodplain. Removal/breaches must be designed to avoid creation of focal points for flood flow which may cause scour of the river banks and floodplain. Floodbank removal should be accompanied by riparian zone improvements which allow natural vegetation to develop, e.g. exclusion of livestock or tree planting,	Provides scope for lateral channel movement and a more natural planform to develop. Connectivity of channel and floodplain reduces flood impacts downstream, impacts on channel structure and risk of catastrophic floodbank failure (stream energy is dissipated). Deposition of fine sediment onto floodplain, reduces deposition in the channel. Improves drainage of floodwater back to the channel.	High costs. Increased frequency of floodplain inundation, may cause loss of agricultural productivity and/or necessitate changes in farming practices. Presence of services (sewer, water main, electricity cable, gas main) could restrict channel migration. Potential minor loss of land. Earthworks will cause disruption and generates large volume of spoil.

Creating Wet Woodland



Outline	Benefits	Constraints
Wet woodland in the river corridor can influence the direction / extent of channel migration and help to slow and attenuate floodwaters. It retains woody debris during flood flows and provides habitat benefits for in-channel and riparian species. Locations should be wider than the riparian zone, may form part of the erodible river corridor and need not follow the river channel. Likely to be dominated by alder, willow or birch.	Interrupts flood flows. Reduces sediment erosion / runoff, helping to stabilise banks over medium/long term. Appropriate for unproductive land. Creates habitat diversity, supporting a range of species.	Timescale for development. Loss of land. Initial & maintenance costs.

(e) Riparian measures

Rehabilitation of banks & riparian zone

Involves the rehabilitation of bankside habitats to improve their physical structure and condition where this has been degraded as a result of channel modification, bank protection or over-grazing / poaching.

Removing major hard bank protection

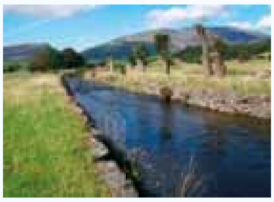
Hard bank reinforcement includes erosion protection measures constructed with stone, concrete or metal; including gabion baskets, block stone, rip-rap and sheet piling. Often regarded as the preferred/only solution where infrastructure (e.g. roads) or buildings are adjacent to channel. The use of hard protection at a location may cause erosion problems to move up or downstream, requiring continual extension of the protected area. Rehabilitation may involve the installation of softer bioengineered solutions (see Large Woody Debris, below).

Outline	Benefits	Constraints
Removal of bank protection to allow a more natural morphology to develop, able to adjust to changes in flow and sediment supply. Replacement with more natural materials, e.g. ELJs, tree planting, willow spiling and stock exclusion or to locally re-profile the bank may be beneficial. Development of bankside and riparian vegetation cover will ensure any future bank erosion is part of natural processes.	Enables bank retreat and natural channel planform / morphology to develop. Natural bank materials are exposed Enhances habitat diversity on bed / banks (fish spawning and juvenile habitat; otter; invertebrates). Reduces maintenance and risk of erosion spreading, requiring increasing lengths of protection.	In-channel works result in short-term disturbance. Short to mid-term bank retreat, sediment release and potential impacts on downstream reaches. Age/location of protection may create significant bank disturbance on removal. Presence of services (sewer, water main, electricity cable, gas main) could restrict channel migration. Potential for minor loss of land.

Removing major hard bank protection:

Stone bank protection along both banks.

(From Jacobs 2010 : River Kent Catchment – Restoration Vision)



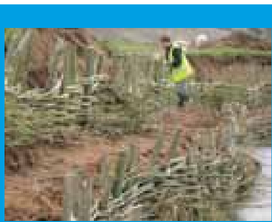
After removal of stone, regenerated vegetation provides natural erosion protection

Removing localised bank reinforcements

Short sections of stone wall, concrete, riprap, gabion baskets, stone toe protection, timber stakes/boards and flow deflectors, intended to reduce bank erosion, occur throughout the SSSI.

Outline	Benefits	Constraints
Removal of local bank protection may require machine extraction of more substantial structures (e.g. gabion baskets) or manual removal (e.g. intermittent toe protection). Removal may be followed by installation of more natural erosion protection. Sites will usually benefit from the exclusion of livestock and/or tree planting, allowing development of riparian vegetation, ensuring that any future erosion is part of natural processes.	Local morphological diversity in channel in response to flow and sediment supply. Allows natural bank materials to be exposed. Enhanced habitat diversity on bed / banks (fish spawning and juvenile habitat; otter; invertebrates). Reduced maintenance. Reduced risk of erosion issues spreading and requiring increasing length of protection.	Removal is potentially labour intensive due to intermittent location & small scale of protection. Age/location of protection may create significant bank disturbance on removal. Short to mid-term sediment release and potential impacts on downstream reaches.

Soft engineering bank protection



Outline	Benefits	Constraints
Using living and inert vegetation to stabilise banks by (i) binding together unstable bank material or (ii) protecting the bank face from erosion. Appropriate for sites unsuited to management changes (e.g. restricting livestock access) or where sediments are non-cohesive. Relies on vegetation cover; sites with very high flow velocities may need additional structural elements (e.g. stakes).	Reduced rates of bank erosion and siltation along channel margins. Woody debris will enhance morphological diversity and provide preferential habitat. Increased roughness encourages sediment storage & prevents / reverses continued incision.	Potential for damage / removal of protection before it's established. Change in bank position may require further action. Skilled installation.

Improving the riparian zone		
Outline	**Benefits**	**Constraints**
Measures to improve the riparian zone include: improved stock management, (including fencing to exclude stock, reduced stocking levels, seasonal reductions) permitting natural regeneration; planting appropriate riparian species; use of ELJs or spiling to create bank stability. (The ideal width of the riparian zone is about one channel width in larger lowland rivers, several channel widths in narrow upland streams and very narrow, merged with valley woodland, in steep headwaters).	Reduced rates of bank erosion & siltation along channel margins. Removing livestock access permits re-colonisation of plants & reduces eutrophicaton. Woody debris enhances morphological diversity and provides habitat. Increased roughness encourages sediment storage & prevents / reverses continued incision. Bankside vegetation creates shading and cover important for juvenile fish, otters.	Potential for damage / removal of fencing by floods. Cost of repair / replacement of fencing. Loss of grazing, e.g. on meander loops. Change in bank position may require further action.

Issue : Eroding bank, livestock access to channel.

Solution : Riparian zone fenced-off to allow vegetation recovery.

Outcome : Bank stabilises through natural re-profiling and vegetation colonisation. Vegetation provides natural bank reinforcement.

(From Jacobs 2010 : River Kent Catchment – Restoration Vision)

(f) In-channel measures

Removing / modifying engineered structures

Removal of hard engineering structures that modify the natural flow and sediment regime, including weirs, bed armouring and erosion control structures, should be considered as a first option. If this is not possible, modifying the structure should be considered; phased modifications, to assist a change in natural processes, may be appropriate

Removal of redundant channel structures & lowering weirs.

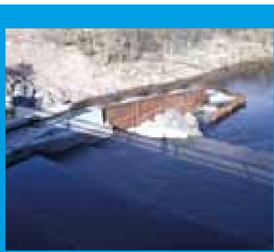
Functioning weirs and redundant channel structures (e.g. derelict weirs, bridge abutments & bridge piers) create local hard points which influence flow patterns and impact on natural channel morphology. They may also reduce biological connectivity e.g. by impeding fish passage. Proposals for removal should be informed by appropriate modelling of the implications and effects of removal.

Outline	Benefits	Constraints
Removal of a structure will allow the channel to develop a natural morphology and adjust to changes in flow and sediment supply. Weir removal is a major engineering undertaking resulting in potentially significant channel re-adjustment. At some sites constraints may mean that modification, such as lowering the crest of a weir, is the only option for reducing impacts on sediment transport and upstream water levels. In some cases, modification can achieve the majority of the benefits of complete removal.	Encourages natural recovery of channel : creates a more natural water level / flow regime and reduces interruptions to sediment transport. Diverse channel morphology and habitat diversity for all life stages of fish, invertebrates and plants develops. Removes/reduces obstacles to fish movement	Potential bed and / or bank erosion upstream in response to increased flow velocity and fluctuations in water levels. Modification may not fully reinstate natural processes. Channel adjustment may undermine bridge foundations or expose pipes/ cables. Removal may be a major engineering undertaking, with in- channel works and short-term disturbance. The weir may be weakened by modification. A structure may be a heritage or landscape feature.

Installing fish passes

Obstructions such as weirs and culverts can prevent or interfere with fish migration.

Fish passage at weirs is governed by Article 16 of the Tweed Regulation Order 2007. This states that the operator of every dam shall ensure that it is provided with a fish pass which facilitates the free passage of salmon at all times except when, for natural reasons, the flow of the river at the dam is so low that salmon would not reasonably be expected to seek passage.



Outline	Benefits	Constraints
If an obstruction can't be removed, an in-channel structure can be installed to improve upstream and downstream movement of fish and other aquatic fauna. The type of structure needed to maximise fish passage will depend on site conditions and species requirements. Fish passes do not work in all flows or for all species. Some weirs may be a heritage or landscape feature	Achieves fish passage element of WFD objectives by enabling migration of salmonids & other species. Improves resilience of a fishery. May be relatively low cost.	Installation may be a major engineering undertaking, with in- channel works and short-term disturbance. Structure may be weakened by works. Ongoing maintenance commitment.

Local Sediment Management

The RRS aims to retain sediment in the channel as it's an intrinsic part of the functioning of the river system, contributes to diverse channel morphology and provides vital habitats for aquatic organisms. Regular sediment removal, particularly of gravel, is not a sustainable practice as deposition of sediment is a natural response of the river to prevailing flow and sediment conditions.

Outline	Benefits	Constraints
At some key locations with essential infrastructure (e.g. specific road bridges), it may be appropriate to actively manage in-channel sediments, especially if the upstream sediment supply can't be reduced. The implementation of a local gravel management plan, agreed with relevant parties, may be a practical solution.	Achieves fish passage element of WFD objectives by enabling migration of salmonids & other species. Improves resilience of a fishery. May be relatively low cost.	In channel works may have a temporary/permanent impact on natural geomorphic process. Channel is not self-sustaining. Requires commitment of relevant stakeholders. Cost

Creation of small scale, fine sediment traps

Outline	Benefits	Constraints
The creation of pools, containing emergent vegetation, at the confluence of minor tributary ditches/ streams. To retain sediment and buffer higher flows.	Reduce the inflow of excess fine sediment into the system, reducing impacts on the bed downstream. Individually small scale works at low cost. Create potentially beneficial habitat. Involves local stakeholders.	May require periodic maintenance; creating short-term disturbance and potential release of sediment downstream. Minor land take.

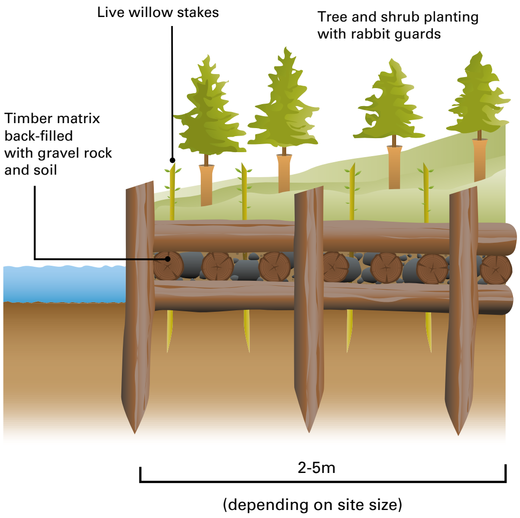
Management & use of large wood : Engineered Log Jams (ELJs)

Wood accumulations influence sediment storage and transport, stream bed and bank structure, velocity distribution and channel sinuosity. They can support a range of habitats. Wood can be used to form natural in-channel or riparian structures which diversify processes and create stability. ELJs are designed to mimic the effects of naturally accumulating 'large woody debris' and will increase roughness, encourage sediment storage and prevent or reverse further incision. There are three potential applications for ELJ in the Till catchment: (i) Bank protection: to direct flows away from banks to prevent erosion; (ii) Bar apex: positioned in the channel to divide it into multiple channels, creating increased channel length, depth, cover and number of pools; (iii) Grade control: to retain sediment and provide bank stabilisation by dissipating river energy.

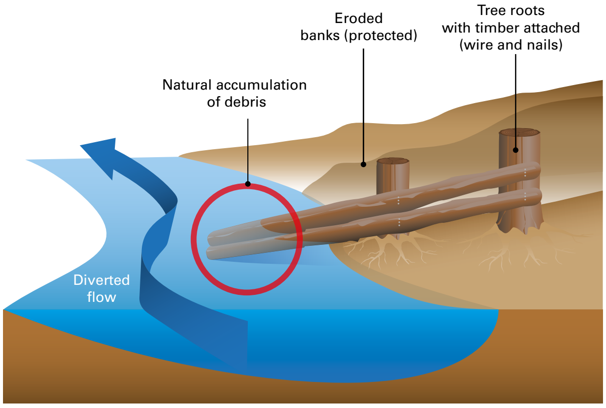
Outline	Benefits	Constraints
Selecting the type of ELJ will depend on the physical characteristics of the reach and the desired restoration outcome.	Equivalent to natural channel features. Self-sustaining once established. Lower cost than traditional engineered solutions. Scale and design relevant to channel size/type. Provide new / diverse habitat.	Ensuring design is resistant to high flows May not be suitable for use in vicinity of infrastructure, e.g.. Bridges, or areas of community flood risk. Visual appearance.

Flow deflector / 'leaky barrier' ELJ :
designed to increase roughness and encourage sediment storage, thereby directing the main flow away from adjacent infrastructure

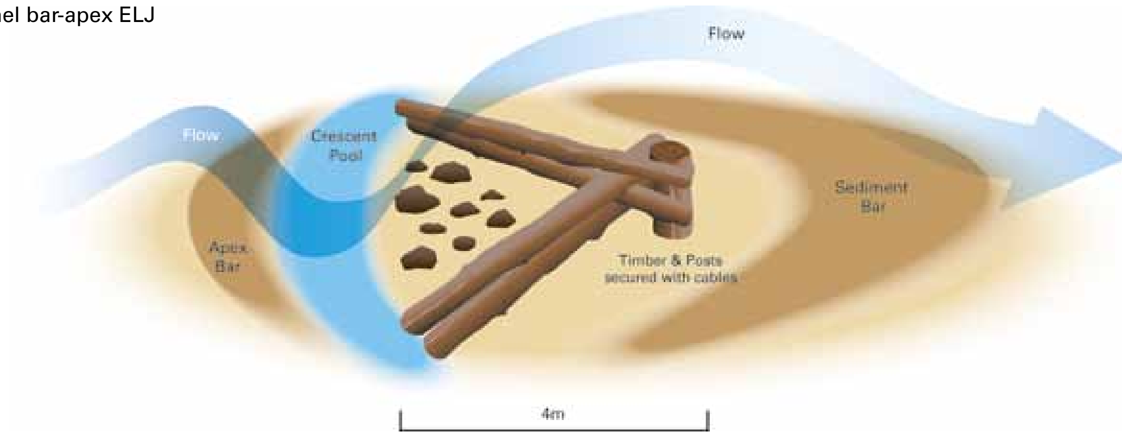
'Engineered' Bank protection ELJ



'Natural' Bank protection ELJ :
placed to reduce erosion pressure on vulnerable bank



In-channel bar-apex ELJ



4. Delivering restoration

4.1 Overview

Actions proposed within this Till River Restoration Strategy (RRS) range from major works for resolving issues created by hard engineering features (e.g. Haugh Head ford on the Wooler Water) through to improved river bank management. Also outlined is a suggested approach to ensuring that any future proposed works are carried out in a way that contributes to delivering the aims of the RRS.

Achieving the restoration Vision will need to be compatible and combined with actions to deliver the objectives of Water Framework Directive (WFD) and Catchment Sensitive Farming (CSF). Examples will include : removing barriers to fish migration (RRS and WFD outcome) and establishing appropriate grazing regimes which protect riparian areas and improve bank structure (RRS outcome) and reduce diffuse pollution (CSF outcome)

Adopting an 'assisted natural recovery' approach, in which rivers are 'nudged' back to health by influencing river processes, is regarded as the most cost-effective way of delivering RRS actions. Delivery of the strategy will need a combination of funded actions and unfunded changes of land use and river management practice. There is no single source of funding for delivering RRS actions. Funding for delivery will be achieved through direct grants for one-off projects and delivering appropriate land and river management improvements through existing and future environmental stewardship schemes such as HLS and CSF.

Delivering the aims of the vision for the Till RRS will crucially require many different parties to work together in partnership. In the upper Bowmont Water sub-catchment delivery cannot be led by the Environment Agency and Natural England, as it lies in Scotland, so will need to involve equivalent Scottish organisations.

The involvement of land owners and managers is essential The links between the RRS, land use and the farming economy are of paramount importance to this key group. Wider benefits for farmers and local communities include : opportunities for improving awareness of the risks associated with the changing river environment, leading to improved land and flood risk management; clarity about future approaches to river management; a basis for longer term planning; and supporting evidence for obtaining funding through agri-environment stewardship schemes.

Amongst relevant organisations, potential delivery partners include : Tweed Forum, Environment Agency, Natural England, Scottish Environment Protection Agency, Scottish Natural Heritage, Northumberland National Park Authority, Northumberland County Council, Scottish Borders Council, Tweed Foundation/River Tweed Commission, National Farmers Union, Forestry Commission.

Given that restoration actions will take time to implement, and natural river systems require time to respond, the overall timescale for implementing restoration measures and achieving related improvements in condition in the Till SAC/SSSI is 30 to 50 years.

4.2 Summary of potential actions, by reach

Priorities

The potential restoration options for each reach have been prioritised according to the degree of improvement to the SSSI/SAC they will bring. To ensure there is no further decline in condition of the SSSI, preventing deterioration in all reaches that are currently in a good condition will be given high priority. Elsewhere, actions which will bring the most significant improvements, by restoring degraded reaches showing no evidence of natural recovery, will be prioritised for implementation. Those reaches which are less impacted or show evidence of natural recovery are given medium priority. The remaining reaches, which already show signs of significant recovery or with relatively insignificant pressures will be addressed in the longer-term.

A summary of the potential restoration options identified by reach is given in Table 8 below. Further details for each reach can be found in Appendix 1. The level of detail in which the restoration options are described in this table reflects its strategic focus. In all cases, further work and detailed discussions with landowners will be required to determine the feasibility of restoration options and develop detailed designs. The involvement of relevant regulatory bodies will be required to ensure that any necessary investigations are incorporated in proposals (e.g. checks for historic/archaeological interest of structures or if earthworks are proposed; highways and power supply infrastructure; fisheries impacts; etc).The level of feasibility assessment and design work required will vary according to the complexity and scale of the options and the outcomes of consultation with the relevant land owners, who will help to shape the detail of the restoration work.

Table 8 A summary of the potential restoration options identified by reach

Reach	Sub-reach	River	Priority* VL (very Low) to VH (very High)	Restoration Options: (✓ – beneficial to ✓✓✓ – highly beneficial measure) Alternative stock management	Riparian planting	Embankment Set-back	Remove hard bank protection	Install bank ELJs	Bar apex ELJs	Re-meander align	Modify/remove weir	Modify Bridge	Field runoff management	Conserve & Protect*
1	1	Lower Till	L								✓✓✓		✓	
1	2	Lower Till	L								✓✓✓		✓	
1	3	Lower Till	VL								✓		✓	
2	4	Lower Till	VL	✓✓✓	✓	✓	✓						✓✓✓	
2	5	Lower Till	L	✓✓✓	✓	✓	✓	✓			✓		✓✓✓	
2	6	Milfield Plain	M	✓	✓		✓	✓	✓✓✓				✓✓✓	
3	7	Milfield Plain	M		✓	✓	✓	✓	✓✓✓				✓	
3	8	Milfield Plain	H	✓✓✓	✓✓✓		✓		✓✓✓				✓	
3	9	Milfield Plain	H	✓✓✓	✓✓✓	✓	✓	✓	✓✓✓				✓	
3	10	Milfield Plain	H	✓✓✓	✓✓✓	✓	✓		✓✓✓		✓		✓	
3	11	Milfield Plain	M	✓	✓	✓	✓	✓	✓✓✓				✓	
4	12	Milfield Plain	L	✓	✓		✓		✓					
4,5	13	Middle Till	M	✓✓✓	✓✓✓	✓	✓		✓					
5,6	14	Middle Till	H	✓✓✓	✓✓✓		✓	✓	✓					
5	15	Middle Till	L			✓	✓		✓					
7	16	Middle Till	M	✓✓✓	✓✓✓	✓✓✓		✓	✓					
7	17	Middle Till	L	✓✓✓	✓✓✓				✓					
7	18	Upper Till	M	✓✓✓	✓✓✓				✓					
7	19	Upper Till	VL		✓									✓
7	20	Upper Till	VL		✓	✓								✓

Table 8 (continued)

Reach	Sub-reach	River	Priority* VL (very Low) to VH (very High)	Alternative stock management	Riparian planting	Embankment Set-back	Remove hard bank protection	Install bank ELJs	Bar apex ELJs	Re-meander align	Modify/remove weir	Modify Bridge	Field runoff management	Conserve & Protect*
				Restoration Options: (✓ – beneficial to ✓✓✓ – highly beneficial measure)										
8	21	Upper Till	L	✓	✓	✓✓✓	✓							
8	22	Upper Till	L	✓	✓	✓✓✓	✓	✓						
9	23	Upper Till	L	✓	✓	✓✓✓	✓	✓			✓			
10	24	Upper Till	M	✓	✓	✓✓✓	✓✓			✓✓✓				
11	25	Breamish	L	✓✓✓	✓✓✓		✓✓✓	✓						
12	26	Breamish	H	✓	✓✓✓		✓✓	✓✓✓	✓✓✓			✓✓✓		
13,14	27	Breamish	VH				✓✓✓		✓✓✓		✓✓✓		✓	
14,15	28	Breamish	VH				✓	✓✓✓	✓✓✓			✓	✓	
15	29	Breamish	M		✓		✓	✓✓✓	✓✓✓	✓✓✓	✓		✓	
16,17	30	Breamish	L				✓	✓						
17	31	Breamish	VL				✓							✓✓✓
17	32	Breamish	VL				✓							✓✓✓
19	33	Glen	M	✓✓✓	✓✓✓		✓		✓✓✓					
19	34	Glen	M	✓✓✓	✓✓✓		✓		✓✓✓					
19	35	Glen	H		✓	✓✓✓	✓			✓✓✓				
19	36	Glen	H			✓✓✓	✓			✓✓✓				
20	37	Glen	M		✓✓✓	✓✓✓	✓		✓	✓✓✓	✓✓✓			
21	38	Bowmont	VL	✓	✓	✓	✓						✓✓	
21	39	Bowmont	L		✓	✓	✓						✓✓	
21	40	Bowmont	L			✓	✓				✓✓✓		✓✓	

Table 8 (continued)

Reach	Sub-reach	River	Priority* VL (very Low) to VH (very High)	Restoration Options: (✓ – beneficial to ✓✓✓ – highly beneficial measure) Alternative stock management	Riparian planting	Embankment Set-back	Remove hard bank protection	Install bank ELJs	Bar apex ELJs	Re-meander align	Modify/remove weir	Modify Bridge	Field runoff management	Conserve & Protect*
22	41	Bowmont	M		✓	✓✓✓	✓	✓		✓				
22	42	Bowmont	L			✓	✓							
23	43	Bowmont	L				✓✓✓	✓						
23	44	Bowmont	VL				✓						✓	✓
23	45	Bowmont	L				✓✓✓	✓						
23	46	Bowmont	VL				✓							✓✓✓
23	47	Bowmont	VL				✓							✓✓✓
23	48	Bowmont	M				✓✓✓	✓✓✓						
23	49	Bowmont	M				✓✓✓	✓✓✓	✓✓✓		✓✓✓	✓✓✓		
24	50	College Burn	L	✓		✓	✓							
24	51	College Burn	VL											✓✓✓
25	52	College Burn	VL											✓✓✓
25	53	College Burn	VL			✓✓✓								
26	–	College Burn	VL											✓✓✓
27	54	Wooler Water	H		✓	✓✓✓		✓✓✓						
27	55	Wooler Water	H	✓	✓	✓		✓✓✓						
28,29	56	Wooler Water	VH				✓	✓✓✓			✓✓✓			
30	57	Wooler Water	VH				✓✓✓	✓			✓✓✓			
30	58	Wooler Water	VH				✓✓✓	✓			✓✓✓			
30	59	Wooler Water	M				✓✓✓	✓✓✓						

Table 8 (continued)

Reach	Sub-reach	River	Priority* VL (very Low) to VH (very High)	Restoration Options: (✓ – beneficial to ✓✓✓ – highly beneficial measure) Alternative stock management	Riparian planting	Embankment Set-back	Remove hard bank protection	Install bank ELJs	Bar apex ELJs	Re-meander align	Modify/remove weir	Modify Bridge	Field runoff management	Conserve & Protect*
31	60	Wooler Water	L				✓✓✓	✓✓✓			✓			
31	61	Wooler Water	L	✓			✓							
31	62	Wooler Water	VL				✓							✓✓
31	63	Harthope Burn	VL				✓							✓✓
31	64	Harthope Burn	VL				✓							✓✓
31	65	Harthope Burn	VL				✓							✓✓
32	–	Harthope Burn	VL				✓							✓✓
33	66	Lilburn	H			✓✓✓	✓	✓✓✓			✓✓✓			
33	67	Lilburn	M	✓✓✓	✓		✓							
33,34	68	Lilburn	L	✓✓✓			✓							
34	69	Lilburn	VL				✓							✓✓✓
35	–	Lilburn	VL											✓✓✓
36	–	Hetton Burn	L								✓✓		✓✓	

* NB. Priorities : In all reaches, high priority will be given to protecting sites in good condition and preventing deterioration. Key reaches for protection are indicated in the Conserve & Protect column. This requirement is not reflected in the ranking of reaches shown in the Priorities column.

4.3 Costs, delivery mechanisms and funding streams

The potential restoration options outlined in Table 8 are intended only to provide a level of detail sufficient to form the basis of a strategic plan for restoration throughout the catchment. Detailed assessments will be required for all options taken forward to implementation. At this stage the restoration options are the actions needed to restore geomorphic processes in the Till system without consideration of landowner requirements, availability of finance or regulatory requirements. Potential socio-economic constraints and benefits related to restoration are listed in Section 3.4.

Costs

Each proposed restoration measure has been assessed in terms of potential cost and the degree of improvement to physical processes which is likely to be attained. Indicative costs have been estimated based on similar measures on other projects. Costs were classed as being low (<£20k), moderate (£20-75k) or high (>£75k). These are purely indicative at this stage and are highly dependent on the exact nature of the work undertaken. Costs will be site specific and will depend on factors including the need for further investigations, length of channel involved, use of external contractors, access and reuse or disposal of materials. Elsewhere, RRS plans have reported that channel restoration alone is vastly more expensive than addressing 'driving variables', for example through Environmental Stewardship.

Table 9 : Indicative cost range for potential RRS delivery measures.

Measure	Indicative cost range (£)	
In-channel		
Removal of weir	25k –175k	Channel / ground works by machine and operator 40-50 £/hr
Modification of weir	10k – 50k	
Install fish pass	75k – 500k	
Remove redundant structure	20 tonne 360 excavator 25-35 £/hr	
Local sediment management	20 tonne 360 excavator 25-35 £/hr	
Install Engineered Log Jam	10k – 50k	
Riparian Zone		
Remove hard bank reinforcement	20 tonne 360 excavator 25 – 35 £/hr	
Remove localized bank protection	1k – 2.5k £/50m	
Install soft bank protection	Willow spilling/weaving 75 –150 £/m	
Riparian stock management (fencing)	Fencing 3.80 – 6.50 £/m	8 – 12 £/m
Riparian planting	1.5k – 2k £/ha	
River Corridor		
Remove/set back floodbanks	7.5k – 12.5k £/100m	Channel / ground works by machine and operator 40-50 £/hr
Modify floodbanks	1.5k – 2k £/ha	
Re-meander / realign channel	7.5k – 30k £/100m	
Create wet woodland	1.5k – 2k £/ha	Tree planting (including tree, guards, post, ties & labour)

Notes

(1) Figures in this table are intended solely to illustrate the potential scale of resources needed for implementation; all measures will require full, contemporary cost estimates.

(2) Measures are not mutually exclusive; implementation will inevitably include elements of several measures.

(3) Individual scheme costs will depend on scale, location/access, etc

(4) Costs for additional labour (12-14 £/hr), consultants & permits are excluded.

Delivery mechanisms & Funding

Current initiatives and funding opportunities which may support delivery of actions in this strategy are summarized in Table 10; a brief explanation of these is provided in Appendix 2. Generally, funding sources will be exclusive to either the English or the Scottish parts of the Till catchment. This summary of potential delivery and funding schemes is for December 2012; schemes and funding criteria will inevitably change during the life of the RRS.

Table 10 : Selected implementation mechanisms for typical restoration measures

Category of Works	Management measure	England									Scotland						
		EA FCRM capital programme (FDGiA)	EA flood risk management maintenance	NE Environmental Stewardship	NE Conservation Enhancement Scheme	FC Woodland Grant Scheme	Catchment Sensitive Farming	Landowners/Interest groups	European or Lottery funding	WFD funding	Water Environment Fund	Scottish RDP (incl woodland)	Scottish Natural Heritage & LIFE	Landfill Communities Fund	SBC flood risk management	Developer contributions	Biodiversity offsetting
Small scale in-channel and riparian works	Introduction of coarse woody debris/ELJs in channel							●		●	●	●					
	Current modification (localised narrowing, log weirs etc.)			●	●			●		●	●				●	●	
	Soft engineered bank re-enforcement, repair, reprofiling		●	●	●			●		●	●	●	●	●		●	
	Local gravel management							●							●		
	Improving riparian vegetation		●	●				●				●	●				
Major channel/ bank works	Re-profile channel	●			●				●	●					●		
	Removal/modification of artificial barriers	●	●						●	●	●		●	●	●		●
	Removal of hard bankside defences	●			●				●	●	●					●	
	Large-scale flow modification – bank re-profiling, narrowing,	●							●	●	●					●	
	Re-meander channel	●			●				●	●	●		●		●	●	
	Re-alignment of floodbanks	●		●	●				●	●	●	●	●		●	●	
	Prevention of trampling by livestock			●			●			●		●					
Change in riparian land use	Prevention of access of livestock to river			●			●			●		●					
	Establishment of riparian margin/buffer zone			●			●				●	●	●	●			●
	Sympathetic tree management		●	●		●		●				●	●			●	●
	Establishment of riparian trees			●		●		●				●		●		●	●
	Conversion from arable to semi-natural habitat			●		●	●					●					
	Establishment of appropriate riparian grazing			●			●					●					
	Control of invasive non-native plants			●						●							

4.4 Timeline for delivering the strategy

The anticipated timeframe during which the Till RRS will guide the improvement of rivers in the Till catchment is 30 to 50 years, starting in 2013. Delivery will rely on multi-partner working over a timescale appropriate for the nature and scale of pressures to be resolved, the negotiation of suitable measures and a best endeavours approach to implementation. The availability of funding will be variable, over the time span of implementation, and will need to be opportunistic as well as targeting current sources. Work in-kind from relevant organisations and land managers will have a vital part to play.

Whilst some options will be able to be implemented over the next few years, other measures will take longer to organise with landowners and interested parties. Some reaches will have little active intervention, but may still need agreements on adjacent land use or to allow the river to naturally recover in its own time, which may take many years. At some locations a major engineering solution, such as modification of floodbanks, may be desirable but will take longer to obtain agreement and funding to achieve.

4.5 Outline delivery programme

The development of the RRS has identified actions which, if there were no constraints, could be implemented to achieve the aims of the strategy; these 'ideal' solutions have been identified on a reach by reach basis. However, the actions are not yet tailored to individual reaches or the constraints which will apply. In all circumstances it will be important to investigate the feasibility of a solution and develop the specific actions appropriate for that reach. The findings of detailed feasibility studies will further refine potential solutions and influence the priority and timing of delivering actions in the programme (e.g. a feasibility study is given short term priority for longer term delivery of agreed actions).

Some actions will only be effective once other options have been implemented so attention will need to be given to sequencing implementation in a reach or subcatchment to reflect these inter-dependencies.

In many situations, actions will need to be implemented in combination to achieve greatest benefits.

The outline delivery programme is split into three phases, based on the current pressures and impacts in each reach. The phases are linked to the delivery timescales for WFD improvements: (1) initiate in the short term (5 years); (2) medium term, to 2027; (3) long term, after 2027. The priority for actions within each phase is not indicated; the relative priority and benefits of actions in every sub-reach is shown in Table 8.

The priority given to reaches has been derived from a combination of the number of pressures in a reach and the degree of impact that these pressures are causing, (costs and practicality of implementation have not been factored into the prioritisation at this stage) guided by a simple matrix :

Matrix Table: Priority for action based on pressures and impacts:

Increasing impact →

↑ Increasing pressures

Low	Moderate	High	Very High
Low	Moderate	High	Very High
Very Low	Low	Moderate	High
Very Low	Low	Moderate	High

Costs

The strategic focus of the delivery plan means that detailed costings for individual actions is not feasible at this stage. Given the lifespan of the RRS confidence in any such costings beyond the next 2 or 3 years would be low. Consequently, the Till RRS programme includes indicative costs only for actions in the first phase, based on a notional extent of works. It must be stressed that the figures shown are intended solely to illustrate the potential scale of resources needed for implementation; all measures will require full, contemporary cost estimates. Also, actions are not mutually exclusive; implementation will inevitably include elements of several measures and individual scheme costs will depend on scale, location/access, etc. No suggested costs have been included for feasibility work, specialist consultants or permit fees.

The outline delivery programme is set out, in three phases, on the following pages :

Till RRS : Phased delivery programme 1 - short term

Reach	Location	Generic measure	Issue	Initiate action	Indicative cost notional minimum
	Strategic	Protect & conserve	Prevent deterioration of currently favourable features	Maintain watching brief on relevant activities in catchment; liaise and engage with land managers; apply regulatory and voluntary controls.	
	Strategic	Protocols for river management	Urgent response required to address threat to public infrastructure	Review and agree with relevant stakeholders the appropriate response and measures to be taken where public infrastructure (e.g. roads, power lines) is at imminent risk from river processes	
	Strategic	Protocols for river management	Managed response to sediment issues at key locations	Review and agree with stakeholders an appropriate sediment management regime at relevant locations	
3	Till : u/s Redscar Bridge to confl Wooler Water	Remove or set back agricultural floodbanks & Providing Space for Channel adjustment	Floodbanks along both banks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	>£250k move 5k floodbanks
		Improving the riparian zone	Stock access & poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Stock exclusion from a short area. Riparian planting	£40k 5k fencing
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness	£30k 3xELJ
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	£40k
		Removal of redundant channel structures & lowering weirs.	Minor 'weir'	Remove or modify weir structure	£20k
5	Till : Sweet Haugh to Heathery Hall	Remove or set back agricultural floodbanks (& Providing Space for Channel Adjustment)	Sections of floodbank	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	>£75k move 1k floodbanks
		Improving the riparian zone	Extensive poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Stock exclusion from a short area. Riparian planting	£6k 1k fencing
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness	£10k 1 ELJ
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	£10k 0.25km

Programme 1 (cont.)

Reach	Location	Generic measure	Issue	Initiate action	Indicative cost notional minimum
12	Breamish : Beanley to Hedgely	Removal of redundant channel structures & lowering weirs.	Culvert bridge and armoured ramp	Remove bridge & ramp (or replace with more appropriate structure to facilitate ongoing access if required)	£5k removal
		Improving the riparian zone	Stock access. Extensive poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering). Riparian planting.	£6k 1km fencing
		Removing localised bank reinforcements	Localised riprap on meander bends	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure or as temporary protection whilst vegetation becomes re-established	£25k 0.5km removal & soft eng
		Review & improve	Former gravel extraction	Assist to re-establish natural form & function with actions above	
13	Breamish : Powburn bridges	Removal of redundant channel structures & lowering weirs.	Major bridge footings/weir at road bridge & former railway bridge, Hedgeley	Undertake assessment to determine potential and benefits of further modification of footings / weir	
		Removing localised bank reinforcements	Localised riprap	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	£2.5k 0.05km removal
		Management & use of large wood : ELJs	Former gravel extraction u/s & d/s.	Install bar-apex ELJs. Assist to re-establish natural form & function with actions in reach 12	£30k 3 ELJs
14	Breamish : Powburn to d/s Brandon ford	Review & improve	Timber groyne structures	Review effectiveness of timber groynes and identify any beneficial improvements	
		Removing localised bank reinforcements	Localised riprap	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	£10k 0.25km removal
		Management & use of large wood : ELJs	Former gravel extraction.	Install bar-apex ELJs. Assist to re-establish natural form & function with actions reach 12	£30k 3 ELJs
		Providing Space for Channel Adjustment	Localised post-flood channel realignment.	Review development of channel to inform establishment of erodible corridor	

Programme 1 (cont.)

Reach	Location	Generic measure	Issue	Initiate action	Indicative cost notional minimum
15	Breamish : d/s Brandon ford to Ingram	Removing major hard bank protection	Hard bank protection	Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure	£100k 0.25km removal & 4ELJs
		Providing Space for Channel Adjustment	Localised post-flood channel realignment / bank protection	Review development of channel to inform establishment of erodible river corridor. Encourage recruitment of stabilising large wood features	
		Providing Space for Channel Adjustment	Localised post-flood channel realignment / bank protection	Establish long term response plan to secure infrastructure; consider options for re-routing infrastructure (power lines, road)	
		Providing Space for Channel Adjustment	Footbridge with in-channel piers	Remove footbridge or replace with single span structure	>£200k
		Review & improve	Timber groyne structures	Review effectiveness of timber groynes and identify any beneficial improvements	
		Removal of redundant channel structures & lowering weirs.	Minor weir structure	Remove minor weir structure	£25k
		Improving the riparian zone	Stock access to banks and bed.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	£7.5k 1km fencing
19	Glen : Till confl to Coupland	Remove or set back agricultural floodbanks & Providing Space for Channel Adjustment	Extensive floodbanks	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	>£250 5km floodbanks
		Improving the riparian zone	Stock access & poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Stock exclusion from a short area. Riparian planting	£3k 0.5km fencing
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness Re-meander straightened sections	£50k 5 ELJs
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	£20k 0.5km removal & soft eng
24	College Burn : Glen confl to d/s Hethpool	Protocols for river management	Sediment deposition at bridge	Establish agreed gravel management regime at bridge	

Programme 1 (cont.)

Reach	Location	Generic measure	Issue	Initiate action	Indicative cost notional minimum
27	Wooler Water : Till confl to Wooler	Remove or set back agricultural floodbanks & Providing Space for Channel Adjustment	Floodbanks along both banks	Potential alternative management of floodbanks (esp RH - to reduce pressure on LH riverbank) e.g. realignment of floodbank to create erodible corridor; lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	£250k move 2.5km floodbanks
		Improving the riparian zone	Localised stock access & poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Stock exclusion from a short area. Riparian planting	£3k 0.5km fencing
		Review & improve	Localised erosion protection using ELJ-type structure	Review effectiveness of backfilled vertical log structures and identify any beneficial improvements	
		Removing localised bank reinforcements	Localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	£10k 0.25km removal
		Removal of redundant channel structures & lowering weirs.	Weir u/s of reach	Remove or modify weir structure	£50k
		Protocols for river management	Locally high sediment loading	Local gravel management plan to ease erosion pressure on infrastructure	
28	Wooler Water : Wooler	Removal of redundant channel structures & lowering weirs.	Weirs	Undertake detailed assessment to assess potential for weir removal or modification	
		Removing major hard bank protection	Hard engineering of banks	Remove or replace hard bank protection with softer form	£10k 0.1km removal
		Remove or set back agricultural floodbanks	Floodbanks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	£25k move 0.25km floodbanks
		Providing Space for channel adjustment		Develop inset channel corridor / two-stage channel	£15k 0.1km extent
29	Wooler Water : Wooler to Earle Mill	Removal of redundant channel structures & lowering weirs	Weirs	Undertake detailed assessment to assess potential for weir removal or modification	£30k 1 weir & 1 structure
		Removing major hard bank protection	Hard engineering of banks	Remove or replace hard bank protection with softer form / ELJs	£4 k 0.1km removal
		Remove or set back agricultural floodbanks	Floodbanks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	£10k move 0.1km floodbanks
		Providing Space for channel adjustment		Develop inset channel corridor / two-stage channel	£30k 0.2km extent

Programme 1 (cont.)

Reach	Location	Generic measure	Issue	Initiate action	Indicative cost notional minimum
30	Wooler Water : Earle Mill to Coldgate Ford	Removal of redundant channel structures & lowering weirs.	Ford, footbridge and unstable / failing weir at Haugh Head	Undertake detailed restoration appraisal to determine best solution; investigate potential to remove / modify weir, ford and u/s check weirs	See : River Restoration Scheme for Haugh Head, Wooler :. Report to Tweed Forum. (cbec 2012). for options appraisal and outline costs
		Removal of redundant channel structures & lowering weirs.	Series of check weirs u/s ford	Undertake detailed restoration appraisal to determine best solution; investigate potential to remove / modify weir, ford and u/s check weirs	
		Removing major hard bank protection	Hard Bank protection and channel straightening	Remove hard bank protection and replace with ELJs	
		Management & use of large wood : ELJs	Former gravel extraction d/s weir	Monitor continuing recovery of channel; install ELJs to stabilise features if required	
33	Lilburn Burn : Till confl to A697 bridge	Removing major hard bank protection	Hard bank protection.	Remove hard bank protection and replace with appropriate scale ELJs	£1.5k 0.05km removal
		Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Floodbanks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	£10k move 0.1km floodbanks
		Review & improve	Minor soft bank protection	Review benefits of protection and improve as required	
		Removal of redundant channel structures & lowering weirs.	Significant weir and ford	Undertake detailed assessment to determine potential for removal or modification of weir and ford	
		Improving the riparian zone	Stock access to channel	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	6k 1km fencing
		Protocols for river management	Bridges	Establish agreed gravel management regime at bridge	
Notional total cost (excluding restoration at Haugh Head ford)					>£1600k

Till RRS : Phased delivery programme 2 - medium term

Reach	Location	Generic measure	Issue	Action	Cost band*
1	Till : Tweed confluence to Ford.	Removal of redundant channel structures & lowering weirs.	Several (8-9) large weirs; significant implications if removed	Review options and benefits of removal or modification. Potential for very significant channel re-adjustment; consider modification, such as lowering the crest. Modelling channel effects is essential. Possible historic importance	H
		Improving the riparian zone	Stock access & poaching	Alternative stock management (eg reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Stock exclusion from a short area. Riparian planting	L
		Potential ingress of fine sediment.	Higher risk area (in catchment) for sediment runoff; pathway to Till via minor tributaries (e.g. Pailinsburn)	Review opportunity for CSF approach to identify/ resolve risks of excessive soil runoff	L

Programme 2 (cont.)

Reach	Location	Generic measure	Issue	Action	Cost band*
2	Till : Ford to u/s Redscar Bridge	Improving the riparian zone	Stock access & poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.). Riparian planting	M
		Remove or set back agricultural floodbanks & Providing Space for channel adjustment	Floodbanks along one or both banks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	H
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness	M
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	L
		Potential ingress of fine sediment.	Higher risk area (in catchment) for sediment runoff; pathway to Till via minor tributaries	Review opportunity for CSF approach to identify/ resolve risks of excessive soil runoff	M
4	Till : Wooler Water to Sweet Haugh	Remove or set back agricultural floodbanks & Providing Space for channel adjustment	Floodbanks along one or both banks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	H
		Improving the riparian zone	Stock access & poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	M
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness	M
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	M
6	Till : Heathery Hall to u/s Hetton House	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Floodbanks along one or both banks	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain	H
		Improving the riparian zone	Extensive poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	M
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness	M
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	L
7	Till : u/s Hetton House to Chillingham Barns	Improving the riparian zone	Extensive poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	M
		Management & use of large wood : ELJs	Incised channel	Install bar-apex ELJs. Monitor operation / effectiveness	M

Programme 2 (cont.)

Reach	Location	Generic measure	Issue	Action	Cost band*
10	u/s Bewick Bridge to Harehope	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment.)	Straightened and embanked channel	Alternative management of floodbanks eg realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain. Consider engineered re-meandering. Install ELJs to improve sediment storage	H
		Improving the riparian zone	Localised poaching	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	L
		Removing major hard bank protection	Hard bank protection	Remove hard bank protection and replace with ELJs where erosion threatens infrastructure	L
		Removal of redundant channel structures & lowering weirs.	Minor boulder/riprap weir structure	Remove minor weir structure	M
20	Glen : Coupland to confl College Burn	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Floodbanks along right bank (south side of floodplain is lower than current channel).	Alternative management of floodbanks, e.g. remove or set back floodbanks to create erodible corridor; lower or designed breaching to reconnect channel to floodplain; reduced maintenance / abandonment	H
		Review & improve	Local timber & hard bank protection.	Review effects of existing bank protection, consider improvements/removal	L
		Improving the riparian zone	Unstable reach	Increase riparian and floodplain tree cover	L
		Management & use of large wood : ELJs	Unstable reach	Encourage sediment storage and improve channel stability in College Burn using ELJs	M
		Removal of redundant channel structures & lowering weirs	Weir (Kirknewton)	Remove or modify weir structure	H
		Removal of redundant channel structures & lowering weirs	Ford (Coupland)	Consider local improvements to reduce impact	M
22	Bowmont Water : u/s Mindrum to SAC limit	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Lengths of single-bank floodbank.	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	M
		Improving the riparian zone	Sparse riparian & corridor vegetation	Increase riparian / floodplain tree cover	M
		Protocols for river management	Potential ingress of fine sediment.	Review opportunity for CSF approach to reduce risks of excessive soil runoff	M
		Removing localised bank reinforcements	Hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs	L
23	Bowmont Water : u/s SAC limit	Removal of redundant channel structures & lowering weirs	Culvert bridges	Replace bridges with more appropriate structures (e.g. single span)	M
		Removal of redundant channel structures & lowering weirs	Ford with c2m head. (potential obstacle to fish movement).	Remove riprap from ford. Replace ford with single span bridge	H
		Management & use of large wood : ELJs		Create weir type structures using ELJs to limit bed instability	M
		Removing localised bank reinforcements	Extensive hard bank & toe protection	Remove hard bank protection; consider installation of soft engineering or ELJs	M

* Cost bands : H > £75k; M £20k-£75k; L <£20k

Till RRS : Phased delivery programme 3 - long term

Reach	Location	Generic measure	Issue	Action	Cost band*
8	Till : Chillingham Barns to u/s Lilburn confl	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Sections of flooodbank prevent connection to floodplain and potential lateral channel movement	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	H
		Improving the riparian zone	Extensive poaching, bank instability, lack of riparian vegetation, fine sediment input	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	M
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	L
9	Till : u/s Lilburn confl to u/s Bewick Bridge	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Floodbanks along one or both banks prevent connection to floodplain and potential lateral channel movement	Alternative management of floodbanks eg realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	H
		Improving the riparian zone	Localised stock access & poaching causes bank instability, lack of riparian vegetation and fine sediment input	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	L
		Removing localised bank reinforcements	Localised hard bank & toe protection prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	L
			Minor boulder/riprap weir structure interrupts longitudinal channel connectivity	Remove or modify weir structure	M
11	Till : Harehope to Beanley	Improving the riparian zone	Extensive poaching, bank instability, lack of riparian vegetation, fine sediment input	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	L
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure.	L
16	Breamish : Ingram to u/s Boulby Wood	Removing major hard bank protection	Hard bank protection prevents lateral channel processes	Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure	M
		Providing Space for channel adjustment	Localised post-flood channel realignment / bank protection. Channel instability and potential for significant changes in flood flows	Review development of channel to inform establishment of erodible river corridor. Encourage recruitment of stabilising large wood features	L
		Review & improve		Establish long term response plan to secure infrastructure; consider options for re-routing infrastructure (power lines, road)	L

Programme 3 (cont.)

Reach	Location	Generic measure	Issue	Action	Cost band*
17	Breamish : Boulby Wood to SAC limit	Removing major hard bank protection	Hard bank protection prevents lateral channel processes	Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure	H
		Protocols for river management	Localised post-flood gravel movement affects channel stability; potential for significant changes in flood flows	Establish agreed plan for channel management at specific sites (e.g. Peggys Bridge)	L
18	Breamish : u/s SAC limit	Review & improve	Potential for changes of land use, e.g. forestry, upland drainage, could affect runoff rates & volumes, with impacts on d/s flood flows	Maintain watching brief & consider implications of any future proposed changes	L
21	Bowmont Water : College Burn confl to u/s Mindrum	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Floodbanks prevent connection to floodplain and potential lateral channel movement	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	H
		Improving the riparian zone	Sparse riparian & corridor vegetation increases risk of bank instability and floodplain impacts	Increase riparian / floodplain tree cover	L
		Improving the riparian zone	Stock access & poaching causes bank instability, lack of riparian vegetation, fine sediment input	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	M
		Protocols for river management	Potential ingress of fine sediment. Potential to change nature of bed substrate and impact on ecology	Review opportunity for CSF approach to reduce risks of excessive soil runoff	M
		Removal of redundant channel structures & lowering weirs	Weir impacts on channel and bed processes	Modify / remove weir	H
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs	L
24	College Burn : Glen confl to d/s Hethpool	Remove or set back agricultural floodbanks (& Providing Space for channel adjustment)	Limited floodbanks prevent potential lateral channel movement	Alternative management of floodbanks, e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	M
		Removing localised bank reinforcements	Intermittent localised hard bank & toe protection prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	L
		Management & use of large wood : ELJs	Incised channel prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness Re-meander straightened sections	M
		Protocols for river management	Changes to bars and bed gravels intended to reduce bank erosion / risk to Westnewton Bridge	Local gravel 'management' : limited gravel management guided by agreed, predefined actions	L

Programme 3 (cont.)

Reach	Location	Generic measure	Issue	Action	Cost band*
25	College Burn : d/s Hethpool to SAC limit	Protocols for river management & Management & use of large wood : ELJs	Extreme sediment transport. Combination of stream energy and sediment inputs results in high level of sediment transfer into River Glen	Establish agreed gravel management regime in lowest reach. Install bar-apex ELJs. Monitor operation / effectiveness	L
		Review & improve	Rapid and extreme response to heavy rainfall events. Subcatchment landform and stream gradient result in rapid runoff, creating impacts in River Glen	Investigate potential for improved natural flow management in catchment	L
26	College Burn : u/s SAC limit	Protocols for river management & Management & use of large wood : ELJs	Extreme sediment transport. The combination of stream energy and sediment inputs results in high level of sediment transfer into River Glen	Establish agreed gravel management regime in lowest reach. Install bar-apex ELJs. Monitor operation / effectiveness	L
		Review & improve	Rapid and extreme response to heavy rainfall events. Subcatchment landform and stream gradient result in rapid runoff, creating impacts in Glen	Investigate potential for improved natural flow management in catchment	L
31	Harthope Burn : Coldgate Ford to SAC limit	Removing major hard bank protection	Hard bank rip-rap & whinstone protection. Impacts on channel / bank processes	Remove hard bank protection and replace with ELJs	M
		Removal of redundant channel structures & lowering weirs.	Weir - Influences bed and channel processes – gradient, substrate regime, flow patterns	Investigate potential to remove or/ modify weir	L
			Stock access to channel impacts on vegetation cover, increasing risk of substrate instability	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	L
32	Harthope Burn : u/s SAC limit	Removing major hard bank protection	Hard bank rip-rap & whinstone protection. Impact on channel / bank processes	Remove hard bank protection and replace with ELJs	M
		Improving the riparian zone	Stock access to channel impacts on vegetation cover, increasing risk of substrate instability	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	L
34	Lilburn Burn : A697 bridge to SAC limit	Removing major hard bank protection	Hard bank protection impacts on channel / bank processes	Remove hard bank protection and replace with appropriate scale ELJs	M
		Improving the riparian zone	Stock access to channel impacts on vegetation cover, increasing risk of substrate instability	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	L
		Protocols for river management	Gravel accumulation impacts on bridge / fish pass	Establish agreed gravel management regime at bridge	L
36	Hetton Burn : u/s SAC limit (confl Till)	Protocols for river management	Sediment carried into main Till settles out & impacts on gravel substrate	Review CSF plan & identify any further actions to reduce soil runoff	L

* Cost bands : H > £75k; M £20k-£75k; L <£20k

4.6 Assessing success

Monitoring & Review

Progress to achieve the aims of the strategy will be monitored by Natural England and the Environment Agency, who are required to report this to DEFRA, using two high-level criteria :

(i) are the improvement actions being delivered in a timely and appropriate way ?

This will be assessed annually by both organisations jointly reviewing delivery of actions.

(ii) are the desired improvements to channel morphology being achieved ?

This will be monitored by Natural England through their standard 6-yearly 'condition assessment' process to determine if the SSSIs are in favourable condition.

The two agencies, together with relevant organisational partners, will therefore be jointly reviewing progress with a rolling programme of implementation at least annually. To assist with this process the formation of a stakeholder-led steering group is envisaged. This would also have the role of ensuring continuing stakeholder input and providing advice on changing pressures in the catchment.

Information about progress, forthcoming priorities and opportunities will be communicated widely through the catchment using web- based / postal newsletters and occasional local meetings.

4.7 Roles for implementation

Ownership

The Till RRS has been developed through a partnership between Natural England, the Environment Agency and Tweed Forum. The lead organisations for taking forward the delivery of the strategy are Natural England and the Environment Agency (except in the upper Bowmont Water). Delivery of actions to implement the strategy will be reported nationally to DEFRA through Natural England's SSSI Remedies Programme and Environment Agency WFD reporting.

Organisational partners

Delivering the restoration vision will involve partnership working between a range of organisations, potentially including:

Environment Agency
Natural England
Tweed Forum
Scottish Environment Protection Agency
Scottish Natural Heritage
Tweed Commission / Tweed Foundation
Northumberland National Park Authority
Northumberland County Council
Cheviot Futures
Northumberland Wildlife Trust
Forestry Commission
National Farmers Union
Country Land and Business Association
Scottish Land and Estates

Working with landowners and land managers

To achieve the aims of this river restoration plan, the Environment Agency and Natural England recognise that effective and positive engagement with landowners and land managers is essential.

Implementation of the proposals in the strategy will rely on close working relationships between the relevant organisations and local stakeholders. The real key to successful delivery will be the involvement and support of land owners and managers, including the major estates, individual farm owners and tenants, other landowners and the local communities. Landowners and managers will play an important role in helping to develop proposals and in some cases will potentially take ownership of implementing actions, with appropriate technical and financial assistance.

Delivery of the aims of the strategy clearly doesn't end with the implementation of restoration measures. Natural England and the Environment Agency, will continue to work proactively with land owners and members of the local community to ensure the long term success and sustainability of the measures. This will include monitoring the restored areas and, where necessary, undertaking adaptive management. This could include: managing woody debris within the channel and riparian trees, in line with best practice; maintenance of bankside fences; occasional removal of blockages, due to a local build-up of gravel/debris/wood. All of these activities will require agreement from the Environment Agency and Natural England (or SEPA and SNH in Scotland) and, where appropriate, a 'rolling' approval will be considered.

Comments and suggestions from stakeholders have already helped to shape the RRS. More detailed views on priorities and options for individual reaches will come out of discussions with landowners as reach-specific restoration options are developed.

Synopsis of stakeholder comments received during the preparation of the RRS :

Overall strategy

- What priority is behind delivering the strategy : how will this be maintained over it's 25-50 year timespan as UK values change ?
- Much stronger emphasis needed on needs of landowners & residents.
- Give stronger emphasis on landowner economic priorities.
- The plan needs to be flexible and adapt to changing circumstances over it's lifespan.
- The appraisal of the catchment issues is well constructed; restoration options will work.

Queries about measures

- The need remains for hard engineering at places where property / roads are at risk.
- Concerns regarding moving floodbanks and the viability of stock fencing.
- Query regarding how the width of erodible corridor is decided.
- How can field drainage be improved as part of the RRS.

Delivering measures

- Removal of instream structures must be supported by comprehensive modelling to be able to understand and respond to the potential effects of removal.
- Removal of structures or realigning the channel may have archaeological/historic implications.
- There is a legal requirement for fish passage. Improvements are needed at several locations.
- Planting floodplain & riparian trees would be beneficial and should be supported.
- Wider catchment-scale measures will be most cost-beneficial (e.g. trees to hold sediment).
- Add another measure : create sediment reed pools at burn/ditch ends to retain sediment/slow flows.

Strategic actions

- The speed of delivery for emergency works is important; provide one point of contact.
- Would welcome guidelines on river management, provided they take protection of farmland into account.

Involvement

- Will be willing to help implement the strategy.
- Prepared to be involved if better emphasis is given to protection of property/ homes

Discussion with stakeholders has so far been focused on understanding issues and constraints. Further dialogue will be essential as the measures are developed and tailored for delivery in relevant locations. Continuing stakeholder involvement will also include seeking support for taking the wider strategy forward and providing advice on changing pressures in the catchment through representation on a stakeholder-led steering group.

Appendix 1

Individual Reach Summaries

Explanatory notes

1 These individual summary sheets are intended to comprise a simple listing of facts about a reach (front) and an illustrative map (reverse) when printed. The map in Figure. A1 identifies the position of each reach.

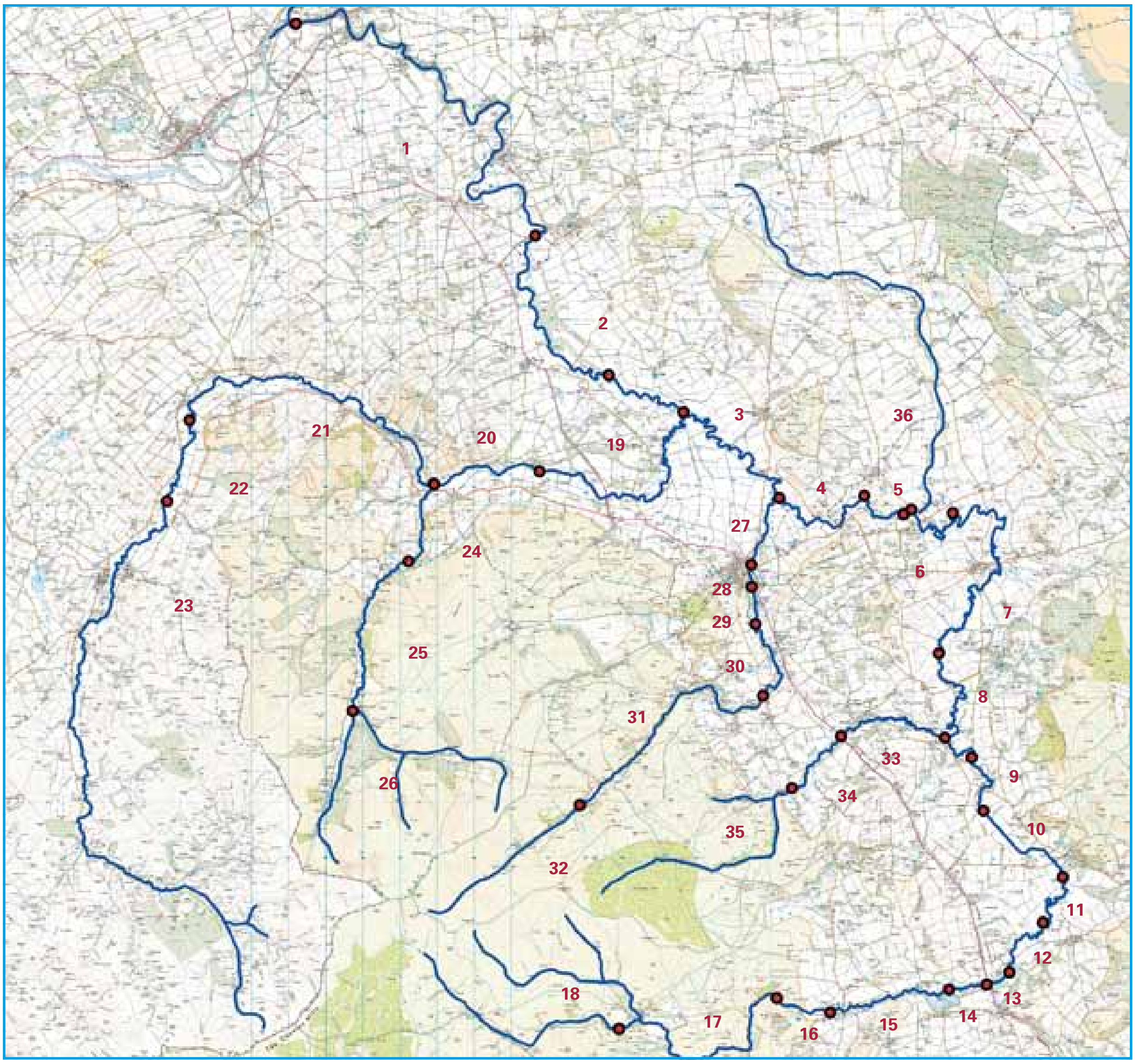
2 The characteristics, pressures, impacts and potential restoration actions in each reach are summarised on the sheets. Reaches upstream of the SSSI/SAC are included for completeness; they have not generally been assessed for impacts or assigned a priority for action.

3 The map for each reach shows basic information about pressures on the channel - they are for guidance and are not exhaustive. Further detailed information is incorporated in the GIS and has been used in developing our understanding of the pressures and impacts. The maps are, of necessity, at different scales. The background maps are OS 1:25k so each grid square is 1km x 1km.

4 Priorities for action have been assessed using a combination of the number of pressures in a reach and the impact that these are having (see section 4.5). For example, frequent occurrences of bank protection in a reach will not result in the reach being given high priority for action if the impact on the channel is assessed as 'low'. In some reaches there are different priorities for sub-reaches, to reflect the degree of impact that pressures are exerting; all numbers in brackets indicate the relevant sub-reaches. The priorities for all sub-reaches are listed in Table 8.

5 The potential restoration measures listed represent the ideal. At this stage **no potential measures have been omitted** because of costs, effects on landowner interests, or practicality. These factors will heavily influence which actions may be taken forward and over what timescale; no measures will be taken forward without consultation and agreement with landowners and/or other relevant stakeholders.

Figure A1 : Map showing location of Reaches in the Till RRS.
For use as an Index to the following Individual Reach Sheets



Restoration reach limits

N

N

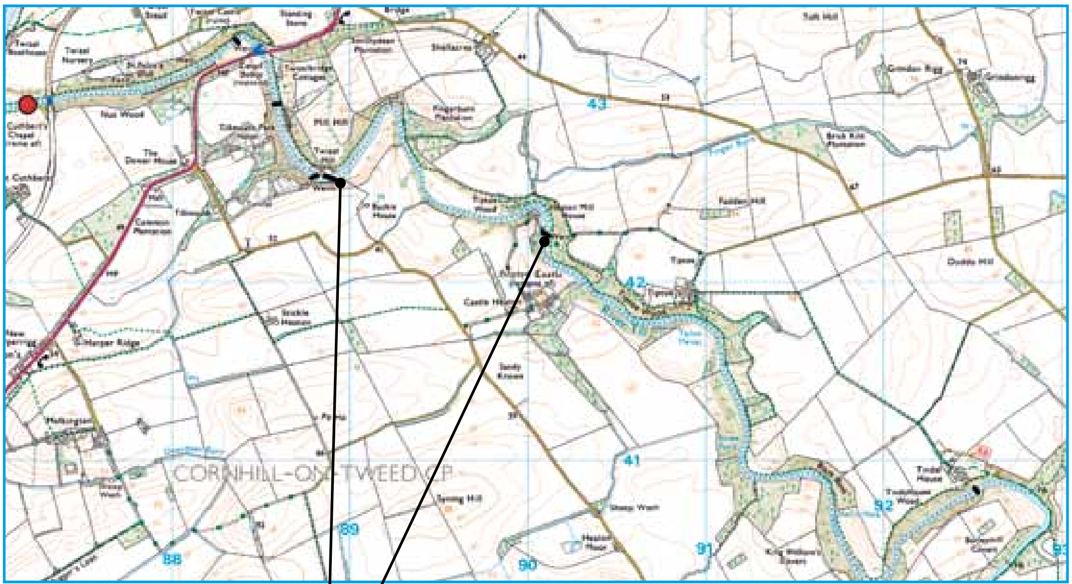
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 01 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	01	L	
Location	NGR	Channel length	
Tweed confluence to Ford	NT870429 to NT935373	15km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Bedrock, Cascade	1,2,3	Transport	Low
Key Pressures			
Weirs			
Pressure score	Reach impact severity		
Very low	Low (1,2), Very low (3)		
Principal restoration issues		Potential restoration options	
Weirs	Interrupt sediment transport regime	Remove or modify weir structure.	
Potential ingress of fine sediment.	Potential risk via minor tributaries (e.g. Palinsburn) arising from combination of soil types, slope & land use.	Review opportunity for CSF approach to identify/resolve risks of excessive soil runoff.	
Relative costs of restoration		M	
Potential constraints on restoration options.			
Remove or modify weirs	Cost. Potential for bed and / or bank erosion upstream. Requires extensive technical modelling of effects.		
Reduce silt ingress.	Extent of potential source area. Changes to land management. Cost.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 01

River Till : Tweed confluence to Ford



Weir

Tributary input

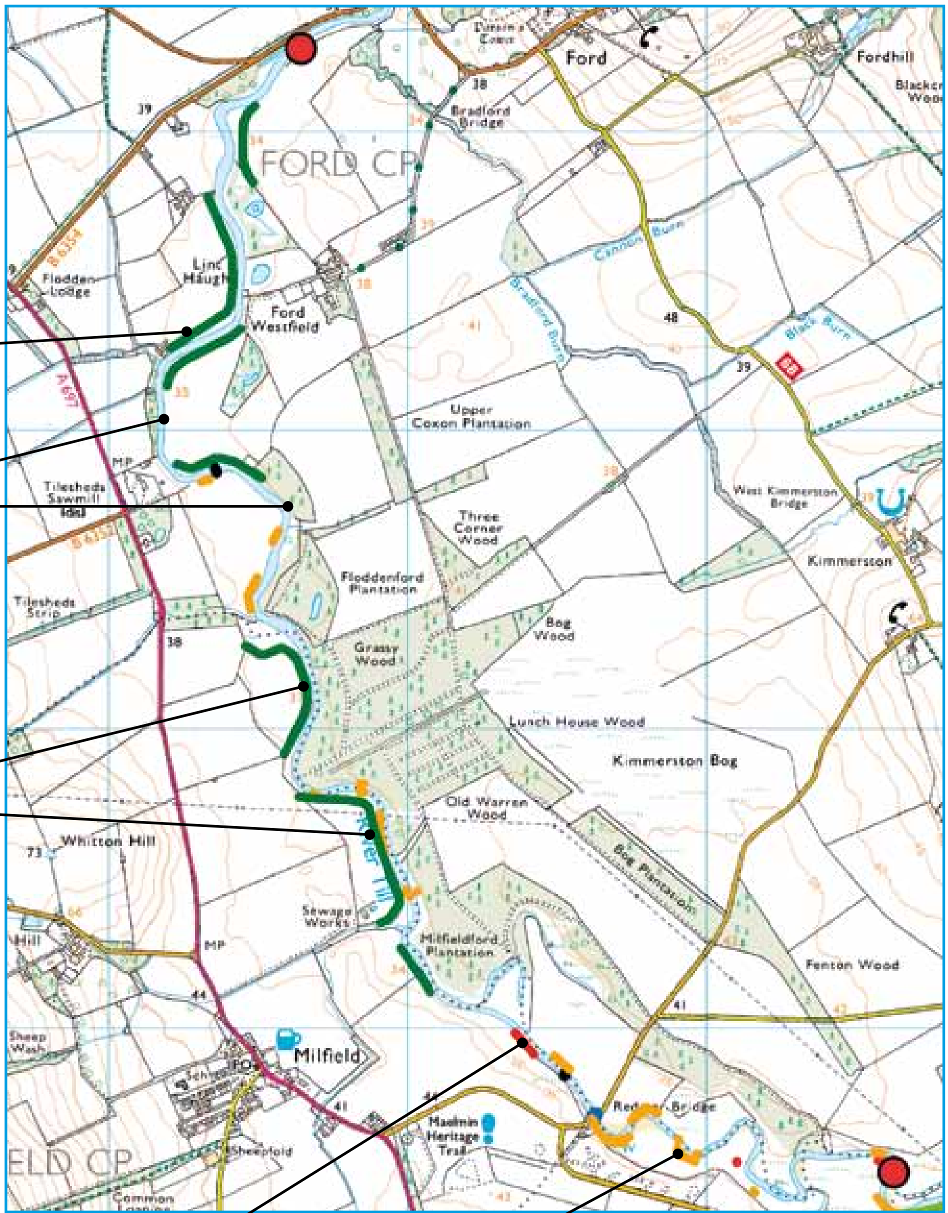
N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 02 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	02	L 4-5 M 6	
Location	NGR	Channel length	
Ford to u/s Redscar Bridge	NT870429 to NT956335	7km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	4, 5, 6.	Supply	Low
Key Pressures			
Short floodbanks, mostly one side only; minimal engineered banks			
Pressure score	Reach impact severity		
Low (4) Medium (5,6)	Moderate (6), Very low (4) Low (5)		
Principal restoration issues		Potential restoration options	
Stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting.	
Floodbanks along both banks	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Potential ingress of fine sediment	Potential risk via minor tributaries arising from combination of soil types, slope & land use.	Review opportunity for CSF approach to identify/resolve risks of excessive soil runoff	
Relative costs of restoration		M	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		
Reduce silt ingress.	Extent of potential source area. Changes to land management. Cost.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 02
River Till : Ford to u/s Redscar Bridge



Channel bounded by floodbanks

Incised channel

Floodbanks on one side

Hard bank protection

Sporadic bank / toe protection

N

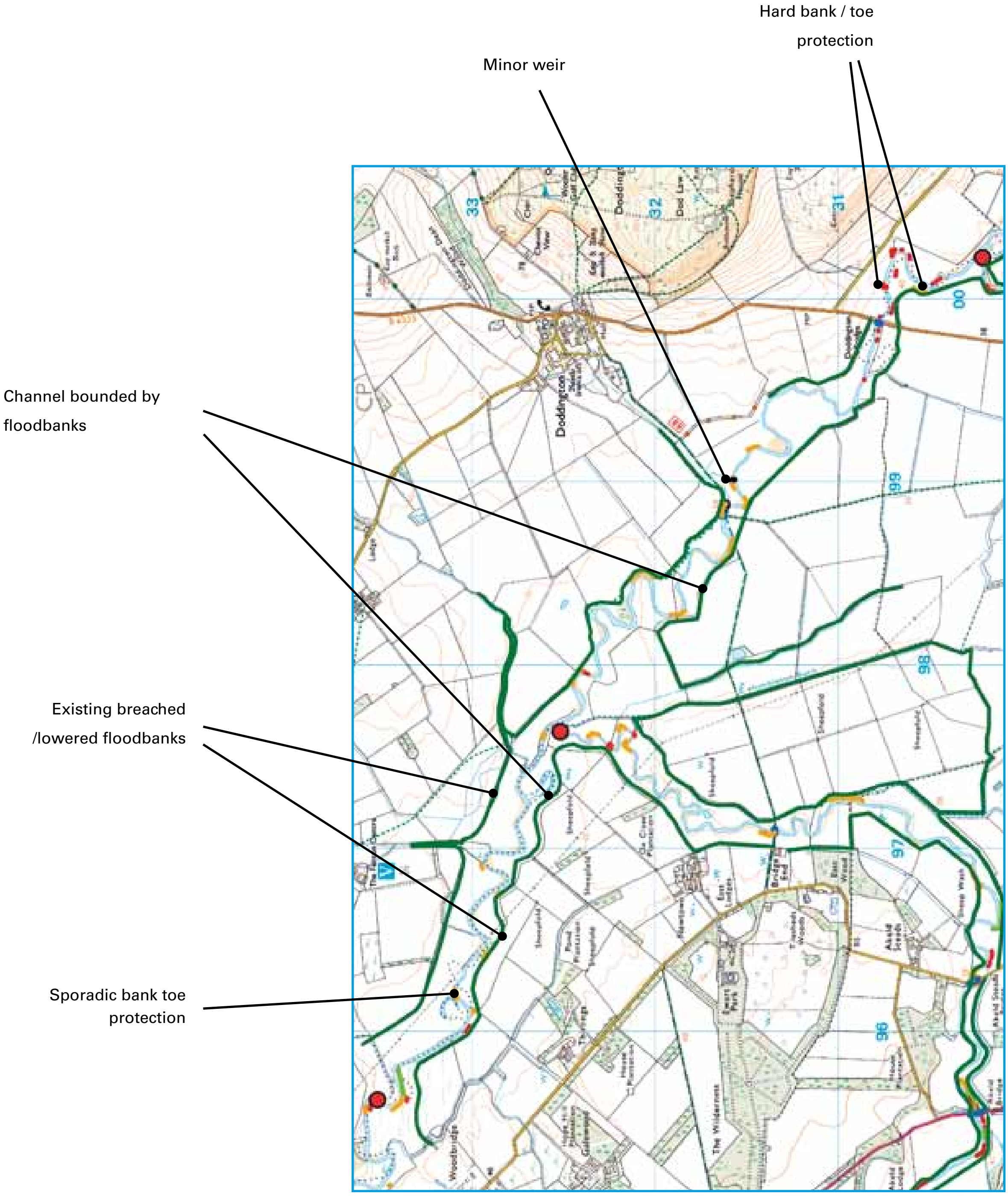
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 03 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	03	M H	
Location	NGR	Channel length	
u/s Redscar Bridge to confl Wooler Water	NT556335 to NU003302	8.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	7, 8, 9, 10, 11	Storage (7,9)	Low (7,11)
		Supply (8,10,11)	Moderate (8,9,10)
Key Pressures			
Floodbanks along both sides, (some lengths breached or lowered at Fenton, Nisbet, Thirlings); minimal engineered banks			
Pressure score	Reach impact severity		
High (9,10,11)	High (8,9,10,11)		
Moderate (7,8)	Moderate (7)		
Principal restoration issues		Potential restoration options	
Floodbanks along both banks	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Minor 'weir'	Interrupts sediment transport regime	Remove or modify weir structure.	
Relative costs of restoration		M	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		
Remove minor 'weir'	Potential for bed and / or bank erosion upstream		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 03

River Till : u/s Redscar Bridge to confl Wooler Water



N

- Floodbanks
- Hard bank protection
- Toe protection
- Soft bank protection
- Weir / Ford
- Bridge
- Limits of reach

Reach 04 Summary

Watercourse Name	Reach No	Restoration Priority	
River Till	04	M 13 L 12	
Location	**NGR**	**Channel length**	
Wooler Water to Sweet Haugh	NU0033302 to NU025303	6.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	12,13	Supply	Low
Key Pressures			
Short floodbank on one side & floodbank c50% of other side; soft engineered banks			
Pressure score	**Reach impact severity**		
Moderate (13)	Moderate (13)		
Low (12)	Low (12)		
Principal restoration issues		**Potential restoration options**	
Floodbanks along both banks	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Relative costs of restoration		L M	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

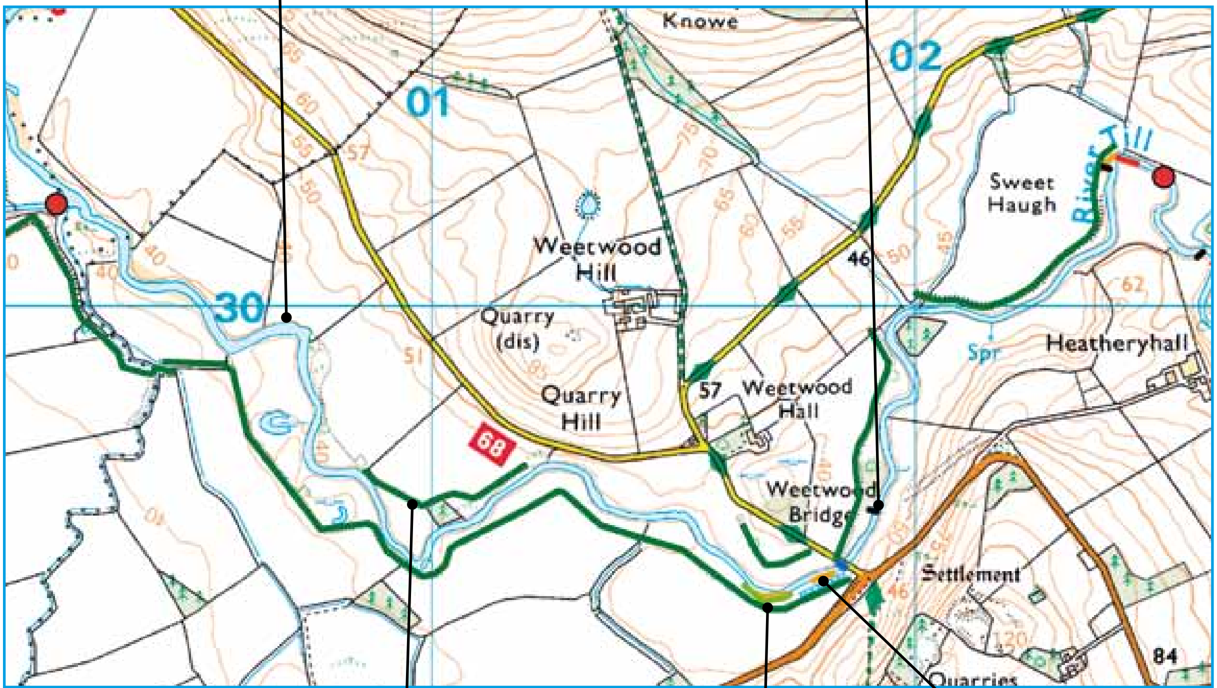
NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 04

River Till : Wooler Water to Sweet Haugh

Incised channel

Minor Weir



Channel bounded by floodbanks

Soft bank

protection

Sporadic bank / toe protection

N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 05 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	05	M 13 H 14	
Location	NGR	Channel length	
Sweet Haugh to Heathery Hall	NU025303 to NU035298	2km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	13,14	Supply	Low
Key Pressures			
No floodbanks or engineered banks etc			
Pressure score	Reach impact severity		
Moderate (13)	Moderate (13)		
High (14)	High (14)		
Principal restoration issues		Potential restoration options	
Sections of floodbank	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Extensive poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Relative costs of restoration		L M	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 05

River Till : Sweet Haugh to Heathery Hall

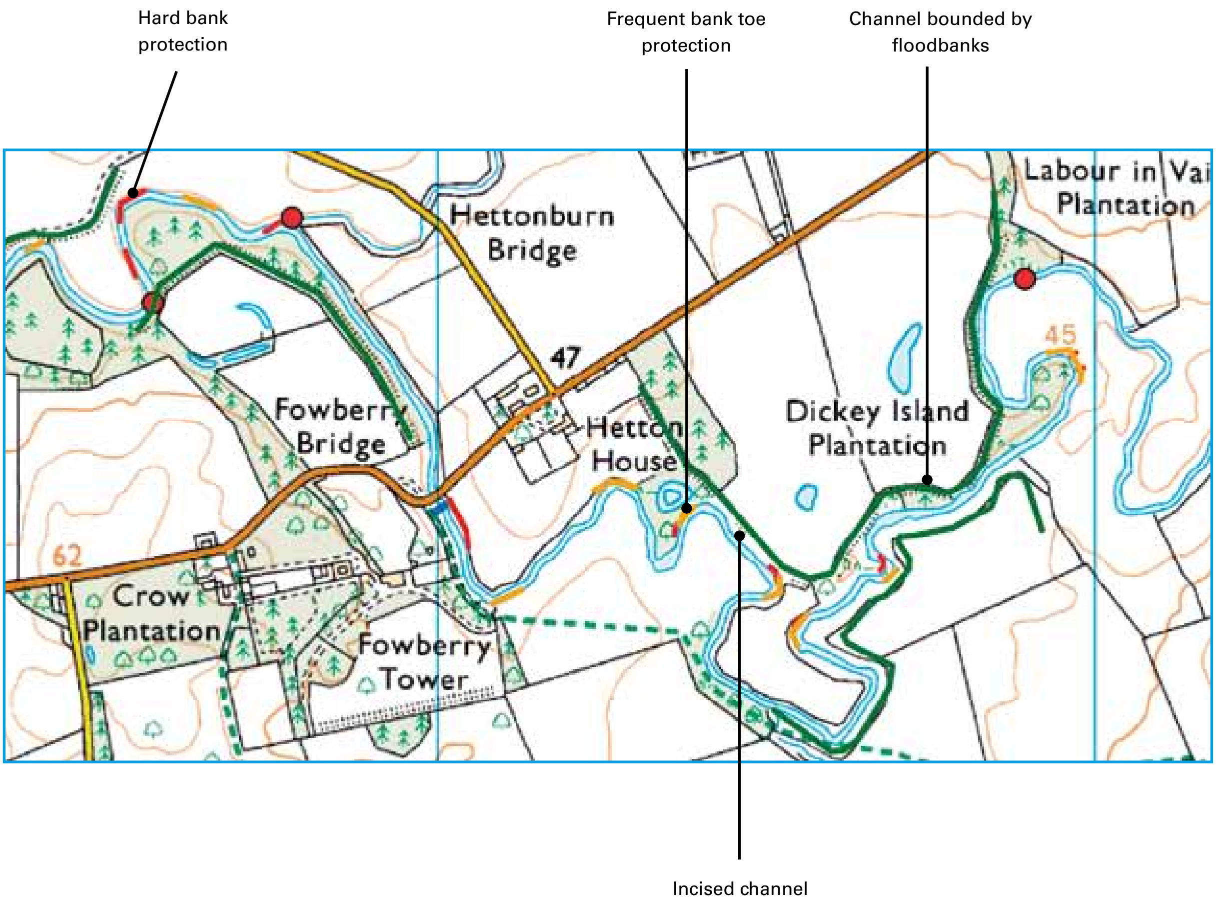
N

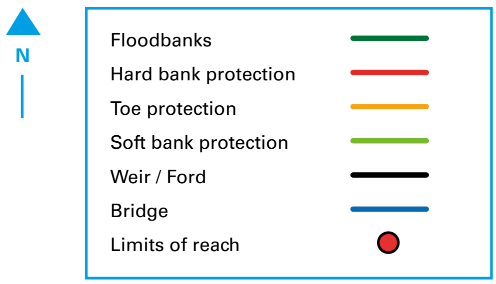
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 06 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	06	M 16 L 15	
Location	NGR	Channel length	
Heathery Hall to u/s Hetton House	NU035298 to NU049298	4km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	15,16	Supply	Low
Key Pressures			
Floodbanks c50% both sides; hard engineered banks near bridge			
Pressure score	Reach impact severity		
Moderate (13)	Moderate (13)		
High (14)	High (14)		
Principal restoration issues		Potential restoration options	
Sections of floodbank	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Extensive poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Relative costs of restoration		M	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 06
River Till : Heathery Hall to u/s Hetton House





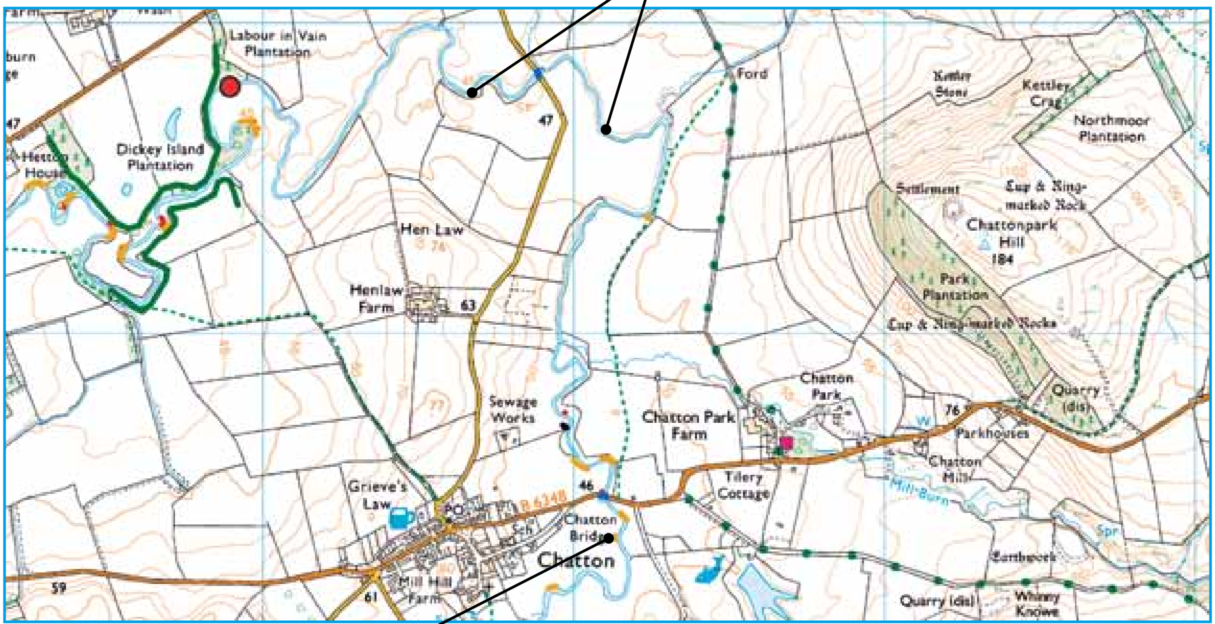
Reach 07 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	07	M 16,18 L 17 VL 19,20	
Location	NGR	Channel length	
u/s Hetton House to Chillingham Barns	NU049298 to NU044260	8.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	16,17,18,19, 20	Supply	Low
		Storage (20)	
Key Pressures			
No floodbanks or engineered banks etc			
Pressure score	Reach impact severity		
Moderate (16,18)	Moderate (16,18)		
Low (17)	Low (17)		
Very low (19,20)	Very low (19,20)		
Principal restoration issues		Potential restoration options	
Extensive poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness	
Relative costs of restoration		L M	
Potential constraints on restoration options.			
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

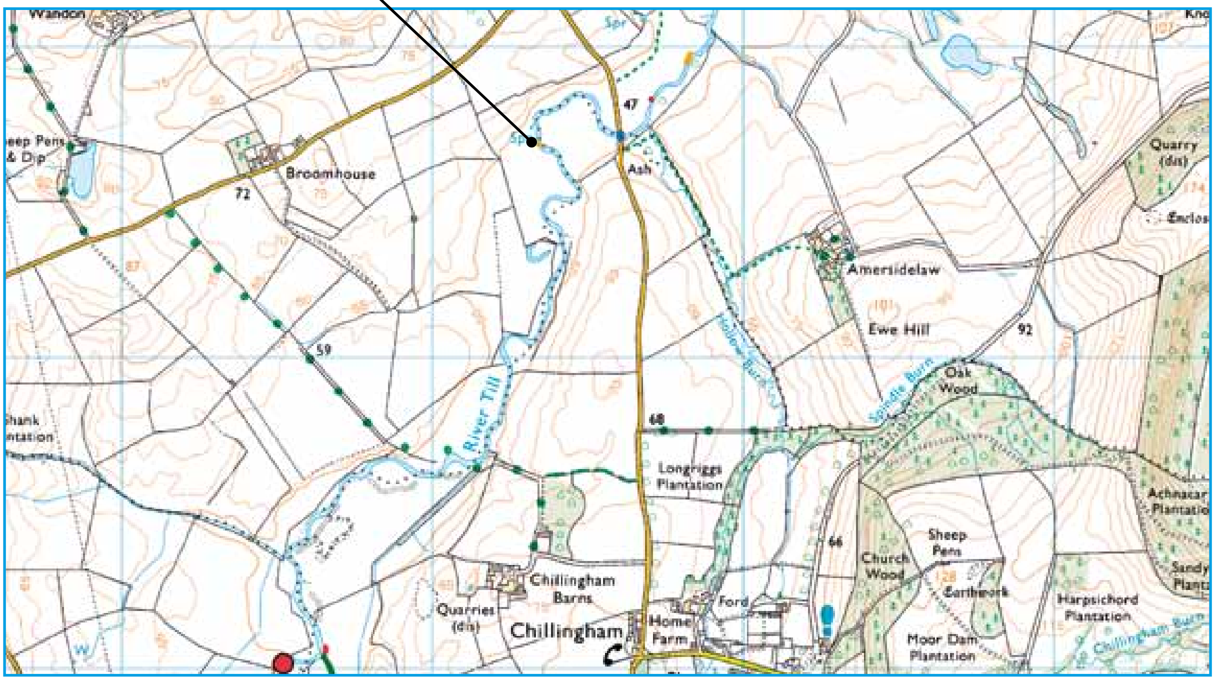
Reach No 07

River Till : u/s Hetton House to Chillingham Barns

Incised channel



Sporadic bank toe protection



N

- Floodbanks
- Hard bank protection
- Toe protection
- Soft bank protection
- Weir / Ford
- Bridge
- Limits of reach

Reach 08 Summary

Watercourse Name	Reach No	Restoration Priority	
River Till	08	L 21,22,23 VL 20	
Location	**NGR**	**Channel length**	
Chillingham Barns to u/s Lilburn confl	NU044260 to NU053232	8.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	20,21,22,23	Supply (22,23)	Moderate (22,23)
		Storage (21)	Low (21)
Key Pressures			
Floodbanks one side c80%, small lengths both banks; hard engineered banks at two sites			
Pressure score	**Reach impact severity**		
Low	Low		
Principal restoration issues		**Potential restoration options**	
Sections of floodbank	Prevent connection to floodplain and potential lateral channel movement	Alternative management of floodbanks e.g. realignment or set back floodbanks at meander bends to create erodible corridor; further lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment	
Extensive poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering. Riparian planting	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Relative costs of restoration		L	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 08

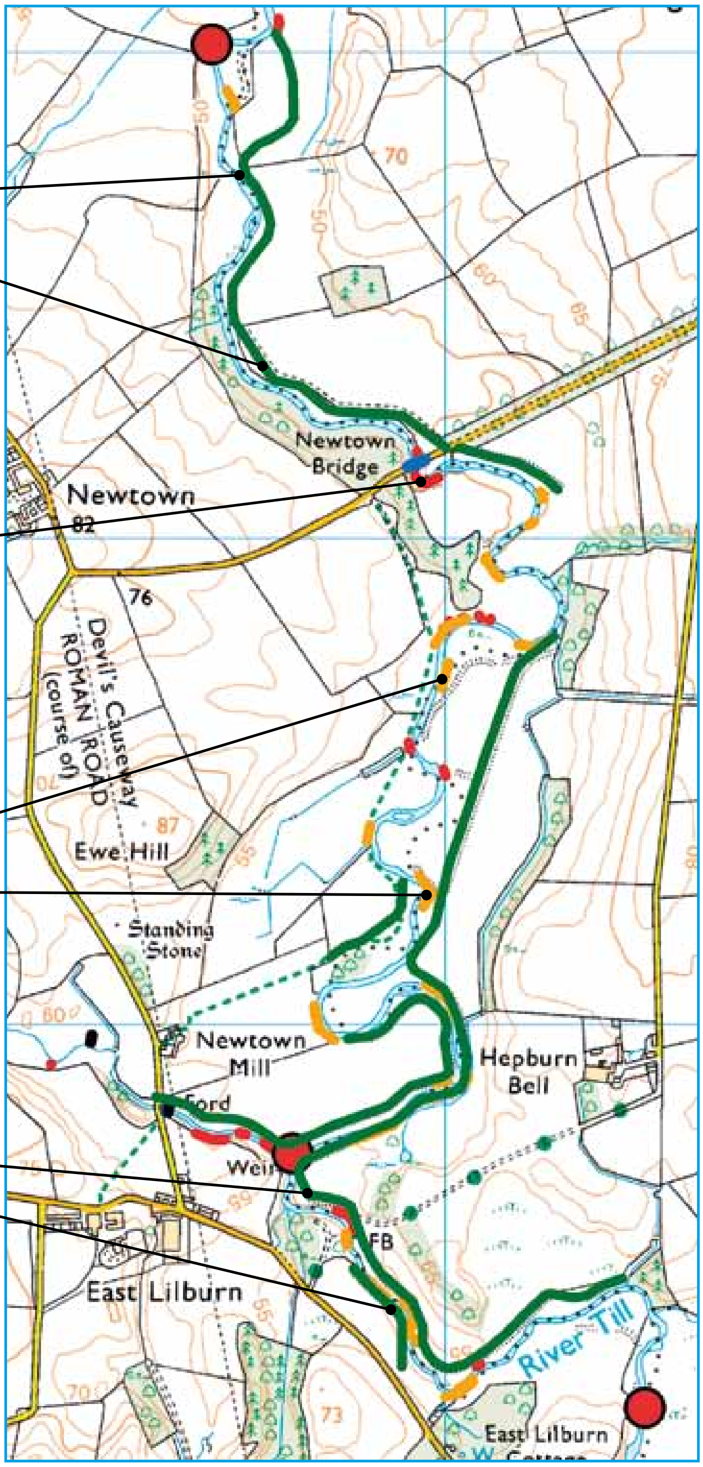
River Till : Chillingham Barns to u/s Lilburn confluence

Extensive floodbanks

Hard Bank protection

Sporadic bank & toe protection

Channel bounded by floodbanks



N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

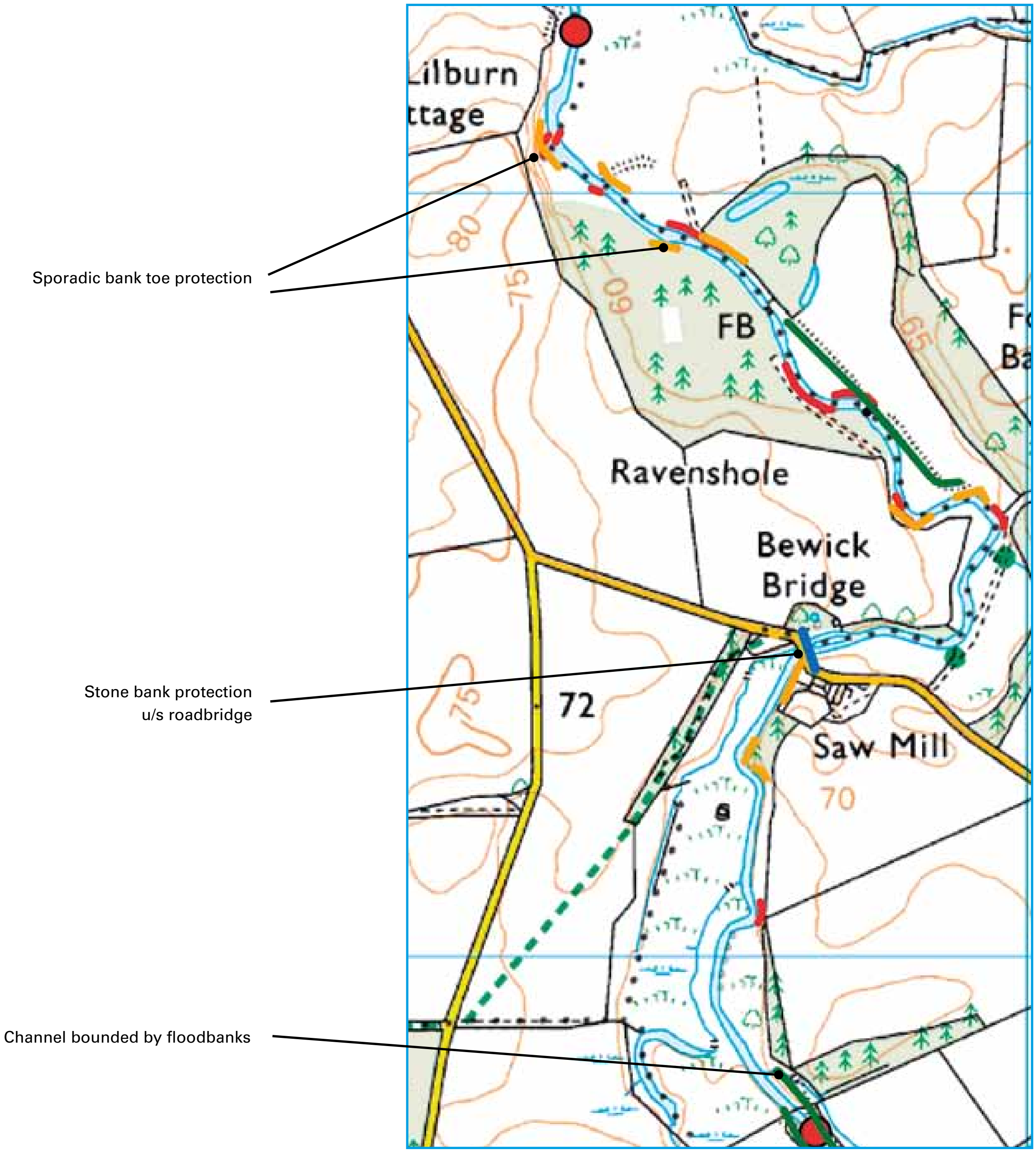
Reach 09 Summary

Watercourse Name	Reach No	Restoration Priority	
River Till	09	L	
Location	**NGR**	**Channel length**	
u/s Lilburn confluence to u/s Bewick Bridge	NU053232 to NU058218	2km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	23	supply	medium
Key Pressures			
Floodbanks east side 70%, both sides 10%; sporadic toe protection u/s Newtown Bridge; occasional hard bank protection; roadbridge			
Pressure score	**Reach impact severity**		
Low	Low, Very low, Moderate		
Principal restoration issues		**Potential restoration options**	
Floodbanks along one or both banks	Prevent connection to floodplain and potential lateral channel movement.	Potential for removal/breaching floodbanks, creating erodible corridor to adjacent higher ground.	
Localised stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.). Riparian planting	
Localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Minor boulder/riprap weir structure	Interrupts longitudinal channel connectivity.	Remove or modify weir structure.	
Relative costs of restoration		L	
Potential constraints on restoration options.			
Create erodible corridor	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Remove hard bank protection;	Cost. Potential short-term bank instability. Risk to infrastructure		
Soft engineering / ELJs	Ensuring design will resist high flows.		
Remove minor weir	Potential for bed and / or bank erosion upstream.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 09

River Till : u/s Lilburn confluence to u/s Bewick Bridge



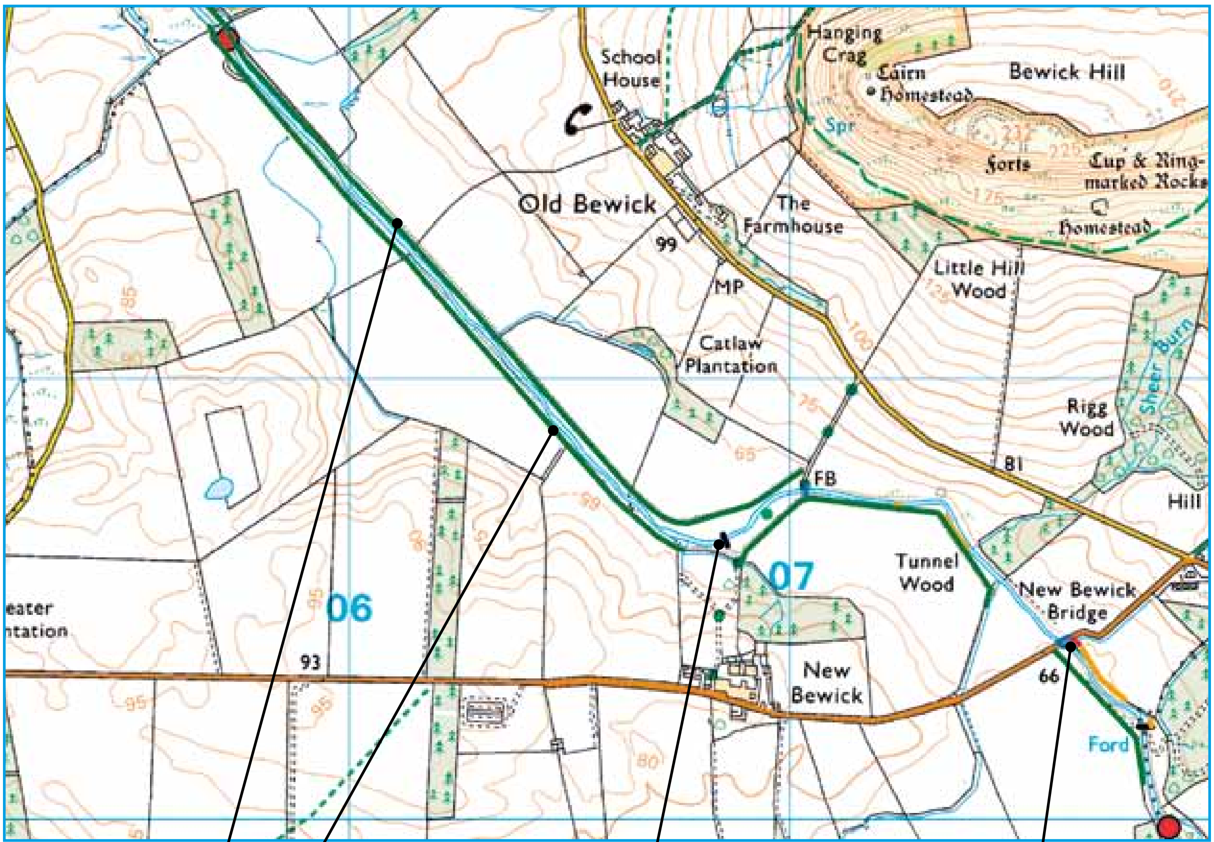
- Floodbanks
- Hard bank protection
- Toe protection
- Soft bank protection
- Weir / Ford
- Bridge
- Limits of reach

Reach 10 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	10	M	
Location	NGR	Channel length	
u/s Bewick Bridge to Harehope	NU058218 to NU079200	3km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain	24	Transport	Low
Key Pressures			
Floodbanks both sides 70%, one side 25%; some hard engineered banks, straightened channel			
Pressure score	Reach impact severity		
Moderate	Moderate		
Principal restoration issues		Potential restoration options	
Straightened and embanked channel.	Restriction of lateral mobility & interaction/connectivity with floodplain; very limited opportunities for sediment storage	Set back floodbanks to enable development of meanders or /re-meander reach. Install ELJs to improve sediment storage	
Localised poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Hard bank protection	Prevents lateral channel processes	Remove hard bank protection and replace with ELJs where erosion threatens infrastructure	
Minor boulder/riprap weir structure	Interrupts longitudinal channel connectivity.	Remove minor weir structure.	
Relative costs of restoration		L	
Potential constraints on restoration options.			
Set back floodbanks	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Remove weir	Potential for bed and / or bank erosion upstream		
Remove hard protection	Cost. Potential short-term bank instability. Risk to infrastructure. Crossing point for major gas pipeline.		
Install ELJs	Ensuring design will resist high flows. Visual impact.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 10

River Till : u/s Bewick Bridge to Harehope



Straightened channel bounded by floodbanks

Farm access fords

Stone bank protection u/s roadbridge

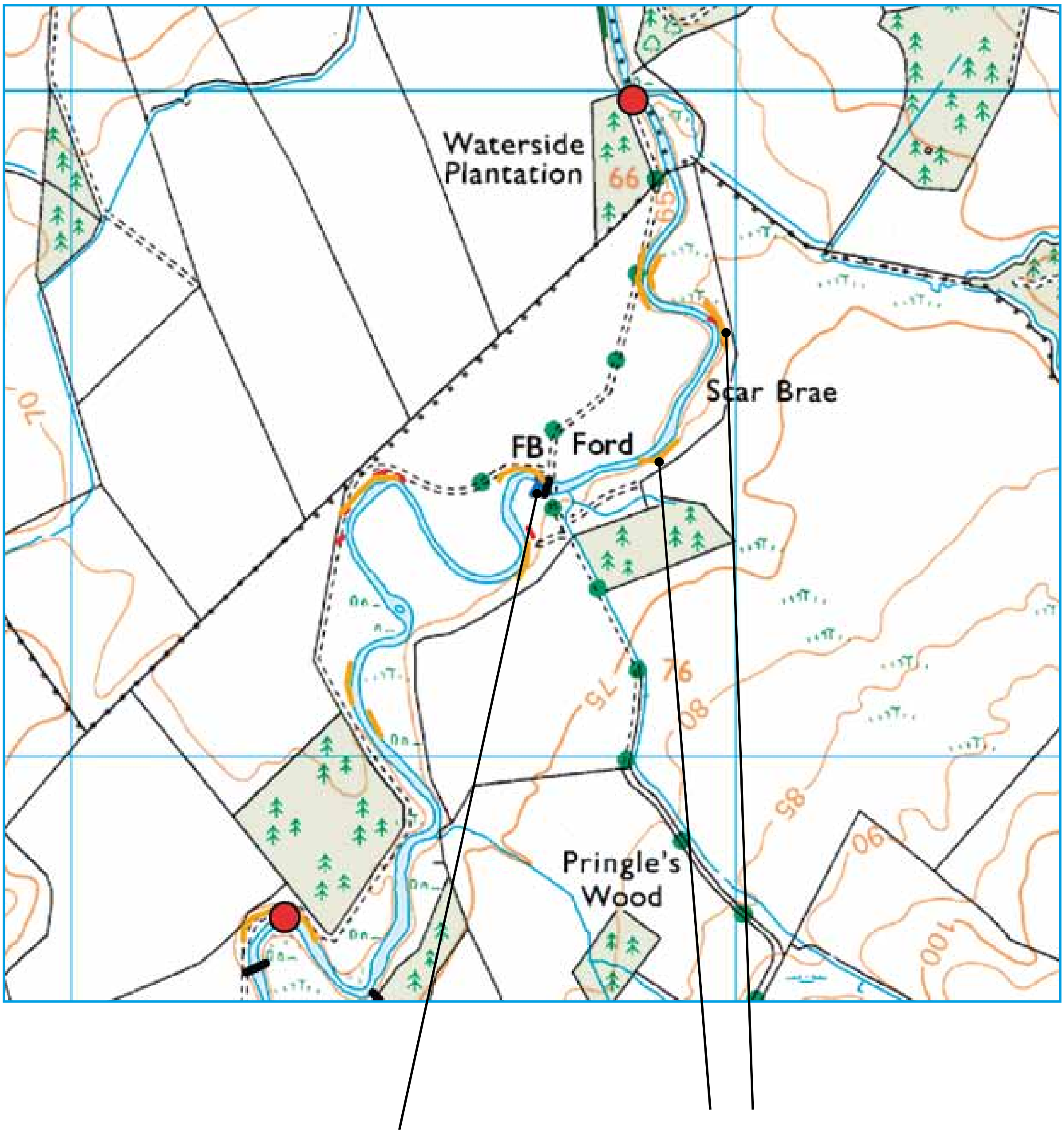
N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 11 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Till	11	L	
Location	NGR	Channel length	
Harehope to Beanley	NU079200 to NU074188	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont Wandering	25	Supply	Moderate
Key Pressures			
No floodbanks or hard engineered banks; potential former gravel workings			
Pressure score	Reach impact severity		
Low	Low		
Principal restoration issues		Potential restoration options	
Extensive poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering). Riparian planting	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Relative costs of restoration			
Potential constraints on restoration options.			
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 11
River Till : Harehope to Beanley



Access ford

Extensive intermittent bank toe protection

N

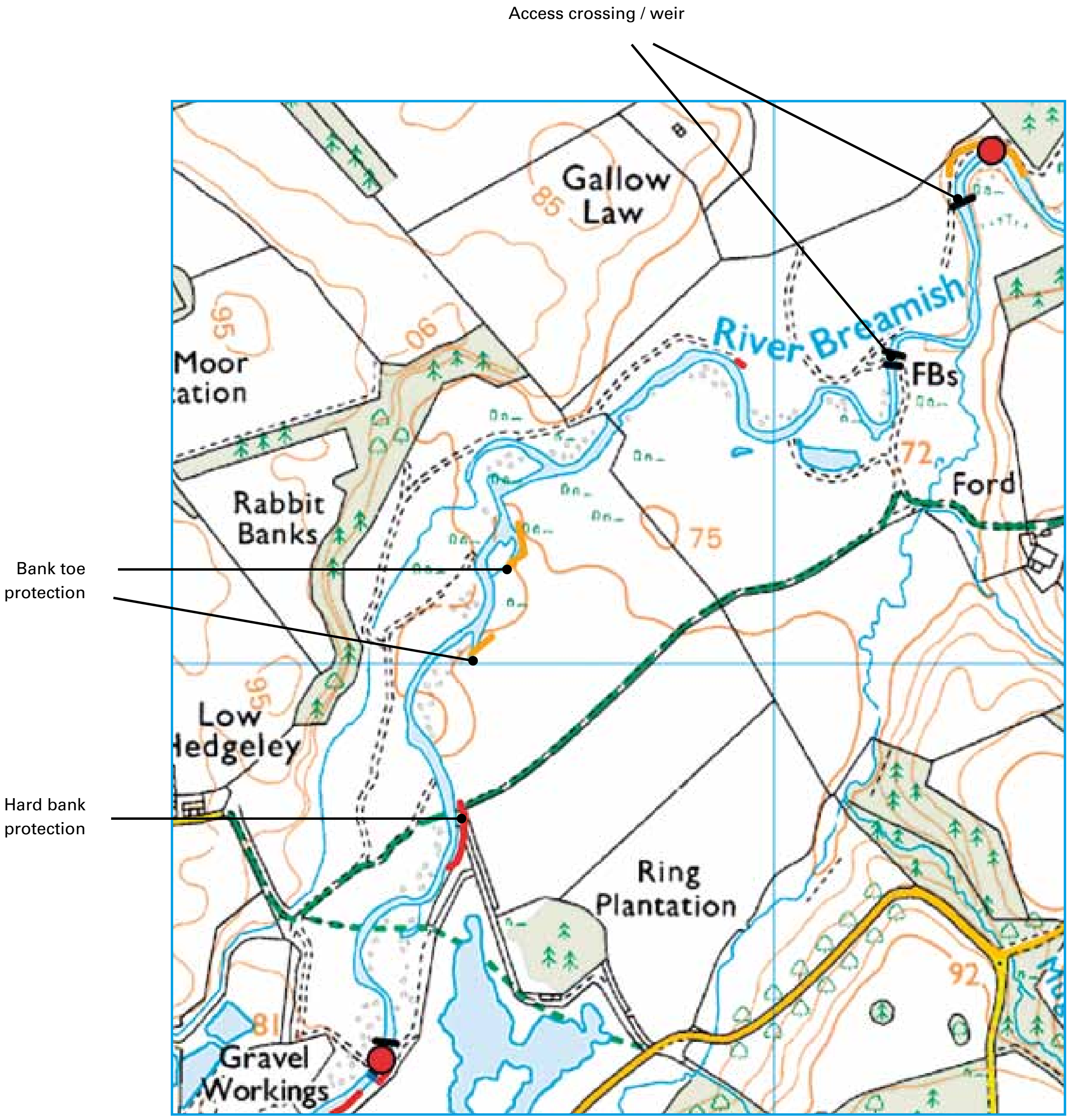
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 12 Summary

Watercourse Name	Reach No	Restoration Priority	
River Breamish	12	L 25 H 26	
Location	**NGR**	**Channel length**	
Beanley to Hedgeley	NU074188 to NU064174	3km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont Wandering	25, 26	Storage	Very high
Key Pressures			
No floodbanks; hard engineered banks, gravel workings,			
Pressure score	**Reach impact severity**		
Moderate	High		
Principal restoration issues		**Potential restoration options**	
Culvert bridge and armoured ramp	Restricts channel / bed processes, including sediment transport.	Remove bridge & ramp (or replace with more appropriate structure to facilitate ongoing access if required)	
Stock access. Extensive poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering).Riparian planting	
Localised riprap on meander bends	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure or as temporary protection whilst vegetation becomes re-established.	
Former gravel extraction	Residual changes to channel planform and floodplain structure.	Assist to re-establish natural form & function with actions above.	
Relative costs of restoration		H M	
Potential constraints on restoration options.			
Culvert removal / modification	Cost. Potential ongoing access requirements. Short-term risk to upstream channel stability.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 12
River Breamish : Beanley to Hedgeley



N

Floodbanks	green line
Hard bank protection	red line
Toe protection	orange line
Soft bank protection	light green line
Weir / Ford	black line
Bridge	blue line
Limits of reach	red circle

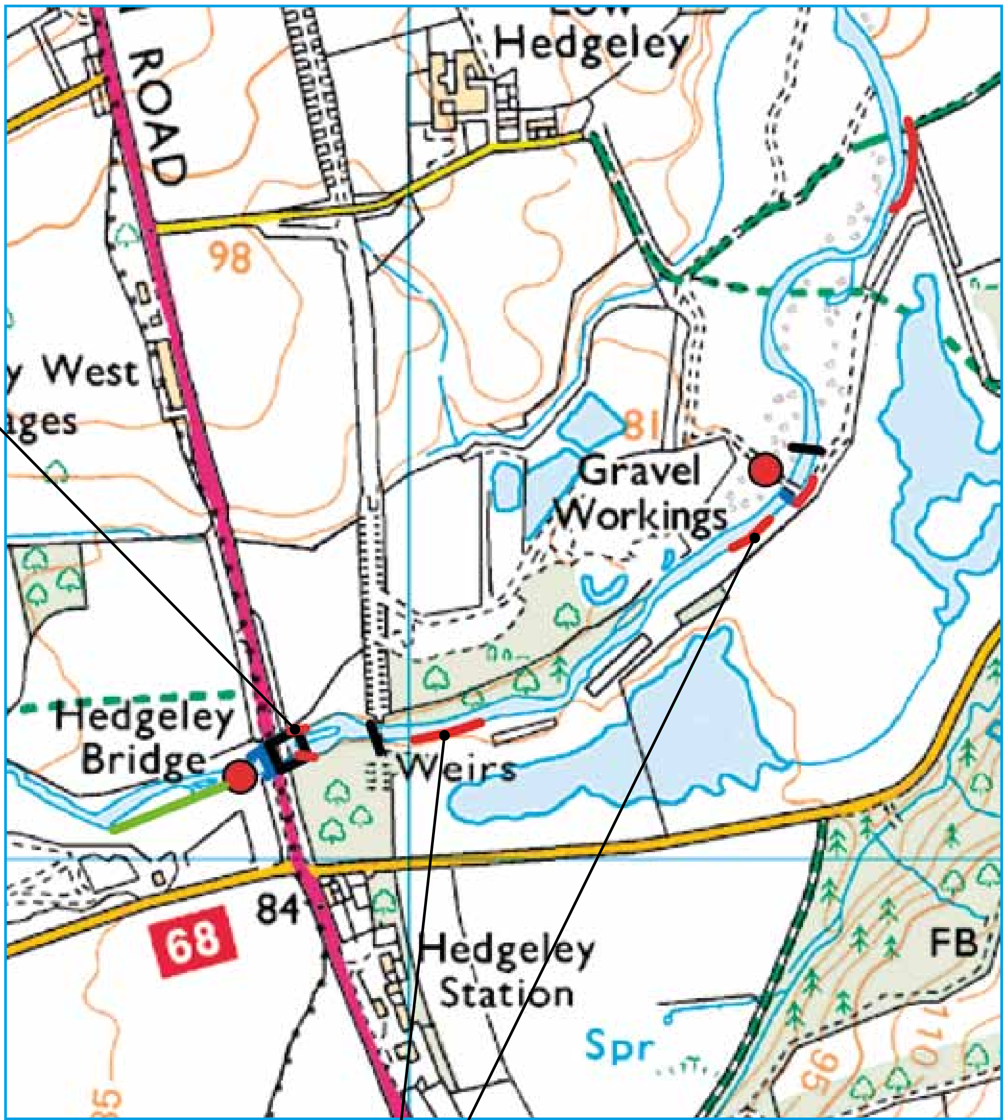
Reach 13 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Breamish	13	VH	
Location	NGR	Channel length	
Powburn bridges	NU064174 to NU058171	3km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont Wandering	27	Transport	Low
Kay Pressures			
Road & ex railway bridges, footings & sills			
Pressure score	Reach impact severity		
Very High	Very High		
Principal restoration issues		Potential restoration options	
Major bridge footings/weir at road bridge and former railway bridge, Hedgeley.	Restrict sediment transport and channel / bed processes.	Undertake assessment to determine potential and benefits of further modification of footings / weir.	
Localised riprap	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure.	
Former gravel extraction u/s and d/s.	Residual changes to channel planform and floodplain structure.	Install bar-apex ELJs. Assist to re-establish natural form & function with actions reach 12.	
Relative costs of restoration		H M	
Potential constraints on restoration options.			
Weir / footings modification	Cost. Priority to road infrastructure..		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 13

River Breamish : Powburn bridges

Major bridge footings & apron



Hard bank protection

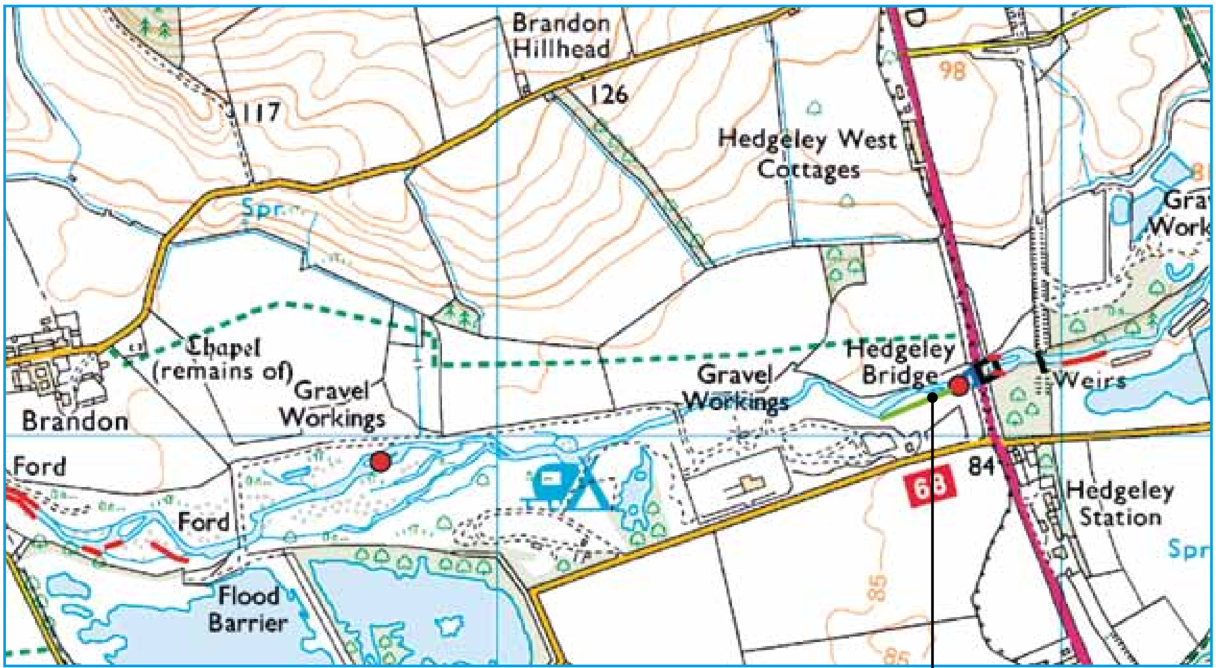
N

- Floodbanks
- Hard bank protection
- Toe protection
- Soft bank protection
- Weir / Ford
- Bridge
- Limits of reach

<table>
<tr><th colspan="4">Reach 14 Summary</th></tr>
<tr><td>Watercourse Name</td><td>Reach No</td><td colspan="2">Restoration Priority</td></tr>
<tr><td>River Breamish</td><td>14</td><td colspan="2">L</td></tr>
<tr><td>Location</td><td>NGR</td><td colspan="2">Channel length</td></tr>
<tr><td>Ingram to u/s Boulby Wood</td><td>NU016164 to NNU002167</td><td colspan="2">2km</td></tr>
<tr><td colspan="4">Geomorphological summary</td></tr>
<tr><td>Till River Type</td><td>Geomorphological sub reaches</td><td>Dominant process</td><td>Process intensity</td></tr>
<tr><td>Montane confined</td><td>30</td><td>Transport</td><td>High</td></tr>
<tr><td colspan="4">Key Pressures</td></tr>
<tr><td colspan="4">Hard engineered banks at roadbridge; soft engineering and gravel realignment</td></tr>
<tr><td>Pressure score</td><td colspan="3">Reach impact severity</td></tr>
<tr><td>Very low</td><td colspan="3">Low</td></tr>
<tr><td colspan="2">Principal restoration issues</td><td colspan="2">Potential restoration options</td></tr>
<tr><td>Hard bank protection</td><td>Prevents lateral channel processes</td><td colspan="2">Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure.
Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure.</td></tr>
<tr><td>Localised post-flood channel realignment / bank protection.</td><td>Results in channel instability and potential for significant changes in flood flows.</td><td colspan="2">Review development of channel to inform establishment of erodible river corridor. Encourage recruitment of stabilising large wood features.</td></tr>
<tr><td colspan="4">Potential constraints on restoration options.</td></tr>
<tr><td>Post flood works</td><td colspan="3">Urgency to maintain infrastructure.</td></tr>
<tr><td>Remove hard bank protection</td><td colspan="3">Cost. Potential short-term bank instability. High risk to infrastructure</td></tr>
</table>

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 14
Powburn to d/s Brandon ford



Soft bank protection / groynes

N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

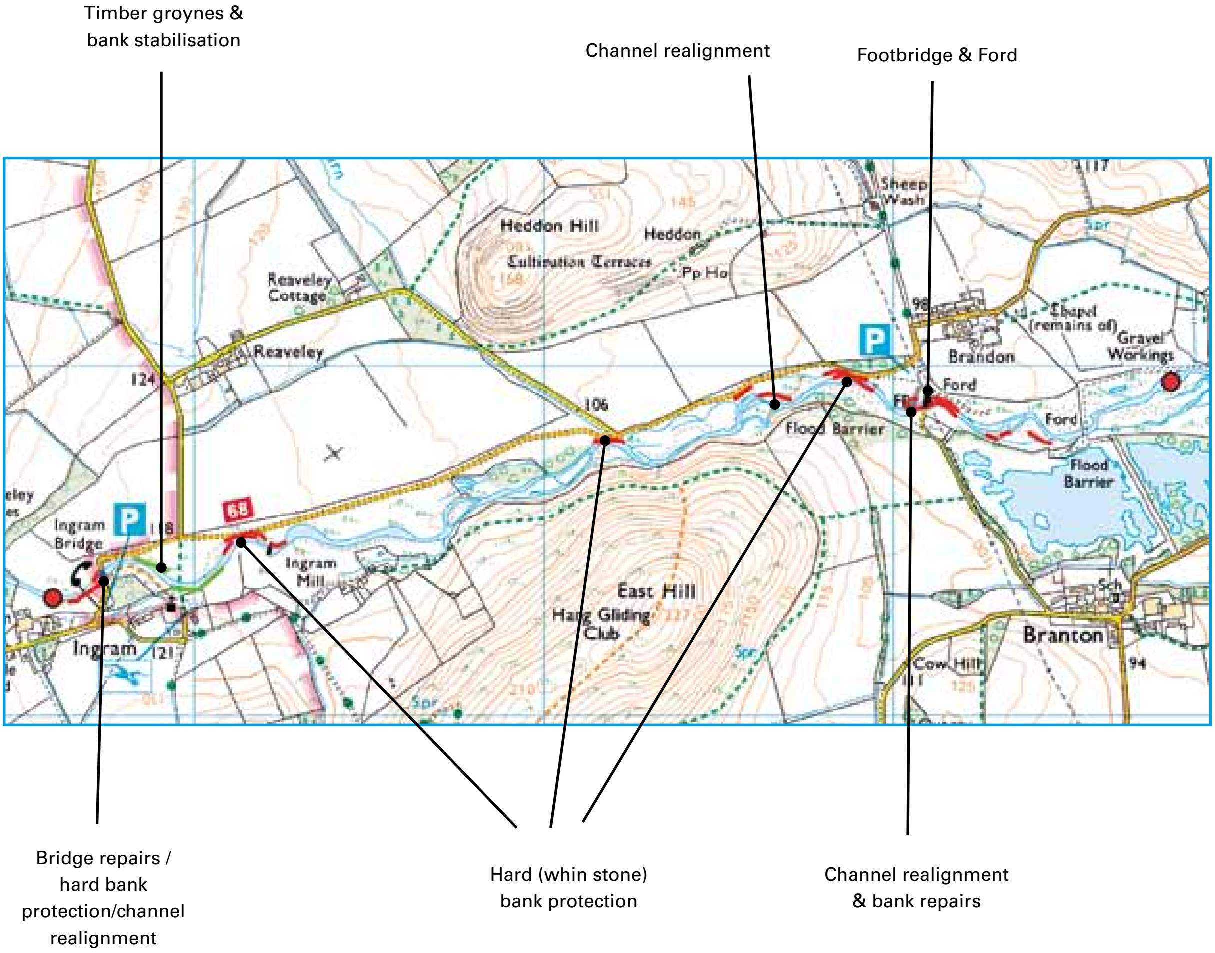
Reach 15 Summary

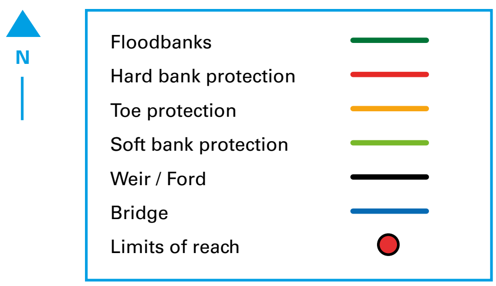
Watercourse Name	Reach No	Restoration Priority	
River Breamish	15	VH 28 M 29	
Location	**NGR**	**Channel length**	
D/s Brandon ford to Ingram	NU048169 to NU016164	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont Wandering	28,29	Storage	Very high
Key Pressures			
Major hard engineered bank (road) protection and gravel realignment			
Pressure score	**Reach impact severity**		
Low	Moderate		
Principal restoration issues		**Potential restoration options**	
Hard bank protection	Prevents lateral channel processes	Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure.	
Localised post-flood channel realignment / bank protection.	Results in channel instability and potential for significant changes in flood flows.	Review development of channel to inform establishment of erodible river corridor. Encourage recruitment of stabilising large wood features. Establish long term response plan to secure infrastructure; consider options for re-routing infrastructure (power lines, road).	
Footbridge with in-channel piers.	Influences sediment transport / deposition encouraging lateral migration (bank erosion).	Remove footbridge or replace with single span structure	
Timber groyne structures	Installed post-flood to stabilise channel line.	Review effectiveness of timber groynes and identify any beneficial improvements.	
Minor weir structure	Local impacts on channel / bed processes.	Remove minor weir structure.	
Stock access to banks and bed.	Reduces vegetation cover, increasing risk of erosion / instability.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	
Relative costs of restoration		M H	
Potential constraints on restoration options.			
Footbridge	Cost. Priority to rights of way.		
Post flood works	Urgency to maintain infrastructure.		
Remove hard bank protection	Cost. Potential short-term bank instability. High risk to infrastructure		
Alternative stock management	Loss of grazing. Loss of fencing due to floods / cost of replacement.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 15

River Breamish : d/s Brandon ford to Ingram





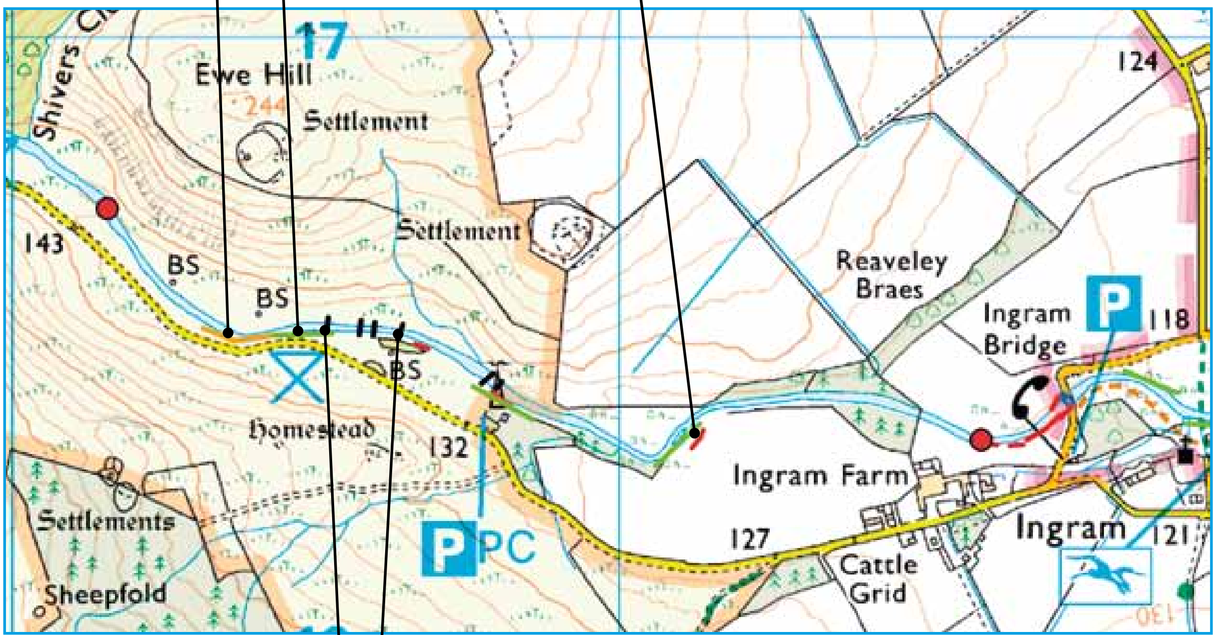
Reach 16 Summary			
Watercourse Name	**Reach No**	**Restoration Priority**	
River Breamish	16	VH 28 M 29	
Location	**NGR**	**Channel length**	
D/s Brandon ford to Ingram	NU048169 to NU016164	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont Wandering	28,29	Storage	Very high
Key Pressures			
Major hard engineered bank (road) protection and gravel realignment			
Pressure score	**Reach impact severity**		
Low	Moderate		
Principal restoration issues		**Potential restoration options**	
Hard bank protection	Prevents lateral channel processes	Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure.	
Localised post-flood channel realignment / bank protection.	Results in channel instability and potential for significant changes in flood flows.	Review development of channel to inform establishment of erodible river corridor. Encourage recruitment of stabilising large wood features. Establish long term response plan to secure infrastructure; consider options for re-routing infrastructure (power lines, road).	
Footbridge with in-channel piers.	Influences sediment transport / deposition encouraging lateral migration (bank erosion).	Remove footbridge or replace with single span structure	
Timber groyne structures	Installed post-flood to stabilise channel line.	Review effectiveness of timber groynes and identify any beneficial improvements.	
Minor weir structure	Local impacts on channel / bed processes.	Remove minor weir structure.	
Stock access to banks and bed.	Reduces vegetation cover, increasing risk of erosion / instability.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.)	
Relative costs of restoration		M H	
Potential constraints on restoration options.			
Footbridge	Cost. Priority to rights of way.		
Post flood works	Urgency to maintain infrastructure.		
Remove hard bank protection	Cost. Potential short-term bank instability. High risk to infrastructure		
Alternative stock management	Loss of grazing. Loss of fencing due to floods / cost of replacement.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 16
River Breamish : Ingram to u/s Boulby Wood

Hard & soft bank protection

Channel / bank reinstatement



Minor 'weirs'

N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 17 Summary

Watercourse Name	Reach No	Restoration Priority	
River Breamish	17	L 30 VL 31,32	
Location	**NGR**	**Channel length**	
Boulby Wood to SAC limit	NU002167 to NT959159	6.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Montane confined & bedrock cascade	30,31,32	Transport	High (30) Moderate (31) Low (32)
Key Pressures			
Local hard bank protection at roadbridge;			
Pressure score	**Reach impact severity**		
Very low	Very Low		
Principal restoration issues		**Potential restoration options**	
Hard bank protection	Prevents lateral channel processes	Remove hard bank protection and replace with ELJs or softer engineering where erosion threatens infrastructure.	
Localised post-flood gravel movement	Affects channel stability; potential for significant changes in flood flows.	Establish agreed plan for channel management at specific sites (e.g. Peggys Bridge)	
Potential constraints on restoration options.			
Remove hard bank protection	Cost. Potential short-term bank instability. High risk to infrastructure		
Gravel movement.	Local delivery.		

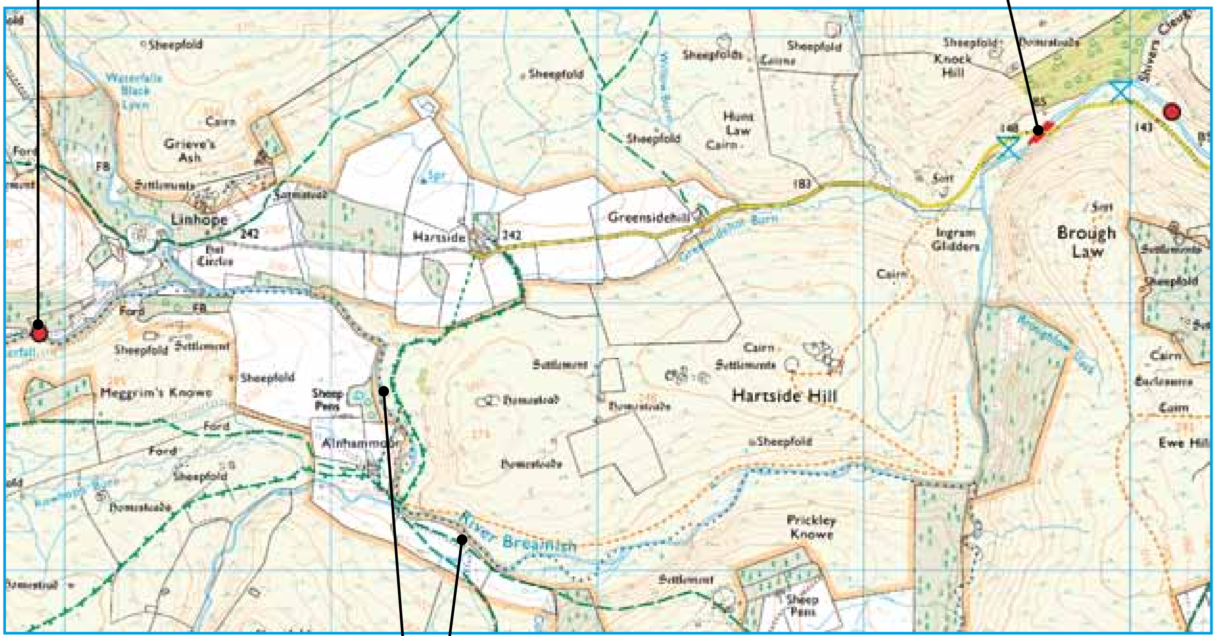
NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 17

River Breamish : u/s Boulby Wood to SAC limit

SAC limit

Hard bank protection at roadbridge



Minor gravel reinstatement of banks

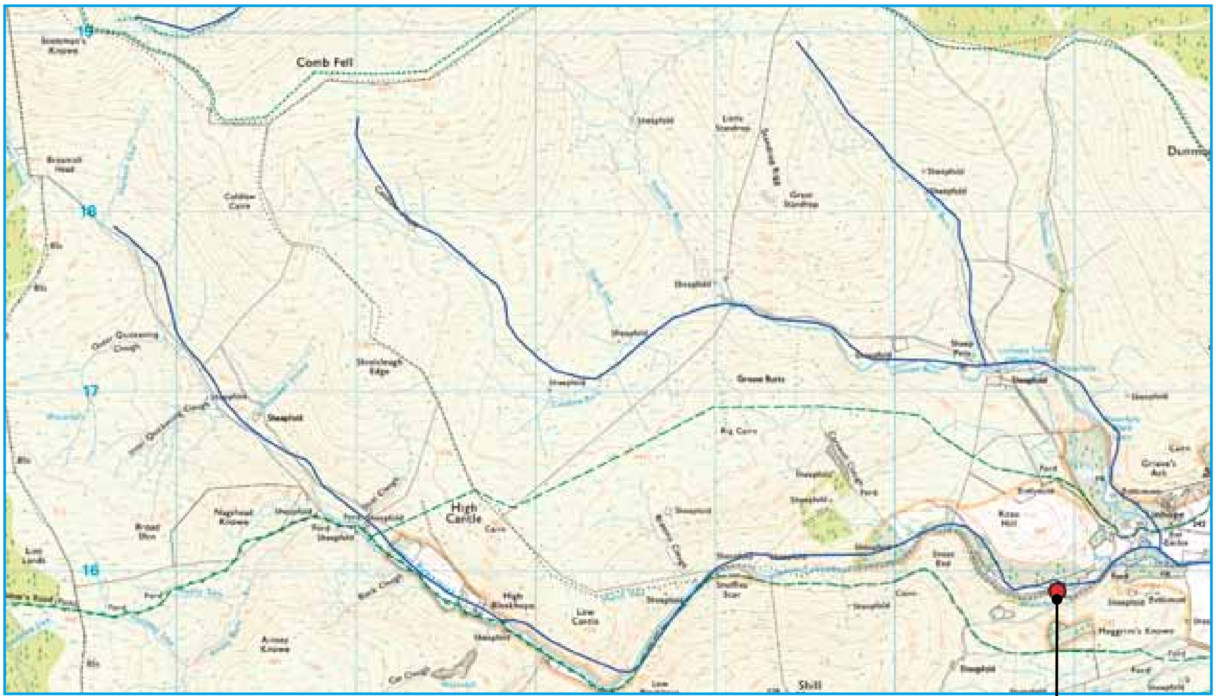
N

- Floodbanks
- Hard bank protection
- Toe protection
- Soft bank protection
- Weir / Ford
- Bridge
- Limits of reach

Reach 18 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Breamish	18	L 30 VL 31,32	
Location	NGR	Channel length	
u/s SAC limit	NT959159 to –	—	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Bedrock cascade	–	–	– – –
Key Pressures			
Potential for land management changes to affect downstream hydrology. Locally significant post-flood bank realignment and hard bank protection to access road.			
Pressure score	Reach impact severity		
–	–		
Principal restoration issues		Potential restoration options	
Potential for changes of land use.	Changes e.g. forestry, upland drainage, could affect runoff rates & volumes, with impacts on d/s flood flows.	Maintain watching brief & consider implications of any future proposed changes.	
Hard bank protection	Prevents lateral channel processes	Consider potential for relocating access road; then remove hard bank protection and replace with ELJs.	
Potential constraints on restoration options.			
Watching brief on potential land use changes.	Requires an effective consultation processes.		
Remove hard bank protection	High risk to infrastructure (access road). Cost. Potential short-term bank instability.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 18
River Breamish : upstream of SAC limit



SAC limit

N

Floodbanks	dark green line
Hard bank protection	red line
Toe protection	orange line
Soft bank protection	light green line
Weir / Ford	black line
Bridge	blue line
Limits of reach	red circle

Reach 19 Summary			
Watercourse Name	Reach No	Restoration Priority	
River Glen	19	M 33,34 H 35,36	
Location	NGR	Channel length	
Till confluence to Coupland	NT976325 to NT938309	8km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain & Piedmont wandering	33,34,35,36	Supply (33,34) Transport (35,36)	Low
Key Pressures			
Flood banks to c100% of both sides; sporadic hard toe protection; local soft bank protection; stock access			
Pressure score	Reach impact severity		
Moderate (33,34)	Moderate (33,34)		
Principal restoration issues		Potential restoration options	
Extensive floodbanks	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting.	
Incised channel	Prevents connection to floodplain and affects in-channel processes	Install bar-apex ELJs. Monitor operation / effectiveness Re-meander straightened sections.	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Relative costs of restoration		M H	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Re-meander straightened channel	High costs. Potential impacts on farming practices / productivity.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

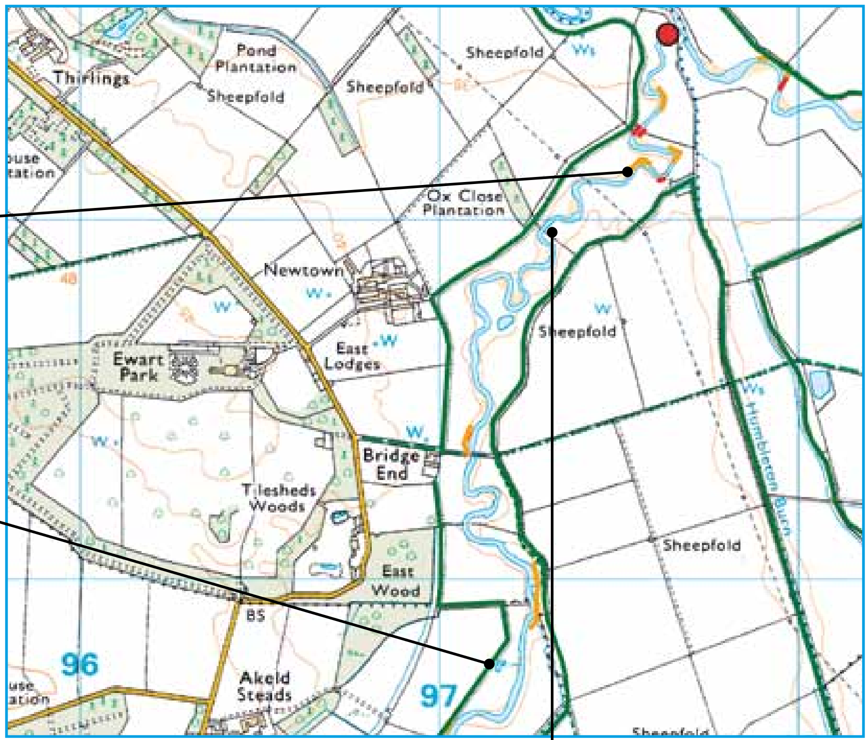
NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 19

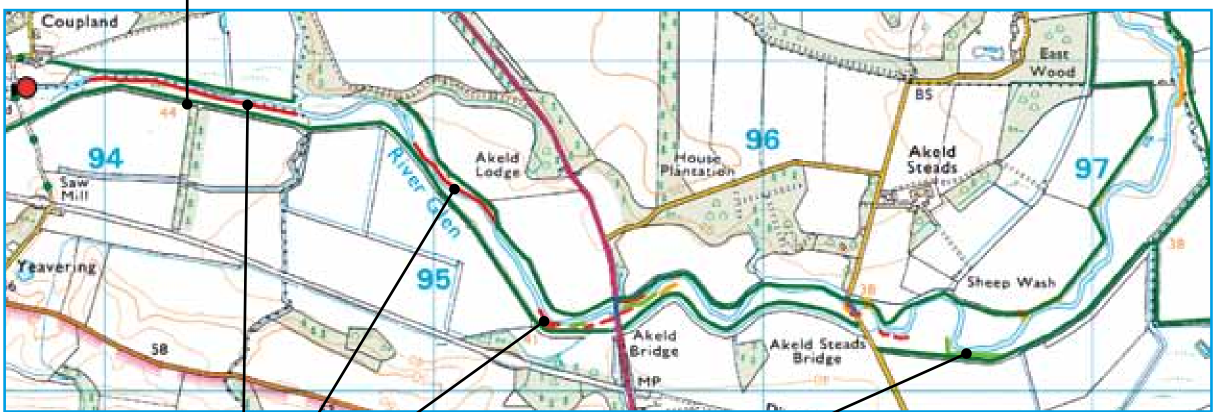
River Glen : Till confluence to Coupland

Bank toe protection

Channel bounded by floodbanks on both sides



Incised channel



Hard bank / toe protection

Soft bank protection

N

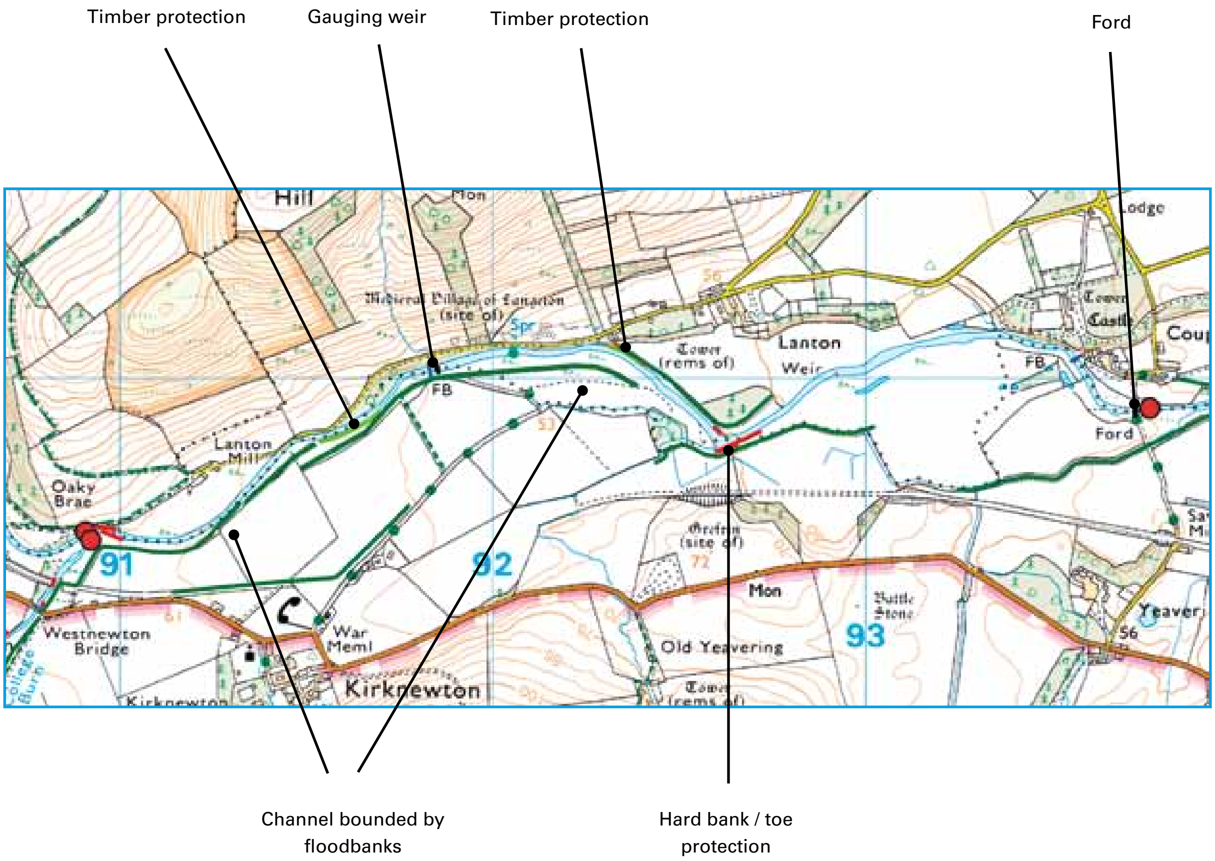
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 20 Summary			
Watercourse Name	**Reach No**	**Restoration Priority**	
River Glen	20	M	
Location	**NGR**	**Channel length**	
Coupland to confluence with College Burn	NT938309 to NT909305	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	37	Transport	Moderate
Key Pressures			
Floodbanks along c30%; toe protection, gauging weir; soft engineering; avulsion			
Pressure score	**Reach impact severity**		
Moderate	Moderate		
Principal restoration issues		**Potential restoration options**	
Floodbanks along right bank (south side of floodplain is lower than current channel).	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks, e.g. remove or set back floodbanks to create erodible corridor; lower or designed breaching to reconnect channel to floodplain; reduced maintenance / abandonment.	
Local timber & hard bank protection.	Prevents development of natural channel form.	Review effects of existing bank protection, consider improvements/removal.	
Unstable reach	High stream energy, flood flows and sediment input from College Burn cause rapid local change to channel.	Increase riparian and floodplain tree cover / install ELJs to improve stability. Encourage sediment storage in College Burn using ELJs. Consider local gravel management plan at Westnewton Bridge (reach 24)	
Weir (Kirknewton)	Interrupts sediment transport regime	Remove or modify weir structure.	
Ford (Coupland)	Interrupts sediment transport regime	Consider local improvements to reduce impact	
Potential constraints on restoration options.			
Alternative management of floodbanks	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Providing Space for Channel Adjustment	Loss of agricultural land in short – medium term.		
Installing ELJs to improve stability	Ensuring design will resist high flows. Visual impact.		
Remove or modify weir	Potential for bed and / or bank erosion upstream. Specialist modelling of effects required.		
Reducing impact of ford	User requirements. Potential for bed and / or bank erosion upstream.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 20

River Glen: Coupland to confluence with College Burn



N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 21 Summary

Watercourse Name	Reach No	Restoration Priority	
Bowmont Water	21	L 39 VL 38	
Location	**NGR**	**Channel length**	
College Burn confluence to u/s Mindrum	NT909305 to NT843324	13km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	38.39.40	Transport	Low
Key Pressures			
Single bank : 3 short lengths of single-bank floodbank; 1 short lenth of double-bank floodbank.			
Pressure score	**Reach impact severity**		
Very low (38) Low (39.40)	Very Low (38) Low (39,40)		
Principal restoration issues		**Potential restoration options**	
Floodbank management	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Sparse riparian & corridor vegetation	Increases risk of bank instability and floodplain impacts.	Increase riparian / floodplain tree cover.	
Stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting.	
Potential ingress of fine sediment.	Potential to change nature of bed substrate and impact on ecology.	Review opportunity for CSF approach to reduce risks of excessive soil runoff.	
Weir	Impacts on channel and bed processes.	Modify / remove weir	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs.	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Remove weir	Cost. Potential short term instability. Loss of landowner amenity.		
Control input of fine sediment	Changes in farm management practices. Cost		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		

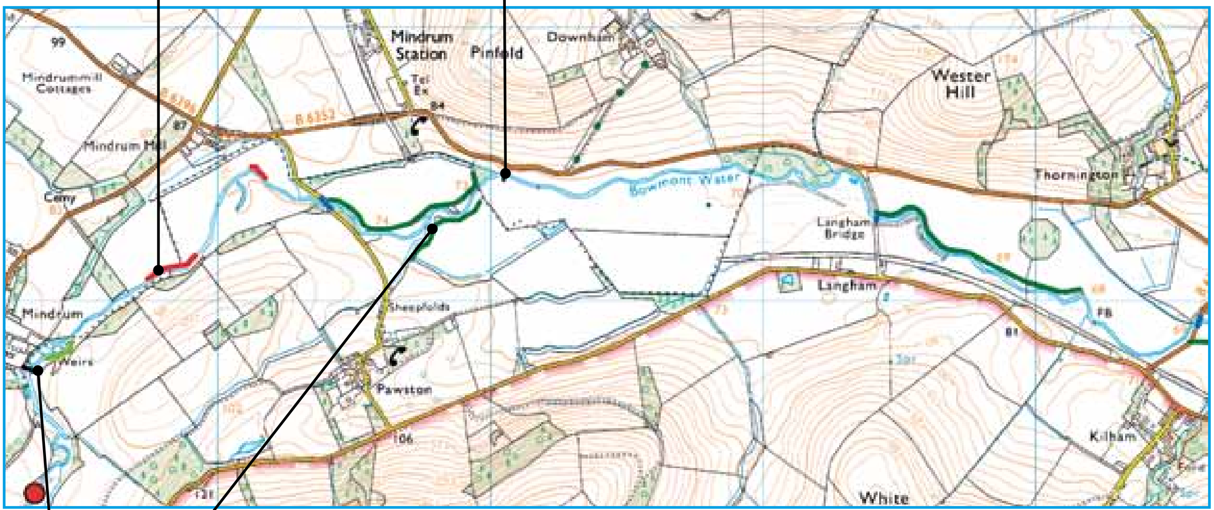
NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 21

Bowmont Water : College Burn confluence to u/s Mindrum

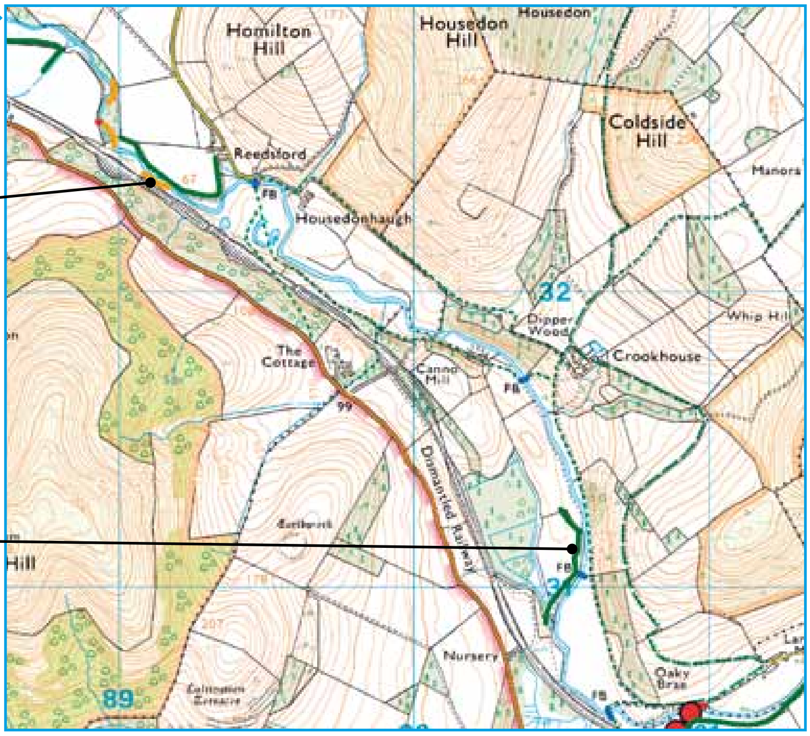
Hard bank / toe protection

Weir



Weirs

Floodbanks on both banks



Sporadic bank / toe protection

Isolated lengths of floodbank

N

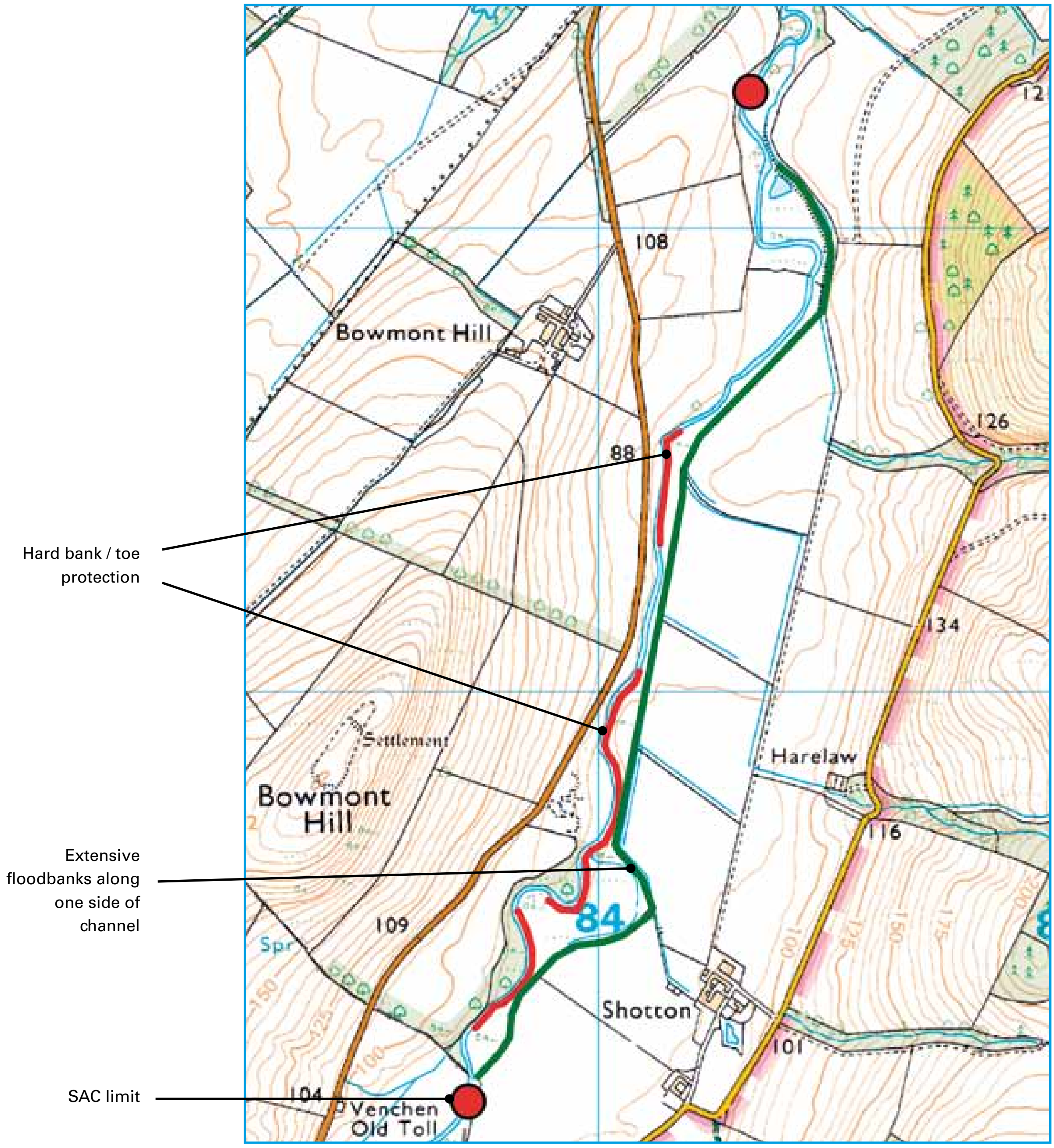
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 22 Summary			
Watercourse Name	Reach No	Restoration Priority	
Bowmont Water	22	M 41 L 39	
Location	NGR	Channel length	
u/s Mindrum to SAC limit	NT843324 to NT837302	13km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Milfield Plain & Piedmont wandering	41,42	Supply (41) Storage (42)	Low Moderate (41) High (42)
Key Pressures			
Significant length single bank floodbank; bank toe protection.			
Pressure score	Reach impact severity		
Low (41) Moderate (42)	Low (41) Moderate (42)		
Principal restoration issues		Potential restoration options	
Floodbank management	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Sparse riparian & corridor vegetation	Increases risk of bank instability and floodplain impacts.	Increase riparian / floodplain tree cover.	
Potential ingress of fine sediment.	Potential to change nature of bed substrate and impact on ecology.	Review opportunity for CSF approach to reduce risks of excessive soil runoff.	
Hard bank toe protection	Prevents lateral channel processes	Remove bank toe protection; consider installation of soft engineering or ELJs.	
Relative costs of restoration		M H	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Control input of fine sediment	Changes in farm management practices. Cost		
Remove hard bank toe protection	Cost. Potential short-term bank instability. Risk to infrastructure		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 22

Bowmont Water Till : u/s Mindrum to SAC limit



N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 23 Summary

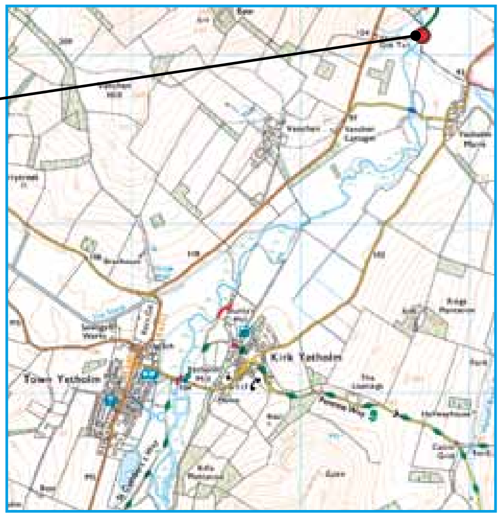
Watercourse Name	Reach No	Restoration Priority	
Bowmont Water	23	M 48,49 L 43,45 VL 44,46,47	
Location	**NGR**	**Channel length**	
u/s SAC limit	NT837302 to –	–	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering, montane floodplain, bedrock cascade	43, 44, 45, 46, 47, 48, 49	Supply (44,45,48,49) Storage (43,46,47)	Very high (46,47) High (44,45,48,49)
Key Pressures			
Culvert bridges; Ford with c2m head ; Extensive riprap protection			
Pressure score	**Reach impact severity**		
Low (45,48,49) Very low (43,44,46,47)	Moderate (49) Low (43,45) Very low (44,46,47)		
Principal restoration issues		**Potential restoration options**	
Culvert bridges	Influence sediment movement and channel / bed processes	Replace bridges with more appropriate structures (e.g. single span).	
Ford with c2m head	Restricts sediment processes and impacts on channel structure. (potential obstacle to fish movement)	Remove riprap from ford. Replace ford with single span bridge. Create weir type structures using ELJs to limit bed instability.	
Extensive hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs.	
Potential for changes of land use.	Changes e.g. forestry, upland drainage, could affect runoff rates & volumes, with impacts on d/s flood flows.	Maintain watching brief & consider implications of any future proposed changes.	
Relative costs of restoration		M H	
Potential constraints on restoration options.			
Replace culvert bridges	Cost.		
Replace / modify ford.	Cost (e.g. bridge). Suitability for users.		
Remove hard bank protection	Cost. Potential short-term bank instability.		
Watching brief on potential land use changes	Requires an effective consultation process.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 23
Bowmont Water u/s SAC limit

1

SAC limit



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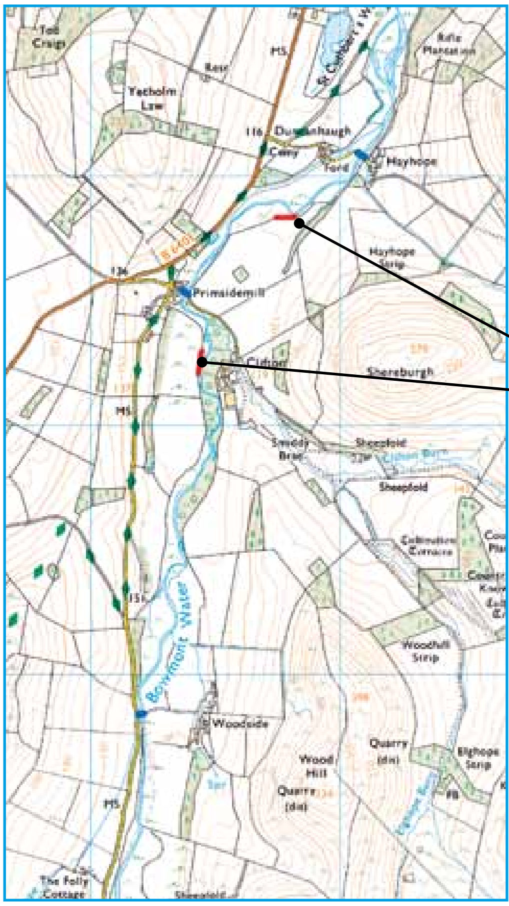
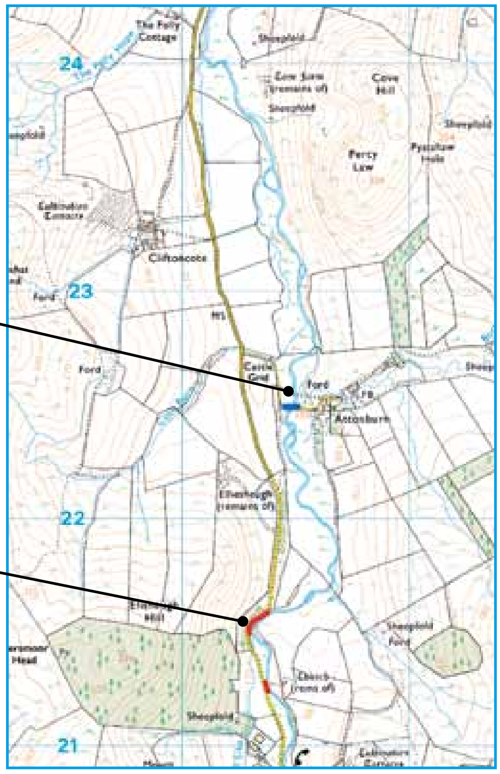


Sporadic hard bank protection

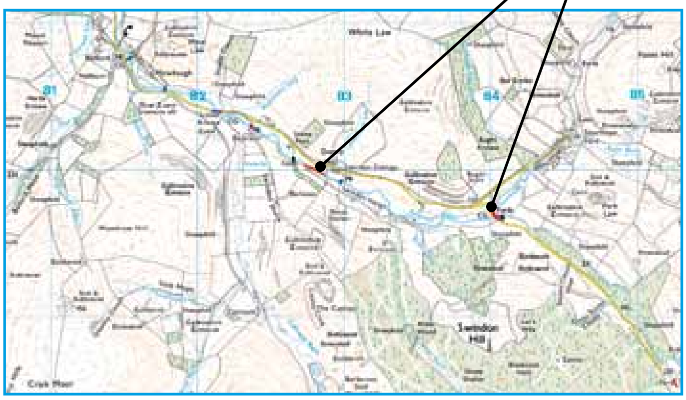
3



Ford

Hard toe/bank protection

4



N

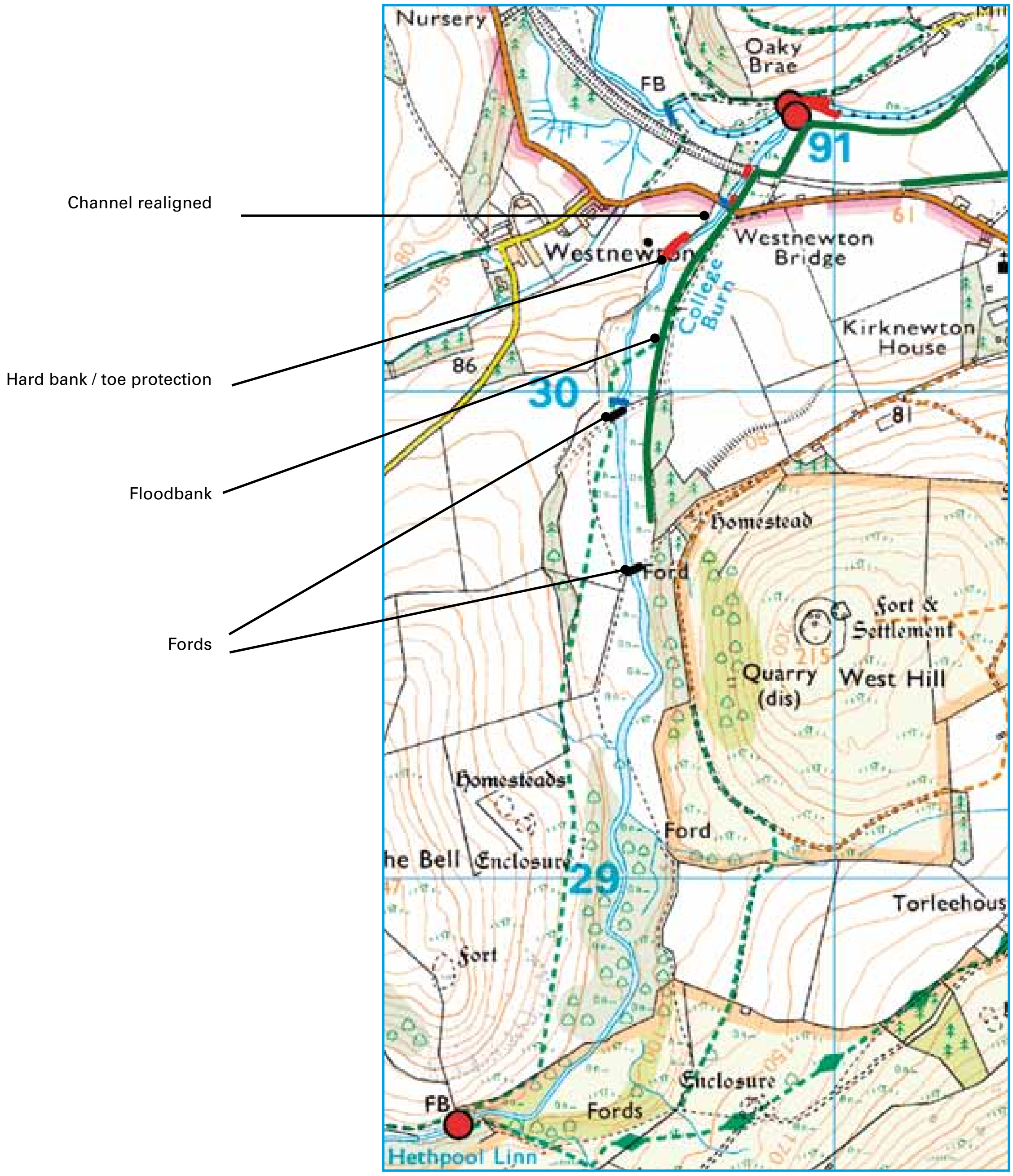
Floodbanks	dark green line
Hard bank protection	red line
Toe protection	orange line
Soft bank protection	light green line
Weir / Ford	black line
Bridge	blue line
Limits of reach	red circle

Reach 24 Summary			
Watercourse Name	Reach No	Restoration Priority	
College Burn	24	L 50 VL 51	
Location	NGR	Channel length	
Glen confluence to Hethpool	NT909305 to NT902284	8km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	50,51	Transport	Moderate
Key Pressures			
Floodbanks on c5% of length; local hard & soft bank protection; former bridge abutments			
Pressure score	Reach impact severity		
Low (50) Very low (51)	Low (50) Very low (51)		
Principal restoration issues		Potential restoration options	
Limited floodbanks	Prevent potential lateral channel movement.	Alternative management of floodbanks e.g. realignment or set back floodbanks to create erodible corridor; lowering or breaching floodbanks to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Intermittent localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Local gravel 'management'	Changes to bars and bed gravels intended to reduce bank erosion / risk to Westnewton Bridge	Limited gravel management guided by agreed, predefined actions.	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure		
Install bar-apex ELJs	Ensuring design will resist high flows.		
Local gravel management	Potential risk to infrastructure. Reliant on stakeholder support.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 24

College Burn : Glen confluence to Hethpool



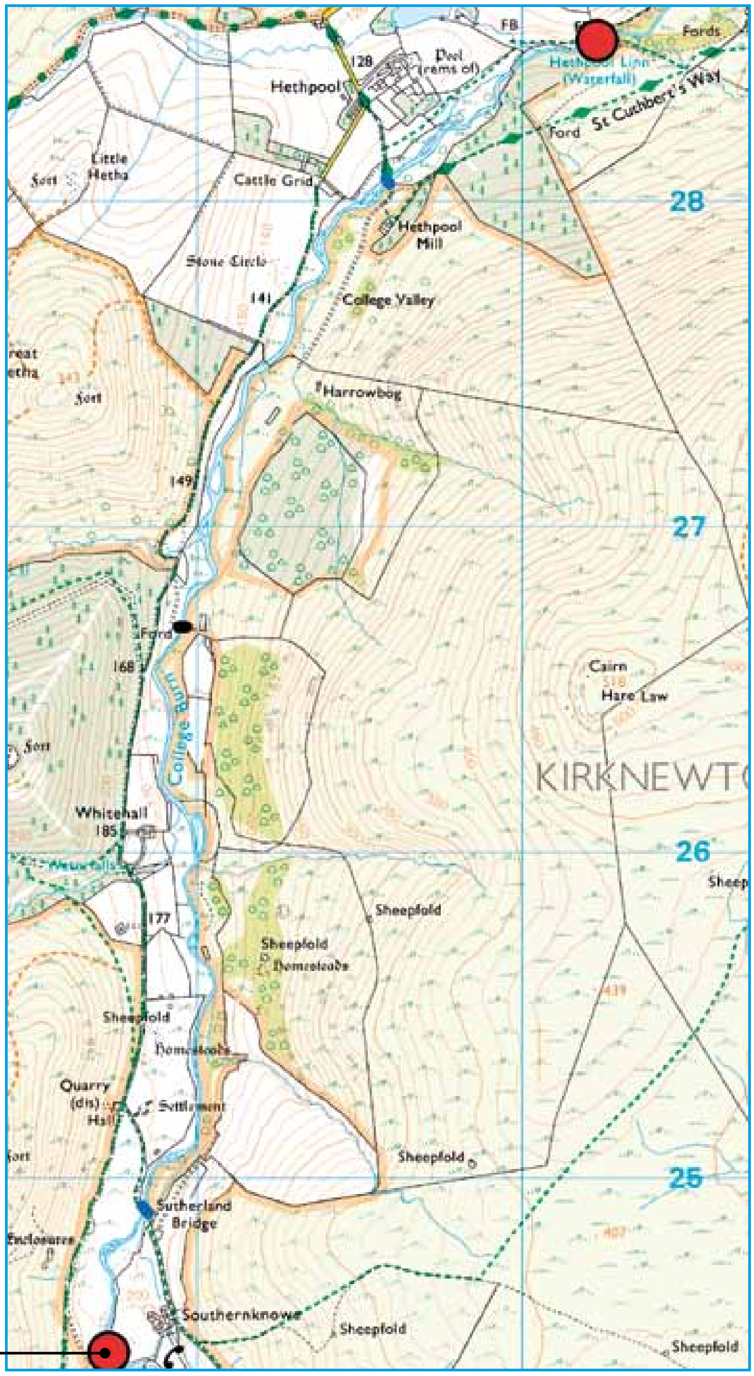
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 25 Summary			
Watercourse Name	Reach No	Restoration Priority	
College Burn	25	VL	
Location	NGR	Channel length	
Hethpool to SAC limit	NT904284 to NT887244	4km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	52,53	Transport	Moderate (52) Low (53)
Key Pressures			
–			
Pressure score	Reach impact severity		
Very low	Low		
Principal restoration issues		Potential restoration options	
Extreme sediment transport	The combination of stream energy and sediment inputs results in high level of sediment transfer into River Glen.	Establish agreed gravel management regime in lowest reach. Install bar-apex ELJs. Monitor operation / effectiveness.	
Rapid and extreme response to heavy rainfall events.	Prevents lateral channel processes Subcatchment landform and stream gradient result in rapid runoff, creating impacts in River Glen.	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Potential constraints on restoration options.			
Reduce sediment transfer issues	Ensuring design of bar-apex ELJs will resist high flows. Local gravel management is reliant on stakeholder support		
Reduce extreme hydrological response	Extent & sensitivity of subcatchment.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 25

College Burn : Hethpool to SAC limit



SAC limit

N

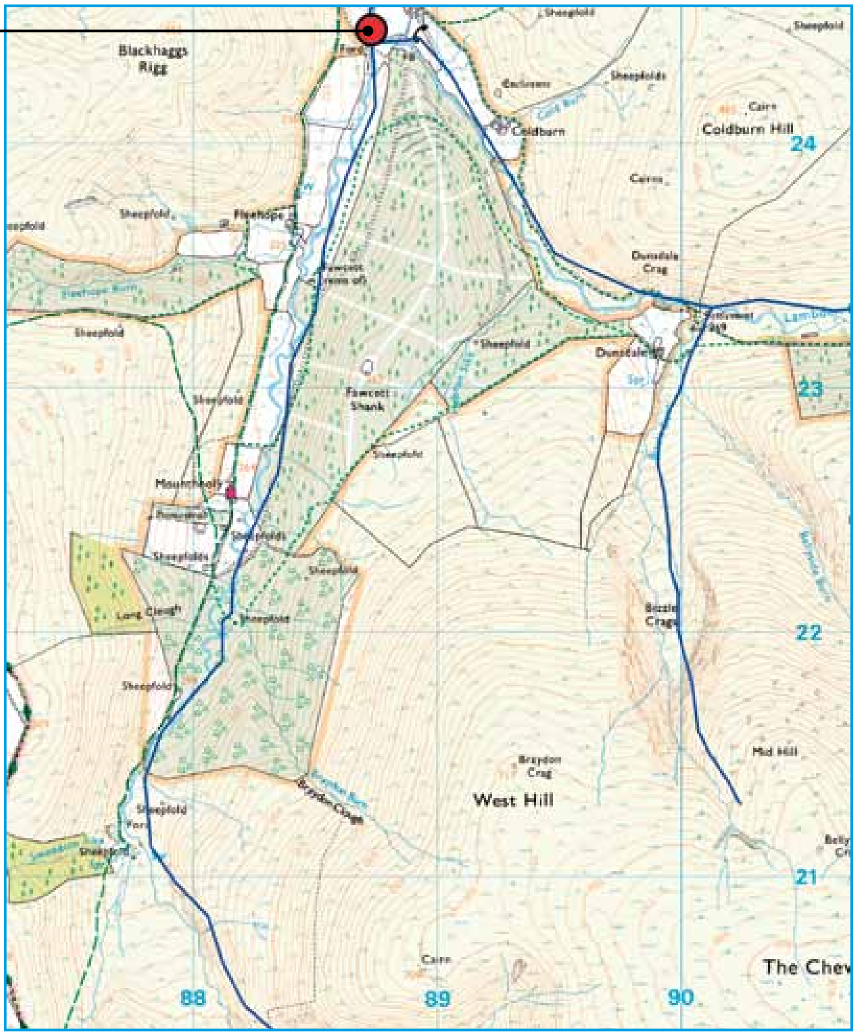
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 26 Summary			
Watercourse Name	Reach No	Restoration Priority	
College Burn	26		
Location	NGR	Channel length	
u/s SAC limit	NT887244 to –	–	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Bedrock cascade	–	–	–
Key Pressures			
Several piped fords; local hard bank protection at bridges.			
Pressure score	Reach impact severity		
–	–		
Principal restoration issues		Potential restoration options	
Extreme sediment transport	The combination of stream energy and sediment inputs results in high level of sediment transfer into River Glen.	Establish agreed gravel management regime in lowest reach..Install bar-apex ELJs. Monitor operation / effectiveness.	
Rapid and extreme response to heavy rainfall events.	Sub-catchment landform and stream gradient result in rapid runoff, creating impacts in River Glen.	Investigate potential for improved natural flow management in catchment	
Potential for changes of land use.	Changes e.g. forestry, upland drainage, could affect runoff rates & volumes, with impacts on d/s flood flows.	Maintain watching brief & consider implications of any future proposed changes.	
Potential constraints on restoration options.			
Reduce sediment transfer issues	Ensuring design of bar-apex ELJs will resist high flows. Local gravel management is reliant on stakeholder support		
Reduce extreme hydrological response	Extent & sensitivity of subcatchment.		
Watching brief on potential land use changes	Requires an effective consultation processes.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 26
College Burn : u/s SAC limit

SAC limit



N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 27 Summary			
Watercourse Name	Reach No	Restoration Priority	
Wooler Water	27	H	
Location	NGR	Channel length	
Till confluence to Wooler	NU002 to NT995284	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	54, 55	Transport (54) Supply (55)	Low (54) Moderate (55)
Key Pressures			
Floodbanks both sides 100%; regular hard toe protection; occasional hard bank protection; weir u/s of reach			
Pressure score	Reach impact severity		
High	High		
Principal restoration issues		Potential restoration options	
Floodbanks along both banks	Prevent connection to floodplain and potential lateral channel movement.	Alternative management of floodbanks (esp RH - to reduce pressure on LH riverbank) e.g. realignment of floodbank to create erodible corridor; lowering or breaching to reconnect channel to floodplain; improved floodwater evacuation; reduced maintenance / abandonment.	
Localised stock access & poaching	Causes bank instability, lack of riparian vegetation and fine sediment input.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting	
Localised erosion protection using ELJ-type structure	Reduces erosion risk in vulnerable location	Review effectiveness of backfilled vertical log structures and identify any beneficial improvements.	
Localised hard bank & toe protection	Prevents lateral channel processes	Remove hard bank protection; consider installation of soft engineering or ELJs where erosion threatens infrastructure	
Weir u/s of reach	Interrupts sediment transport regime	Remove or modify weir structure.	
Locally high sediment loading.	Causes bank instability, lack of riparian vegetation and fine sediment input.	Local gravel management plan.	
Potential constraints on restoration options.			
Alternative floodbank management	High costs. Potential loss of agricultural productivity and/or changes in farming practices.		
Alternative stock management	Loss of grazing, e.g. on meander loops. Potential for flood damage to fencing. (cost of repair)		
Install ELJs	Ensuring design will resist high flows. Visual impact.		
Weir removal	Cost. Potential for bed and / or bank erosion upstream.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

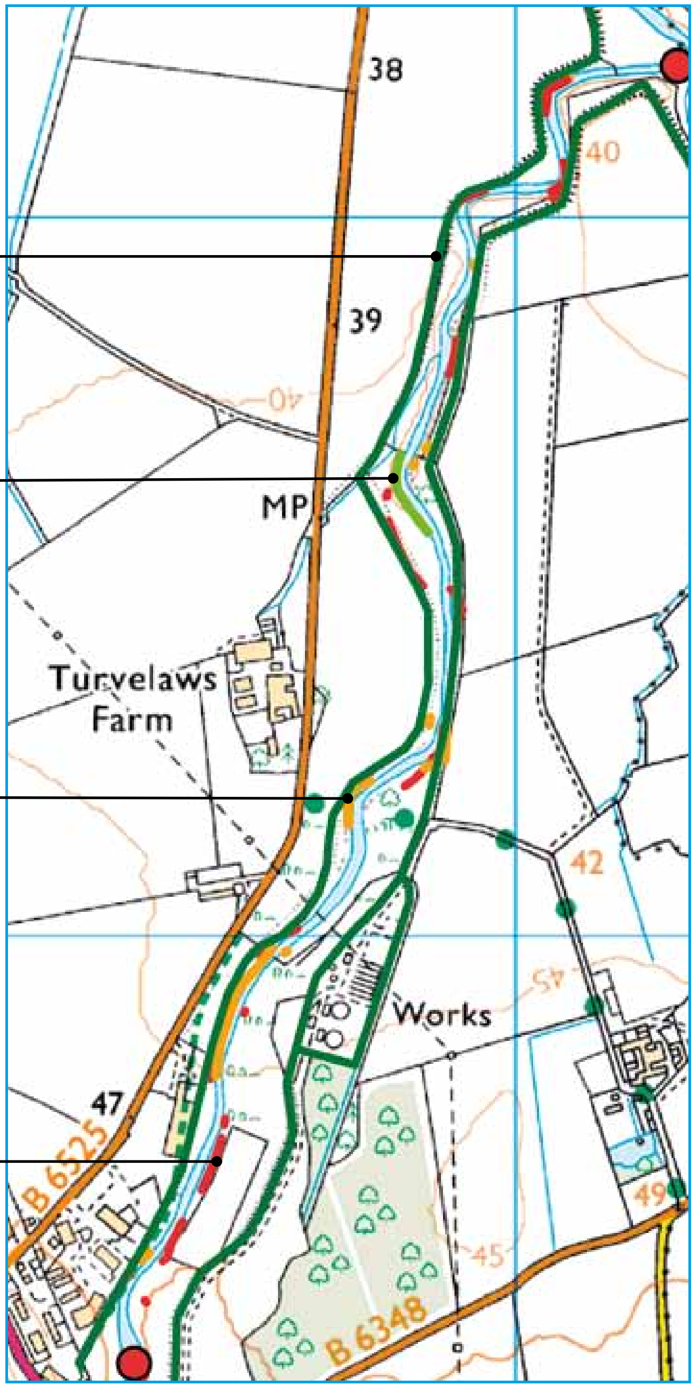
Reach No 27
Wooler Water : Till confluence to Wooler

Channel bounded by floodbanks

'Soft' timber bank protection

Sporadic bank/toe protection

Hard bank protection



N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 28 Summary			
Watercourse Name	Reach No	Restoration Priority	
Wooler Water	28	VH	
Location	NGR	Channel length	
Wooler	NT995284 to NT995278	1km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	56	Transport	Low
Key Pressures			
Hard engineered banks both sides; weirs & bridges			
Pressure score	Reach impact severity		
Very High	Very High		
Principal restoration issues		Potential restoration options	
Weirs	Impact on channel / bed processes	Undertake detailed assessment to assess potential for weir removal or modification.	
Hard engineering of banks	Impact on channel / bank processes	Remove or replace hard bank protection with softer form.	
Floodbanks	Prevent potential lateral channel movement	Set back embankments. Develop inset channel corridor / two-stage channel	
Relative costs of restoration		H	
Potential constraints on restoration options.			
Weirs	Cost. Potential impact on infrastructure and local flood risk.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure and local flood risk.		
Alternative floodbank management	High costs. Potential impact on local flood risk.		
NB The high degree of constraints in this reach will preclude actions except as part of any future re-development.			

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

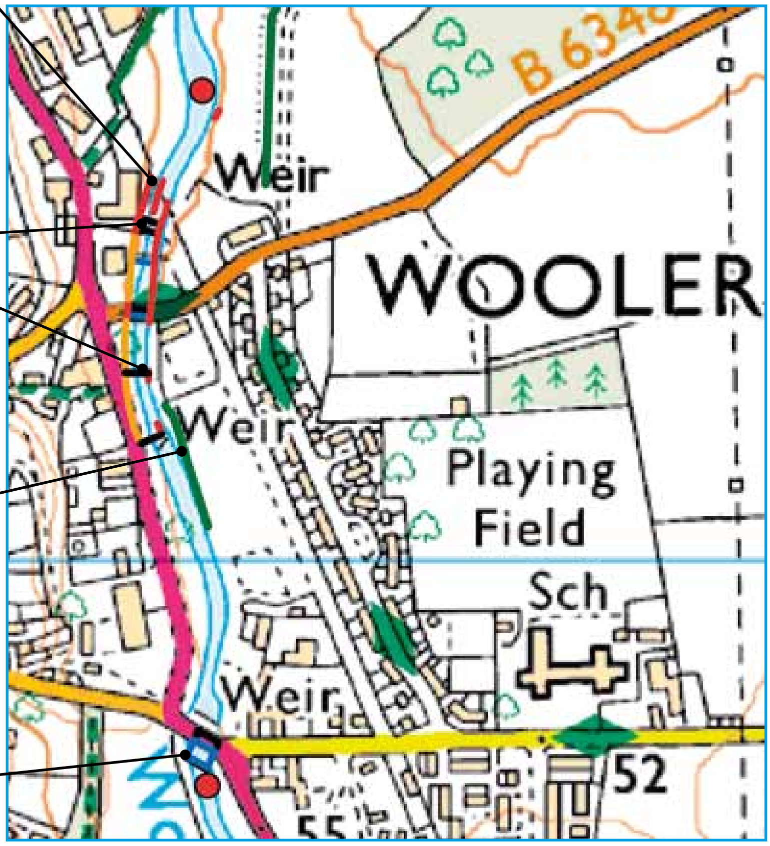
Reach No 28
Wooler Water : Wooler

Hard bank / toe protection

Weirs

Short floodbank

Bridge apron / weir



N

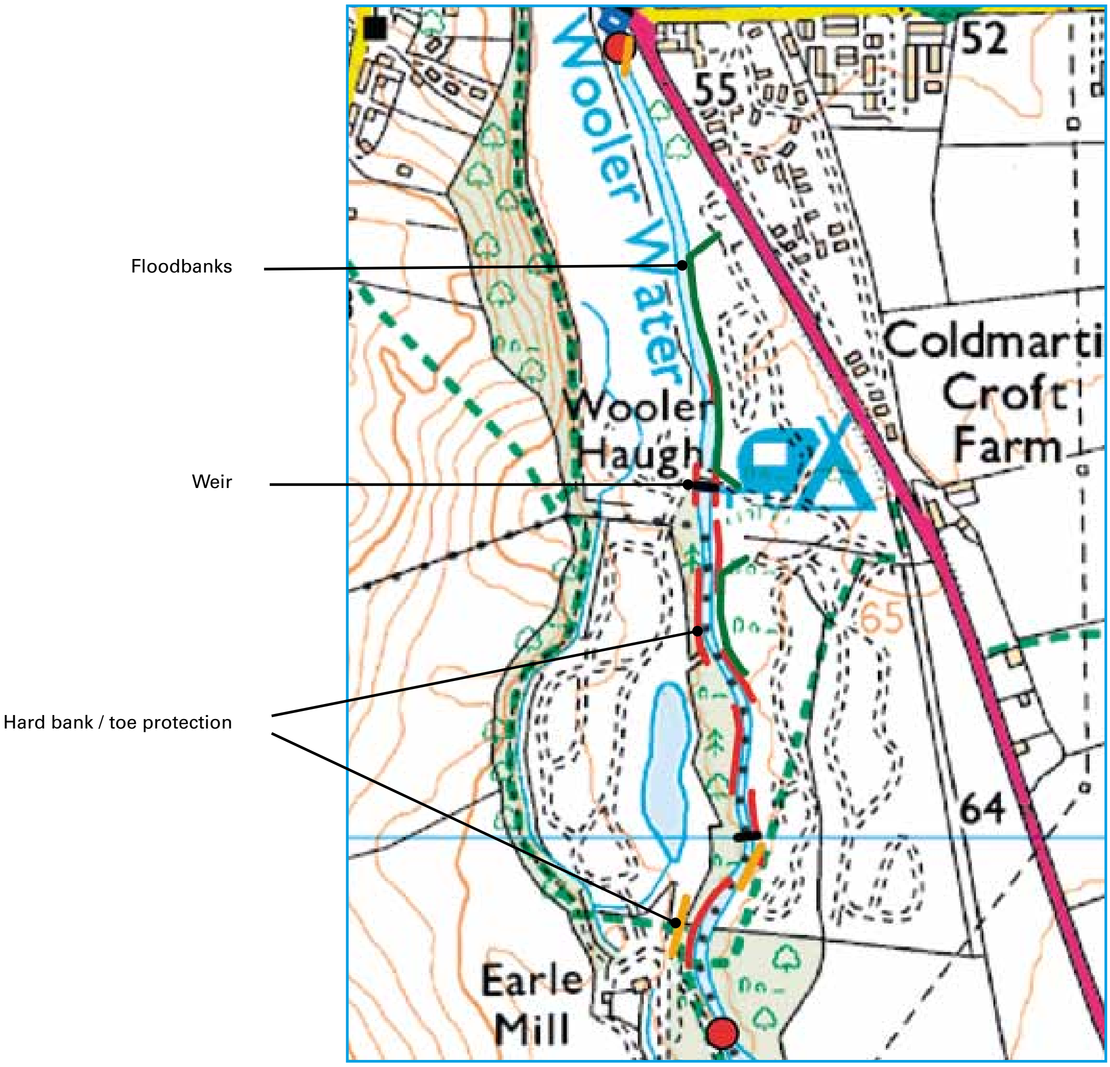
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 29 Summary			
Watercourse Name	Reach No	Restoration Priority	
Wooler Water	29	VH	
Location	NGR	Channel length	
Wooler to Earle Mill	NT995278 to NT996268	1km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	56	Transport	Low
Key Pressures			
Floodbank and some hard protection at campsite			
Pressure score	Reach impact severity		
Very High	Very High		
Principal restoration issues		Potential restoration options	
Weirs	Impact on channel / bed processes	Undertake detailed assessment to assess potential for weir removal or modification.	
Hard engineering of banks	Impact on channel / bank processes	Remove or replace hard bank protection with softer form / ELJs.	
Floodbanks	Prevent potential lateral channel movement	Set back embankments. Develop inset channel corridor / two-stage channel	
Relative costs of restoration		H	
Potential constraints on restoration options.			
Weirs	Cost. Potential impact on infrastructure and local flood risk.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure and local flood risk.		
Alternative floodbank management	High costs. Potential impact on local flood risk.		
Current channel form	In high flows the existing channel form creates flow and sediment transport conditions which reduce sediment deposition in reach 28, downstream, lowering flood risk in Wooler.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 29

Wooler Water : Wooler to Earle Mill



N

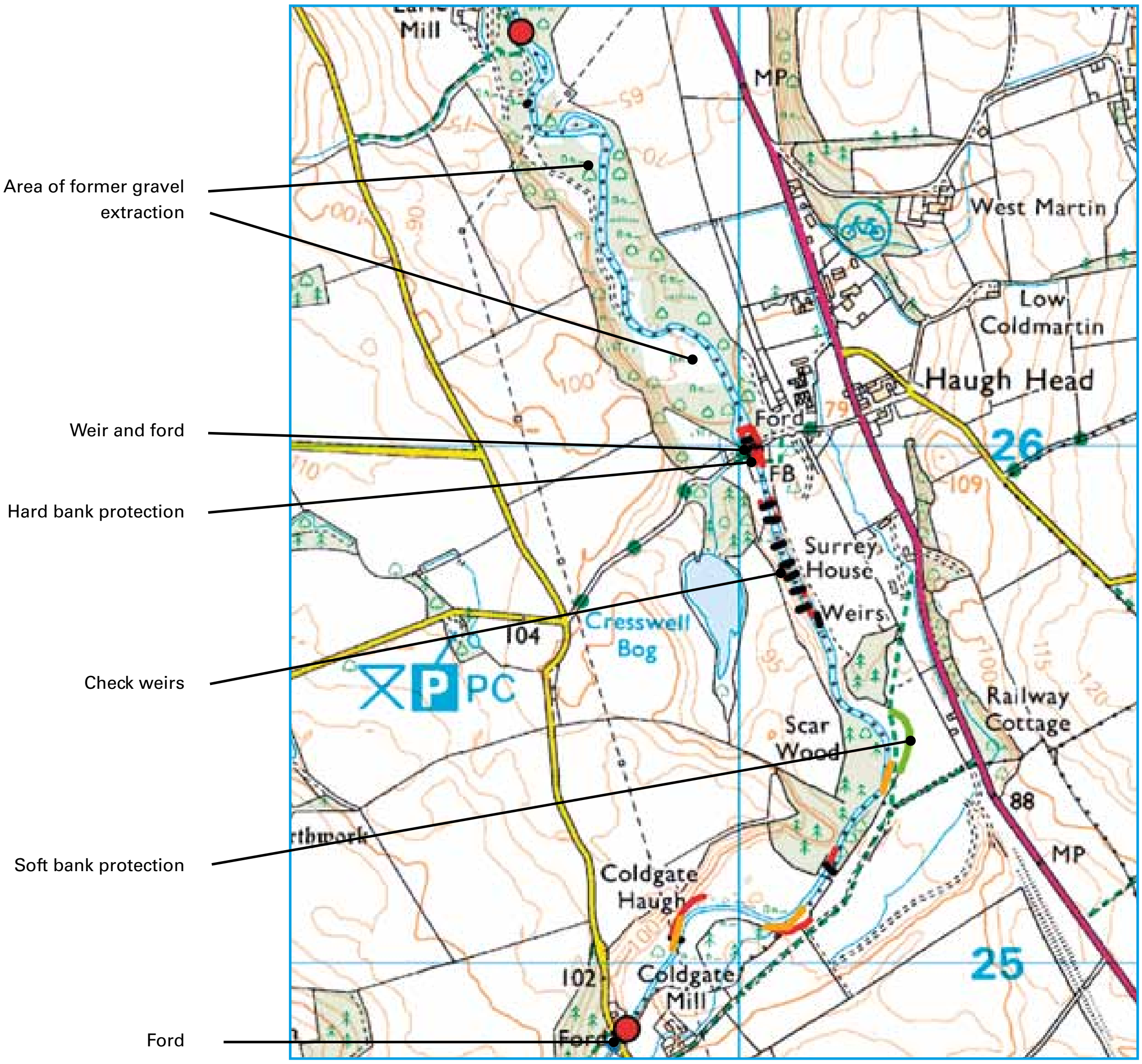
Floodbanks	(dark green line)
Hard bank protection	(red line)
Toe protection	(orange line)
Soft bank protection	(light green line)
Weir / Ford	(black line)
Bridge	(blue line)
Limits of reach	(red dot)

Reach 30 Summary			
Watercourse Name	Reach No	Restoration Priority	
Wooler Water	30	VH 57,58 M 59	
Location	NGR	Channel length	
Earle Mill to Coldgate Ford	NT996268 to NT998249	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	57, 58, 59	Storage (57,59) Transport (58)	Very high
Key Pressures			
Haughhead : ford & check weirs; hard engineered; former gravel extraction			
Pressure score	Reach impact severity		
Very High (57) High (58) Low (59)	Very High (57,58) Moderate (59)		
Principal restoration issues		Potential restoration options	
Ford, footbridge and unstable / failing weir at Haugh Head	Impact on channel / bed processes. Obstruction to fish passage (ineffective existing fish pass)	Undertake detailed restoration appraisal to determine best solution; investigate potential to remove / modify weir, ford and u/s check weirs.	
Series of check weirs u/s ford.	Impact on channel / bed processes		
Hard Bank protection and channel straightening.	Impact on channel / bank processes	Remove hard bank protection and replace with ELJs	
Former gravel extraction d/s weir.	Natural channel recovery is ongoing, within deeply eroded banks, including recovery of riparian woody vegetation.	Monitor continuing recovery of channel; install ELJs to stabilise features if required.	
Relative costs of restoration		H	
Potential constraints on restoration options.			
Ford and weirs	Cost. Potential impact on public right of way.		
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure and local flood risk.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 30

Wooler Water : Earle Mill to Coldgate Ford



N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

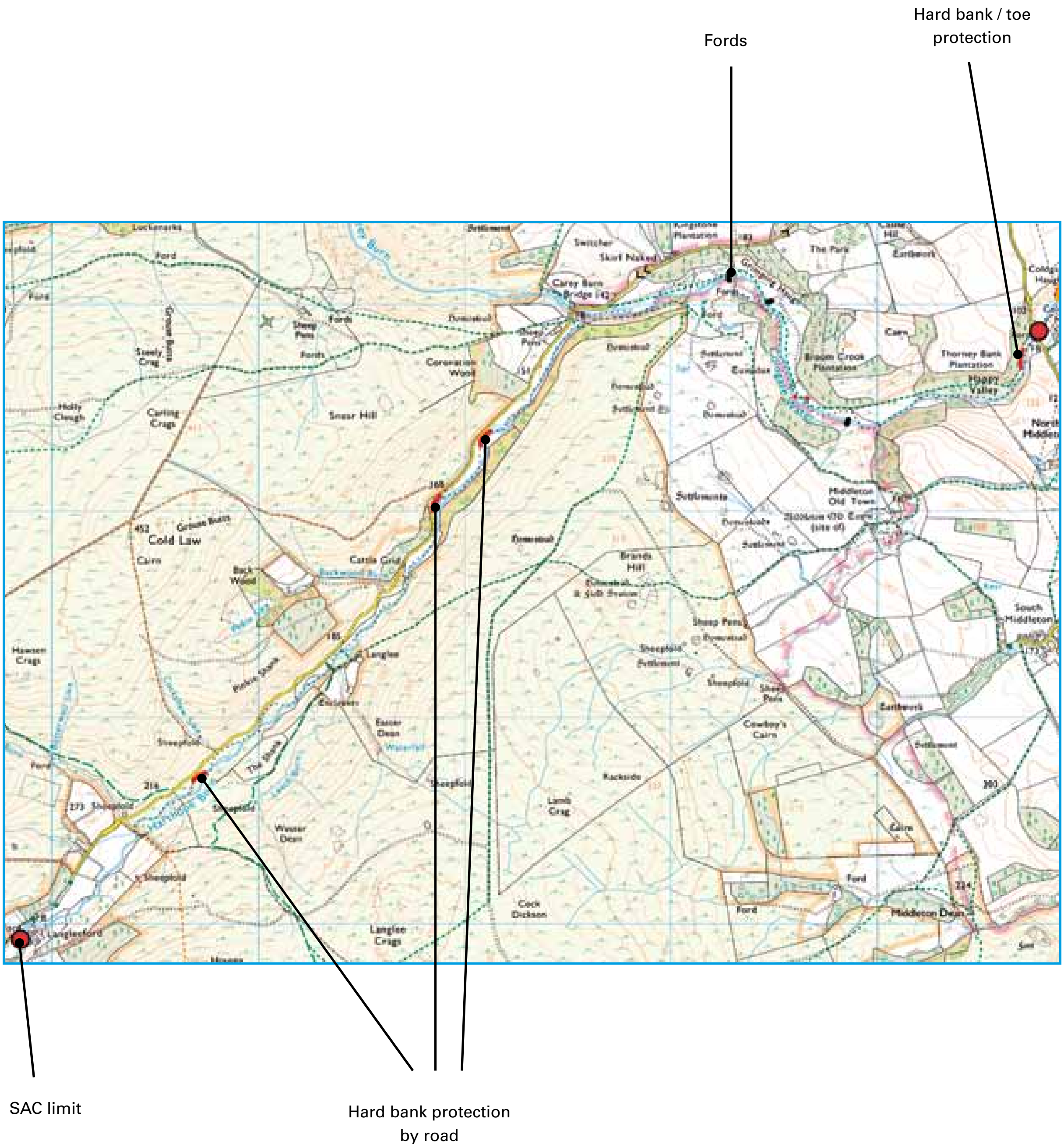
Reach 31 Summary

Watercourse Name	Reach No	Restoration Priority	
Harthope Burn	31	L 60,61 VL 62-65	
Location	**NGR**	**Channel length**	
Coldgate Ford to SAC limit	NT998249 to NT949219	6.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Montane confined	60, 61, 62, 63, 64, 65	Storage (62) Transport (60,61,63,64,65)	Low (60, 63,64,65) Moderate (62) Very high (61)
Key Pressures			
Lengths of rock armour by road			
Pressure score	**Reach impact severity**		
Low (60,61) Very low (62,63,64, 65)	Low (60,61) Very low (62,63,64,65)		
Principal restoration issues		**Potential restoration options**	
Hard bank rip-rap & whinstone protection.	Impact on channel / bank processes	Remove hard bank protection and replace with ELJs	
Weir	Influences bed and channel processes – gradient, substrate regime, flow patterns	Investigate potential to remove or modify weir.	
Stock access to channel	Impacts on vegetation cover, increasing risk of substrate instability.	Alternative stock management.	
Potential constraints on restoration options.			
Hard bank protection	Cost. Risk to wider channel stability.		
Weir/ford	Cost. Potential impact on public right of way.		
Stock access	Changed agricultural practices. Risk of flood damage to fencing, cost of replacement.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 31

Harthope Burn : Coldgate Ford to SAC limit



N

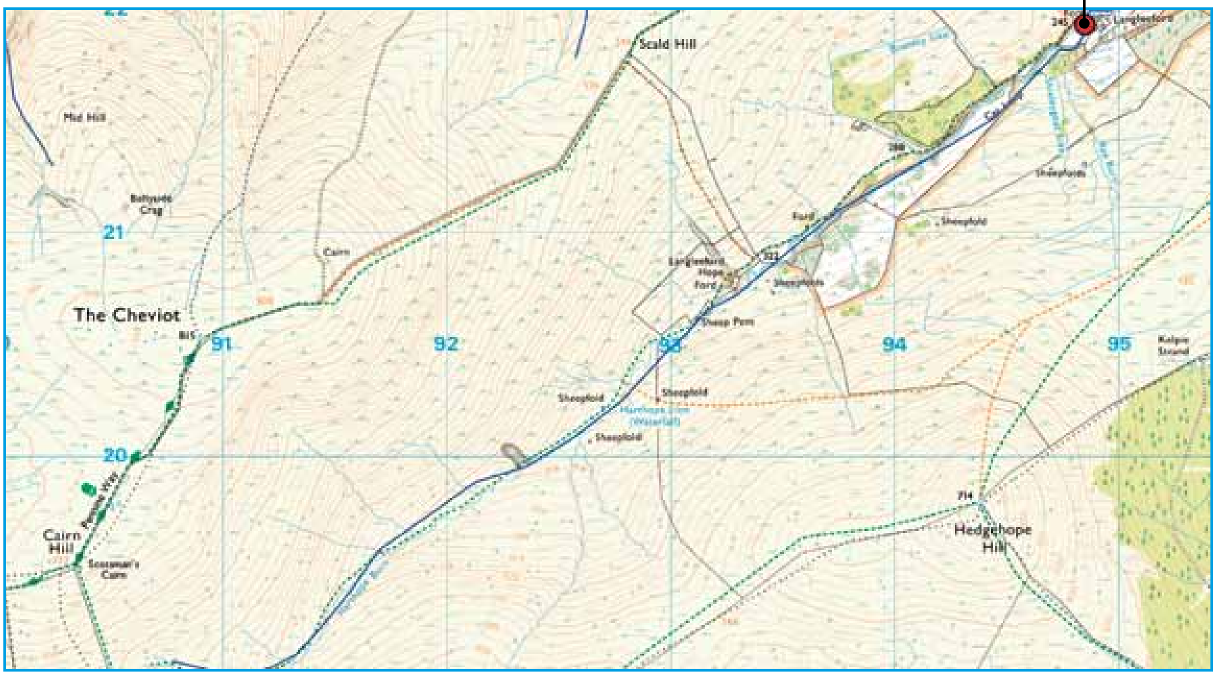
Floodbanks	(dark green line)
Hard bank protection	(red line)
Toe protection	(orange line)
Soft bank protection	(light green line)
Weir / Ford	(black line)
Bridge	(blue line)
Limits of reach	(red dot)

Reach 32 Summary			
Watercourse Name	Reach No	Restoration Priority	
Harthope Burn	32	–	
Location	NGR	Channel length	
u/s SAC limit	NT949219 to –	–	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Montane confined	–	–	–
Key Pressures			
–			
Pressure score	Reach impact severity		
–	–		
Principal restoration issues		Potential restoration options	
Hard bank rip-rap & whinstone protection.	Impact on channel / bank processes	Remove hard bank protection and replace with ELJs	
Potential for changes of land use.	Influences bed and channel processes – gradient, substrate regime, flow patterns Changes e.g. forestry, upland drainage, could affect runoff rates & volumes, with impacts on d/s flood flows.	Maintain watching brief & consider implications of any future proposed changes.	
Stock access to channel	Impacts on vegetation cover, increasing risk of substrate instability.	Alternative stock management.	
Potential constraints on restoration options.			
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure (road).		
Watching brief on potential land use changes	Requires an effective consultation process.		
Stock access	Changed agricultural practices. Risk of flood damage to fencing, cost of replacement.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 32
Harthope Burn : u/s SAC limit

SAC limit



N

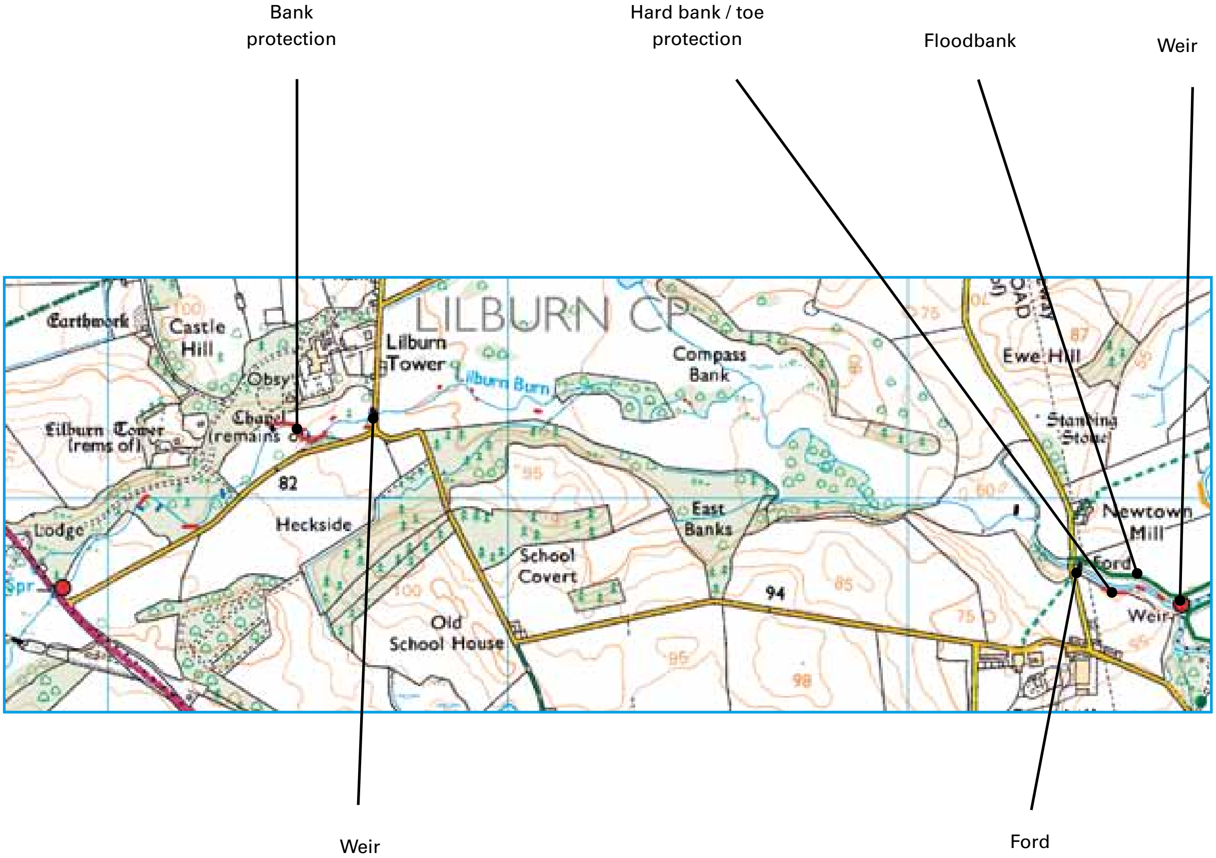
Floodbanks	green line
Hard bank protection	red line
Toe protection	orange line
Soft bank protection	light green line
Weir / Ford	black line
Bridge	blue line
Limits of reach	red circle

Reach 33 Summary

Watercourse Name	Reach No	Restoration Priority	
Lilburn Burn	33	H 66 M 67 L 68	
Location	**NGR**	**Channel length**	
Till confluence to A697 bridge	NU046238 to NU019238	2.5km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	66, 67, 68	Transport (66) Supply (67) Storage (68)	Low (66) Moderate (67,68)
Key Pressures			
Weir & bridge apron; ford; soft bank works.			
Pressure score	**Reach impact severity**		
High (66,67)	High (66) Moderate (67) Low (68)		
Principal restoration issues		**Potential restoration options**	
Hard bank protection.	Impact on channel / bank processes	Remove hard bank protection and replace with appropriate scale ELJs	
Floodbanks	Prevent potential lateral channel movement	Alternative floodbank management	
Minor soft bank protection	Potential effect on channel / bank processes	Review benefits of protection and improve as required.	
Significant weir and ford	Influences bed and channel processes – gradient, substrate regime, flow patterns. Potential effect on fish movement.	Undertake detailed assessment to determine potential for removal or modification of weir and ford.	
Stock access to channel	Impacts on vegetation cover, increasing risk of substrate instability.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting.	
Bridge (Lilburn)	Impact on sediment transfer and effectiveness of fish pass	Establish agreed gravel management regime at bridge	
Relative costs of restoration		H L	
Potential constraints on restoration options.			
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure (road).		
Alternative floodbank management.	Cost. Potential loss of agricultural productivity and/or changes in farming practices.		
Remove/modify weir & ford.	Cost. Risk of increased short term channel instability. Ford is public right of way.		
Stock access	Changed agricultural practices. Risk of flood damage to fencing, cost of replacement.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 33
Lilburn Burn : Till confluence to A697 bridge



N

- Floodbanks
- Hard bank protection
- Toe protection
- Soft bank protection
- Weir / Ford
- Bridge
- Limits of reach

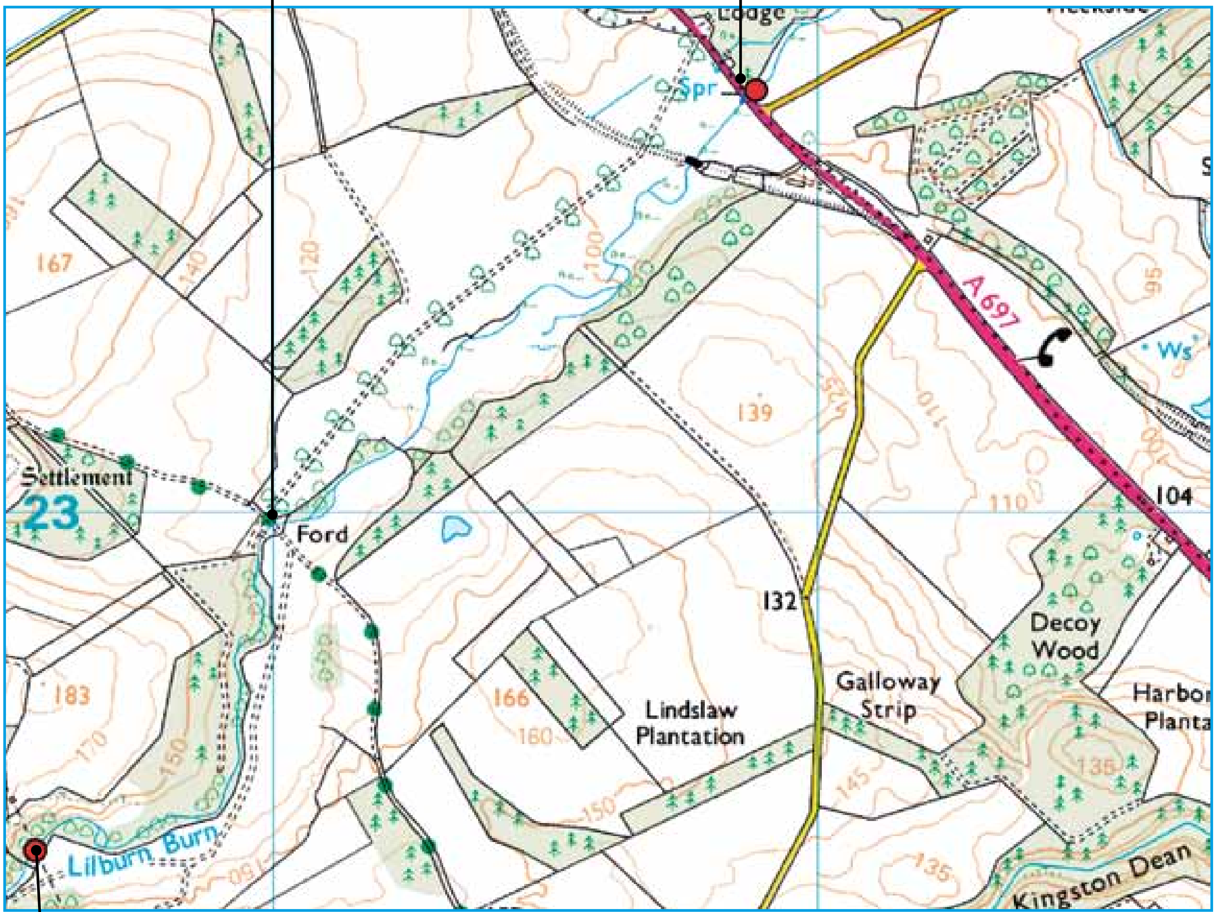
Reach 34 Summary			
Watercourse Name	Reach No	Restoration Priority	
Lilburn Burn	34	L 68 VL 69	
Location	NGR	Channel length	
A697 bridge to SAC limit	NU019238 to NU006224	2km	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	68, 69	Storage (68) Transport (69)	Moderate (68) Low (69)
Key Pressures			
Former railway bridge footings			
Pressure score	Reach impact severity		
Low (68) Very low (69)	Low		
Principal restoration issues		Potential restoration options	
Hard bank protection.	Impact on channel / bank processes	Remove hard bank protection and replace with appropriate scale ELJs	
Stock access to channel	Impacts on vegetation cover, increasing risk of substrate instability.	Alternative stock management (e.g. reduced stocking levels, seasonal variations, temp/ permanent exclusion & alternative stock watering.) Riparian planting.	
Bridge		Establish agreed gravel management regime at bridge	
Potential constraints on restoration options.			
Remove hard bank protection	Cost. Potential short-term bank instability. Risk to infrastructure (road).		
Stock access	Changed agricultural practices. Risk of flood damage to fencing, cost of replacement.		
Local gravel management	Reliant on stakeholder support.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 34
Lilburn Burn : A697 bridge to SAC limit

Ford

Bridge apron



SAC limit

N

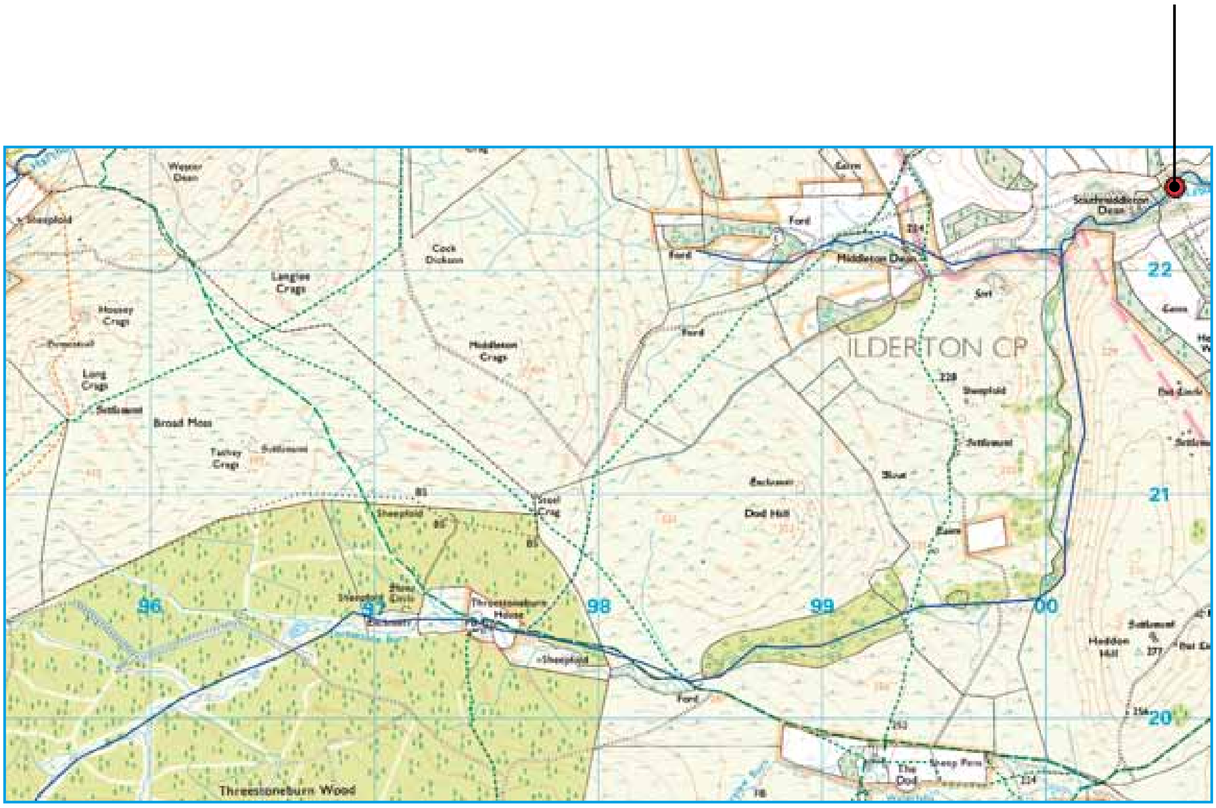
Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Reach 35 Summary			
Watercourse Name	Reach No	Restoration Priority	
Lilburn Burn	35	–	
Location	NGR	Channel length	
u/s SAC limit	NU006224 to –	–	
Geomorphological summary			
Till River Type	*Geomorphological sub reaches*	*Dominant process*	*Process intensity*
Piedmont wandering	–	–	–
Key Pressures			
–			
Pressure score	Reach impact severity		
–	–		
Principal restoration issues		Potential restoration options	
Potential for changes of land use.	Changes e.g. forestry, upland drainage, could affect runoff rates & volumes, with impacts on d/s flood flows.	Maintain watching brief & consider implications of any future proposed changes.	
Potential constraints on restoration options.			
Watching brief on potential land use changes	Requires an effective consultation process.		

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 35
Lilburn Burn : u/s SAC limit

SAC limit



N

Floodbanks
Hard bank protection
Toe protection
Soft bank protection
Weir / Ford
Bridge
Limits of reach

<table>
<tr><th colspan="4">Reach 36 Summary</th></tr>
<tr><td>Watercourse Name</td><td>Reach No</td><td colspan="2">Restoration Priority</td></tr>
<tr><td>Hetton Burn</td><td>36</td><td colspan="2">–</td></tr>
<tr><td>Location</td><td>NGR</td><td colspan="2">Channel length</td></tr>
<tr><td>u/s confluence with Till
(SAC limit)</td><td>NU038299 to –</td><td colspan="2">–</td></tr>
<tr><td colspan="4">Geomorphological summary</td></tr>
<tr><td>Till River Type</td><td>Geomorphological sub reaches</td><td>Dominant process</td><td>Process intensity</td></tr>
<tr><td>Piedmont wandering</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td colspan="4">Key Pressures</td></tr>
<tr><td colspan="4">–</td></tr>
<tr><td>Pressure score</td><td colspan="3">Reach impact severity</td></tr>
<tr><td>–</td><td colspan="3">–</td></tr>
<tr><td colspan="2">Principal restoration issues</td><td colspan="2">Potential restoration options</td></tr>
<tr><td>Potential ingress of fine sediment</td><td>Sediment carried into main Till settles out & impacts on gravel substrate.</td><td colspan="2">Review CSF plan & identify any further actions to reduce soil runoff.</td></tr>
<tr><td>Hetton Dean Weir</td><td>Obstruction to fish movement</td><td colspan="2">Undertake detailed assessment to determine potential for installation of fish pass or removal of weir.</td></tr>
<tr><td colspan="4">Potential constraints on restoration options.</td></tr>
<tr><td>–</td><td colspan="3">–</td></tr>
</table>

NB. Numbers in brackets indicate relevant sub-reaches; see Explanatory Note 4

Reach No 36

Hetton Burn : u/s Till confluence (SAC limit)

SAC limit

N

Floodbanks	
Hard bank protection	
Toe protection	
Soft bank protection	
Weir / Ford	
Bridge	
Limits of reach	

Appendix 2

Summary details of potential delivery and funding mechanisms

This summary of delivery and funding schemes is as at December 2012, schemes will change during the life of the RRS

Potential English delivery and funding mechanisms

(Not applicable to upper Bowmont Water subcatchment).

Water Framework Directive Catchment Restoration Fund

In 2011 the government announced a £110m fund to improve the health of over 880 water bodies. £92 million will be provided over four years to start bringing waterbodies up to good ecological status, as required by the WFD. This includes improving the physical state of river channels, potentially involving the removal of redundant dams, weirs, and other man-made structures, so that wildlife can thrive in water catchments across England. An additional £18 million was allocated during 2011 to assist farmers with actions to prevent agricultural pollution, including measures such as buffer strips and fences to protect watercourses, under the Catchment Sensitive Farming programme (see below).

European funding

The Innovation and Environment Regions of Europe Sharing Solutions (Interreg) are co-financed by the European Regional Development Fund (ERDF). It includes funding for water management, including: (i) improving quality of water supply and treatment, including co-operation in the field of water management; (ii) supporting integrated, sustainable and participatory approaches to management of inland and marine waters, including waterway infrastructure; (iii) adapting to climate change effects related to water management.

The LIFE programme is the EU's funding mechanism for environmental improvement initiatives. LIFE projects support a wide range of water-related issues, such as urban water management, industrial wastewater treatment, river basin monitoring and improving groundwater quality.

Environmental Stewardship Schemes

The Environmental Stewardship scheme is likely to be an appropriate source of funding for delivering parts of the strategy and is particularly appropriate to measures for improving the riparian zone and giving the river more space by defining such land as buffer strips. Improvements to the riparian zone can also provide improved soil conservation, especially in arable areas. There are a number of levels of Stewardship: Entry Level; Organic Entry Level; Upland Entry Level; and Higher Level Stewardship.

Higher Level Stewardship (HLS) at present provides funding for land management / land use changes relating to livestock management and improved wetland riparian land use. Environmental Stewardship is a key part of the EU funded Rural Development Programme for England, with an overall budget of over £700 million for new HLS agreements for the period 2007 – 2013. The current RDPE ends in December 2013 and the new programme is expected to start from January 2015 onwards. Details of the new ES schemes and interim arrangements for 2014 are not yet available.

Catchment Sensitive Farming

The 'Catchment Sensitive Farming' initiative in England (CSF) is a partnership between the Environment Agency and Natural England, funded by Defra and the EU Rural Development Programme. It aims to deliver practical measures for reducing diffuse pollution from agricultural land, to protect water bodies and habitats. Funding, as capital grants, is prioritised and targeted within each catchment through a Funding Priority Statement. The Till catchment CSF initiative, steered by a group of local stakeholders, is part of this programme.

Woodland Grant Scheme (FC England)

The planting of riparian woodland may be supported by the English Woodland Grant Scheme (EWGS) administered by the Forestry Commission. This funding is intended to develop the co-ordinated delivery of public benefits from England's woodlands. Grants are available to improve the stewardship of existing woodland and to promote and enable the creation of new woodland.

Potential Scottish delivery and funding mechanisms

(Only applicable to upper Bowmont Water sub- catchment.)

Water Environment Fund

Previously known as the Restoration Fund, the Water Environment Fund provides funding for projects to help restore Scotland's catchments from the source to the sea. The primary focus of the funding is to tackle impacts on the morphology or physical condition of these ecosystems. Funded projects funded will: restore the morphology and/or remove barriers to fish migration. Funding of £1 million is available annually by SEPA and the Scottish Government. The fund is managed by SEPA, with support from Scottish Natural Heritage, Forestry Commission, and Scottish Government

Scotland Rural Development Programme

The SRDP is a programme of economic, environmental and social measures, utilising European Agricultural Fund for Rural Development funding plus Scottish Government match funding. The programme is designed to support rural Scotland from 2007 to 2013. Relevant regional LEADER & Rural priorities include :

- Reduced diffuse pollution from rural land uses: the prevention of access to watercourses by livestock; creation of constructed wetlands to intercept lightly contaminated farm drainage; use of buffer strips to prevent direct run off from cultivated land to watercourses.

- Achieving good ecological status of water bodies which are currently classified as being at a lesser status. Particularly proposals: for forest management action in and adjacent to water bodies; conservation and enhancement of riparian habitats.

- Sustainable flood management and reduced flood risk (including adaptation to climate change), through appropriate land management,

- Improved protection in areas most at risk from erosion and flooding by appropriate management of existing habitats or the creation of appropriate habitats (e.g. floodplains and along river edges)

- Actions to bring the special features of sites (incl. SSSIs, SACs) in unfavourable condition into recovering or favourable condition; actions to maintain sites in favourable condition, including those recovering.

Scottish Natural Heritage

Funding priorities include projects that get more people and communities actively involved in and caring for Scotland's nature and landscapes. Including action to improve, protect and manage habitats, species and landscapes, citizen science and biological recording. SNH also coordinate applications for 'LIFE+ nature and biodiversity in Scotland' funding on behalf of Scottish Government. An EU fund to support large scale projects (£2 million+) delivering environmental and nature conservation projects. Priorities in Scotland include the implementation of the European Union's Birds and Habitats Directives.

Landfill Communities Fund

The Landfill Communities Fund (formerly the Landfill Tax Credit Scheme), regulated by Entrust, provides funding from landfill site operators to approved environmental bodies for projects that benefit the environment. Relevant objectives of the Fund include the conservation of a specific species or a specific habitat where it naturally occurs. Generally projects should be located within 10 miles of a landfill site.

Scottish Borders Council

Natural Flood Risk Management : Supports studies research and demonstration projects which improve natural flood risk management and provide evidence for the benefits of this approach. Includes initiatives for upstream storage which reduce flood risk in the Bowmont Water subcatchment.

Biodiversity offsetting : conservation activities designed to deliver planning policy requirements for compensation for biodiversity losses in a measurable way.

Developer Contributions : contributions towards absorbing anticipated increased burdens generated by cumulative development activities. Includes priorities for : landscape and open spaces, trees and woodland, built and natural heritage.

Appendix 3

Acronyms and Glossary of terms

Acronyms	
RRS	River Restoration Strategy
NE	Natural England
EA	Environment Agency
SAC	Special Area of Conservation
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive
CSF	Catchment Sensitive Farming initiative
GIS	Geographic Information System
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
LiDAR	Low intensity radar mapping
DWP	Diffuse Water Pollution Plan
ELJ / LWD	Engineered Log Jam / Large Woody Debris

Glossary of terms	
Catchment	Area drained by a river and its tributaries
Buffer zone	Area or strip of uncultivated land, with natural or specifically selected vegetation, retained between a water body and adjacent farmland to reduce and filter field runoff into a watercourse .
Ecological status (Water Framework Directive)	Surface waters are classified as being of good ecological status when each of the quality elements that represent indicators of ecological quality of the waterbody are classified as being good or high. The quality elements fall into three categories, i) biological quality elements, ii) chemical and physicochemical quality elements and iii) hydromorphological quality elements.
Engineered Log Jam (ELJ)	Wood accumulations influence sediment storage & transport, stream bed and bank structure, velocity distribution and channel sinuosity. They can support a range of habitats. Wood can be used to form natural in-channel or riparian structures which diversify processes and create stability.
Erosion	Removal of sediment or bedrock from the bed or banks of the channel by flowing water. Mostly occurs during high flows and flood events. Forms various river features such as scour holes and steep outer banks.
Favourable Condition (Habitats Directive)	State of the features for which a SSSI or SAC has been designated. Favourable condition means that the site is being adequately conserved and is meeting its 'conservation objectives'. all of the targets for the mandatory attributes (population and habitat) used to assess a feature have been met.
Floodplain	A floodplain is flat or nearly flat land adjacent to a stream or river, stretching from the banks of its channel to the base of the enclosing valley walls and (under natural conditions) experiences flooding periods of high discharge.
Geomorphology	The study of landforms and the processes which create them.
Good status	The general objective of the WFD is to achieve ‘good status’ for all surface waters by 2015. ‘Good status’ means the achievement of both ‘good ecological status’ and ‘good chemical status’.
Good ecological status	WFD term denoting a slight deviation from ‘reference conditions’ in a waterbody, or the biological, chemical and physio-chemical and hydromorphological conditions associated with little or no human pressure.
Large Woody Debris(LWD)	See ELJ
Planform	River channel pattern when viewed from above. This often either straight, sinuous, meandering or braided.
Piedmont Wandering	Channel type characteristic of mid-upper reaches where valley form and gradient permit active lateral channel migration.

Glossary of terms	
Pressure	The direct effect of the driver (for example, an effect that causes a change). Pressures include morphological alterations, abstraction diffuse source pollution, point source pollution and flow regulation. In the context of the WFD a significant pressure is one that, on its own, or in combination with other pressures, would be liable to cause a failure to achieve the environmental objectives set out under Article 4.
Reach	A length of channel which, for example, may have a homogeneous geomorphology (river type) or restoration solution.
Re-profiling	The reshaping of a river bank. May be a reflection of channel modification (impact) or restoration.
Riffle	A stream bed accumulation of coarse alluvium linked with the scour of an upstream pool.
Riparian zone	Land adjacent to a water body.

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