THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

THE RIVER NAR

A WATER FRAMEWORK DIRECTIVE LOCAL CATCHMENT PLAN

DEVELOPED IN PARTNERSHIP WITH

WWF — WORKING TOGETHER TO CONSERVE AND PROTECT ENGLISH RIVERS

Coca-Cola Great Britain

Coca-Cola Enterprises

WITH SUPPORT FROM

Water Management Alliance

NATURAL ENGLAND

Environment Agency

CONTENTS

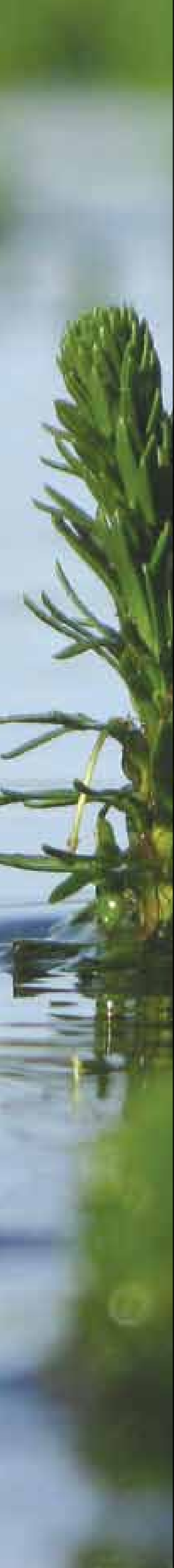
ACKNOWLEDGEMENTS

This plan has been prepared by the Norfolk Rivers Trust in consultation with the other members of the River Nar Partnership: the Norfolk Rivers Drainage Board, the Environment Agency, Natural England, the River Restoration Centre and WWF-UK.

Its findings are based on catchment walks and surveys, historical research, previous publications (see back cover for references) and a specialist knowledge of the river and of chalk-streams.

The Norfolk Rivers Trust would like to acknowledge that the following organisations and individuals have already dedicated a lot of time and research towards planning restoration initiatives on the river. This Local Catchment Plan would not have been possible without their work:

The Environment Agency, Natural England, Norfolk Rivers Drainage Board, The River Restoration Centre, D. A. Sear, M Newson, J. C. Old, C. Hill, Karen Fisher, James Holloway, Dr Jenny Mant, Dr Nigel Holmes, Susan Chambers, Chris Bell, Jen Small, Lou Mayer, Roger Gerry, WWF-UK and The Coca-Cola Freshwater Partnership.



THE CATCHMENT PLAN IN BRIEF

THE RIVER NAR

The River Nar is a small chalk stream which flows through the downs and fenland of north-west Norfolk. Its progression from chalk river to fen river is distinctive and gives the Nar particular conservation value, which is reflected in its Site of Special Scientific Interest (SSSI) designation.

Although the river is of high conservation value, it has been modified along most of its length source to sea and only in a few places does an unchanged natural river exist. Everywhere pressures on the river are intense: abstraction, diffuse pollution and the legacy of channel modifications all inhibit the ecological potential of the river.

THE PURPOSE OF THIS PLAN

This Water Framework Directive (WFD) Local Catchment Plan aims to identify the pressures the River Nar is under, and the way ahead to restoring and conserving a healthy river, meeting the requirements of the WFD.

We hope it will form the foundation of the summary of measures for the River Nar included in the next Anglian River Basin Management Plan due in 2015.

THE NEXT STEPS

Wider consultation will now follow with key stakeholders, and with the River Nar Conservation Group which will be drawn from the Castle Acre, West Acre and Narborough Fishing Clubs, the Parish Councils of town and villages along the river, the Norfolk Wildlife Trust, the Nar Valley Ornithological Society, Anglian Water, from landowners and interested members of the public.

Restoration schemes are already in place. Some were completed in 2010 / 2011. Others are planned for the near future.

The Norfolk Rivers Trust has been awarded a Catchment Restoration Fund grant as well as support from WWF-UK and Coca-Cola which – together with ongoing initiatives from the Norfolk Rivers Drainage Board, the Environment Agency and Natural England – will enable the River Nar Partnership to proceed with ambitious restoration schemes on the river.

Timetabled summaries of existing and proposed restoration schemes and plans relating to other pressures on the river are at the back of this document.

Deadlines to GES under WFD are 2015, 2021 and 2027; 2021 and 2027 are only valid if there is full justification why this status cannot be reached earlier.

THE WAY TO A HEALTHY RIVER

Chalk-streams are globally rare river systems. Most flow through southern England. The River Nar is arguably Norfolk's most unspoilt and beautiful chalk river. And yet it is not without its problems and challenges.

This Plan is designed to help us preserve and enhance its rich and diverse ecology, to achieve what is termed "Good Ecological Status or Potential" (GES or GEP) under the European Water Framework Directive.

UPPER RIVER

To achieve Good Ecological Status on the upper river we need a phased and strategic restoration programme which addresses the priority issues of:

- Canalisation / Connectivity
- Sediment loading
- Diffuse water pollution
- Extreme overshading
- Absence of riparian trees
- Invasive plants
- Impoundments
- Obstructions to fish passage
- Excessive abstraction

LOWER RIVER

To achieve Good Ecological Potential (GEP) on the lower, highly modified river we needs a phased and strategic restoration programme which addresses the priority issues of:

- Lack of morphological variety
- Sediment pollution
- Diffuse water pollution
- Absence of riparian trees
- Impoundments
- Obstructions to fish passage

THE RIVER NAR PARTNERSHIP

Restoration work on the River Nar will be driven forward by the River Nar Partnership, comprising the Norfolk Rivers Trust, Norfolk Rivers Drainage Board, the Environment Agency, Natural England, WWF-UK , Coca-Cola Freshwater Partnership and the River Restoration Centre, all working in close partnership with the new River Nar Conservation Group and other key stakeholders.

SECTION 1 THE CATCHMENT

THE RIVER NAR AND ITS CATCHMENT

The River Nar is a small chalk stream which flows through the downs and fenland of north-west Norfolk. Its progression from chalk river to fenland river is distinctive and gives the Nar particular conservation value, which is reflected in its SSSI designation.

Rising in chalk hills to the east of the village of Tittleshall, the river flows west for 42 km through the villages of Litcham, Castle Acre, West Acre and Narborough until it reaches the tidal Ouse at King's Lynn.

Narborough, which is just over half-way between the source and the Ouse, forms the dividing point between the upper chalk river and the lower fen river. The source is 60 metres above sea level, but 90% of the fall of the river occurs through the chalk reaches. The fen river is of extremely low gradient.

Although the river is of high conservation value, it has been modified along most of its length, source to sea. Some of these modifications took place many centuries ago, some are much more recent. Some are relic only, with no contemporary function other than occasionally significant archaeological value; others – particularly those of the lower fenland river – remain vital to the socio-economic value of surrounding land.

THE LOWER RIVER

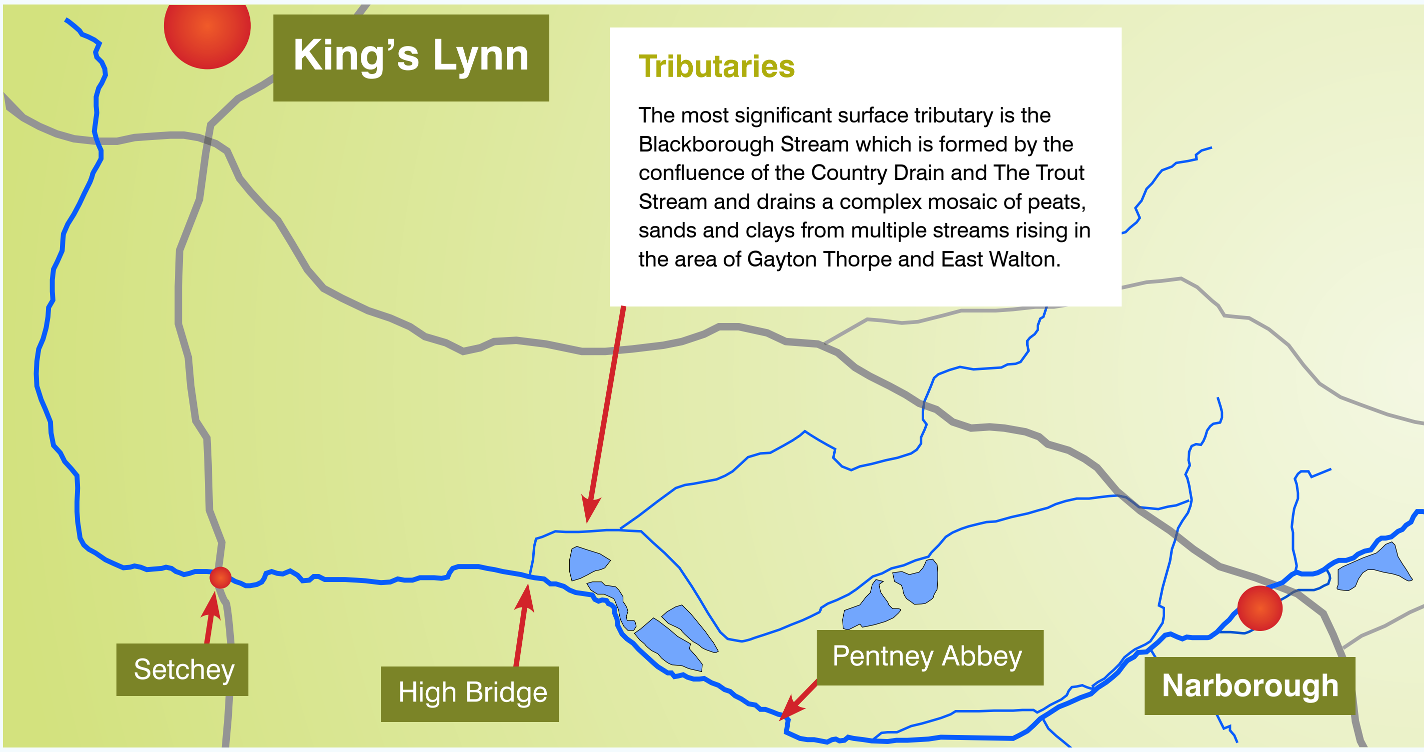
Narborough is the natural divide between the upper and lower river. The gradient changes at Narborough where the river passes from its chalk valley into the fens: what would once, many thousands of years ago, have been an estuary. Under natural conditions a river of this extremely low gradient – it falls only 5 metres in 20 km and most of that fall occurs in only two places, at Marham and Pentney – would have developed a highly sinuous, meandering course. Sea levels changed several times during the slow formation of the lower river and as the Nar flowed over soft, alluvial deposits it is probable that the river's course moved backwards and forwards over the flood-plain and that some of its current course follows parts of one or several of those relic channels. It is likely also that the river once entered the Ouse at Wiggenhall St German's and not Kings Lynn, but was diverted north, perhaps along another relic course, sometime in the early medieval period.

Flow conditions through this once mazy channel would have been very different from today and most of the lower river would have evolved under the influence of the tide. There would have been marked ecological differences as well, with brackish estuarine conditions and fully developed salt marsh being major features of the lower river.

Now the man-made channel runs in straight sections, with angular turns every so often, sometimes tracking field boundaries and gradient edges. In places meanders still exist, downstream of Pentney Abbey for example, or up stream of High Bridge, while old meanders are betrayed in the eccentric routes of neighbouring roads, for example just downstream of Setchey.

Along this modified course the river flows between man-made trapezoidal banks with steep bank edges and shallow or non-existent wetted riparian margins. The channel shape and bed profile tend to be uniform.

A few relic structures at the Narborough Bonemill, at Pentney Abbey, along with the road bridges at High Bridge and Setch, the rail bridge near Seech farm and the tidal scour near Kings Lynn, form the few geomorphological features in the lower river which give shape and variety to the flow and channel.



Tributaries

The most significant surface tributary is the Blackborough Stream which is formed by the confluence of the Country Drain and The Trout Stream and drains a complex mosaic of peats, sands and clays from multiple streams rising in the area of Gayton Thorpe and East Walton.

From Pentney downstream the river is higher than the land to the south which, like much of the fens, has shrunk as it has dried.

This all has very significant repercussions for the ecological potential of this heavily modified channel.

THE UPPER RIVER

Above Narborough the natural chalk stream course has also been modified in various ways and for many reasons over the centuries: for navigation – dating as far back as the 12th century; for milling – there are mills and their leats, races and pools at Newton, West Acre and Narborough; in ornamental estate lakes at Lexham, West Lexham and Narford; to create water-meadows – the Lexham and Castle Acre water-meadows were laid out in the early 19th century by the famous geologist and water-engineer William Smith; and for land-drainage – to reduce flooding and enhance the productivity of farmland.

Mileham to Lexham

Throughout the upper reaches from Mileham down to Lexham, the river has been dredged and straightened. Many field drains feed directly into it and often the river looks more like a deeply-incised ditch than a chalk stream. In these reaches the river has all but lost connectivity with the surrounding meadows. Sediment eroded from the surrounding land, from field drains and the edges of the incised channels becomes a significant problem for the whole river. Riparian land in these reaches is either semi-wild wet woodland, grazing meadow or very occasionally arable.

Lexham to West Acre

In the middle reaches from Lexham through Castle Acre to West Acre, while some of the natural meanders exist the river has been dredged and raised levees are visible along the edges of the river. The stream is incised and only in a few places does reasonable connectivity exist. This legacy of dredging imposes a brake on the ability of the river to heal itself – incised in a box-section channel, the low-energy river cannot recreate its meanders, pools and riffles; sediment is deposited across the full width of the channel creating excessive and unfocussed plant-growth, and that has precipitated plant management regimes that only perpetuate the problem. Riparian land in these reaches is mostly semi-wild wetland, scrub, or meadow. Grazing intensity varies from extensive to intensive, with varying impacts on landscape and ecology. In some parts of this middle upper-river stands of mature trees and woodland provide a good mix of light and shade, as well as the potential for fallen trees and branches to interact with the natural processes of the river.

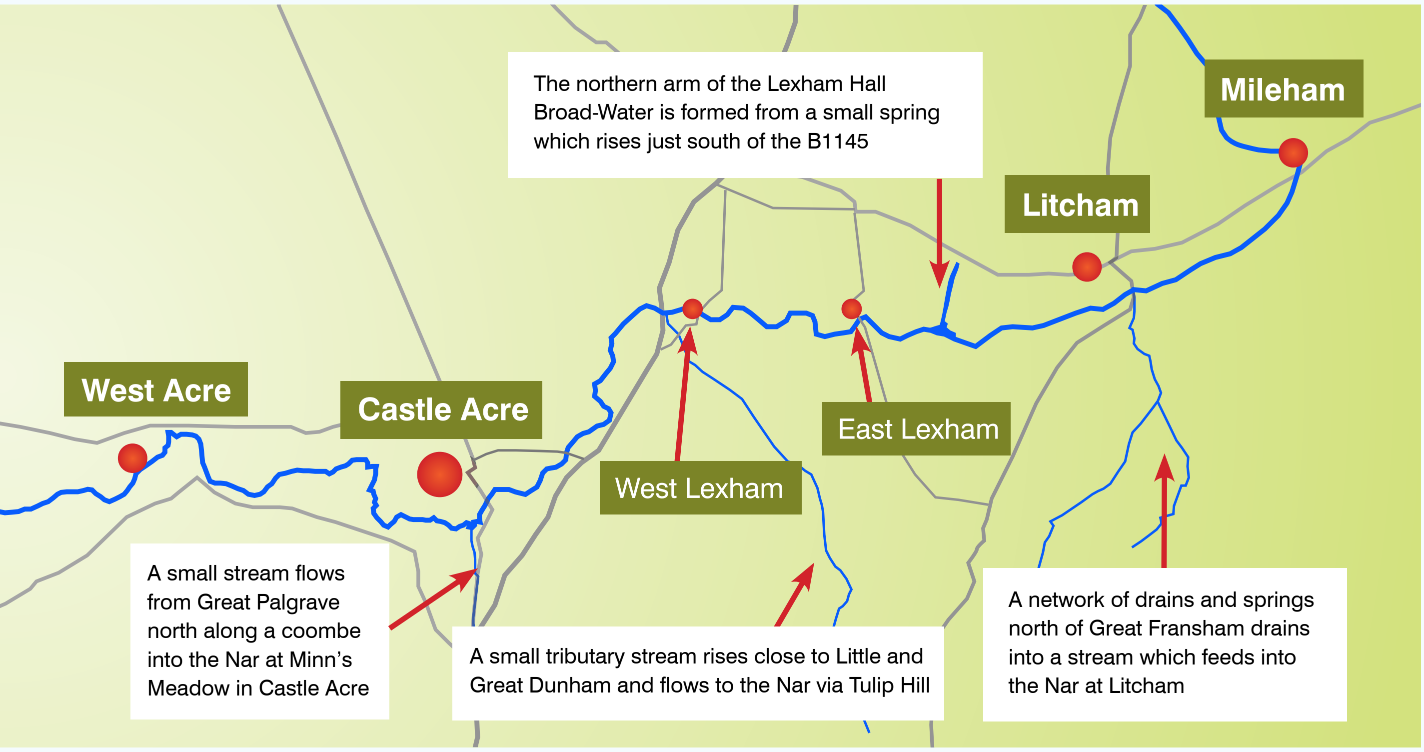
West Acre to Narborough

From the downstream end of Castle Acre Common through West Acre and on to Narborough the nature of the riparian woodland changes. Patches of wet-woodland remain, but increasingly a plantation woodland comes to dominate and where it does, the result is heavy shade and a less ecologically rich riparian habitat. The West Acre Fishing Club and West Acre Estate have recently experimented with clearing patches of woodland, using the timber to create Large Woody Debris (LWD) structures: the results, though unquantified, have been very encouraging with enhanced scouring and pinching of the channel, noticeably improved insect life, better in-stream and riparian plant growth, and greater numbers of adult fish.

The Natural River

Just outside West Acre and at Talent's meadow, just upstream of West Acre, two exceptional reaches of relatively unmodified stream exists. Here the river exhibits extreme meanders through wet woodland and an unimproved wetland meadow. There are shallows and deep channels between weedbeds and wild flowers in the wetted meadows.

Upstream in and around Castle Acre village, and also near Lexham and Litcham there are also isolated reaches of natural or semi-natural river. Apart from their conservation value these short reaches are vital a reference for planning restoration works on the rest of the upper river.



GEOMORPHOLOGY

The geomorphology of the River Nar is reviewed in detail in English Nature's **Geomorphological Appraisal of the River Nar Site of Special Scientific Interest** published 2005. Several important conclusions are reached in that survey:

- The natural river was shaped by glacial and periglacial forces now no longer at work or operating at a very slow rate.
- Very little coarse material enters the system nowadays, material with which the river can interact dynamically.
- Moreover peak flows in this spring-fed river never reach a level where significant re-shaping of the channel can occur.
- Therefore once modified the river does not have the means to self-heal.
- 90% of the channel has been modified in some degree.
- The few unmodified reaches are of extremely high conservation value.

The report also concluded that:

- Fine sediments washing off agricultural land via ditches and roads, or from the road edges themselves, are accumulating in the river and significantly altering the ecology.
- This problem is acute in the upper river where the natural channel has been modified into a network of incised and straightened ditches, with very little protection against run-off.
- Most of this run-off can be pin-pointed to very specific sources linked to field drains, tributaries and road drainage, and in the lower river to the two IDB pumping stations and the Country Drain / Trout Stream tributary – which is in itself affected like the upper river by field and road drains.

The river rises on chalk and in its course to Narborough flows over chalk formations. In its lower course the underlying geology is more complex and consists of a progression from Narborough downstream through a series of clays and greensands.

The catchment formed from this geological canvas was shaped by complicated glacial and periglacial processes. Repeated freezing and thawing of an ice-bound landscape, ephemeral ice dams and the slow regression of a shallow sea that once flooded the lower valley, have left behind a highly complex landscape.

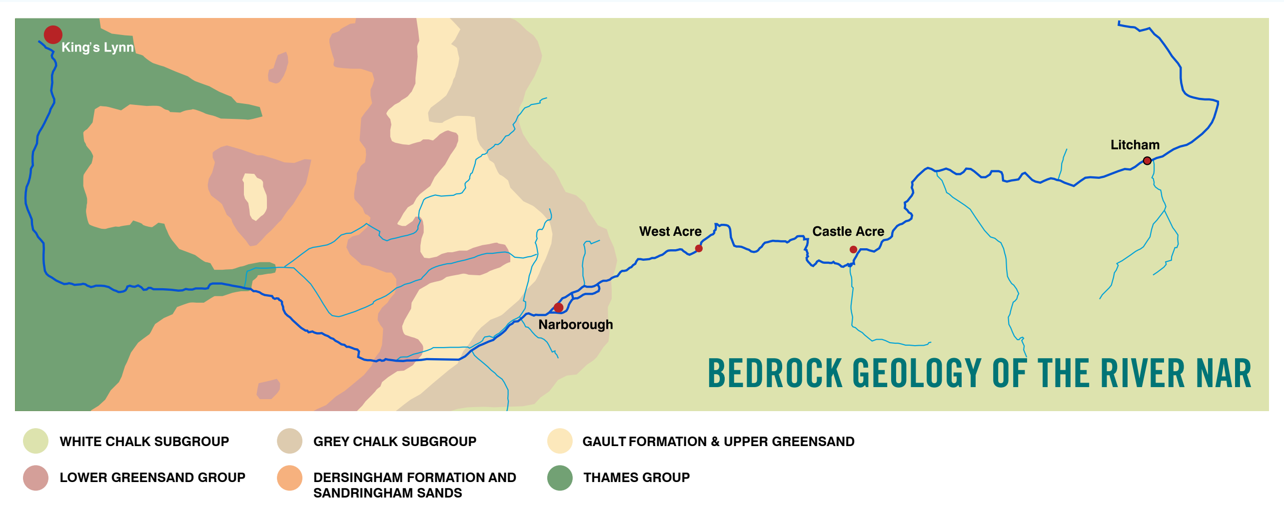
There are areas of gravel, alluvial sands, freshwater silts, peaty soils, and in the lower valley clays, sands and marine silts. The topography and this marbled patterning of soil types determines the locally varying character of the valley.

The distribution of different soil types also largely determines the pattern of fine sediment erosion in the valley.

Understanding the geological formation of the catchment and the soil distribution is essential when considering a catchment-scale approach to river restoration.

The main points are:

- The underlying chalk creates a river with a high Base Flow Index (BFI – a high groundwater component to the flows) typical of pure chalk streams, but a low-energy system.
- Overlying glacial deposits – sands and gravels – offset this groundwater flow to a small extent, particularly in the upper valley, by supplying a proportion of semi-surface flow and instantaneous run-off.
- The incision of the channel into a network of field drains in the upper reaches, where there are significant deposits of sand and gravel, has lowered the ability of that land to retain and slowly release water, further offsetting the BFI.
- There is a widespread presence of highly erodible sandy soils in the catchment.
- The silty, peaty soils in the lower valley allow seepage from the main channel.



LAND USE

- **Arable land dominates 75% of the total catchment area.** The main crops are: winter wheat, spring barley, sugar beet and winter barley. In the upper valley the riparian fields are very rarely arable, but the arable land often connects with the river via drains, many of which are not buffered against run-off in any way. In the lower valley the surrounding land is frequently arable, but most of this is below the level of the river and only impacts directly on the river through the network of IDB maintained drains, particularly via the pumping stations upstream of Setchey.

- **Sheep and cattle** dominate the cultivated riparian land in the upper valley, mostly low intensity sheep pasture, although cattle graze waterside meadows, for example downstream of Newton Mill, or Castle Acre sewage works. Poaching of the river banks has been an issue. Natural England promotes lower intensity grazing and Talent's Meadow is a good example of where light grazing helps to create a ecologically rich riparian meadow.

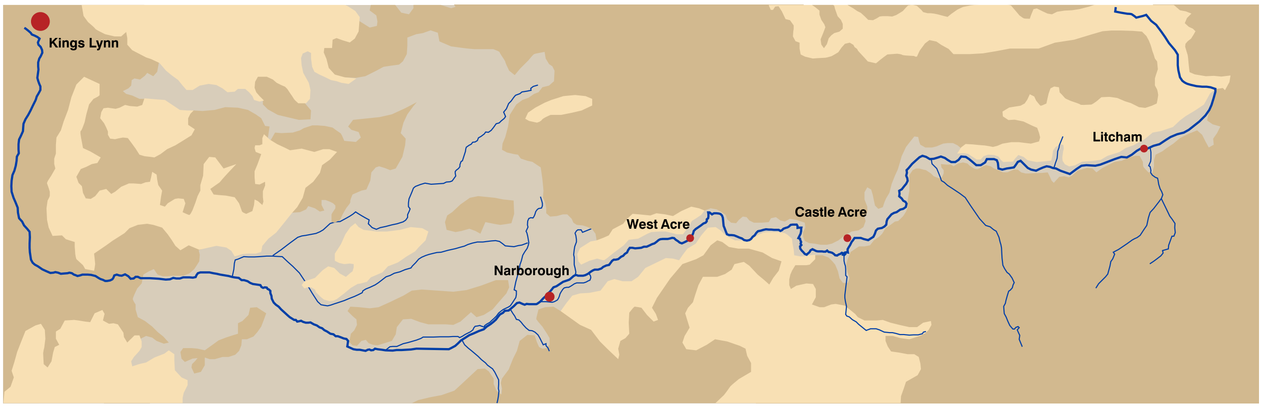
- **Pig farming** is increasingly present in the valley and is a threat to the ecology of the river. The EN fluvial audit quantified the sediment washing from a pig farm along a road and into the river during one summer storm at the rate of 6 tons per hour! Promoting good practice on pig units should be a priority.

- **Sand and Gravel Pits** - there are several disused and flooded pits in the valley as well as working pits between Pentney and Blackborough End. There is some potential for sediment run-off from working pits.

- **Forestry** - there are significant areas of planted riparian forestry upstream of Narborough through the Bradmoor Plantation, through The Oaks and The Carr towards West Acre and upstream of West Acre Mill through Big Wood.

- **Fish Farms** - there are two fish farms at Narborough and West Acre.

In its upper reaches the river channel has been modified into a network of deeply-incised ditches. This has not only reduced the ability of that land to retain and slowly release water, but has created a considerable problem of soil erosion and sediment loading.



SANDY SOIL LOAMY SOIL PEATY SOIL

SOIL TYPES AROUND THE RIVER NAR

ECOLOGY

The River Nar can be broadly classified within the Joint Nature Conservancy Committee (JNCC) River Community Type (RCT) classifications as follows:

- **Litcham upstream to source** RCT IV (ditch community) sub-type b (base rich, close to source) – though this classification might in large part derive from modifications.
- **Narborough to Litcham** RCT III (base-rich, stable, low energy, lowland river such as a chalk stream) sub-type b (influenced by variable geology).
- **Kings Lynn to Narbrorough** RCT I (lowland, low gradient) sub-type c (very low gradient, fine substrate).

The Nar's clear, equable and fertile flows create a typical chalk-stream ecology. A key component of the SSSI designation was the distinctive **Callitricho-Batrachion** plant community typical of a groundwater River Community Type III.

Above Litcham starwort, water cress and sweet-grass, are the few in-river plant species capable of surviving intermittent flows.

In the main body of the upper river from **Narbrough upstream through Castle Acre** all of the species archetypal of or commonly found in chalk streams are present, but of particular note are: water-parsnip and water crowfoot as well as lesser water-parsnip, blunt-fruited water-starwort, lesser pond-sedge, stream water-crowfoot and blue water-speedwell.

The flora varies according to conditions from reach to reach, reflecting the natural gradient, but also the extent of the channel modifications. The slower, more incised reaches can be dominated by emergent and encroaching reeds and in places where silt and sand have accreted across the full width of a uniform channel mare's tail is common and crowfoot absent.

Nutrient enrichment, reflecting poor agricultural practices in the catchment, can lead to a smothering of blanket weed at certain times of year.

Downstream of Narborough this typical chalk-stream flora is only present near the village itself where there is still some gradient over a pebbly stream bed, and in a short reach downstream of the old toll bridge at Pentney Abbey, again where there is a faster flow over gravel.

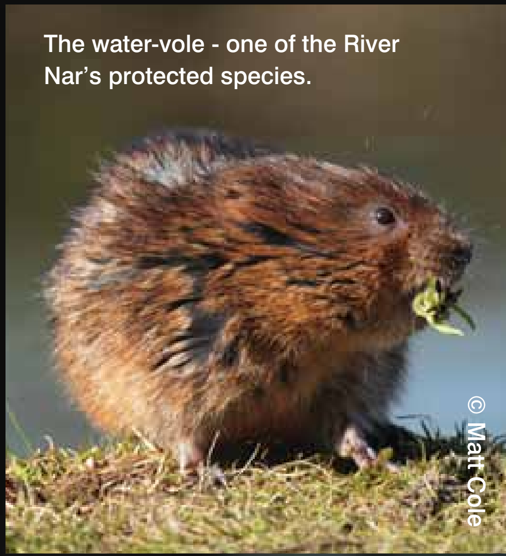
Elsewhere downstream the flora is typical of a fen drain. Along the banks marginal stands of reed sweet-grass, reed canary-grass, common reed and branched bur-reed and in the river water-dropwort, unbranched bur-reed, lesser water-parsnip, fennel pondweed, perfoliate pondweed, shining pondweed, arrowhead and Canadian pondweed.

Tube-weed, blanket weed and filamentous green algae are also all present.

In the riparian zone along the upper river alders and willow dominate and along the lower river mown grass embankments create something of a monoculture, except around High Bridge where some deliberate seeding has created a more diverse community.

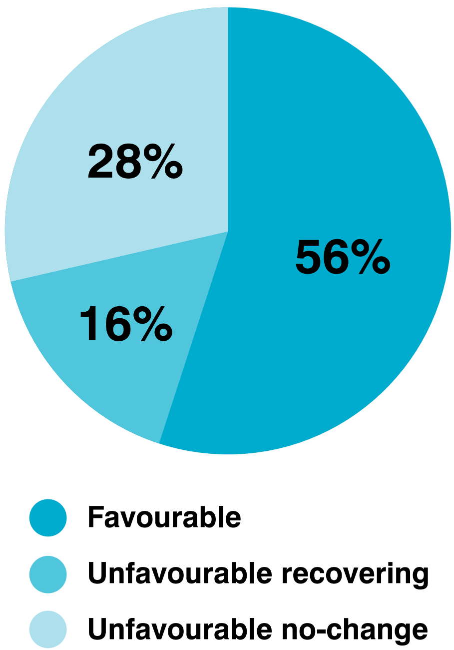
Across the floodplain in the upper river there are extensive tracts no longer managed for grazing – Castle Acre Common, or Emmanuel's Common for example – and here alder and willow dominate because both species are adapted to wet soils, and can spread through wind-throw, or through their root system. In these damp riverside meadows southern marsh orchid, yellow rattle and bog bean have all been noted.

A significant proportion of the upper Nar is heavily shaded under forestry plantations and while tree-fall is a vital part of a dynamic river system, the extent of shading in these reaches is extreme and ecologically and morphologically counter-productive.



The water-vole - one of the River Nar's protected species.

CONDITION SUMMARY
RIVER NAR SSSI



LOCAL DESIGNATIONS AND PRIORITY AREAS

The River Nar is designated as a **Site of Special Scientific Interest (SSSI)**: "The river combines the characteristics of a southern chalk stream and an East Anglian fen river. Together with the adjacent terrestrial habitats, the Nar is an outstanding river system of its type."

In addition to the Fluvial SSSI Units there are 38 Terrestrial Units (making up 180 ha of 233 ha SSSI designated area) of swamp, sedge swamp, reed-bed, flush, wet woodland and lowland meadow on land bordering and associated with the river, particularly in the upper reaches at Talent's Meadow in West Acre and from Castle Acre through to Lexham and again at Litcham. There are named SSSI sites at Horse Wood, Mileham; Castle Acre Common; and Setchey.

There is a **Local Nature Reserve** at Litcham Common TF 855172, described as: "Heathland with pockets of wet and dry heath and acid grassland. Blocks of scrub and attractive well developed oak/birch woodland."

OTHER DESIGNATIONS

There are a number of **County Wildlife Sites** associated with the river (in order traveling upstream these are numbered): 402 (just south of the King's Lynn by-pass), 520 / 891 (west of the A47 near Narborough), 522 / 525 (west of West Acre), 524, 497 (east of West Acre), 902, 893, 895, 500 (between Talent's Meadow and Castle Acre Common), 945 (Castle Acre d'stream of the priory), 951 (West Lexham), 957, 962, 2052 (East Lexham to Litcham), 964,967, 2177 (Litcham).

There are **Biodiversity Action Plan (BAP)** priority habitats for **purple moor grass and rush pasture** at Mileham and Narborough, **lowland heathland** at Litcham and Castle Acre Common, **lowland dairy acid grassland** at Narborough and **lowland meadow** and floodplain grazing marsh throughout the river corridor.

Catchment Sensitive Farming (CSF) - The Nar is a priority under the CSF Delivery Initiative for England.

Norfolk Wet Woodland Project - now closed. Was funded by The Forestry Commission East England Conservancy, Norfolk County Council Environment Department, the Norfolk Biodiversity Partnership and the EA to address the decline of wet woodland, with the objective within the Nar catchment of establishing 10ha of new habitat and bringing 40ha of existing habitat into better management.

Nar Ouse Regeneration Area is a partnership led by the Borough Council of Kings Lynn and West Norfolk to regenerate the area around the confluence of the Ouse and Nar. A 2007 Marina Masterplan was revised in 2009, when the preferred option for the Nar was to divert its course across the southern edge of the proposed site with a new outfall into the River Ouse. Restoration schemes at the downstream end of the lower Nar will need to take into account this ongoing NORA project to ensure compatibility.

Photography by Nigel Holmes

PROTECTED AND CITED SPECIES IN AND AROUND THE RIVER NAR

The River Nar SSSI designation cites:

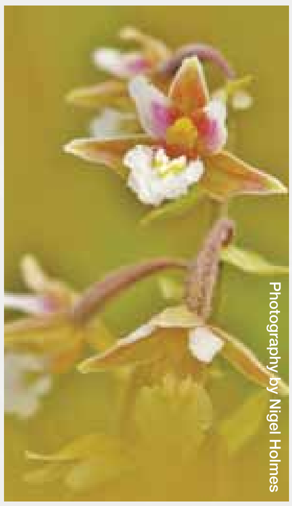
- **Reed warblers, teal, marsh harriers and willow and marsh tits.**
- **Brown trout, eel, bullhead and spined loach.**
- **Southern marsh orchid, yellow rattle and bogbean.**
- **Starwort, reed sweet-grass, narrow-leaved water-parsnip, mare's tail, greater tussock-sedge, water crowfoot, opposite-leaved pondweed, hornwort, water mil-foil and river water-dropwort.**

In addition

- **Water voles** have been noted throughout the river especially Castle Acre, Marham Flume and the Narborough Trout Fishery.
- **Otters** have been noted between Setchey and Narford Hall.
- **Great crested newts** have been seen in the wet meadows near Castle Acre.
- **White-clawed crayfish** – 14 surveys have yielded only negative results, although there is anecdotal evidence of their one-time presence in the reservoir at Lexham.

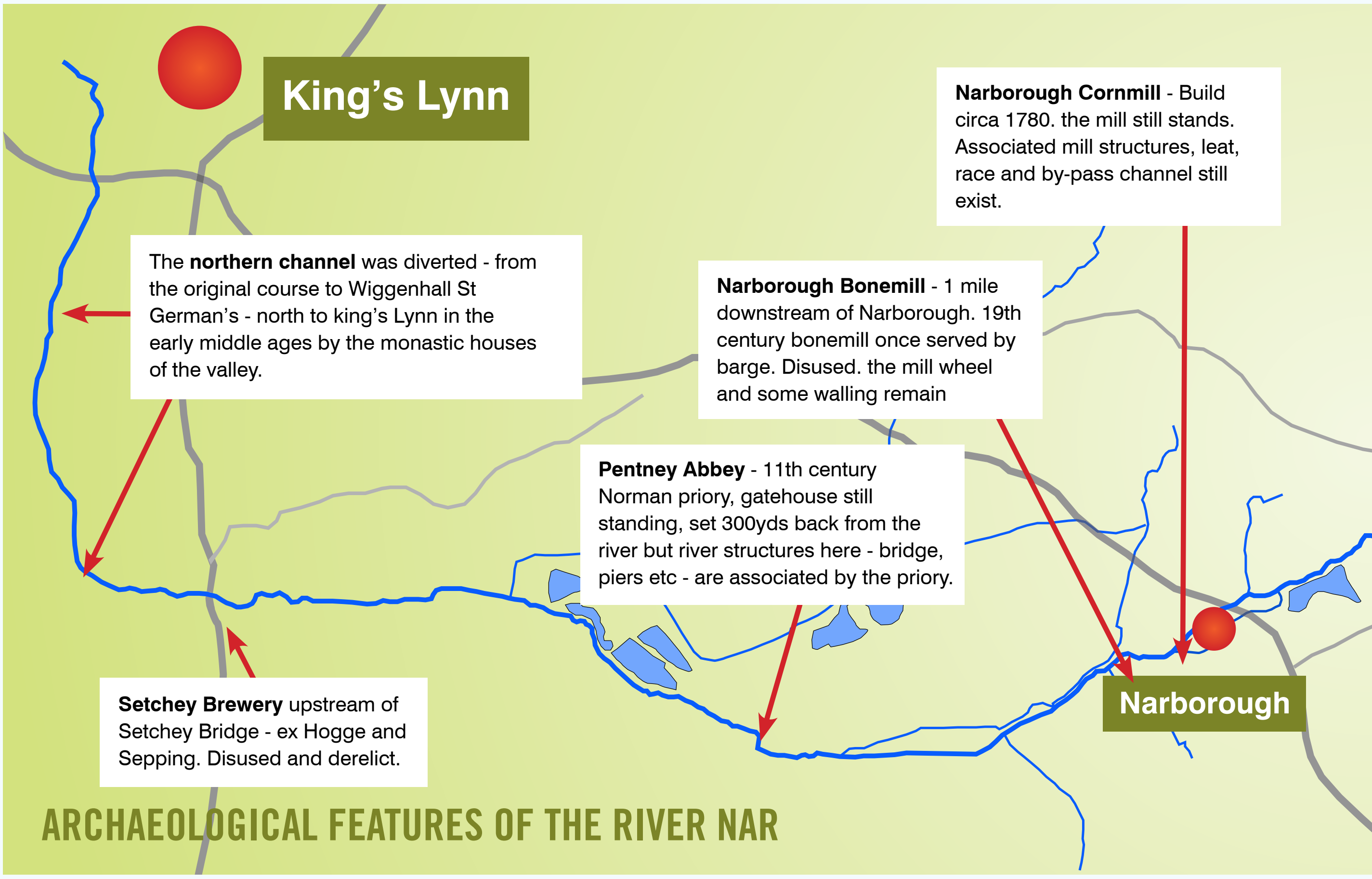
NON-NATIVE SPECIES IN AND AROUND THE RIVER NAR

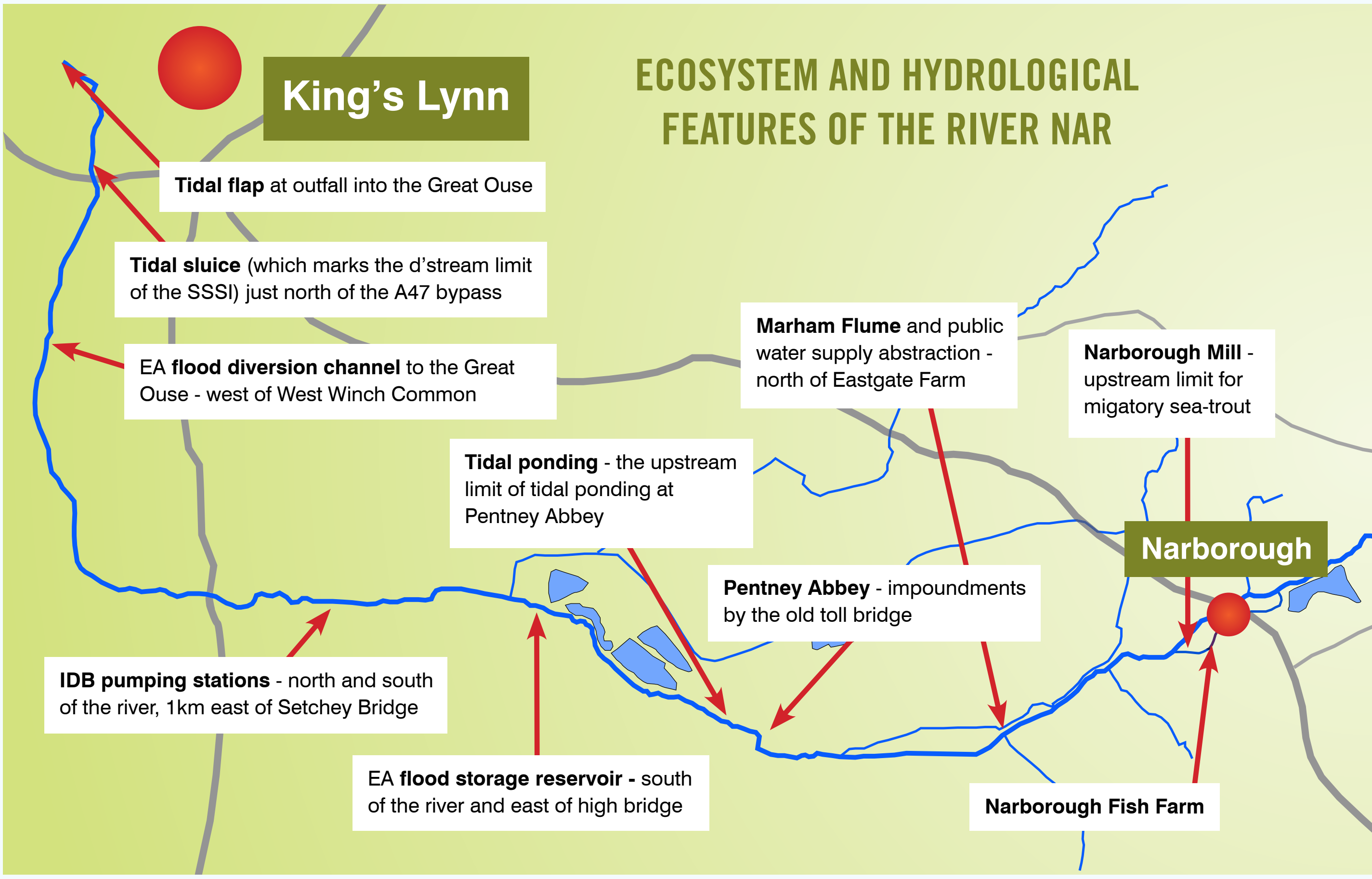
- **Rainbow trou**t - regularly escape from fish farms. There is also evidence that rainbow trout might occasionally be breeding in the upper river.
- **Signal crayfish** - are present in the lower river. The impoundment at Narborough may be preventing their upstream migration.
- **Giant hogweed** - outbreaks have been recorded near Newton Mill and d'stream of the A1065, though these may have been successfully controlled.
- **Himalayan balsam** - is widespread in the upper reaches.
- **Parrot's feather** - has been observed in the marginal wetlands near Marham.
- **Australian swamp stonecrop** - has been noted at Narborough lakes.

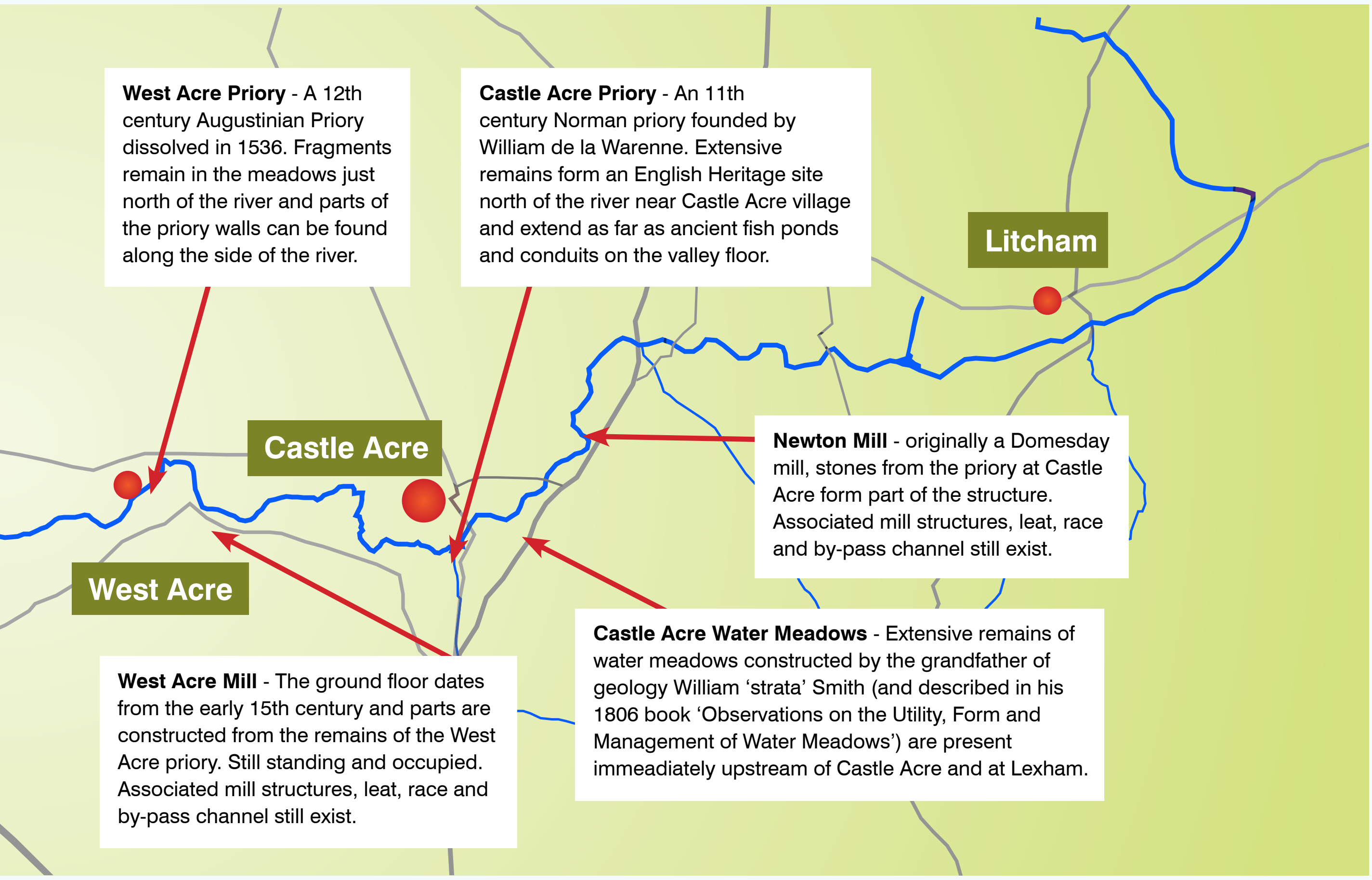


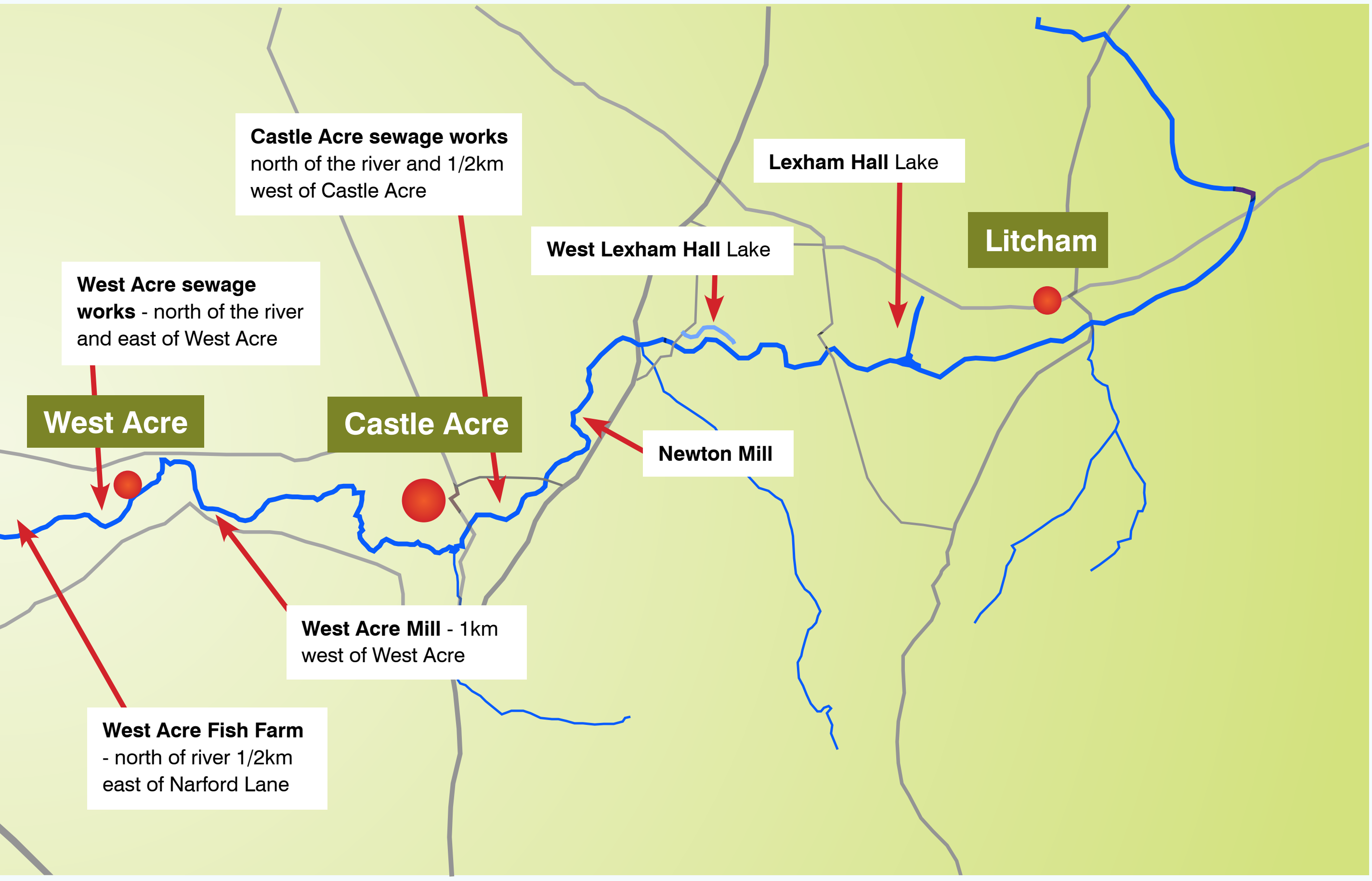
The southern marsh orchid - Above left - and marsh helibore Above right - thrive in the damp, uncultivated meadows surrounding the River Nar.

ARCHAEOLOGY AND HYDROLOGY






West Acre Priory - A 12th century Augustinian Priory dissolved in 1536. Fragments remain in the meadows just north of the river and parts of the priory walls can be found along the side of the river.
Castle Acre Priory - An 11th century Norman priory founded by William de la Warenne. Extensive remains form an English Heritage site north of the river near Castle Acre village and extend as far as ancient fish ponds and conduits on the valley floor.
Litcham
Castle Acre
Newton Mill - originally a Domesday mill, stones from the priory at Castle Acre form part of the structure. Associated mill structures, leat, race and by-pass channel still exist.
West Acre
Castle Acre Water Meadows - Extensive remains of water meadows constructed by the grandfather of geology William 'strata' Smith (and described in his 1806 book 'Observations on the Utility, Form and Management of Water Meadows') are present immeadiately upstream of Castle Acre and at Lexham.
West Acre Mill - The ground floor dates from the early 15th century and parts are constructed from the remains of the West Acre priory. Still standing and occupied. Associated mill structures, leat, race and by-pass channel still exist.


Castle Acre sewage works north of the river and 1/2km west of Castle Acre
Lexham Hall Lake
West Lexham Hall Lake
Litcham
West Acre sewage works - north of the river and east of West Acre
West Acre
Castle Acre
Newton Mill
West Acre Mill - 1km west of West Acre
West Acre Fish Farm - north of river 1/2km east of Narford Lane

THE WATER FRAMEWORK DIRECTIVE CLASSIFICATION

R-13 **GB105033047791**
Grid Ref **TF8027115129**
NAR to confluence with Blackborough Drain
Current Overall Potential: **MODERATE**
Status Objective: **GOOD BY 2027**
Justification if status objective is not good by 2015:
TECHNICALLY INFEASIBLE
Hydromorphological Designation: **HEAVILY MODIFIED**
Reason for Designation: **WIDER ENVIRONMENT**

BIOLOGICAL ELEMENTS

Fish – **Moderate (Quite Certain)**
Invertebrates – **High**

Ammonia - **High**
Dissolved Oxygen - **Good**
pH - **High**
Phosphate - **High**
Temperature - **High**
2,4-dichlorephenol - **High**
Copper - **High**
Iron - **High**
Zinc - **High**
Ammonia (Annex 8) - **High**

SUPPORTING ELEMENT

Quantity and Dynamics of Flow –
Does not Support Good

High = of high status not high concentration!

The man-made lower Nar which flows between trapezoid banks floating above the level of the surrounding land is designated Not a Heavily Modified Water Body whereas the upper Nar which flow through wet-woodland, scrub, marsh and unimproved pasture is designated Heavily Modified: a WFD classification that appears counter-intuitive.

R-14 **GB105033047792**
Grid Ref **TF6223413624**
NAR d'stream Blackborough Drain
Current Overall Potential: **GOOD**
Status Objective: **GOOD BY 2015**
Hydromorphological Designation:
Not A/HMWB

BIOLOGICAL ELEMENTS

Fish – **Good**
Invertebrates – **High**

Ammonia - **High**
Dissolved Oxygen - **Good**
pH - **High**
Phosphate - **High**
Temperature - **High**
Copper - **High**
Iron - **High**
Ammonia (Annex 8) - **High**

SUPPORTING ELEMENT

Quantity and Dynamics of Flow
Does not Support Good (Uncertain)
Morphology – **supports good.**

R-12 **GB105033047770**
Grid Ref **TF7168314202**
COUNTRY DRAIN
Current Overall Status: **GOOD**
Status Objective: **GOOD by 2015**
Hydromorphological Designation: **Not A/HMWB**

BIOLOGICAL ELEMENTS

Invertebrates – **High**

Ammonia - **High**
Dissolved Oxygen - **Good**
pH - **High**
Phosphate - **Good**
Temperature - **High**
Ammonia (Annex 8) - **High**

SUPPORTING ELEMENT

Quantity and Dynamics of Flow –
Supports Good
Morphology – **Supports good.**

In the current River Basin Management Plan (RBMP). The River Nar and its tributaries constitute three water bodies. Their current WFD classifications are summarised opposite.

SOME CONCERNS

- In spite of all the pressures on the river (identified on page 15) there is only one failing element (fish populations on the upper river) and one failing supporting supporting element (quantity and dynamics of flow upper and lower river).
- The river is classed as of High Status with regard to phosphates in spite of the fact that it is failing SSSI standards.
- The designation does not appear to describe the actual river.

COUNTER-INTUITIVE DESIGNATIONS

The waterbody status designations within the classifications appear counter-intuitive:

The heavily modified channels of the Lower Nar and the Country Drain are designated as Not Heavily Modified Water Bodies (NOT HMWB).

The more natural channel in the upper river has been designated as a Heavily Modified Water Body (HMWB).

The purpose of the HMWB designation is to draw a distinction between water bodies where modifications provide vital socio-economic benefits[1] and those where modifications do not. Water bodies given HMWB status have to achieve Good Ecological Potential as opposed Status, the distinction between the two being that the heavily modified waterbody must be at GOOD in every respect other than in those 'ELEMENTS' which are definitively limited by the indispensable modifications. A screening process is used to determine whether or not a waterbody is HMWB, and one of the screens is that if a waterbody is determined as at GOOD status that waterbody **must** be designated NOT HMWB.

The lower Nar was classified as GOOD and so was excluded from HMWB designation.

The upper river was classified as MODERATE. Because the upper river was therefore not excluded at the same point in the screening process it was designated HMWB.

IS THE FISH DATA REPRESENTATIVE?

The failing ELEMENT for the upper river was fish. Counts are excellent around Castle Acre but only moderate in the heavily forested reaches above Narborough and poor in the incised, ditched channel upstream of Lexham.

There were no failing ELEMENTS on the lower river. Unlike the upper river the fish data was universally GOOD. BUT at present the data collection points are immediately downstream of bridges where conditions are different from the majority of the river. The bridges offer cover, pools, riffles and accelerated flows in an otherwise uniform channel. It is probable therefore that the data is skewed. It is also highly questionable that the morphology of the lower river supports GOOD as stated in the designation.

For the upper river the data would appear representative but the reasons behind the river's modifications (medieval navigation systems, domesday mills, floated water-meadows) are not current and do not provide socio-economic benefits.

All of this adds up to a classification that does not make sense.

The counter-intuitive designation appears to have been caused by;

- A loophole† in the "detailed designation" process for HMWB whereby rivers classified GOOD – for whatever reason – must not be HMWB: this is a flawed in that it draws a morphological conclusion from ecological data.
- A split in the waterbody designation that does not relate to the river (the split at Blackborough End is half-way down the very heavily modified channel) making accurate classification and designation impossible.
- Reliance on a limited range of potentially unrepresentative ecological data.
- Non-reliance on Expert Judgement which may have been more useful in this case.

WATER QUALITY

In the RBMP WFD classification there were no failing elements for water quality.

Current WFD obligations requires no deterioration and so these recordings are now baselines against which there should be no regression.

Please see also the Diffuse Water Pollution page.

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[1] Annex I to the River Basin Management Plan Anglian District

ACTIONS (for the 2015 RBMP)

- The split between GB105033047791 and GB105033047792 should be at Narborough and not Blackborough End.

This would reflect the geo-morphological shift between upper and lower river allowing a re-classification that describes the river.

- The loophole identified above† should be closed.
- The River below Narborough should be classed a HMWB with a target status of GEP
- The River above Narborough should be classed as NOT A HMWB with a target status of GES.
- Phosphate targets should relate to the more stringent SSSI targets.
- Classification should assess morphology, but not as a conclusion drawn from other data.

FURTHER INVESTIGATION BEFORE 2015

- More fish data on the lower Nar, from sites not immediately downstream of bridges.
- The impact of the current weed-cutting regime (see page 28) on fish numbers and distribution in the lower river needs urgent investigation.
- Fish data is needed from the Country Drain and the Trout Stream.
- Investigate the potential impact of raised phosphate levels allowing for the possibility of levels peaking after heavy rain.
- The failing element of 'quantity and dynamics of flow' needs urgent investigation, particularly given the evidence that the river is heavily over-abstracted and that flows are well below UK TAG guidelines (see page 18).

SECTION 2 PROBLEMS AND SOLUTIONS

OVERVIEW OF LIMITING FACTORS

An overview of the limiting pressures holding the river back from achieving Good Ecological Status or Potential.

The limiting pressures cited here were identified in and collated from the 2006 Geomorphological Appraisal, the 2010 River Nar Restoration Strategy, and corroborated by Norfolk Rivers Trust catchment walkovers and consultation with local stakeholders with expert knowledge of the river.

The RBMP WFD classification identifies "quantity and dynamics of flow" as a limiting factor and cites a failure in fish numbers in the upper river: this failure is currently being investigated by the Environment Agency.

UPPER RIVER

- **Canalisation and lack of connectivity** – various modifications to the channel deriving from navigation, milling, water-meadows, but most acutely post-war land drainage have resulted in a straightened, uniform and lowered river channel which cannot function as a chalk stream should.
- **Abstraction** – the river is over-abstracted†: reduced flows exacerbate every other pressure exerted on the river.
- **Sediment Pollution** from the wider catchment.
- **Overshading** within dense plantations.
- **Lack of shade** – in some extensive treeless reaches.
- **Excessive in-stream plant growth**
- **Impoundments**
- **Invasive alien plants**
- **Nutrient enrichment**

These issues are inter-related: for example the blanket emergent plant growth that occurs in some reaches is caused by the canalisation, the sediment pollution, the abstraction and the impoundments.

LOWER RIVER

- **Extreme Canalisation of the river channel** – which to a significant extent cannot be altered.
- **Uniform Morphology** – a function of the above, but something that can be addressed.
- **Sediment Pollution** via flows from the upper river, from the Country Drain and the IDB pumping stations.
- **Abstraction – the river is over-abstracted†.**
- **Control structures and impoundments.**
- **Nutrient enrichment**

The extreme modification of the channel is so linked to the evolution of the surrounding fen landscape that it is technically infeasible to restore the river to natural conditions. However, within the constraints of the channel's highly modified condition and function it is possible to address the issue of channel uniformity, which would form a large part of the work needed to get the river to Good Ecological Potential throughout its length and not just down-stream of the bridges.

† Based on expert analysis of EA data commissioned by the Norfolk Rivers Trust in 2012 (see pages 14 to 17)

CANALISATION and DREDGING creates a river that is isolated from its riparian fringes and floodplain: a low-energy, spring-fed stream flowing through an incised trench is unable to function as a river and the whole river's ecology suffers.

SEDIMENT POLLUTION which washes off farmland, hard-stands, tracks and roadside verges flows into the river through a network of drains and ditches.

POOR AGRICULTURAL PRACTICES. This pile of manure was left on a hard-standing beside the river (April 2012) and its effluent was leaching across the road, into a ditch, through a culvert and into the river.

OVERVIEW OF RESTORATION MEASURES

A SUMMARY OF THE STEPS NEEDED TO TAKE THE UPPER RIVER TO GES

- Restore connectivity and reverse the canalisation through a catchment wide programme of re-sculpting the channel, planform and riparian margin: reinstate or re-create meanders, allow woody debris to remain in the river, or introduce it where appropriate. Successful restoration of connectivity will involve different measures in different places.

Restoration of connectivity from the headwaters downstream will by default go a long way to addressing other limiting pressures such as sediment deposition and excessive in-stream plant growth.

- Address fine sediment and sand pollution through a strategic farm and land-management liaison process.
- Investigate the impact of nutrient enrichment and reduce its impact through a strategic farm and land-management liaison process.
- Mitigate impoundments, by removal or by-pass.
- Create a more even distribution of light and shade, by careful planting in the wide open reaches and careful felling in the densely shaded reaches.
- Reduce abstraction to within UK TAG guidelines.
- Instigate a stakeholder-led invasive plant eradication programme, approached strategically, starting at the top of the catchment.

A SUMMARY OF THE STEPS NEEDED TO TAKE THE LOWER RIVER TO GEP

- In appropriate reaches of higher gradient or greater sinuosity between Pentney and Narborough consider in-stream works that enhance morphological variety.
- Address sediment ingress into the Country Drain and The Trout Stream through a strategic farm and land-management liaison process.
- Address sediment ingress from the NRDB pumping stations near Setchey and devise mitigating solutions.
- Examine the weed-cutting and bank-maintenance regime to explore ways in which changes of practice can enhance the in-stream and riparian habitat.

For large sections of the lower river this might be the most appropriate and cost-effective way to enhance the habitat in this very low-gradient stream.

- Investigate and address issues of fish passage at Kings Lynn, Marham and Narborough. Ensure any channel modifications caused by the Nar Ouse Regeneration Project take fish passage into account.
- Reduce abstraction to within UK TAG guidelines.

PIG-FARMING is an increasing presence in the valley. Unchecked the run-off from pig fields can be massive and it arrives at the river along roads and tracks and ditches.

IMPOUNDMENTS are a major impediment to the ecological well being of the river: not only do they cause an accumulation of sediment in the impounded reaches, but they also impede the free passage of fish.

PLANTATION FORESTRY: the dense shade within plantation forestry leaves bare river banks vulnerable to erosion and devoid of cover for fish and insects.

CANALISATION AND CONNECTIVITY

The cumulative legacy of the various ways in which the river channel has been modified presents a significant and fundamental limit on the ecological status of the upper River Nar.

These channel modifications derive from navigation (most likely as early as the 11th century and extending as far upstream as Castle Acre), ancient mills and water-meadows and most recently the agricultural drainage programme of the late twentieth century. Of these the latter is the most damaging because of the extent and intensity of the changes. Every other issue the River Nar faces is made worse by the impact of canalisation and dredging. And some derive from it.

- **The dynamic, riverine processes at work in a small chalk-stream operate at a far more gentle pace than in a steep, rain-fed stream.**
- **The dynamics of a spring fed river utterly depend on their naturally shallow dish-like channel shape and on the gradual shift from water to dry land through a wetted margin: on the connectivity between the river and the riparian zone.**

THE NATURAL RIVER

Natural spring-fed streams are typically 'brim-full': there is little distance between the water level at normal height and the top of the bank. This allows the river to 'breathe'. In the higher flows of winter or in a summer flood, the river naturally spills over its banks and deposits sediment along the margins. These gradually accrete and colonise with plants. The riparian plants which grow in summer and partially recede in winter create a channel which naturally varies in size with the seasons.

This relationship between the selected, graded pattern of deposition and accretion and subsequent colonisation by plants forms **the** vital component in the dynamic processes of the spring-fed river, catalysing meanders and scours, pools and riffles.

Tree-fall plays a vital role too, interacting with the processes above to enhance the dynamism of the river and most significantly enabling fresh injections of coarse material from the river bed or banks.

THE CHANGED RIVER

But the River Nar lies within a deeply incised channel for most of its length. In places mounds of spoil dredged from the river are still visible along the banks. Elsewhere the canalisation reveals itself in a more subtle levee, now grown over with grass and nettles.

THE IMPACT OF CANALISATION

The effect of dropping a spring-fed stream into an incised, box-shaped channel is severe. The natural riparian margin of vegetation that fades gradually from river to meadow is replaced by a steep bank on which little can grow. This steep bank proves vulnerable to erosion and so over time the river gets wider and wider, exacerbating the other problems which have been caused by the creation of a uniform channel. All the riverine processes referred to above have now been severely curtailed – and they were slow in the first place.

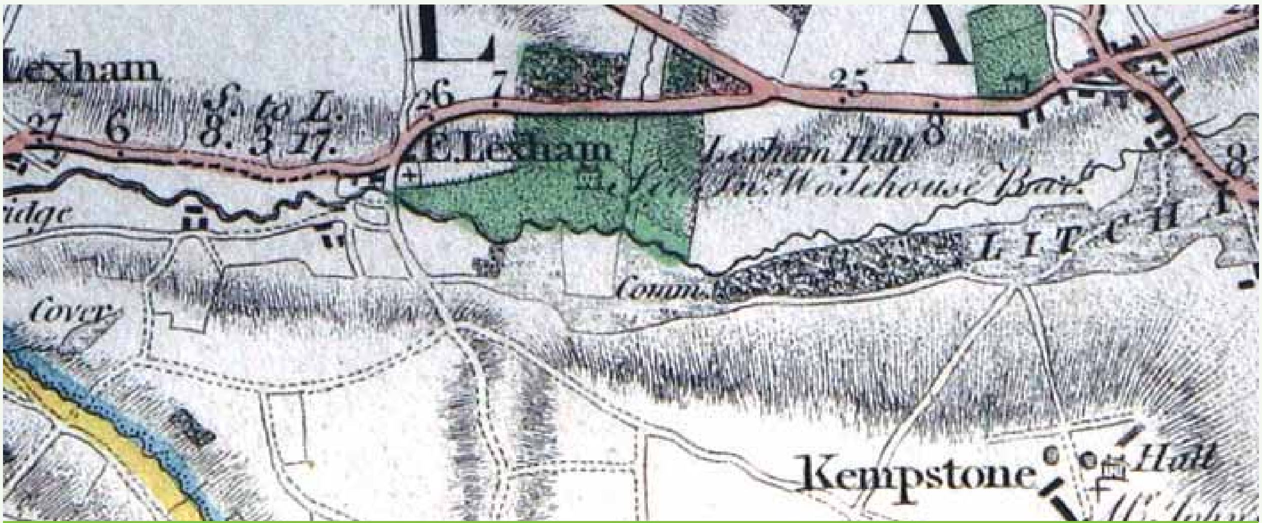
Even a significant lift in the flow does not release the river over the riparian shelf. Sediment is deposited uniformly across the flat river-bed leading to blanket communities of emergent plants which favour low, laminar flows.

These communities only worsen the problem as they are 'managed' through spraying and dredging, processes which further canalise the stream.

This box-section straight-jacket, which is the dominant channel shape over the majority of the upper river, is something the river will never escape from of its own accord within any kind of acceptable time-frame.

On an undredged reach of the Sydling Brook in Dorset (above and below) it is possible to see the interaction between a diverse community of plants in a shallow wetted, riparian margin and the dynamic, sinuous channel. Note these picture were taken in low flows and yet the river is close to bank level.

Connectivity is the underlying issue on the upper Nar. This reach (above) just outside Castle Acre is a good example of a part of the river that looks unmodified but which has, in fact, been dredged: the northern (right) bank is a levee formed by dredgings from the river. And again below the northern (left) bank is built high by dredgings. Even in flood – as illustrated in both photos – the channel is so incised that water is nowhere near the top of the bank.



The Nar at Lexham Hall: Faden's 1797 map shows the extent to which the upper Nar, now mostly a straightened ditch, once meandered. Faden's map, early Ordnance Survey Maps and WW2 aerial photos all show that the original course of the river once followed the northern edge of the wood known as the Old Covert along a channel that is still there, while the river now runs through a ditch a few yards to the north. A cost-effective way to restore some parts of this upper river may be to restore flows to the old channel where possible.

RESTORING CONNECTIVITY

TAKING THE BANKS DOWN

Here on the River Babingley a shallow bank profile is created by pushing the old bank in, creating an uneven planform and bed profile with deeper pools and shallows between.

The front edge of the new bank is planted up with plugs of reed canary grass. When the river rises in higher flows it will be able to spill over the margins and deposit silt on the bank edges and in the back eddies created by the uneven planform, while the main channel remains scoured and clean.

RESTORING CONNECTIVITY

RE-SCULPTING WITHIN THE CHANNEL

Here on a River Nar pilot project at Minn's Meadow connectivity has been created by re-sculpting the river within the confines of the dredged channel.

The high bank on the right is left untouched, but has been faced with berms made from scrapes of vegetation taken from the riparian meadow. In places the uniform bed profile has been sculpted into pools and shallows and again the planform is uneven, with pinches alternating with broader reaches. As a result of this project connectivity has been restored on at least one bank over the full length of the restored reach: this should be a minimum aim for the restored river.

RESTORING CONNECTIVITY

Connectivity can be restored wholly or partly and in different ways, but in the broadest terms, either the river needs to be brought back up, or the banks need to be taken down or a new channel needs to be cut with the correct sinuosity and morphological variety.

BRINGING THE RIVER BACK UP

This is expensive and difficult. There is always a danger of imposing yet another tier of modification, an artificial staircase structure, and of the unchanged pools between the riffles becoming silt traps: natural riffles never interrupt a straight channel in a series of bars according to the model most artificial riffle insertions have followed.

However along short sections of the river restoring a gravel bed may be a viable option, allowing the riverine processes, in concert with LWD structures, to shape and contour it. With sufficient funding available it would possible to entertain this idea in certain suitable reaches of the upper Nar.

TAKING THE BANKS DOWN

A more practical option is to shape the leveed and incised banks to create low-lying flood berms. Incised berms of this sort should be three to five meters deep if possible, from the rivers edge to the lift in slope, or built on a very gentle incline. The re-shaping can involve a combination of pulling back the levees and pushing in the toe of the bank, so that as well as creating a connected riparian zone, one is also manipulating the planform of the river to create pinches and wider reaches.

This option does not recreate wide-scale connectivity, but it is more easily accomplished, less expensive and poses no wider flooding risk: it is a very practical and realistic option.

CARVING A NEW CHANNEL

A third option, where the ground is available and the land-owner willing, is to carve a new channel. This may often be an easier and more cost-effective solution than ‘bringing the river up’, and is especially viable in some reaches of the upper river. Old maps indicate that the very upper Nar once occupied an extremely sinuous channel. There are no reference sections left on the Nar from which it is possible to get a good idea of the extent to which small, low gradient spring-fed rivers naturally meander, but using old maps and aerial photos a full survey of the upper course would reveal large tracts of that relic course.

OTHER TECHNIQUES

There are a number of other ways in which elements of connectivity can be re-created:

RE-SCULPTING WITHIN THE CHANNEL

Already piloted on three reaches around Castle Acre. By sculpting pools and pinches in the river bed and ‘planting’ mats of vegetation either as shoulders pinching the flow, or as long berms which narrow the channel, it is possible to restore connectivity on a localised scale, immediately surrounding the river. On the upper section of Minn’s Meadow the density of the work over 400 meters was such

that a berm of one sort or another was created on at least one bank along almost 100% of the channel length.

TREE-FALL LARGE-WOODY-DEBRIS (LWD) OR FLOW DEFLECTORS

Tree-fall is vital in catalysing the dynamic processes of a spring-fed stream. When a tree falls across a stream, complex processes are set in motion which vastly add to the ecological richness of the river. In forcing its way past the obstruction a low energy river is energised. The river becomes gently impounded upstream but is forced to blow a deep hole in the river bed or bank to get around or under the tree. New gravel enters the system. Berms are thrown up along the downstream edges and often the channel is forced to braid, creating islands. All of this enhances connectivity and morphological variety. **See picture on previous page.**

As importantly the tree fall creates a window of daylight and that light allows the colonisation and consolidation of the accreted berms around the fallen tree. Under the natural conditions which are referred to in explaining the vitality of LWD, trees fall out of mature and relatively extensive woodland, so that the old, dead tree when it falls, or the mature one blown over, opens up a broad window to the sky. This link between LWD and daylight is crucial.

Flow deflectors also energise low energy rivers, forcing the water to make pools and riffles and berms. Built properly a flow deflector has a very similar impact and function to tree-fall. It is possible to make flow deflectors where there are no trees, recreating the impact of LWD in open reaches of the river. They only work well in more or less unshaded areas and they must be built properly.

ACTIONS

- Identify reference natural and undredged reaches on the River Nar to asses the characteristics of their planform, sinuosity, width-to-depth and water-height to ground-height ratios. Use these reference characteristics to develop restoration techniques.
- Conduct a river corridor survey in late winter / early spring, to identify and collate the full extent of canalisation and dredging.
- Continue with the development of pilot restoration projects.
- Convene a means of assessing pilot projects, taking lessons to inform future plans and knowledge.
- Develop a restoration programme which plans according to a scale of existing reach condition, set against criteria such as cost-effective gains, feasibility, linking natural reaches via restored reaches and funding with a view to completing a whole-river connectivity restoration by 2027.

CREATING A NEW RIVER CHANNEL ON THE NAR AT MILEHAM

Simon Rawles on behalf of WWF-UK

CONNECTIVITY IN THE LOWER RIVER

From Narborough downstream the River Nar runs inside a man-made trapezoid channel. Restoring connectivity with the broader floodplain is more or less impossible. However, it is possible to restore connectivity within the immediate confines of the river.

Localised connectivity could be enhanced by:

A MORE ECOLOGICALLY SENSITIVE REED AND WEED MANAGEMENT PROGRAMME

The lower river from Marham Flume downstream is cut three times a year: 60% cuts in July and August and an 80% cut in October – (Environment Agency Flood Risk Management – FRM – figures). The impact this has on fish populations is most likely severe † and it is unlikely the lower river will ever yield good fish data (except in the unrepresentative sections where data is currently collected) or achieve genuine GEP until this regime is modified.

The uniform cutting leaves little cover or habitat and the fish coral into the few places where the cutters cannot work. It is likely that this weed management regime has a negative impact on invertebrates, mammals and birds too.

A meander cut in which the river weeds and riparian reeds are left uncut on one bank or the other in 100 or 200 meter sections would be a far better solution for the ecology of the river. Under this regime the river would develop its own localised connectivity and in-channel sinuosity.

A trial meander cut was undertaken in August 2006 at the request of Natural England, but the Operations Delivery Team concluded 'that the channel was too narrow' and that the machinery seized. The trial cut as described in the FRM statement 2009 appears insufficient to have proved the meander cut non-viable.

RE-SCULPTING WITHIN THE CHANNEL

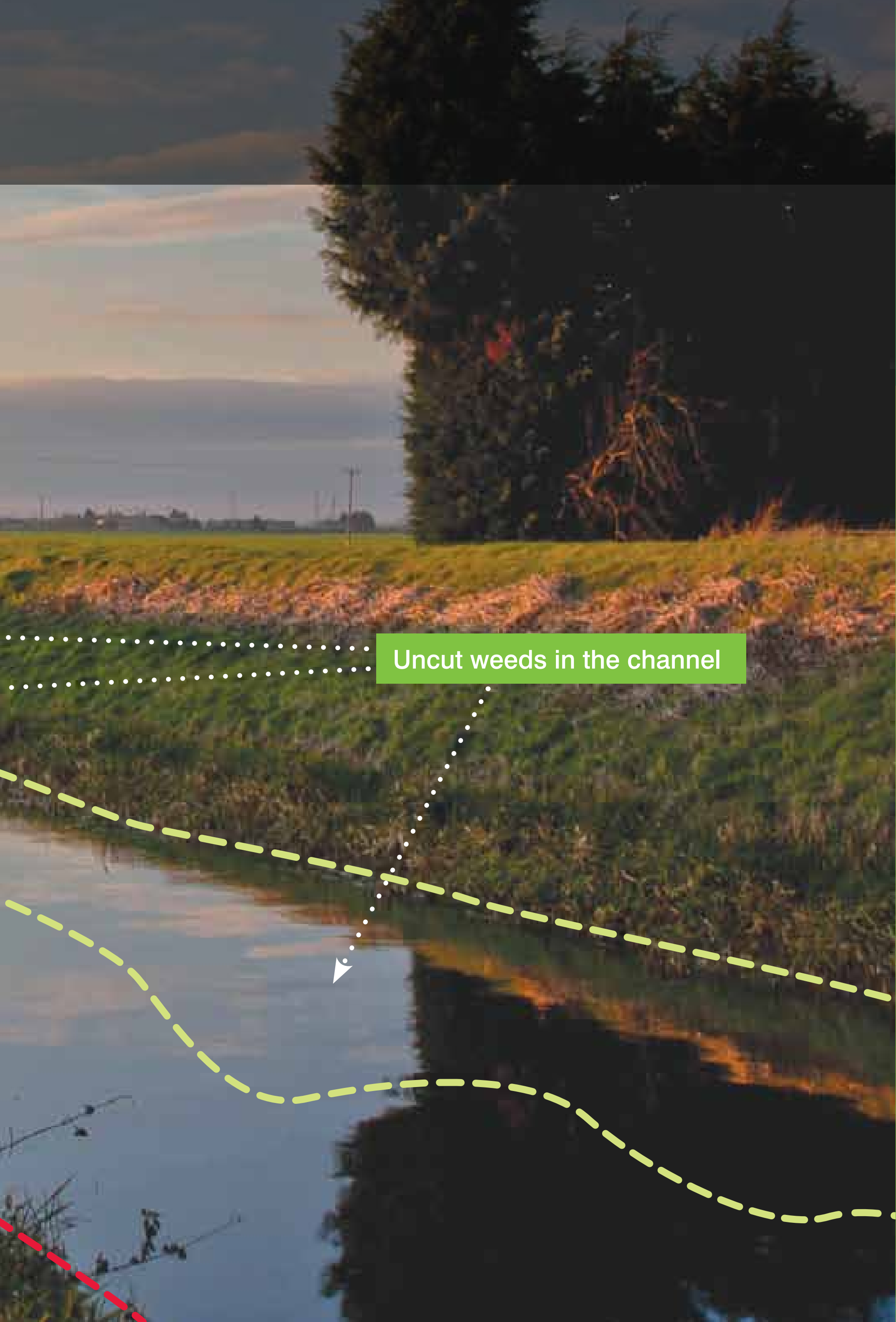
Re-sculpting the channel to achieve localised connectivity is far more challenging within the confines of the steep banks. However a pilot project has been completed near Narborough between the village and the bone mill. It will be worth studying the evolution of the channel where it has been enhanced.

PULLING BACK THE BANKS

Between Pentney Abbey and Narborough the river hugs the northern edge of the floodplain, meaning that the land to the north, rather than being below the level of the raised bank, slopes down to it. It is possible in these reaches to re-grade the northern bank to create a low-lying flood berm.

Stated as a long-term aspiration in the River Nar Restoration Strategy 2010 is the idea of pulling back the banks along the entire course of the lower river as far as the King's Lynn by-pass. Where the surrounding land lies below the level of the top of the levee (along most of the southern bank and along both banks from mid-way between Pentney and Blackborough End) or where the land is below the level of the river, pulling back the banks is technically challenging, and expensive and would involve some loss of agricultural land. However a more gentle incline for the first two or three meters of slope would make a significant difference to the ecology of the lower river and so this proposal should be examined in more detail to see if there is a good compromise to be made between connectivity, practicality and expense.

† based on local anglers comments during catchment walkovers and observations made over many years by this report's author



RESTORING CONNECTIVITY ON THE LOWER RIVER

An ecologically sensitive weed and reed-cutting regime might involve:

- Dividing the river into 100 or 200 meter sections;
- Cutting in alternating sections as illustrated left, only 50% of channel width, with uncut banks adjacent to the cut channel, switching sides so as to create sinuosity and unbroken habitat along the full length of the river, whilst still keeping macrophyte growth under control;
- Phasing the cutting so that each reach is cut according to the same pattern for a minimum of two years.

Over several years a strategic and ecologically sensitive weed and reed management regime would vastly improve the distribution and abundance of fish, invertebrates, mammals, birds and flora in the lower river.

ACTIONS

- Urgently investigate the impact of the current weed-cutting regime on fish populations and distribution.
- Undertake another trial lasting at least one full year, designed, reviewed and analysed by an independent third party.
- Research beneficial impacts to ecology of a revised weed-cutting regime.
- Undertake research into the beneficial impacts of localised channel modifications at the pilot restoration site at Narborough.
- Develop secondary pilot restoration at Pentney, eventually linking through with Narborough.
- Where feasible between Pentney and Narborough consider re-grading the banks to enhance connectivity.

ABSTRACTION AND WATER RESOURCES

2005 CATCHMENT ABSTRACTION MANAGEMENT STRATEGY

The Environment Agency's 2005 **Catchment Abstraction Management Strategy (CAMS)** divides the Nar and its aquifers into two **Water Resource Management Units:**

- **Unit 8** (upstream of Narborough)
- **Unit 9** (downstream of Narborough)

In **Unit 8** there are 90 licences to abstract split evenly between public water supply, fish farm and spray irrigation.

Unit 8 'resource availability' is classified:

- **over-licenced**[1] for groundwater
- **over-abstracted**[2] for surface water

In **Unit 9** there are 28 licences to abstract split between public water supply, spray irrigation and industrial use.

Unit 9 'resource availability' is classified:

- **No water available 3** for groundwater
- **Over-licenced** for surface water

Under the EA's **Restoring Sustainable Abstraction** scheme a groundwater model is being developed to better understand the impact of abstraction on the delicate habitats in the Nar which are highly sensitive to alterations in the hydrology.

Current strategy is for no more groundwater abstraction and additional surface water abstraction only at high flows with restrictions.

To view the current Environment Agency Catchment Abstraction Management Strategy (CAMS) go to: http://publications.environment-agency.gov.uk/PDF/GEAN0305BQYU-E-E.pdf

The Environment Agency is currently (as of summer 2012) composing a revised Catchment Abstraction Management Strategy

1 No water available at low flows and if all licences were used to their maximum this would cause unacceptable damage at low flows. Water may be available at high flows with restrictions.

2 Existing abstraction is causing unacceptable damage at low flows. Water may be available at high flows with restrictions.

3 No water is available for licensing at low flows. Water may be available at high flows with restrictions.

THE IMPACT OF ABSTRACTION ON RIVER ECOLOGY

The impact of abstraction on the ecology of a chalk stream is significant and widespread – all the other pressures on the river are magnified if flows are artificially reduced by too great an extent: the river warms up more in hot weather; its upper reaches dry more quickly and for a greater distance downstream; the concentration of diffuse pollutants in the river goes up; sediment drops out of slower flows; rare and vital river plants such as stream-water crowfoot, suffer; the oxygen content of the water is diminished; the volume of habitat available to fish and insects is reduced, and so therefore are their numbers. In extreme cases abstraction can cause a river to dry up when naturally it wouldn't have done – with obvious disastrous consequences for wildlife.

NORFOLK RIVERS TRUST ABSTRACTION ANALYSIS

Pending publication of the next CAMS report, in summer 2012 the Norfolk Rivers Trust commissioned independent expert analysis of Environment Agency data relating to historic flows, abstraction licences, groundwater levels and models of flows in the River Nar from 1953 to the present day.

THE ANALYSIS REVEALED THAT ABSTRACTION IS HAVING A SIGNIFICANT IMPACT ON FLOWS IN THE RIVER NAR.

- **Abstraction is causing flows to fall below WFD target flows for up to 28% on average and for longer in dry years.**
- **Abstraction is reducing flows in the river by half in drought years.**
- **Abstraction remained relatively constant between 1960 and 1990 but has been steadily increasing since then: see Abstraction Graph 1.**
- **Between 1960 and 1990 abstraction reduced summer flows by on average between 10% to 15%, but since 1990 abstraction has reduced summer flows by closer to 30% and occasionally up to 50%: see Abstraction Graph 2.**
- **WFD targets for chalk rivers state that – depending on flow levels – abstraction should reduce summer flows by no more than between 20% and sometimes as little as 7.5%.**

FLOW TARGETS FOR THE RIVER NAR

Extreme highs of winter flow between 1953 and 2012 averaged 281 Ml/d.

Extreme lows of summer flow between 1953 and 2012 averaged 45.2 Ml/d.

In the drought years of 1976, 1991, 2006 and 2011 flows dropped to 12, 13, 14 and 23 Ml/d respectively.

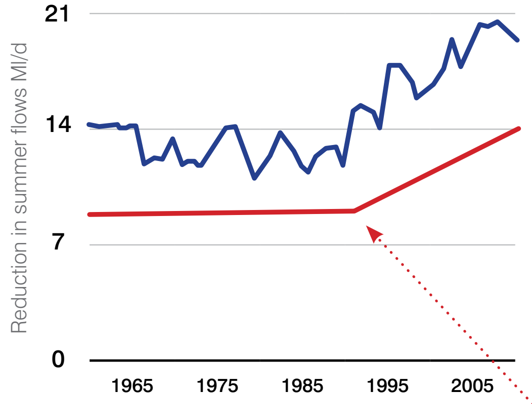
Under the **Water Framework Directive** UK flow targets have been developed to reflect the sensitivity of ecologies to changes in flow level. The targets were set for WFD by the **UK Technical Advisory Group (UK TAG)**, and are broadly in line with 'current standards and conditions applied in England and Wales'. They are not therefore unduly restrictive.

The River Nar is a chalk river Class A2. A2 is sub-divided between headwaters and downstream. The table below shows the maximum permitted levels of reduction allowable for Class A2 chalk rivers at GOOD status.

Type	Season	Flow>QN60	Flow>QN70	Flow>QN95	Flow>QN95
A2 d'stream	Apr - Oct	25	20	15	10
A2 d'stream	Nov - Mar	30	25	20	15
A2 h'waters	Apr - Oct	20	15	10	7.5
A2 h'waters	Nov - Mar	25	20	15	10

RIVER NAR – MARHAM GAUGING STATION

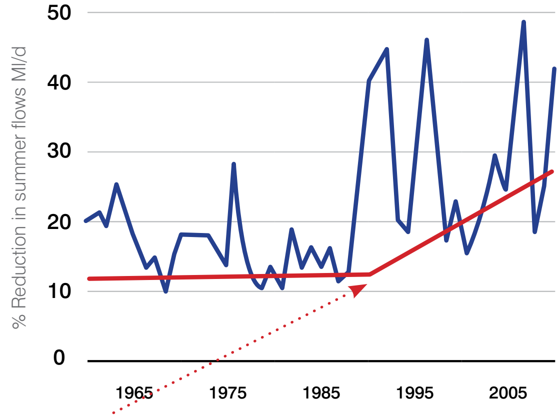
Reduction in summer flows Ml/d due to abstraction 1961 - 2009



ABSTRACTION GRAPH 1

RIVER NAR – MARHAM GAUGING STATION

% reduction in summer flows due to abstraction 1961 - 2009



ABSTRACTION GRAPH 2

Reductions in flow due to abstraction remained relatively constant until the early 1990s, but have increased markedly since.

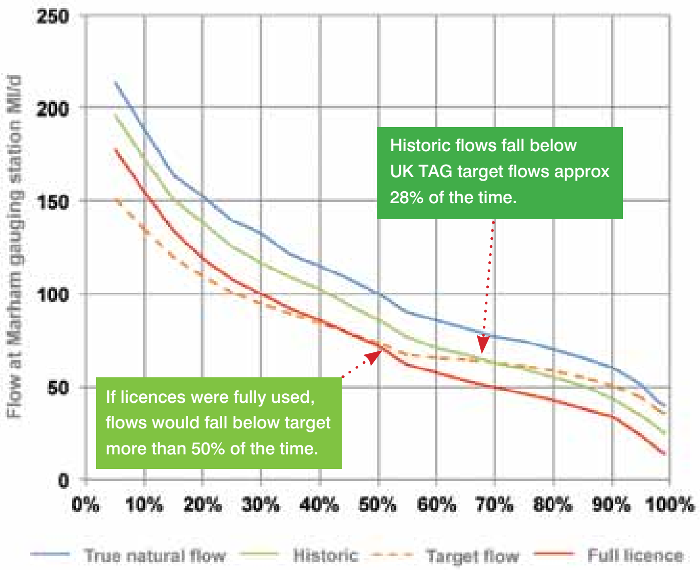
FLOW DURATIONS

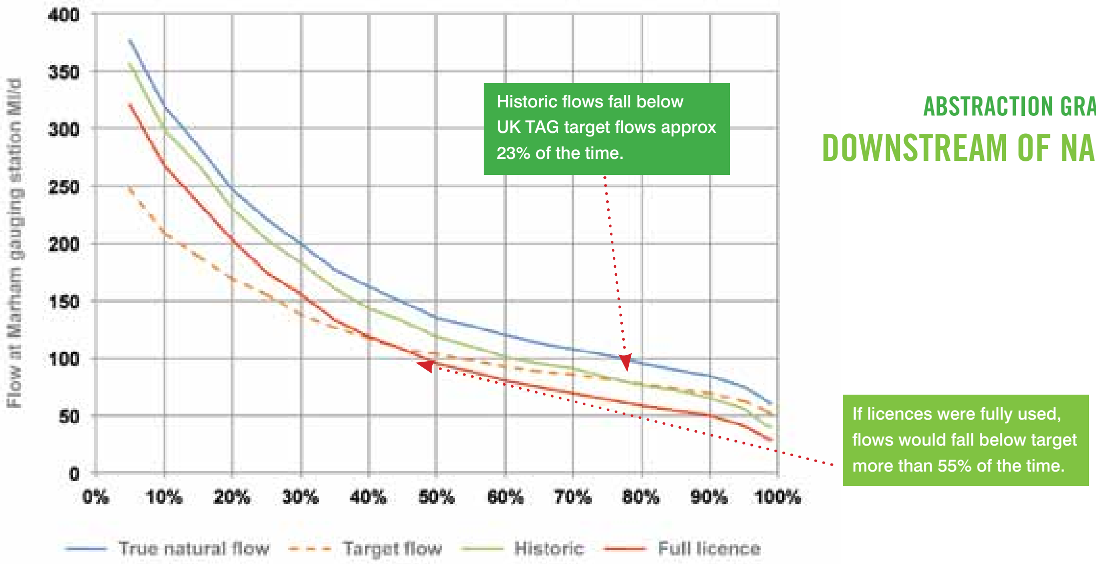
These graphs show the flow durations for CAMS Units 8 and 9, showing the actual flow as it occurred (green), the flow as it would have been without abstraction (blue), the flow as it would have been abstracted to full licence and the UK TAG target flows from the table opposite. In the upper river flows fall below target for 28% of the time and in the lower river for 23% of the time.

Note: These flow durations are for type A2 d'stream: it could be argued that the majority of the River Nar in CAMS Unit 8 should be classed as a chalk river headwater.

ABSTRACTION GRAPH 3

UPSTREAM OF NARBOROUGH





ABSTRACTION GRAPH 4

DOWNSTREAM OF NARBOROUGH

THE IMPACT OF ABSTRACTION IN DROUGHT YEARS

Years of extreme low flows are worth particular attention as these are the years when abstraction most acutely threatens the ecology of the river.

The flow graphs below (Abstraction Graphs 5 and 6) show actual recorded flows in two drought years against modelled flows. The models – prepared for the Environment Agency by ENTEC – estimate the impact of abstraction on natural flows month by month from 1961 through to 2009.

- **Natural:** the river flow unaffected by abstraction
- **Historic:** the river flow as it is predicted to have occurred
- **Full licence:** the river flows if abstraction licences had been used to the maximum

The modelled historic flow closely matches the lower parameters of recorded flow, indicating the model is at least reliable for extreme low predictions.†

The graph shows clearly that in the summers of 1976 and 1991 recorded flows were reduced to a third of what the natural flows would have been: this is vastly outside the UK TAG tolerance which allows for a reduction of only -7.5% at these extreme low flows (below QN95). The impact would have been even worse if abstraction licences had been used to their maximum.

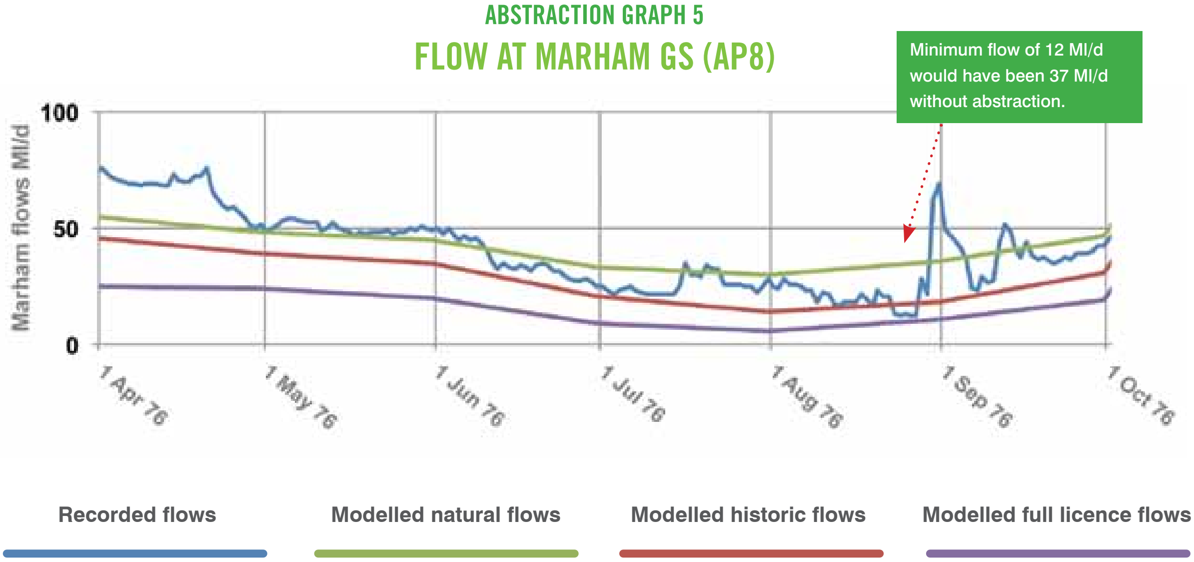
The same picture emerges for all relatively dry years. Only in wet years do real flows get close to target flows.

At times of high stress the River Nar is failing its flow targets to a very significant extent

† For higher flows the model considerably underestimates historic flows set against recorded flows, indicating that the model is not a perfect fit for the River Nar.

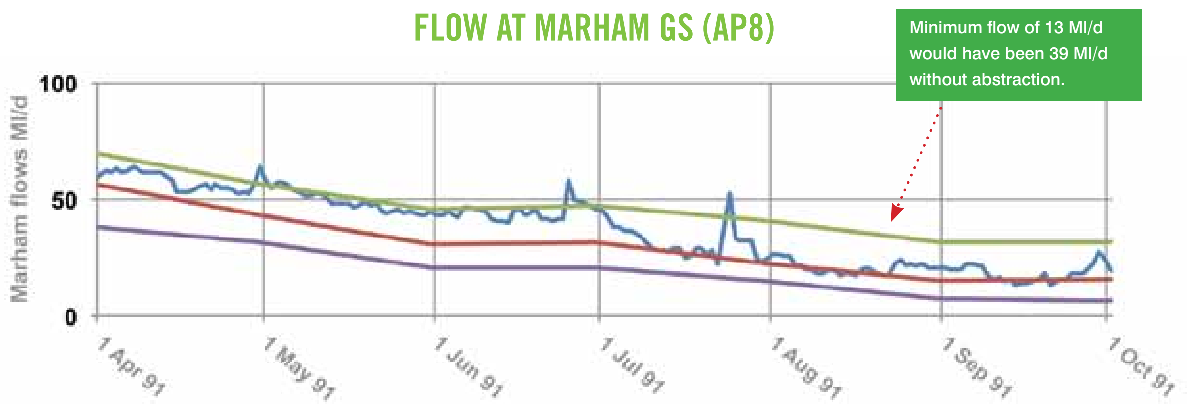
ABSTRACTION GRAPH 5

FLOW AT MARHAM GS (AP8)



ABSTRACTION GRAPH 6

FLOW AT MARHAM GS (AP8)



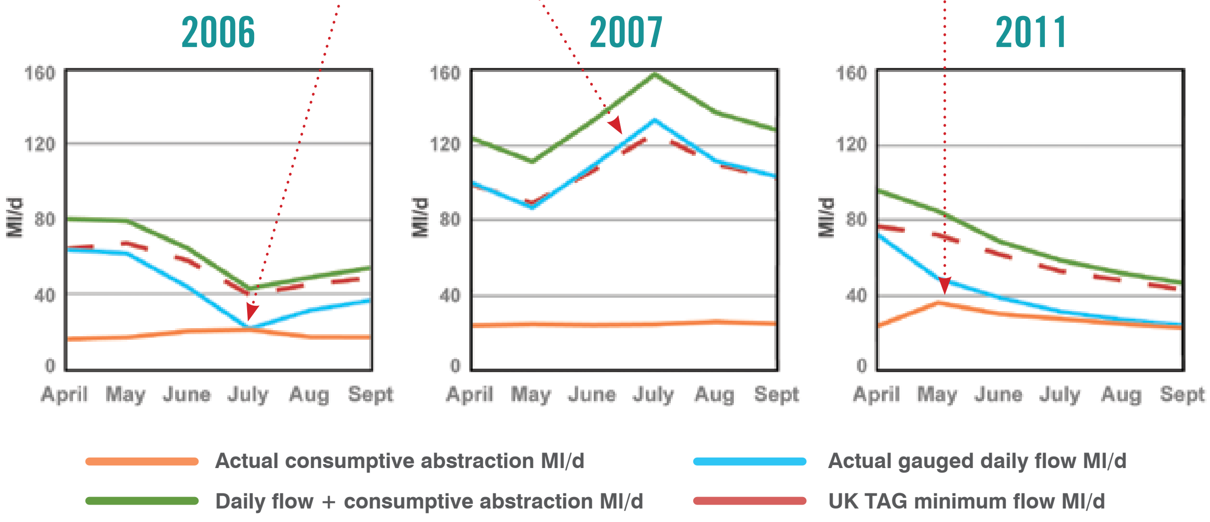
FLOWS IN RECENT YEARS

ABSTRACTION GRAPH 7

In the very dry summer of 2006 as recorded flows fell to very low levels abstraction actually increased. There appears to be no mechanism for lessening abstraction as flows reach critical levels.

Only in wet years such as 2007 do summer flows get close to target flows.

In 2011 – another dry year – flows fell to half of natural flows and almost half of TAG flow targets. In addition note how abstraction is steadily increasing – inflation within existing licences.

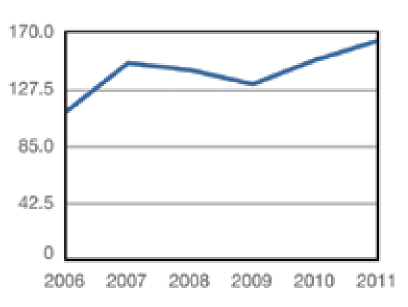


Flows downstream of Narborough summer months – actual flows, actual consumptive abstraction surface and groundwater and UK TAG target flows adjusted for Unit QN 60, 70, > 95 and < 95.

The flow charts above (Abstraction Graph 7) show the years 2006 and 2007 and also 2011. 2006 was a dry year. In July 2006 gauged flows dropped to 22 Ml/d. As flows fell through May and June abstraction actually increased, to the point where abstraction peaked as the river flows bottomed out. There appears to have been no mechanism in place to restrict abstraction and help the river achieve target flows, in spite of the fact that the 2005 CAMS had already identified damaging levels of abstraction at low flows.

2011 was another dry year with real flows falling to half TAG target flows. Although there are "Hands Off" restrictions on some abstraction licences the quantity of water abstracted in summer is steadily increasing regardless of whether it is a dry or wet summer.

ABSTRACTION GRAPH 8



April to Sept totals of average daily consumptive abstraction for the years 2006 to 2011

Summer abstraction is steadily increasing. This amounts to inflation within the existing abstraction licences. Unless checked abstraction – already damaging the river – can keep on rising within existing licences with increasingly disastrous consequences for the River Nar.

ACTIONS

- Re-focus local area groundwater model so that it more accurately fits the River Nar and is up to date including 2011.
- Develop – in consultation with licence holders and stakeholders – a functional mechanism for reducing abstraction as flows fall towards QN90 and 95.
- Halt the abstraction inflation that is occurring within existing licences.
- Renegotiate existing licences to reverse the abstraction inflation trend.
- Encourage winter storage solutions for farmers.
- Current groundwater abstraction is enough to supply 80,000 people – far more than the population of the Nar valley. Encourage Anglian Water to develop a more conjunctive use of river water and groundwater supplies: there is a lot of water in the Ouse, albeit more expensive to treat.
- Ensure that the next Catchment Abstraction Management Plan and the next River Basin Management Plan identify the extent to which flows in the River Nar are failing UK TAG targets.
- Through the Restoring Sustainable Abstraction programme engage with licence holders to find a way of reducing overall abstraction and summer abstraction so that the River Nar meets UK TAG targets. This is is essential if the river is to achieve GOOD Status and Potential.

RIVER NAR

DIFFUSE POLLUTION

CATCHMENT SENSITIVE FARMING

Practical and Cost-effective Solutions to Protect Water Quality

The River Nar is a **Catchment Sensitive Farming Priority Catchment** as there are concerns about the level of sediment, nutrients and some pesticides that can be found in both the river and the groundwater.

Catchment Sensitive Farming (CSF) is a joint venture between Natural England and the Environment Agency to tackle sources of diffuse pollution in priority catchments across England.

CSF encourages voluntary participation by offering free advice and some incentive payments. Agri-environment schemes (Entry Level Stewardship and Higher Level Stewardship) have options that can be used to buffer watercourses and reduce the risk of sediment and nutrient loss on susceptible fields.

CSF advises on making the best use of these options and also has its own capital grant scheme which can provide up to 50% of the cost of installing selected items.

In the Nar catchment the most appropriate options include:

- **Track surfacing and drains**
- **Gate relocation**
- **Watercourse fencing**
- **Sediment ponds and traps**
- **Pesticide handling facilities and yard works.**

CSF also offers advice from specialists on topics such as nutrient and soil risk management.

Training is available to identify particular problems with soil structure – such as compaction – that occur during the cropping cycle and which if not dealt with can lead to high levels of sediment in run off. Planning nutrient applications is also important so that they are closely matched to crop requirements and avoid excessive applications which leach to the river through surface flow, ditches and drains.

CSF also liaises with Highways and in 2007 - 08 a joint initiative included the clearing of sediment from road-side 'grips' and the installation of bollards at a problematic ford near West Acre.

CSF promotes practical and cost effective solutions to protect water quality.

> **Elevated phosphorus levels interfere with competitive interactions between higher plant species and between higher plants and algae, leading to dominance by attached forms of algae, deterioration of vegetative habitat, and declines in abundance and/or diversity of characteristic plant species (which may include lower plants such as mosses and liverworts). Ranunculus habitat is extremely vulnerable.**
>
> Natural England

SSSI target phosphate levels are 0.06 mgL as an annual mean from the source to Marham Flume and 0.1 mgL as an annual mean from Marham Flume to Kings Lynn.

Environment Agency figures show a decline upstream at Litcham from 2000 mean of 0.13 mgL to 2010 mean of 0.09 mgL. Both of these figures are above SSSI targets, but nevertheless there has been an encouraging decline.

Downstream at Castle Acre across the same period phosphate levels have remained at 0.07 to 0.08 mgL.

At Marham levels declined from the 2000 mean of 0.06 mgL to 2005 (0.04 mgL) and have risen since to the 2010 mean of 0.07 mgL

ACTIONS

- Ensure the baseline figures of phosphates (and nitrates) do not regress.
- Ensure the decline in phosphate levels in the upper reaches continues until the river is within SSSI target levels.
- Investigate the likely causes of a rise in phosphate levels in the lower river.
- Investigate the impact of the Castle Acre STW soak-away and the potentially cumulative impacts of small-point sewage discharges.
- Re-base the lower river phosphate limit to 0.06mgL a figure which was achieved from 2000 until 2005 to ensure that the recent phosphate inflation in the lower river does not continue towards the present higher limit.
- Bring WFD phosphate standards up to the level of SSSI standards to ensure continuity of standards across all areas of environmental assessment.

SEDIMENT POLLUTION

The 2005 English Nature Geomorphological Appraisal makes it clear that sediment ingress from the wider catchment is a significant problem in the River Nar.

Coupled with the canalisation and a reduction in flows caused by abstraction, sediment makes a considerable impact on the ecology of the river, smothering the substrate of the river bed. An excess of fine sediment changes the morphology, the plant communities and the natural flows in the river, and negatively impacts on fish and insect numbers.

The audit reveals that fine sediment comes from:

- **Arable fields** – especially when they are recently ploughed.
- **Pig units** – there are increasing numbers in the valley, some on steep land, close to the river.
- **Road-side verges** – especially when they are crushed each winter by farm vehicles too large for the roads they are driven down: this is a worsening problem.
- **Dirt tracks** – especially where these join up with the road network or run directly to the river.
- **Aggregate works** – from the exposed landscape around the works and from the road network servicing the works.

And enters the river via:

- **Road crossings** – where road drains discharge into the river.
- **Footpaths, tracks and fords** – where they cross the river.
- **Intersections** – of the dry valley network with the main river.
- **Drains and ditches.**
- **IDB pumping stations and drains.**
- **Tributaries.**

The floodplain of the upper Nar is characterised by low intensity land-use, which would ordinarily buffer the river against fine sediment run-off within the wider catchment. Points of ingress therefore are quite localised, though the area of origin may be broad.

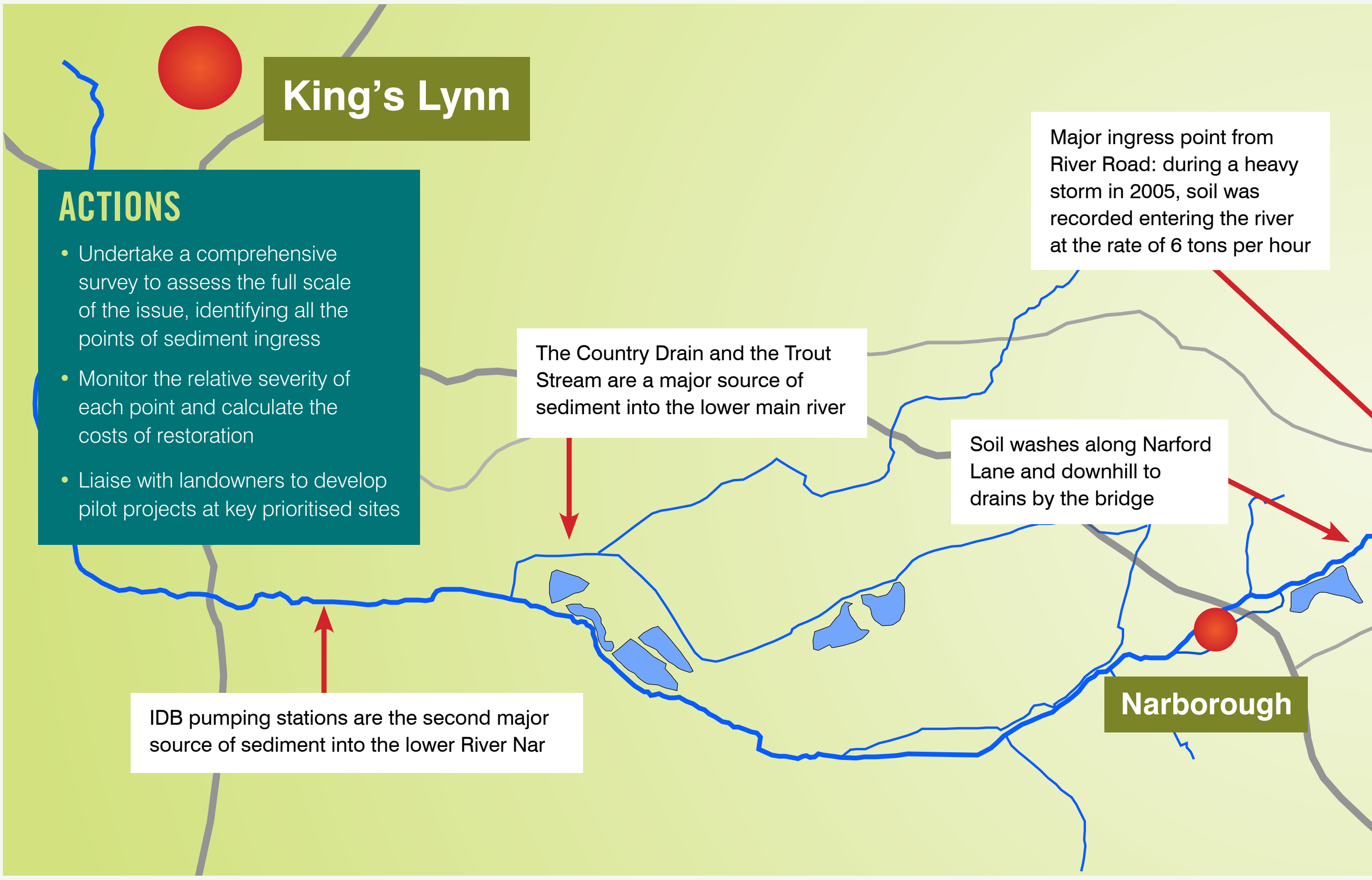
The issue of fine sediment pollution must be tackled strategically in three ways:

- **In the river** – dealing with the sediment once it is in the river – restoring connectivity as above.
- **At the points of entry** – identifying and dealing with the points of ingress.
- **In the wider landscape** – encouraging catchment sensitive land-use so as to lessen the amount of soil lost to erosion in the first place.

TURNING A SEDIMENT PROBLEM INTO A WETLAND SOLUTION

Restoration measures which would address these point sources directly could include:

- Stopping field drains where they enter the main river.
- Diverting track-side drains into riparian settling ponds.
- Creating wetland sediment-sink areas where tributaries join the main channel.



ACTIONS

- Undertake a comprehensive survey to assess the full scale of the issue, identifying all the points of sediment ingress
- Monitor the relative severity of each point and calculate the costs of restoration
- Liaise with landowners to develop pilot projects at key prioritised sites

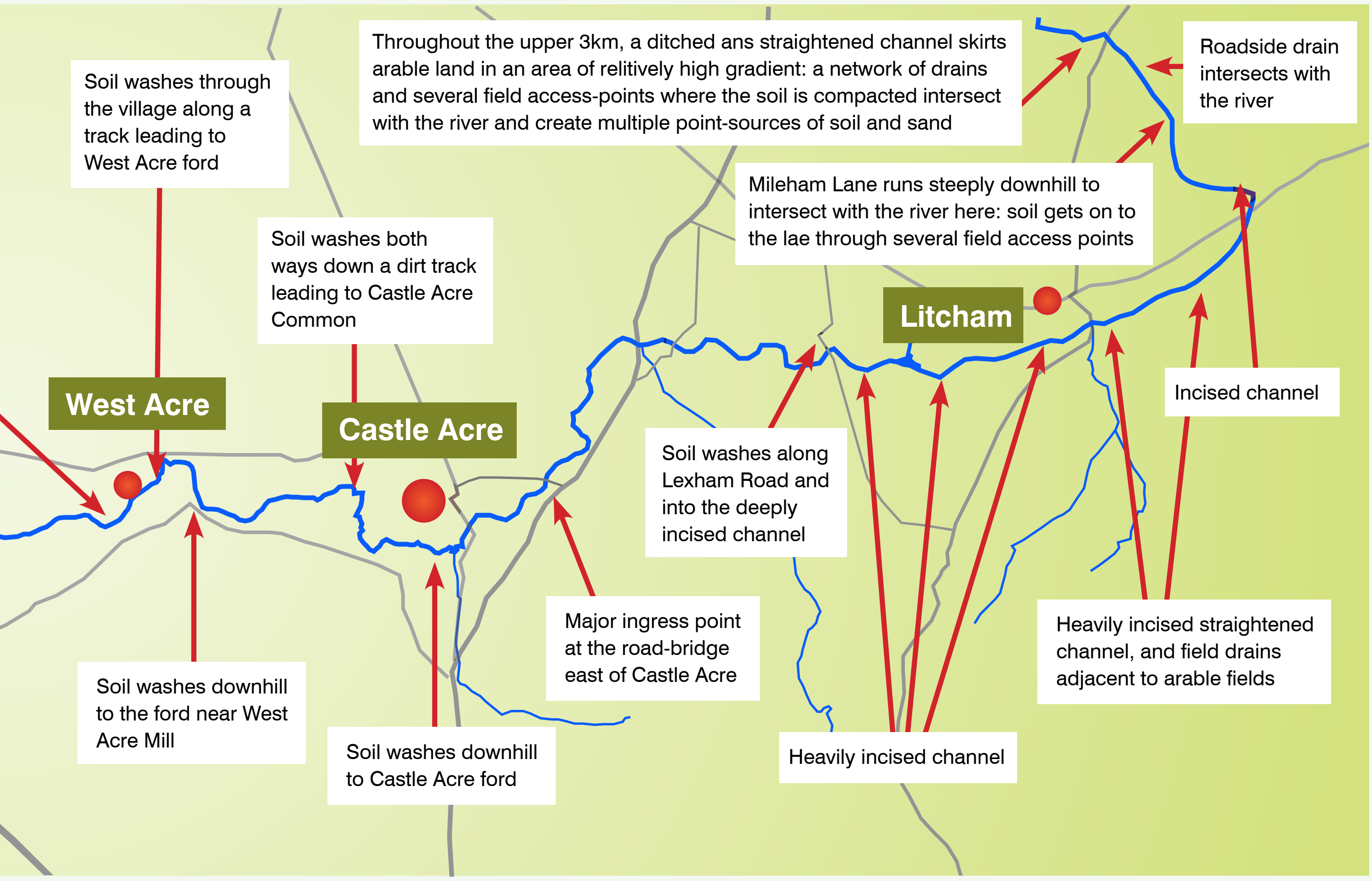
All these restoration strategies would have add on eclogical benefits. Undertaken in combination with:

- Ongoing Catchment Sensitive Farming initiatives;
- Modifications to the channel which promote connectivity and the selective deposition of sediment along the riparian fringe;

The problem of excessive sediment loads can be tackled on both fronts – supply and deposition.

In addition addressing sediment loading will also help tackle nitrate and phosphate levels in the river.

West Acre ford after a heavy downpour May 2012: a clear illustration of the impact of point-source sediment pollution. Diverting this flow into a wetland settlement pond in the meadow beside the river would make a big difference with the add-on ecological benefit of creating more wetland habitat.



NOTES ON THE RIVER NAR DRINKING WATER PROTECTED AREAS AND SAFEGUARD ZONE DESIGNATION

1. INTRODUCTION

The Water Framework Directive (WFD) Article 7 allows for the designation of Drinking Water Protected Areas (DrWPAs).

Under WFD any water body from which greater than 10 m3/day (as an average) is abstracted for human consumption, any water body serving more than 100 people or intended for such future use is defined as and should be designated as a Drinking Water Protected Area (DrWPA).

Increasing concentrations of pollutants in raw water within drinking water protected areas and failure to meet drinking water standards must be avoided. The Water Framework Directive requires member states to put additional monitoring and measures in place to prevent the deterioration of raw water quality so that the need for extra treatment is reduced.

DrWPAs have been identified with the water companies as 'at – risk' where there is either:

- **Evidence of an upward trend that will lead to failure of Drinking Water Directive standards or**
- **Evidence of repeated failure of the standard in locations where companies would need to invest in additional treatment.**

The River Nar catchment contains both a surface water Drinking Water Protected Area and corresponding Safeguard Zone (SgZ). In addition the Chalk aquifer in the catchment forms part of a groundwater Drinking Water Protected Area.

1.1 Drinking Water Protected Areas and Safeguard Zone

Safeguard Zones form part of an overall strategy to improve water quality and will be put in place to protect 'at – risk' DrWPAs from pollution. This is the area that will have investigations and measures to address the sources of pollution identified and resultant investigations and actions will be linked and developed as part of River Basin Management Plans.

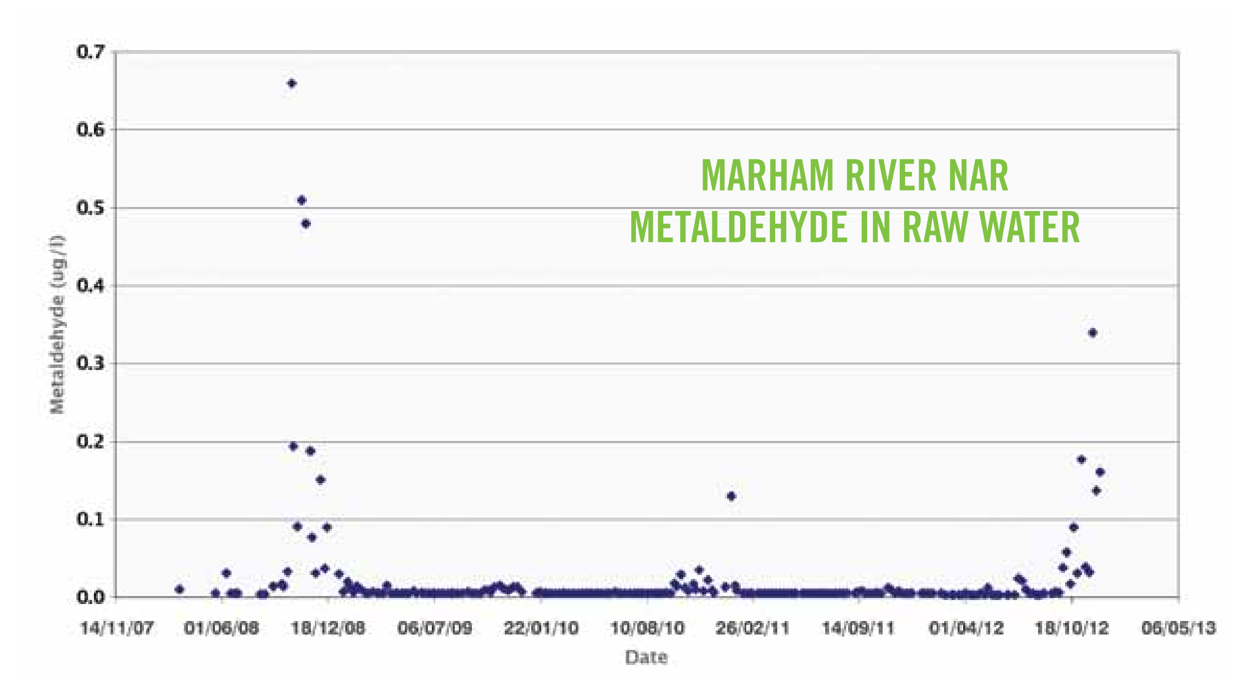
Safeguard zones are non-statutory designated areas upstream of and inclusive of the DrWPA where the sources of pollution found in the DrWPA arise, or are thought to arise from. This is the area in which any measures to reduce pollution will be targeted.

2. NAR SURFACE WATER DRWPA 'AT RISK' STATUS

Monitoring data for the abstraction point on the River Nar has been assessed by the Environment Agency for deteriorating trend in quality. The assessment showed that there is high confidence that metaldehyde to be at risk of failing the objective of Article 7.3 (i.e. the prevention of deterioration in water quality).

Results showed that concentrations of pesticides in the raw water exceeded drinking water directive standards of 0.1ug/l particularly in wet Autumns. See chart below.

Anglian Water has an AMP5 Drinking Water Inspectorate (DWI) Undertaking for Metaldehyde for Marham WTW because of concentrations of pesticides in the raw water (primarily originating from agriculture) above or at risk of exceeding the prescribed concentration of 0.1μg/l for pesticides and remains so regardless of this undertaking.



Many pollutants can be removed with conventional treatment processes such as granular activated carbon (GAC) treatment for pesticides or ion exchange for nitrate. However, some substances are extremely difficult or impossible to remove (for example, metaldehyde and clopyralid). Even when effective, treatment is expensive and energy-intensive.

The Environment Agency has worked with Anglian Water to confirm the nature of the water quality problem in terms of: the chemicals causing failure, the nature of the failure i.e. rising trend; operational and treatment constraints, the level of understanding of the source(s) of the chemical and to agree a revised list of 'at – risk' drinking water protected areas and the substances that pose a risk.

River Nar has been identified as at – risk DrWPA from pesticides i.e. metaldehyde.

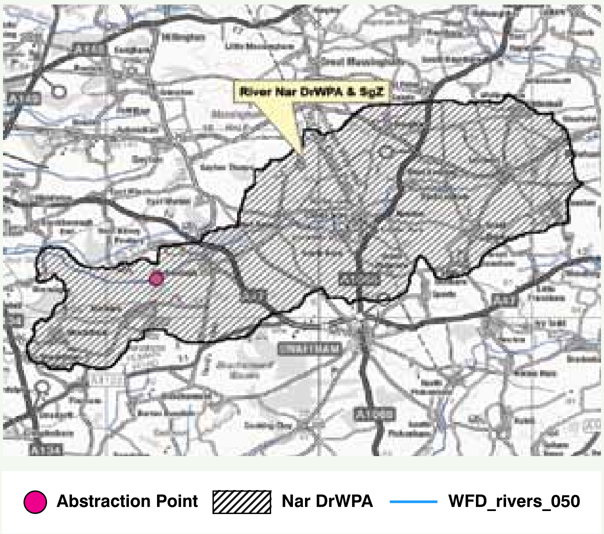
Table 1: Parameters of concern in the SgZ

WATER BODY	SUBSTANCES AT RISK
River Nar GB105033047791	Metaldehyde

Therefore the Drinking Water Protected Area is deemed to be at risk of failing Article 7.3, and therefore requiring a Safeguard Zone, because:

1. **Metaldehyde has recently (in 2008) been discovered in the raw water feeding Marham Treatment Works.**
2. **The existing treatment regime at the works supplied with water from River Nar is ineffective in the removal of metaldehyde to achieve the drinking water standard of 0.1 μg/l in treated water.**
3. **Metaldehyde is attributed to ongoing anthropogenic activity in the catchment.**
4. **Anglian Water has DWI Undertaking to address the issue of metaldehyde**

ENVIRONMENT AGENCY MAP OF RIVER NAR DRWPA AND SAFEGUARD ZONE



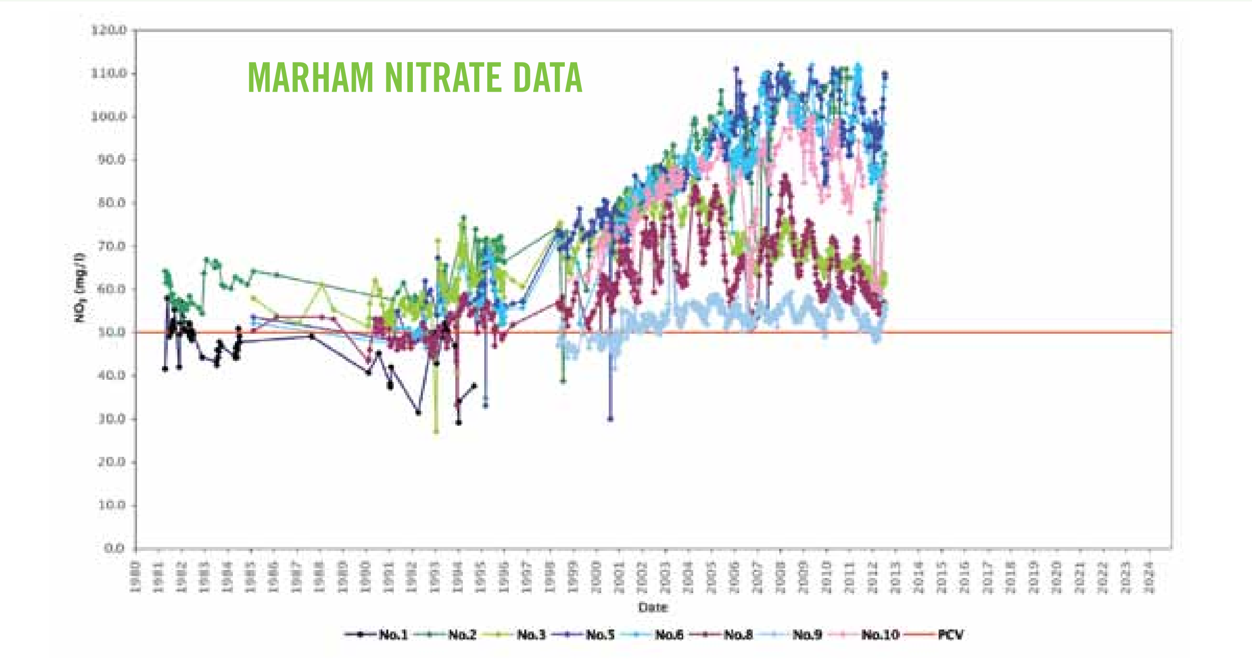
2. NAR GROUNDWATER DRWPA 'AT RISK' STATUS

The River Nar catchment lies comprise the southern part of the North Norfolk Chalk Groundwater body (GB40501G400100).

There are a number of abstractions for public water supply from the North Norfolk Chalk and as such it is designated a Drinking Water Protected Area. It is also designated a Protected Area under the Nitrates Directive.

Based on Chemical Status assessments, the Current Overall Status of the water body is 'Poor'.

Chalk groundwater abstracted from boreholes at Marham shows high concentrations of nitrate significantly above the drinking water standard of 50 mg/l (as NO3). Nitrate as a diffuse pollution from the mainly arable catchment is currently removed by treatment but measures are required in order to reduce the reduce concentrations at source and effect a sustained downward trend.



OVERSHADING

On the upper Nar between Castle Acre Common and Narborough the dense shading effect of forestry plantations limits the ecological potential of the river.

The River Nar Restoration Strategy and Plan published 2010 states:

'Around 18.2 km of the Nar's 42 km length was shaded by trees in 2006, but this tends to be distributed in long, heavily shaded reaches – mean lengths of fragments in 2006 being 506 meters … the influence of plantations just upstream of Narborough is particularly strong in this respect.'

Unmodified spring streams create very high water tables in which trees like alder and willow thrive. The dynamic relationship between a spring-fed stream and fallen trees is best expressed in wet-woodland and where where trees are of varying age and height, where they grow old, die and fall over in a natural rotation and where their distribution is uneven and extensive. Wild woodland like this creates a continuous supply of woody debris and a mosaic pattern of light and shade.

When a mature trees dies in an natural riverside wood a broad window of light is thrown open. If the tree collapses into the river that light allows the structures which the tree-fall creates – the riffles, islands and berms – to consolidate with vegetation, enhancing the habitat and cover for wildlife as well as the overall extent, impact and the longevity of the structures.

Single-age plantations create blanket shade from tall and densely packed trees which have small crowns. Even if one falls, very little light follows and the hole in the canopy is soon filled. The beneficial impact of Large Woody Debris in plantations like this is muted. Moreover the density of the shade allows very little vegetation to grow along the river-bank or in the stream itself.

An effective restoration measure where plantation forest borders a river is to selectively thin as much as is necessary to re-create a more natural diversity of tree size and age and a pattern of dappled shade.

Thinning of this kind has been carried out in pilot reaches by the members of the West Acre Fishing Club. Timber from the felled trees has been used to re-create LWD structures in and alongside the river. The results have been very encouraging: the size and age range of the wild trout has improved (it was a deficiency in this respect in these over-shaded reaches that caused a failure in the WFD classification), as has macrophyte and invertebrate abundance.

Elsewhere in the upper valley, in the few places where there is a complete absence of riparian wet woodland, it may be desirable to re-establish or to allow the natural regeneration of, patches of willow / alder woodland.

> **"The dynamics of natural woodland are typified by continual death and new recruitment, which results in a mixed stand of trees of varying age, height and structure. Where such stands interact with the river, they will provide a continuous supply of woody debris and areas of deep, dappled and no shade, leading to a varied, patchy, macrophyte community structure."**
>
> The River Nar River Restoration Strategy and Plan 2010: IDB / NE / EA / RRC.

In a pilot restoration project carried out by the West Acre Fishing Club this reach has been selectively thinned to recreate a more extensive, natural woodland. All of the visible bank on the right hand side of the image has consolidated naturally on a mattress of woody debris.

IMPOUNDMENTS AND FISH PASSAGE

Brown trout are naturally a migratory species. A component of any brown trout population will run to sea and return to spawn. Currently sea trout cannot ascend the river beyond Narborough.

Eels are an endangered migratory species and passage of eels is the subject of UK legislation which can be used to compel the construction of eel passes where the Environment Agency deem free passage is hindered.

There are obstructions to fish passage at:

- **The outfall at Kings Lynn** – tidal gates. Flaps have been inserted as part of the North Norfolk Sea Trout Project.
- **Pentney Abbey** – two weirs associated with a historic bridge. Rock ramps have been built. There are some maintenance issues which may need addressing in due course.
- **Marham flow gauging weir** – a feasibility study is in draft investigating the possibility of using drainage channels to by-pass the flume.
- **Narborough mill and main channel** – modelling and designs are in progress.
- **West Acre Mill** – modelling and designs are in progress.
- **Newton Mill** – the millway is open and fish passage under the mill building is possible.
- **Small weir** – upstream of A1065 near Emmanuel's Common. Now removed.
- **Weir at West Lexham Hall** – an ornamental estate lake occupies the old course of the river, while the main channel runs along a gradient line at the edge of the floodplain to the south. This creates a weir of 1 meter fall and no easy way to remove the weir and still maintain flow through the lakes.
- **Hatchways impounding Lexham Hall Lakes (East).**

The upper Nar around Litcham and Mileham has yielded only moderate to poor fish counts in Environment Agency surveys. This is one of the main reasons behind current WFD failure. Restoration works upstream of West Lexham Hall and Lexham Hall will have a limited beneficial impact while serious obstructions to fish passage remain in situ.

ACTIONS

- While plans to deal with obstructions from Kings Lynn to West Acre are all in motion and have in some cases been delivered, the impoundments in the upper river should now be prioritised.

The WFD failure in the upper river was due to low fish numbers and impoundments will be a barrier to re-colonisation.

RIVER NAR

INVASIVE PLANTS

Himalayan Balsam is present in the upper valley and is a major threat to the ecology of the river. Himalayan balsam spreads quickly, especially along the edges of a river. Once established Himalayan balsam dominates almost all native vegetation, creating a riparian mono-culture. Moreover it dies away in winter leaving nothing to protect the fragile, bare banks below. Himalayan balsam causes severe erosion and siltation comparable in scale and impact with heavy overgrazing by livestock, but more difficult to contain.

The most reliable control strategy is the total eradication from the top of the valley working downstream. This is a labour intensive exercise. The plant is best strimmed or pulled as it starts to grow in spring, but before it flowers. Once it flowers the seed pods burst open when the plants is touched. The seeds last for some time in the ground and patches dealt with will need to be revisited even as the eradication is unrolled downstream year by year.

Australian Swamp Stonewort, noted at Narborough lakes, is adapted to slow-moving freshwater environments and can smother native species. It can inadvertently be spread by humans and also by animals: and so the lower Nar is at risk. Mechanical control is not an option. Chemical control (disquat / glycophosphate) over a wide area is awkward.

Parrot's Feather, noted in the marginal wetlands near Marham. It will colonise slow-moving canals, ponds and ditches, and can spread itself via fragments from cuttings. Consequently it is difficult to control manually once in a moving water-body. Chemical control ((dichlobenil / glycophoshpate) over a wide area is awkward.

Giant hogweed, like Himalayan balsam, will smother native species, but also dies back in winter leaving bare, exposed riverbanks. It is a public health hazard. It spreads through seed dispersal and especially by water. Only reliable control: glycophosphate in April / May.

ACTIONS

- Consult the River Monnow Association: they have successfully eradicated Himalayan Balsam from the Monnow catchment. Take advice.
- Devise and enact phased and strategic eradication programme.
- Eradicate outbreaks of Australian Stonewort, Parrot's Feather and Giant Hogweed before they spread. Ensure that alien plants in the River Nar are assessed in the next round of the River Basin Management Plan.

SECTION 3 ACTION PLAN

RESTORATION UNITS: SOURCE to CASTLE ACRE

The River Nar was assessed for condition firstly in the 2005 Fluvial Audit, secondly during the 2010 River Nar Restoration Strategy and thirdly during the composition of this Catchment Restoration Plan. The former two present detailed analysis of relative levels of modification and degradation.

For the 2010 Nar Restoration Strategy the river is divided into 31 Restoration Units. Restoration strategies are proposed according to long-term aspirations, pragmatic and interim measures and referenced towards 'favourable' status as related to SSSI criteria.

These 2010 restoration proposals form the basis of the summary presented here,but with the exception of reaches 30 and 31, long-term aspirations and pragmatic measures have been dovetailed into one ambitious but realisable restoration vision for each unit.

- at or restored to Good Ecological Status (GES)
- close to GES subject to simple and inexpensive restoration
- potential of GES subject to more complex and / or costly restoration
- potential of GES subject to highly complicated and / or expensive restoration

Restoration Unit 10

TF84891690 to TF83761698 - 1330m

- Channel splits to run through two estate lakes and southern, raised carrier
- Sedimentation - eutrophication in lakes
- Raised channel and others structures failing and likely to breach
- Smith's water-meadows built 1804
- Broadwater built between 1826 and 1840
- Upper lake post-war
- Broadwater and upper lake occupy the original course of the river
- Restoration Measures (several complex options in EA/NE/IDB Nar Restoration Strategy) Options at their simplest:
- Drain both lakes, allow river to re-establish original course / surrounding land will revert to floodplain carr / wet woodland - cheapest, simplest and most ecologically sound option
- Drain the upper lake, allow river to re-establish course as far as lower lake / construct a new structure to feed some water from restored channel to broad-water / construct new, low-lying channel for main river to the side of broad-water - retains broadwater which has some archaeological importance
- With both of above restore connectivity and morphological variety to the channel downstream of the lakes

Costs

Based on a work rate of 50 to 100 meters per day **£20,700 to £41,400**

TOTAL **£20,700 to £41,400**

Funding Sources

Catchment Restoration Fund

Restoration Unit 12 and 13

TF83201669 to TF83131576 - 1300m
TF83131576 to TF82901564 - 270m

- The channel is incised and lacks riparian or flood plain connectivity
- Upstream of the mill the channel is heavily incised
- The channel is too wide and too deep in places

Restoration Measures

To restore / enhance connectivity:

- Re-grade existing channel to create shallower bank profile and a narrower, more sinuous channel, with greater morphological variety

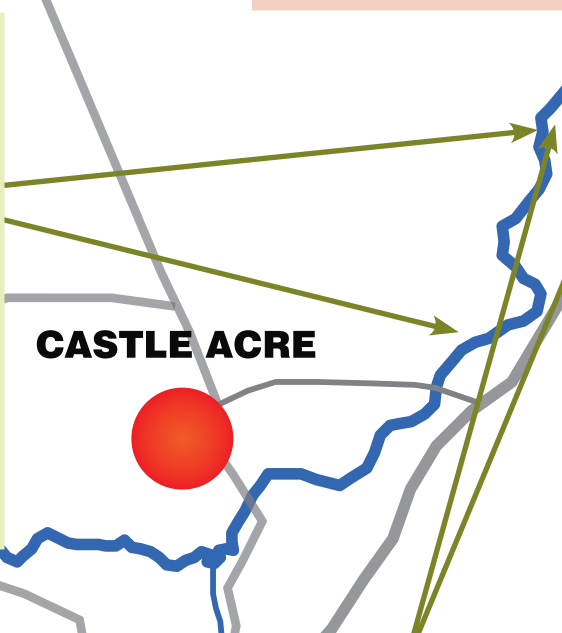
Costs

Based on a work rate of 100 meters per day **£24,000**

Total £24,000

Funding Sources

Catchment Restoration Fund



Restoration Unit 11

TF83761698 to TF83201669
790m + 600m approx original loop

- The channel is straightened and incisedand too wide in places
- The channel lacks riparian or floodplain connectivity

Restoration Measures

To restore / enhance connectivity:

- Re-instate original, meandering channel to the south
- Re-grade existing channel to create shallower bank profile and narrower, more sinuous channel

Costs

Based on a work rate of 100 meters per day = **£20,850**

Total £20,850

Funding Sources

Catchment Restoration Fund

Restoration Unit 09

TF85541682 to TF84891690 - 930m

- The channel is straightened and deeply incised
- The modified channel lacks riparian or floodplain connectivity
- Heavy shading in parts, total absence in other parts

Restoration Measures

- Cut a new, sinuous channel on upstream reach NB current course on upstream reach is the old course - see tithe maps
- Allow development of native wet-woodland
- Manage woodland on down stream reach to create mosaic of light and shade
- Use trees to allow natural restoration of channel via interaction with LWD

Costs

- Based on a work rate of 100 meters per day = **£13,950**
- Forestry and in-river LWD works 300 m @ 50 m per day = **£3,000**

Total £16,950

Funding Sources

Catchment Restoration Fund

A NOTE ON THE COSTS

These river-restoration costs are based on the pilot projects at Castle Acre and Narborough.

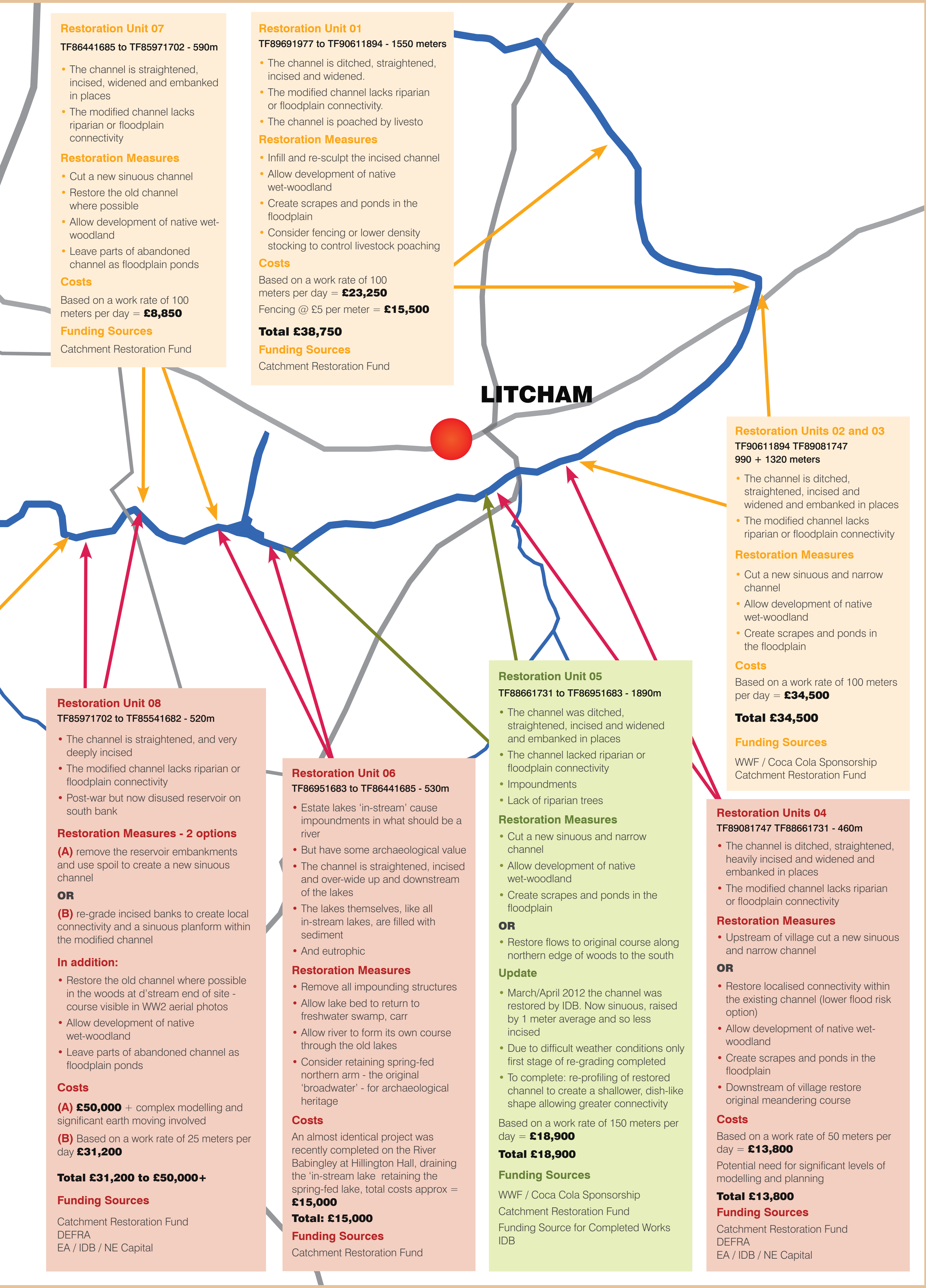
Allowing for the costs of machinery (one digger and driver), consultancy and works supervision, planning, consents, searches and overheads and a margin for error they are based on £1500 per day

In some units there are extra costs – for example gravel or foresters.

Each unit is costed based on an estimate of the relative complexity of the restoration proposals yielding a work rate in meters per day.

Restoration is more complex where the river runs near villages, under road bridges, through estate lakes or mills, or other impoundments of various sorts. These units are more difficult to cost accurately as so much is contingent on the particular circumstances of each project.

Elsewhere estimation of cost is more straightforward, although local conditions, including weather at the time of delivery, can make a big difference. The second Castle Acre project took less time and cost less than was envisaged because the ground was so dry.



Restoration Unit 07

TF86441685 to TF85971702 - 590m

- The channel is straightened, incised, widened and embanked in places
- The modified channel lacks riparian or floodplain connectivity

Restoration Measures

- Cut a new sinuous channel
- Restore the old channel where possible
- Allow development of native wet-woodland
- Leave parts of abandoned channel as floodplain ponds

Costs

Based on a work rate of 100 meters per day = **£8,850**

Funding Sources

Catchment Restoration Fund

Restoration Unit 01

TF89691977 to TF90611894 - 1550 meters

- The channel is ditched, straightened, incised and widened.
- The modified channel lacks riparian or floodplain connectivity.
- The channel is poached by livesto

Restoration Measures

- Infill and re-sculpt the incised channel
- Allow development of native wet-woodland
- Create scrapes and ponds in the floodplain
- Consider fencing or lower density stocking to control livestock poaching

Costs

Based on a work rate of 100 meters per day = **£23,250**

Fencing @ £5 per meter = **£15,500**

Total £38,750

Funding Sources

Catchment Restoration Fund

Restoration Units 02 and 03

TF90611894 TF89081747
990 + 1320 meters

- The channel is ditched, straightened, incised and widened and embanked in places
- The modified channel lacks riparian or floodplain connectivity

Restoration Measures

- Cut a new sinuous and narrow channel
- Allow development of native wet-woodland
- Create scrapes and ponds in the floodplain

Costs

Based on a work rate of 100 meters per day = **£34,500**

Total £34,500

Funding Sources

WWF / Coca Cola Sponsorship
Catchment Restoration Fund

Restoration Unit 08

TF85971702 to TF85541682 - 520m

- The channel is straightened, and very deeply incised
- The modified channel lacks riparian or floodplain connectivity
- Post-war but now disused reservoir on south bank

Restoration Measures - 2 options

(A) remove the reservoir embankments and use spoil to create a new sinuous channel

OR

(B) re-grade incised banks to create local connectivity and a sinuous planform within the modified channel

In addition:

- Restore the old channel where possible in the woods at d'stream end of site - course visible in WW2 aerial photos
- Allow development of native wet-woodland
- Leave parts of abandoned channel as floodplain ponds

Costs

(A) £50,000 + complex modelling and significant earth moving involved

(B) Based on a work rate of 25 meters per day **£31,200**

Total £31,200 to £50,000+

Funding Sources

Catchment Restoration Fund
DEFRA
EA / IDB / NE Capital

Restoration Unit 06

TF86951683 to TF86441685 - 530m

- Estate lakes 'in-stream' cause impoundments in what should be a river
- But have some archaeological value
- The channel is straightened, incised and over-wide up and downstream of the lakes
- The lakes themselves, like all in-stream lakes, are filled with sediment
- And eutrophic

Restoration Measures

- Remove all impounding structures
- Allow lake bed to return to freshwater swamp, carr
- Allow river to form its own course through the old lakes
- Consider retaining spring-fed northern arm - the original 'broadwater' - for archaeological heritage

Costs

An almost identical project was recently completed on the River Babingley at Hillington Hall, draining the 'in-stream lake retaining the spring-fed lake, total costs approx = **£15,000**

Total: £15,000

Funding Sources

Catchment Restoration Fund

Restoration Unit 05

TF88661731 to TF86951683 - 1890m

- The channel was ditched, straightened, incised and widened and embanked in places
- The channel lacked riparian or floodplain connectivity
- Impoundments
- Lack of riparian trees

Restoration Measures

- Cut a new sinuous and narrow channel
- Allow development of native wet-woodland
- Create scrapes and ponds in the floodplain

OR

- Restore flows to original course along northern edge of woods to the south

Update

- March/April 2012 the channel was restored by IDB. Now sinuous, raised by 1 meter average and so less incised
- Due to difficult weather conditions only first stage of re-grading completed
- To complete: re-profiling of restored channel to create a shallower, dish-like shape allowing greater connectivity

Based on a work rate of 150 meters per day = **£18,900**

Total £18,900

Funding Sources

WWF / Coca Cola Sponsorship

Catchment Restoration Fund

Funding Source for Completed Works
IDB

Restoration Units 04

TF89081747 TF88661731 - 460m

- The channel is ditched, straightened, heavily incised and widened and embanked in places
- The modified channel lacks riparian or floodplain connectivity

Restoration Measures

- Upstream of village cut a new sinuous and narrow channel

OR

- Restore localised connectivity within the existing channel (lower flood risk option)
- Allow development of native wet-woodland
- Create scrapes and ponds in the floodplain
- Downstream of village restore original meandering course

Costs

Based on a work rate of 50 meters per day = **£13,800**

Potential need for significant levels of modelling and planning

Total £13,800

Funding Sources

Catchment Restoration Fund
DEFRA
EA / IDB / NE Capital

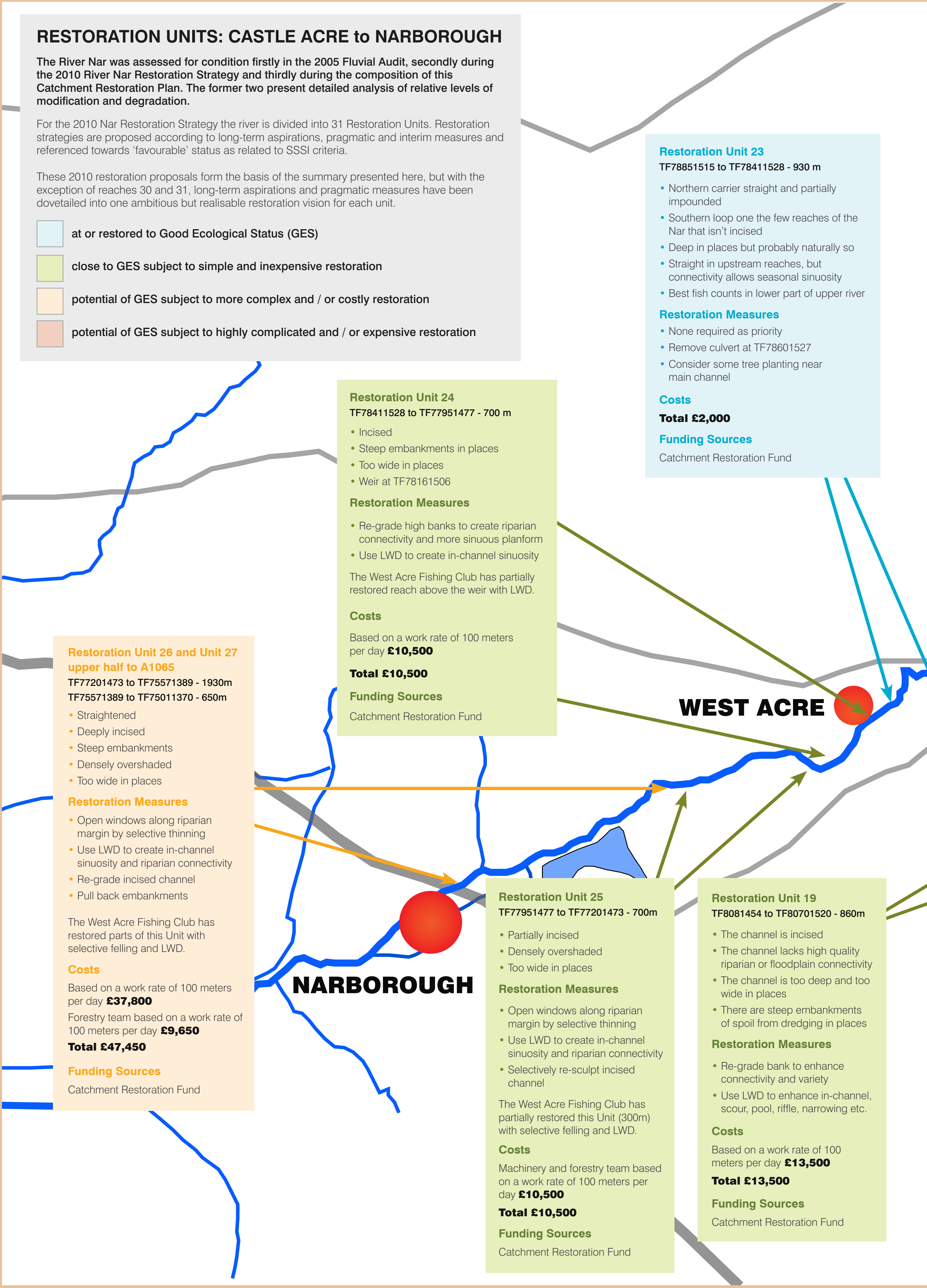
RESTORATION UNITS: CASTLE ACRE to NARBOROUGH

The River Nar was assessed for condition firstly in the 2005 Fluvial Audit, secondly during the 2010 River Nar Restoration Strategy and thirdly during the composition of this Catchment Restoration Plan. The former two present detailed analysis of relative levels of modification and degradation.

For the 2010 Nar Restoration Strategy the river is divided into 31 Restoration Units. Restoration strategies are proposed according to long-term aspirations, pragmatic and interim measures and referenced towards 'favourable' status as related to SSSI criteria.

These 2010 restoration proposals form the basis of the summary presented here, but with the exception of reaches 30 and 31, long-term aspirations and pragmatic measures have been dovetailed into one ambitious but realisable restoration vision for each unit.

- at or restored to Good Ecological Status (GES)
- close to GES subject to simple and inexpensive restoration
- potential of GES subject to more complex and / or costly restoration
- potential of GES subject to highly complicated and / or expensive restoration



Restoration Unit 23
TF78851515 to TF78411528 - 930 m

- Northern carrier straight and partially impounded
- Southern loop one the few reaches of the Nar that isn't incised
- Deep in places but probably naturally so
- Straight in upstream reaches, but connectivity allows seasonal sinuosity
- Best fish counts in lower part of upper river

Restoration Measures
- None required as priority
- Remove culvert at TF78601527
- Consider some tree planting near main channel

Costs
Total £2,000

Funding Sources
Catchment Restoration Fund

Restoration Unit 24
TF78411528 to TF77951477 - 700 m

- Incised
- Steep embankments in places
- Too wide in places
- Weir at TF78161506

Restoration Measures
- Re-grade high banks to create riparian connectivity and more sinuous planform
- Use LWD to create in-channel sinuosity

The West Acre Fishing Club has partially restored reach above the weir with LWD.

Costs
Based on a work rate of 100 meters per day **£10,500**

Total £10,500

Funding Sources
Catchment Restoration Fund

Restoration Unit 26 and Unit 27 upper half to A1065
TF77201473 to TF75571389 - 1930m
TF75571389 to TF75011370 - 650m

- Straightened
- Deeply incised
- Steep embankments
- Densely overshaded
- Too wide in places

Restoration Measures
- Open windows along riparian margin by selective thinning
- Use LWD to create in-channel sinuosity and riparian connectivity
- Re-grade incised channel
- Pull back embankments

The West Acre Fishing Club has restored parts of this Unit with selective felling and LWD.

Costs
Based on a work rate of 100 meters per day **£37,800**

Forestry team based on a work rate of 100 meters per day **£9,650**

Total £47,450

Funding Sources
Catchment Restoration Fund

Restoration Unit 25
TF77951477 to TF77201473 - 700m

- Partially incised
- Densely overshaded
- Too wide in places

Restoration Measures
- Open windows along riparian margin by selective thinning
- Use LWD to create in-channel sinuosity and riparian connectivity
- Selectively re-sculpt incised channel

The West Acre Fishing Club has partially restored this Unit (300m) with selective felling and LWD.

Costs
Machinery and forestry team based on a work rate of 100 meters per day **£10,500**

Total £10,500

Funding Sources
Catchment Restoration Fund

Restoration Unit 19
TF8081454 to TF80701520 - 860m

- The channel is incised
- The channel lacks high quality riparian or floodplain connectivity
- The channel is too deep and too wide in places
- There are steep embankments of spoil from dredging in places

Restoration Measures
- Re-grade bank to enhance connectivity and variety
- Use LWD to enhance in-channel, scour, pool, riffle, narrowing etc.

Costs
Based on a work rate of 100 meters per day **£13,500**

Total £13,500

Funding Sources
Catchment Restoration Fund

Restoration Unit 22

TF79071495 to TF78851515 - 340 m

- The mill pond is impounded and full of silt
- Restricted fish passage due to impoundment
- Channels too wide and straight
- Mill and its channels have archaeological significance

Restoration Measures

- Modify and or remove structures to create free-flowing by-pass channel
- Link bypass with the new channel in Unit 22 - removing need for specialist fish pass
- Modify flow regime accordingly to maintain archaeological and aesthetic features of the mill

OR

- Modify and / or remove all structures to create free-flowing mill and bypass channel
- Link upstream channel with new channel in Unit 22
- Meander new upstream channel to cope with release of gradient

Costs

- Complex planning
- Costs contingent on solution

Total £25,000 to £50,000

Funding Sources

Catchment Restoration Fund
DEFRA
EA / IDB / NE Capital

Restoration Unit 21

TF79811512 to TF79071495 - 890m

- The channel is incised and increasingly so moving downstream
- The channel is too wide in places
- Lower reach the channel is perched along southern contour line and embanked
- Heavy overshading in lower reaches

Restoration Measures

- Cut a new channel, following original course where it can be detected to north

and / or (see Unit22)

- Re-grade mill-leat and insert LWD to create connectivity and in-channel sinuosity

Costs

Based on a work rate of 50 to 100 meters per day **£13,350 to £26,700**

Total **£26,700**

Funding Sources

Catchment Restoration Fund

Upper Valley Tributaries

- Straightened and incised ditches
- Lack connectivity
- No attenuation of run-off or selective deposition of sediment.

Restoration Measures

- Pulling back and re-grading banks above mean water level to create a simple two-stage channel.
- Less vigorous maintenance regime

Costs

Total £75,000

Funding Sources

Catchment Restoration Fund

Restoration Unit 20

TF80701520 to TF79811512 - 860 m

- The channel is slightly incised in places
- The channel is too deep and too wide in places

Restoration Measures

- This reach was restored March 2011 and March 2012 using a combination of LWD pinchpoints and re-sculpting of bank and bed to create localised connectivity and enhanced morphological variety

Funding Sources

March 2011 – Castle Acre Fishing Club / EA

March 2012 – DEFRA Phase2 Norfolk Rivers Trust

Restoration Unit 14 and 15

TF82901564 to TF82601527 - 550m
TF82601527 to TF82271498 - 500m

- The channel is incised and lacks riparian or floodplain connectivity
- In the downstream reaches the channel is heavily incised
- The channel is too wide in places
- In places lacking riparian trees

Restoration Measures

to restore / enhance connectivity:

- Re-grade existing channel to create shallower bank profile and a narrower, more sinuous channel, with greater morphological variety
- Establish some willow and alder

Costs

Based on a work rate of 100 meters per day = **£15,750**

Total £15,750

Funding Sources

Catchment Restoration Fund

Restoration Unit 18

TF81641459 to TF8081454 - 930m

- The channel is incised in places esp. d'stream of ford
- The channel lacks high quality riparian or floodplain connectivity
- The channel is too deep and too wide in places
- Ford and lane create sediment and erosion issues

Restoration Measures

- Re-grade bank to enhance connectivity and variety
- Lift river bed in few selected places with imported gravel
- Install v. large oak trunk where lane enters river from north
- Bio-engineer bank along lane and open windows in canopy above

Costs

Based on a work rate of 100 meters per day **£15,000**
Gravel 500 cubic meters = **£7,500**
Bio-engineering along lane = **£2,000**
Total £14,950

Funding Sources

Catchment Restoration Fund

Restoration Unit 17

TF81851474 to TF81641459 - 480m

Upper half: restored in 2011 see unit 16.

Lower half:

- The channel is deeply incised and lacks riparian or floodplain connectivity
- The channel is too deep and too wide

Restoration Measures

- Lift river bed in places with imported gravel
- Re-grade bank to enhance connectivity and variety

Costs

Based on a work rate of 100 meters per day over 250 meters = **£7,500**
Gravel 500 cubic meters = **£7,500**
Total £15,000

Funding Sources

Catchment Restoration Fund

Restoration Unit 16

TF82271498 to TF81851474 - 570m

- The channel was incised and lacked riparian or floodplain connectivity
- The channel was too wide in places

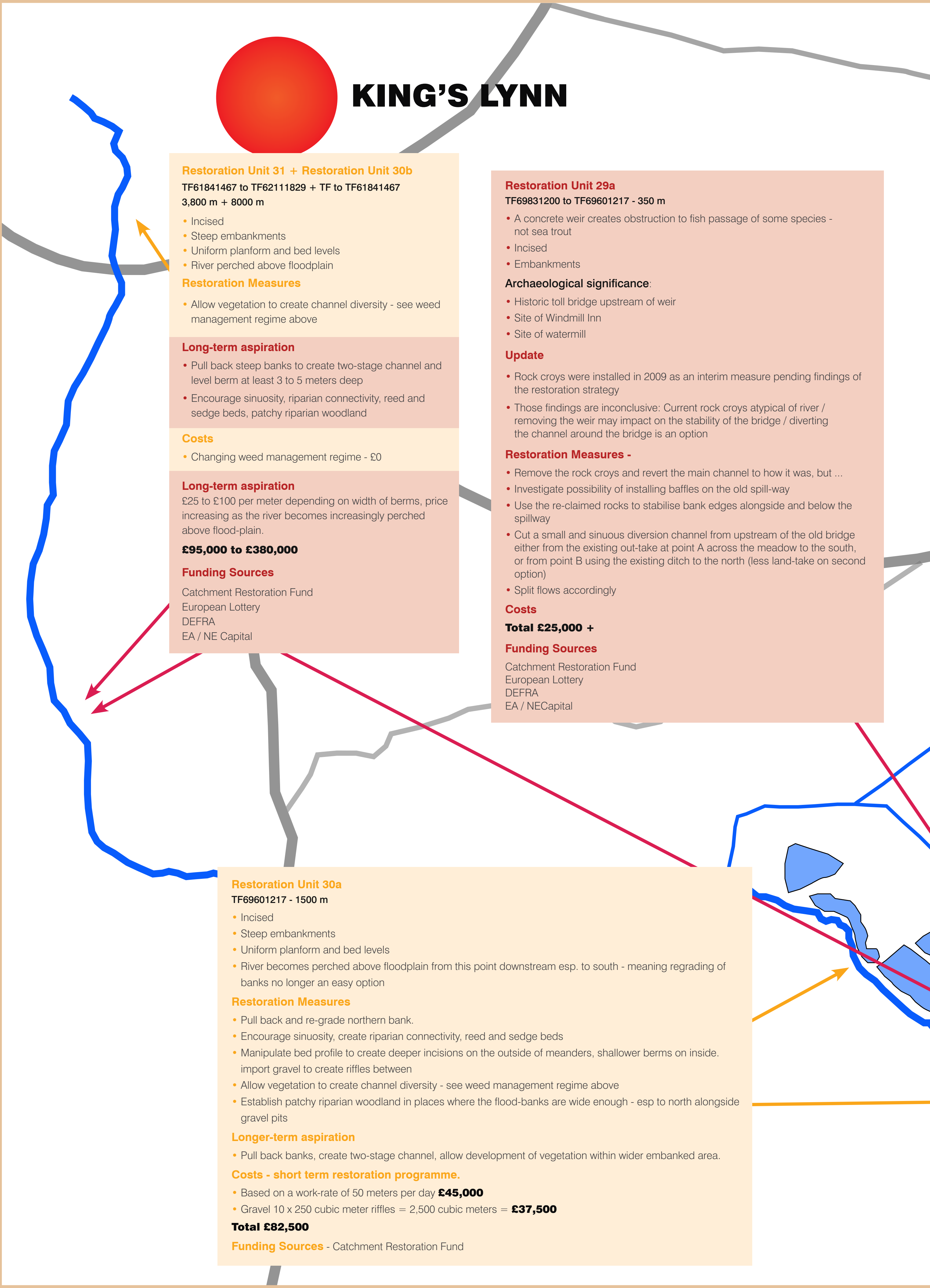
Restoration Measures

- Unit 16 was restored in 2011 and 2012. There is now greatly enhanced connectivity and morphological variety.
- EA fish counts in spring 2012 yielded record numbers

Funding Sources

March 2011 IDB
March 2012 DEFRA Phase2 / Norfolk Rivers Trust

KING'S LYNN



Restoration Unit 31 + Restoration Unit 30b

TF61841467 to TF62111829 + TF to TF61841467
3,800 m + 8000 m

- Incised
- Steep embankments
- Uniform planform and bed levels
- River perched above floodplain

Restoration Measures

- Allow vegetation to create channel diversity - see weed management regime above

Long-term aspiration

- Pull back steep banks to create two-stage channel and level berm at least 3 to 5 meters deep
- Encourage sinuosity, riparian connectivity, reed and sedge beds, patchy riparian woodland

Costs

- Changing weed management regime - £0

Long-term aspiration

£25 to £100 per meter depending on width of berms, price increasing as the river becomes increasingly perched above flood-plain.

£95,000 to £380,000

Funding Sources

Catchment Restoration Fund
European Lottery
DEFRA
EA / NE Capital

Restoration Unit 29a

TF69831200 to TF69601217 - 350 m

- A concrete weir creates obstruction to fish passage of some species - not sea trout
- Incised
- Embankments

Archaeological significance:

- Historic toll bridge upstream of weir
- Site of Windmill Inn
- Site of watermill

Update

- Rock croys were installed in 2009 as an interim measure pending findings of the restoration strategy
- Those findings are inconclusive: Current rock croys atypical of river / removing the weir may impact on the stability of the bridge / diverting the channel around the bridge is an option

Restoration Measures -

- Remove the rock croys and revert the main channel to how it was, but ...
- Investigate possibility of installing baffles on the old spill-way
- Use the re-claimed rocks to stabilise bank edges alongside and below the spillway
- Cut a small and sinuous diversion channel from upstream of the old bridge either from the existing out-take at point A across the meadow to the south, or from point B using the existing ditch to the north (less land-take on second option)
- Split flows accordingly

Costs

Total £25,000 +

Funding Sources

Catchment Restoration Fund
European Lottery
DEFRA
EA / NECapital

Restoration Unit 30a

TF69601217 - 1500 m

- Incised
- Steep embankments
- Uniform planform and bed levels
- River becomes perched above floodplain from this point downstream esp. to south - meaning regrading of banks no longer an easy option

Restoration Measures

- Pull back and re-grade northern bank.
- Encourage sinuosity, create riparian connectivity, reed and sedge beds
- Manipulate bed profile to create deeper incisions on the outside of meanders, shallower berms on inside. import gravel to create riffles between
- Allow vegetation to create channel diversity - see weed management regime above
- Establish patchy riparian woodland in places where the flood-banks are wide enough - esp to north alongside gravel pits

Longer-term aspiration

- Pull back banks, create two-stage channel, allow development of vegetation within wider embanked area.

Costs - short term restoration programme.

- Based on a work-rate of 50 meters per day **£45,000**
- Gravel 10 x 250 cubic meter riffles = 2,500 cubic meters = **£37,500**

Total £82,500

Funding Sources - Catchment Restoration Fund

RESTORATION UNITS: NARBOROUGH to KING'S LYNN

The River Nar was assessed for condition firstly in the 2005 Fluvial Audit, secondly during the 2010 River Nar Restoration Strategy and thirdly during the composition of this Catchment Restoration Plan. The former two present detailed analysis of relative levels of modification and degradation.

For the 2010 Nar Restoration Strategy the river is divided into 31 Restoration Units. Restoration strategies are proposed according to long-term aspirations, pragmatic and interim measures and referenced towards 'favourable' status as related to SSSI criteria.

These 2010 restoration proposals form the basis of the summary presented here, but with the exception of reaches 30 and 31, long-term aspirations and pragmatic measures have been dovetailed into one ambitious but realisable restoration vision for each unit.

- **at or restored to Good Ecological Status (GES)**
- **close to GES subject to simple and inexpensive restoration**
- **potential of GEP* subject to more complex and costly restoration**
- **potential of GES subject to highly complicated and expensive restoration**

* Good Ecological Potential as correct target for lower river

Restoration Unit 29

TF72341197 to TF69831200 - 2610 m

- Straightened channels
- Incised
- Embankments - but much lower than upstream
- Uniform planform and bed levels
- Too wide in places

Restoration Measures

- Pull back and re-grade embankments
- Narrow channel in places and encourage sinuosity
- Create marginal riparian connectivity, reed and sedge beds
- Establish patchy riparian woodland
- Allow vegetation to create channel diversity - see weed management regime above

Costs

Based on a work-rate of 50 meters per day (re-grading here would involve moving a lot of spoil) **£78,300**

Total £78,300

Funding Sources

Catchment Restoration Fund
European Lottery
DEFRA
EA / NE Capital

Restoration Unit 28

TF74681318 to TF72341197 - 2780 m

- Straightened channels
- Incised
- Steep embankments
- Uniform planform and bed levels
- Impoundments at bone mill and gauging flume
- Far too wide in places

Restoration Measures

- Pull back and re-grade steep embankments - at least on north bank
- Narrow channel in places and encourage sinuosity
- Create marginal riparian connectivity, reed and sedge beds
- Allow vegetation to create channel diversity - see weed management regime above
- Modify gauging flume to lessen impoundment and allow fish passage

Costs

Based on a work-rate of 50 meters per day (re-grading here would involve moving a lot of spoil)
£83,400

Total £83,400

Funding Sources

Catchment Restoration Fund
European Lottery
DEFRA
EA / NE Capital

Restoration Unit 27 lower half d'stream of A47

TF75011370 to TF74491322 and mill leat TF74681318
690 m + 700 m

- Straightened channels
- Incised
- Steep embankments
- Impounded and full of sediment
- Too wide in places
- Culvertd' stream of main road

Restoration Measures

- Remove, by-pass or modify the structures on the mill relief channel to the north - the primary aim is fish passage / the secondary aim is to recover the gradient and remove impoundments
- Manipulate embankments and edges on this relief channel to create sinuosity and riparian connectivity
- Modify the culverted relief channel to enhance its ecological potential
- Remove structures on the mill leat and allow natural recovery

Costs

This Unit of restoration would require complex modeling and planning and everything is contingent of the consent of those who own the impounding structures.

Costs are still likely to be i.r.o **£50,000 to £100,000**

Funding Sources

Catchment Restoration Fund
European Lottery
County Council
DEFRA
EA / IDB / NE Capital

RESTORATION UNIT	COST	FUNDING SOURCE
Unit 1	£23,250 + £16,000 capital WWF	CRF / WWF (Mileham)
Unit 2 & 3	£34,500 + £15,000 monitoring + £16,000 capital WWF	WWF (Mileham)
Unit 4	£13,800	CRF / DEFRA / EA / IDB / NE
Unit 5	£18,900	CRF (Mileham +)
Unit 6	£15,000	CRF / DEFRA / EA / IDB / NE
Unit 7	£8,850	CRF (Mileham +)
Unit 8	**£31,200 to £50,000**	CRF / DEFRA / EA / IDB / NE
Unit 9	£16,950	CRF (Mileham +)
Unit 10	£21,750 to £41,400	CRF / DEFRA / EA / IDB / NE
Unit 11	£20,850	CRF / DEFRA / EA / IDB / NE
Unit 12 & 13	£24,000	CRF / DEFRA / EA / IDB / NE
Unit 14 & 15	£15,750	CRF / DEFRA / EA / IDB / NE
Unit 16		
Unit 17	£15,000	CRF / DEFRA / EA / IDB / NE
Unit 18	£14,950	CRF / DEFRA / EA / IDB / NE
Unit 19	£13,500	CRF / DEFRA / EA / IDB / NE
Unit 20		
Unit 21	£26,700	CRF (West Acre)
Unit 22	**£25,000 to £50,000**	CRF / DEFRA / EA / IDB / NE
Unit 23		
Unit 24	£10,500	CRF (West Acre)
Unit 25	£10,500	CRF (West Acre)
Unit 26/27 (upper)	£47,450	CRF (West Acre)
Unit 27 (lower)	**£50,000 to £300,000 (EA estimate)**	CRF / DEFRA / EA / IDB / NE
Unit 28	**£0 to 2015** + £300,000 **for the flume by-pass (latest EA figure) / £83,400 to 2021**	CRF / DEFRA / EA / NE
Unit 29	£0 to 2015 / **£78,300 to 2021**	CRF / DEFRA / EA / NE
Unit 29a	**£25,000**	CRF / DEFRA / EA / NE
Unit 30 (upper)	£82,500 - £100,000	CRF (Pentney)
Unit 30 (lower)	**£0 to 2015 / £95,000 - £380,000 to 2027**	CRF / DEFRA / EA / NE
Unit 31	**£0 to 2015 / £200,000 - £800,000 to 2027**	CRF / DEFRA / EA / NE
SEDIMENT to WETLAND	£300,000	CRF

Stage 1 CRF bid **Stage 1 unsecured** **Stages 2 and 3 unsecured**

STATUS 2012		STATUS 2015		STATUS 2021	STATUS 2027
Stage 1					
Stage 1					
Stage 2. complex due to bridge and village					
Stage 1. re-grading of existing project					
Stage 1. complex due to lakes but **high priority** to remove barrier					
Stage 1					
Stage 2. complex due to bridge, village, reservoir and steep embankments					
Stage 1					
Stage 1. complex due to lakes but **high priority** to remove barrier					
Stage 1					
Stage 1					
Stage 1					
DELIVERED					
Stage 1					
Stage 1					
Stage 1					
DELIVERED					
Stage 1					
Stage 2. complex due to mill but **high priority** to remove barrier					
Stage 1					
Stage 1					
Stage 1					
Stage 2. complex due to impoundments but **high priority** to remove barrier					
Stage 1. weed-management and gauging flume at Marham and **in-channel works delivered**	Stage 2. Re-grading				
Stage 1. weed-management	Stage 2. Re-grading				
Stage 2. highly complex due to bridge and impoundment but **high priority** to remove barrier					
Stage 1. weed-management and restoration: Complex due to land take required					
Stage 1. weed-management	Stage 3. Re-grading				
Stage 1. weed-management	Stage 3. Re-grading				
		£1,067,900 to **£1,087,550**		**£145,000** to **£438,800**	**£295,000** to **£1,280,000**

The Restoration Unit table on pages 37 and 38 tabulate physical, reach-based restorations, unit by unit, aimed towards key WFD delivery dates – 2015, 2021 and 2027: these reach-based restorations address pressures identified as: canalisation and connectivity, overshading / lack of shade and impoundments. Restored channel morphology will also ease the pressures of sediment pollution and abstraction.

PRESSURE	BEFORE 2015
ABSTRACTION	• Re-focus local area groundwater model so that it more accurately fits the River Nar • Develop – in consultation with licence holders and stakeholders – a functional mechanism for reducing abstraction as flows fall towards QN90 and 95 • Halt the abstraction inflation that is occurring within existing licences • Renegotiate existing licences to reverse the abstraction inflation trend • Encourage winter storage solutions for farmers • Current groundwater abstraction is enough to supply 80,000 people – far more than the population of the Nar valley. Encourage Anglian Water to develop a more conjunctive use of river water and groundwater supplies: there is a lot of water in the Ouse, albeit more expensive to treat • Ensure that the next Catchment Abstraction Management Plan and the next River Basin Management Plan identify the extent to which flows in the River Nar are failing UK TAG targets
PHOSPHATE AND NITRATE ENRICHMENT	• Ensure the baseline figures of phosphates and nitrates do not regress • Ensure the decline in phosphate levels in the upper reaches continues until the river is within SSSI target levels • Investigate the likely causes of a rise in phosphate levels in the lower river • Investigate the impact of the Castle Acre STW soak-away and the potentially cumulative impacts of small-point sewage discharges • Re-base the lower river phosphate limit to 0.06mgL a figure which was achieved from 2000 until 2005 to ensure that the recent phosphate inflation in the lower river does not continue towards the present higher limit • Bring WFD phosphate standards up to the level of SSSI standards to ensure continuity of standards across all areas of environmental assessment
SEDIMENT POLLUTION	• Appoint a project officer to tackle this catchment-wide issue. **Status update: DONE** • Apply for funding from the Catchment Restoration Fund. **Status update: DONE. BUDGET IN PLACE** • Undertake a comprehensive survey to assess the full scale of the issue, identifying all the points of sediment ingress, the means of transfer and the costs of restoration • Undertake pilot projects addressing sediment ingress in at least five prioritised ingress points
INVASIVE PLANTS	• Consult the River Monnow Association: they have successfully eradicated Himalayan Balsam from the Monnow catchment. Take advice. • Devise a phased and strategic eradication programme • Apply for funding to enact the eradication plan

However, ALL the pressures identified on pages 15 and 16 need to be addressed to get to GOOD Status or Potential. At this point in time we can't know the full extent of how and when we can address these pressures. Instead, in the table below we have identified the actions we can plan for now, in anticipation that this actions table will be revised on a regular basis.

BEFORE 2021	BEFORE 2027
• Through the Restoring Sustainable Abstraction programme engage with licence holders to find a way of reducing overall abstraction and summer abstraction so that the River Nar meets UK TAG targets. This is is essential if the river is to achieve GOOD Status and Potential	
• Roll out pilot projects addressing sediment ingress in a further five prioritised ingress points	
• Eradicate outbreaks of Australian Stonewort, Parrot's Feather and Giant Hogweed before they spread • Ensure that alien plants become an assessed 'Supporting Element' in the next round of the River Basin Management Plan	

The Norfolk Rivers Trust

Stody Hall Barns,Stody, Near Holt, Norfolk. NR24 2ED.

www.norfolkriverstrust.org

Water Management Alliance / Kings Lynn Internal Drainage Board

Kettlewell House, Austin Fields Industrial Estate, King's Lynn, Norfolk, PE30 1PH, UK

e:info@wlma.org.uk | www.wlma.org.uk

The Environment Agency

Environment Agency Anglian Region, Central Area, Brampton Office, Bromholme Lane, Brampton, Huntingdon, Cambs, PE28 4NE

www.environment-agency.gov.uk

Natural England

Natural England, Dragonfly House, 2 Gilders Way, Norwich, Norfolk, NR3 1UB

www.naturalengland.org.uk

OTHER DELIVERY PARTNERS

The River Nar Restoration Group

Collective group representing local stakeholder interests.

Helen Mandely, The Norfolk Rivers Trust, Stody Hall Barns, Stody, Near Holt, Norfolk. NR24 2ED.

The River Restoration Centre

Cranfield University, Building 53, Cranfield, Bedfordshire, MK43 0AL

www.therrc.co.uk

WWF-UK

Panda House, Weyside Park, Godalming, Surrey GU7 1XR

wwf.org.uk

Norfolk Wildlife Trust

Norfolk Wildlife Trust, Bewick House, 22 Thorpe Road, Norwich, NR1 1RY

www.norfolkwildlifetrust.org.uk

The Wild Trout Trust

www.wildtrout.org

The Castle Acre Fishing Club

The West Acre Fishing Club

The Narborough Fishing Club

Karen Fisher

Dr Nigel Holmes

REFERENCES

English Nature Geomorphological Appraisal of the River Nar Site of Special Scientific Interest. Sear, D.A., Newson, M., Old, J.C., & Hill, C. 2006.

http://publications.naturalengland.org.uk/publication/59058

Note "Appendix 5 Defining Reference Conditions for Chalk Stream Natural Channels" and the discussion of width to depth ratios in groundwater dominated streams with erodible sandy, peaty banks. This is a KEY consideration in restoring as close to natural conditions as possible to the upper river Nar.

River Nar Site of Special Scientific Interest River Restoration Strategy and Plan for Norfolk Rivers Internal Drainage Board in partnership with The Environment Agency and Natural England. 2010. Karen Fisher, James Holloway and Dr. Jenny Mant, Dr Nigel Holmes

River Basin Management Plan Anglia River Basin District / Defra and the Environment Agency

www.environment-agency.gov.uk/research/planning/124725.aspx

River Nar SSSI citation

www.english-nature.org.uk/citation/citation_photo/1006323.pdf

River Nar SSSI Units

www.sssi.naturalengland.org.uk/Special/sssi/unitlist.cfm?sssi_id=1006323

The North West Norfolk Catchment Abstraction Management Strategy

http://publications.environment-agency.gov.uk/PDF/GEAN0305BQYU-E-E.pdf

Joint Nature Conservancy Council Common Standards Monitoring Guidance for Rivers March 2005

http://jncc.defra.gov.uk/pdf/csm_rivers_mar05.pdf

Water Framework Directive UK Technical Advisory Group

www.wfduk.org

Study of Water Control Structures in the Upper Nar. Fisher, K., Mant, J., & Pepper, A. The River Restoration Centre.

Anglia Sea Trout Project - obstructions to sea trout passage. Beach, M. The Wild Trout Trust.

THE NORFOLK RIVERS TRUST

RESTORING NORFOLK'S RIVERS

The catchment plan was written and designed by Charles Rangeley-Wilson on behalf of the Norfolk Rivers Trust.