RIVER NAR RIVER REHABILITATION

March 2011

'AS BUILT' SUMMARY OF PROJECT IMPLEMENTATIONS @ West Lexham, Castle Acre & Narborough






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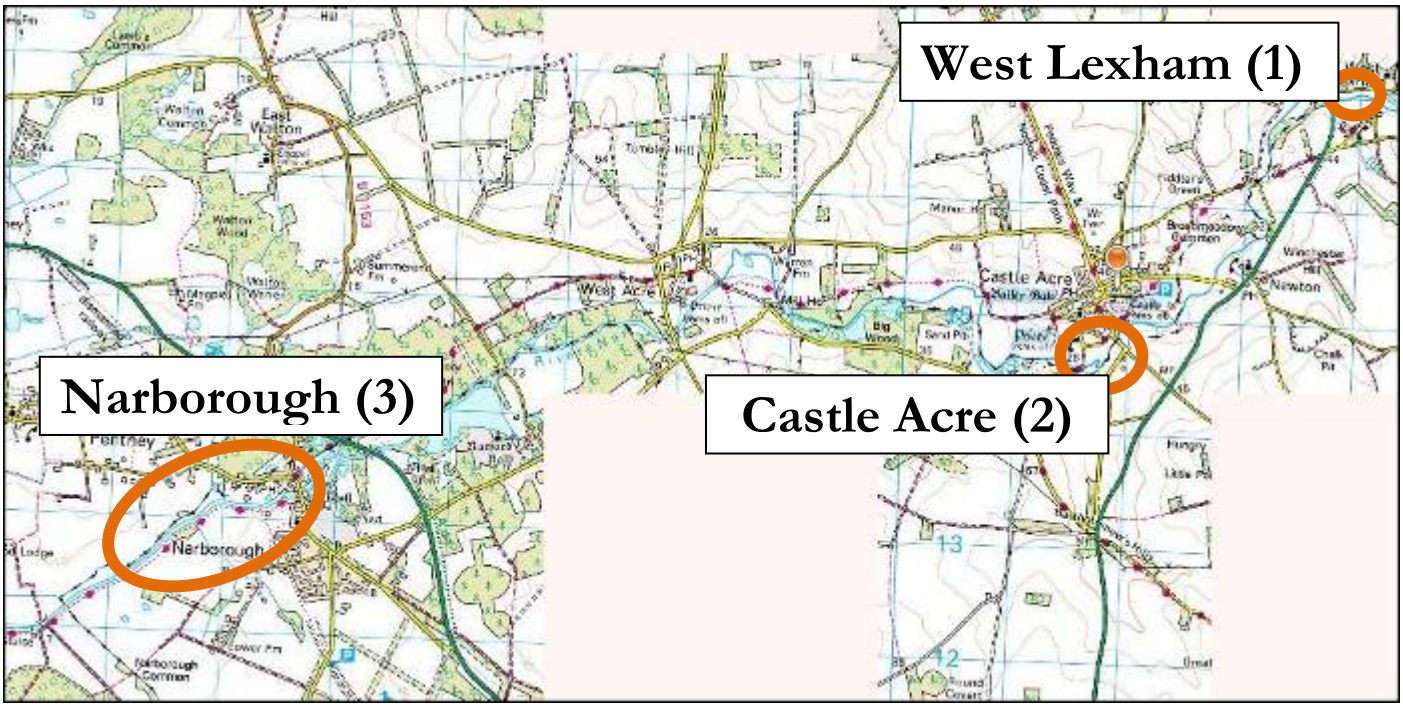
Introduction

In the week February 28th to March 4th 2011 three river rehabilitation projects were carried out on the River Nar, north Norfolk. The locations of the three projects, at West Lexham – TF8316 (1), Castle Acre – TF 8114 (2) and Narborough - TF 7413 (3) are shown on the map below.

This report provides a record of what was done at each site, the rationale behind the approaches taken, and the predicted outcomes in the future. More details of the work that was carried out are available in reports that were produced for consultation to reach agreement on what should be done. A full set of digital images showing conditions prior to the works, and immediately after, is available from the author on request.

All sites either had, or potentially had, water voles present. Prior to work being undertaken, a working protocol was established to ensure work could go ahead without harming the animals or their habitats, and enable progress to be made within the law. A full survey for water voles was carried out prior to the work at Narborough, and two personnel from Natural England (NE) were on site during implementation of the work at West Lexham to provide advice on how work could proceed. Due to the importance of water voles, the agreed approach is appended to this report as Annex A for reference to enable others to benefit from the successful approach adopted.



PROJECT 1 WEST LEXHAM: work completed in half a day

The Figure over-leaf shows the extent of work carried out. In essence, the impounding influence of a weir was removed, and in the channel upstream four pools and runs were dug. A second weir, between two bridges c35m downstream of the one shown in the images, was also removed. This structure had minimal impact on habitat, but was an impediment to easy migration of fish etc. wishing pass upstream.

The structure within the meadow that was impounding the Nar upstream had some archaeological interest. For this reason there was a 'watching brief' from Norfolk County Council to ensure there was no damage done to any known existing interest features, and to record anything else of interest should this be revealed during the removal of the impounding structure. To minimise damage to the historical elements of the bridge, the concrete 'boards' were removed with great care, leaving the central pillar and upper lintel in place, yet drawing the bed down to the required level.

The effect of centuries of impoundment has been to create a sluggish/non-existent flow in the river upstream with the resultant deposition of thick layers of mud. Pools were created by widening the channel locally. To help keep the pools clear in the future, the channel was narrowed upstream. Due to the extreme depth of soft mud, narrowing was achieved by pushing in one side of the existing river edge with the back of the bucket, and the void created behind this was filled with the arisings from creating the pools. Four pools and upstream 'runs' were created, with the run formed upstream of the second pool from the top having a small amount of gravel spread on the bed – this was won from the bed of the river in the pool downstream.

No water voles were present. As a precaution to impacting potential burrows close to the bank, the excavator laid protective boards over the soft ground, worked from these, and then removed them.

Digital references are Nar WL1-6, with the locations of photos shown on the Figure over-leaf. As in all cases, U = photo shot from upstream location, and D = photo shot from downstream location. (B) = Before work done, (P) = post work images from the same locations.

Assessment and Predictions for Future

The removal of the impounding influence of the weir was achieved simply and with no risk of destabilising the structure itself. Over the long-term flow velocity will be fast in the section upstream of the structure and maintain a narrow, self-scouring, channel.

The long-term future of the pools and runs is less predictable. The extent of reeds in the channel is immense, and during low flows the channel may nearly close over with this reed. The second pool from the top is expected to be sustained best (in terms of depth and width) due to the combined effect of upstream narrowing and the slight bed-raising with flints and gravel. The other three may become less defined over time, but should sustain contrasting habitats from the rest of the channel for years to come.

Removal of the impoundment was the key requirement here, and the benefits should be sustained for ever; the pools were more experimental and may not be sustained in perpetuity.

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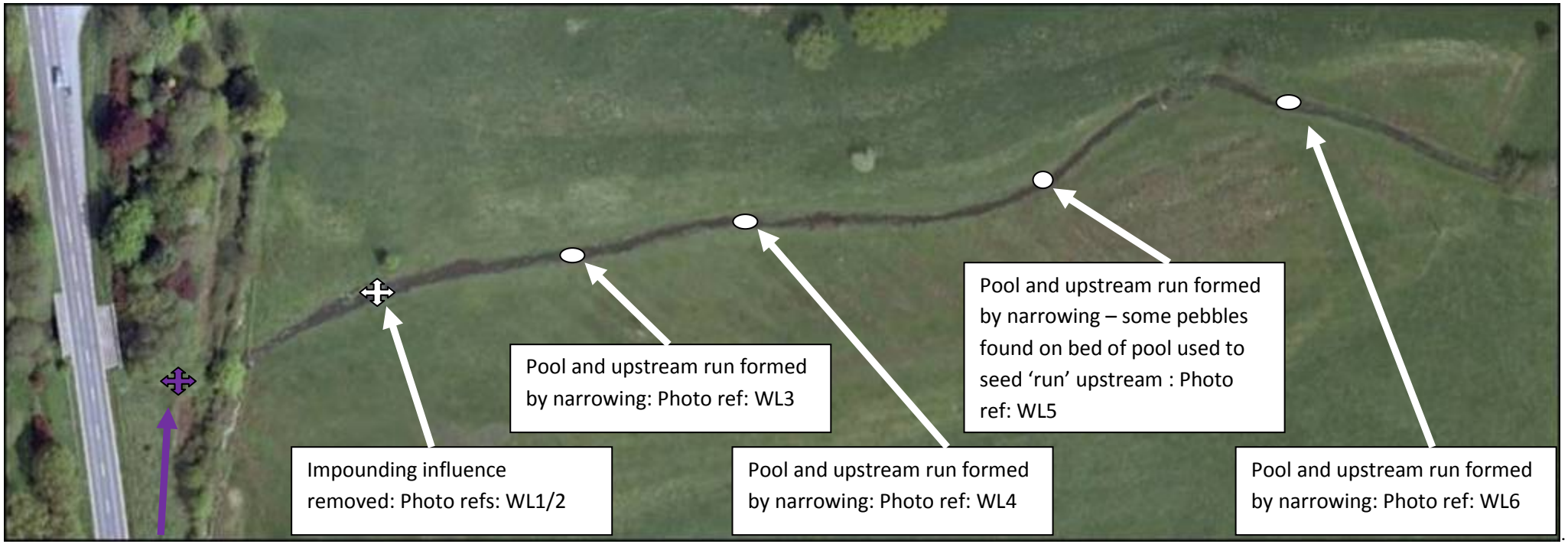


Impounding structure modified between two bridges: No photos


Nar West Lexham – upstream pool and run formed – (Photo ref: WL6)


Nar West Lexham –pool and run formed d/s dilapidated bridge – run seeded with gravel from bed (Photo ref: WL5)


Nar West Lexham – middle pool and run formed – (Photo ref: WL4)


Nar West Lexham – downstream pool and run formed – (Photo ref: WL3)

Nar West Lexham – effect on upstream channel of removal of impoundment– (Photo ref: WL2)

Nar West Lexham – removal of sluice impounding concrete 'boards' – (Photo ref: WL1)

PROJECT 2 CASTLE ACRE; work completed in under two days

The Figure over-leaf shows the extent of work carried out. Work was considerable, affecting about 65% of the channel within a stretch of c300m. Work was undertaken to:

- create greater diversity of habitat by modifying both the long and cross-sections (formation of pools and fast 'run' habitat);
- narrow the channel to improve self-cleansing of the bed and thus reduce sand and silt deposition as well as 'weed' growth in the future;
- improve the landscape quality of the area by replacing the unsightly deflectors with 'living' features that would do a more effective job than the deflectors were attempting to do.

This section of river has more gradient than the other two sites, and this tended to recede on passing downstream. In habitat terms it primarily suffers badly from historic widening, and attempts to narrow it with deflectors have been generally ineffectual due to the inability of marginal plants to encroach and become firmly established – some deflectors have, however, established some habitat diversity.

The key to being able to carry out the works as desired was the presence of large patches of sedge (*Carex acutiformis*) and reed (*Phalaris arundinacea*). In several places the river was narrowed by over 4m simply by transferring large 'sods' of sedges; these imports were placed within the inside the existing bank, and will now form the new bank.

In the upstream straight section to the first bend, three pools and upstream deflectors were created. As the bed of the newly created two downstream pools of this sequence (photos 2-5) had flinty-gravel present, this was sprinkled on the bed of the narrowed channel upstream to accentuate the improved speed of flow into the pools, and improve the habitat variability within the reach. Material dug from pools to form the upstream shoulders that narrowed the channel were blinded by sedge/reed from the adjacent field. These features were enlarged by further sedge/reed sods.

Photos 6U/D show simple narrowing of the channel only. Around the first large meander loop there was considerable narrowing on the left bank (Photo 7) followed by the formation of a small pool and then a run downstream formed from re-distributed gravels and considerable narrowing – again on the left bank (photos 8-9). Narrowing continued downstream on the inside of the meander where a wide and deep expanse of silt was present (photo 10). At the bend a small pool was created, with the material dragged to the edge of the channel below the bank on the meander. This material was not very cohesive, and not placed in the most appropriate location to be sustained in the future; however it was minor attempt to reduce erosion on the bank that is close to the footpath.

Photos 11D/U show extensive narrowing in a wide part of the channel, and Photos 12D/U show slight narrowing and bank re-profiling. The former section could be effectively narrowed as it was not very deep; the latter could not as it was very deep, and adjacent reed was not bound tightly with earth (sandy) so no large 'sods' could be added to the river.

Banks were riddled with water vole burrows, so a gap was left between the in-filled areas and the bank. The only exceptions were the upstream ends of the shoulders that were sometimes tied into the bank where inspection indicated the absence of burrows.

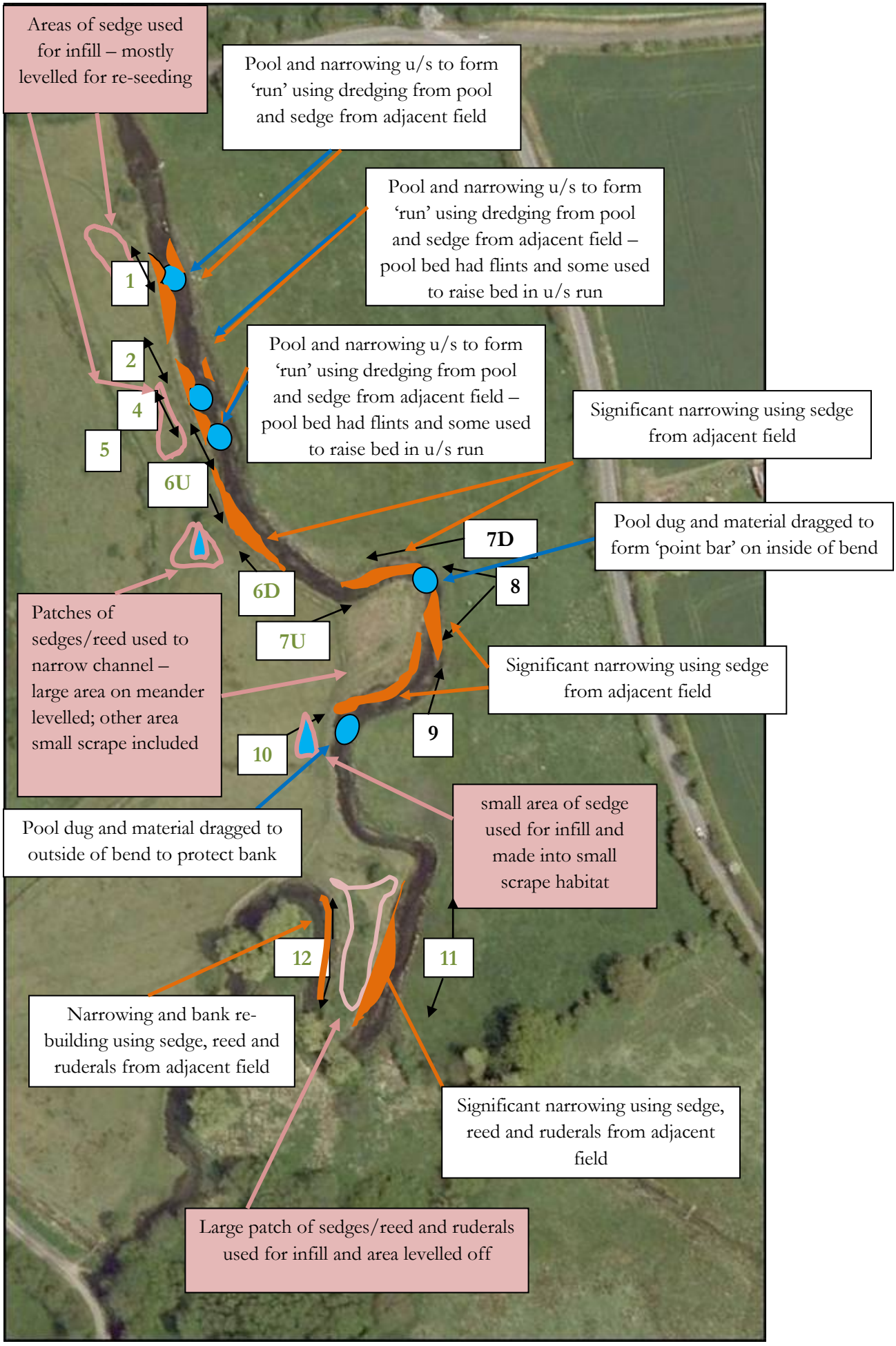
Digital image references are Nar CA1-12, with the locations of photos shown on the Figure over-leaf. Where two images of the same created feature have been take, U = photo shot from upstream location, and D = photo shot from downstream location. (B) = Before work done, (P) = post work images from the same locations.

Assessment and Predictions for Future

Everything that was wanted to be achieved was, and the prediction is that over time the elements created will improve, not decline. The only exception is the pool and scraped material at pool 10. Thus narrowing is expected to be maintained for ever, and pools (apart from at 10) will not infill and depth will be maintained by the acceleration of flow into them by the narrowing upstream.

Visually the reach can only improve as it stabilizes and vegetates. No unsightly deflectors are now present and should not be needed in the future. The adjacent land disturbed by excavation of sedge/reed was either restored to level ground for re-seeding, or shallow scrapes formed for habitat enhancement.

Future maintenance of the channel needs to be mindful of what has been done, and why. It is absolutely essential that the narrowing is maintained, and where the bed has been raised upstream of pools this is not compromised either. It is recommended no maintenance is carried out at all in the near future to enable the channel to establish a new equilibrium with its new shape and size. Should 'weed' become a problem in the future, only 50% of the channel should be cut. If the summer discharge is low, maintaining water depth can be achieved by cutting vegetation in strips at right angles to the bank, ACROSS the channel. Ideally, cutting of a 50% width ALONG the channel will help improve the self-cleansing character of the river and reduce the need for future maintenance. It should be recognised that weed cutting is not required for flood defence nor ecological reasons, and thus must be seen purely as a service to the fishing interests.


Areas of sedge used for infill – mostly levelled for re-seeding
Pool and narrowing u/s to form 'run' using dredging from pool and sedge from adjacent field
Pool and narrowing u/s to form 'run' using dredging from pool and sedge from adjacent field – pool bed had flints and some used to raise bed in u/s run
1
2
4
5
Pool and narrowing u/s to form 'run' using dredging from pool and sedge from adjacent field – pool bed had flints and some used to raise bed in u/s run
Significant narrowing using sedge from adjacent field
6U
Pool dug and material dragged to form 'point bar' on inside of bend
7D
8
6D
7U
Patches of sedges/reed used to narrow channel – large area on meander levelled; other area small scrape included
Significant narrowing using sedge from adjacent field
9
10
small area of sedge used for infill and made into small scrape habitat
Pool dug and material dragged to outside of bend to protect bank
12
11
Narrowing and bank re-building using sedge, reed and ruderals from adjacent field
Significant narrowing using sedge, reed and ruderals from adjacent field
Large patch of sedges/reed and ruderals used for infill and area levelled off

Summary of works at Castle Acre, March 2nd and 3rd 2011. Photo references in boxes are taken on right bank when shown in green.


Nar Castle Acre – narrowing and pool formation (Photo ref: CA1)


Nar Castle Acre – narrowing and pool formation (Photo ref: CA2)


Nar Castle Acre – narrowing and pool formation (Photo ref: CA4)


Nar Castle Acre – narrowing and pool formation (Photo ref: CA5)


Nar Castle Acre – narrowing (Photo ref: CA6)


Nar Castle Acre – narrowing (Photo ref: CA7)

Nar Castle Acre – narrowing, pool and gravel run formation (Photo ref: CA8)

Nar Castle Acre – narrowing and shallow run/riffle formation (Photo ref: CA9)

Nar Castle Acre – narrowing (Photo ref: CA10)

Nar Castle Acre – narrowing (Photo ref: CA11)

Nar Castle Acre – slight narrowing and bank re-profiling (Photo ref: CA12)

PROJECT 3 NARBROUGH; river excavations and modifications took three days, the majority of one of these being import of the gravel to the 'runs'

The Figures following this short text show the extent of work carried out. Work was implemented in c1km of river. Unlike at Castle Acre, there was absolutely no gradient within the sections modified, with the river being deep and sluggish throughout. In essence the work carried out was similar to that at Castle Acre, but on a very different, and even more degraded, channel morphology – i.e.:

- created greater diversity of habitat by modifying both the long and cross-sections;
- locally narrowed the channel to improve self-cleansing of the bed in these locations, and accelerated flow into pools created immediately downstream;
- removed the unsightly deflectors by replacing them with 'living' features that already are doing a much more effective job than the deflectors were attempting to do;
- the one main difference from the Castle Acre stretch was that some of the upstream 'runs' had a thin layer of gravel spread over them too.

Due to the contrasting character of the features formed, details of individual features are identified in the Figures that follow. Differences in character were primarily determined by the character of the river bed where pools were excavated, and the extent of reed/sedge available from adjacent to the river to add to the channel.

Where the bed was hard, and reed/sedge was plentiful, upstream narrowing could be more extensive. In all cases where the bed was hard (predominantly chalky clay), very distinct pools and upstream 'runs' were formed. Where-ever possible the bed of the narrowed channel upstream of the pools was shallowed by adding material dug from the pools – this could only be done where flints or firm clay formed the substrate.

Where the bed was pure soft peat, the distinction between the narrowed channel upstream, and the deepened channel downstream, was much less. Had deflectors not already been present in the channel, it would have been difficult, or impossible, to establish narrowing upstream.....the deflectors now form the downstream edges of the shoulders. Without reeds/sedge from adjacent to the river being added to these areas, they could not have been expected to be retained in the long term.

Digital image references are Nar Narb – Berm refers to the upstream berm, and P1-14 refer to pools 1-14, with the locations of these pool features identified in the figures that follow. As for the other two sites, where two images of the same feature created have been taken, U = photo shot from upstream location, and D = photo shot from downstream location. (B) = Before work done, (P) = post work images from the same locations.

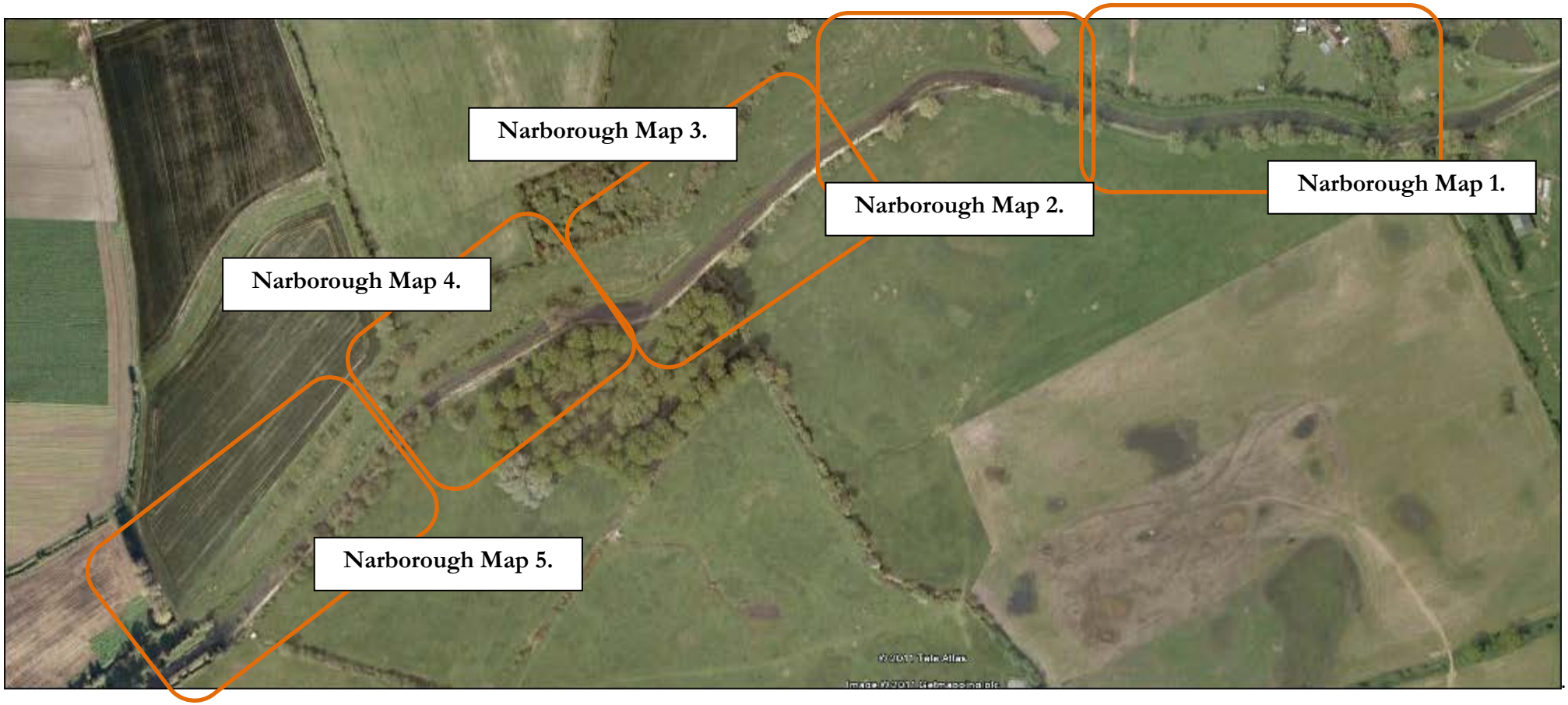
Assessment and Predictions for Future

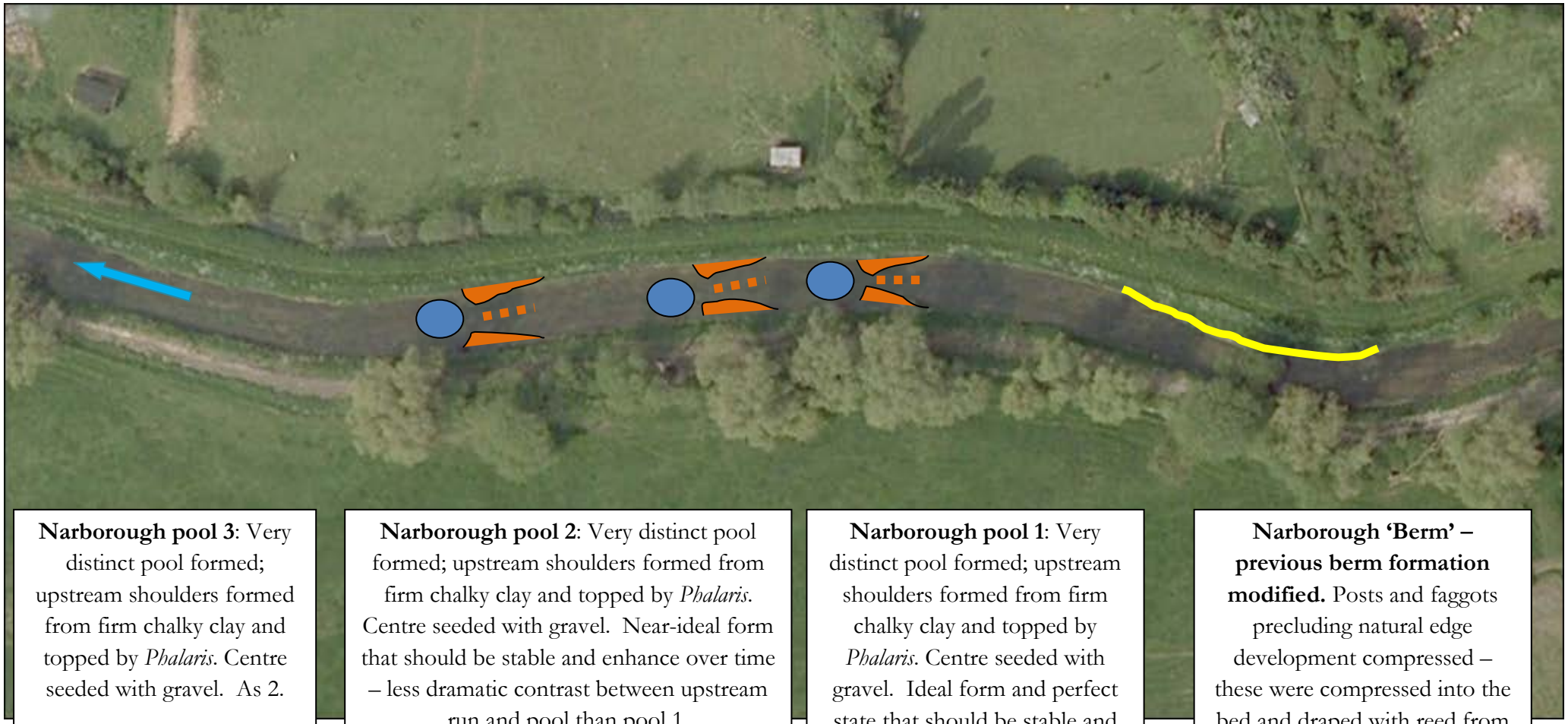
Everything that was wanted to be achieved was, and the prediction is that the majority of the features will improve, not decline, over time. The only exceptions are the indistinct pools created where the bed was pure peat. The upstream shoulders of these will be most prone to being washed away, but it is predicted that the extent of reed placed upon them will mean they will not be washed away in the future. As for those pools and runs created where the bed was hard, there is very strong confidence these will stay in perpetuity. It is not known if the gravel will stay in place during future high spate flows.

Visually the reach can only improve as it stabilizes and vegetates. All unsightly deflectors have been removed or covered in vegetation, and there is no reason to expect any to be installed the future.

As at Castle Acre, future maintenance of the channel needs to be mindful of what has been done, and why. It is absolutely essential that the combined effects of narrowing and bed raising are maintained and not compromised. It is recommended no maintenance is carried out at all in the near future to enable the channel to establish a new equilibrium in the sections where pools and runs have been formed. Should 'weed' become a problem in the future, only 50% of the channel should be cut. In low-flow conditions, maintaining water depth can be achieved by cutting weed in strips ACROSS the channel. In all other conditions, cutting a sinuous 50% width ALONG the channel will help improve the self-cleansing character of the river and reduce the need for maintenance in the future.

Weed cutting is almost certainly not required for flood defence nor ecological reasons, and thus should be seen as an operation purely to assist angling.


Narborough Map 3.
Narborough Map 2.
Narborough Map 1.
Narborough Map 4.
Narborough Map 5.



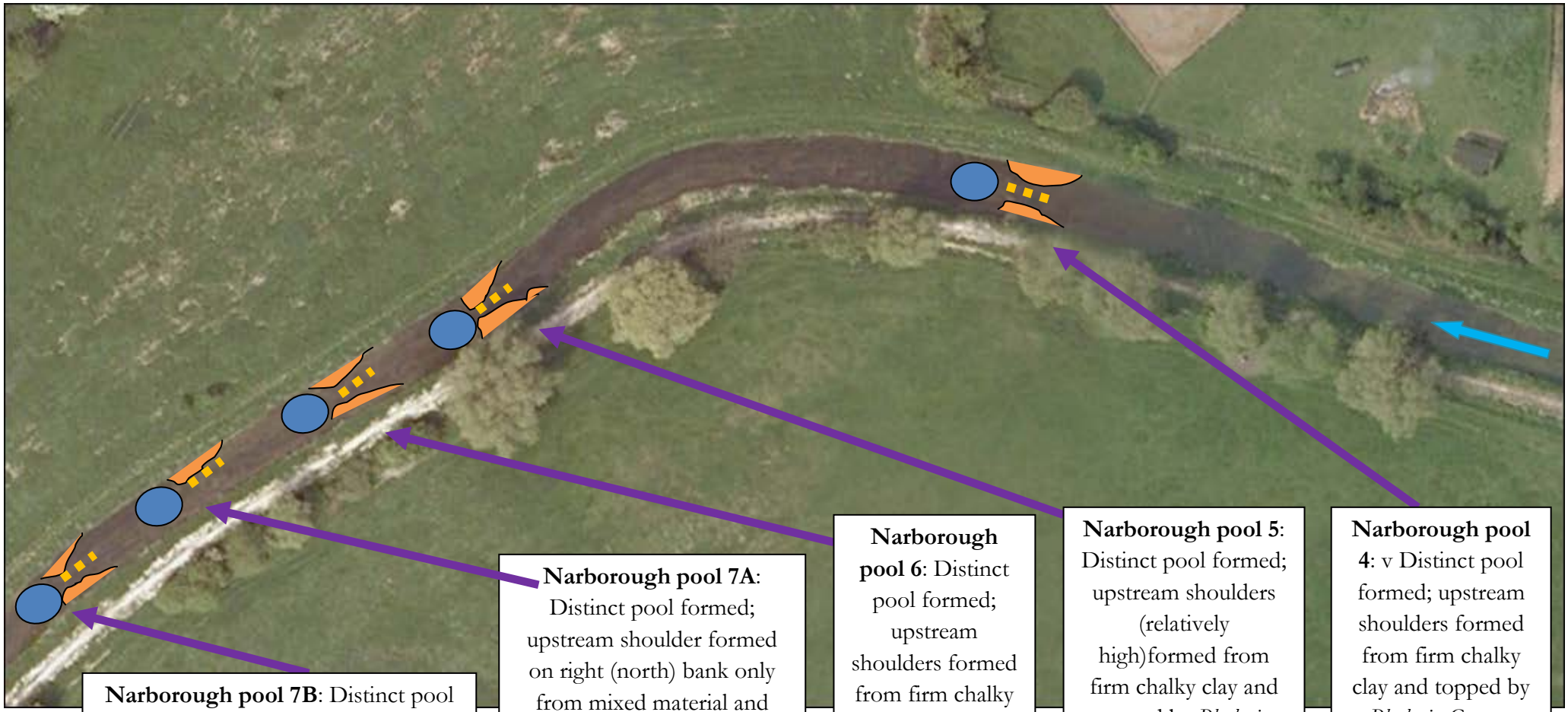
Narborough pool 3: Very distinct pool formed; upstream shoulders formed from firm chalky clay and topped by *Phalaris*. Centre seeded with gravel. As 2.

Narborough pool 2: Very distinct pool formed; upstream shoulders formed from firm chalky clay and topped by *Phalaris*. Centre seeded with gravel. Near-ideal form that should be stable and enhance over time – less dramatic contrast between upstream run and pool than pool 1.

Narborough pool 1: Very distinct pool formed; upstream shoulders formed from firm chalky clay and topped by *Phalaris*. Centre seeded with gravel. Ideal form and perfect state that should be stable and enhance over time.

Narborough 'Berm' – previous berm formation modified. Posts and faggots precluding natural edge development compressed – these were compressed into the bed and draped with reed from upper edge of the berm

Narborough Map 1.



Narborough pool 7B: Distinct pool formed; upstream shoulder formed from firm chalky clay and topped by *Phalaris*. On left (south) bank; narrow ledge formed on right mainly from reed. Bed raised slightly pre-seeding with gravel. Good example.

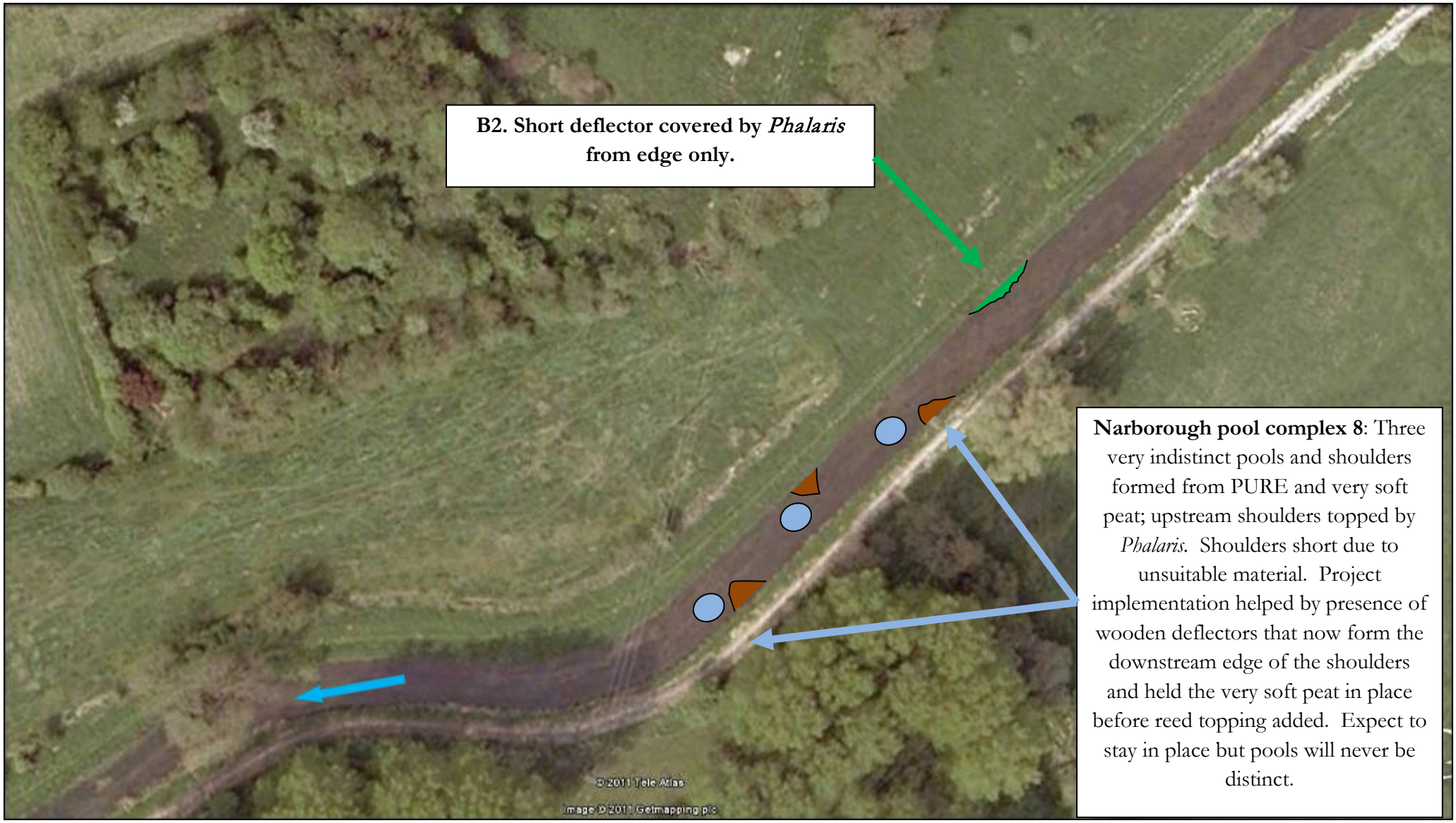
Narborough pool 7A: Distinct pool formed; upstream shoulder formed on right (north) bank only from mixed material and topped by *Phalaris*. Edge of shoulder seeded with small amount of gravel. 'Average' example only due to channel width and availability of suitable material.

Narborough pool 6: Distinct pool formed; upstream shoulders formed from firm chalky clay and topped by *Phalaris*. Centre seeded with gravel. Perfect example.

Narborough pool 5: Distinct pool formed; upstream shoulders (relatively high)formed from firm chalky clay and topped by *Phalaris*. Centre seeded with gravel. Perfect example. South bank upstream deflector 'draped' with reed.

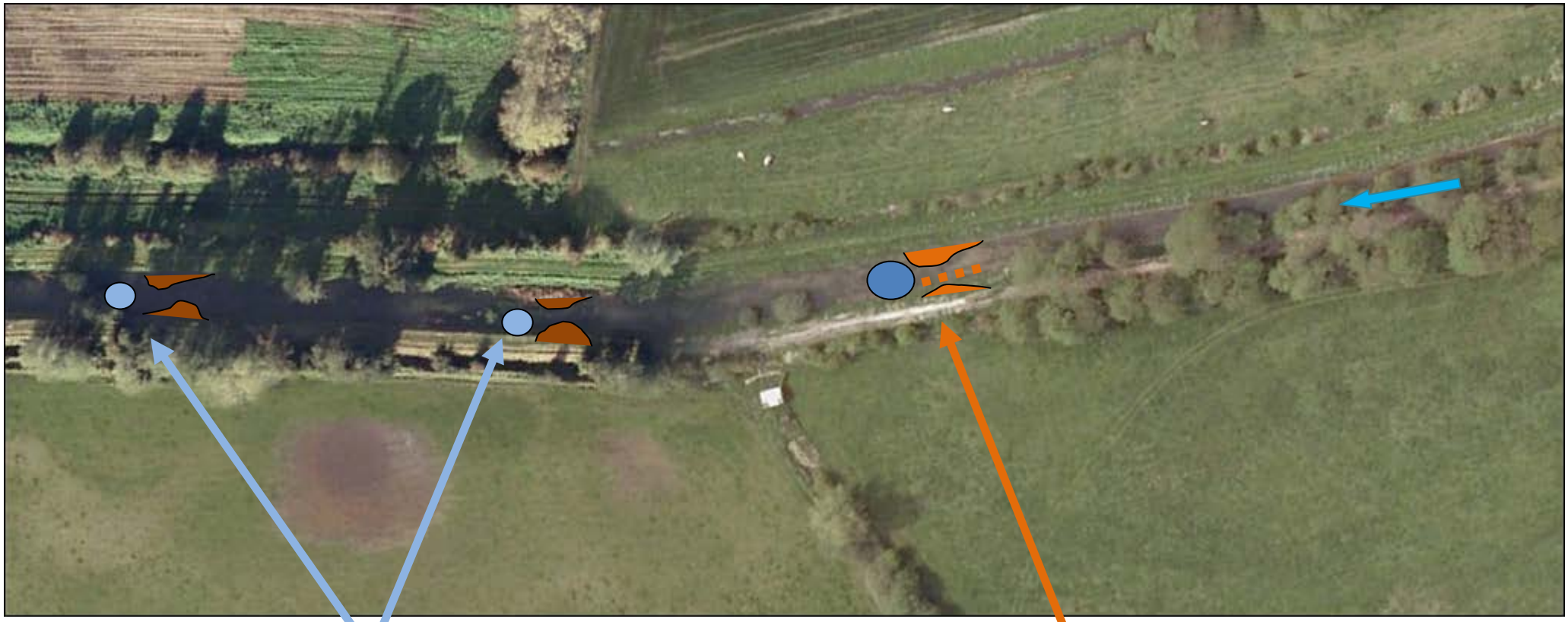
Narborough pool 4: v Distinct pool formed; upstream shoulders formed from firm chalky clay and topped by *Phalaris*. Centre seeded with gravel. Ideal form and a good example. Old log pole deflector evident on d/s end.

Narborough Map 2.



Narborough Map 3.

Narborough Map 4.



Narborough pools 13 & 14: Two very indistinct pools and shoulders formed from PURE and very soft peat; upstream shoulders topped by *Phalaris* limited amounts available here so relatively shallow and small). Shoulders short also due to unsuitable material. Project implementation helped by presence of wooden deflectors that now form the downstream edges of the shoulders and held the very soft peat in place before reed topping added. Expect to stay in place but pools will never be distinct.

Narborough pool 12: Very distinct pool formed; upstream shoulders formed from firm chalky clay and topped by *Phalaris*. Centre slightly raised with dredging and then seeded with gravel. Perfect example. Should get even better over time.

Narborough Map 5.

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Nar Narborough - Berm re-profiling


Nar Narborough - Pool 1 looking d/s


Nar Narborough - Pool 2 looking u/s


Nar Narborough - Pool 3 looking d/s


Nar Narborough - Pool 4 looking u/s – note old pole deflectors still visible


Nar Narborough - Pool 5 looking u/s


Nar Narborough - Pool 6 looking d/s with pools 7A and 7B in the background


Nar Narborough - Pool 7B looking u/s with pools 7A, 6 & 5in the background

Nar Narborough – 'Pool' complex 8 – soft peat shoulders; indistinct deepening - not discrete pools

Nar Narborough – 'Pools' 9 & 10 plus shoulder formed over old deflector – soft peat shoulders with reeds; indistinct deepening – non-existent pools (looking d/s with pool 11 in background)

Nar Narborough – Pool 11 – looking upstream; firm chalky bed enables discrete pool creation

Nar Narborough – Pool 12 – looking d/s; firm chalky bed enables discrete pool creation


Nar Narborough – Non-existent 'Pool' 13 plus shoulder formed over old deflectors – very soft peat shoulders with limited reeds – looking u/s


Nar Narborough – Non-existent 'Pool' 14 plus shoulder formed over old deflectors – very soft peat shoulders with limited reeds – looking d/s

Annex A

Working Plan to Protect Water Voles During River Restoration Works on the Nar

Report to all concerned: Environment Agency, Natural England, Water Management Alliance

February 10th 2011

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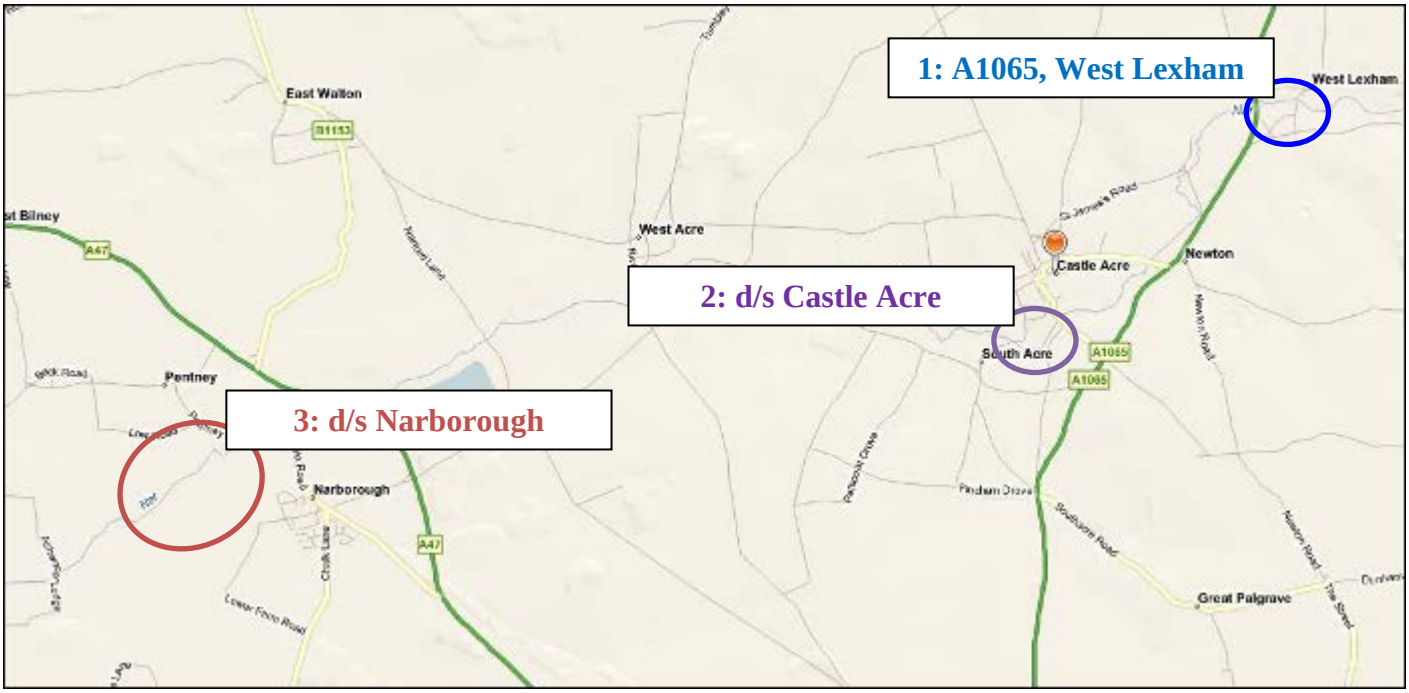
In the week beginning Monday February 28th to Friday March 4th 2011 it is hoped that river rehabilitation will take place at three locations on the River Nar, North Norfolk. These locations are shown on the map below.



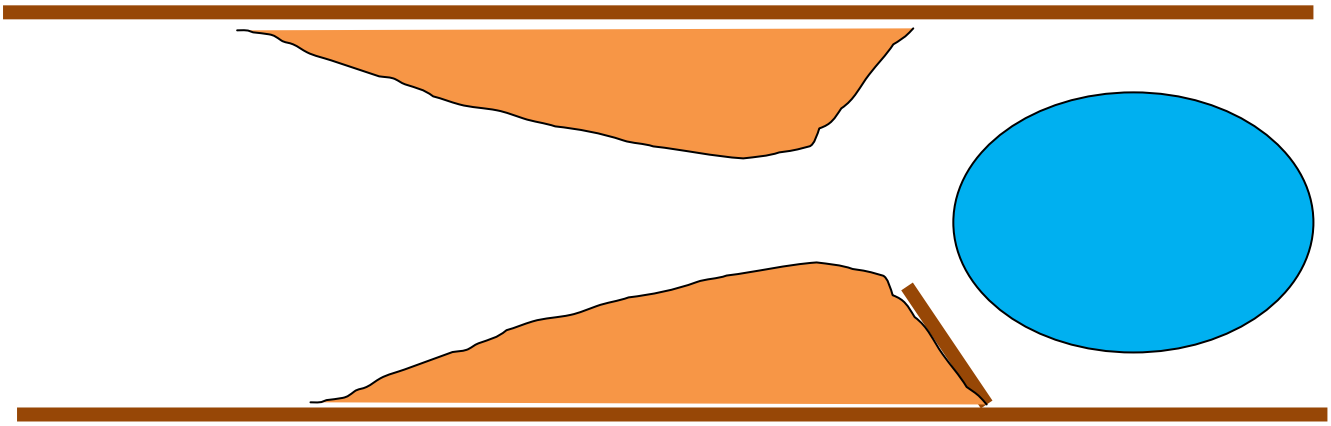
A key requirement is to ensure water voles, and their habitats, are not impacted in any way. This is a requirement of legislation. There is a presumption that water voles are present, or show signs of recent presence (such as burrows) in all banks. For this reason, therefore, all works will assume their presence and work accordingly. There will be a generic approach to undertaking the river rehabilitation work that will be followed in all locations unless otherwise agreed before-hand, for local exceptions only. Diggers will be supervised at all times by experienced personnel.

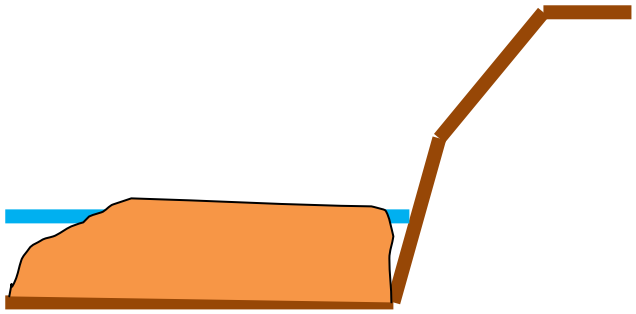
RULE 1: No exceptions – machines must not encroach within 1m of the top of the bank.

RULE 2: No 'natural' earth banks will be re-profiled – the only exception MAY be at Site 1 following on-site confirmation by NE (on the day) that works can be undertaken because signs of water voles are not present.

RULE 3: Dredgings will be placed along the channel margin, and leave a narrow gap (c10cm) between the inside edges of the existing bank and spoil deposited in the river. Exceptions MAY apply to local areas that are identified in subsequent sections of this Working Plan.

One of the major generic types of work to be carried out at all three locations is the narrowing of the channel using dredged material, and where available, utilizing reed/sedge 'sods' dug from adjacent ditches/wetlands. These are described as upstream deflector 'shoulders' or marginal narrowing 'ledges'. During the construction of the ledges and shoulders, the required gap may be temporarily closed; where this occurs required gaps will be achieved either by hand, using a spade, or by use of the back of the excavator bucket. Overleaf an example is shown where the shoulder is created upstream of a pool where one side has an existing deflector, and other has not.





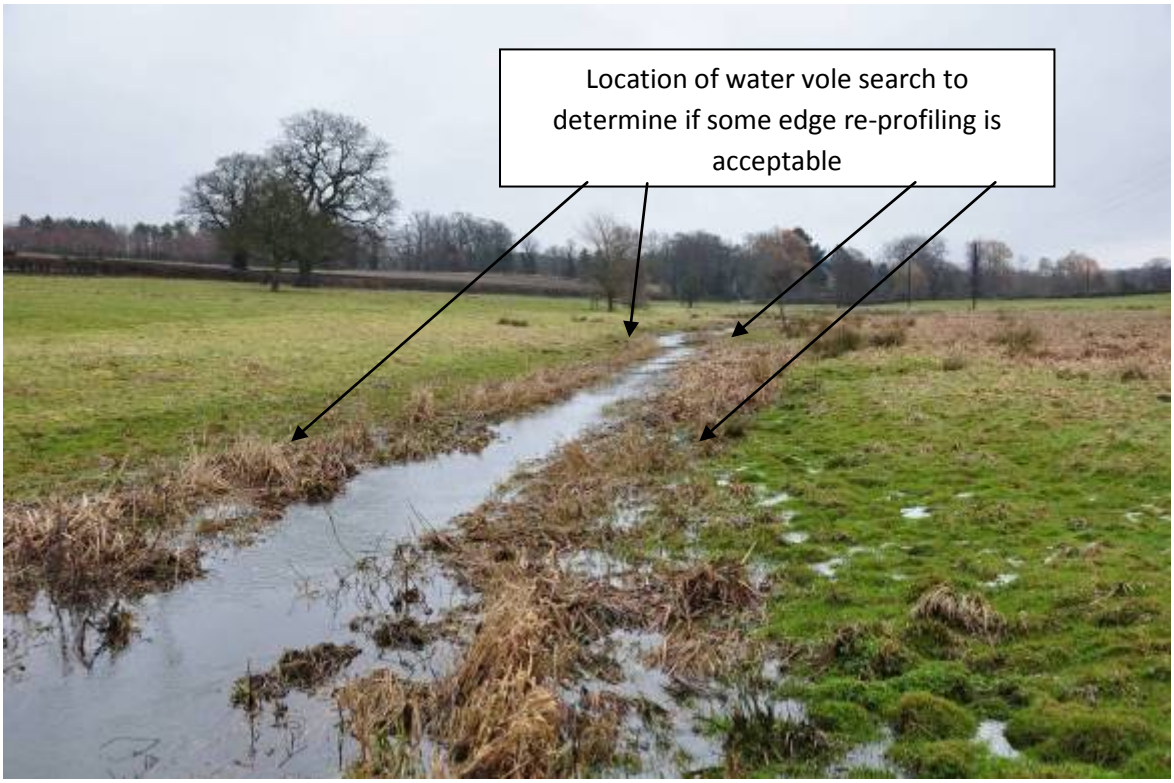
RULE 4: No compression into the bed of deflector posts if within 30cm of the bank, thus ensuring no compression of the bank. Exceptions MAY apply to some deflectors in Site 3 only if a pre-work survey identifies no water vole activity in that area. Here, and only here, MAY deflectors be lowered, and the installed reed/dredgings can be keyed into the bank as far upstream/downstream of the deflector where NO water vole presence (past or present) has been determined in pre-work surveys.

On both sites 2 and 3 there are deflectors in the river that extend to the bank. At site 2 the plan is to either remove, or leave, the deflectors. At site 3 the plan is to lower the majority to within 30cm of the bank.

Site-Specific Considerations/Exceptions: Site 1 – u/s A1065 road

The core task here is to remove the weir(s) to lower water levels upstream (see photos below). The very flat, water-logged, banks are probably the only known location where water voles are probably absent.

Once the water level has been dropped by the weir, Julia Masson of Natural England will do an inspection of the banks. Should they be present, any in-stream channel modifications will comply with all general rules. Should they not be present, some manipulation of margins may be undertaken during the in-channel habitat enhancement works.



Site-Specific Considerations/Exceptions: Site 2 – Castle Acre

Water voles are present throughout, confirmed by Jen Small and Julia Masson (10/2/2011) There is not point in surveying for them, we just need to carry out work in accordance with best practice, and within the letter of the law.

Only at the highlighted a location is it necessary to depart from the four guiding principles (rules 1-4). At this location, the bank is eroding, and very close to the bank.

Survey by JS and JM indicate burrow holes are not below water level – here i is proposed imported sedge to form a ledge will be abutted up close to the base of the bank and leave no gap (exception to rule 3). Fill will not extend up the bank to height where water vole holes are present

Site-Specific Considerations/Exceptions: Site 3 – Narborough

A pre-work water vole survey of the RIGHT (North) bank of the river will undertaken at the location of ALL deflectors keyed into this bank. Survey should extend 2m downstream and 10m upstream. Surveys should specify, and mark clearly with spray paint, where no signs of water voles are present. An example is shown below, where the bank above the three deflectors on the right bank would surveyed. Should no water vole presence be identified, these locations enable relaxation of rules 3 and 4 should they be deemed desirable. Hence posts can be driven down close to the bank, and spoil can be keyed into the bank without leaving a gap.

At the start of the reach there is a recently constructed vegetated 'berm' held in place by posts and faggots. The posts and faggots are constraining the natural encroachment of the reed, and hence stopping them trapping the silt that is deposited at the river margin. It is proposed the posts are carefully pushed into the channel, leaving the faggots in place. Reeds from the top of the berm can be deposited in front of the faggots to a depth of c20-30cm. The faggots will form a space enabling any voles, if present, to exit any burrows. This is thus an exception to rule 4 only, as strictly the berm is not part of bank and there will be a gap between existing bank and infill material.

Immediate Actions:

- **EA to undertake water vole surveys in the locations specified in site 3 and feed back information to inform final working programme;**
- **Natural England amend/comment on suggested working protocol, and then agree to works being able to proceed!!**

It should be noted that supervision of works will be overseen throughout the week by Nigel Holmes. He has worked on such sensitive sites such as the Itchen at Winchester and East Lodge in the past two years. Similar measures were proposed and adhered to throughout. Should confirmation of this be required, please contact Rue Ekins of Natural England.

ADDENDUM (March 5th 2011): Survey at Narborough prior to implementation identified the absence of any water vole burrows adjacent to, and 10m upstream of, all deflectors on the right bank. Permission was granted by NE to allow keying-in of the right bank shoulders, but a gap between imported material and the left bank was retained.

Example of retained gap between in-fill to narrow the channel and the existing bank