Navigation Committee
10 December 2015
Agenda Item No 13

Waterways Specification Revisions

Report by Rivers Engineer and Environment and Design Supervisor

Summary: In several localised areas of the Broads navigation, achieving compliance with waterways specification depths stated in the Sediment Management Strategy is an issue. These areas include:

- River Ant at Irstead
- River Chet at Pyes Mill
- River Bure at Coltishall

In each area natural bed material (typically sand and gravel) is within the ideal navigation envelope. This report considers the different factors affecting each site and suggests appropriate means of managing the issues. In some cases a revision to the current waterways specification depth is proposed.

Particular attention is made to the River Ant at Irstead where committee members and boat users have expressed most concern.

Consideration has also been made to the appropriateness of the current waterways specification depth for Hickling Broad outside the marked channel. This follows recent core samples identifying the level of the natural substrate. In this case no revisions are proposed.

1 Introduction

1.1 The Broads Authority's Sediment Management Strategy (2007) outlines the generic ideal navigation envelope for the Broads. This includes a waterway specification depth developed through consultation with key users. The generic navigation envelope is shown below.

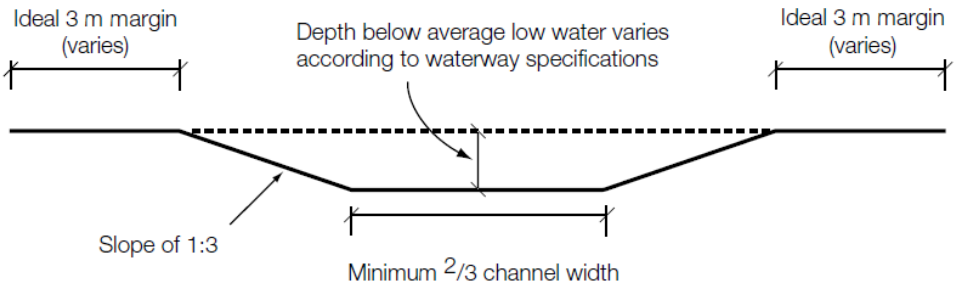

Figure 1: Ideal navigation envelope

1.2 It is important to maintain a margin where river width allows, ensuring that banks are not undercut and allow for reeded edges to develop, proving a

good buffer against erosion. However, the full depth specification should be achieved for a minimum of two thirds of the river width.

1.3 For all navigation areas, the navigation envelope is compared to the actual surveyed bed profile to map compliance and calculate dredge volumes. This information along with other considerations of the prioritisation matrix (i.e. level of boat use, disposal suitability etc.) is then used to develop a targeted dredging programme each year.

1.4 This approach works well for the vast majority of navigation areas, where non-compliant areas of the bed have accumulated sediments. The Broads Authority's dredging equipment is well suited to this and maintenance dredging of this nature is consistent with the principles of the Authority's Sediment Management Strategy.

1.5 Removal of the natural bed constitutes capital dredging which is not promoted by the Strategy and cannot be managed within standard regulatory permits or within standard exemptions.

1.6 There is however some localised areas where the bed has not previously been dredged to the waterways specification depth and natural bed material is within the ideal navigation envelope. These areas include the River Ant at Irstead Shoals, the River Chet at Pyes Mill and the River Bure upstream of Coltishall Common.

1.7 These areas have not historically been dredged deeper as the natural bed consists of harder material such as sand and gravel.

1.8 Members were alerted to this issue at the meeting in June 2015, and asked for further details to help in the consideration. This report sets out the issues and baseline data for each site and recommends proportionate measures balancing the scale of the issue with the practicalities and costs.

2 River Ant, Irstead Shoals

2.1 Current Waterways Specification & Mean Low Water

2.1.1 The current waterways specification depth for the River Ant at Irstead is 1.8m below mean low water. The ideal navigation envelope as outlined in the Sediment Management Strategy is shown below.

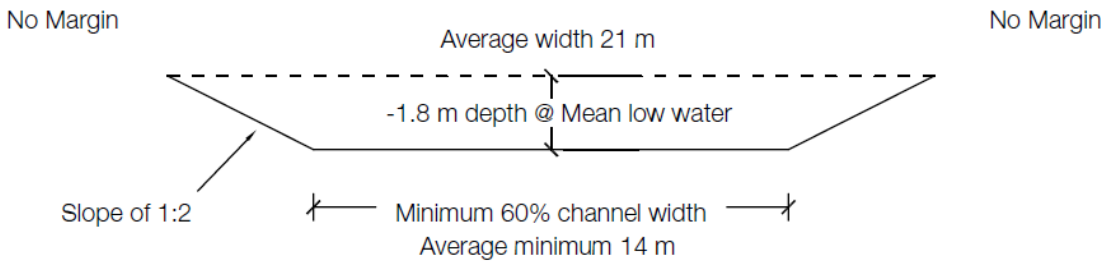

Figure 2: Downstream of Barton Broad to Ant Mouth

2.1.2 This depth is relative to an assumed 'mean low water' which for the River Ant at Irstead is 0.26mOD (relative to ordnance datum Newlyn). This figure has been checked against Environment Agency water level data from Barton Broad (2006 to 2011) and recent Broads Authority monitoring at Irstead Billet (July 2015 to date).

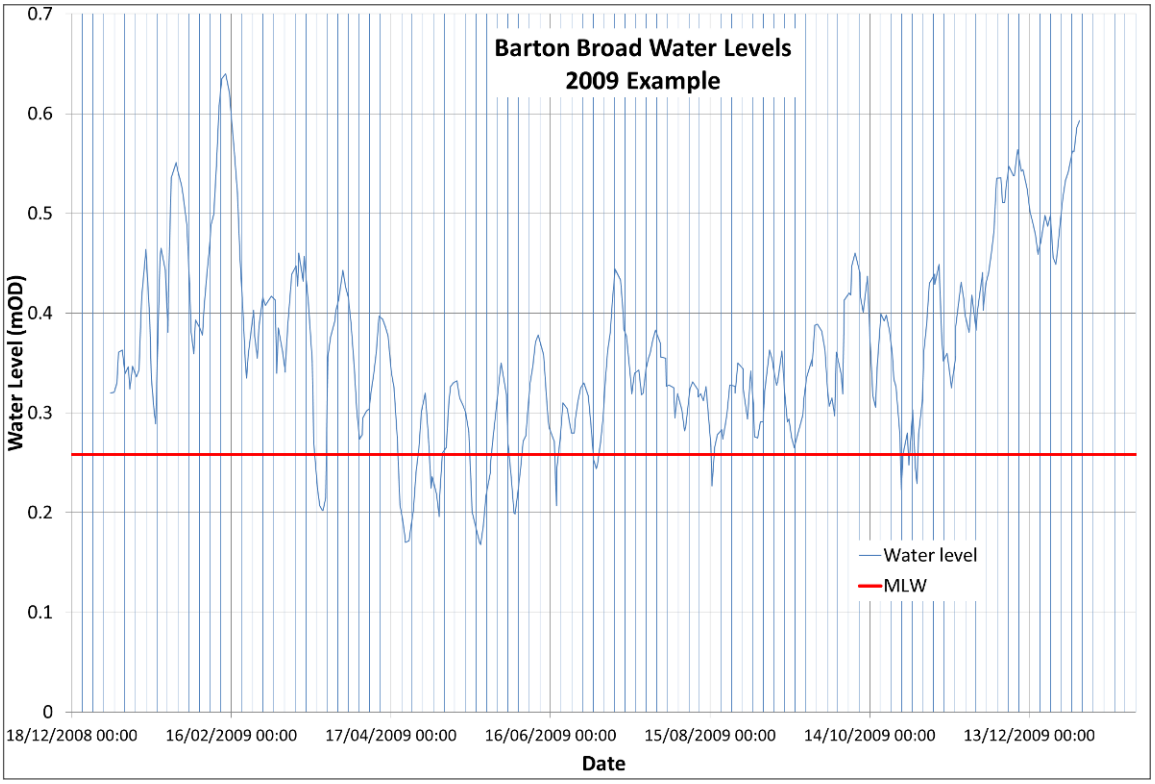

Figure 3: Water level during 2009 (typical example year)

2.1.3 These data sets suggest a water level of 0.26mOD lies approximately on the 10th percentile of water levels experienced at Irstead (i.e. 90 percent of the time the water level at Irstead is higher than 0.26mOD). Therefore this assumed mean low water value is a reasonable representation of typical low water and a reasonable reference level for measuring water depth.

2.1.4 It must however be noted that water levels at Irstead are influenced more significantly by climatic conditions than tide. Therefore periods of low or high water can typically last for period of several days rather than a few hours as experienced in more tidal reaches.

2.2 Compliance and Scale of the Issue

2.2.1 Between the most upstream and downstream property at Irstead Shoals the river bed is almost 100 percent non-compliant with the waterways specification depth of 1.8m below mean low water (MLW).

2.2.2 With reference to recent survey data and manually checked cross sections, the bed level through Irstead Shoals is fairly uniform and almost entirely between 1.3m and 1.8m below MLW. The worst area being just upstream of

the staithe where the river is narrowest (16m wide) and the bed level is consistently between 1.3m and 1.5m below MLW.

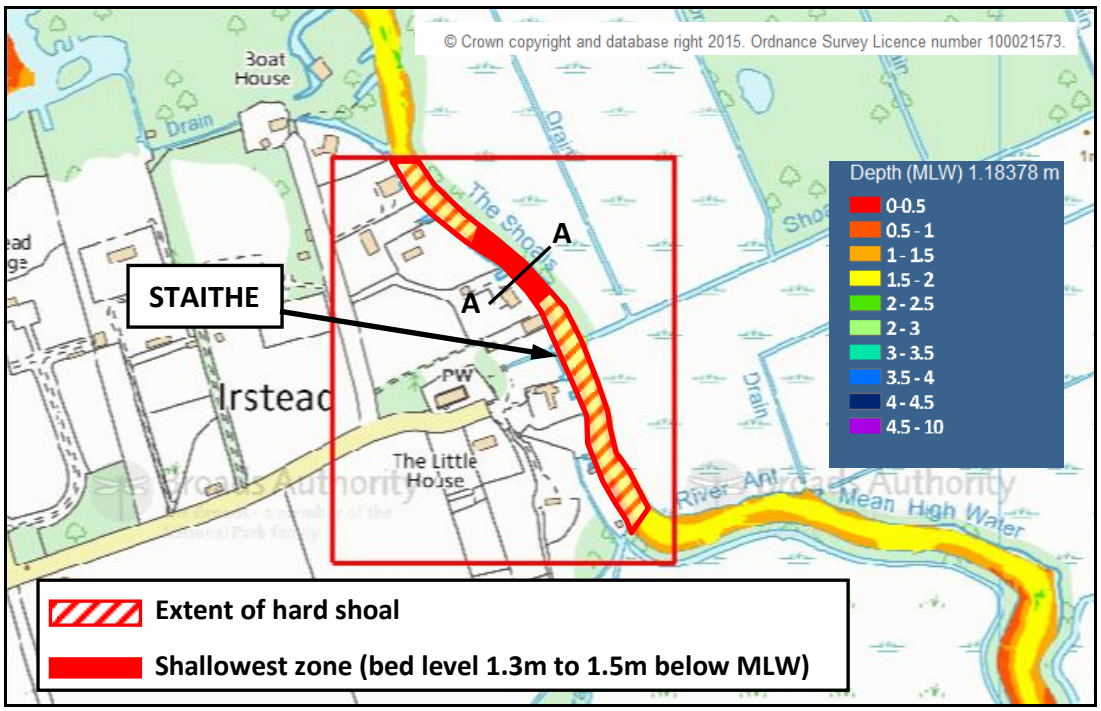

Figure 4: Irstead Shoals extent

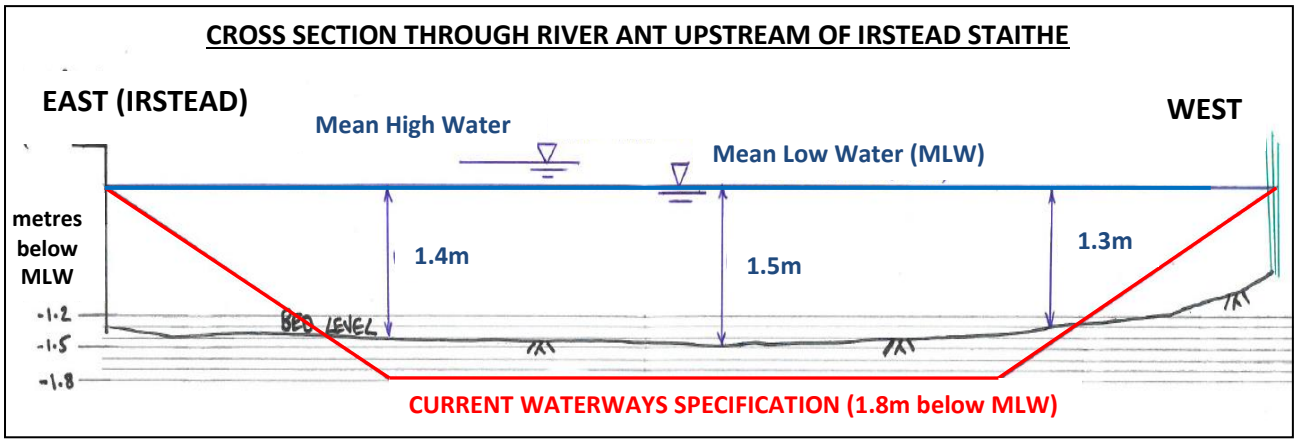

Figure 5: Cross section A-A (shallowest cross section)

2.2.3 Samples of the bed material were taken at several cross sections though the river at Irstead. The core samples recovered dense sand and gravel underlying a thin layer of organic matter and zebra mussel shells throughout the Shoals. In some localised areas particularly near the staithe pure fine sand was also found. This hard granular bed material appeared to dip under peat to the east of the river and became increasingly clayey and deeper upstream of the Shoals with an increasing thickness of accumulated silt on top.

2.2.4 The sand and gravel deposits recovered in the samples are consistent with the extent of the natural crag formation deposits (sand and gravel) mapped by

the British Geological Survey. This material has clearly provided a good site for the establishment of as village, but it is also a reason why the river has not previously been dredged deeper and remains shallow as the name 'Irstead Shoals' suggests.

2.3 **Officer View**

2.3.1 The navigation reach through Irstead Shoals is a busy section used by all types of broads vessels subject to maximum dimension bylaws.

2.3.2 Ideally dredging work through the Shoals could be undertaken to achieve the waterways specification depth within the ideal navigation envelope. Options for dredging have been considered including a central deeper channel.

2.3.3 Removing sand and gravel material at Irstead Shoals would be a capital dredging activity. Although such deepening is permitted under the Broads Act, this does not absolve the Broads Authority from requiring other permits and permissions relating to capital dredging which would be time consuming in preparation and costly.

2.3.4 Much of the Irstead bank is retained by timber piling which is unlikely to penetrate far into the hard bed. Dredging in the river channel could present undermining issues, which was reported by a local resident to have been a problem during a dredging attempt in the 1950's.

2.3.5 The Broads Authority plant and equipment is set up for mechanical dredging which is suited to accumulated silts and cohesive material. Our newer excavators with the right choice of bucket are capable of dredging sand and gravel; however production (rate of removal) would be severely reduced multiplying the cost of a typical dredging operation and locating a deposition location is always a major issue.

2.3.6 For the reasons outlined above dredging to deepen Irstead Shoals is not recommended. However there is scope to greatly improve information provided to waterways users to provide a better understanding of depths and real time assessment of water levels (and thus available depth).

2.3.7 Officers met with committee members Brian Wilkins and John Ash to discuss the approach to assessing water levels, dredge depths and site specific concerns. Dredging solutions were discussed including a deeper central channel; however it was agreed that improving local signage and published hydrographic information would be an appropriate approach. It is therefore proposed that:

(i) The published hydrographic chart for Irstead is improved to show more precise depth contours.
(ii) Consideration is given to providing simple water depth board, installed alongside the Ludham Bridge gauge board and similarly at Barton Broad to indicate available water depth through the Shoals. These

depth gauge boards will however need to be clear and distinct from the bridge gauge boards, in order to avoid confusion particularly for hirers.

(iii) The waterways specification depth through Irstead Shoals is revised to 1.5m below mean low water to better reflect the level of the natural bed and calculate required dredge volumes. This reflects the 5ft central depth as published by Hamilton's in 1978.

(iv) Any areas of the bed remaining within the revised navigation envelope (shallower than 1.5m below MLW) are to be targeted in subsequent dredging work in the area with due consideration made to any adjacent piling.

3 River Chet, Pyes Mill

3.1 Current Waterways Specification & Mean Low Water

3.1.1 The current waterways specification depth for the River Chet is 1.5m below mean low water. The ideal navigation envelope as outlined in the Sediment Management Strategy is shown below.

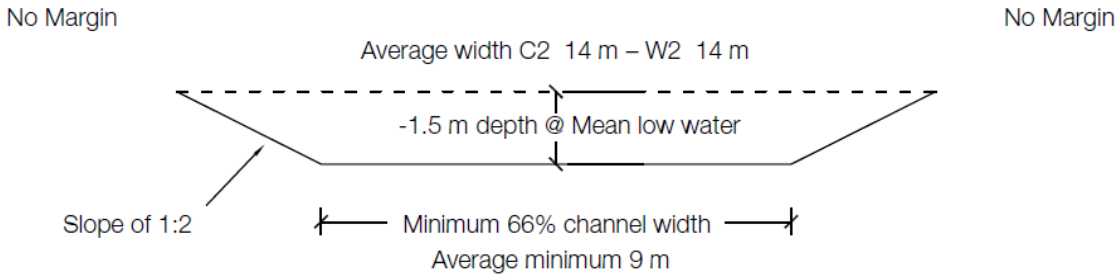

Figure 6: Loddon to River Yare

3.1.2 This depth is relative to an assumed 'mean low water' which for the River Chet at Pyes Mill is -0.08mOD. Data from Environment Agency water level monitoring at Reedham and Cantley (closest monitoring sites) has been checked however low water readings from these monitors appeared onerous (little variation in low water readings). Recent dredging work on the Chet using temporary gauge boards has provided good confidence that -0.08mOD does represent a good low water on the Chet and is not often exceeded.

3.1.3 It must however be noted that water levels on the River Chet are influenced predominantly by tide. Therefore periods of low water typically last for just a few hours.

3.2 Compliance and Scale of the Issue

3.2.1 Depth compliance in the River Chet is an ongoing issue. It is a small tidal river with effectively a dead end at Loddon and inputs from arable land directly upstream. This results in a significant siltation rate and therefore a regular dredging requirement.

3.2.2 The vast majority of the River Chet has been dug into soft ground to a level compliant with the waterways specification. Although the siltation rate is an

issue it can be dredged to the required depth. The exception is mainly localised to the Pyes Mill area where hard bed material has presented a problem to dredging.

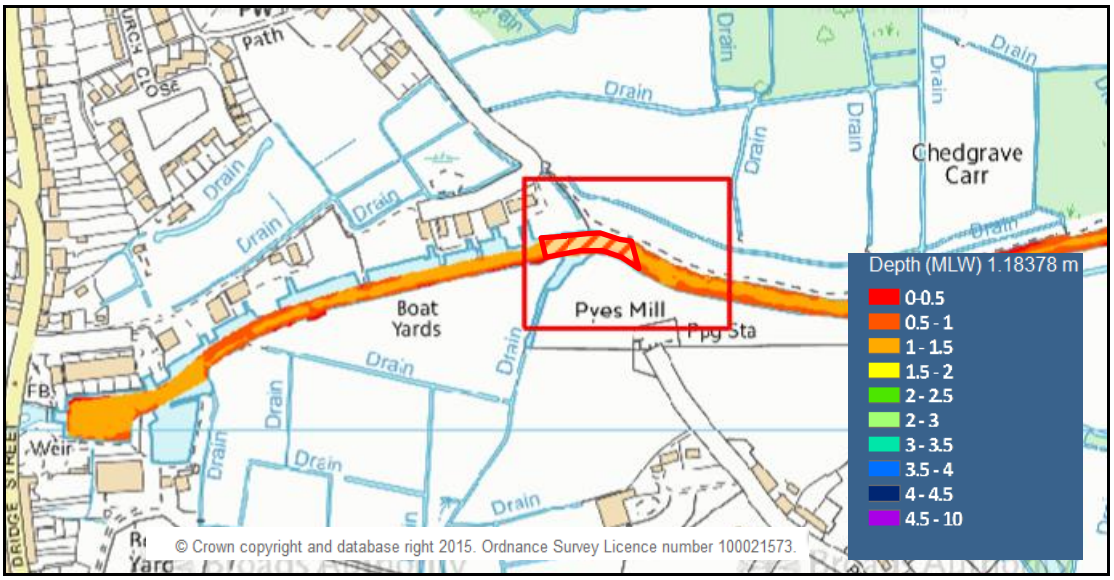

Figure 7: Pyes Mill, extent of hard bed

3.2.3 Samples of the bed material were taken at and close to Pyes Mill. The core samples recovered dense sand and gravel underlying a layer of sandy silt on a cross section between Pits Lane and Pyes Mill Road. The level of the natural sand and gravel bed was typically at or slightly above the waterways specification depth of 1.5m below MLW.

3.3 Officer View

3.3.1 The navigation along the Chet to Loddon Basin and local boatyards is well used and maintaining the navigation channel is important.

3.3.2 At Pyes Mill the natural hard bed is close to the waterways specification depth. The issue with compliance is primarily related to accumulated sediment and the high siltation rate. The hard bed at this location does however present an unforgiving bed for deeper draught vessels at low or very low water.

3.3.3 Due to the significant tidal range of the River Chet, depth issues at Pyes Mill are relatively short lived and awaiting the tide at Chedgrave Common or Pyes Mill moorings is an option.

3.3.4 Given these considerations, work to further dredge the hard material is not proposed nor is a revision to the waterways specification depth. The recommendation of this report is to improve information on the hydrographic charts and guidance notes on the Authority's public website.

4 River Bure, Coltishall

4.1 Current Waterways Specification & Mean Low Water

4.1.1 The current waterways specification depth for the River Bure at Coltishall is 1.5m below mean low water. The ideal navigation envelope as outlined in the Sediment Management Strategy is shown below.

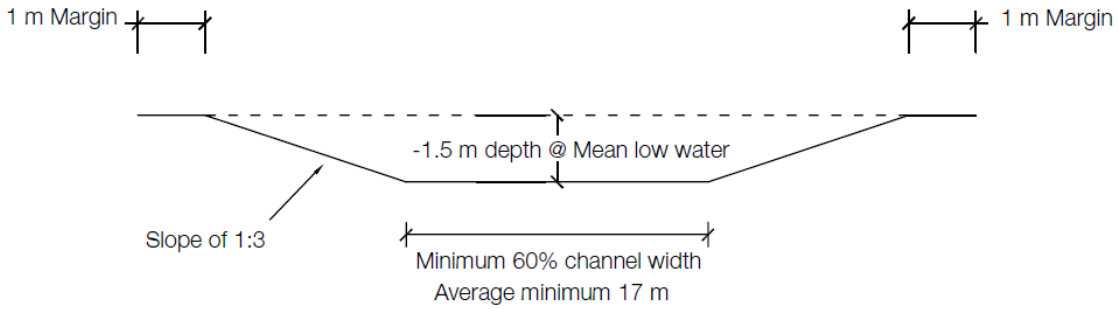

Figure 8: Horstead to Wroxham

4.1.2 This depth is relative to an assumed 'mean low water' which for the River Bure at Coltishall is 0.34mOD. Data from Essex and Suffolk Water's water level monitoring at the Belaugh intake (closest monitoring site) has been checked and a graph of this data is shown below.

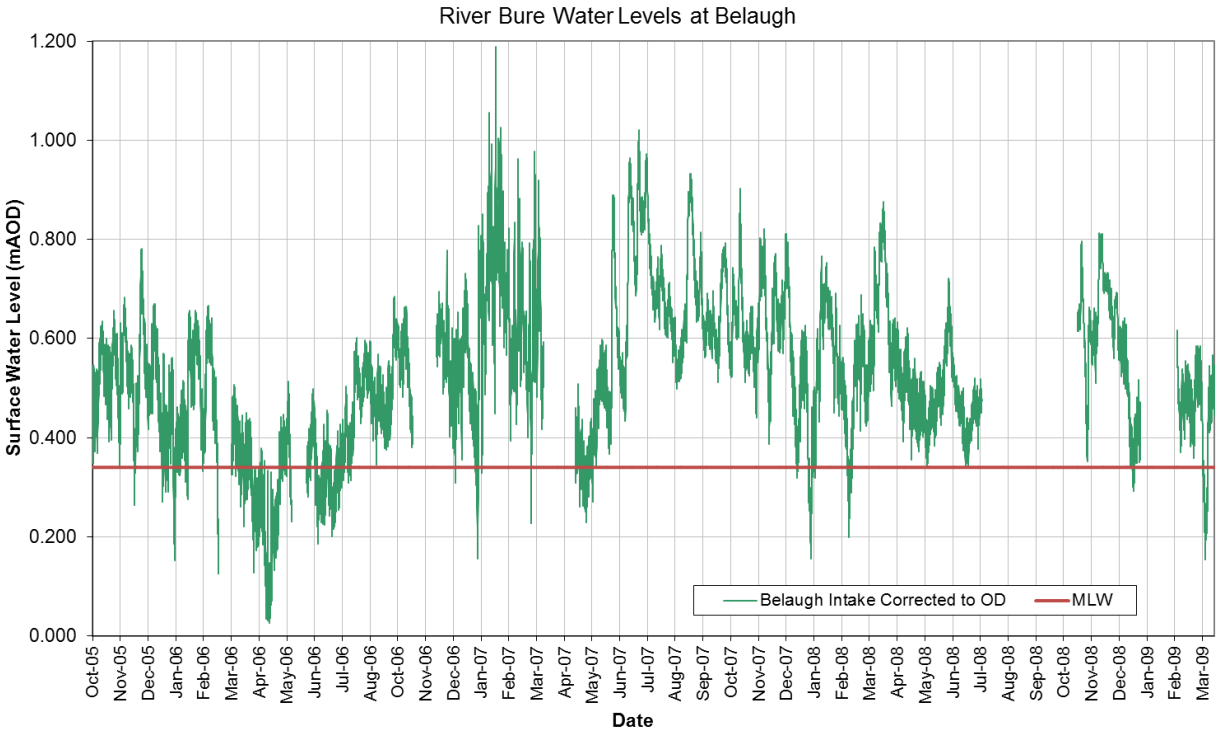

Figure 9: Water level monitoring at Belaugh

4.1.3 This data sets suggest a water level of 0.34mOD lies approximately on the 10th percentile of water levels experienced at Coltishall. Therefore this

assumed mean low water value is a reasonable representation of typical low water and a reasonable reference level for measuring water depth.

4.1.4 It must however be noted that, like the Ant at Irstead, water levels at Coltishall are influenced more significantly by climatic conditions than tide. Therefore periods of low or high water can typically last for period of several days rather than a few hours as experienced in more tidal reaches.

4.2 Compliance and Scale of the Issue

4.2.1 Most of the upper reaches of the River Bure navigation are situated on natural sand and gravel deposits. Therefore the bed of the river is typically sand and gravel with accumulations of silt above.

4.2.2 The road bridge at Wroxham limits the size of vessel on the upper Bure and therefore although the river is shallow in a number of places, reports of groundings and other depth issues are not common.

4.2.3 The focus of this report with regard to the Bure is the canal section between The Mead at Coltishall (where the river forks) and the head of navigation at the lock.

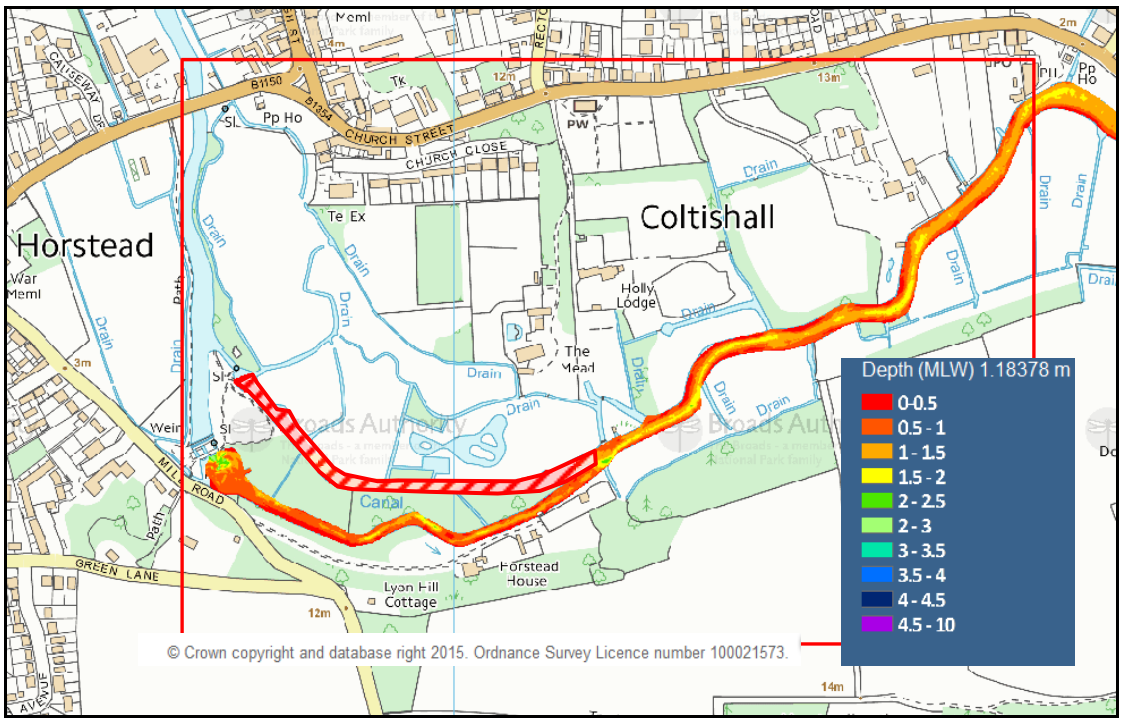

Figure 10: Coltishall Lock canal

4.2.4 Recent dredging work in this narrow section improved depths by the removal of organic matter and silt, but compliance with the waterways specification depth was not possible due to the presence of sand and gravel at a depth of approximately 1.2m below MLW.

4.3 **Officer View**

4.3.1 The navigation along the canal section between the lock and The Mead is not a busy part of the waterway and generally visited by smaller vessels.

4.3.2 Due to the difficult access, limited width and trees, mobilising large dredging equipment to deal with the hard bed is not a feasible option or considered best value. Smaller equipment as recently used could not effectively dredge the harder material.

4.3.4 Given these considerations it is recommended that the waterways specification depth for this section is revised to 1.2m below mean low water and that information on the hydrographic charts and guidance notes is updated make this clear to users. This is consistent with the information contained in Hamilton's Guide published 1978.

5 Hickling Broad, outside the channel

5.1 The current Waterways Specification depth for Hickling Broad is 1.5 m within the marked channel and 1.3 m outside the marked channel. This is documented in the Sediment Management Strategy Action Plan 2010/11 in "Appendix 3 Sediment Removal Tables", which includes a full list of Waterway Specification depths and dredge volumes.

5.2 From the latest hydrographic survey in Hickling Broad the dredge volume required to meet the 1.3 m specification in the areas outside the marked channel is 267,300 m^3.

5.3 In 2015 an extensive sediment coring exercise was conducted by Broads Authority Environment Officers, across the whole of Hickling Broad, to determine the nature of the underlying substrate and record depths of accumulated lake sediments. In total 67 sediment cores were collected and the depths of each layer of different lake sediment type and natural underlying substrate was recorded. The base of the cores was composed of either peat or marine clay. Above that, various layers of lake sediment showed the development of the lake from an early wetland habitat post peat-extraction, through clear water conditions dominated by submerged water plants, to modern eutrophic conditions with higher accumulation of organic matter.

5.4 The survey shows that across all but a very few naturally deeper patches in the centre of the Broad, the natural substrate is at or about 1.3 m beneath mean low water level. Figure 11 shows mapped depths of the natural substrate, with contours calculated between points of similar depth. Caution must be used in interpreting natural substrate depths towards the edge of the broad, as the mapping software was forced to assume a zero depth at the water's edge.

5.5 The survey supports and corroborates the current Waterway Specification of 1.3 m outside the marked channel. Hickling Broad is one of the more

shallowly dug broads, and has not developed the relatively deep accumulations of lake sediment; such is in the Bure broads.

5.6 The survey in Hickling Broad has helped identify where accumulated sediment is deepest and confirmed the lowest depths to which maintenance dredging can be carried out.

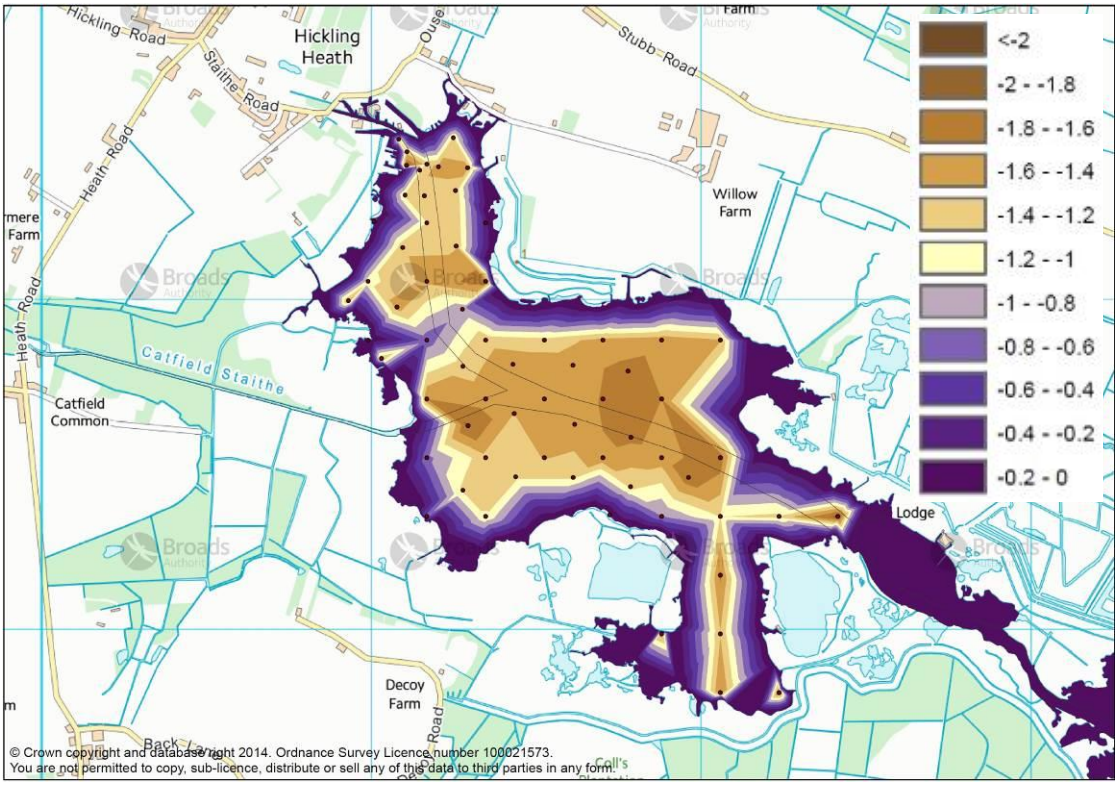

Figure 11: Map of the natural substrate depth below mean low water in Hickling Broad. Scale in metres.

6 Conclusions

6.1 The Sediment Management Strategy promotes well managed maintenance dredging. This is well suited and achievable for the vast majority of the Broads navigation areas where the ideal navigation envelope and waterways specification depth is within the profile of the natural bed. There are however some localised areas where compliance with the waterways specification depth is an issue due to a natural and shallow bed of sand and gravel. Removal of such material has significant cost and operation implications as well as additional regulation.

6.2 Officers have considered each location where this has been raised as a concern. Revision to waterways specification depths are proposed where appropriate and it is suggested that local signage and published information can be improved to provide more precise information to users. They are summarised in the following table.

River Ant at Irstead	a) Revise the waterways specification depth to 1.5m below mean low water b) Improve guidance notes and level of detail shown on hydrographic chart on Broads Authority website to identify affected area c) Consider installation of depth gauge boards at Ludham Bridge and Barton Broad indicating water depth though Irstead
River Chet at Pyes Mill	a) No revision to waterways specification depth b) Improve guidance notes and indicate hard bed area on hydrographic chart on Broads Authority website
River Bure at Coltishall (canal section leading to the lock)	a) Revise the waterways specification depth to 1.2m below mean low water b) Update guidance notes on Broads Authority website
Hickling Broad, outside marked channel	a) No revisions to waterways specification depths required

6.3 With reference to the Hamilton's Guide it is interesting to note that recommended revised specifications are consistent with information provided in the 1970's when boating was at its height.

6.4 Looking forward, the Authority is the sponsor for a PhD studentship at the UEA which will include research into flood modelling for the Broads and saline incursion taking into account climate change. This work will be undertaken over the next five years and could present a good opportunity to consider scientifically the implications of any increase in water levels from isostatic change and potential sea level rise from climate change.

6.5 Members comments and views are welcomed.

Background papers: Sediment Management Strategy 2007, Broads Authority
http://www.broads-authority.gov.uk/looking-after/managing-land-and-water/Dredging/sediment-management-strategy

Sediment Management Strategy Action Plan 2010/11
http://www.broads-authority.gov.uk/__data/assets/pdf_file/0003/419241/SMS_Action_Plan_2010-11_May_2010_Final.pdf

Navigation Committee Report: Construction, Maintenance and Environment Work Programme, 6 June 2015

Author: Tom Hunter, Dan Hoare
Date of report: 23 November 2015

Broads Plan Objectives: NA1.1

Appendices: None